LONGHORN ARMY AMMUNITION PLANT

KARNACK, TEXAS

ADMINISTRATIVE RECORD

VOLUME 2 of 4

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Volume 1 - General
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LHAAP-11 Suspected TNT Burial Site At Avenues P & Q
LHAAP-12 Active Landfill
LHAAP-13 Suspected TNT Burial Site Between Old & Active Landfills
LHAAP-14 Area 54 Burial Ground
LHAAP-16 Old Landfill
LHAAP-17 Burning Ground No. 2 / Flashing Area
LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Evaporation Pond
LHAAP-27 South Test Area
LHAAP-29 Former TNT Production Area
LHAAP-32 Former TNT Disposal Plant
LHAAP-54 or LHAAP-XX Ground Signal Test Area
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LONGHORN ARMY AMMUNITION PLANT

RI/FS

WORK PLAN

VOLUME 1
GENERAL

PREPARED FOR:
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

PREPARED BY:
U.S. ARMY CORPS OF ENGINEERS

JUNE 1992

EXECUTIVE SUMMARY

This Remedial Investigation/ Feasibility Study (RI/FS) Work Plan describes the remedial activities necessary to conduct an RI and FS for Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas. The RI/FS will be conducted using guidelines for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). There are 13 areas on LHAAP that are identified in the CERCLA Section 120 Agreement, referred to the Federal Facility Agreement (FFA), as requiring an RI/FS. This work plan addresses the activities required to perform an RI/FS at those 13 areas.

LHAAP has been issued a Resource Conservation and Recovery Act (RCRA) Part B permit by the Texas Water Commission. The permit became effective in February 1992. It requires corrective action at eight solid waste management units (SWMUs) on LHAAP. The eight SWMUs identified in the RCRA permit are included in the thirteen areas being addressed in this work plan. Table ES-1 lists the areas included in this RI/FS. The remedial activities carried out under this CERCLA action are intended to satisfy the requirements for corrective action under RCRA.

LHAAP is a government-owned, contractor-operated (GOCO) industrial facility under the jurisdiction of the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM). The facility was established in 1942 to produce 2,4,6-trinitrotoluene (TNT). Production of TNT stopped in August 1945 with the ending of World War II. Currently, its primary mission is to load, assemble, and packout pyrotechnic, illuminating, and signal ammunition and solid propellant rocket motors. The Longhorn Division of Thiokol Corporation is the operating contractor. The installation has also been responsible for the static firing and elimination of Pershing I and II rockets motors in compliance with the Intermediate Nuclear Force (INF) Treaty in

effect between the United States and the former U.S.S.R..

TABLE ES-1
Areas for Remedial Activities at LHAAP

	LHAAP No.	Area Name
*	11 (base)	Suspected TNT Burial Site at Avenues P and Q
*	13 "	Suspected TNT Burial Site Between Old and Active Landfills/Acid Dump
*	14 "	Area 54 Burial Ground
*	16	Old Landfill
*	17	Burning Ground No. 2/ Flashing Area
*	18 & 24	Burning Ground No. 3 and Unlined Evaporation Pond/ Rocket Motor Washout Lagoon
*	29	Former TNT Production Area
	12	Active Landfill
	32	Former TNT Disposal Plant
	1 (base)	Inert Burning Grounds
	XX "	Ground Signal Test Area
	27 "	South Test Area

Note: An "*" denotes a SWMU listed in the RCRA Permit as requiring corrective action.

The CERCLA remedial activities for LHAAP have been divided into 18 tasks. The tasks describe activities from the initial project planning to remedial action. This RI/FS Work Plan is part of Task 1 - Project Planning. A listing of the tasks is provided in Volume I, Section 1.0 - Introduction.

TABLE ES-2
Tasks and Required Documents for Remedial Activities

TASK 1 - Project Planning	
Submittal:	-Schedule of Remedial Activities.
Primary Document:	-RI/FS Work Plans.
Secondary Document:	-Initial Remedial Action/DQOs.
TASK 2 - Community Relations	
Primary Document:	-Community Relations Plan.

TASK 3 - Field Investigations

TASK 4 - Sample Analysis and Data Validation
Secondary Document: -Sampling and Data Results.

TASK 5 - Data Evaluation and Site Characterization
Secondary Document: -Site Characterization Summary.

TASK 6 - Remedial Investigation Report
Primary Document: -Remedial Investigation Report.

TASK 7 - Risk Assessment
Primary Document: -Risk Assessment.

TASK 8 - Initial Screening of Alternatives
Primary Document: -Initial Screening of Alternatives.

TASK 9 - Treatability Study
Secondary Document: -Post-Screening Investigation Work Plan.
Secondary Document: -Treatability Study Report.

TASK 10 - Detailed Analysis of Alternatives
Secondary Document: -Detailed Analysis of Alternatives Discussion.

TASK 11 - Feasibility Study Report
Primary Document: -Feasibility Report.

TASK 12 - Proposed Plan
Primary Document: -Proposed Plan.

TASK 13 - Responsiveness Summary
Primary Document: -ROD Responsiveness Summary.

TASK 14 - Record of Decision
Primary Document: -Record of Decision.

TASK 15 - Remedial Design Planning
Submittal: -Target Dates for RD/RA.
Primary Document: -Remedial Design Work Plan.

TASK 16 - Remedial Design
Secondary Document: -30% Draft Remedial Design.
Secondary Document: -60% Draft Remedial Design.
Secondary Document: -90% Draft Remedial Design.
Primary Document: -Remedial Design.

TASK 17 - Remedial Action Planning
Primary Document: -Remedial Action Work Plan.

TASK 18 - Remedial Action.

The RI/FS Work Plan is divided into three volumes. Volume I is a general volume that contains information about the facility, a summary of previous investigations, proposed investigations for the RI, FS

activities, lists ARARs, and presents the schedule and an estimate of the budget. Volume II is the Chemical Data Acquisition Plan. It discusses data quality procedures and techniques to ensure that all data obtained is of acceptable quality. The Site Safety and Health Plan is Volume III. It establishes procedures to protect field personnel from potential safety and health hazards.

The proposed investigations presented in Volume I, Section 4.0 are intended to satisfy the data requirements for the RI, the risk assessment, and some of the data for the FS. Additional data needs for the FS will be identified in the Post Screening Investigation Work Plan. This is a secondary document that will be prepared after the Initial Screening of Alternatives. Also, additional data may be required during the RI phase if unexpected conditions are encountered.

LIST OF ACRONYMS/ABBREVIATIONS

ACD	Air Curtain Destructor
AE	Acid Extractable Organics
Ag	Silver
Al	Aluminum
AMCCOM	US Army Armament, Munitions and Chemical Command
ARARs	Applicable or Relevant and Appropriate Requirements
As	Arsenic
Ba	Barium
Be	Beryllium
BG	Background (Sample)
BH	Borehole
BHC	Benzene hexachloride
BN	Base-Neutral Extractable Organics
Cd	Cadmium
CDAP	Chemical Data Acquisition Plan
CDM	Camp, Dresser and McKee, Inc.
COD	Chemical Oxygen Demand
COE	US Army Corps of Engineers
Cr	Chromium
Cu	Copper
DARCOM	Defense Armament Command
DCA	Dichloroethane
DCE	Dichloroethene
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DNB	Dinitrobenzene
DNT	Dinitrotoluene
DQOs	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
EPS	Environmental Protection Systems, Inc.
Fe	Iron
GC/MS	Gas Chromatograph/Mass Spectrometer
GC/EC	Gas Chromatograph/Electron Capture
GOCO	Government-owned, Contractor-operated
gpm	Gallons per minute
GWQA	Ground-Water Quality Assessment
HEAST	Health Effects Assessment Summary Tables
HMX	Cyclotetramethylenetetranitramine
HTW	Hazardous and toxic waste
INF	Intermediate-Range Nuclear Forces
IRIS	Integrated Risk Information System
LAP	Load, assemble and pack
LHAAP	Longhorn Army Ammunition Plant
MCL	Maximum Contaminant Level
Mg	Magnesium
Mn	Manganese
msl	Mean sea level
MW	Monitoring Well
NA	Not analyzed
ND	Not detected
Ni	Nickel
NRHP	National Register of Historic Places
PARCC	Precision, Accuracy, Representativeness, Completeness and Comparability

LIST OF ACRONYMS/ABBREVIATIONS (cont)

Pb	Lead
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethylene
PEP	Propellants, explosives, and pyrotechnics
PII	Pershing II
PVC	Polyvinylchloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylenetetranitramine
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
Sb	Antimony
SD	Sediment
Se	Selenium
SED	Sediment
SHPO	State Historic Preservation Officer
Sr	Strontium
SS	Soil sample
SSHP	Site Safety and Health Plan
SVOCs	Semivolatile organic compounds
SW	Surface water
SWDA	Safe Water Drinking Act
SWMUs	Solid Waste Management Units
TAC	Texas Administrative Code
TCA	Trichloroethane
TCE	Trichloroethene, trichloroethylene
TDH	Texas Department of Health
Tl	Thallium
TNB	Trinitrobenzene
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total Organic Halides
TRPH	Total Recoverable Petroleum Hydrocarbons
TWC	Texas Water Commisssion
UEP	Unlined Evaporation Pond
USAEHA	US Army Environmental Hygiene Agency
USATHAMA	US Army Toxic and Hazardous Materials Agency
VOCs	Volatile organic compounds
VOL	Volatile organics
Zn	Zinc

LONGHORN ARMY AMMUNITION PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
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SECTION 1.0

INTRODUCTION

This work plan was prepared to fulfill the requirements for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/ Feasibility Study (RI/FS) Work Plan. This RI/FS Work Plan is a deliverable under the Federal Facility Agreement for Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas.

LHAAP was placed on the National Priority List (NPL) on August 9, 1990. After being listed on the NPL, LHAAP, the U S Environmental Protection Agency (EPA), and the Texas Water Commission (TWC) entered into a CERCLA Section 120 Agreement for remedial activities at LHAAP. The CERCLA Section 120 Agreement, referred to as the Federal Facility Agreement (FFA), became effective on December 30, 1991. The FFA specified that remedial activities would be conducted at 13 areas on LHAAP following CERCLA guidelines. A listing of the 13 areas is provided in Table 1-1. Their locations are shown on Figure 1-1. The FFA became effective on December 30, 1991. It requires an RI/FS Work Plan and an RI/FS to ensure that environmental impacts associated with past and present activities at the LHAAP are thoroughly investigated and an appropriate remedial action is selected to protect the public health, welfare, and the environment.

The remedial activities at LHAAP shall to address the corrective action requirements under the Resource Conservation and Recovery Act (RCRA). LHAAP was issued a RCRA Part B permit, permit no. HW-50135, in February 1992. The permit requires corrective action at eight solid waste management units (SWMUs), but specifies that corrective action can be accomplished with the CERCLA process. The areas listed as SWMUs in the Part B permit that require corrective action have an

asterisk in front of the LHAAP number in Table 1-1. The LHAAP number corresponds to the SWMU number for the area.

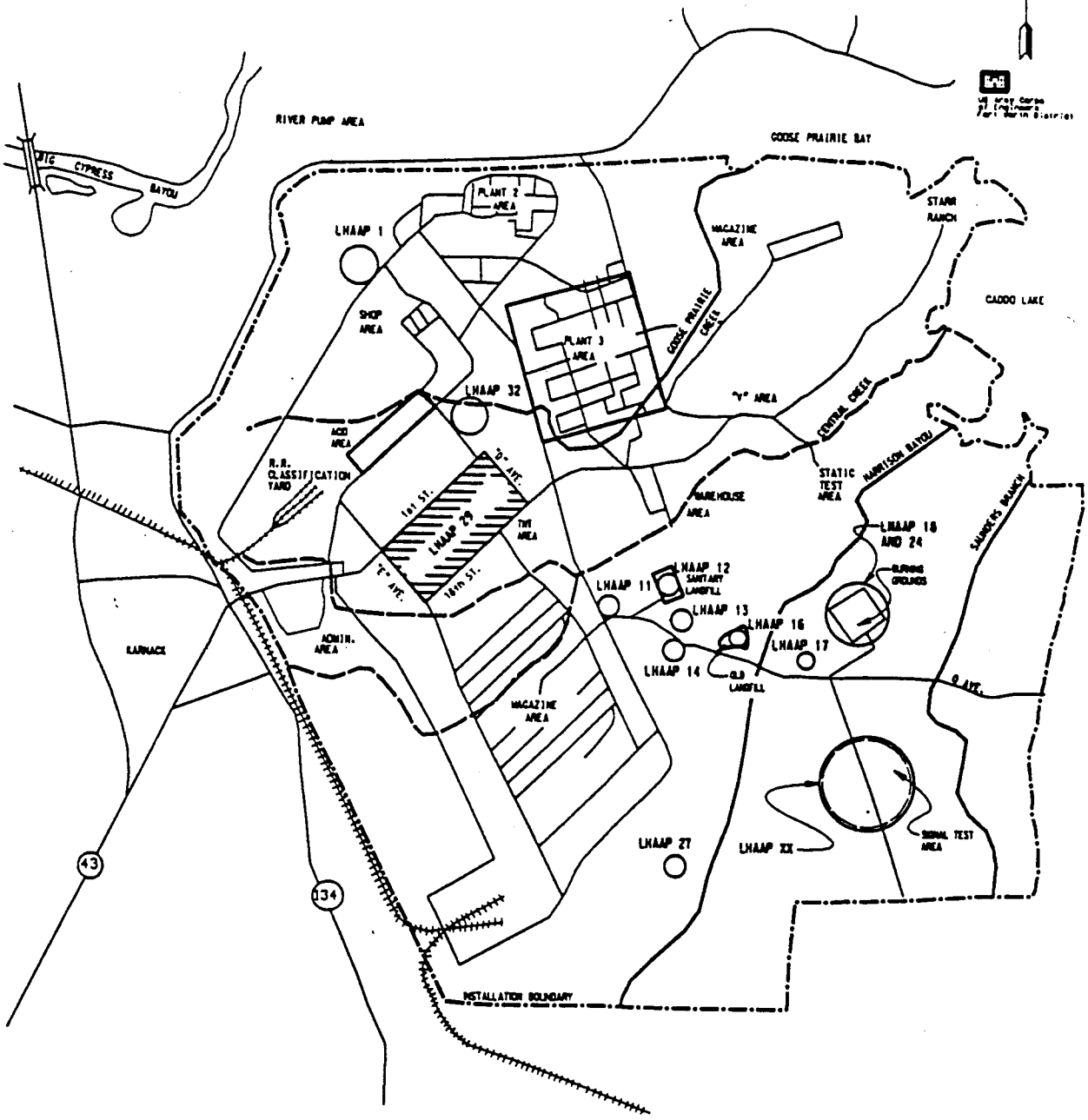
TABLE 1-1
Areas for Remedial Activities at LHAAP

LHAAP No.	Area Name
* 11	Suspected TNT Burial Site at Avenues P and Q
* 13	Suspected TNT Burial Site Between Old and Active Landfills/Acid Dump
* 14	Area 54 Burial Ground
* 16	Old Landfill
* 17	Burning Ground No. 2/ Flashing Area
* 18 & 24	Burning Ground No. 3 and Unlined Evaporation Pond/ Rocket Motor Washout Lagoon
* 29	Former TNT Production Area
12	Active Landfill
32	Former TNT Disposal Plant
1	Inert Burning Grounds
XX	Ground Signal Test Area
27	South Test Area

Note: An "*" denotes a SWMU listed in the RCRA Permit as requiring corrective action.

1.1 Objective of the RI/FS. The objective of this RI/FS is to characterize the nature and extent of contamination at the areas identified and develop a remedy for remediation of each area. The conclusion of the RI/FS will be the selection of a remedy for remediation of each area. The decision for selection of the remedy will be based on the nine evaluation criteria specified in CERCLA.

1.2 Remedial Activities Tasks. The LHAAP remedial activities have been broken into eighteen tasks. The tasks are listed in Table 1-2. Table 1-2 also lists the documents required for each task, as



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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RI/FS WORK PLAN

LOCATION MAP FOR PROJECT AREAS

DATE: JUNE 1992 | FIGURE 1-1

specified in the FFA, and lists whether they are primary or secondary documents.

TABLE 1-2
Tasks and Required Documents for Remedial Activities

TASK 1 - Project Planning
Submittal: -Schedule of Remedial Activities.
Primary Document: -RI/FS Work Plans.
Secondary Document: -Initial Remedial Action/DQOs.

TASK 2 - Community Relations
Primary Document: -Community Relations Plan.

TASK 3 - Field Investigations

TASK 4 - Sample Analysis and Data Validation
Secondary Document: -Sampling and Data Results.

TASK 5 - Data Evaluation and Site Characterization
Secondary Document: -Site Characterization Summary.

TASK 6 - Remedial Investigation Report
Primary Document: -Remedial Investigation Report.

TASK 7 - Risk Assessment
Primary Document: -Risk Assessment.

TASK 8 - Initial Screening of Alternatives
Primary Document: -Initial Screening of Alternatives.

TASK 9 - Treatability Study
Secondary Document: -Post-Screening Investigation Work Plan.
Secondary Document: -Treatability Study Report.

TASK 10 - Detailed Analysis of Alternatives
Secondary Document: -Detailed Analysis of Alternatives Discussion.

TASK 11 - Feasibility Study Report
Primary Document: -Feasibility Report.

TASK 12 - Proposed Plan
Primary Document: -Proposed Plan.

TASK 13 - Responsiveness Summary
Primary Document: -ROD Responsiveness Summary.

TASK 14 - Record of Decision
Primary Document: -Record of Decision.

TASK 15 - Remedial Design Planning
Submittal: -Target Dates for RD/RA.

Primary Document: -Remedial Design Work Plan.

TABLE 1-2 (Continued)

Tasks and Required Documents for Remedial Activities

TASK 16 - Remedial Design
Secondary Document: -30% Draft Remedial Design.
Secondary Document: -60% Draft Remedial Design.
Secondary Document: -90% Draft Remedial Design.
Primary Document: -Remedial Design.

TASK 17 - Remedial Action Planning
Primary Document: -Remedial Action Work Plan.

TASK 18 - Remedial Action.

NOTE: Task 1 - Schedule of Remedial Activites and Initial Remedial Action/DQOs are complete. Task 1 - RI/FS Work Plan and Task 2 - Community Relations Plan are underway.

1.3 RI/FS Work Plan Organization. The RI/FS Work Plan consists of three volumes. Volume I is the main part of the work plan. It describes general information about the facility, previous investigations, and the proposed plan for the RI/FS, Volume II is the Chemical Data Acquisition Plan (CDAP), and Volume III is the Site Safety and Health Plan (SSHP).

1.3.1 Volume I - General. Volume I of the RI/FS Work Plan is the main part of the work plan. It is divided into 8 sections. Section 1.0 is the introduction. It describes the sites to be investigated, the remedial activities tasks, and the organization of Volumes 1, 2, and 3 of the RI/FS Work Plan. Section 2.0 provides general information about the facility. It describes the facility location, background, and other facility and area features.

Section 3.0 gives site specific information about each area. The section is divided into 12 subsections, one for each area requiring investigation. LHAAP 18 and LHAAP 24 will be investigated as one area. A detailed site description is provided for each site. A discussion of previous investigations and a summary of the results is

provided. The potential contaminants, migration pathways, and receptors of contaminants are also provided in the section. Initial remedial actions for each site are also discussed in Section 3.0.

Section 4.0 presents the data requirements needed for site characterization and the plan of investigations for each site. The section is divided into 12 subsections, one for each area requiring investigation. The number of samples, type of samples (soil, ground water, sediment, or surface water), and parameters to be tested are presented. The field procedures for obtaining the samples and lab procedures for analysis are described in Volume II of the work plan, the CDAP.

FS activities are described in Section 5.0. The section includes discussion on the development and initial screening of alternatives, the detailed analysis of alternatives, and the final feasibility study report.

Section 6.0 describes the plan for development of a risk assessment for each site and installation wide. The data needs for the risk assessment are identified. The plan of investigations presented in Section 4.0 describes the activities to obtain the required data for the risk assessment. Section 7.0 describes the Applicable or Relevant and Appropriate Requirements (ARARs) and provides a list of ARARs for the RI/FS.

Section 8.0 of the work plan discusses the budget and schedule information for the RI/FS tasks. Changes to the schedule will be made each time a review period or submittal date is extended. The schedule will be revised when operable units are identified. When individual operable units are identified, a scheduled will be developed for remediation of each operable unit.

1.3.2 **Volume II - Chemical Data Acquisition Plan**. Volume II of the RI/FS Work Plans is the Chemical Data Acquisition Plan. The CDAP discusses the data quality procedures and techniques to be used to ensure that all data obtained from the investigations are of acceptable quality. Section 1.0 gives the purpose of the CDAP and describes the organization of the document. Section 2.0 discusses project organization and the personnel involved in the project. Section 3.0 discusses the quality assurance objectives and evaluation procedures for this project. Section 4.0 contains a description of the field operations including drilling, well installation, field measurements, and sampling. The required handling and testing procedures for each type of sample are discussed in Section 5.0. Sections 6.0 through 9.0 discuss sample integrity, data reduction and validation, audits, and corrective action for improper procedures.

1.3.3 **Site Safety and Health Plan**. Volume III of the RI/FS Work Plans is the Site Safety and Health Plan. The SSHP establishes procedures to protect field personnel from potential safety and health hazards on this project. Section 1.0 gives the purpose of this document and all emergency personnel. Section 2.0 includes a brief summary of the project location, history, and A description of the thirteen sites. Section 3.0 list the planned investigation activities at each site. Section 4.0 discusses the training requirements for all field personnel. Site work zones and emergency communication equipment are discussed in Section 5.0. Section 6.0 contains an assessment of any hazards which may be present during the field investigations. Monitoring procedures and action levels to prevent exposure to any hazards are discussed in Section 7.0. Section 8.0 addresses the requirements for personal protective equipment for field

personnel. Decontamination procedures and SSHP approval are contained in Section 9.0 and 10.0, respectively. Each contractor conducting fieldwork will develop a Site Safety and Health Plan in accordance with Volume III of the RI/FS Work Plan.

1.4 Program Management. Remedial activities at LHAAP will be performed by the U.S. Army with review and direction from the EPA Region VI and the TWC. The Army will use the Corps of Engineers (COE) and the COE's contractors to perform the remedial activities at LHAAP. The COE will conduct operations under the direction of the Army's Project Manager for LHAAP, Mr. Lynn Muckelrath, Longhorn Army Ammunition Plant, ATTN: SMCLO-EV; Marshall, Texas 75671-1059.

Work done by contractors for the COE will be reviewed and revised before submittal to the EPA and the TWC. Tulsa District COE will be responsible for execution of all work by the COE. All submittals, revisions, review times will be in accordance with the guidelines in the FFA.

SECTION 2.0

FACILITY BACKGROUND

2.1 Location. Longhorn Army Ammunition Plant (LHAAP) is located in central east Texas in the northeast corner of Harrison County, approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The installation occupies 8,493 acres between State Highway 43 and the western shore of Caddo Lake. State Highways 43 and 134 access the installation. A location map is shown on Figure 2-1.

2.2 Boundary Features. Longhorn Army Ammunition Plant is bounded to the north and east by Caddo Lake, a large fresh water lake lying on the Texas-Louisiana state line. The eastern fence of the installation is 3-1/2 miles from the state border. The small incorporated city of Uncertain and the non-incorporated community of Karnack, Texas, are located immediately north and west of the installation boundary, respectively. The remaining surrounding area is sparsely populated and is known as the Pineywoods of east Texas.

2.3 Facility Background. Longhorn Army Ammunition Plant is a government-owned, contractor-operated (GOCO) industrial facility under the jurisdiction of the U.S. Army Armament, Munitions, and Chemical Command (AMCCOM). Its primary mission is to load, assemble, and pack (LAP) pyrotechnic and illuminating/signal ammunition and solid propellant rocket motors. The Longhorn Division of Thiokol Corporation is the current operating contractor.

Longhorn Army Ammunition Plant was established in October 1942 with the primary mission of producing 2,4,6-trinitrotoluene (2,4,6-TNT) flake in the Plant 1 area. Monsanto Chemical Company was the first contract operator of the plant. Production of TNT continued

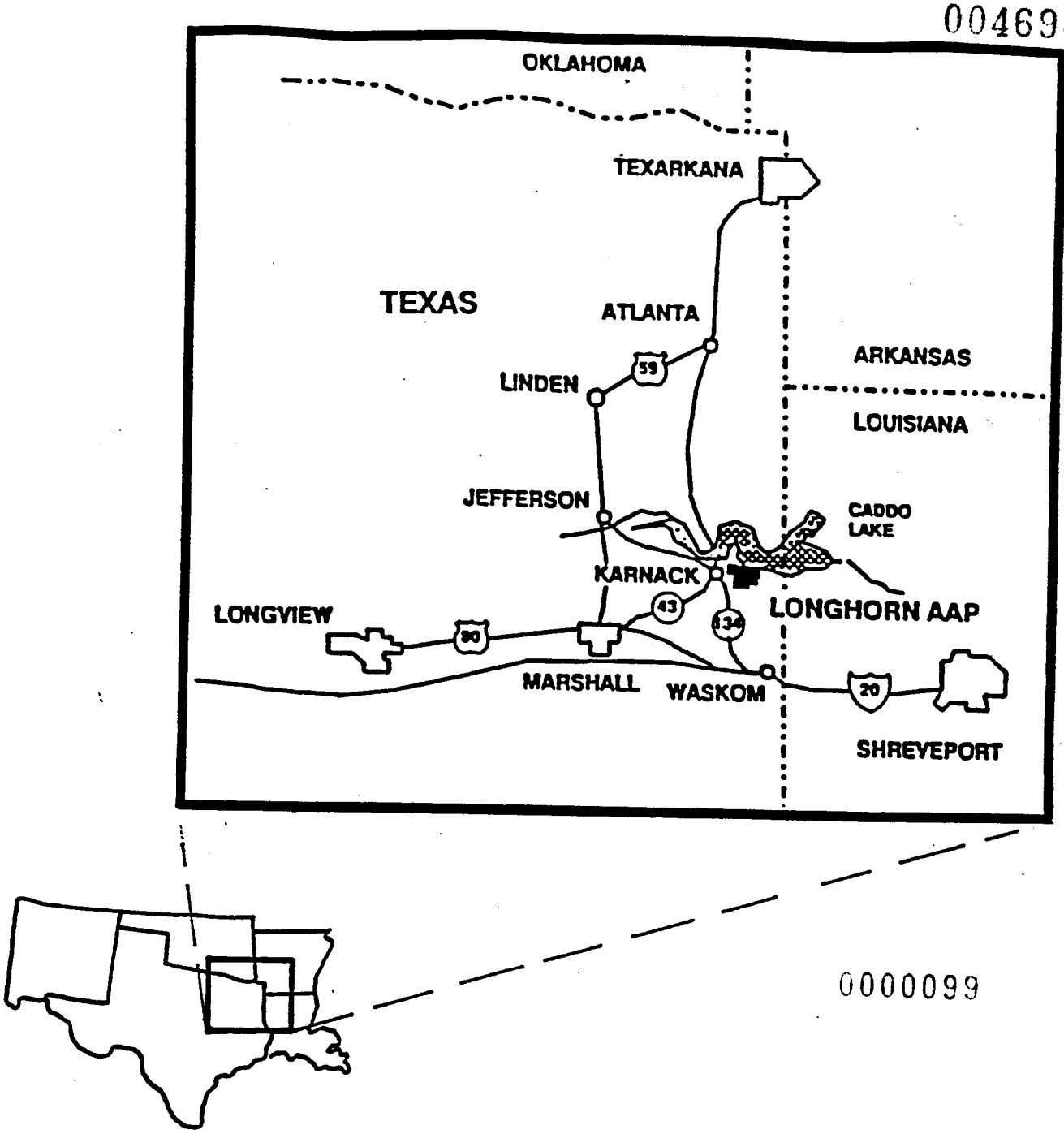


FIGURE 2-1 - REGIONAL LOCATION MAP

through World War II until August 1945 when Monsanto's role ceased and the plant went on standby status until February 1952. From 1952 until 1956, Universal Match Corporation was the operating contractor, producing such pyrotechnic ammunition as photoflash bombs, simulators, hand signals, and tracers for 40mm. In November 1955, Thiokol Corporation began operation of the Plant 3 area rocket motor facility. Thiokol assumed responsibility for total operation of the plant with the departure of Universal Match Corporation in 1956. Production of rocket motors continued to be the primary mission of LHAAP until 1965, when the production of pyrotechnic and illuminating ammunition was reestablished.

Current operations consist of compounding pyrotechnic and propellant mixtures, LAP activities, accomodating receipt and shipment of containerized cargo, and the maintenance and/or layaway of standby facilities and equipment as they apply to mobilization planning. The installation has also been responsible for the static firing and elimination of Pershing I and II rocket motors in compliance with the Intermediate-Range Nuclear Force (INF) Treaty in effect between the United States and the former U.S.S.R.

2.4 Environmental Conditions.

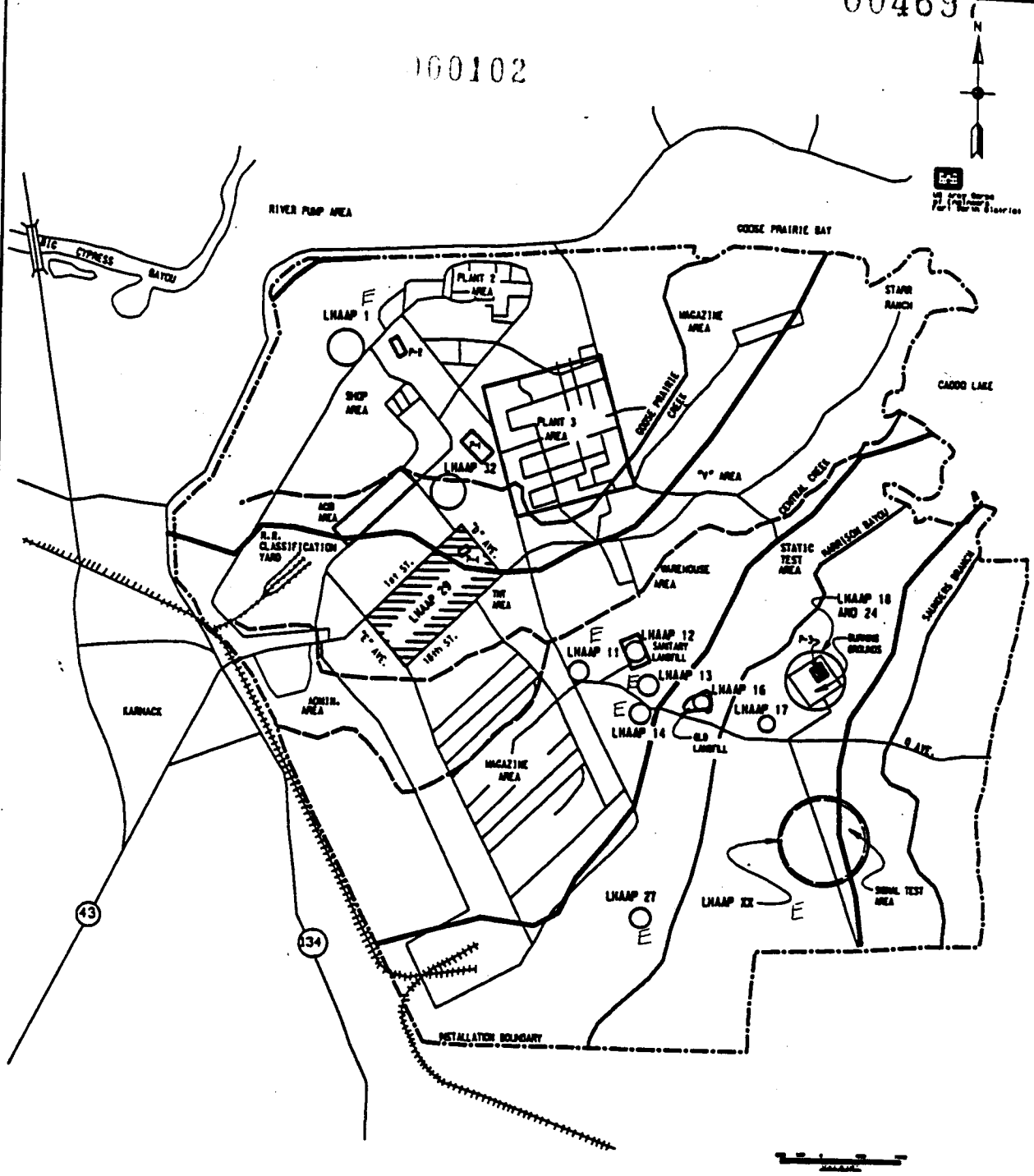
2.4.1 Climatology. Longhorn Army Ammunition Plant is located in a moist, subhumid to humid, mild climate. The average annual rainfall is 46 inches. Precipitation is fairly evenly distributed throughout the year, although summer and fall are frequently drought seasons, and December through May are often the wettest months. Precipitation almost always occurs as rain, with snow a rare occurrence.

2.4.2 Topography and Surface Drainage. The installation is situated on gently rolling land with an average slope of 3 percent

towards the northeast. Most of the terrain slopes 3 percent or less, but slopes as steep as 12 percent are common in the western and northwestern portions of the installation and along the Harrison Bayou floodplain. Elevations on LHAAP vary from 335 to 170 feet above mean sea level (msl).

All surface water from the plant drains into Caddo Lake via four drainage systems that cross portions of the installation, as shown on Figure 2-2. These systems are known as Saunder's Branch, Harrison Bayou, Central Creek, and Goose Prairie Bayou. Caddo Lake is itself a part of Big Cypress Bayou, into which a very small portion of the northwest corner of the installation drains. Saunder's Branch of Martin's Creek flows onto LHAAP near the southeast corner of the installation and flows northward into Caddo Lake. Approximately 11 percent of the heavily wooded eastern section of the plant is drained by this system. Harrison Bayou enters LHAAP on the southern edge of the installation and carries 30 percent of the surface drainage of the plant. This bayou bisects the installation in a northeasterly direction. Central Creek enters LHAAP on its western edge just south of the town of Karnack. Approximately 29 percent of the surface drainage from the installation is carried to Caddo Lake via this drainage course. The headwaters of Goose Prairie Creek are located near the northwest corner of the plant and consist of one larger creek and several smaller tributaries. Goose Prairie Creek flows along the northern edge of the installation and drains approximately 30 percent of LHAAP.

Caddo Lake is created by Caddo Dam, constructed on the Big Cypress Bayou in Caddo Parish, Louisiana. The original dam was constructed in 1914 for local navigation purposes and was



4000 2000 0 4000 8000

SCALE IN FEET

P-1: BOILER BLOWDOWN EVAPORATION POND
P-2: WATER TREATMENT PLANT EFFLUENT SETTLING POND
P-3: ROCKET MOTOR CASING WASHOUT POND
P-4: PUMPHOUSE POND
DRAINAGE BASIN DIVIDES

Source: EPS, June 1984

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN

DRAINAGE BASINS AND HOLDING PONDS

DATE: JUNE 1992 | FIGURE 2-2

reconstructed in 1971. The spillway elevation of the lake is 168.9 feet. Big Cypress Bayou resumes east of Caddo Lake and joins the Red River at Shreveport, Louisiana, which flows southeast across Louisiana into the Mississippi River at Simmesport, Louisiana.

2.4.3 **Geology and Soils**. Longhorn Army Ammunition Plant is situated on a deep inland extension of the Gulf Coastal Plain commonly referred to as the Pineywoods, an area characterized by mixed pine-hardwood forests that cover gently rolling to hilly terrain. The installation lies on the northern flank of the Sabine Uplift, which is bordered on the west by the East Texas Basin.

Longhorn Army Ammunition Plant is situated on an outcrop of the Wilcox Group, which crops out over a large part of the eastern half of Harrison County, as shown on Figure 2-3. The Wilcox has a maximum thickness of 700 feet and consists mostly of fine- to medium-grained sands interbedded with a considerable amount of clay and seams of lignite. Although sand beds up to 50 feet thick are present locally, individual beds are generally lenticular, with lenses of clay, sand, and silt pinching out or grading into each other over very short distances, making correlation difficult. The Wilcox Group is underlain conformably by the predominantly calcareous clay of the Midway Group. Regional dip of the Wilcox is to the northwest into the East Texas syncline, while the ground surface generally dips gently to the southeast. A typical section through an area of LHAAP illustrating the complex stratigraphy of the Wilcox Group is shown on Figure 2-3A.

Soil types on LHAAP are generally fine-grained clays, silts, and sands that occur either as residuum from weathering of Wilcox materials or as alluvial deposits associated with the drainage systems

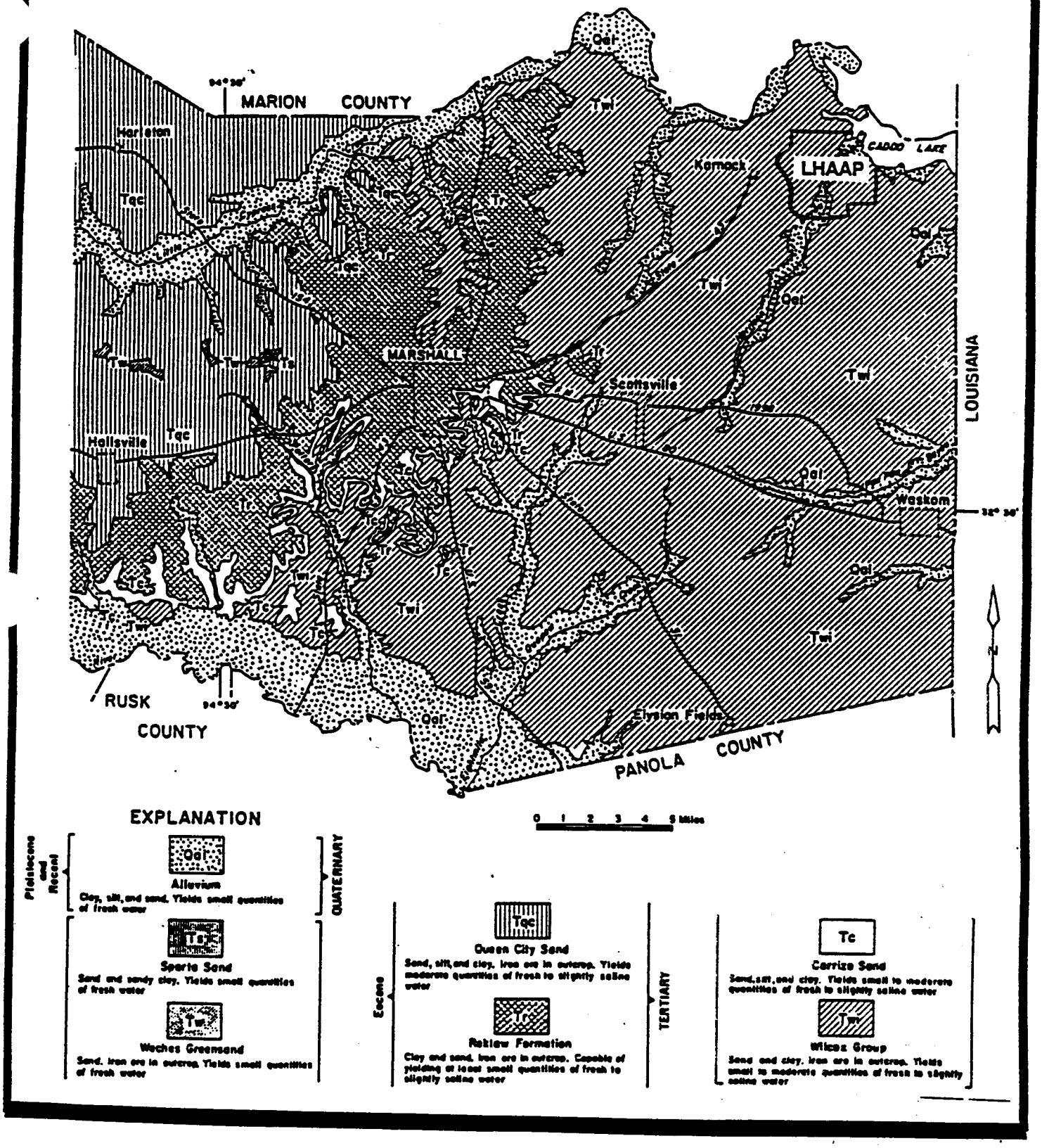
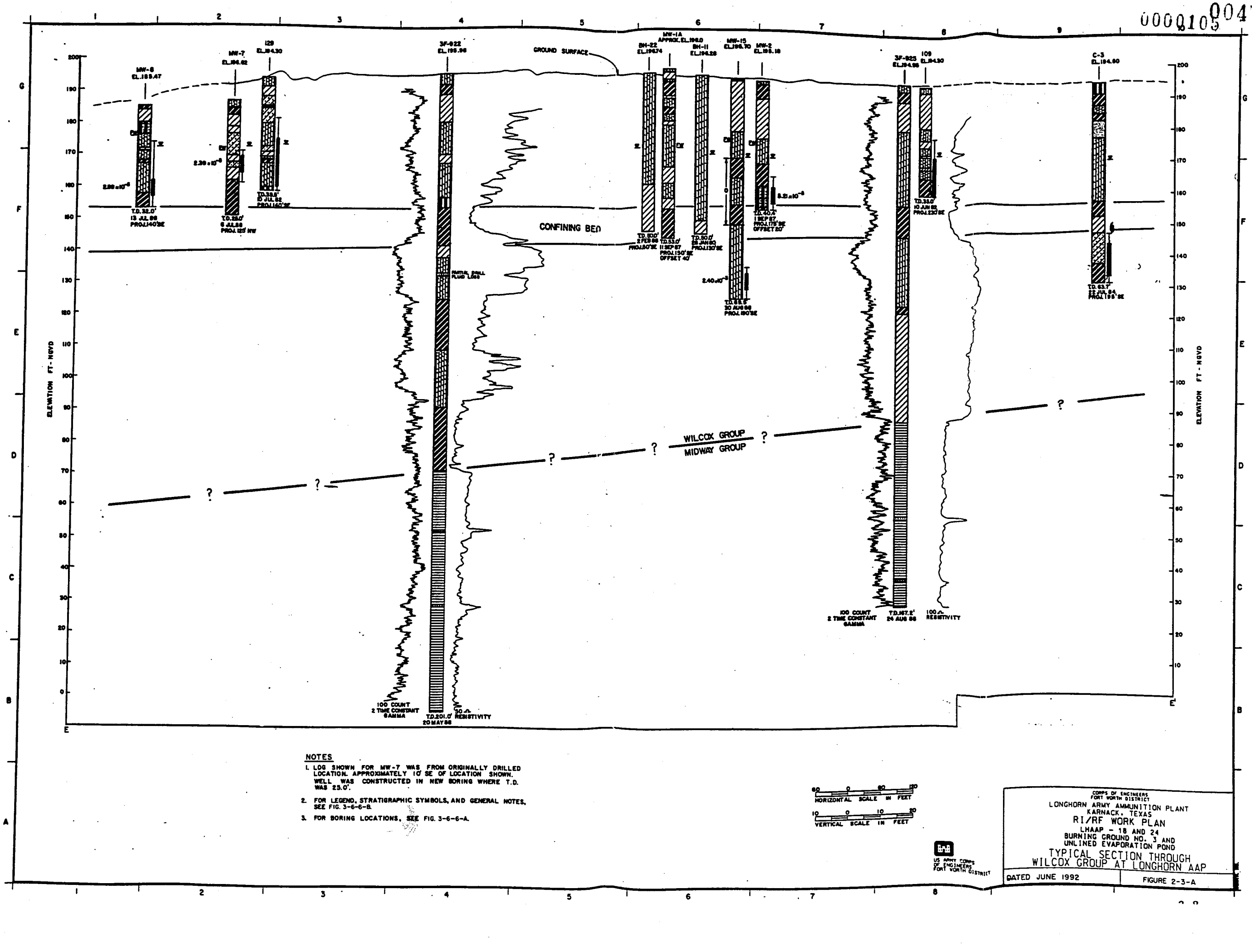


FIGURE 2-3 - GEOLOGY MAP OF HARRISON COUNTY, TEXAS

rce: Texas Water Development Board Report 27,

0000105 004700



NOTES

1. LOG SHOWN FOR MW-7 WAS FROM ORIGINALLY DRILLED LOCATION. APPROXIMATELY 10' SE OF LOCATION SHOWN. WELL WAS CONSTRUCTED IN NEW BORING WHERE T.D. WAS 23.0'.
2. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
3. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

60 0 60 120
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

TYPICAL SECTION THROUGH WILCOX GROUP AT LONGHORN AAP

DATED JUNE 1992 | FIGURE 2-3-A

crossing the installation. Residual soils typically consist of silty or sandy clay occasionally interbedded with sand strata. Alluvial soils occur as interbedded fine-grained clays, silts, and sands. Permeablilities for both types of deposits are relatively moderate to low.

2.4.4 **Regional Hydrogeology**. The Wilcox Group has been identified by the Texas Water Development Board as the basal unit of the regional Cypress aquifer, also known as the Carrizo-Wilcox aquifer. The Cypress aquifer outcrops over most of Harrison County and is comprised of, in ascending order, the Wilcox Group, the Carrizo Sand, the Reklaw Formation, and the Queen City Sand. All units are believed to be hydraulically connected. A brief description of each of these units is provided on Figure 2-4. These units all dip to the northwest into the East Texas syncline.

The availability of ground water in Harrison County is largely dependent on the hydrologic characteristics of the units comprising the Cypress aquifer. The Wilcox Group, outcropping in the area of LHAAP, yields small (<50 gpm) to moderate (50-500 gpm) quantities of fresh water to wells throughout the county. As the basal unit of the Cypress aquifer, the Wilcox is also considered as the base of fresh water in the area, conformably overlying the Midway Group, which does not yield usable quantities of water but tends to serve as a relatively impermeable basement to the overlying water-bearing Wilcox. The base of the Wilcox, as does the base of the overlying units, slopes westward, and ranges from elevation 193 feet above msl in the central part of the county to more than 70 feet below msl in the northwest corner of the county. Contoured elevations approximating the base of the Wilcox are shown on Figure 2-5. In the vicinity of

System	Series	Group	Unit	Approximate maximum thickness (feet)	Character of rocks	Water-bearing properties
Quaternary	Recent and Pleistocene		Alluvium and terrace deposits (undivided)	50	Predominantly clay, silt, and fine sand. Terrace material locally fine to coarse sand.	Yields small quantities of water to a few wells
Tertiary	Eocene	Claiborne	Sparta Sand	25	Fine sand and sandy clay. Limonitic ironstone seams common in outcrop area.	Do.
			Weches Greensand	50	Fine to medium sand, glauconitic and quartzitic, laminar to cross-bedded. Limonitic ironstone seams and concretions common in outcrop area.	Do.
			Queen City Sand	200	Very fine to medium sand, quartzitic, interbedded with silt and clay, laminar to cross-bedded. Contains minor amounts of lignite. Limonitic ironstone seams common in outcrop area	Cypress aquifer
			Reklaw Formation	100	Clay and fine sand, glauconitic and quartzitic, mostly laminar but locally cross-bedded. Locally contains marine fossils. Limonitic ironstone seams common in outcrop area.	
			Carrizo Sand	100	Fine to medium sand interbedded with silt and clay. Laminar to cross-bedded. Limonitic ironstone seams common in outcrop area.	
		Wilcox		700	Fine to medium sand interbedded with considerable amounts of clay. Commonly contains seams of lignite. Limonitic ironstone seams common in outcrop area.	
	Paleocene	Midway		900	Predominantly marine clay; becomes silty in upper part.	Not known to yield fresh water in Harrison County.

FIGURE 2-4 - GEOLOGIC UNITS OF HARRISON COUNTY, TEXAS

Source: Texas Water Development Board Report 27, Groundwater Resources of Harrison County, Texas, August 1966.

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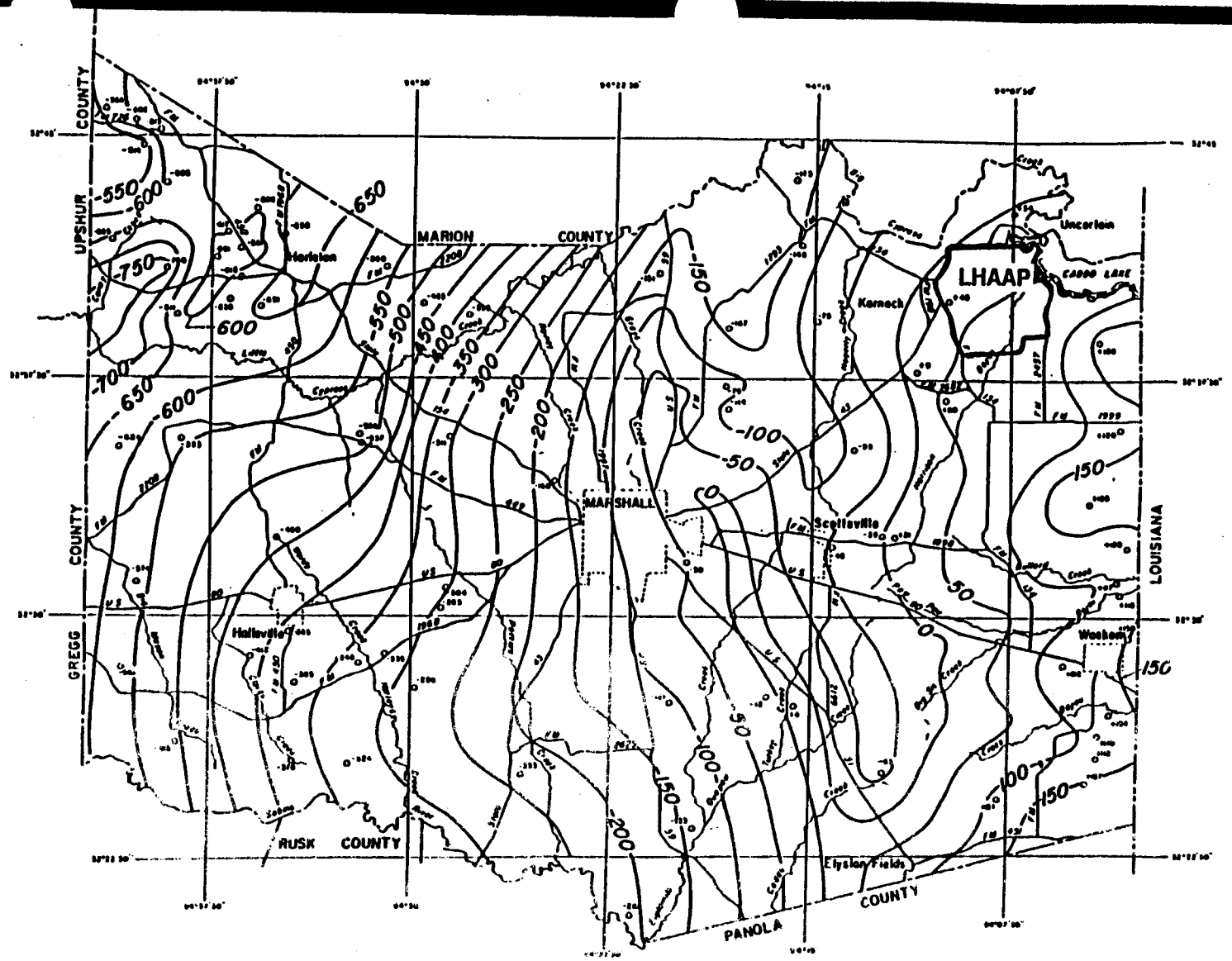

EXPLANATION

400

Structure Contour
Drawn at the base of the Cypress aquifer
Contour interval 50 feet
Datum is mean sea level

NOTE: The contours also represent the approximate altitude of the base of the Wilcox Group

FIGURE 2-5
APPROXIMATE ELEVATIONS OF BASE OF CYPRESS AQUIFER

Source: Texas Water Development Board Report 27, Groundwater Resources of Harrison County Texas, August 1966.

0000108
004703

LHAAP, this elevation of the Wilcox is approximately 50 feet above msl, which makes the Wilcox approximately 120 to 300 feet thick beneath the installation.

Ground water at LHAAP generally occurs under unconfined conditions, whether in alluvial or Wilcox materials, and can vary in depth from within 1 foot of the ground surface to approximately 20 feet. Perched and locally confining conditions frequently occur within the Wilcox due to the high clay content and highly variable stratigraphy. Recharge is primarily by infiltration from the surface. Depth to ground water in the Wilcox has been observed to fluctuate as much as 2 feet within a 6-month period in some areas of the installation. These fluctuations are most likely due to seasonal variations in rainfall.

A complete round of water levels using all of the ground-water monitoring wells installed as part of previous investigations was performed by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) on 14-15 November 1989 for the purpose of determining the regional direction of ground-water flow across the installation (USATHAMA, 1990, draft). These data, as well as the well construction data, are summarized on Table 2-1. A potentiometric surface map illustrating ground-water elevations across LHAAP is presented on Figure 2-6.

2.4.5 Regional Surface Water Use. LHAAP draws its water supply from Big Cypress Creek northwest of the installation. The city of Marshall, Texas, draws it water further upstream on Big Cypress Creek. Most of the small communities near LHAAP draw their water supply from water wells. LHAAP property is adjacent to, and drains into, Caddo Lake, an impoundment on Big Cypress Creek. The lake straddles the

TABLE 2 - 1
GROUND-WATER ELEVATION DATA *
14 - 15 NOVEMBER 1989
LONGHORN ARMY AMMUNITION PLANT
(p. 1 of 2)

LHAAP UNIT NO.	WELL NO.	STATE PLANE COORDINATES		GROUND ELEV	STICK UP (ft)	SCREENED INTERVAL (ft)	GW DEPTH (ft)	GW ELEV (ft)
		X	Y					
14	BH12 (P)	3036815	379420	203.31	0.00	UNKNOWN	24.29	179.02
14&16	BH13 (P)	3036705	379694	203.23	2.88	UNKNOWN	27.10	179.01
16	122	3038100	380092	184.43	3.00	8.5 - 23.5	13.88	173.55
16	BH14 (P)	3037644	380463	200.10	0.83	UNKNOWN	24.40	176.53
16	BH15 (P)	3037425	380300	201.92	3.17	UNKNOWN	27.94	177.15
16	BH16 (P)	3037073	380147	202.08	3.08	UNKNOWN	27.38	177.78
17	130	3039882	379741	174.44	2.79	8.2 - 23.2	6.54	170.69
17,18 & 24	C-07 (BG)	3039884	379012	195.18	2.51	20.0 - 30.0	25.04	172.65
18 & 24	101 (P)	3041557	380663	193.84	3.73	3.7 - 18.7	DRY	DRY
18 & 24	102	3040635	379882	191.34	2.96	15.2 - 30.2	19.58	174.72
18 & 24	109	3041185	381150	193.94	2.83	20.0 - 35.0	23.88	172.89
18 & 24	120	3040088	380689	180.15	2.80	9.2 - 24.2	10.83	172.12
18 & 24	123 (P)	3040332	380969	183.55	3.21	2.8 - 17.8	12.52	174.24
18 & 24	124	3040421	381114	183.05	3.02	10.2 - 25.2	12.25	173.82
18 & 24	125	3040905	381486	193.01	2.94	10.0 - 25.0	23.92	172.03
18 & 24	126	3041260	379948	196.21	2.71	22.3 - 37.3	26.98	171.94
18 & 24	129	3040295	380317	194.06	2.88	19.6 - 34.6	22.73	174.21
18 & 24	BH03 (P)	3040851	381369	192.75	2.28	UNKNOWN	23.19	171.84
18 & 24	BH04 (P)	3040976	381190	193.29	3.06	UNKNOWN	23.73	172.62
18 & 24	BH07 (P)	3040174	381064	193.83	2.31	UNKNOWN	23.35	172.79
18 & 24	BH11 (P)	3040949	380831	195.58	2.25	UNKNOWN	24.63	173.20
18 & 24	BH22 (P)	3040912	380695	195.92	2.35	UNKNOWN	24.77	173.50
18 & 24	C-01	3040700	379444	192.48	1.88	27.6 - 47.6	21.63	172.73
18 & 24	C-02	3039721	380733	175.00	1.71	17.8 - 27.9	5.21	171.50
18 & 24	C-03	3041525	381349	194.06	1.60	51.0 - 61.2	24.75	170.91
18 & 24	C-04	3041212	381673	192.57	1.73	43.6 - 53.7	23.27	171.03
18 & 24	C-04A	NR	NR	NR	NR	108.5 - 113.5	NR	NR
18 & 24	C-05	3041408	382470	179.90	1.50	27.5 - 37.5	11.73	169.67
18 & 24	C-06	3042772	382817	191.01	1.92	43.0 - 53.2	24.23	168.70
18 & 24	C-08	3041946	380798	190.89	2.21	15.0 - 25.0	20.35	172.75
18 & 24	C-09 (BG)	3041566	379166	200.49	3.61	20.0 - 40.0	30.31	173.79
18 & 24	C-10 (BG)	3041636	379123	199.44	3.81	65.0 - 80.0	29.52	173.73
18 & 24	MW-1	3040744	380865	197.73	1.54	31.0 - 36.0	24.69	174.58
18 & 24	MW-2	3040989	380905	195.18	1.84	33.4 - 38.4	22.58	174.44
18 & 24	MW-3	3040963	381196	194.02	2.52	39.0 - 44.0	24.38	172.16
18 & 24	MW-4	3040882	381318	195.77	1.60	36.0 - 41.0	24.00	173.37
18 & 24	MW-5	3040720	381347	193.35	1.90	33.8 - 38.8	23.29	171.96
18 & 24	MW-6	3040587	381239	190.26	2.00	38.8 - 43.8	20.58	171.68
18 & 24	MW-7	3040413	380073	186.79	2.00	18.0 - 23.0	14.58	174.21
18 & 24	MW-8	3040106	380184	185.50	1.48	24.0 - 29.0	12.94	174.04
18 & 24	MW-9	3040117	380467	182.23	2.25	20.0 - 25.0	10.65	173.83
18 & 24	MW-10	3039837	380649	176.02	1.79	26.5 - 31.5	7.04	170.77
18 & 24	MW-11	3040098	380910	176.19	1.17	4.6 - 9.6	6.92	170.44
18 & 24	MW-12	3039957	380753	176.77	1.56	20.8 - 25.8	7.33	171.00
18 & 24	MW-13	3039722	380716	174.04	2.10	38.0 - 43.0	5.72	170.42
18 & 24	MW-14	3040085	380689	179.29	2.04	43.0 - 48.0	11.52	169.81
18 & 24	MW-15	3040976	380905	195.70	1.65	61.5 - 66.5	25.77	171.58
18 & 24	MW-16	3039863	380871	173.40	1.73	23.0 - 28.0	4.38	170.75
18 & 24	MW-17	3039710	380508	177.37	1.67	18.3 - 23.3	8.44	170.60
18 & 24	MW-18	3039844	380174	177.09	1.31	23.3 - 28.3	7.00	171.40
18 & 24	MW-19	3040143	379883	176.83	1.67	23.1 - 28.1	6.73	171.77
18 & 24	MW-20	3040613	379761	185.21	2.00	7.5 - 12.5	12.08	175.13
18 & 24	MW-21	3041379	380887	195.85	2.96	36.1 - 41.1	25.56	173.25
18 & 24	MW-22	3041170	380502	195.33	2.19	32.5 - 37.5	23.65	173.87
18 & 24	MW-23	3040786	380358	196.31	2.46	35.5 - 40.5	24.25	174.52

TABLE 2 - 1
GROUND-WATER ELEVATION DATA *
14 - 15 NOVEMBER 1989
LONGHORN ARMY AMMUNITION PLANT
(p. 2 of 2)

LHAAP UNIT NO.	WELL NO.	STATE PLANE COORDINATES X	Y	GROUND ELEV	STICK UP (ft)	SCREENED INTERVAL (ft)	GW DEPTH (ft)	GW ELEV (ft)
29	114 (BG)	3028428	381945	241.13	2.73	15.1 - 30.1	26.13	217.73
29	115	3030500	382326	221.90	2.85	18.5 - 33.5	29.84	194.91
29	116	3031410	383560	213.47	2.67	22.5 - 37.5	23.17	192.97
29	117	3031914	382971	210.92	3.08	19.0 - 34.0	21.90	192.10
29	118	3030915	381929	216.28	2.77	20.4 - 35.4	23.42	195.63
29	119	3029482	380571	219.84	2.90	10.2 - 25.2	23.29	199.45
12	103	3035919	380800	192.66	3.33	9.8 - 24.8	15.46	180.53
12	121	3035673	380786	199.92	3.13	19.1 - 34.1	20.79	182.26
12	BH17 (P)	3035097	379935	193.5	NR	UNKNOWN	NR	NR
12	BH18 (P)	3035896	381032	196.92	3.13	UNKNOWN	19.48	180.57
12	BH19 (P)	3035763	381437	201.4	NR	UNKNOWN	NR	NR
12	BH20 (P)	3035478	381284	193.00	2.92	UNKNOWN	13.46	182.46
32	113	3030060	385181	211.97	2.83	14.2 - 29.2	16.02	198.78
1	104	3027448	388343	245.37	2.69	10.0 - 25.0	5.41	242.65
XX	127	3040106	376692	185.58	2.87	10.1 - 25.1	NR	NR
XX	128	3041763	378015	189.05	2.71	17.4 - 32.4	17.92	173.84
27	131	3036639	374091	186.31	2.71	8.0 - 23.0	12.75	176.27
27	132	3036595	373906	185.51	2.83	9.2 - 24.2	11.29	177.05
NA	105	3034206	387296	196.32	2.75	10.1 - 25.1	17.23	181.84
NA	106	3040704	386109	174.56	3.40	8.5 - 23.5	12.67	165.29
NA	107	3040764	384617	174.97	3.00	4.5 - 19.5	9.27	168.70
NA	108	3044711	384027	172.85	2.75	5.5 - 20.5	9.64	165.96
NA	110	3037719	371274	186.32	2.79	5.0 - 20.0	9.88	179.23
NA	111	3026208	378562	218.00	3.58	5.4 - 20.4	12.96	208.62
NA	112	3023012	384101	248.98	3.25	5.2 - 20.2	9.21	243.02

* SOURCE : USATHAMA 1990 DRAFT
NA = DOES NOT MONITOR ANY SITE ADDRESSED IN THIS REPORT
BG = BACKGROUND
P = TO BE PLUGGED
NR = NOT RECORDED

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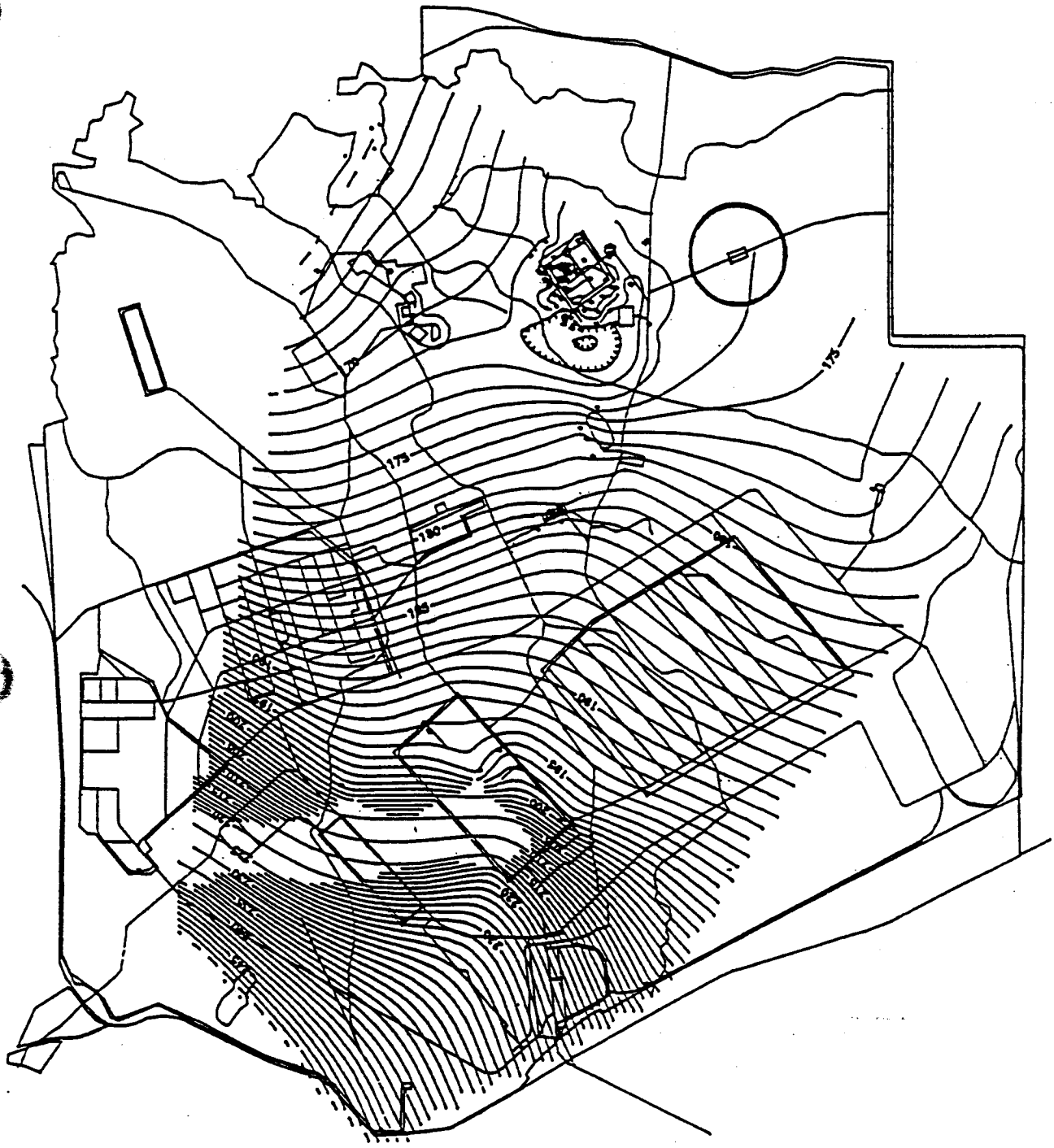

FIGURE 2-6
POTENTIOMETRIC SURFACE MAP,
14-15 NOVEMBER 1989, LONGHORN
ARMY AMMUNITION PLANT

SOURCE: USATHAMA, 1990 DRAFT

Texas-Louisiana border. Caddo Lake is used for recreation and supplies several communities in Louisiana. Communities/water supply districts in Louisiana include Oil City (Waterworks District No. 1 serving approximately 3,760 residents), Blanchard Water Supply (Waterworks District No. 2 serving approximately 6,555 residents), Vivian (serving approximately 4,300 residents), Mooringsport (serving approximately 1012 residents), East Mooringsport (serving 500-600 residents), and East Cove (serving about 400 residents) (personal communication with Ron King, Caddo Parish, Louisiana Health Department, August 3, 1990).

2.4.6 **Regional Ground-Water Use**. Water supply wells located near LHAAP are shown on Figure 2-7. There are two public supply wells in use in the area. One, well number 502, is located in and owned by Caddo Lake State Park. It is completed to a depth of 315 feet (el. -5) and has been in use since 1935. The other public supply well, well number 801, is owned by the Karnack Water Supply Corporation and services the town of Karnack. It is located approximately 1/2 mile southeast of town. The well is 430 feet deep (el. -165), and the pump is set at a depth of 200 feet (el. 65). It has been in use since 1942. Two other public water supply wells exist near LHAAP. These wells are numbers 504 and 902 and are used by the Karnack School and the George Washington Carver School, respectively, as standby wells only. Well 504 is 265 feet deep (el. 0) and well 902 is 105 feet deep (el. 135). All other wells in the area of LHAAP are used for stock and domestic purposes. These wells are typically around 250 feet deep, bottoming at approximate elevation 0.

There are no water supply wells on LHAAP. At one time, two water supply wells were located within the Administration Area of the

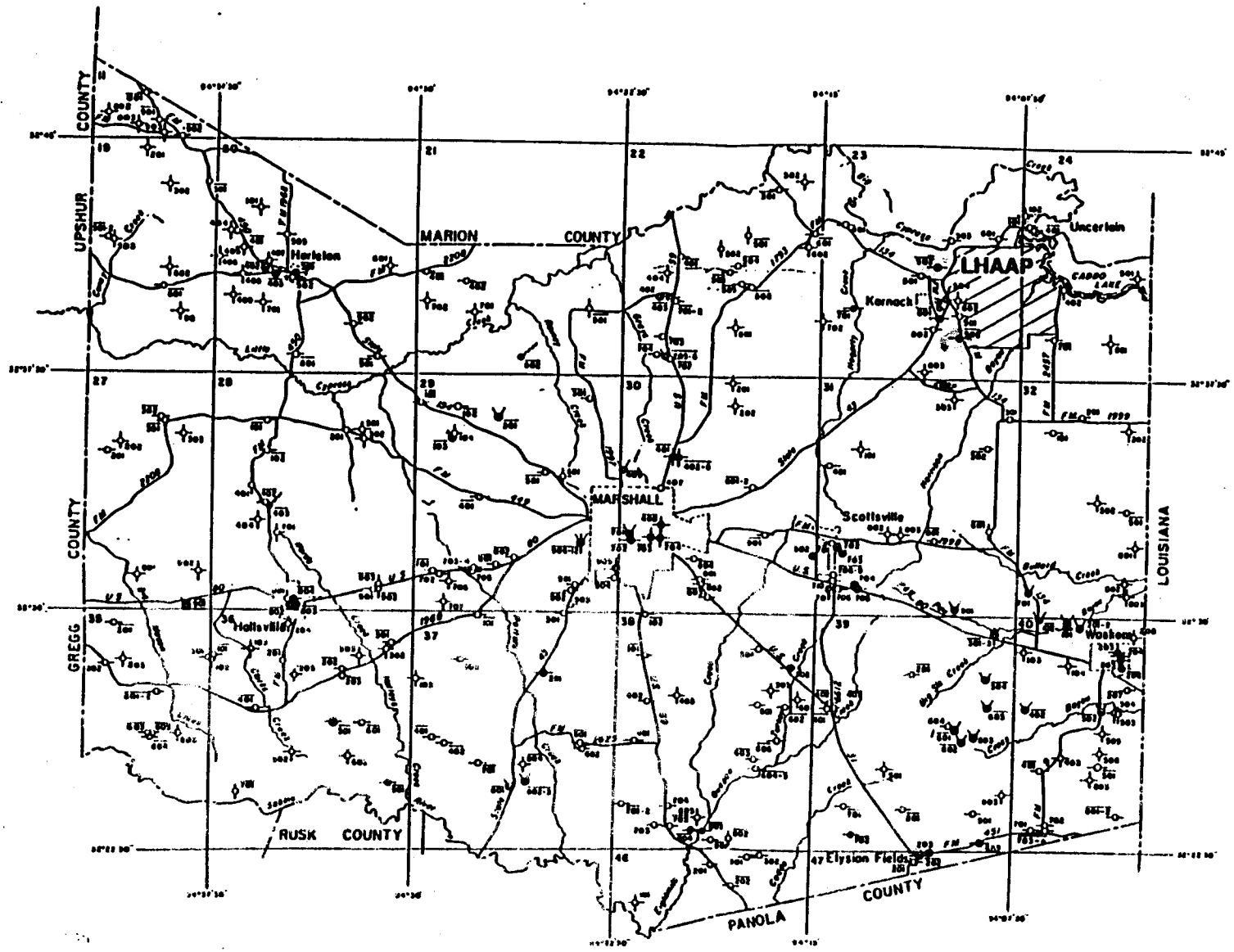

FIGURE 2-7 -WATER SUPPLY WELL LOCATION MAP, HARRISON COUNTY, TEXAS

Source: Texas Water Development Board Report 27, Groundwater Resources of Harrison County, Texas, August 1966.

0004709
0004714

installation. Both were probably constructed in 1942. One supplied potable water to the Administration Area. The other, shown as Well 602 on Figure 2-7, was used as a standby well. Both were abandoned and probably plugged in the 1950s. Construction and plugging data are not available and exact well locations are uncertain.

2.4.7 **Surrounding Land Use**. Caddo Lake, Caddo Lake State Park, and the small unincorporated town of Karnack border LHAAP. Other surrounding land is forested, with an oil and natural gas field located to the east of LHAAP along the Louisiana border. Caddo Lake State Park is located approximately 2.8 miles west-northwest of the installation. Other recreational facilities and nearby lake shore communities are within 5 miles. The town of Uncertain is 1.9 miles north of LHAAP.

The installation is bordered on three sides by state roads which provide access to recreational areas and communities. Other small hamlets nearby include Long Point (1.2 miles east), Elizabeth Church (2.2 miles southeast), South Shore residential development (2-4 miles east), Potters Point residential development (3.2 miles northeast), and Annie Glade Bluff residential area (3.5 miles northwest). Although surrounded by small communities, LHAAP is located in a relatively rural setting.

2.4.8 **Ecological Conditions**. LHAAP is located in a region that is commonly called the Pineywoods, a deep inland extension of the Gulf Coastal Plain that extends into Texas, Louisiana, Arkansas, and Oklahoma. The area is characterized by mixed pine-hardwood forests that cover gently rolling to hilly terrain. Mild temperatures and ample rainfall in East Texas provide excellent conditions to support an abundant and diverse plant community. This, in turn, provides a

number of niches for a rich faunal community.

LHAAP is forested with loblolly and shortleaf pines, a variety of oaks, sweet gum, black tupelo, ash, bald cypress, and a few scattered willows. Pines predominate throughout the installation. Most of the LHAAP woodlands are managed to improve pine harvest for lumber. In many areas of the installation, oaks and other trees are killed to encourage further pine growth.

LHAAP government and contract work personnel and their accompanying guests are allowed to hunt deer and squirrel on Friday, Saturday, and Sunday during hunting season. There are many hunting zones on LHAAP, but each hunter is restricted to only one.

Wildlife is relatively diverse in the LHAAP area. Common mammals found on the installation include white-tailed deer, red and gray foxes, eastern cottontail and swamp rabbits, fox and gray squirrels, opossum, skunk, armadillo, and raccoon. Reptiles common in the area include eastern hognose snake, common water snake, western cottonmouth, coachwhip, pine snake, black snake, spotted king snake, diamondback ribbon snake, garter snake, terrapin, common snapping turtle, and various skinks. Ducks common to the area include mallard, blue-winged teal, green-winged teal, pintail, and wood duck. Other birds common include black and turkey vultures, barn and barred owls, a variety of hawks, barn swallow, eastern blue bird, purple gallinule, coot, and bobwhite quail, killdeer, variety of sparrows, various woodpeckers, blue jay, robin, mockingbird, crows and other black birds, various thrushes, various warblers, Carolina wren, Carolina chickadee, belted kingfisher, ruby-throated hummingbird, cardinal, meadowlark, rock and morning doves, and many other species. Crayfish and variety of frogs are also common in and near aquatic environments.

Nearer to Caddo Lake on LHAAP, cypress is a common tree type in the wetland areas. Much of Caddo Lake is covered by vegetation. Heavy cypress growths occur, and open water areas are periodically infested by water hyacinth (*Eichornia crassipes*), American lotus (*Nelumbo lutea*) and other aquatic plant species. Control of these species has been a major management concern for the past few decades resulting in treatments of 2,4-D herbicide (DA, 1988).

Caddo Lake has more fish species than any other lake in Texas and has supported commercial fisheries and commercial harvests of aquatic plants. At least 80 fish species have been observed in Caddo Lake. Common fish found in the lake include a variety of bass, crappie, catfish, sunfish, shiners, bullhead, carp, shad, gar, and drum. Shovelnose sturgeon (*Scaphirynchus platorynchus*) and the bigscale perch (*Percina macrolepida*) are believed to be present in Caddo Lake, but have not been captured due to limited sampling (DA, 1988).

Protection of endangered species falls under the jurisdiction of both the state of Texas and the federal government. Species in Harrison County listed as threatened or endangered by the Texas Parks and Wildlife Department are presented in Table 2-2. Federally listed protected species for the area include the bald eagle and American alligator. The bald eagle has been sighted along the Louisiana side of Caddo Lake (DA, 1988).

The red-cockaded woodpecker is an endangered species on both the federal and state lists. The federal listing does not include Harrison County as having known existing populations. Active colony sites are known in Cass County to the north and in several east Texas counties to the south of Harrison County. Harrison County is within the recent historical range of the red-cockaded woodpecker and is

TABLE 2-2

STATE LISTING OF THREATENED AND ENDANGERED SPECIES IN HARRISON COUNTY, TEXAS

Texas Parks and Wildlife Department
April 1992

Threatened Species	Potential Presence
Bat, Big-eared, Rofinesque's (*Plecotus refinesquii*)	Confirmed
Kite, Swallow-tailed, American (*Elanoides forficatus*)	Confirmed
Stork, Wood (*Mycteria americana*)	Confirmed
Sparrow, Bachman's (*Aimophila aestivalis*)	Confirmed
Ibis, White-faced (*Plegadis chiki*)	Possible
Falcon, Peregrine, Artic (*Falco peregrinus tundrius*)	Possible
Lizard, Horned, Texas (*Phrynosoma cornutum*)	Confirmed
Snake, Scarlet, Northern (*Cemophora coccinea copei*)	Confirmed
Turtle, Snapping, Alligator (*Macroclemys temminckii*)	Confirmed
Rattlesnake, Timber (*Crotalus horridus*)	Possible
Bluehead shiner (*Notropis hubbsi*)	Confirmed
Creek Chubsucker (*Erimyzon oblongus*)	Confirmed
Blackside Darter (*Percina maculata*)	Confirmed
Blue Sucker (*Cyceptus elongatus*)	Possible
Endangered Species	
Bear, Black (*Ursus americanus*)	Probable
Woodpecker, Red-cockaded (*Picoides borealis*)	Confirmed
Eagle, Bald (*Haliaeetus leucocephalus*)	Confirmed
Louisiana Pine Snake (*Pituophus melanoleucus ruthveni*)	Probable
Paddlefish (*Polyodon spathula*)	Confirmed
Shovelnose Sturgeon (*Scaphichynchus platorynchus*)	Possible
Big Scale Log Perch (*Percina macrolepida*) [a]	Probable

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a - Endangered in Louisiana. Louisiana Natural Heritage Program (1988).

between counties having active colonies. No protected plant species are known to occur in Harrison or the surrounding counties. Rare, threatened and endangered fish species also occur in Caddo Lake (see Table 2-2). Five of these species are listed as rare, endangered, or threatened by Texas and/or Louisiana (DA, 1988).

2.4.9 **Cultural Resources**. A total of 1,484 acres at LHAAP has been surveyed intensively for cultural resources. An additional 1,931 acres have been excluded from survey requirements because of previous ground disturbances. The installation's remaining 5,073 acres still require intensive cultural resources survey. Nineteen cultural resource sites have been recorded at LHAAP, including 16 archeological sites and three historic cemeteries. Of the 16 recorded archeological sites, 7 have been determined ineligible for inclusion on the National Register of Historic Places (NRHP) with the concurrence of the Texas State Historic Preservation Officer (SHPO). The eligibility status of the other nine archeological sites is considered unknown pending further investigation. Cemeteries normally are not considered eligible for the NRHP, but are protected under State law.

Because much of the installation has not been surveyed for cultural resources, there is a high probability that additional properties are present. Studies of archival documents and historic maps indicate that more than a dozen historic housesites likely remain to be discovered. The discovery of additional prehistoric sites within presently unsurveyed portions of LHAAP also is likely.

One of the suspected contaminated sites, LHAAP 29, has been surveyed, and no cultural resources have been identified at that location. The other suspected contaminated sites have not been surveyed for cultural resources. However, because these sites have

been subjected to major ground disturbances, it is unlikely that significant cultural resource properties would remain intact at these locations.

SECTION 3.0

SITE NATURE AND EXTENT OF CONTAMINATION

NPL & RCRA CA

3.1 LHAAP 11 - SUSPECTED TNT BURIAL SITE AT AVENUES P & Q

3.1.1 Site History. The Suspected TNT Burial Site is an undocumented location where it is suspected that bulk TNT might have been disposed during the 1940s. Other than the designation of this location by USATHAMA in the early 1980s, where contamination investigations were later conducted, there is no confirmed documentation that TNT burial occurred at this site. The site has been inactive since its suspected use in the 1940s.

3.1.2 Site Description. The site is situated in the south central portion of LHAAP adjacent to the intersection of Avenues P & Q, as shown on see Figure 3-1-1. A detailed map of the Suspected TNT Burial Site showing current site conditions is shown on Figure 3-1-2. The site consists of a relatively flat area of cut grass immediately north of the intersection, bounded by Avenue P on the west, Avenue Q on the south, and the tree line on the north and east. Power lines parallel Avenues P & Q on two sides of the site. A large forested area extending to Central Creek exists north of the site. Surface drainage from the area flows to ditches along the eastern and western edges of the site, eventually draining to Central Creek.

A borrow pit exists north of the site and at one time was considered for investigation at this TNT disposal site. Aerial photographs do not document the presence of this 5-foot deep depression prior to 1963, and the area does not appear to be active in aerial photos dating as late as 1985.

3.1.3 Previous Investigations. The Suspected TNT Burial Site was originally investigated by Environmental Protection Systems, Inc.,

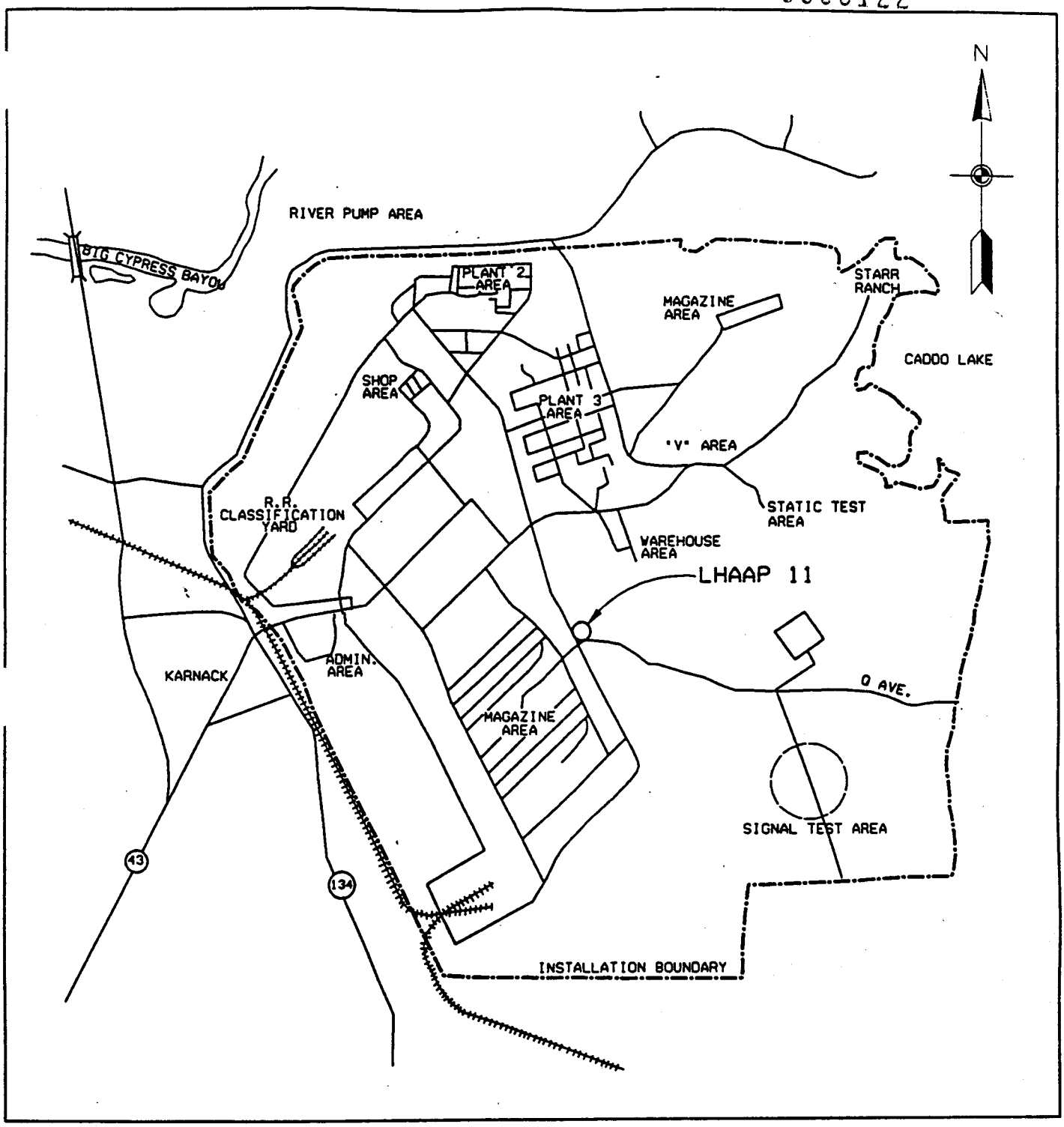
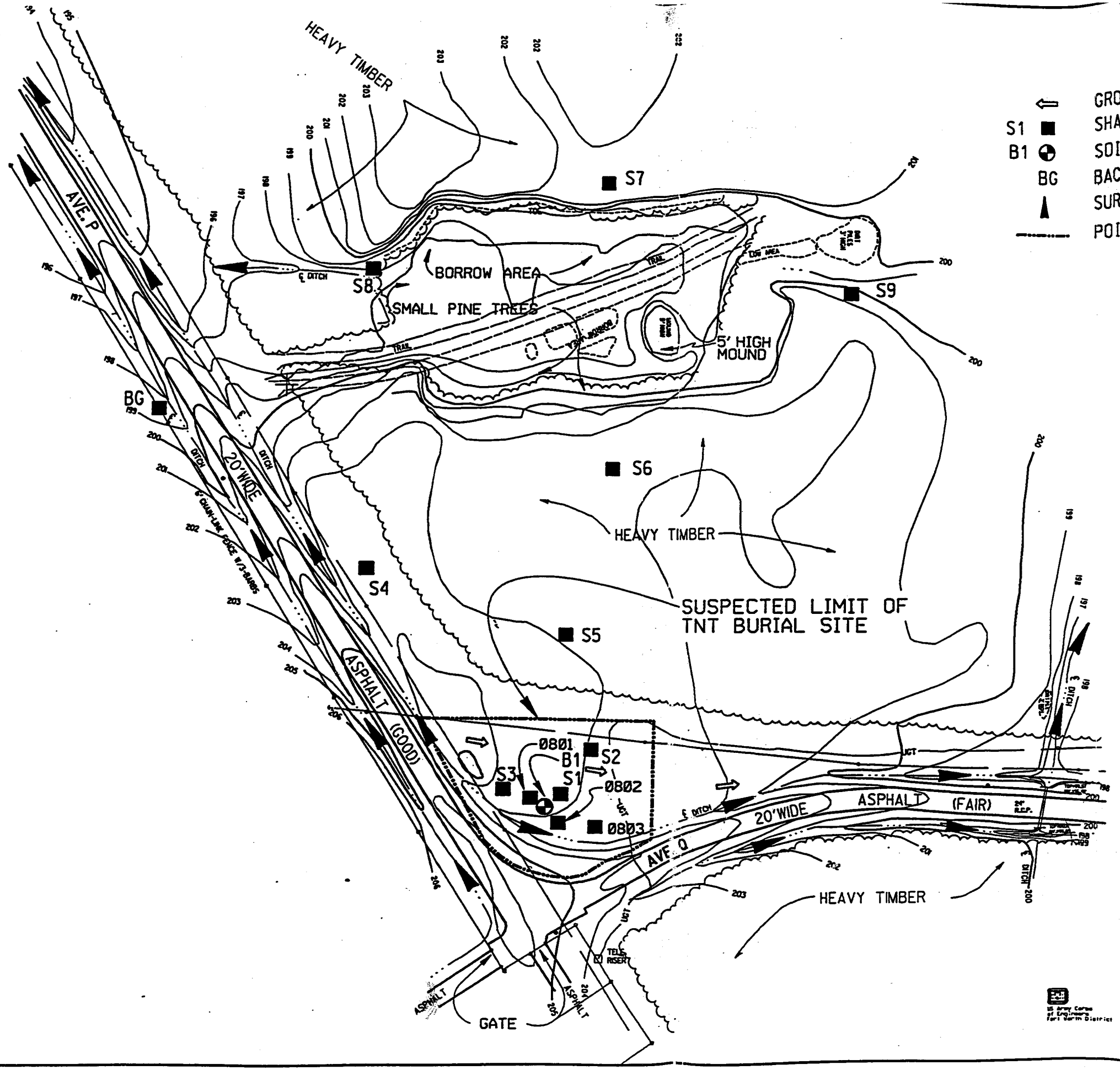


FIGURE 3-1-1 LOCATION MAP FOR LHAAP #11

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

LEGEND

- ⇦ GROUND WATER FLOW DIRECTION
- S1 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- B1 ⊕ SOIL BORING AND NUMBER (PREVIOUS)
- BG BACKGROUND SAMPLE
- ▲ SURFACE WATER FLOW DIRECTION
- ——— POINT OF COMPLIANCE



50 0 50 100
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 11
SUSPECTED TNT BURIAL SITE
SITE MAP

DATE: JUNE 1992 | FIGURE 3-1-2

:/ed/drawing/longhorn/llsite.dgn May 15 1992 12:18:20

(EPS) for USATHAMA, and was documented in the report "Longhorn Army Ammunition Plant Contamination Survey", dated June 1984 (EPS, 1984). Three shallow 5 feet deep soil borings (0801, 0802, and 0803) were sampled at the locations shown on Figure 3-1-2, with the top 2.5 feet from each boring and the bottom 2.5 feet being composited and analyzed separately for explosives.

Another investigation was performed by EPS for Morton Thiokol, Inc., and was documented in the report "A Study of Suspected TNT Burial Sites at Longhorn Army Ammunition Plant, Texas, As Defined in the Contamination Survey," dated May 1988 (EPS, 1988). One 5-foot deep boring was drilled at the approximate location of previously investigated shallow boring 0801, and vertical composite samples were taken from 0 to 18 inches and from 18 inches to 5 feet. Nine surface soil samples and one background surface soil sample were also taken to depths of 18 inches at random locations adjacent to the intersection of Avenues P & Q and throughout the wooded area north of the site. All soil samples were analyzed for explosive compounds. These sample locations are shown on Figure 3-1-2.

3.1.4 **Assessment of Existing Data and Historic Records**. Results of analyses performed on soil samples taken during the earlier investigation of the site are summarized on Table 3-1-1. These results indicate a trace amount of 2,4,6-TNT (1.86 ug/g) was found in the bottom 2.5 feet of the composited sample collected from Station 0801. No other explosive compounds were detected at this time.

Analyses from samples collected during the later investigation from the top 18 inches of soil at random locations across the site are summarized on Table 3-1-2. These results showed concentrations of 1,3,5-TNB, a degradation product of TNT, ranging from below detection

TABLE 3-1-1
SUMMARY OF 1984 SOIL ANALYSES
LHAAP 11
SUSPECTED TNT BURIAL SITE

	SOIL SAMPLES					
Sample Number Depth	801T 0-2.5 ft.	801B 2.5-5 ft.	802T 0-2.5 ft.	802B 2.5-5 ft.	803T 0-2.5 ft.	803B 2.5-5 ft.
EXPLOSIVES ug/g						
1,3-DNB	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-TNT	<0.73	1.86	<0.73	<0.73	<0.73	<0.73
1,3,5-TNB	<0.71	<0.71	<0.71	<0.71	<0.71	<0.71
2,4-DNT	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,6-DNT	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61

From EPS Inc. report dated June 1984.

TABLE 3-1-2
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 11
SUSPECTED TNT BURIAL SITE

	SOIL SAMPLES													
Sample Number Depth Units	Backgrnd 0-18 in. ug/kg	B1 0-18 in. ug/kg	B1 18in-5 ft. ug/kg	S1 0-18 in. ug/kg	S2 0-18 in. ug/kg	S3 0-18 in. ug/kg	S4 DUPL 0-18 in. ug/kg	S4 0-18 in. ug/kg	S4 RINS 0-18 in. ug/l	S5 0-18 in. ug/kg	S6 0-18 in. ug/kg	S7 0-18 in. ug/kg	S8 0-18 in. ug/kg	S9 0-18 in. ug/kg
EXPLOSIVES														
1,3-DNB	<10	<10	<10	<10	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10
2,4,6-TNT	<10	<10	<10	<10	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10
1,3,5-TNB	30	23	37	40	<10	22	40	10	<1	97	70	117	13	<10
2,4-DNT	<10	<10	<10	<10	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10
2,6-DNT	<10	<10	<10	<10	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10

From EPS Inc. report dated May 1988.

0000126 0047121

limits of 10 ug/kg to as high as 117 ug/kg at a location north of the borrow area. The background concentration for this explosive compound was found to be 30 ug/kg. The soil boring located adjacent to Station 0801 detected 23 and 37 ug/kg of 1,3,5-TNB at the respective depths composited from 0 to 18 inches and from 18 inches to 5 feet. No 2,4,6-TNT or other explosive compounds were detected during this investigation.

Low levels of 1,3,5-TNB were detected in surface soil samples from various locations in the area of the suspected site, making it difficult to determine any one location to be indicative of TNT burial. Except for the four soil borings drilled near the intersection of Avenues P & Q, samples were restricted to depths of 18 inches. The subject of the investigation is a burial site for bulk TNT. It is assumed that a burial depth on the order of 5 feet or more would be a reasonable depth to investigate for contamination caused by buried waste. Because 1,3,5-TNB was detected in the surface soil sample taken at the background location, it is likely that the concentrations detected at other locations reflect a different phenomenon other than a burial event.

Previous investigations did not detail soil types, site-specific geology, or hydrogeologic conditions. However, based on the location on LHAAP, it is likely that the site occurs on typical Wilcox materials consisting of interbedded sands, silts, and clays. Ground water was observed to be within 3 feet of the ground surface during previous investigations (EPS, 1984). However, water levels obtained by USATHAMA in 1989 for the entire installation indicate that the water table probably occurs at approximately 16 feet in this area of LHAAP (see Figure 2-6). Direction of ground-water flow is assumed to

be topographically controlled, following an eastward direction shown on Figure 3-1-2.

No soil samples were taken within the limits of the borrow area to verify that this site was never used for disposal. The area adjacent to the intersection of Avenues P & Q will remain the designated site for this investigation, but the borrow area will also be investigated to determine if it should be eliminated from any further consideration.

3.1.5 Potential Contaminants and Migration Pathways. The suspected source of contamination is a burial pit used for the disposal of TNT in the 1940s. Although the source of the 1,3,5-TNB concentrations detected in surface soil samples in the area of the site is unknown and apparently not related to the source being investigated in this RI Work Plan, the potential migration pathways for this contaminant are addressed, as well as the pathways for buried explosive wastes, so that any concentrations of 1,3,5-TNB detected during the RI may be taken into account and properly addressed.

Assuming that TNT is buried somewhere near the intersection of Avenues P & Q and knowing that surface soils in the area contain low concentrations of 1,3,5-TNB, explosive contaminants could follow the potential migration pathways described below.

3.1.5.1 Surface Water. Runoff across surface soils contaminated with explosive compounds would collect in the drainage ditches along Avenues P & Q, which would then carry the contaminated water into Central Creek and eventually into Caddo Lake. Surface soils have already been identified as containing low concentrations of 1,3,5-TNB.

3.1.5.2 Sediment. Erosion of contaminated surface soils

during heavy rainfall could produce contaminated sediment that would be carried by surface water runoff into the collection ditches adjacent to the site where it could deposit or be carried by surface runoff into Central Creek. However, a good stand of vegetation at the site retains the soil and prevents erosion by water or wind, therefore inhibiting the generation and migration of contaminated sediments from the site.

3.1.5.3 **Soil**. Previous investigations have shown that soils are contaminated to a depth of 5 feet with trace amounts of the explosive compound 2,4,6-TNT and low concentrations of 1,3,5-TNB. A good stand of vegetation inhibits erosion of contaminated surface soils to surface migration pathways. However, water percolating downward through contaminated soils may leach contaminants into the shallow ground water occurring beneath the site.

3.1.5.4 **Ground Water**. Contaminated soil could leach explosive contaminants into the ground water, which was observed within 3 feet of the ground surface during previous investigations, but may occur as deep as 16 feet. Because ground water likely occurs under unconfined conditions, contaminants could eventually discharge to surface migration pathways.

3.1.5.5 **Air**. The site is currently well protected from wind erosion by vegetation. Air could become a contaminant migration pathway if the vegetative cover was removed or contaminated soils were disturbed.

3.1.6 **Identification of Potential Receptors**. The general public does not have ready access to the Suspected TNT Burial Site at Avenues P & Q because the site is located within the confines of LHAAP boundaries. The population having direct use of the site is primarily

limited to few LHAAP or contract service personnel and occasional hunters who may cross the field to hunt in the adjacent woodland. Installation personnel and authorized visitors have easy access because the site is not enclosed with fencing and is located near road pavement. On occasion, maintenance personnel mow the site. On a less frequent basis, other personnel service and maintain, as needed, utility lines crossing the site. The site is located in hunting zone 10. However, because it is near the paved road area, the site itself is limited for hunting, but may serve as an access point to the adjacent woodland.

Because ground water occurs under unconfined conditions over much of the installation, possible discharge of contaminated ground water to the many surface water channels bisecting LHAAP poses a potential threat to human health and the environment. To threaten any public area water supply wells, contaminants must first migrate downward to elevations below which surface water discharge could occur to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply well, Well 902, is approximately 1.8 miles southwest of the site in the down dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future

use.

The site is located in the Central Creek drainage basin within the Caddo Lake watershed about 3.0 miles upstream from Caddo Lake. There are no water bodies or watercourses running through the site. The site surface is fairly level and is vegetated with grasses and weeds. There are no signs of significant erosion. The site is relatively remote, and there are no obvious signs of water discharging into nearby tributaries. The site is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would disturb the soil and cause sediment transport to Central Creek and hence into Caddo Lake. Caddo Lake water, which ultimately supplies about 16,600 Louisiana residents, is not known to have been affected by potential contamination from this site.

The surface of the area is a vegetated field of various grasses and weeds, bordered by the paved roads Avenues P and Q on two sides and a piney woodland area on the other sides. There are no visible signs of plant stress from suspected contamination on site. Occasional mowing limits the area for wildlife foraging, and there is no potential habitat value to any potentially endangered or threatened species located or migrating through the area.

3.1.7 Initial Remedial Action. Based upon what is known about the site and the nature and extent of the contaminants identified to date, immediate remedial action is not deemed necessary. The trace amount of 2,4,6-TNT and low levels of 1,3,5-TNB identified in the shallow and surface soils at and around the site pose no immediate threat to potential receptors at this time.

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NPL
RCRA CA

3.2 LHAAP 13 - SUSPECTED TNT BURIAL SITE BETWEEN OLD AND ACTIVE LANDFILLS/ACID DUMP

3.2.1 Site History. The Suspected TNT Burial Site/Acid Dump is an undocumented location where it is suspected that TNT or waste acid may have been disposed sometime during the history of the installation. Other than this suspected one-time disposal, no other activities have taken place at the site.

3.2.2 Site Description. The site is situated in the south central portion of LHAAP in a clearing 130 feet north of Avenue Q, as shown on Figure 3-2-1. A detailed map of the Suspected TNT Burial Site/Acid Dump showing site conditions is shown on Figure 3-2-2. The clearing is an extension of a power line easement adjacent to the northern edge of the site. The remaining surrounding area is heavily wooded.

The site is situated on a topographic high between the Harrison Bayou and Central Creek drainage basins. It is essentially flat with little or no surface drainage. What drainage does exist is toward the north into a tributary of Central Creek.

The clearing contains a number of bare patches that support little or no vegetation. The patches vary in size from 2 to 10 feet in diameter. The three larger bare patches stand out very well in the surrounding 1- to 2-foot tall grass. Based on the presence of these bare patches it appears reasonable to suspect something may have been disposed of at these locations which is preventing the native grasses from re-establishing themselves.

Soil borings drilled by the U.S. Army Corps of Engineers (COE) for foundation design purposes are located in the general area of the site. Four of them are located adjacent to building 49-W,

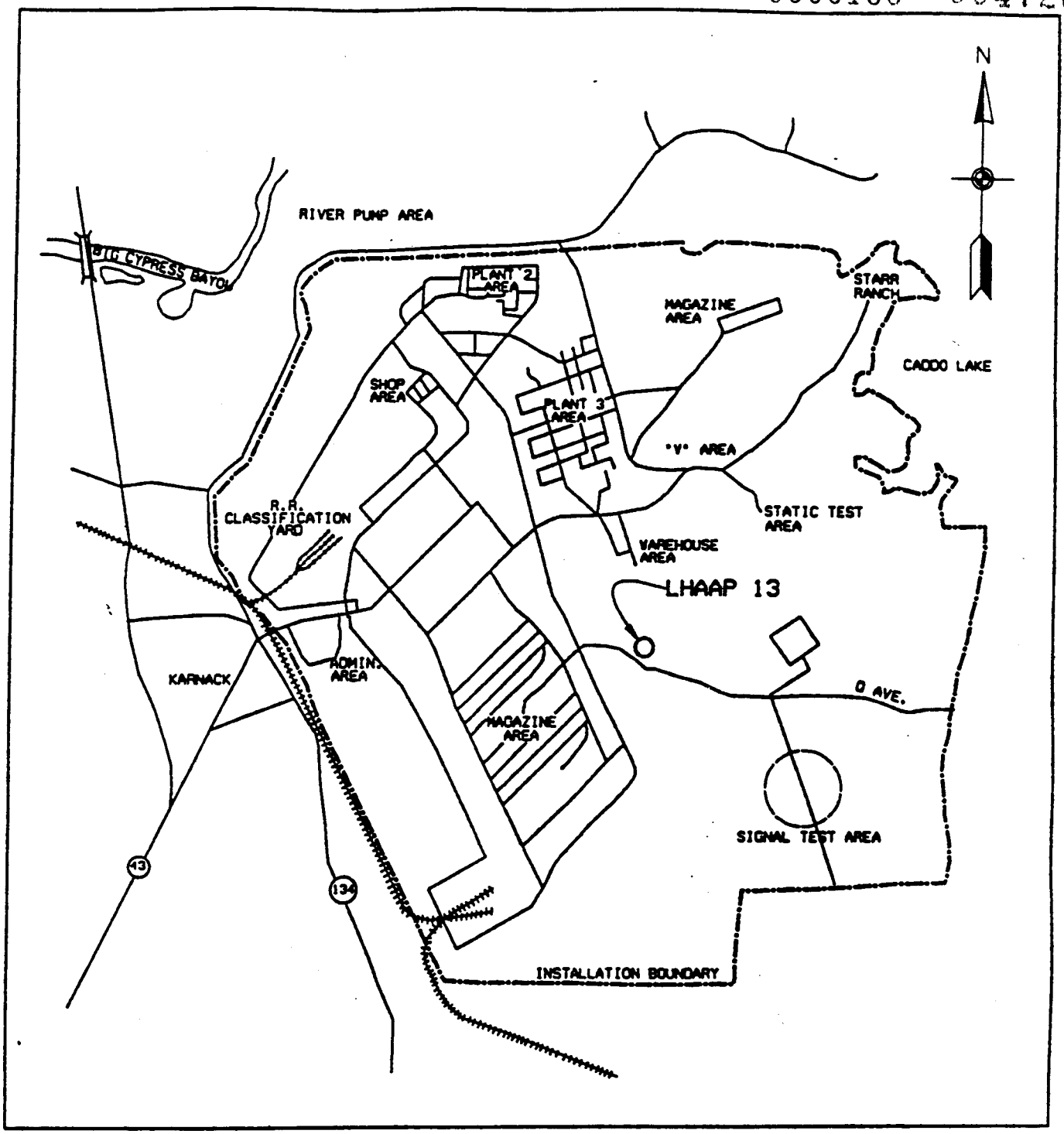

FIGURE 3-2-1 LOCATION MAP FOR LHAAP #13

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

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LEGEND

BH-12 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (NOV 89)

▲ SURFACE WATER FLOW DIRECTION

⇧ GROUND-WATER FLOW DIRECTION

---- POINT OF COMPLIANCE

SUSPECTED LIMIT OF TNT BURIAL SITE

HEAVY TIMBER

BARE PATCHES

HEAVY TIMBER

APPROXIMATE LIMITS OF 1963 ACTIVITIES

℄ DITCH

(GOOD) ASPHALT

HEAVY TIMBER

BH-13 179.01

HEAVY TIMBER

20' WIDE ℄ DITCH

HEAVY TIMBER

BH-12 179.02

HEAVY TIMBER

HEAVY TIMBER

BH-15 177.15

BH-16 177.78

GRAVEL ROAD

HEAVY TIMBER

LIGHT TIMBER

RETAIL SALES AREA

ASPHALT (POOR)

ASPHALT ROAD (POOR)

AVE. O

℄ DITCH

℄ DITCH

BULK STORAGE

BULK STORAGE

HEAVY TIMBER

HEAVY TIMBER

NOTE: GROUND-WATER ELEVATION NOV 89

N

50 0 50 100

SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 13
TNT BURIAL SITE
SITE MAP

DATE: JUNE 1992 | FIGURE 3-2-2

approximately 750 feet south of the site. Based on these borings, the near surface soils in the area consist of predominantly medium plasticity clays with some high plasticity zones (CL,CH) to a depth of 4 to 10 feet. Below the surface stratum, and extending to the total depth investigated of 25 feet, the soils are typically low plasticity clays (CL) or silty, clayey sands (SC, SM-SC). This stratum is distinguished from the surface stratum by typically being much sandier and less plastic; however, it does contain some medium to high plasticity clay zones. There does not appear to be any layering to the soils in the lower stratum. These materials are typical of the Wilcox Group. No alluvium is expected at the site.

Based on the soil boring data near Bldg. 49-W, ground water was encountered 7 to 8 feet below the ground surface. However, water levels later recorded for nearby monitoring wells BH-12 and BH-13 show the water table to be at approximately 24 feet deep (elevation 179). The direction of ground-water flow has not been established at this site, but other studies in nearby areas indicate it is probably towards the east in the direction of Harrison Bayou.

3.2.3 Previous Investigations. The first reporting of suspected waste disposal at this location was made by USAEHA in a report titled "Interim Final Report, Ground-Water Contamination Survey No. 38-26-0851-88, Evaluation of Solid Waste Management Units, Longhorn Army Ammunition Plant, Marshall, TX, 18-22 May 1987" (USAEHA, 1987). No investigations have been performed to date.

3.2.4 Assessment of Existing Data and Historic Records. Evidence of possible TNT burial or acid waste disposal at the site consists of several areas of little or no vegetation which is consistent with the suspicion that some form of waste disposal has

occurred at this location. Examination of aerial photographs dated 1963 show these same locations stripped of vegetation with some type of activity being performed at the site. The extent of these activities is shown on Figure 3-2-2. These locations are not evident in 1954 photos, and most of the area appears to be revegetated and inactive in 1970 photos. Although not suspected, later pesticide and/or herbicide waste disposal may also be responsible for the site conditions observed.

3.2.5 Potential Contaminants and Migration Pathways. The suspected source of contamination is essentially unknown but assumed to be burial of bulk TNT or acidic wastes. Although unlikely, but worth consideration, is possible disposal of pesticides/herbicides. Assuming that either type of waste is present in the surface and subsurface soils at this location, contaminants and their constituents could migrate along the potential pathways described below.

3.2.5.1 Surface Water. The site is relatively flat with no ditches or surface drainage channels in the immediate vicinity to divert runoff. Any runoff occurring from the site could become contaminated with constituents in the surface soils. This runoff would flow northward, eventually into a branch Central Creek, which leads to Caddo Lake.

3.2.5.2 Sediment. Sediment is not a potentially contaminated medium because there are no surface drainage paths in the immediate vicinity of the site where contaminated sediment from surface runoff would collect. A good stand of vegetation surrounding the site would also inhibit any erosion of contaminated surface soils that could be carried as sediment.

3.2.5.3 Soil. Soil is the suspected contaminated medium at

the site. Although the ground surface at the suspected disposal locations lacks a good stand of vegetation to deter erosion of possibly contaminated surface soils, vegetation around the site inhibits their migration. However, water percolating downward through contaminated soils may leach contaminants into the ground water.

3.2.5.4 Ground Water. Contaminated soil could leach explosive or other contaminants into the ground water. Depth to ground water at the site is suspected to be about 25 feet. Because ground water likely occurs under unconfined conditions, contaminants could eventually discharge to surface migration pathways.

3.2.5.5 Air. Although the site is lacking a good stand of vegetation, the clearing is well protected from wind erosion by trees. Air could become a contaminant migration pathway if contaminated soils were disturbed.

3.2.6 Identification of Potential Receptors. The general public does not have ready access to the Suspected TNT Burial Site/Acid Dump because the site is located within the confines of LHAAP boundaries. The population having direct use of the site is primarily limited to few LHAAP or contract service personnel and occasional hunters who may cross the clearing to hunt in the adjacent woodland. Installation personnel and authorized visitors have easy access because the site is not enclosed with fencing and is located near road pavement. On occasion, maintenance personnel mow near the site to maintain the power line easement. Also, other personnel service and maintain these utility lines, as needed. The site is located in hunting zone 10. However, because it is near the paved road area, the site itself is limited for hunting, but may serve as an access point to the adjacent woodland.

Because ground water occurs under unconfined conditions over much of the installation, discharge of contaminated ground water to the many surface water channels bisecting the installation poses a potential threat. To threaten any area public water supply wells, contaminants must first migrate downward to elevations below which surface water discharge could occur to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply well, Well 902, is approximately 2.0 miles southwest of the site in the down-dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future use.

The site is located in the Central Creek drainage basin within the Caddo Lake watershed about 3.0 miles upstream from Caddo Lake. There are no water bodies or watercourses running through the site. The site surface is slightly raised and is vegetated with grasses/weeds. There are no signs of significant erosion. The site is relatively remote, and there are no obvious signs of water leaching into nearby tributaries. The site is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would disturb the soil and cause sediment transport to Central Creek and hence into Caddo Lake. Caddo Lake

water, which ultimately supplies about 16,600 Louisiana residents, is not known to be affected by potential contamination from this site.

The site is near a utility pole line right-of-way and is in an area vegetated with various grasses and weeds. In the immediate site area, there are a number of places where the grass is stressed or the ground is barren from unnatural causes. There is no potential habitat value to any potentially endangered or threatened species located or migrating through the area.

3.2.7 Initial Remedial Action. Because the nature and extent of contaminants at the site have not yet been identified, and potential migration pathways are limited, immediate remedial action is not deemed necessary.

3.3 LHAAP 14 - AREA 54 BURIAL GROUND

NPL & RCRA CA

3.3.1 Site History. The Area 54 Burial Ground is an undocumented location where it is suspected that demolition debris, building rubble, explosives, and acidic wastes were disposed during the 1940s and early 1950s. The disposal site is reportedly beneath the asphalt parking area adjacent to Bldg. 49-W. Other than this period of operation, no other waste activities have taken place at the site.

3.3.2 Site Description. The site is situated in the south central portion of LHAAP adjacent to and on the south side of Avenue Q, as shown on Figure 3-3-1. The center of the site is approximately 330 feet southwest of the Retail Sales Area and 350 feet north-northwest of building 49-W. It is bounded on the north by Avenue Q, on the east by the access road to Building 49-W, and on the south and west by a mowed grass strip separating it from heavy forest. The area is approximately 150 by 115 feet in size and contains a small 25- by

water, which ultimately supplies about 16,600 Louisiana residents, is not known to be affected by potential contamination from this site.

The existing site is of low ecological value. The site is near a utility pole line right-of-way and is in an area vegetated with various grasses and weeds. In the immediate site area, there are a number of places where the grass is stressed or the ground is barren from unnatural causes. There is no potential habitat value to any potentially endangered or threatened species located or migrating through the area.

3.2.7 **Initial Remedial Action.** Because the nature and extent of contaminants at the site have not yet been identified, and potential migration pathways are limited, immediate remedial action is not deemed necessary.

NPL, RCRA CA

3.3 LHAAP 14 - AREA 54 BURIAL GROUND

3.3.1 **Site History**. The Area 54 Burial Ground is an undocumented location where it is suspected that demolition debris, building rubble, explosives, and acidic wastes were disposed during the 1940s and early 1950s. The disposal site is reportedly beneath the asphalt parking area adjacent to Bldg. 49-W. Other than this period of operation, no other waste activities have taken place at the site.

3.3.2 **Site Description**. The site is situated in the south central portion of LHAAP adjacent to and on the south side of Avenue Q, as shown on Figure 3-3-1. The center of the site is approximately 330 feet southwest of the Retail Sales Area and 350 feet north-northwest of building 49-W. It is bounded on the north by Avenue Q, on the east by the access road to Building 49-W, and on the south and west by a mowed grass strip separating it from heavy forest. The area is approximately 150 by 115 feet in size and contains a small 25- by

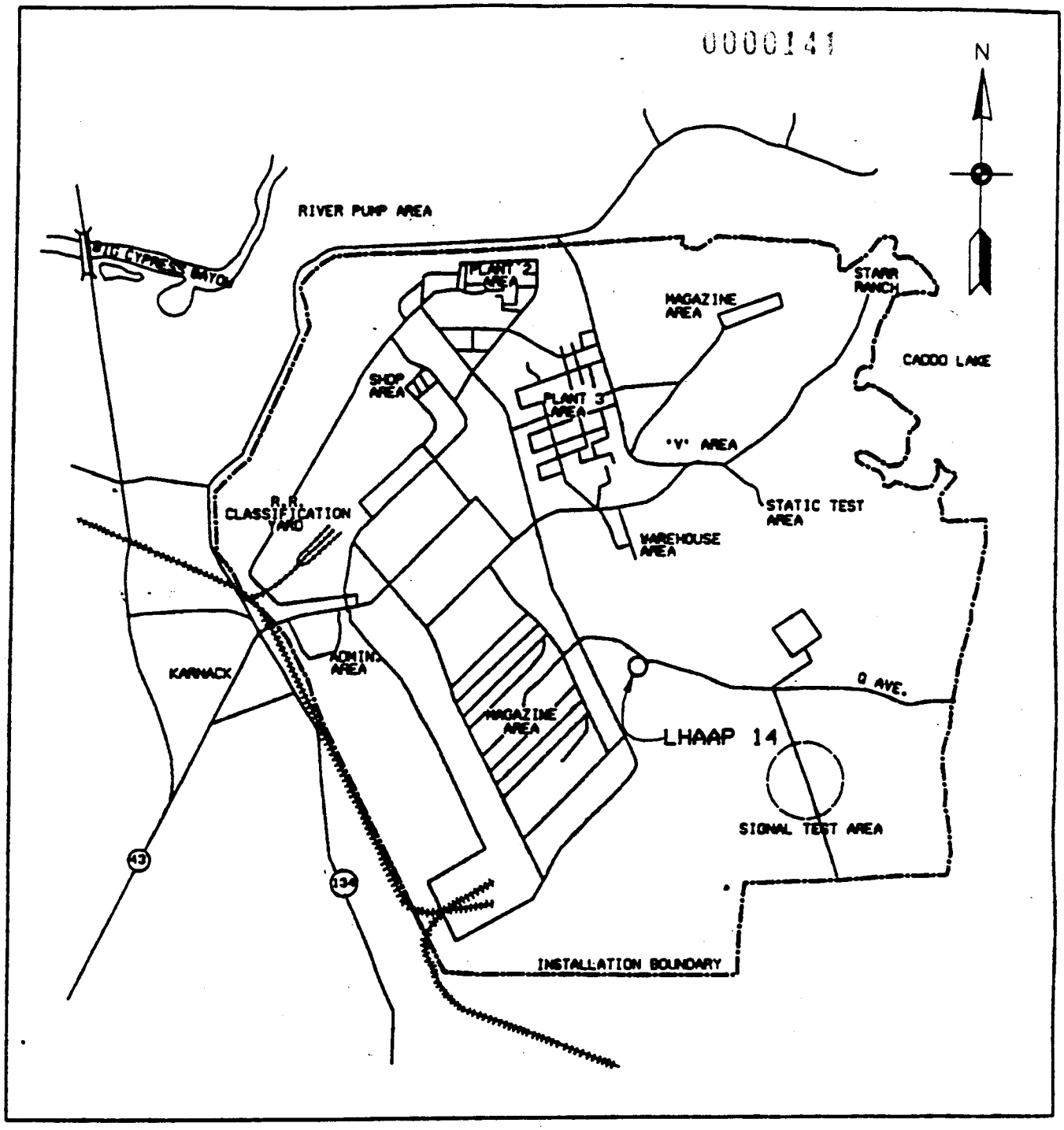

FIGURE 3-3-1 LOCATION MAP FOR LHAAP #14

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

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30-foot asphalt parking lot serving four to five vehicles. A detailed map of the Area 54 Burial Ground site showing current site conditions is shown on Figure 3-3-2.

The site is essentially flat with little or no surface drainage. What drainage does exist is toward the east to a ditch running along Avenue Q and eventually discharging to Harrison Bayou.

Four soil borings drilled for foundation design purposes by the COE are located adjacent to building 49-W. Based on the data obtained from these four borings, the near surface soils at this site consist of predominantly medium plasticity clays with some high plasticity zones (CL,CH) to a depth of 4 to 10 feet. Below the surface stratum, and extending to the total depth investigated of 25 feet, the soils are typically low plasticity clays (CL) or silty, clayey sands (SC, SM-SC). This stratum is distinguished from the surface stratum by typically being much sandier and less plastic; however, it does contain some medium to high plasticity clay zones. There does not appear to be any layering to the soils in the lower stratum. These materials are typical of the Wilcox Group. No alluvium is expected at the site.

Based on these soil boring data, ground water was encountered 7 to 8 feet below the ground surface. However, water levels later recorded for nearby monitoring wells BH-12 and BH-13 show the water table to be at approximately 24 feet deep at elevation 179. The direction of ground-water flow has not been established at this site, but other studies for nearby areas indicate it is probably towards the east in the direction of Harrison Bayou.

3.3.3 **Previous Investigations**. The Area 54 Burial Ground was first documented as a possible waste disposal site in the USAEHA

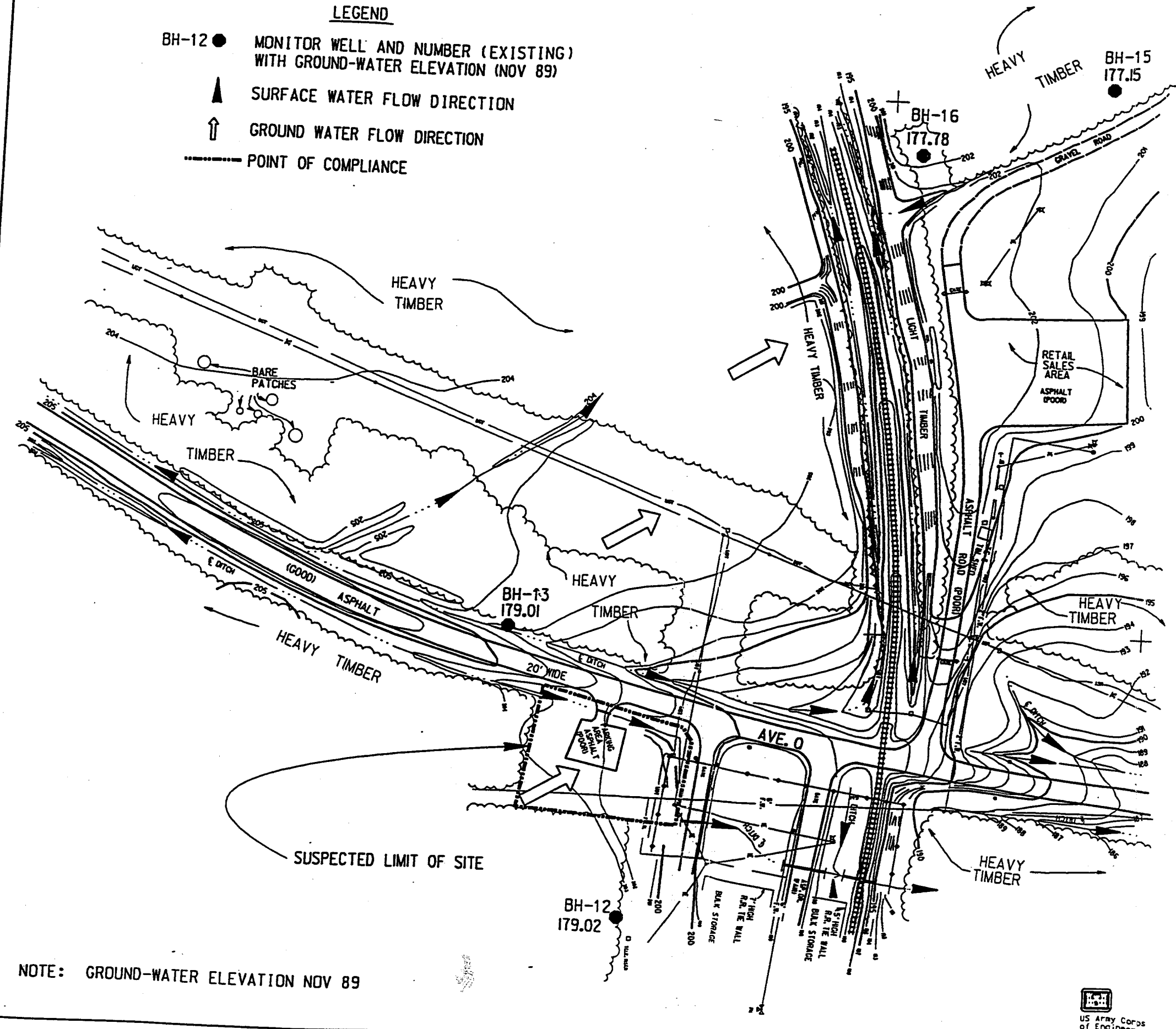
LEGEND

BH-12 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (NOV 89)

SURFACE WATER FLOW DIRECTION

GROUND WATER FLOW DIRECTION

POINT OF COMPLIANCE



NOTE: GROUND-WATER ELEVATION NOV 89

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 14
TNT BURIAL SITE
SITE MAP

DATE: JUNE 1992

FIGURE 3-3-2

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report entitled "Land Disposal Study No. 38-26-0104, Longhorn Army Ammunition Plant, Marshall, Texas," dated February 1980 (USAEHA, 1980). The report stated that the 10- by 20-foot area was once designated for waste disposal; however, whether or not the area was actually used was not know. As part of the USAEHA study, two wells, BH-12 and BH-13, were installed at the locations shown on Figure 3-3-2 and were sampled. The report contains no well construction details.

Wells BH-12 and BH-13 were later sampled by EPS in a study performed for USATHAMA (EPS, 1984) as part of an investigation for the Old Landfill, LHAAP 16, located northeast of the site. The wells were again sampled by EPS in a separate study performed for Morton Thiokol, Inc., in 1987 (EPS, 1988). The Area 54 Burial Ground site itself was not investigated after 1980.

3.3.4 Assessment of Existing Data and Historic Records.

Sampling of both wells BH-12 and BH-13 by USAEHA showed BH-12 having a high concentration of chlorides (USAEHA, 1980). Analyses performed on ground-water samples taken by EPS in 1982 for investigating the Old Landfill detected a low concentration of 1,3,5-TNB (6.1 ug/l) in monitoring well BH-12. Chromium and mercury also exceeded Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs). No contaminants were found in BH-13.

Analyses performed on ground-water samples taken from both of these wells by EPS in 1987 showed cadmium exceeding the SDWA MCL in BH-12. Only well BH-13 is located downgradient of the site. Because these wells were sampled as part of the Old Landfill investigations, ground-water analytical results are presented and further discussed in Section 3.4. The wells do not appear to be situated at appropriate locations to monitor the suspected disposal areas, and lack of well

construction data makes previous analytical data questionable.

3.3.5 Potential Contaminants and Migration Pathways. The suspected source of contamination is essentially unknown, but is assumed to be a burial pit used for the disposal of demolition debris, building rubble, explosives, and acidic wastes. Assuming these wastes are present in the subsurface soils either beneath or outside the paved parking area, contaminants and their constituents could migrate along the potential pathways described below.

3.3.5.1 Surface Water. Runoff from contaminated surface soils could collect in the drainage ditch along Avenue Q, which could then carry the contaminated water eastward into Harrison Bayou and eventually into Caddo Lake.

3.3.5.2 Sediment. Erosion of contaminated surface soils during heavy rainfall could produce contaminated sediment that would be carried by surface water runoff into the collection ditch along Avenue Q where it could deposit or be carried by surface runoff into Harrison Bayou. However, a good stand of vegetation at the site, as well as asphalt pavement, retains the soil and prevents erosion by water or wind, therefore inhibiting the generation and migration of contaminated sediments from the site.

3.3.5.3 Soil. Soil is the suspected contaminated medium at the site. A good stand of vegetation inhibits erosion of contaminated surface soils to surface migration pathways. However, water percolating downward through contaminated soils may leach contaminants into the ground water beneath the site. If the extent of the buried waste is confined to the limits of the parking area, the potential for leaching of contaminants to the ground water decreases.

3.3.5.4 Ground Water. Contaminated soil could leach

contaminants into the ground water. Depth to ground water at the site is suspected to be about 24 feet. Because ground water likely occurs under unconfined conditions, contaminants could eventually discharge to surface drainage migration pathways.

3.3.5.5 **Air**. The site is currently well protected from wind erosion by vegetation and an asphalt surface. Air could become a contaminant migration pathway if the vegetative cover or asphalt surface were removed, or contaminated soils were disturbed.

3.3.6 **Identification of Potential Receptors**. The general public does not have ready access to the Area 54 Burial Ground because the site is located within the confines of LHAAP boundaries. The population having direct use of the site is primarily limited to few LHAAP personnel, personnel involved in forest management, and occasional hunters. Installation personnel and authorized visitors have easy access because the site is not enclosed with fencing and is located near road pavement. In fact, the asphalt overlying the suspected waste burial location serves as a parking area for personnel working at Bldg. 49-W. On occasion, maintenance personnel mow the grass and weeds along the site perimeter. The site is located in hunting zone 9. The forester has visited the area to kill certain trees to optimize pine growth.

Because ground water occurs under unconfined conditions over much of the installation, discharge of contaminated ground water to the many surface water channels bisecting the installation poses a potential threat. To threaten any area public water supply wells, contaminants must first migrate downward to elevations below which surface water discharge occurs to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well

intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply well, Well 902, is approximately 1.9 miles southwest of the site in the down dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future use.

The site is located in the Harrison Bayou drainage basin within the Caddo Lake watershed over 3.0 miles upstream of Caddo Lake. There are no water bodies or watercourses running through the site. The site surface is fairly level and is vegetated with mostly woodlands, grasses, and weeds. There are no signs of significant erosion. The site is relatively remote, and there are no obvious signs of water leaching into nearby tributaries. The site is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would significantly disturb the soil and cause sediment transport to downstream surface water and hence into Caddo Lake. Caddo Lake water, which ultimately supplies about 16,600 Louisiana residents, is not known to be affected by potential contamination from this site.

A pine/hardwood woodland lies beyond the grass strip bordering the site to the south. Most of the hardwood in these woods has been killed to promote

pine growth for lumber. Dead hardwood stands are relatively mixed with live pines. The conifers and other non-hardwood plants show no obvious signs of stress from suspected contamination.

3.3.7 **Initial Remedial Action.** Because the nature and extent of contaminants at the site have not yet been identified, there is no evidence of a release to the environment, and potential migration pathways are limited, immediate remedial action is not deemed necessary.

3.4 LHAAP 16 - OLD LANDFILL

3.4.1 **Site History.** The Old Landfill was originally used from 1942 to 1944 for the disposal of TNT red water ash generated from the TNT Waste Disposal Plant (LHAAP 32). In the mid- to late-1950s, three rocket motor casings were reportedly burned and possibly buried on the eastern side of the site. During this time, a large bermed depression encompassing the central section of the site was reportedly used as an all-purpose junkyard for the disposal of a variety of materials such as substandard TNT, barrels of chemicals, oil, paint, scrap iron, and wood. This area was eventually filled in, and landfilling operations continued moving eastward, eventually raising the ground surface to its current elevation approximately 15 feet above original grade. Burn pits and waste storage were common at the site during the history of its operation, but little is known about the nature of the wastes handled by these activities. The site continued to be used for a variety of waste disposal and treatment activities until sometime in the 1980s, when the disposal of inert solid wastes was moved to the Active Landfill (LHAAP 12). The site is no longer active.

3.4.2 **Site Description.** The Old Landfill encompasses approximately 20 acres in the south-central portion of LHAAP, just

north of Avenue Q and adjacent to the Retail Sales Area. The location of the site on LHAAP is shown on Figure 3-4-1. It is defined as an open area of grass bounded along the western and northern edges by a gravel road and along the eastern and southern edges by a wooded area, as shown on Figure 3-4-2. A large rectangular paved area designated as the Retail Sales Area for LHAAP is located on the western edge of the site. A tributary of Harrison Bayou runs closely along the eastern edge of the site where the ground surface drops sharply down to the floodplain. Surface drainage is to the south and east toward Harrison Bayou.

Although the site has been previously investigated, there is little documentation addressing the geology and the soil types occurring there. However, based on the site's location on LHAAP, the landfill is likely situated on Wilcox materials, with the toe along the eastern edge of the area occurring adjacent to alluvial materials of the Harrison Bayou floodplain.

Based on previous water level measurements made in the four existing monitoring wells at the site, depth to ground water varies from approximately 22 feet along the northern edge of the landfill to approximately 8 feet towards the floodplain. Ground water likely occurs under unconfined conditions and flows eastward towards Harrison Bayou.

3.4.3 Previous Investigations. The Old Landfill was originally investigated as a potentially contaminated site by the USAEHA in 1980, at which time three monitoring wells (BH-14, BH-15, and BH-16) were installed to monitor the site. Documentation for this investigation, Land Disposal Study No. 38-26-0104-81 (USAEHA, 1980), does not provide well construction details for these wells. The study noted ponding on

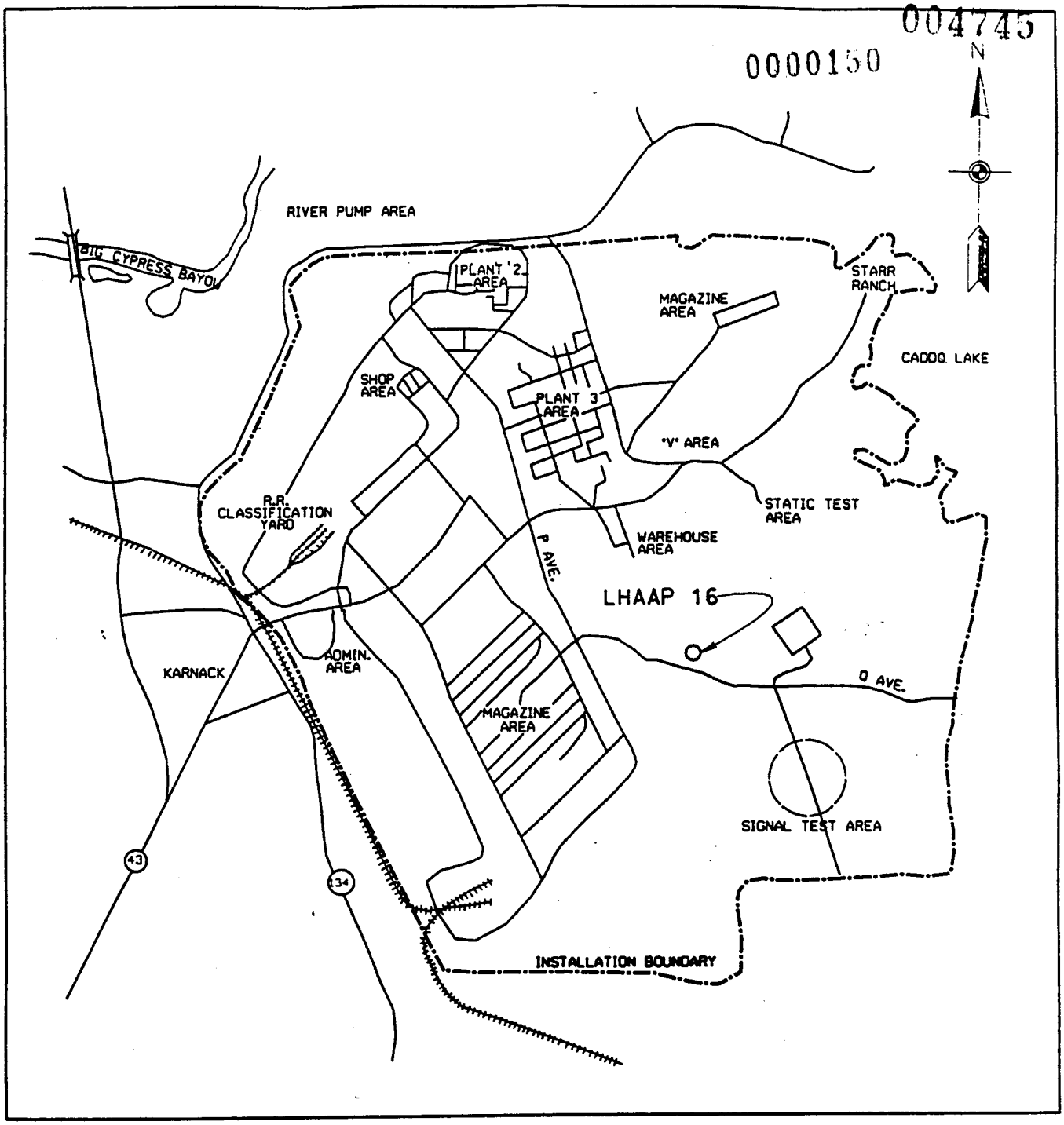
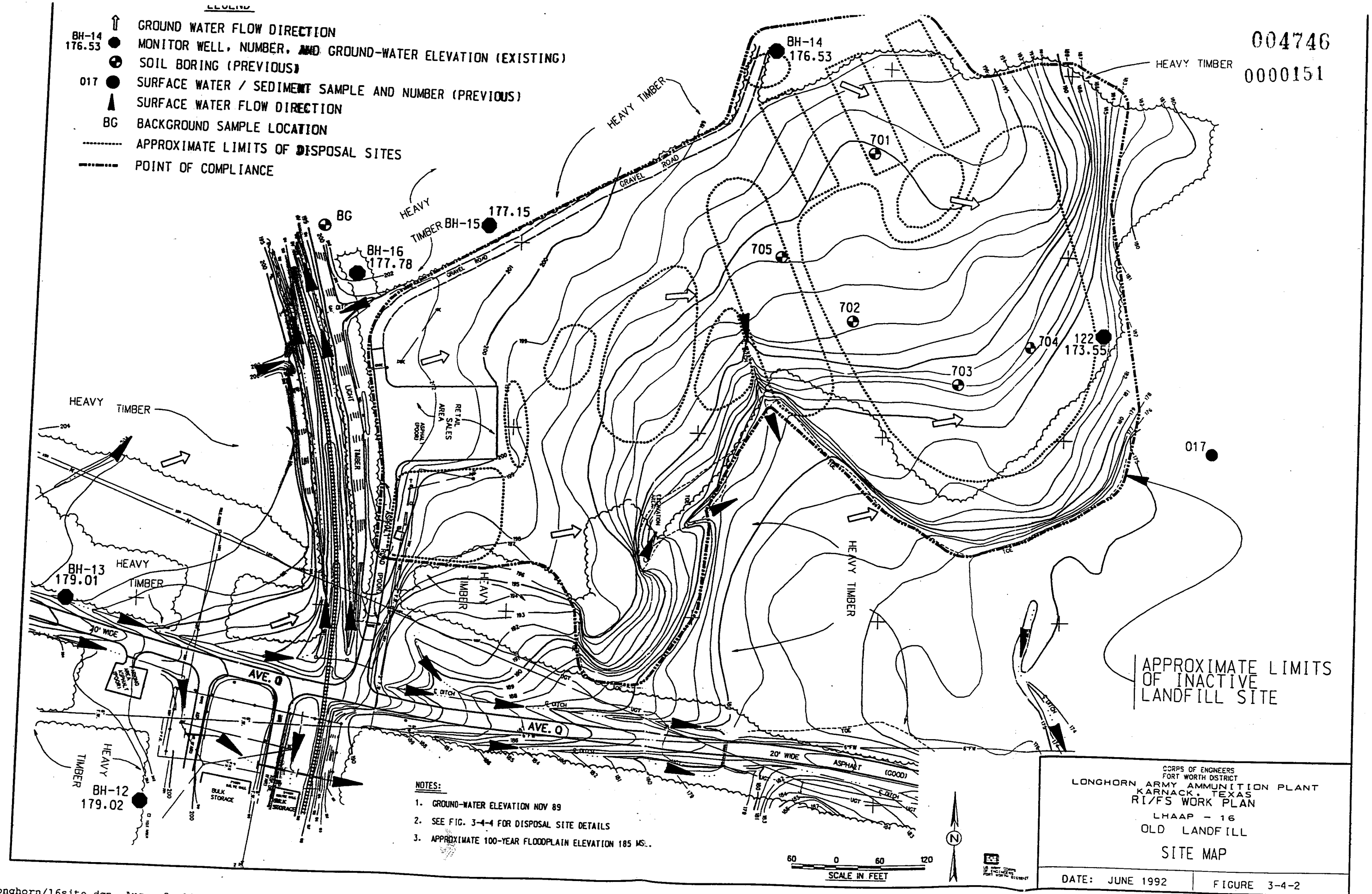


FIGURE 3-4-1 LOCATION MAP FOR LHAAP #16

US Army Corps of Engineers Fort Worth District

LEGEND

- GROUND WATER FLOW DIRECTION
- BH-14 176.53 — MONITOR WELL, NUMBER, AND GROUND-WATER ELEVATION (EXISTING)
- SOIL BORING (PREVIOUS)
- 017 — SURFACE WATER / SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- SURFACE WATER FLOW DIRECTION
- BG — BACKGROUND SAMPLE LOCATION
- ..... APPROXIMATE LIMITS OF DISPOSAL SITES
- ----- POINT OF COMPLIANCE



NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. SEE FIG. 3-4-4 FOR DISPOSAL SITE DETAILS
3. APPROXIMATE 100-YEAR FLOODPLAIN ELEVATION 185 MSL.

60 0 60 120
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 16
OLD LANDFILL
SITE MAP

DATE: JUNE 1992 | FIGURE 3-4-2

I:/ed/drawing/longhorn/16site.dgn Aug. 3, 1992 10:28:51

the landfill and leachate generated; however, locations of these observations were not noted.

Environmental Protection Systems, Inc. investigated the site in 1982 for USATHAMA and published a report documenting the investigation in June 1984 (EPS, 1984). As part of this investigation, monitoring well 122 was installed on the eastern downgradient edge of the site. Well 122 has a screen setting which monitors shallow ground water at depths between 8.5 and 23.5 feet. The boring log and well construction detail for Well 122 is provided as Figure 3-4-3. Both Well 122 and four of the USAEHA wells in the vicinity of the landfill, wells BH-12, BH-13, BH-14, and BH-16, were sampled. No explanation was given for not sampling BH-15. A summary of the ground-water analytical results is shown on Table 3-4-1. A surface water and stream sediment sampling station (017) was established immediately east of the site in Harrison Bayou to determine the impact of surface water runoff and any ground-water discharge from the landfill into the bayou. The results of the analyses performed on these samples are shown on Table 3-4-2. Additionally, surface (0 - 2.5 feet) and near-surface (2.5 - 5.0 feet) soil samples were taken at five locations (701 through 705) on the landfill, shown on Figure 3-4-2. Analytical results for these soil samples are summarized on Table 3-4-3. All samples taken were analyzed for explosives, selected metals (total), and selected anions.

An investigation to verify the presence of explosives contamination at the site was performed by EPS for Morton Thiokol, Inc., in 1987, and the report was published in May 1988 (EPS, 1988). Wells 122, BH-12, BH-13, and BH-16 were sampled, and ten surface soil samples (SS-1 through SS-10) were taken to a depth of 6 inches each

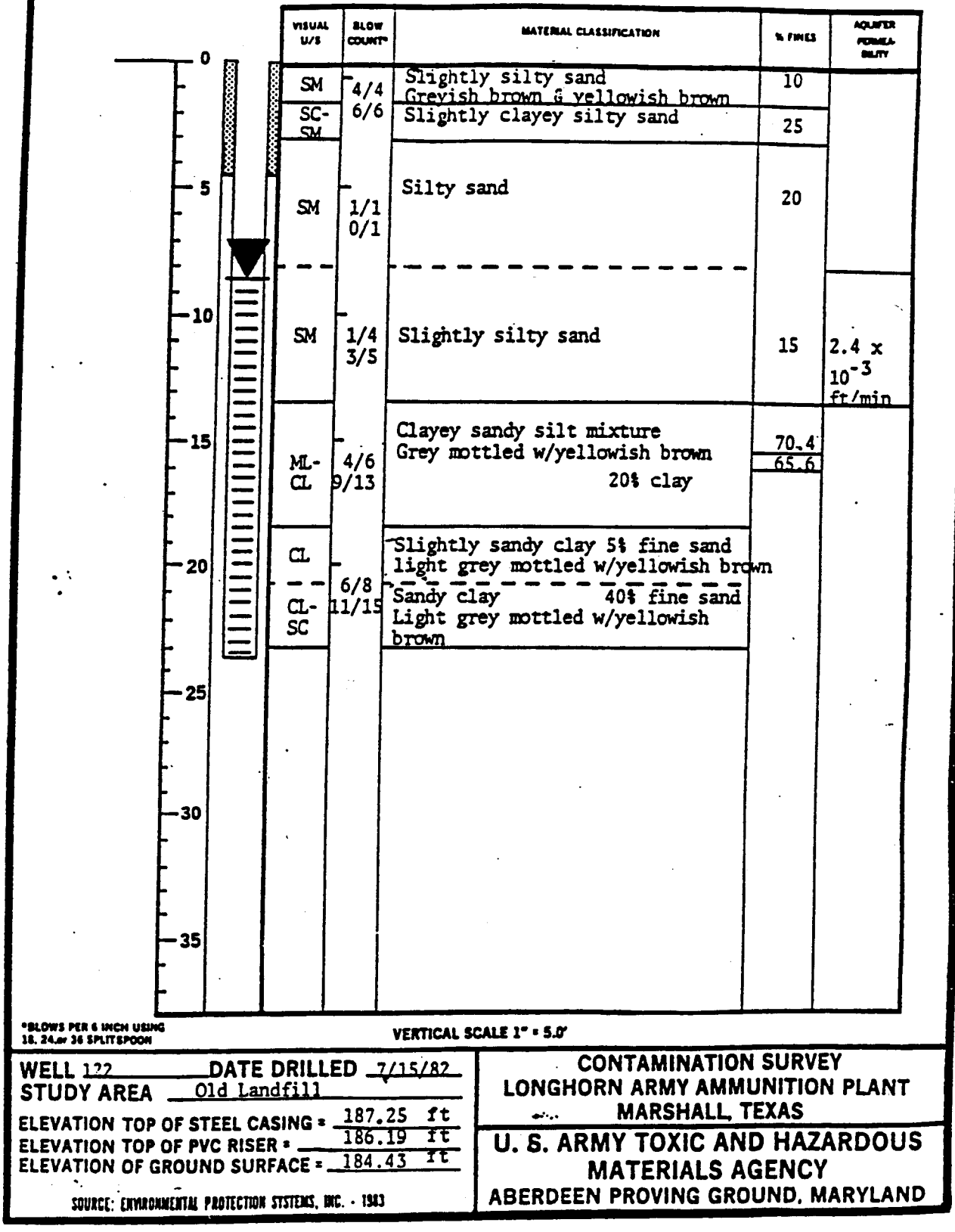


FIGURE 3-4-3
BORING LOG AND WELL
CONSTRUCTION DETAIL FOR
MONITORING WELL NO. 122

TABLE 3-4-1

SUMMARY OF 1984 GROUND-WATER ANALYSES
LHAAP 16
OLD LANDFILL
(p. 1 of 2)

PARAMETER	WELL 122	WELL BH-12	WELL BH-13	WELL BH-14	WELL BH-16
EXPLOSIVES (ug/l)					
1,3-DNB	<1.68	<1.68	<1.68	<1.68	<1.68
2,4-DNT	<0.89	<0.89	<0.89	<0.89	<0.89
2,6-DNT	<1.20	<1.20	<1.20	<1.20	<1.20
Nitrobenzene	<0.76	<0.76	<0.76	<0.76	<0.76
2,4,6-TNT	<1.46	<1.46	<1.46	<1.46	<1.46
1,3,5-TNB	<1.08	6.09	<1.08	<1.08	<1.08
METALS (ug/l)					
Aluminum	362.00	67.70	24.20	227.00	236.00
Antimony	<10.2	<10.2	<10.2	<10.2	<10.2
Arsenic	<6	<6	<6	<6	<6
Barium	217.00	42.40	60.50	95.50	156.60
Beryllium	<10	<10	<10	<10	<10
Cadmium	6.84	<0.28	<0.28	2.97	0.91
Chromium	8.70	55.80	13.30	7.60	9.00
Copper	<23.9	<23.9	<23.9	<23.9	<23.9
Lead	<7.49	49.60	<7.49	80.90	<7.49
Manganese	4460.00	151.00	127.00	312.00	360.00
Mercury	<1.3	3.2	<1.3	<1.3	<1.3
Nickel	<30	49	34	73	165
Selenium	<6	<6	<6	<6	<6
Silver	<10	<10	<10	<10	<10
Strontium	1112.00	62.00	930.00	1560.00	29.20.00
Thallium	<50	<50	<50	140	160
Zinc	<27.1	<27.1	<27.1	<27.1	<27.1
ANIONS (ug/l)					
Chloride	328000	6000	1056000	826000	878000
Chromate	<500	<500	<500	<500	<500
Cyanide	<600	<600	<600	<600	<600
Fluoride	100	<500	2000	2000	1000
Nitrate	<500	1230	700	<500	<500
Nitrite	<250	<250	<250	<250	<250
Phosphates	<125	<125	3930	<125	<125
Sulfate	122000	2110	1340	67000	67000
Thiocyanate	<500	<500	<500	<500	<500

TABLE 3-4-1

SUMMARY OF 1984 GROUND-WATER ANALYSES
LHAAP 16
OLD LANDFILL
(p. 2 of 2)

PARAMETER	WELL 122	WELL BH-12	WELL BH-13	WELL BH-14	WELL BH-16
ORGANICS [GC/MS] (ug/l)					
Benzene	<1	<1	<1	<1	NA
Chlorocyclohexane	ND	ND	ND	ND	NA
Chloroform	<1	<1	<1	<1	NA
o-Chlorophenol	<0.7	<0.7	<0.7	<0.7	NA
Dibutylphthalate	<2	<2	<2	<2	NA
Dichloromethane	ND	ND	ND	ND	NA
2,4-Dichlorophenol	<1	<1	<1	<1	NA
Diethylphthalate	<2	<2	<2	<2	NA
2-(1-1-Dimethylethoxy)-Ethanol	12	ND	ND	ND	NA
2-Dimethyl-4-Delene	12	ND	ND	ND	NA
Nitrobenzene	<1	<1	<1	<1	NA
Pentachlorophenol	<2	<2	<2	<2	NA
Phenol	ND	ND	ND	ND	NA
Tetrahydrofuran	ND	ND	10	ND	NA
Trichloroethene	<1	<1	<1	<1	NA
Trichloromethane	ND	ND	10	ND	NA
ORGANICS [GC/EC] (ug/l)					
Arocior 1016	<0.6	NA	NA	<0.6	<0.6
alpha-BHC	<0.09	NA	NA	<0.09	<0.09
beta-BHC	ND	NA	NA	ND	ND
delta-BHC	ND	NA	NA	ND	ND
gamma-BHC	ND	NA	NA	ND	ND
p,p'-DDT	<0.05	NA	NA	<0.05	<0.05
p,p'-DDE	ND	NA	NA	ND	ND
Dieldrin	<0.09	NA	NA	<0.09	<0.09
Endosulfan I	ND	NA	NA	ND	ND
Endrin	ND	NA	NA	ND	ND
Heptachlor	<0.05	NA	NA	<0.05	<0.05
Toxaphene	<4	NA	NA	<4	<4

ABBREVIATIONS:

< Below Detection Limit
NA Not analyzed
ND Analyzed but not detected. No detection limits specified.

SOURCE OF DATA : Environmental Protection Systems, Inc., 1984

TABLE 3-4-2

SUMMARY OF 1984 SURFACE WATER AND SEDIMENT ANALYSES
LHAAP 16
OLD LANDFILL
(p. 1 of 2)

PARAMETER	SW 017 (ug/l)	SED 017 (ug/g)
EXPLOSIVES		
1,3-DNB	< 1.68	12.2
2,4-DNT	< 0.89	< 0.5
2,6-DNT	< 1.20	15
Nitrobenzene	< 0.76	< 1.15
1,3,5-TNB	< 1.08	< 0.71
2,4,6-TNT	< 1.46	3.9
METALS		
Aluminum	337.00	1520.7
Antimony	< 10.2	< 0.76
Arsenic	< 6	< 0.3
Barium	< 11.4	333
Beryllium	< 10	< 0.5
Cadmium	< 0.28	< 0.5
Chromium	8.40	9.1
Copper	< 23.9	12.2
Lead	20.10	32.1
Manganese	49.00	1032.3
Mercury	< 1.3	< 2.7
Nickel	82	15
Selenium	< 6	< 0.5
Silver	< 10	< 0.5
Strontium	80.00	29.6
Thallium	40	< 3
Zinc	< 27.1	3.9
ANIONS		
Chloride	8000	41
Chromate	< 500	< 5
Cyanide	< 600	< 5
Fluoride	< 500	< 5
Nitrate	< 500	12.25
Phosphate	< 125	< 25
Sulfate	8170	84.92
Thiocyanate	< 500	< 10

TABLE 3-4-2

SUMMARY OF 1984 SURFACE WATER AND SEDIMENT
LHAAP 16
OLD LANDFILL
(p. 2 of 2)

PARAMETER	SW 017 (ug/l)	SED 017 (ug/g)
ORGANICS (GC/MS)		
1,1-Bicyclohexyl	17	ND
Benzene	< 1	ND
6-Bromohexanone	ND	ND
Chloroform	< 1	ND
o-Chlorophenol	< 0.7	< 0.7
Cyclopentylmethyl-cyclohexane	ND	ND
2,4-Dichlorophenol	< 1	< 1
Dibutylphthalate	< 2	< 0.7
Diethylphthalate	< 2	< 1
Nitrobenzene	< 1	< 0.6
Pentachlorophenol	< 2	< 1
Pentane	<	ND
Phenol	10	ND
2-Quinolinecarbox-Aldehyde-8-Hydroxy-oxime	10	ND
Trichlorethylene	< 1	ND
ORGANICS (GC/EC)		
Aroclor 1016	< 0.6	NA
Aroclor 1260	< 1	NA
alpha-BHC	< 0.09	NA
p,p'-DDT	< 0.05	NA
Dieldrin	< 0.09	NA
Heptachlor	< 0.05	NA
Lindane	< 0.09	NA
Toxaphene	< 4	NA

ABBREVIATIONS:

<	Below Detection Limit
NA	Not analyzed
ND	Analyzed but not detected. No detection limits specified.
SW	Surface Water
SED	Sediment

SOURCE OF DATA : Environmental Protection Systems, Inc., 1984

TABLE 3-4-3

SUMMARY OF 1984 SOIL ANALYSES
LHAAP 16
OLD LANDFILL

SAMPLE NO. / DEPTH / PARAMETER	701T (0-2.5 ft) [ug/g]	701B (2.5-5 ft) [ug/g]	702T (0-2.5 ft) [ug/g]	702B (2.5-5 ft) [ug/g]	703T (0-2.5 ft) [ug/g]	703B (2.5-5 ft) [ug/g]	704T (0-2.5 ft) [ug/g]	704B (2.5-5 ft) [ug/g]	705T (0-2.5 ft) [ug/g]	705B (2.5-5 ft) [ug/g]
EXPLOSIVES										
1,3-DNB	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
2,4-DNT	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
2,6-DNT	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61
Nitrobenzene	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15	< 1.15
1,3,5-TNB	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71
2,4,6-TNT	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73	< 0.73
METALS										
Aluminum	1954.3	1067.00	1461.5	1462.6	604.2	1162.8	1799.2	2024.6	2230.1	1591.2
Antimony	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Arsenic	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Barium	557.3	290.4	208.5	201.9	991.1	42.6	151.8	178.1	200.5	188.2
Beryllium	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cadmium	2.3	5.2	< 0.5	1.3	< 0.5	< 0.5	31.2	15.9	< 0.5	2.7
Chromium	14.5	22.6	9.0	16.5	95.4	47.9	70.7	58.3	10.0	15.6
Copper	155.1	153.9	5.1	53.6	33.9	26.5	66.6	63.6	8.2	86.3
ad	27.2	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	12.8	4.9
nganese	121.0	3.1	390.4	352.3	234.3	184.9	5.2	2	325.3	49.9
Mercury	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7
Nickel	7	18	5	6	8	9	10	10	5	7
Selenium	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Silver	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Strontium	153.0	232.9	25.8	340.9	91.2	116.3	1071.2	1378	32.8	137.3
Thallium	< 3	< 3	< 3	5	5	5	5	5	5	5
Zinc	18.6	472.0	37.8	133.9	169.6	132.5	759.2	773.8	53.2	23.9
ANIONS										
Chloride	72	14	120	236	102	100	426	810	5	6
Chromate	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Cyanide	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Fluoride	11	9	8	10	78	19	17	10	7	9
Nitrate	< 5	< 5	7.09	< 5	24.46	< 5	< 5	< 5	5.90	19.43
Nitrite	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Phosphate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	244.02	53.44	236.80	469.17	1323.09	446.25	187.26	239.56	54.46	152.76
Thiocyante	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

ABBREVIATIONS:

< Below Detection Limit

NA Not analyzed

ND Analyzed but not detected. No detection limits specified.

SOURCE OF DATA : Environmental Protection Systems, Inc., 1984

along the eastern toe of the landfill. No explanation was given for not sampling wells BH-14 and BH-15. Deeper soil samples were taken from a total of 20 soil borings within the limits of the landfill and were composited both vertically and horizontally in an effort to characterize any contamination present within a given area of the landfill itself. The landfill was divided into four equal quadrants (I, II, III, and IV). Five borings were drilled in each quadrant to a depth approximating the bottom of landfilled material. Borings in quadrants II and III on the eastern half of the landfill were drilled to a depth of 5 feet each, with samples composited vertically from 0 to 6 inches and from 6 inches to 5 feet in each boring. Borings in quadrants I and IV on the western half of the landfill were drilled to a depth of 15 feet, with samples composited vertically from 0 to 6 inches, 6 inches to 5 feet, 5 feet to 10 feet, and 10 feet to 15 feet. Vertically composited samples were then composited horizontally within a given quadrant to yield one sample for each depth interval sampled. Two other 5-foot deep soil borings, L1 and M1, were also drilled and sampled along the eastern toe of the site. Samples from these borings were composited vertically only from 0 to 6 inches and from 6 inches to 5 feet. Exact sample locations are unclear from available documentation in EPS, 1988, and are not shown on Figure 3-4-2 for this reason. All samples were analyzed for explosives, Priority Pollutant organics, selected metals (total), and selected anions. Results for the ground-water analyses are presented on Table 3-4-4. Results for the surface soil analyses are presented on Table 3-4-5. Results for the composited soil samples are presented on Table 3-4-6.

3.4.4 **Assessment of Existing Data and Historic Records**. Of the four wells installed during past investigations to monitor the Old

TABLE 3-4-4

SUMMARY OF 1988 GROUND-WATER ANALYSES
LHAAP 16
OLD LANDFILL

PARAMETER	BH12	BH12 Duplicate	BH12 Rinsate	BH13	122	BH16
EXPLOSIVES (ug/l)						
1,3-DNB	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,4-DNT	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,6-DNT	< 1.0	< 1.0	< 1.0	< 1.0	8.6	< 1.0
1,3,5-TNB	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,4,6-TNT	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
METALS (ug/l)						
Aluminum	24100	12.7	130	1600	< 10	11900
Antimony	< 1	< 1	< 1	< 1	1	< 1
Arsenic	< 3	< 3	< 3	< 3	< 3	< 3
Barium	340	160	< 10	260	850	600
Beryllium	10	10	10	20	0.01	0.01
Cadmium	20	10	< 10	10	10	10
Chromium	41	23	5	8	< 1	28
Copper	30	100	10	20	0.03	0.04
Lead	35	18	6	31	< 1	66
Manganese	190	250	< 10	80	30	110
Mercury	< 1	< 1	< 1	< 1	< 1	< 1
Silver	< 10	10	< 10	10	< 10	< 10
Strontium	80	< 50	< 50	290	1130	1790
Thallium	< 1	< 1	< 1	< 1	< 1	< 1
Zinc	1300	180	40	70	0.01	0.10
ANIONS (mg/l)						
Chloride	4.5	4.5	< 0.5	280	27	1180
Cyanide	< 0.01	0.01	< 0.01	< 0.01	0.01	0.06
Fluoride	0.55	< 0.02	< 0.02	0.59	4.3	2.1
Nitrate	0.53	0.68	0.08	0.78	2.76	2.19
Nitrite	0.04	0.04	0.01	0.04	0.08	0.05
Phosphate	0.33	0.16	< 0.02	0.48	0.64	0.52
Sulfate	2.2	1.0	4.5	4.5	6	58
ORGANICS [GC/MS] (ug/l)						
Vinyl Chloride	< 0.1	< 0.1	< 0.1	< 0.1	10.5	< 0.1
[BN] (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
[AE] (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

ABBREVIATION:

< Below Detection Limit

SOURCE OF DATA : Environmental Protection Systems, Inc., 1988

TABLE 3-4-5

SUMMARY OF 1988 SURFACE (0-6") SOIL ANALYSES
LHAAP 16
OLD LANDFILL

PARAMETER	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10
EXPLOSIVES (ug/kg)										
1,3-DNB	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
2,4-DNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
2,6-DNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
1,3,5-TNB	< 10	< 10	< 10	19	153	< 10	< 10	< 10	39	13
2,4,6-TNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
METALS (ug/g)										
Aluminum	10200	9250	9080	5500	4990	8820	6610	6080	10000	8870
Antimony	< 0.1	< 0.1	< 0.76	< 0.76	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.76
Arsenic	1.0	0.6	0.8	< 0.3	0.6	3.0	0.7	1.1	1.9	1.9
Barium	80	28	59	69	61	80	60	25	80	43
Beryllium	0.8	0.6	0.8	0.9	0.8	1.1	0.6	0.6	1.5	1.1
Cadmium	0.8	0.6	0.7	0.5	0.5	0.9	0.5	0.5	0.5	0.5
Chromium	11.2	7.7	8.7	5.9	6.6	12.2	7.3	8.6	8.4	5.5
Copper	6.9	3.8	5.4	3.1	3.0	11.0	5.0	4.1	6.0	4.3
Lead	14	12	18	14	15	26	37	11	21	9
Manganese	240	192	364	735	523	520	224	118	2020	1020
Mercury	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Silver	0.6	0.2	0.3	0.1	0.2	0.5	0.1	0.3	0.3	0.2
Strontium	1.2	0.5	0.7	0.6	0.8	1.8	1.0	1.0	1.6	0.8
Thallium	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Zinc	26.3	15.8	32.5	17.8	21.3	50.4	46.2	35.5	51.5	19.9
ANIONS (mg/kg)										
Chloride	20	20	20	20	40	60	60	40	40	20
Cyanide	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0.5	0.8	0.4
Fluoride	67	35	57	42	22	59	70	59	50	32
Nitrate	22	5.4	12	14	12	16	9.8	12	11	4.8
Nitrite	2.6	1.0	2.2	4.0	2.2	2.0	1.8	1.8	1.2	2.0
Phosphate	75	45	85	70	85	25	15	70	5	20
Sulfate	2.8	7.0	5.0	3.0	2.5	25	138	6.3	8.3	10
ORGANICS (mg/kg)										
GC/MS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
BN	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
AE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

ABBREVIATION:

< Below Detection Limit

SOURCE OF DATA : Environmental Protection Systems, Inc., 1988

TABLE 3-4-6

SUMMARY OF 1988 SOIL ANALYSES
LHAAP 16
OLD LANDFILL
(p. 1 of 2)

PARAMETER	BG (0"-6")	BG (6"-5')	BG (5'-10')	BG (10'-15')	L1 (0"-6")	L1 (6"-5')	L1 (6"-5') DUP	L1 RINS	M1 (0"-6")	M1 (6"-5')	QUAD II (0"-6")
EXPLOSIVES (ug/kg)											
1,3-DNB	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 10	< 10
2,4-DNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 10	< 10
2,6-DNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 10	< 10
1,3,5-TNB	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 10	67
2,4,6-TNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 10	< 10
METALS (ug/g)											
Aluminum	4180	17100	14800	7230	9730	6940	7590	494000	6890	7010	9040
Antimony	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	< 0.1
Arsenic	0.5	3.7	4.8	2.1	3.0	2.1	2.3	< 3	0.9	0.9	2.3
Barium	94	71	80	60	100	46	43	< 10	17	29	80
Beryllium	0.8	1.1	1.4	0.9	1.3	0.8	0.8	20	0.5	0.6	0.7
Cadmium	0.5	0.7	0.6	0.4	0.8	0.5	0.4	< 10	0.4	0.4	0.8
Chromium	10.6	12.3	12.1	11.8	9.7	6.7	6.2	3	6.2	8.3	11.7
Copper	1.8	7.2	9.2	6.0	4.9	5.5	4.6	< 10	2.8	4.1	14.7
Lead	15	10	9	5	27	10	11	< 1	5	11	330
Manganese	2100	148	109	98.5	1170	660	719	1390	69.0	117	176
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 0.1	< 0.1	0.1
Silver	0.2	0.4	0.3	0.3	0.3	0.3	0.2	10	0.2	0.3	0.6
Strontium	< 0.5	0.9	1.0	1.0	1.4	0.5	0.5	< 50	0.5	0.7	0.8
Thallium	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 1	< 3	< 3	< 3
Zinc	10.6	31.3	53.9	35.4	54.1	21.0	19.9	730	12.2	13.6	92.8
ANIONS (mg/kg)											
Chloride	30	70	70	30	270	170	< 10	2.5	50	40	30
Cyanide	0.7	0.5	< 0.1	0.1	0.2	0.1	0.1	0.01	0.1	0.2	0.6
Fluoride	26	59	46	57	38	30	69	0.59	40	71	70
Nitrate	45	18	12	35	160	39	3.8	0.11	13	15	14
Nitrite	5.9	4.8	3.4	4.2	8.4	7.8	0.8	0.01	3.0	4.6	1.0
Phosphate	96	35	98	45	171	105	146	0.03	102	90	166
Sulfate	2.4	5.0	6.7	3.0	4.5	250	288	2.7	13	21	60
ORGANICS											
GC/MS (mg/kg)											
Trichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.1	<0.001	<0.001	0.05
Dichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.1	<0.001	<0.001	<0.001
Vinyl Chloride	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.1	<0.001	<0.001	<0.001
1,1-Dichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.1	<0.001	<0.001	<0.001
BN (mg/kg)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.01	< 0.3	< 0.3	< 0.3
AE (mg/kg)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.01	< 0.3	< 0.3	< 0.3

TABLE 3-4-6

SUMMARY OF 1988 SOIL ANALYSES
LHAAP 16
OLD LANDFILL
(p. 2 of 2)

SAMPLE NO. (Depth)	QUAD II (6"-5')	QUAD III (0"-6")	QUAD III (6"-5')	QUAD IV (0"-6")	QUAD IV (6"-5')	QUAD IV (5'-10')	QUAD IV (10'-15')	QUAD I (0"-6")	QUAD I (6"-5')	QUAD I (5'-10')	QUAD I (10'-15')
EXPLOSIVES (ug/kg)											
1,3-DNB	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
2,4-DNT	< 10	< 10	< 10	< 10	< 10	< 10	73	< 10	< 10	< 10	47
2,6-DNT	< 10	< 10	< 10	< 10	< 10	173	87	< 10	< 10	< 10	100
1,3,5-TNB	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
2,4,6-TNT	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
METALS (ug/g)											
Aluminum	9570	7750	16900	9400	9800	8510	6670	13400	27	127	5280
Antimony	< 0.1	< 0.1	< 0.1	< 0.1	3.4	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.76
Arsenic	3.5	1.7	4.4	2.4	4.5	2.6	1.4	3.3	< 0.3	< 0.3	0.3
Barium	68	250	130	37	700	290	160	120	90	< 5	96
Beryllium	0.9	1.2	1.3	0.9	0.9	0.7	0.7	0.7	0.1	0.1	0.7
Cadmium	0.7	1.3	1.3	0.6	3.4	0.9	0.4	0.5	0.1	0.1	0.6
Chromium	11.9	14.1	16.7	9.9	104	43.7	24.8	33.6	< 0.5	0.6	23.3
Copper	10.8	15.6	17.0	5.5	190	244	38.2	18.5	0.6	0.2	37.3
Lead	1300	7.2	110	8	2000	980	200	25	2	2	140
Manganese	61.1	680	197	149	474	200	243	229	16.5	1.0	126
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Silver	0.6	0.5	0.5	0.5	0.9	0.6	0.5	3.9	< 0.1	< 0.1	0.5
Strontium	0.9	10.3	2.3	0.7	35.8	14.1	10.1	7.1	7.2	< 0.5	0.9
Thallium	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Zinc	123	98.7	105	21.6	796	459	115	131	0.8	1.6	268
ANIONS (mg/kg)											
Chloride	110	40	190	30	60	50	90	< 10	30	190	130
Cyanide	0.2	0.2	0.1	0.1	0.1	0.1	0.4	0.2	0.1	< 0.1	0.4
Fluoride	68	50	89	48	84	93	58	74	23	16	13
Nitrate	73	46	86	29	65	86	108	3.5	82	81	107
Nitrite	7.2	5.8	7.6	6.4	1.4	1.4	1.2	1.1	1.2	7.4	2.8
Phosphate	63	79	83	13	8.0	120	16	72	6.0	5.0	46
Sulfate	740	7.3	38	12	83	80	170	23	49	70	433
ORGANICS											
GC/MS (mg/kg)											
Trichloroethene	<0.001	<0.001	<0.001	<0.001	0.14	0.073	<0.001	<0.001	<0.001	<0.001	1.0
Dichloroethene	<0.001	<0.001	<0.001	<0.001	0.48	0.177	<0.001	<0.001	<0.001	1.9	1.4
Vinyl Chloride	<0.001	<0.001	<0.001	<0.001	0.16	0.19	0.22	<0.001	<0.001	2.1	0.8
1,1-Dichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	2.6	<0.001	<0.001	<0.001	<0.001
BN (mg/kg)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
AE (mg/kg)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	11.6

ABBREVIATION:

< Below Detection Limit

SOURCE OF DATA : Environmental Protection Systems, Inc., 1988

Landfill, only Well 122 is considered to be downgradient of the site. Well BH-12, located southwest of the site adjacent to Bldg 49-W, was installed as a downgradient well, to monitor LHAAP 14, is really upgradient to both LHAAP 14 and LHAAP 16, yet analyses in 1984 showed a trace of 1,3,5-TNB at 6.09 ug/l. The source of this ground-water contamination is not related to the Old Landfill or the Area 54 Burial Ground and discounts the well for use to establish background levels. Well 122 detected 8.6 ug/l of 2,6-DNT and 10.5 ug/l of vinyl chloride during the 1988 investigation. Except for lead exceeding the SWDA MCL in BH-16, no other contaminants were identified in any of the other wells.

The analytical results for surface water collected at Station 017 in Harrison Bayou did not differ from background concentrations (EPS, 1984); however, sediments collected from the same station showed traces of the explosives 1,3-DNB (12.2 ug/g), 2,6-DNT (15 ug/g), and 2,4,6-TNT (3.9 ug/g). A few surface soil samples showed low concentrations (<153 ug/kg) of 1,3,5-TNB, with no 1,3,5-TNB identified in soils at depth. The explosive 2,4,6-TNT was also identified in one near surface soil sample at a concentration of 13.6 ug/g. Explosive compounds identified at depth were 2,4-DNT and 2,6-DNT at maximum concentrations of 73 ug/kg and 173 ug/kg, respectively, to composited depths up to 15 feet within Quadrant IV. Quadrant IV also exhibited concentrations of TCE as high as 0.14 mg/kg in the top 5 feet, DCE as high as 0.48 mg/kg in the top 5 feet, vinyl chloride as high as 0.22 mg/kg down to 15 feet, and 1,1-DCA at 2.6 mg/kg from 10 to 15 feet. Quadrant I also exhibited concentrations of the organic compounds with TCE at 1.0 mg/kg at 15 feet, DCE as high as 1.9 mg/kg at 10 feet, and vinyl chloride as high as 2.1 mg/kg at 10 feet.

There is little documentation identifying the types of wastes treated and disposed at the landfill during its approximately 40 years of operation. What is available, however, are aerial photographs of the site and an undated sketch made by installation personnel showing the locations of some of the activities performed at the site. These activities are several burn pits, landfilling of construction debris and materials, disposal of sulfur, TNT, stripping wastes, burning ground ashes and residues, and photo flash wastes, as well as the approximate area for burial of the Pershing rocket casings. A schematic representation of the location of these activities is provided on Figure 3-4-4. Review of 1954 aerial photos shows a large bermed depression in the center of the site, referred to during previous EPS investigations as an artificial pond. It is suspected that a variety of wastes, many with a solvent base, were disposed of in this area. Some photos show smoke at the site, probably indicative of burn pit activities. Materials appeared to be stacked and stored at several times in both the northwest and southeast corners of the site. By 1985, all activities appear to have ceased.

The random sampling performed during the two previous investigations identifies low concentrations of explosives and chlorinated organic compounds in the soils at the site. One explosive compound (2,6-DNT) occurs both in the ground water downgradient of the site and in the sediments of Harrison Bayou adjacent to the site. Other explosive compounds have also been identified in the sediments of Harrison Bayou at the one location that was sampled. Of the organic compounds identified in the landfill soils at the eastern end of the site, vinyl chloride was the only compound detected in the ground water sampled from Well 122. Organics were not detected in any

LEGEND

- GROUND WATER FLOW DIRECTION
- BH-14 176.53 — MONITOR WELL, NUMBER, AND GROUND-WATER ELEVATION (EXISTING)
- SURFACE WATER FLOW DIRECTION
- APPROXIMATE LIMITS OF DISPOSAL SITES
- POINT OF COMPLIANCE

BH-14 176.53
BH-15 177.15
BH-16 177.78
BH-13 179.01
BH-12 179.02
122 173.55

PHOTO FLASH
HEAVY TIMBER
GRAVEL ROAD
BURN PIT
GLASS PIT
BURNING GROUND NO. 3 ASH
CONSTRUCTION MATERIAL, IRON SCRAP, RUBBLE, BURNING GROUND NO. 3 ASH, 3 PERISHING CASINGS
CONSTRUCTION MATERIAL
SULFUR, TNT
STRIPPING, MISC.
RETAIL SALES AREA
ASPHALT ROAD
SCRAP WOOD
AVE. Q
30' WIDE
20' WIDE ASPHALT (GOOD)
BULK STORAGE
F. DITCH
UCT
TOE
TOP

APPROXIMATE LIMITS OF INACTIVE LANDFILL SITE

NOTES:

1. LOCATIONS AND MATERIALS SHOWN ARE INTERPRETED FROM 1954, 1963, 1970, 1978, AND 1985 AERIAL PHOTOS AND LHAAP FILES.
2. APPROXIMATE 100-YEAR FLOODPLAIN ELEVATION 185 MSL.

60 0 60 120
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 16
OLD LANDFILL
PAST ACTIVITIES

DATE: JUNE 1992 | FIGURE 3-4-4

/ed/drawing/longhorn/16garbge.dgn Aug. 3, 1992 11:21:00

other media sampled. The presence of these constituents are consistent with the scarce documentation for the site which indicates a good possibility of explosive wastes and solvent-based wastes being disposed here.

3.4.5 **Potential Contaminants and Migration Pathways**. The suspected source of contamination is primarily buried explosive and solvent wastes, as well as possible other unknown wastes. Previous investigations have confirmed low concentrations of explosive and organic compounds in the soils at depth within the landfill, in the surface soils of the landfill, and in the ground water downgradient of the landfill. Explosives were also identified in the sediment of Harrison Bayou adjacent to and downslope of the site. The organic compound vinyl chloride, a degradation product of TCE, was identified in both the soils of the landfill and at a low concentration in the downgradient Well 122. No metallic compounds have been verified as contaminants in ground water downgradient of the site. However, assuming that explosives, organics, and metallic wastes are buried within the soils at the site, these contaminants could follow the potential migration pathways described below.

3.4.5.1 **Surface Water**. Although previous investigations have not identified contaminants in the surface water in the adjacent tributary of Harrison Bayou, the potential exists for surface water contamination due to runoff across surface soils contaminated with explosives and from possible discharge of contaminated ground water to surface water drainage. The eastern end of the site is located within the floodplain of Harrison Bayou.

3.4.5.2 **Sediments**. Erosion of contaminated soils during heavy rainfall and flooding could produce contaminated sediment that

would be carried by surface water runoff into the tributary of Harrison Bayou adjacent to the site.

3.4.5.3 **Soils**. Soils are contaminated at the surface and to depths of at least 15 feet with very low concentrations of explosive compounds and low concentrations of chlorinated organic compounds within the eastern portion of the site. This creates the potential for contaminating surface runoff from the site and for leaching contaminants down to ground water beneath the site.

3.4.5.4 **Ground Water**. Ground water in Well 122, located immediately downgradient of the site, shows some evidence of explosive and organics contamination, demonstrating that ground water is a pathway for contaminant migration from the site. Seasonal fluctuation of the water table also increases the potential for contaminants to enter this pathway by allowing the ground water to possibly intercept wastes or residues buried at the site. Rainfall from the surface can also percolate through the landfill and leach contaminants present in the soil down to the water table. Contaminated ground water could discharge to the surface drainage regime.

3.4.5.5 **Air**. The site is currently protected from wind erosion by the vegetative cover that exists over most of the site. Air could become a contaminant migration pathway if the vegetative cover was removed or contaminated soils were disturbed.

3.4.6 **Identification of Potential Receptors**. The general public does not have ready access to the Old Landfill site because it is confined within secured LHAAP boundaries. Access is further restricted by a locked gate on the entrance road to the site. The landfill itself is no longer active, but near the entry way is an open area currently used for storing inert goods awaiting to be sold. Work

personnel transport these materials to and from this holding area, but have little reason to go further to the landfill area. The Old Landfill site is located in hunting zone 14. Therefore, the population having direct use of the site is primarily limited to the occasional hunter.

Because ground water occurs under unconfined conditions over much of the installation, discharge of contaminated ground water to the tributary of Harrison Bayou adjacent to the site poses a potential threat. To threaten any area public water supply wells, contaminants must first migrate downward to elevations below which surface water discharge occurs to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply well, Well 902, is approximately 2.2 miles southwest of the site in the down-dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future use.

The site is located in the Caddo Lake watershed. As water flows, the site is over 2.0 miles upstream of Lake Caddo. There are no water bodies or watercourses running through the site. A tributary of Harrison Bayou flows adjacent to the toe of the landfill. The landfill surface is sloped and is vegetated with mostly grass and

weeds. Although there are no visible signs of contaminant seepage on the surface or signs of significant erosion, there is a relatively high potential for contaminated ground water to enter the adjacent water course. The site is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would significantly disturb the soil and cause sediment transport to downstream surface water and hence into Caddo Lake. Caddo Lake water, which ultimately supplies about 16,600 Louisiana residents, is not known to be affected by contamination from this site.

The surface of the Old Landfill site is predominantly vegetated with a variety of grasses and forbs and with a few small scattered willows. There are few places on the surface where the ground vegetative cover is scarce. In these areas, contamination from the landfill is suspected of inhibiting the existing plant life. However, passerine birds like the eastern bluebird have been sighted in the field. On the perimeter of the field near the dirt access road, plum and pear trees grow wild near an old home site located in the adjacent woodland. There are also a few dogwoods, willows, and shrubs along the edge. Woods adjacent to this transition are predominantly pine/hardwood.

3.4.7 Initial Remedial Action. Explosives and organic compounds have been identified in the soils at the site and in the ground water downgradient of the site. Explosives have also been found in the sediments leaving the site. However, the low concentrations detected along these migration routes pose no imminent threat to potential receptors at this time, thus precluding any immediate remedial action being performed.

NPL + RCRA 004766

3.5 LHAAP 17 - BURNING GROUND NO. 2/FLASHING AREA

3.5.1 Site History. Burning Ground No. 2/Flashing Area was used for burning bulk TNT, photo flash powder, and reject material when LHAAP was operated by Universal Match Corporation. Although it has been reported that bulk TNT was uncovered at the site in 1954, there is no documentation to support bulk TNT burial at the site. In 1959, all of the materials removed from the TNT Production Area (LHAAP 29) and the TNT Waste Disposal Plant (LHAAP 32) during razing were burned and/or flashed at this site. The site was then used until 1980 as a flashing area to decontaminate recoverable metal by-products. Burning trenches were located around the inside perimeter of the previous fenced area and within the open area on the western side of the site. As each trench filled with ash, the trench was covered and a new trench was dug. The waste residues were reportedly removed in 1984 and the site was allowed to revegetate. The site is presently inactive.

3.5.2 Site Description The Burning Ground No. 2/Flashing Area site is located in the southeastern quadrant of LHAAP at the intersection of Long Point Road and Avenue Q. The site is approximately 350 feet north of Long Point Road and immediately southwest of Burning Ground No. 3 (LHAAP 18), as shown on Figure 3-5-1. The site is situated within a heavily wooded section of LHAAP. It consists of two 185- by 305-foot cleared areas separated by a gravel entrance road. The area east of the entrance road was fenced until recently, and the area west of the road is open. Harrison Bayou flows approximately 1200 feet northwest of the site. A detailed map of the Burning Ground No. 2/Flashing Area is shown on Figure 3-5-2.

The site is relatively flat and is covered with grass and

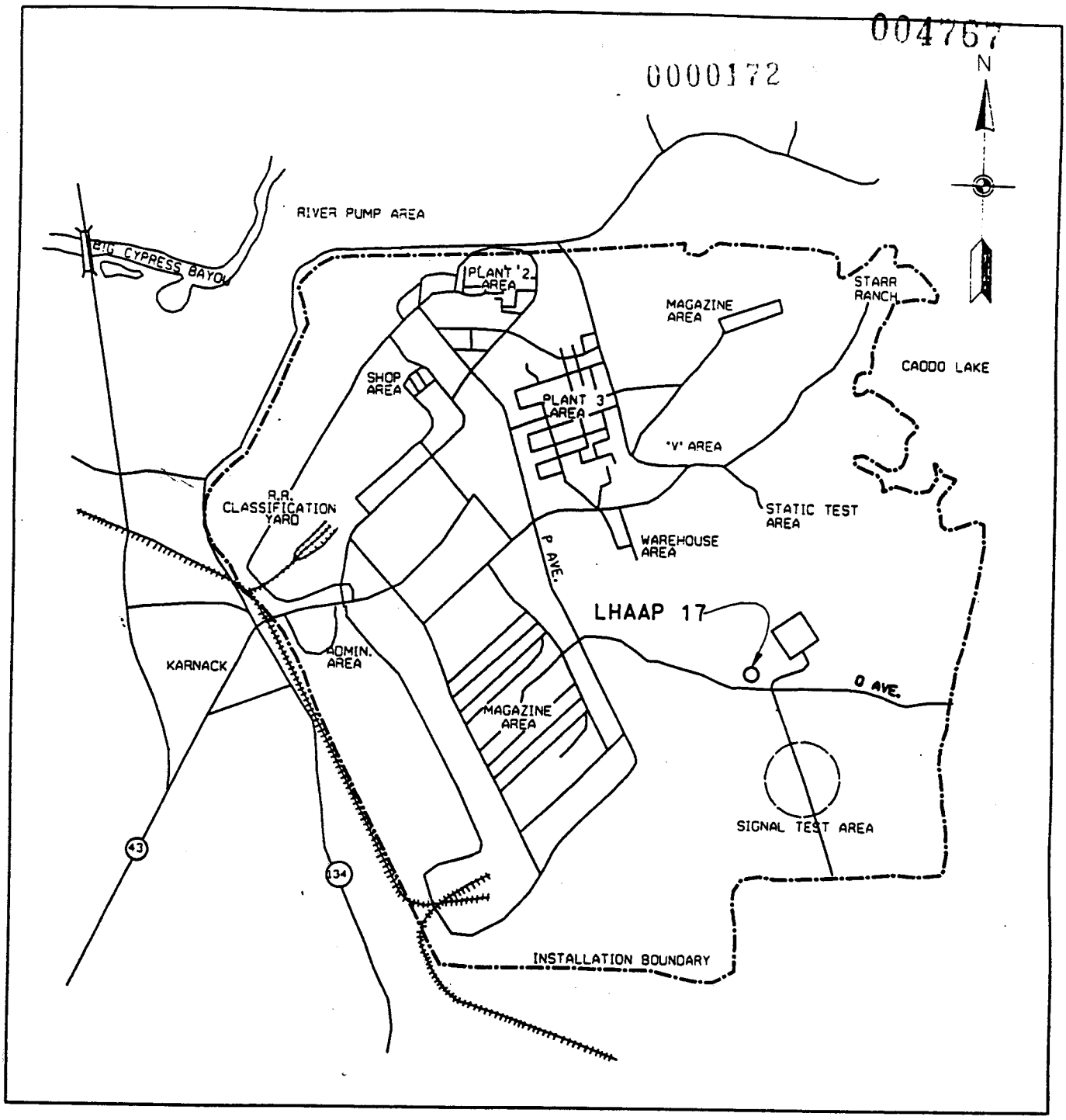
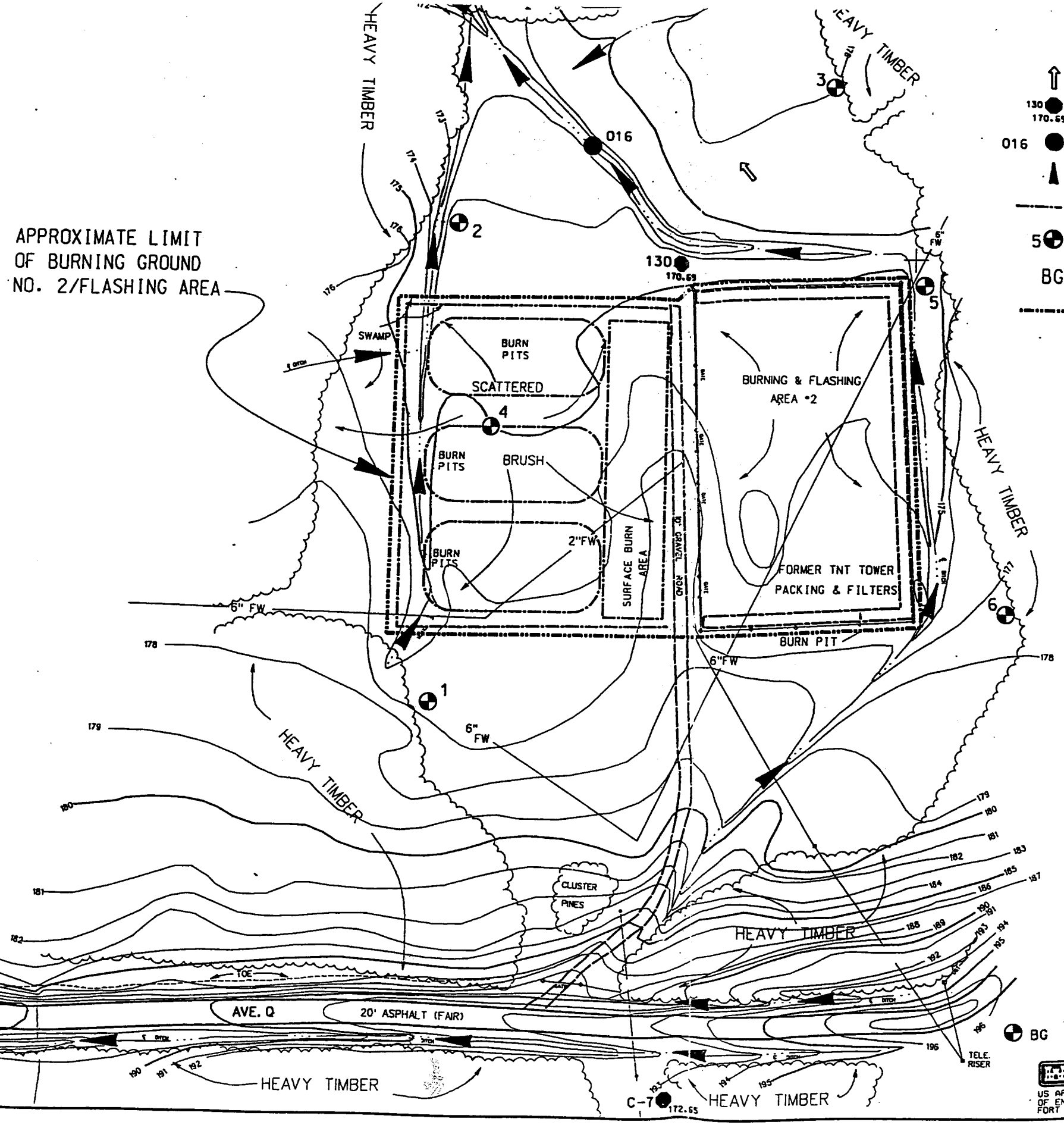


FIGURE 3-5-1 LOCATION MAP FOR LHAAP #17

US Army Corps of Engineers Fort Worth District

004768

0000173

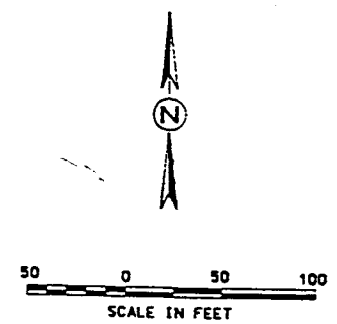


LEGEND

- GROUND WATER FLOW DIRECTION
- 130 / 170.63 — MONITOR WELL, NUMBER, AND GROUND-WATER ELEVATION (EXISTING)
- 016 — SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- SURFACE WATER FLOW DIRECTION
- APPROX. LIMITS OF BURN PITS/TRENCHES
- 5 — SOIL BORING AND NUMBER (PREVIOUS)
- BG — BACKGROUND SAMPLE
- POINT OF COMPLIANCE

NOTES:

1. GROUND-WATER ELEVATIONS NOV 89
2. PREVIOUS SAMPLE LOCATIONS ARE APPROXIMATE
3. APPROXIMATE 100-YEAR FLOODPLAIN ELEVATION 185 MSL



US ARMY CORPS
OF ENGINEERS
FORT WORTH DISTRICT

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 17
BURNING GROUND NO. 2/FLASHING AREA
SITE MAP

DATE: JUNE 1992 | FIGURE 3-5-2

ed/drawing/longhorn/17site.dgn Aug. 3, 1992 13:25:31

scattered brush. Surface drainage flows to ditches along the eastern and western edges of the site, then on to Harrison Bayou. The entire site is within the 100-year floodplain of the bayou.

Although the site has been previously investigated, there is little documentation addressing the geology and the soil types occurring there. However, based on the site's location within the floodplain of Harrison Bayou and its proximity to Burning Ground No. 3 (LHAAP No. 18), at which extensive subsurface mapping has been performed, the burning ground is likely situated on alluvial materials, overlying Wilcox materials at an unknown depth. The information logged for well boring 130 located at the site supports this assumption, showing soils consisting of silty sand interbedded with high plasticity zones (CL) to the total depth investigated of 25 feet.

Ground water occurs under unconfined conditions at a shallow depth of less than 5 feet. Based on water level measurements made in the wells monitoring the Burning Ground No. 3 area, the direction of ground-water flow across the site is to the west and northwest towards Harrison Bayou, where the ground water likely discharges to surface water drainage. The site is located hydraulically downgradient from Burning Ground No. 3 where ground-water contamination has been verified (see Para 3.6.3).

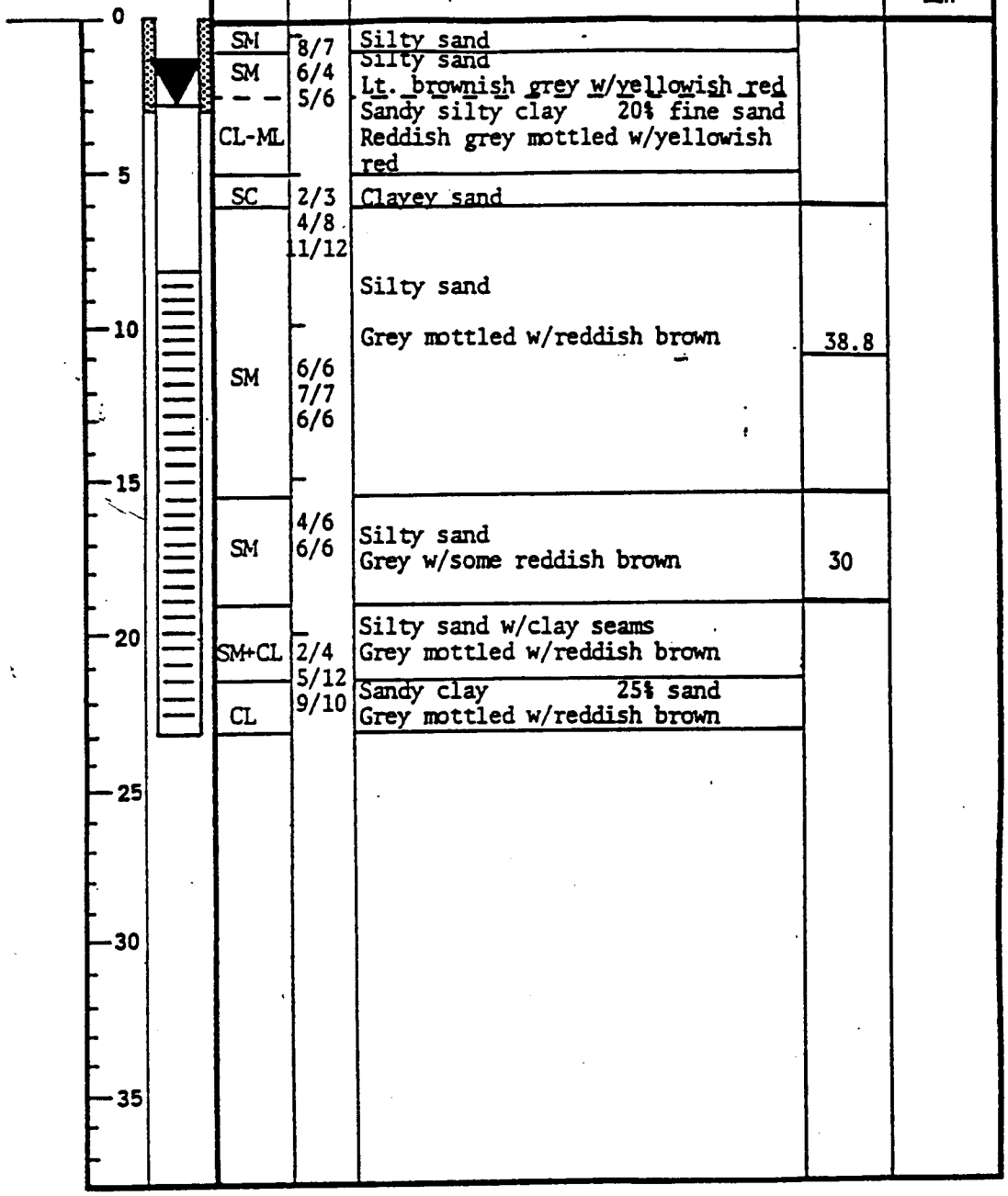
3.5.3 **Previous Investigations**. This site was originally investigated as a potentially contaminated site by EPS for USATHAMA, and a report was published in June of 1984 (EPS, 1984). One monitoring well, Well 130, was installed and sampled, and a surface water and sediment sample was collected from one location (Station 016) northwest of the site in a surface drainage path leading to

Harrison Bayou. Sampling locations are shown on Figure 3-5-2. All samples were analyzed for explosives, VOCs, selected (total) metals, and selected anions. The boring log and well construction detail for Well 130 is provided on Figure 3-5-3. The screen setting for Well 130 is from 8.2 to 23.2 feet, which monitors shallow ground water.

Well 130 was sampled as part of a study conducted in February of 1986 by Camp, Dresser and McKee Inc. (CDM, 1986), for ground-water contamination related to operation of the Unlined Evaporation Pond (LHAAP 24) located inside Burning Ground No. 3 upgradient of the site. Analyses were performed for VOCs, selected (total) metals, and selected anions.

Another investigation of the site to determine if explosives contamination was present was performed by EPS for Morton Thiokol, Inc., and the report was published in May 1988 (EPS, 1988). During this investigation, a suspected pond area was identified on 1958 aerial photos on the western side of the site. This area was not shown on 1954 or 1963 aerial photos, and there is no documentation or other evidence for a pond or lagoon at the site. Seven 5-foot deep soil borings (six at the site and one background boring off-site) were drilled. One boring was located in the center of the suspected pond area. Soil samples were vertically composited from 0 to 6 inches and from 6 inches to 5 feet. Approximate sample locations are shown on Figure 3-5-2. Monitoring Well 130 was also sampled again as part of this study. All samples were analyzed for explosives, VOCs, and selected (total) metals.

3.5.4 **Assessment of Existing Data and Historic Records**. Results of analyses performed during the first investigation of the site showed dichloromethane in Well 130 at a concentration of 153 ug/l and



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/7	Silty sand		
SM	6/4	Silty sand		
	5/6	Lt. brownish grey w/yellowish red Sandy silty clay 20% fine sand		
CL-ML		Reddish grey mottled w/yellowish red		
SC	2/3	Clayey sand		
SM	4/8	Silty sand		
	11/12	Grey mottled w/reddish brown	38.8	
	6/6			
	7/7			
	6/6			
SM	4/6	Silty sand		
	6/6	Grey w/some reddish brown	30	
SM+CL	2/4	Silty sand w/clay seams Grey mottled w/reddish brown		
	5/12			
CL	9/10	Sandy clay 25% sand Grey mottled w/reddish brown		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 130 DATE DRILLED 6/7/82
STUDY AREA Flashing Area

ELEVATION TOP OF STEEL CASING = 177.36 ft
ELEVATION TOP OF PVC RISER = 176.71 ft
ELEVATION OF GROUND SURFACE = 174.44 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-5-3
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 130

000617

0000177

004772

tetrahydrofuran at a concentration of 46 ug/l. The chloride concentration in the ground water was elevated. The ground-water analytical results for this investigation are shown on Table 3-5-1. Results for the surface water and sediment sample taken are shown on Table 3-5-2. Results from this surface water analysis indicate the presence of phenol and elevated levels of nitrate, sulfate, chloride, and nickel.

Chloride concentrations remained high during the 1986 sampling event for Well 130, as shown on Table 3-5-3. Dichloromethane was again detected at a lower concentration of 15 ug/l, which likely reflected field contamination as shown in the field blank analyses.

Soil sample analyses from the 1988 investigation are summarized on Table 3-5-4. Soil samples taken from 0 to 6 inches identified concentrations of 1,3,5-TNB at several locations to a maximum concentration of 127 ug/g at location B5. The background concentration for this compound at this depth was found to be 17 ug/kg. No other explosive compounds were identified except at location B4, centered within the suspected pond area, in which 1,3-DNB, 2,4,6-TNT, 1,3,5-TNB, 2,4-DNT, and 2,6-DNT were identified to the depth sampled of 5 feet. The highest concentration of explosive compounds found at this location was 470 ug/kg of 1,3-DNB at the composited depth of 6 inches to 5 feet. The only other analytes detected were dichloromethane, trichloroethene, and 1,4-dichlorobenzene, which were found to the total depth investigated in boring B4. Concentrations ranged from 0.13 mg/kg of dichloromethane up to 0.86 mg/kg of 1,4-dichlorobenzene. Cadmium was detected at 20 ug/l in the ground-water sample taken at this time, which exceeds the SWDA MCL of 10 ug/l. However, the rinsate for this sample detected

TABLE 3-5-1
1984 GROUND-WATER ANALYTICAL RESULTS
WELL 130
LHAAP 17
BURNING GROUND NO. 2 / FLASHING AREA (BG-2)

004773
0000178

PARAMETER	UNITS ug/l	PARAMETER	UNITS ug/l
ANIONS		EXPLOSIVES	
Nitrate	<500	1,3-DNB	<1.68
Nitrite	<250	2,4,6-TNT	<1.46
Phosphates	<125	1,3,5-TNB	<1.08
Sulfate	152,200	2,4-DNT	<0.89
Chloride	2,348,000	2,6-DNT	<1.20
Fluoride	1,000	Nitrobenzene	<0.76
Chromate	<500		
Miocyanate	<500	ORGANICS (GC/MS)	
Cyanide	<600	Benzene	<1
		Chloroform	<1
METALS		Trichloroethylene	<1
Aluminum	125	Pentachlorophenol	<2
Antimony	<10.2	o-Chlorophenol	<0.7
Barium	105	2,4-dichlorophenol	<1
Cadmium	2.22	Dibutylphthalate	<2
Chromium	<6.64	Diethylphthalate	<2
Lead	<7.49	Nitrobenzene	<1
Manganese	<12.1	Dichloromethane	153
Strontium	1160	Tetrahydrofuran	46
Mercury	<1.3		
Copper	<23.9		
Zinc	<27.1		
Arsenic	<6		
Beryllium	<10		
Nickel	81		
Selenium	<6		
Silver	<10		
Thallium	100		

From EPS Inc. report dated May 1984.

TABLE 3-5-2
SURFACE WATER AND SEDIMENT ANALYSES
LHAAP 17
BURNING GROUND NO. 2/FLASHING AREA (BG-2)

SAMPLING SITE Units	016 WATER (ug/l)	016 SEDIMENT (ug/g)		016 WATER (ug/l)	016 SEDIMENT (ug/g)
EXPLOSIVES			ORGANICS (GC/MS)		
1,3-DNB	<1.68	<0.5			
2,4,6-TNT	<1.46	<0.73	BENZENE	<1	ND
1,3,5-TNB	<1.08	<0.71	CHLOROFORM	<1	ND
2,4-DNT	<0.89	<0.5	PENTACHLOROPHENOL	<2	<1
2,6-DNT	<1.20	<0.61	o- CHLOROPHENOL	<0.7	<0.7
NITROBENZENE	<0.76	<1.15	2,4-DICHLOROPHENOL	<1	<1
			DIBUTYLPHTHALATE	<2	<0.7
ANIONS			DIETHYLPHTHALATE	<2	<1
NITRATE	940	19.62	DICHLOROMETHANE	ND	ND
NITRITE	<250	<5	PHENOL	14	ND
PHOSPHATES	<125		TRICHLOROETHENE	<1	ND
SULFATE	10500	414.40	1,1-BICYCLOHEXYL	ND	ND
CHLORIDE	4000	55	TETRADECANOIC ACID	ND	ND
FLOURIDE	<500	6			
CHROMATE	<500	<5			
THIOCYANATE	<500	<10			
CYANIDE	<600	<5			
METALS					
ALUMINUM	110.00	1281.4			
ANTIMONY	<10.2	<0.76			
BARIUM	<11.4	122.0			
CADMIUM	<0.28	<0.5			
CHROMIUM	34.50	7.1			
LEAD	<7.49	9.9			
MANGANESE	33.00	73.2			
STRONTIUM	1.60	<0.5			
MERCURY	<1.3	<2.7			
COPPER	<23.9	3.4			
ZINC	<27.1	18.3			
ARSENIC	<6	<0.3			
BERYLLIUM	<10	<0.5			
NICKEL	58. +	3			
SELENIUM	<6	<0.5			
SILVER	<10	<0.5			
THALLIUM	<50	<3			

NOTE:
+ Exceeds limit of Aquatic Life Criteria or Human Health Criteria designated by U.S. E.P.A..
ND Analyzed but not detected. No detection limits specified.
< Below detection limit

From EPS Inc. report dated May 1984.

TABLE 3-5-3
1986 GROUND-WATER ANALYTICAL RESULTS
WELL 130
LHAAP 17
BURNING GROUND NO. 2 / FLASHING AREA (BG-2)

004775

0000180

PARAMETER	WELL SAMPLE (ug/l)	FIELD BLANK (ug/l)	FIELD BLANK (ug/l)
ANIONS			
Nitrate	<100	<100	<100
Sulfate	150,000	<1000	<1000
Chloride	1,600,000	<1000	<1000
Flouride	700	<100	<100
Bromine	8,000	<2000	<2000
METALS			
Aluminum	5,600	<100	<100
Barium	<200	<200	<200
Chromium	<30	<30	<30
Lead	<50	<50	<50
Strontium	1,000	<100	<100
Magnesium	38,000	<100	<100
Mercury	<0.2	<0.2	<0.2
Zinc	40	<10	<30
ORGANICS			
Benzene	<10	<10	<10
Chloroform	ND	ND	ND
Trichloroethylene	ND	ND	ND
Dichloromethane	15	45	17
CONDUCTIVITY (umhos)	4,600	NA	NA
pH	6.8	NA	NA
Temp (deg. C)	20.0	NA	NA

ND = Not detected above quantitation limits. Quantitation limits not known.
NA = Not analyzed.
Source: CDM, 1986.

TABLE 3-5-4
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 17
BURNING GROUND NO. 2 / FLASHING AREA (BG-2)
(p. 1 of 2)

Sample Number	Background	Background	B1	B1	B2	B2 DUPL	B2	RINSATE*
Depth	0-6 in.	6in-5 ft.	0-6 in.	6in-5 ft.	0-6 in.	6in-5 ft.	6in-5 ft.	
EXPLOSIVES ug/kg								
1,3-DNB	<10	<10	<10	<10	<10	<10	<10	<1.0
2,4,6-TNT	<10	<10	<10	<10	<10	<10	<10	<1.0
1,3,5-TNB	17	<10	17	<10	13	10	<10	<1.0
2,4-DNT	<10	<10	<10	<10	<10	<10	<10	<1.0
2,6-DNT	<10	<10	<10	<10	<10	<10	<10	<1.0
METALS ug/g								
Aluminum	3100	10200	7400	11200	8300	12100	9500	2200
Antimony	5	9	9	5	9	8	7	2
Arsenic	0.5	2.8	2.4	3.8	2.3	3.7	2.3	<3
Barium	100	46	150	350	120	57	64	<10
Beryllium	0.6	0.4	0.4	0.4	0.3	0.3	<0.1	30
Cadmium	0.4	0.5	0.5	0.5	0.6	0.5	0.5	10
Chromium	12.8	14.9	9.1	11	9.6	11.2	11.3	3
Copper	2.4	3.9	4.3	5.2	8.6	6.7	12.4	10
Lead	13	9	9	9	30	15	21	38
Manganese	740	150	130	56	85	28	33	40
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1
'ver	0.1	0.2	0.2	0.3	0.2	0.2	0.2	<10
ontium	2.6	2.3	10.4	14.1	13.4	5.1	<0.1	500
nallium	<3	4	3	3	3	3	<3	<10
Zinc	9.9	10	13	12	31	20	21	40
ORGANICS mg/kg								
Dichloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.1
Trichloroethene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.1
1,4-Dichlorobenzene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.1

TABLE 3-5-4
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 17
BURNING GROUND NO. 2 / FLASHING AREA (BG-2)
(p. 2 of 2)

Sample Number	B3	B3	B4	B4	B5	B5	B6	B6
Depth	0-6 in.	6in-5 ft.	0-6 in.	6in-5 ft.	0-6 in.	6in-5 ft.	0-6 in.	6in-5 ft.
EXPLOSIVES ug/kg								
1,3-DNB	<10	<10	180	470	<10	<10	<10	<10
2,4,6-TNT	<10	<10	153	40	<10	<10	<10	<10
1,3,5-TNB	33	60	37	13	127	30	<10	23
2,4-DNT	<10	<10	33	138	<10	<10	<10	<10
2,6-DNT	<10	<10	33	53	<10	<10	<10	<10
METALS ug/g								
Aluminum	4700	8500	12500	9300	6800	9200	5300	4900
Antimony	7	7	10	8	8	9	6	8
Arsenic	1.1	2.5	2.9	4.7	1.6	2.8	0.6	1
Barium	58	210	61	610	89	180	56	77
Beryllium	0.3	0.5	0.5	0.3	0.5	0.5	0.4	1
Cadmium	0.3	0.4	1.8	0.6	0.4	0.6	0.4	0
Chromium	6	8.6	75.6	13.9	14.6	12.5	8.2	5
Copper	3.5	4.4	19	19.8	5.4	6.2	2.8	2
Lead	5	8	670	85	12	14	7	7
Manganese	140	26	280	320	220	220	150	140
Mercury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	0.2	0.2	0.4	0.3	0.2	0.2	0.1	0
Strontium	5.9	3.8	108	44.2	6.3	10.3	4.6	5
Thallium	4	<3	5	4	3	4	3	3
Zinc	12	12	220	33	14	14	8.9	8
ORGANICS mg/kg								
Dichloromethane	<0.001	<0.001	0.26	0.13	<0.001	<0.001	<0.001	<0.001
Trichloroethene	<0.001	<0.001	0.53	0.56	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	<0.001	<0.001	0.21	0.86	<0.001	<0.001	<0.001	<0.001

* UNITS ARE ug/l
< BELOW DETECTION LIMIT

FROM EPS INC. REPORT DATED MAY 1988

cadmium at 10 ug/l, making this a questionable result. Ground-water analytical results are shown on Table 3-5-5.

Results from previous investigations indicate that the suspected pond area on the western side of the site is likely the location for the burn pits and trenches used for the burning ground operations. A sketch from the files of LHAAP show these trenches, which are depicted on Figure 3-5-2. The outline of this excavated area was probably interpreted as a pond from the aerial photos. Analyses of soil samples within this location indicate explosive compounds present, which would confirm the burning of explosive contaminated wastes in this area. The low concentrations of chlorinated organic compounds within this same area also indicate possible process waste disposal within these pits and trenches. Concentrations of 1,3,5-TNB in surface soil samples, including a background location, appears to be related to background conditions rather than site-specific activities. Results from ground-water, surface water, and sediment sampling indicate no contamination of these media; however, Well 130 and the surface water/sediment sample locations are both located downgradient and downstream of the eastern area of the site only. Activities conducted within this area were not investigated.

3.5.5 **Potential Contaminants and Migration Pathways**. The suspected source of contaminants at the site are explosive residues and ash resulting from burning and flashing operations in pits and trenches. It is also possible that chlorinated solvents from process operations may have been disposed and possibly burned in some of these trenches. Low concentrations of explosives and chlorinated organic compounds have been identified in the soils down to a depth of 5 feet at one location suspected to be in the center of the western burn pit

TABLE 3-5-5
1988 GROUND-WATER ANALYTICAL RESULTS
WELL 130
LHAAP 17
BURNING GROUND NO. 2 / FLASHING AREA (BG-2)

Sample Number	WELL 130	WELL 130 Rinsate	WELL 130 Trvl Blnk
EXPLOSIVES ug/l			
1,3-DNB	<1	<1	NA
2,4,6-TNT	<1	<1	NA
1,3,5-TNB	<1	<1	NA
2,4-DNT	<1	<1	NA
2,6-DNT	<1	<1	NA
PARAMETERS ug/l			
Aluminum	4000.00	600.00	NA
Antimony	800.00	80.00	NA
Arsenic	<3	<3	NA
Barium	680.00	<10	NA
Beryllium	<10	<10	NA
Cadmium	20.00	10.00	NA
Chromium	33.00	18.00	NA
Copper	20.00	<10	NA
Lead	38.00	45.00	NA
Manganese	540.00	<10	NA
Mercury	<1	<1	NA
Silver	<10	<10	NA
Strontium	1100.00	<10	NA
Thallium	<10	<10	NA
Zinc	70.00	40.00	NA
Methchloride ug/l	<0.1	<0.1	NA
Trichloroethene ug/l	<0.1	<0.1	NA
1,4-Dichloroben ug/l	<0.1	<0.1	NA
chloroform ug/l	16.00	<0.1	0.80

< = BELOW DETECTION LIMIT
NA = NOT ANALYZED

From EPS Inc. report dated May 1988.

area at the site. Although the source of the 1,3,5-TNB concentrations detected in surface soil samples in the area of the site is unknown and possibly not related to the activities performed at the site, the potential migration pathways for this contaminant are addressed, as well as the pathways for buried explosive wastes, so that any concentrations of 1,3,5-TNB detected during the RI may be taken into account and properly addressed.

Assuming these contaminants are present in the soils at the suspected burn pit and trench locations at the site, explosives and VOCs could follow the potential migration pathways described below.

3.5.5.1 **Surface Water**. Runoff across surface soils contaminated with explosive compounds and VOCs would follow surface drainage paths into Harrison Bayou and eventually into Caddo Lake. The site is situated within the 100-year floodplain of the bayou. Surface soils have already been identified as containing low concentrations of 1,3,5-TNB at various locations and several other explosive compounds within the western burn pit area.

3.5.5.2 **Sediment**. Erosion of contaminated surface soils during flooding or heavy rainfall could produce contaminated sediment that would be carried by surface water runoff into the surface drainage pathways leaving the site where it could deposit or be carried by surface runoff into Harrison Bayou. The potential for erosion is high due to the location of the site within the Harrison Bayou floodplain.

3.5.5.3 **Soil**. Previous investigations have shown that soil is contaminated with low concentrations of explosives and VOCs to a depth of 5 feet at a location within the suspected limits of the western burn pit area. Contaminants in the surface soils may migrate

to Harrison Bayou by runoff during heavy rainfall or during flooding of the bayou. Contaminants in the soil at depth may migrate downward to the shallow ground water occurring beneath the site.

3.5.5.4 **Ground Water**. Contaminated soil could leach explosive compounds and VOCs into the ground water, which occurs within 5 feet of the ground surface. Because ground water occurs under unconfined conditions, contaminants could eventually discharge to Harrison Bayou or other surface migration pathways.

3.5.5.5 **Air**. The site is currently protected from wind erosion by the vegetative cover that exists over most of the site. Air could become a contaminant migration pathway if the vegetative cover was removed or contaminated soils were disturbed.

3.5.6 **Identification of Potential Receptors**. The general public does not have ready access to Burning Ground No. 2/Flashing Area because the site is located within the confines of LHAAP boundaries. Access is further restricted by a locked gate on the entrance road to the site. The site is no longer active. Therefore, installation personnel have little opportunity to visit the site. The site is located in hunting zone 15. Therefore, the population having direct use of the site is primarily limited to the occasional hunter.

Because ground water occurs under unconfined conditions, discharge of contaminated ground water to Harrison Bayou poses a potential threat. To threaten any area public water supply wells, contaminants must first migrate downward to elevations below which surface water discharge occurs to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply

well, Well 902, is approximately 2.4 miles southwest of the site in the down-dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of both alluvial materials and the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future use.

The Burning Ground No. 2/Flashing Area site is located in the Caddo Lake watershed and is within the 100-year floodplain of Harrison Bayou. There are no water bodies overlying or watercourses running through the site. As water flows, the site is approximately 1.5 miles upstream of Caddo Lake. The site surface is fairly level and is vegetated with mostly grass and weeds. Although there are a few bare spots on the ground, there are no visible signs of contaminant seepage on the surface and no signs of significant erosion. However, it is important to note that operations once involved the use of shallow burn trenches that were alternately covered during use. The soil cover may therefore contain residual contaminants that may potentially be carried with runoff. The site is relatively remote, and there are no obvious signs of water discharging into nearby tributaries. The site is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would significantly disturb the soil and cause sediment transport to downstream surface water and hence into Caddo Lake. Caddo Lake water, which ultimately supplies about 16,600 Louisiana residents, is not known to be affected by potential contamination from this site.

This site consists of an open field area. It is overgrown with grasses and forbs. A few willows lie outside the previously fenced area on the eastern side of the site. The western area of the site is vegetated with small woody shrubs, grasses, and forbs. There are several places where the surface of the site is devoid of plant life, possibly impacted by site contamination. A pine/hardwood forest surrounds the general site area. Transitional shrub areas near the forest edge should provide ample cover for rabbits, rodents, and other small wildlife. Passerine birds may frequent field portions of the site.

3.5.7 **Initial Remedial Action.** Although low concentrations of explosives and VOCs have been identified in the surface soils and in soils down to at least 5 feet at the site, the lack of evidence of environmental impact on surface and ground water in the area indicates that immediate remedial action is not necessary at this time.

3.6 LHAAP 18 - BURNING GROUND NO. 3 AND LHAAP 24 - UNLINED EVAPORATION POND/ROCKET MOTOR WASHOUT FACILITY

NPL + RCRA CA

3.6.1 **Site History.** Burning Ground No. 3 has been in operation since 1955. The area has been used for the treatment, storage, and disposal of solid and liquid explosive, pyrotechnic, and combustible solvent wastes by open burning, incineration, evaporation, and burial. Historical waste management units include open burning pits, an unlined evaporation pond (UEP), stockpiles of solvent soaked sawdust, and suspected waste burial pits. The UEP was constructed at the burning ground in 1963 as a holding pond to store explosive wastes resulting from the washout of rocket motor casings, which was performed at the northern corner of the pond. In 1973, the pond also began receiving wash water containing solvent residues and solids

collected from LHAAP operations involving pyrotechnic material preparation and mixing commonly containing the metallic cations aluminum, arsenic, barium, cadmium, chromium, iron, lead, magnesium, sodium, strontium, and zinc; the nonmetallic anions nitrite, nitrate, and phosphate; and the organic solvents acetone, ethyl alcohol, methyl ethyl ketone, methylene chloride, TCE, and toluene. Sawdust soaked with methylene chloride and other solvents that were used to clean and scour mixers used for mixing illuminants were stockpiled along the southern berm of the pond and were burned in trenches in the western portion of the burning ground. An air curtain destructor (ACD) was built in 1979 in the western corner of the burning ground for the purpose of disposing of explosive and explosive-contaminated wastes by burning. Use of burn pits and trenches was reportedly discontinued in 1984. Use of the UEP was discontinued in 1984 when it was discovered that the pond was contaminating ground water beneath the site. The UEP was closed as a RCRA interim status surface impoundment in 1986 by removing all waste and capping the impoundment. The locations of these past waste management activities are shown on Figure 3-6-1.

As part of the INF Treaty activities being conducted at LHAAP, a burn cage was added in 1989 for the open burning of Pershing II (PII) missile motors. Current operations now include treatment of explosive and explosive-contaminated wastes by burning in the ACD, three open burning cages, one open burning pan, and a burn cage for PII motor elimination. The locations of these current waste management activities are shown on Figure 3-6-2.

3.6.2 **Site Description**. Burning Ground No. 3 is a fenced 34.5-acre secured area located in the southeastern quadrant of LHAAP at the end of Avenue Q, as shown on Figure 3-6-3. The Unlined Evaporation

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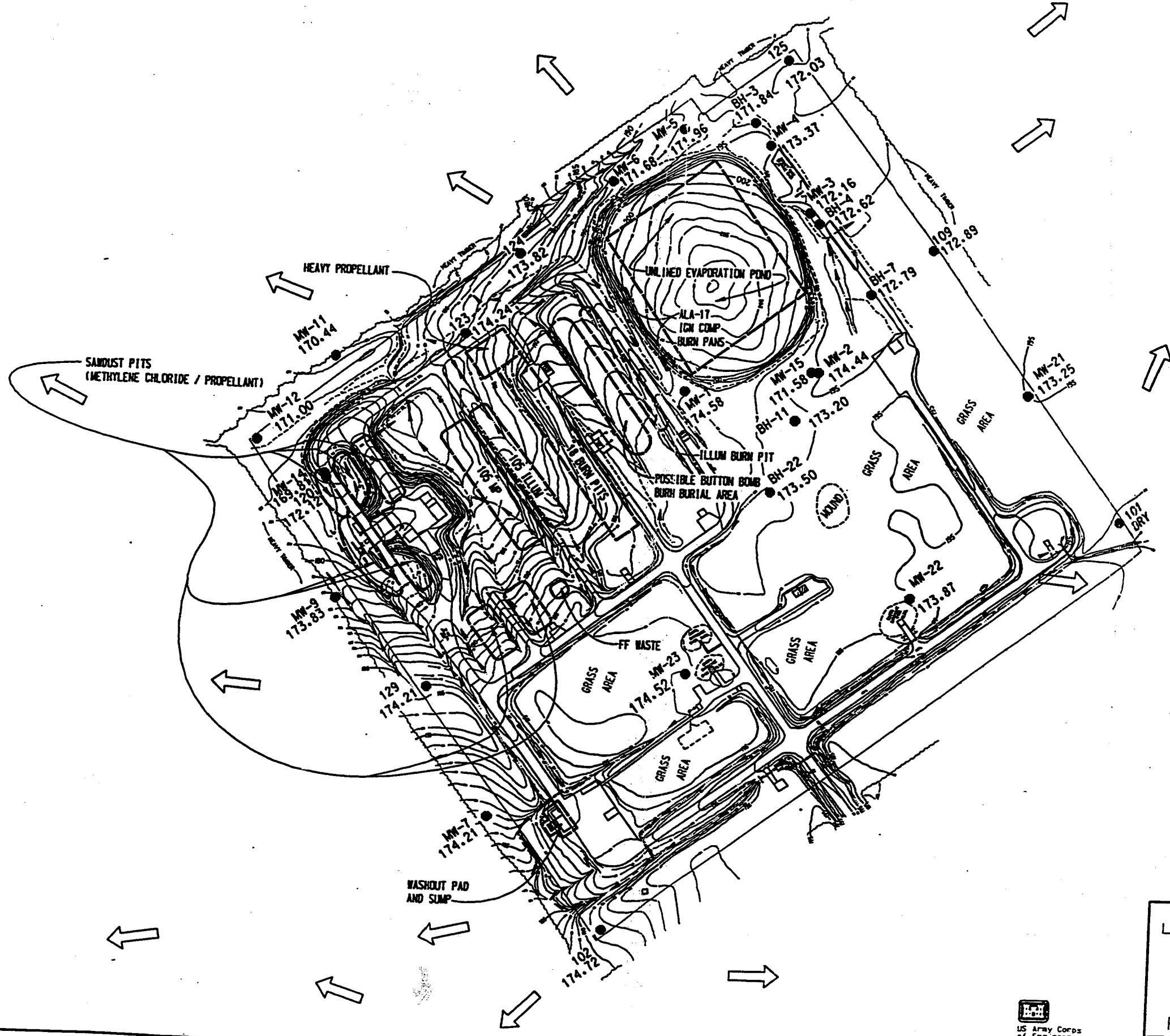

NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. LOCATIONS AND MATERIALS SHOWN ARE INTERPRETED FROM THE FOLLOWING SOURCES:
   A. 1954, 1963, 1970, 1978, AND 1985 AERIAL PHOTOS
   B. LHAAP FILES
   C. GROUND-WATER CONTAMINATION SURVEY NO. 38-26-0851-88, USAEHA, 18-22 MAY 1987
   D. COE, 1989b

LEGEND

- GROUND-WATER FLOW DIRECTION
- MW-11 170.44 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION
- SURFACE WATER FLOW DIRECTION
- APPROXIMATE LIMITS OF PAST DISPOSAL AREAS

100 0 100 200
SCALE IN FEET

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KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
PAST WASTE MANAGEMENT ACTIVITIES

DATE: JUNE 1992 | FIGURE 3-6-1

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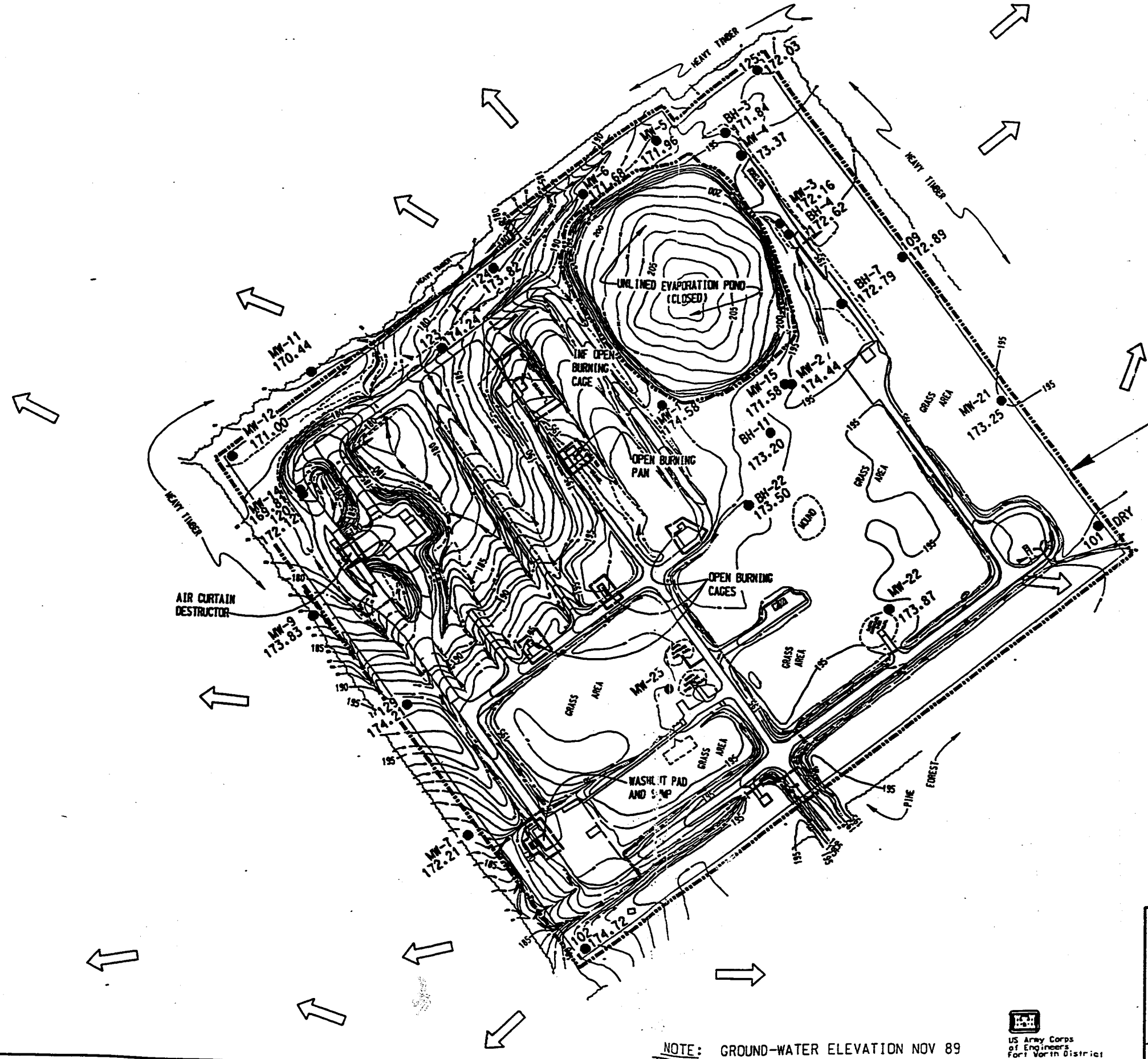

LEGEND

- ⇦ GROUND-WATER FLOW DIRECTION
- MW-11 170.44 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION
- ◄ SURFACE WATER FLOW DIRECTION
- —— APPROXIMATE LIMITS OF CURRENT WASTE MANAGEMENT AREAS
- ▬▪▬▪▬ POINT OF COMPLIANCE

100 0 100 200
SCALE IN FEET

NOTE: GROUND-WATER ELEVATION NOV 89

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RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
CURRENT WASTE MANAGEMENT ACTIVITIES

DATE: JUNE 1992 | FIGURE 3-6-2

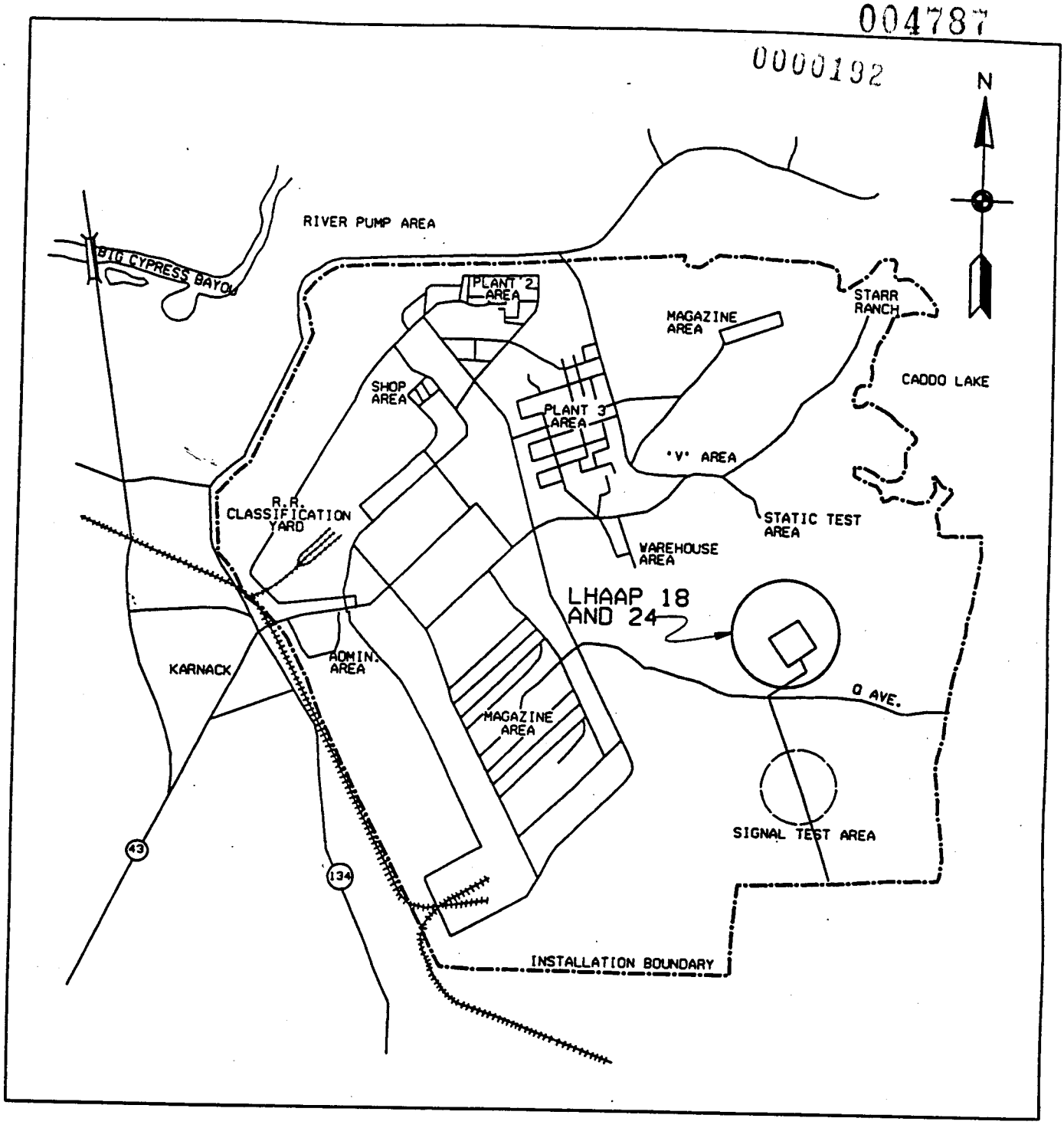

FIGURE 3-6-3 LOCATION MAP FOR LHAAP *18 AND *24

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Pond/Rocket Motor Washout Facility (UEP) site is located within the northern corner of the burning ground. Harrison Bayou flows within 1,000 feet of the western edge and within 500 feet of the northern edge of the burning ground site. Burning Ground No. 3 is a cleared area within a heavily wooded section of LHAAP. It is situated on a natural topographic high slightly west of the crest of a small topographic divide between Harrison Bayou and Saunders Branch. Topography of the site, as shown on Figure 3-6-4, has been greatly altered by operations conducted over the past 35 years. Surface drainage occurs in all directions, but is generally directed towards Harrison Bayou to the west and to the north by both natural and manmade ditches and drainage swales. Harrison Bayou eventually drains into Caddo Lake, which is located approximately 1 mile downstream from the burning grounds area, as shown on Figure 3-6-5. The extreme western corner of the site is located within the 100-year floodplain of Harrison Bayou, which is defined by approximate elevation 180 feet msl in this area of LHAAP and is shown on Figure 3-6-6.

Most of the fenced area of Burning Ground No. 3 is situated on an outcrop of the Wilcox Group, with a contact between the primary materials of the Wilcox and Recent alluvium running somewhere across the western corner of the site. This contact approximates the 100-year floodplain elevation of 180 feet msl. The UEP site is situated entirely on top of the Wilcox Group. Although many borings have been drilled over this entire area, stratigraphic correlation is difficult due to the highly interbedded nature of the materials comprising the Wilcox Group. Subsurface data from soil borings and monitoring wells drilled and constructed as part of past investigations of the UEP and Burning Ground No. 3 show very few strata to be continuous across the

NOTES:

1. FOR LOCATION OF SURFACE WATER/SEDIMENT SAMPLES HB-1 AND HB-5 AND ADDITIONAL MONITOR WELLS, SEE FIGURE 3-6-6.
2. GROUND-WATER ELEVATIONS SHOWN ARE NOV 89

HB-4
HB-3
HARRISON BAYOU
HB-2
100 YEAR FLOODPLAIN
HEAVY TIMBER
MW-16 170.75
MW-13 170.42
C-2 171.50
MW-10 170.77
MW-17 170.60
MW-18 171.40
MW-8 174.04
MW-19 171.77
130 170.69
MW-11 170.44
MW-12 171.00
MW-14 169.8
MW-9 173.83
MW-7 174.21
MW-5 171.96
MW-6 171.68
BH-3 171.84
MW-4 173.37
MW-3 172.16
BH-1 172.82
BH-7 172.79
MW-1 174.58
MW-15 171.58
MW-2 174.44
BH-11 173.20
BH-22 173.50
MW-21 173.25
MW-22 173.87
MW-23 174.52
102 174.72
126 171.94
C-3 170.91
109 172.89
101 DRY
C-8 172.75
APPROXIMATE LIMIT OF CLOSED UNLINED EVAPORATION POND
APPROXIMATE LIMIT OF BURNING GROUND NO. 3
GRASS AREA
PINE FOREST
MOUND
N
100 0 100 200
SCALE IN FEET

LEGEND

- 130 / 170.69 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION, SEE NOTE
- HB-2 — SURFACE WATER / SEDIMENT SAMPLE (EXISTING)
- SURFACE WATER FLOW DIRECTION
- GROUND-WATER FLOW DIRECTION
- POINT OF COMPLIANCE

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LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
SITE MAP

DATE: JUNE 1992 | FIGURE 3-6-4

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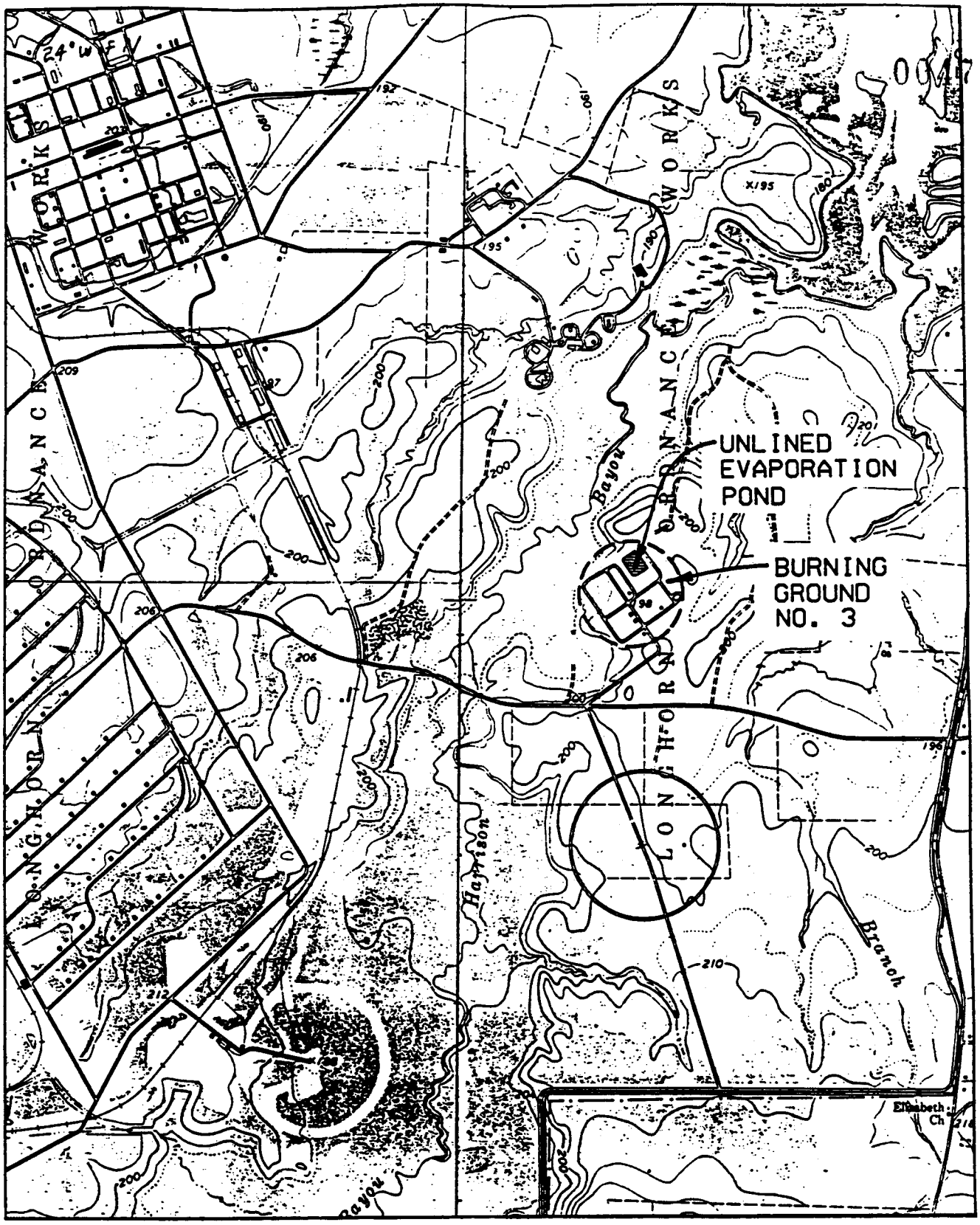

NOTE: 1. 10-FOOT CONTOUR INTERVALS.
2. USGS QUADS FOR KARNACK, TX AND POTTERS POINT, TX-LA, 1978.

FIGURE 3-6-5
LHAAP 18 AND 24

BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

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US Army Corps of Engineers
Fort Worth District

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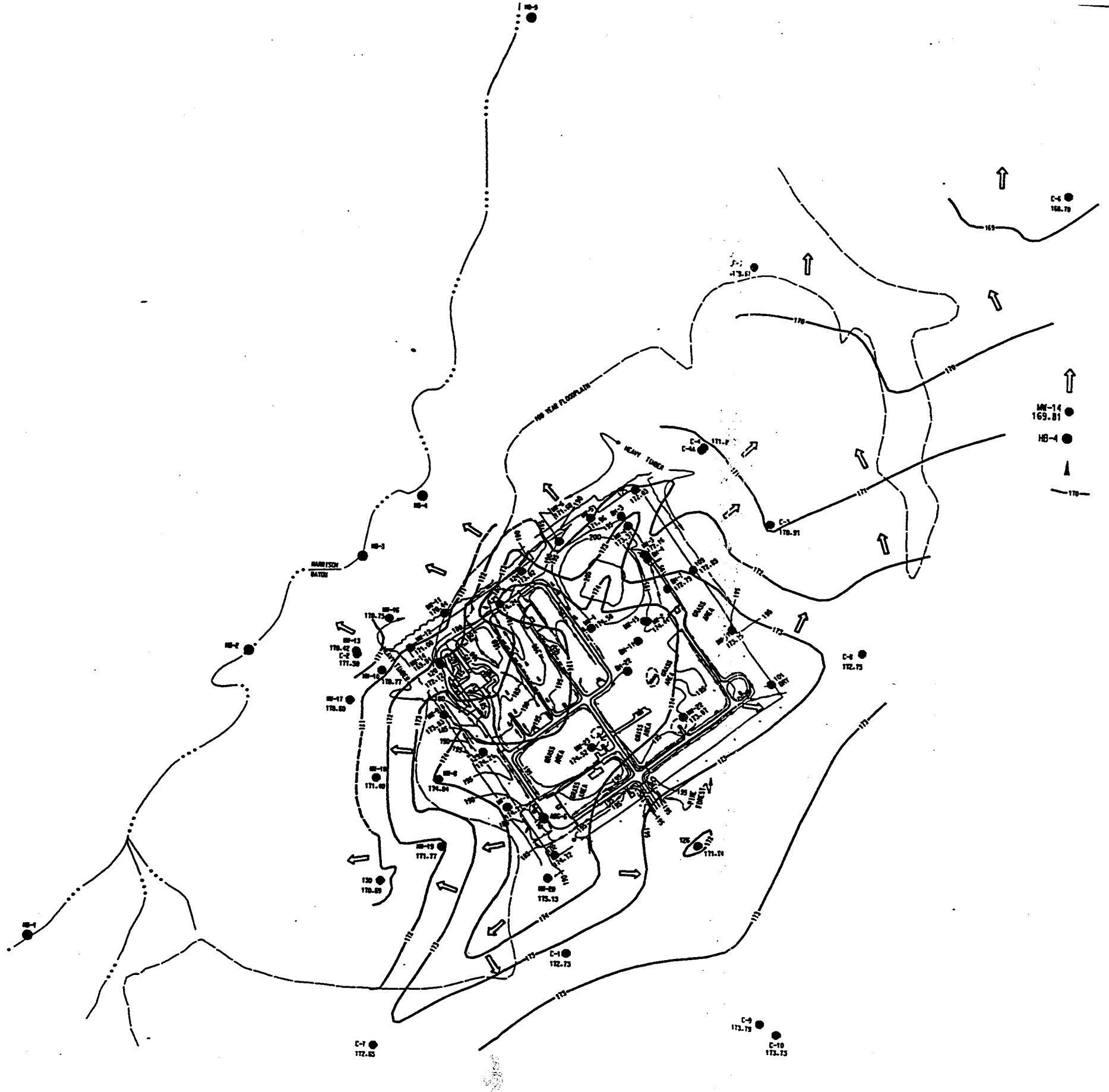

LEGEND

- GROUND-WATER FLOW DIRECTION
- MW-14 169.81 ● MONITOR WELL, NUMBER AND GROUNDWATER ELEVATION (EXISTING)
- HB-4 ● SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (EXISTING)
- SURFACE WATER FLOW DIRECTION
- 170 GROUND-WATER SURFACE ELEVATION

N

250 0 250 500
SCALE IN FEET

NOTE: GROUND-WATER ELEVATIONS SHOWN ARE NOV 89

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LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
WELL LOCATION AND PIEZOMETRIC
SURFACE MAP

DATE: JUNE 1992 | FIGURE 3-6-6

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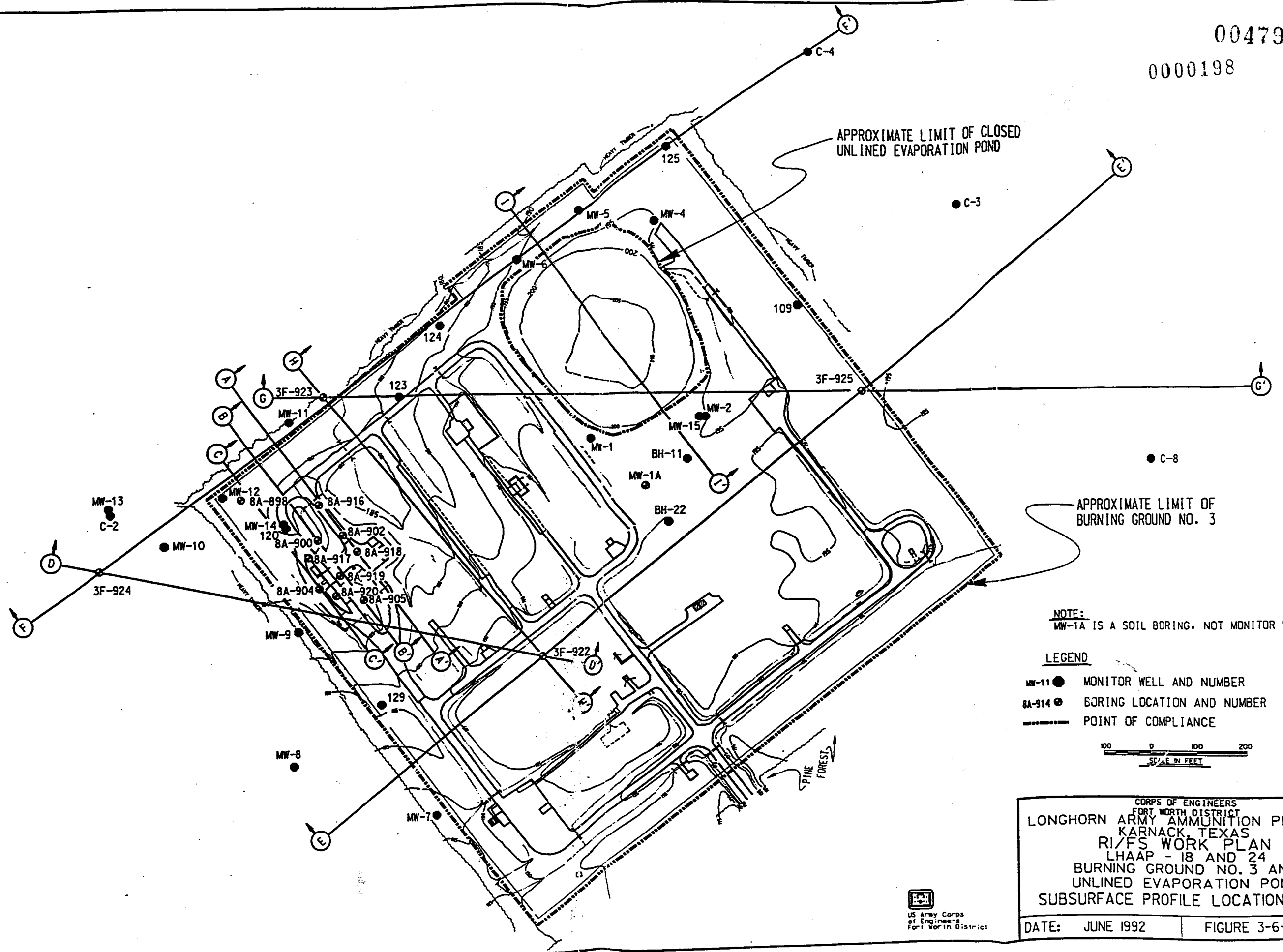
site area. Strata are typical for the Wilcox Group, consisting of varying thicknesses of sands, silts, and clays that are lenticular and discontinuous in nature. Figures 3-6-6-A through 3-6-6-H illustrate this complex stratigraphy.

In the area of the UEP, subsurface data generally indicate the pond was constructed in a sandy/silty clay stratum occurring to approximate elevation 176 feet msl underlain by a sandy silt and silty sand stratum occurring to approximate elevation 155 feet msl, as shown on Figure 3-6-6-H. A low permeability clay varying from 5 to 15 feet thick occurs from elevation 155 feet msl to approximate elevation 140 feet msl across the UEP site. This clay stratum appears to be only locally continuous beneath the UEP and most of the burning grounds area, pinching out to the east of the burning grounds and becoming ill-defined at the contact between the Wilcox Group and the alluvium of Harrison Bayou to the west and north of the site.

Burning Ground No. 3 and the UEP site are situated over the regional Cypress aquifer, the base of which is defined by the contact between the Wilcox and underlying Midway Groups. Evidence obtained from geophysical logs run in deep stratigraphic test borings drilled during previous investigations at the site suggest this contact occurs anywhere from approximate elevation 80 feet msl immediately east of the burning grounds area down to approximate elevation 25 on the western side of the site, shown on figures 3-6-6-C and 3-6-6-F.

Ground water in the burning ground area and beneath the UEP generally occurs under unconfined conditions. Depth to ground water has been observed to vary approximately 2 feet over a 6-month period, from a high elevation of approximately 176.0 feet msl recorded in April 1988 to a high elevation of 174.30 recorded in August of the



NOTE:
MW-1A IS A SOIL BORING, NOT MONITOR WELL

LEGEND

- MW-11 ● MONITOR WELL AND NUMBER
- 8A-914 ⊗ BORING LOCATION AND NUMBER
- POINT OF COMPLIANCE

100 0 100 200
SCALE IN FEET

N

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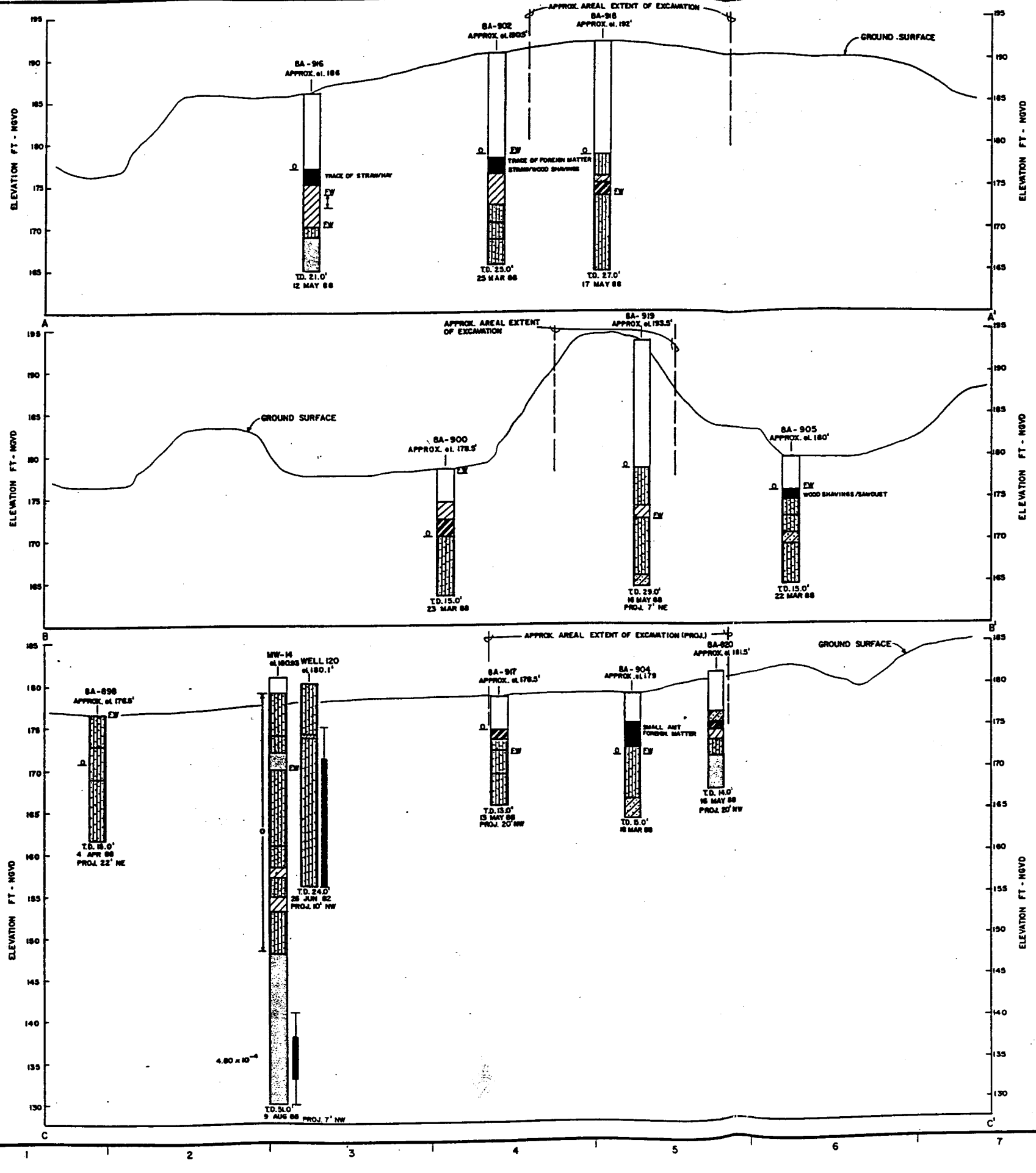
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
SUBSURFACE PROFILE LOCATION MAP

DATE: JUNE 1992 | FIGURE 3-6-6-A

004794

0000199



STRATIGRAPHIC SYMBOLS

- SANDY CLAY AND SILTY CLAY
- FAT CLAY
- SAND
- CLAYEY SAND
- SILTY SAND AND SANDY SILT
- SILT
- CLAYEY SILT
- SANDY CLAYEY SILT
- GRAVEL
- SANDSTONE AND CEMENTED SAND
- SHALE
- FILL
- SOURCE MATERIAL

LEGEND

- FW — FREE WATER ENCOUNTERED DURING DRILLING
- O — ODOR ENCOUNTERED DURING DRILLING
- T — LIMITS OF ODOR AND/OR FREE WATER IF NOT TO T.D.
- ▼ — WATER LEVEL MEASURED 31 AUGUST 1988
- WELL GRAVEL PACK INTERVAL
- WELL SCREEN INTERVAL

GENERAL NOTES

1. STRATIGRAPHIC SYMBOLS ARE IN ACCORDANCE WITH DESCRIPTION OF MATERIALS ON THE FIELD LOGS.
2. THE BORING NUMBER AND ELEVATION ARE SHOWN AT THE TOP OF THE LOG. THE ELEVATION IS THE SURVEYED TOP OF CONCRETE PAD OR SURVEY MARKER.
3. TOTAL DEPTH OF BORING AND DATE COMPLETED ARE SHOWN AT THE BOTTOM OF THE LOG.
4. ASSUME THAT ONCE O AND/OR FW ARE ENCOUNTERED, THE BORING EXHIBITED AN ODOR AND/OR THE BORING MADE WATER UNTIL T.D. WAS REACHED UNLESS OTHERWISE NOTED.
5. FOR 3F BORINGS, RESISTIVITY LOGS ARE SHOWN TO THE RIGHT OF THE BORING. THE RESISTIVITY CALIBRATION IS SHOWN IN OHM3(m) AT THE BOTTOM OF THE LOG. THE GAMMA LOG IS SHOWN TO THE LEFT OF THE BORING. THE COUNT RATE AND TIME CONSTANT ARE SHOWN AT THE BOTTOM OF THE LOG.
6. FOR LOGS OF 8A BORINGS, SEE COE 1989b.
7. FOR LOGS OF 3F BORINGS, SEE COE 1989b.
8. FOR LOGS OF USAEHA, USTHAMA, AND USACE(CDM) WELL BORINGS, SEE COE 1989b.
9. FOR LOGS OF MW WELL BORINGS, SEE COE 1989b.
10. FOR WELL INSTALLATION DETAILS FOR USTHAMA AND USACE(CDM) WELLS, SEE COE 1989b. THERE ARE NO WELL INSTALLATION DETAILS FOR USAEHA WELLS.
11. FOR WELL INSTALLATION DETAILS FOR MW WELLS, SEE COE 1989b.
12. HYDRAULIC CONDUCTIVITY VALUES DETERMINED FOR WELLS MW-1 THRU MW-15 ARE SHOWN OPPOSITE THE WELL SCREEN IN CM/SEC.

NOTES

1. APPROXIMATE LIMITS OF EXCAVATION ARE FOR AIR CURTAIN DESTRUCTOR AS SHOWN ON CONSTRUCTION AS-BUILTS, USACE, FORT WORTH DISTRICT, CONTRACT NO. DACA63-78-8-0010.
2. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

20 0 20 40
HORIZONTAL SCALE IN FEET

5 0 5 10
VERTICAL SCALE IN FEET

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LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
SUBSURFACE PROFILES
A-A', B-B', C-C'

DATED: JUNE 1992 FIGURE 3-6-6-B

004795

0000200

3F-924
EL. 176.10

MW-10
EL. 176.23
T.D. 34.5'
18 JUL 88
PROJ. 70' SW

120
EL. 180.10
T.D. 240'
28 JUN 52
PROJ. 165' SW

MW-14
EL. 180.93
T.D. 51.0'
10 AUG 88
PROJ. 190' SW
OFFSET 20' E

MW-9
EL. 182.36
T.D. 270'
8 JUL 88
PROJ. 50' NE

129
EL. 194.30
T.D. 35.5'
10 JUL 82
PROJ. 165' NE

3F-922
EL. 193.96

GROUND SURFACE

WILCOX GROUP

MIDWAY GROUP

PATIAL DRILL FLUID LOSS

50 COUNT
4 TIME CONSTANT
GAMMA

T.D. 175.0'
26 MAY 88

50 Ω
RESISTIVITY

100 COUNT
2 TIME CONSTANT
GAMMA

T.D. 201.0'
20 MAY 88

50 Ω
RESISTIVITY

ELEVATION FT - NGVD

NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
2. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET

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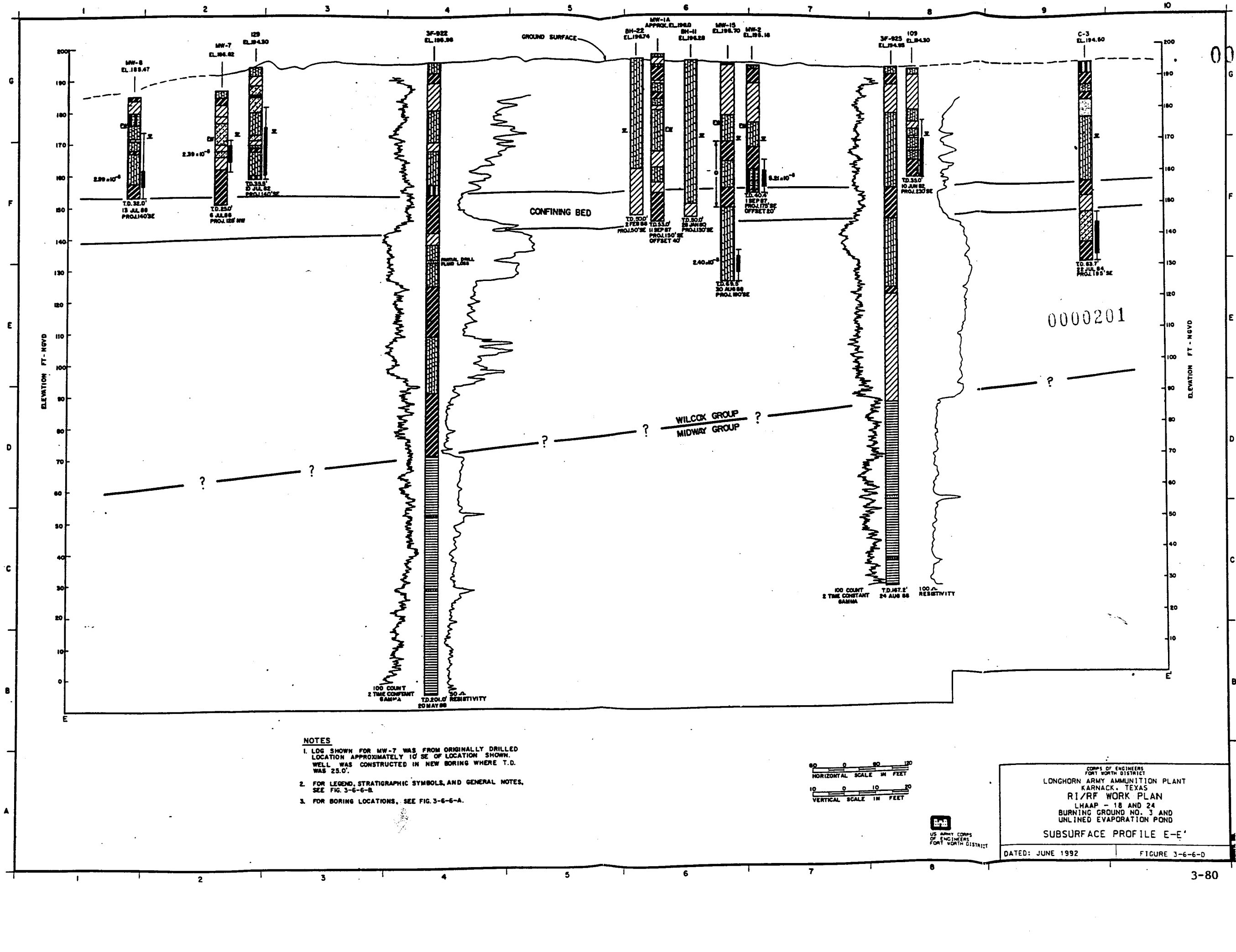
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
SUBSURFACE PROFILE D-D'

DATED: JUNE 1992 | FIGURE 3-6-6-C

004796



0000201

NOTES

1. LOG SHOWN FOR MW-7 WAS FROM ORIGINALLY DRILLED LOCATION APPROXIMATELY 10' SE OF LOCATION SHOWN. WELL WAS CONSTRUCTED IN NEW BORING WHERE T.D. WAS 25.0'.
2. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
3. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

HORIZONTAL SCALE IN FEET: 60 0 60 120

VERTICAL SCALE IN FEET: 10 0 10 20

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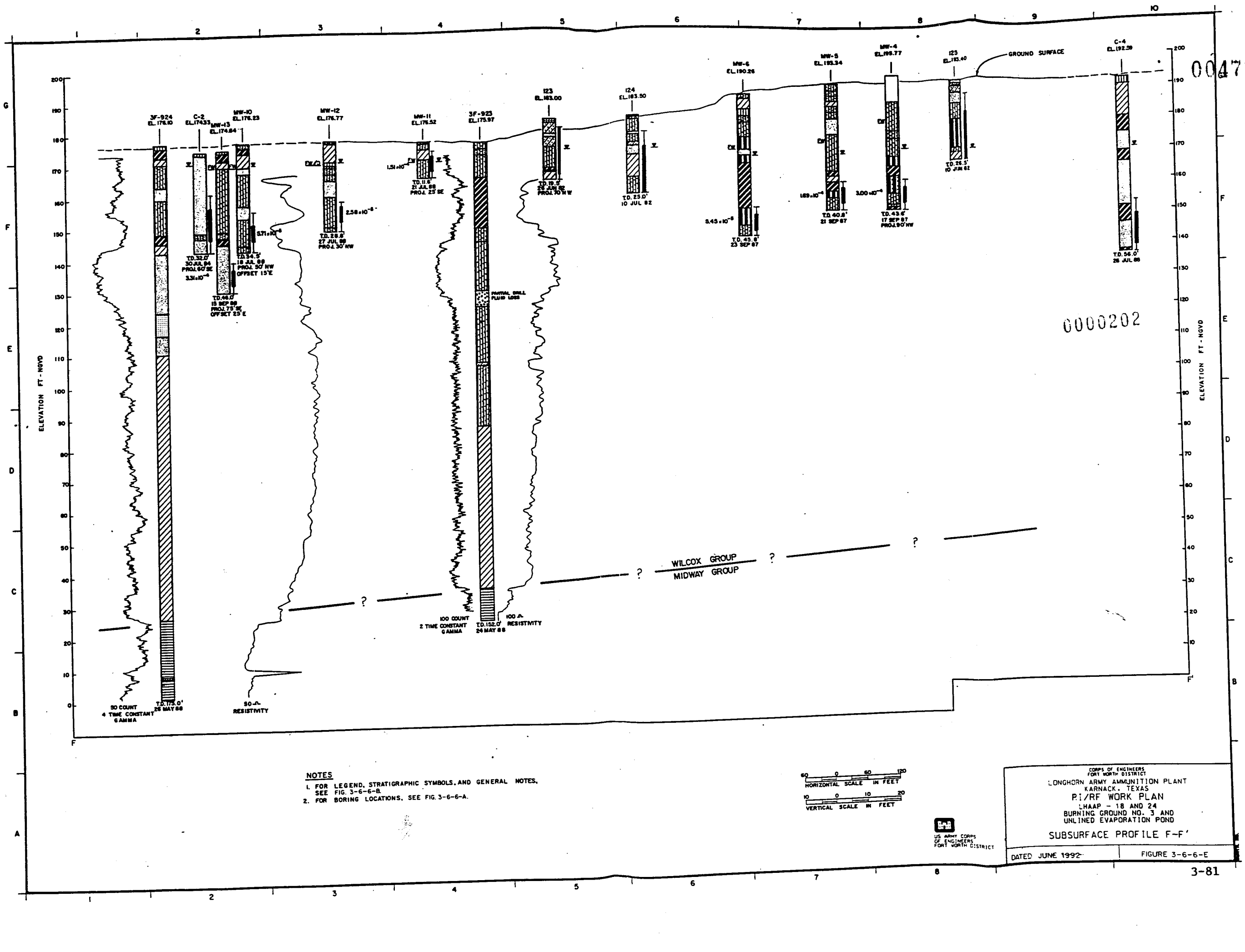
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

SUBSURFACE PROFILE E-E'

DATED: JUNE 1992 | FIGURE 3-6-6-D

004797

0000202



NOTES

1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
2. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

60 0 60 120
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

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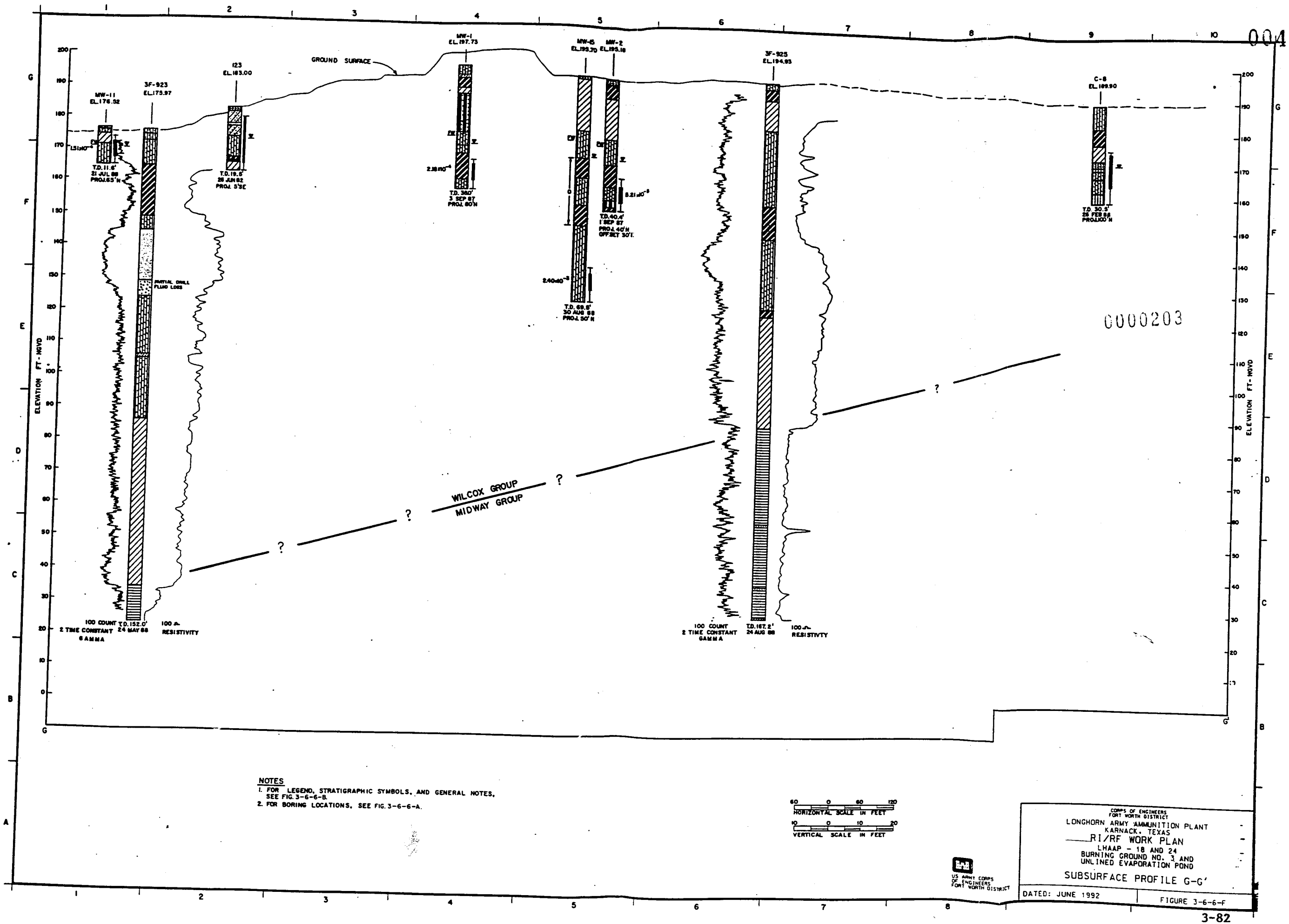
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
P.I./RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

SUBSURFACE PROFILE F-F'

DATED JUNE 1992 | FIGURE 3-6-6-E



0000203

NOTES
1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
2. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

60 0 60 120
HORIZONTAL SCALE IN FEET
10 0 10 20
VERTICAL SCALE IN FEET

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

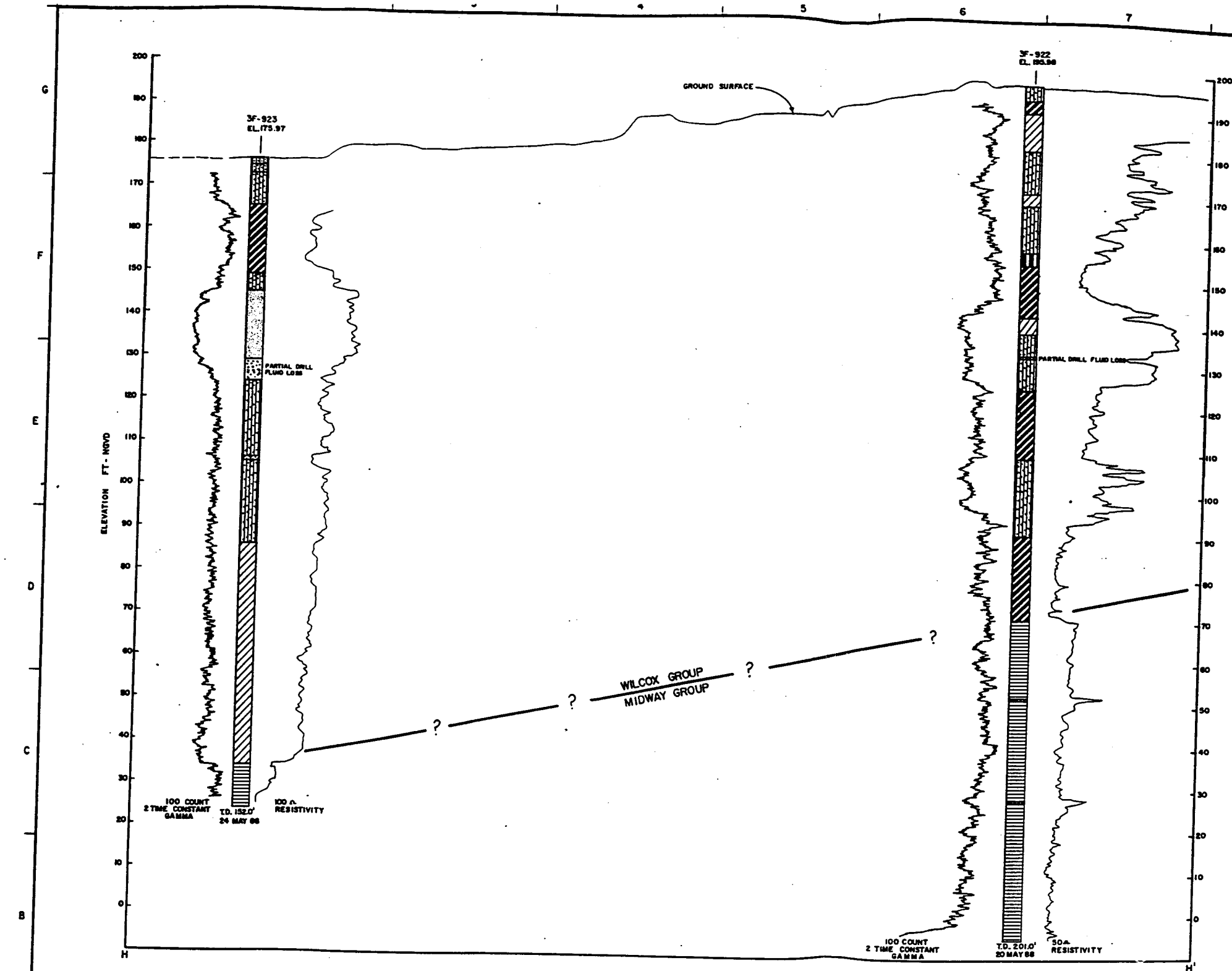
CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

SUBSURFACE PROFILE G-G'

DATED: JUNE 1992 | FIGURE 3-6-6-F

004799

0000204



NOTES

1. FOR LEGEND, STRATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
2. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

40 0 40 80
HORIZONTAL SCALE IN FEET

10 0 10 20
VERTICAL SCALE IN FEET

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

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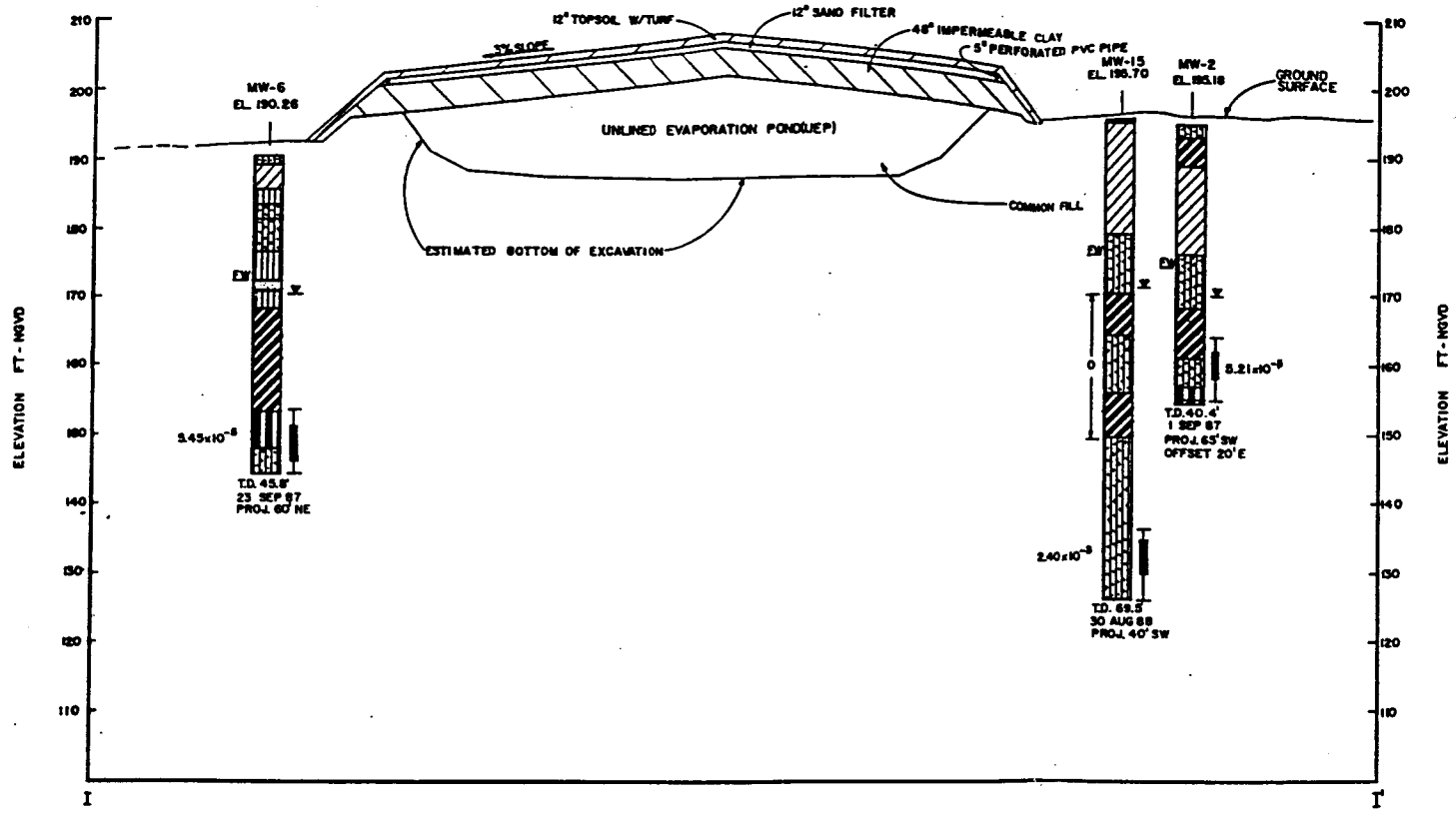
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

SUBSURFACE PROFILE H-H'

DATED: JUNE 1992

FIGURE 3-6-6-G



NOTES

1. FOR LEGEND, STATIGRAPHIC SYMBOLS, AND GENERAL NOTES, SEE FIG. 3-6-6-B.
2. UEP DETAILS ARE AS SHOWN ALONG THE BASELINE SECTION ON THE CONSTRUCTION AS-BUILTS. USACE, FORT WORTH DISTRICT, CONTRACT NO. DACA63-85-C-0262.
3. FOR BORING LOCATIONS, SEE FIG. 3-6-6-A.

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/RF WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND

SUBSURFACE PROFILE I-I'

DATED: JUNE 1992 | FIGURE 3-6-6-H

same year, reflecting the seasonal variations in rainfall (COE, 1989b). Although ground-water elevations are known to vary seasonally, the configuration of the ground-water surface varies little from that shown on Figure 3-6-6. The ground water is mounded under the southern quadrant of the burning grounds in an elongated configuration extending from the southern corner of the fenced area toward the middle of the site. This ground-water mounding reflects the site being a topographic high as well as being a recharge area for the Wilcox. Ground-water flow is in all directions with local variations due to construction activities that have disturbed the natural regime, notably around the ACD and the UEP.

Attempts made during previous investigations to define a continuous shallow confining bed beneath the UEP and burning ground area were unsuccessful. Efforts by the U.S. Army Corps of Engineers from 1987 to 1989 yielded the most information about the continuity of stratigraphy in the area. The majority of this information is contained in the document "RCRA Facility Investigation for Active Burning Ground and Unlined Evaporation Pond, Phase I, Longhorn Army Ammunition Plant, Karnack, Texas," (COE, 1989b). Although borings did encounter a lower permeability stratum at approximate elevation 155 feet msl at the UEP, it appears to be only locally continuous beneath the pond and a portion of the burning ground, pinching out to the east of the burning grounds area and becoming ill-defined to the north and west at the edge of the Harrison Bayou floodplain where sandy alluvial materials are indistinguishable from sandy Wilcox materials. Permeabilities developed from slug test data obtained in monitoring wells constructed at the same elevations within the outcrop of the Wilcox and located in the floodplain of the bayou are similar,

indicating that the two areas are hydraulically connected. The median hydraulic conductivity value for shallow wells screened above approximate elevation 155 feet msl is 5.45 x 10^{-5} cm/sec. The median hydraulic conductivity value for intermediate wells screened immediately below the locally confining stratum is 4.80 x 10^{-4} cm/sec. Ground water flows in a radial pattern off the burning ground site, which contrasts with the regional direction of flow across the area to the northeast. This contrast in flow directions reflects the recharge effects of the topographically high burning grounds site. The average ground-water velocity for ground water screened above approximate elevation 155 feet msl is 1.31 x 10^{-6} cm/sec along a horizontal hydraulic gradient of .0048 in all directions at the site. Regional horizontal gradient across the burning grounds area is even lower at .0025.

3.6.3 **Previous Investigations**. The Army first began conducting studies in 1976 in an effort to characterize the wastes that were being placed in the UEP. Several of these studies were conducted by USAEHA from 1976 until 1983. Only one study, however, was documented for investigating contamination related to open burning activities at Burning Ground No. 3. This investigation was performed in 1981 by the USAEHA and was documented in a report entitled "Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open Detonation Grounds Evaluation." Shallow soil samples and waste residue samples were taken from a 90 x 15 feet burn trench used for burning PEP wastes and from ten 12 x 12 feet square earthen pads used to burn M206 wastes; however, the exact locations of these open burning units are unclear. The soil samples were analyzed for EP toxic metals and explosives. Results as they were presented in the

Camp Dresser & McKee, Inc. (CDM) report entitled "Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to the Seepage from an Unlined Evaporation Pond" (CDM, 1985) showed some residues exceeded EP toxic limits for barium, and elevated concentrations of barium were found in the soils along surface drainage paths leading away from the site. No explosives were detected in either the waste residues or soils sampled.

By 1983, the Army had completed two preliminary studies which indicated that ground water beneath Burning Grounds No. 3 was contaminated with metals and organic compounds. One study was performed by USAEHA and was documented in the report entitled "Ground-Water Quality Assessment Plan, Hazardous Waste Special Study No. 32-26-0252-83" (USAEHA, 1980). The other study was performed by Environmental Protection Systems, Inc. (EPS), for USATHAMA, and was documented in the report entitled "Longhorn Army Ammunition Plant Contamination Survey" (EPS, 1984).

As part of the USAEHA study, 13 monitoring wells (BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7, BH-8, BH-9, BH-10, BH-11, BH-21, and BH-22) were installed in 1980 at the locations shown on Figure 3-6-7 to monitor the UEP. Five of these wells (BH-3, BH-4, BH-7, BH-11, and BH-22) still exist at the site. The others were plugged as part of the closure of the UEP in 1985. There are no well construction details for these wells. However, field logs for the drilling of these five existing wells show each well boring to be 50 feet deep. Personal communication cited by CDM in a later study (CDM, 1985) states that the USAEHA wells screened the top 10 feet of the water table, which is sometimes considerably higher than the final 50-foot

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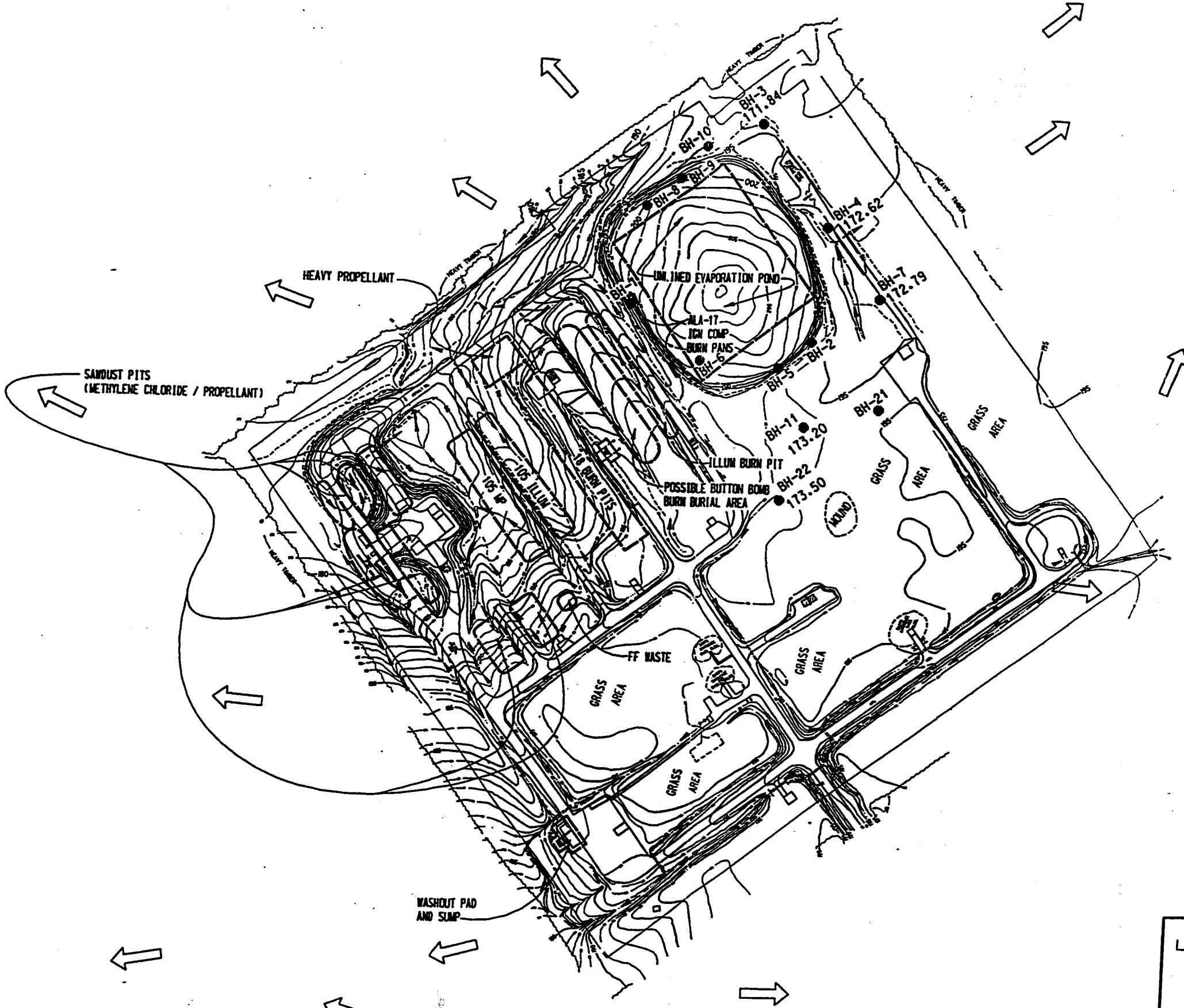

NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. LOCATIONS AND MATERIALS SHOWN ARE INTERPRETED FROM THE FOLLOWING SOURCES:
   A. 1954, 1963, 1970, 1978, AND 1985 AERIAL PHOTOS
   B. LHAAP FILES
   C. GROUND-WATER CONTAMINATION SURVEY NO. 38-26-0851-88, USAEHA, 18-22 MAY 1987
   D. COE, 1989b

LEGEND

- GROUND-WATER FLOW DIRECTION
- BH-11 170.44 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION
- SURFACE WATER FLOW DIRECTION
- APPROXIMATE LIMITS OF PAST DISPOSAL AREAS

100 0 100 200
SCALE IN FEET

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
USAEHA MONITORING WELL LOCATIONS

DATE: JUNE 1992 | FIGURE 3-6-7

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depths of the well borings.

The EPS contamination survey resulted in the installation of nine wells (101, 102, 109, 120, 123, 124, 125, 126, and 129) within and around Burning Ground No. 3 in 1982. Well locations are shown on Figure 3-6-6. Well construction details and boring logs are shown in CDM, 1985. These nine new wells and the existing 13 USAEHA wells were sampled for explosive compounds, metals, selected anions, and organic compounds. Results indicated nitrate, barium, cadmium, and chromium were present in at least one of the wells at concentrations greater than the current EPA drinking water standards. Compounds derived from explosive materials were identified in many of the wells, and organic solvents were found in 13 of the wells sampled. Well BH-11, located immediately southeast of the UEP, exhibited the highest concentrations of organic contaminants. Results of this sampling are summarized in CDM, 1985.

Because operation of the UEP appeared to be causing the metals and organics ground-water contamination identified by these studies, the Army ceased operation of the UEP in 1984 and began formal closure activities for the unit as an interim status surface impoundment following RCRA regulations. In 1985, all liquid, sludge, and soil contaminated with elevated concentrations of total barium and exhibiting high COD values were removed from the pond and were disposed in accordance with EPA regulations. The pond was then backfilled and capped. The Texas Water Commission (TWC) certified in March 1986 that the UEP was closed in accordance with the approved closure plan. The unit was replaced with a pilot industrial wastewater treatment facility located elsewhere on the installation.

Upon closure of the UEP, LHAAP began a quarterly monitoring

program for eight of the remaining wells (101, 102, 109, 120, 123, 124, 125, and 129) in the burning ground area. Parameters analyzed were explosive compounds (2,4,6-TNT, 2,4-DNT, 2,6-DNT, RDX, HMX, tetryl), volatile organic compounds (VOCs), total organic carbon (TOC), total organic halides (TOX), phenol, nitrate, nitrite, chloride, and total and dissolved metals (Ag, Al, As, Ba, Cd, Cr, Hg, Mg, Pb, and Se). The Army also implemented a Ground-Water Quality Assessment (GWQA) for the contamination caused by operation of the pond. The consulting engineering firm Camp Dresser & McKee, Inc. (CDM), performed the GWQA under contract to the U.S. Army Corps of Engineers, Huntsville Division. Results of this GWQA are contained in the document and its addendum "Groundwater Quality Assessment, Longhorn Army Ammunition Plant, Marshall, Texas: Groundwater Contamination Related to the Seepage from an Unlined Evaporation Pond," (CDM, 1985), and "Addendum," (CDM, 1986).

As part of the GWQA investigation, CDM installed a total of ten monitoring wells, C-1 through C-10, around Burning Ground No. 3. Well locations are shown on Figure 3-6-6. These ten new wells and as many as 18 of the existing wells were sampled. Well construction details and boring logs are contained in CDM, 1985 and CDM, 1986. Analyses performed on the ground-water samples taken were for trace metals, TOC, selected anions, VOCs, and explosive compounds. Analytical results were similar to those previously found by USATHAMA. Based on these results, CDM concluded that the UEP was a source of ground-water contamination, but not the primary source for all of the contaminants identified. Contaminants contributed by the UEP and the burning ground activities had not travelled far from their respective sources. It was also noted another source other than the UEP was contributing

to nitrates and organic contamination in the ground water along the western edge of the burning ground, and a source of barium contamination was suspected south of the burning ground boundary to be contributing to the ground-water contamination at the site.

In response to the CDM conclusions, the Army developed a proposal for continued ground-water monitoring and assessment efforts at Burning Ground No. 3. This document, prepared by U.S. Army Engineer Division, Huntsville, is entitled "U.S. Army Proposal for Additional Groundwater Monitoring at the Closed Unlined Evaporation Pond (UEP), Longhorn Army Ammunition Plant (LHAAP), Marshall, Texas," and was submitted by LHAAP to the TWC in April 1987. The Army's proposal consisted of a three-phase program, summarized as follows:

1) Implement a Compliance Monitoring Program at the Point of Compliance of the UEP in order to demonstrate that the UEP is no longer a source of ground-water contamination;

2) Implement a Corrective Action Monitoring Program downgradient of the UEP in order to demonstrate that contaminants in the ground water resulting from operation of the UEP were not present in significant concentrations; and

3) Continue Ground-Water Quality Assessment investigations in the burning ground area to determine the source of inorganic contaminants south of the site and organic contaminants from within the site west of the UEP.

The Fort Worth District Corps of Engineers was tasked by Huntsville Division in March 1987 to perform the work outlined in the proposal submitted to the TWC. Two documents were produced by the Corps of Engineers from these investigations: "Installation and Sampling of Compliance Monitoring Wells, Unlined Evaporation Pond,

Longhorn Army Ammunition Plant, Karnack, Texas," (COE, 1989a); and "RCRA Facility Investigation for Active Burning Ground and Unlined Evaporation Pond, Phase I, Longhorn Army Ammunition Plant, Karnack, Texas," (COE, 1989b).

Geotechnical investigations for the RFI report included a soil gas survey to identify potential organic contaminant sources, drilling and sampling 47 shallow (15-foot) soil borings to verify soil gas survey results, drilling and geophysically logging four deep stratigraphic test borings to define stratigraphy across the site, installing 12 shallow (MW-1 through MW-12) and 3 intermediate depth (MW-13 through MW-15) monitoring wells, slug testing all 15 newly installed wells, and performing one round of water sampling for the 15 new and 10 of the existing wells at the site. Twelve of these wells (MW-1 through MW-12) were screened at the base of the suspected uppermost saturated zone underlying the Burning Ground No. 3 area. The other three wells (MW-13, MW-14, and MW-15) were installed about 10 feet away from wells C-2, 120, and MW-2, respectively, to form cluster wells screening the next deeper saturated zone at each of these locations. Six of the 12 wells installed (MW-1 through MW-6) were the Compliance Monitoring Wells documented in the May 1989 report (COE, 1989a). Soil boring locations are shown on Figure 3-6-8. Monitoring well locations are shown on Figure 3-6-6. All other data obtained from this investigation, as well as the boring logs and well construction details for MW-1 through MW-15, are contained and discussed in COE, 1989b.

Soil and ground-water samples were analyzed for chlorides, nitrates, TOX, explosive compounds, VOCs, and the metals silver, arsenic, barium, cadmium, chromium, mercury, lead, nickel, selenium,

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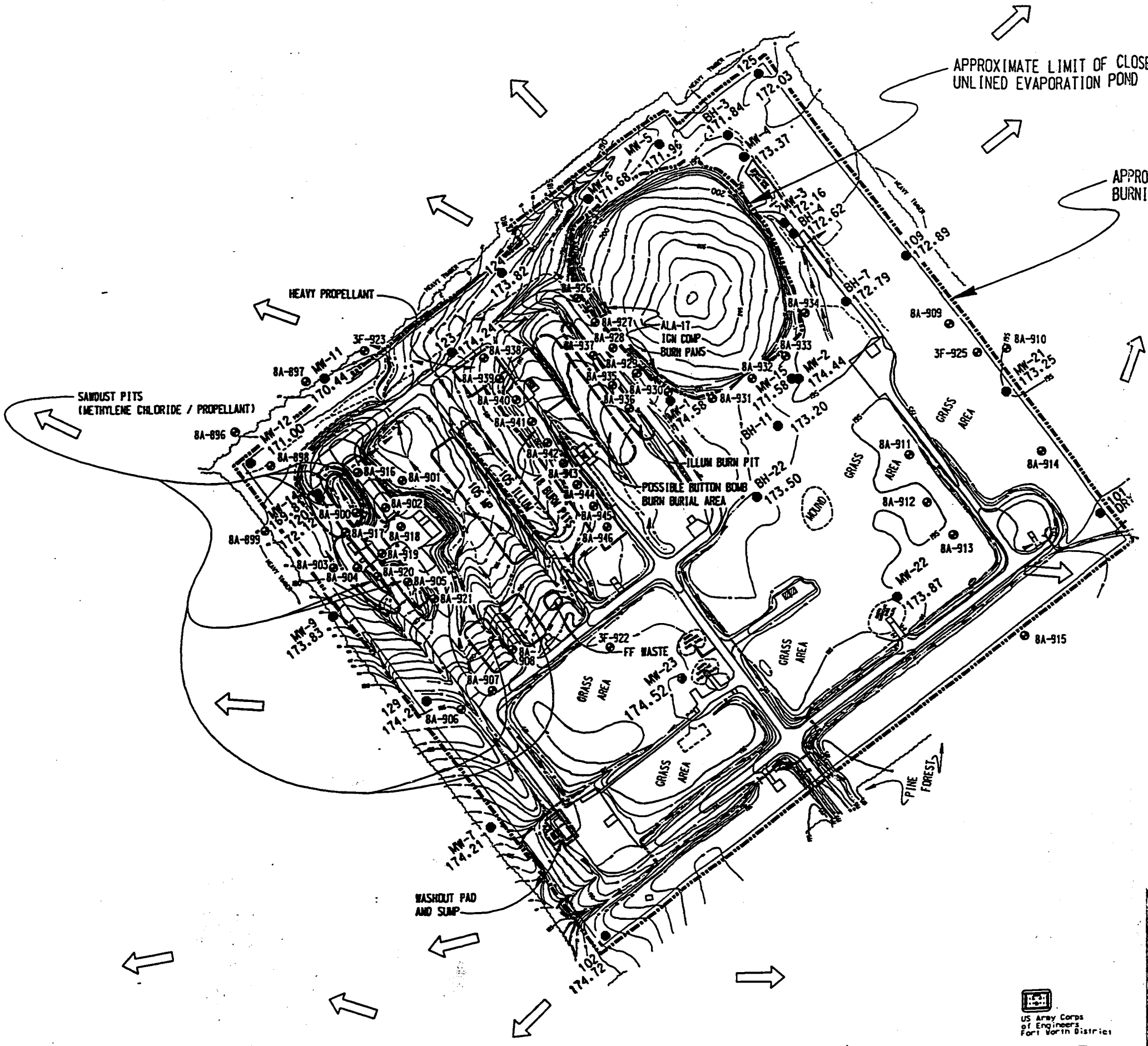

NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. LOCATIONS AND MATERIALS SHOWN ARE INTERPRETED FROM THE FOLLOWING SOURCES:
   A. 1954, 1963, 1970, 1978, AND 1985 AERIAL PHOTOS
   B. LHAAP FILES
   C. GROUND-WATER CONTAMINATION SURVEY NO. 38-26-0851-88, USAEHA, 18-22 MAY 1987
   D. COE, 1989b

LEGEND

- GROUND-WATER FLOW DIRECTION
- MW-11 170.44 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION
- SURFACE WATER FLOW DIRECTION
- APPROXIMATE LIMITS OF PAST DISPOSAL AREAS
- 8A-914 — BORING LOCATION AND NUMBER
- POINT OF COMPLIANCE

100 0 100 200
SCALE IN FEET

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
PHASE I RFI SOIL BORING LOCATIONS

DATE: JUNE 1992 | FIGURE 3-6-8

and zinc. Results of the ground-water analyses are summarized on Table 3-6-1. Phase I RFI investigations showed that the ground water beneath the burning ground area was contaminated with VOCs and elevated concentrations of chlorides, nitrates, and metals. The two most prevalent and highly concentrated contaminants continued to be methylene chloride and TCE, occurring in concentrations in excess of 17,000,000 ug/l and as high as 1,400,000 ug/l, respectively in the point of compliance wells for the UEP. Nitrates, barium, cadmium, lead, TCE and 1,2-DCA were detected at concentrations exceeding TWC primary drinking water standards. Chlorides exceeded TWC secondary drinking water standards. No explosives were found except in soil samples taken of the wastes remaining in the buried trenches around the ACD. Explosives identified were tetryl at a maximum concentration of 26.6 ug/g and TNT at a maximum concentration of 5.7 ug/g. High concentrations of many organic compounds were found at depths of 4 and 10 feet in soil borings drilled along the line of former burn pits. Soil boring logs and sample analyses are contained in COE, 1989b.

Concurrent with the investigations being performed for the Phase I RFI, Morton Thiokol, Inc., contracted to EPS to sample three existing monitoring wells at Burning Ground No. 3 and analyze the samples for explosives as part of a study to identify TNT burial sites at LHAAP. The wells sampled were BH-11, MW-2, and 102. Well BH-11 showed 51 ug/l of 1,3,5-TNB and 3.8 ug/l of 2,4,6-TNT. Well MW-2 showed 5.6 ug/l of 2,4,6-TNT. No explosives were found in Well 102. The results of this study are contained in "A Study of Suspected TNT Burial Sites at Longhorn Army Ammunition Plant, Texas, as Defined in the Contamination Study," (EPS, 1988).

After monitoring wells MW-1 through MW-15 were installed for the

TABLE 3-6-1

SUMMARY OF 1988 GROUND-WATER ANALYTICAL RESULTS

LHAAP 18 & 24
BURNING GROUND NO. 3 & UEP

WELL NO.	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	Travel Blank	MW-8	Equip Blank	MW-9
Chloride (mg/l)	930	890	540	750	420:490.0	980	280		200		43
TOX (mg/l)	4030	3644.0:1300	259.0	502.0	178.9	2747.0	169.5		1608.0		9.2
Nitrates (mg/l)	2.7	3.1	3.2:<2.0	<0.2	4.2	<0.2	0.25		6.1		0.85
Metals (ug/l)											
Silver	<5.0	<5.0	<5.0	<5.0 :<50	<5.0	<5.0	< 5.0		< 5.0	< 5.0	< 5.0
Arsenic	<1.0	<1.0	<1.0	<1.0 :<2	<1.0	3.0	< 1.0		< 1.0	< 1.0	< 1.0
Barium	2200	3600	1900	270 :<1000	2000	1800	11.0		470	< 5.0	130
Cadmium	<5.0	<5.0	<5.0	<5.0 :40	<5.0	<5.0	< 5.0		< 5.0	< 5.0	< 5.0
Chromium	5.8	8.0	27	9.8 :100	18	7.5	15		12	< 5.0	7.5
Mercury	0.42	0.42	0.42	<0.1 :<2	0.42	<0.1	0.42		< 0.1	< 0.1	< 0.1
Lead	14	16	16	12 :<100	10	17	< 1.0		16	8.8	14
Nickel	33	38	24	75 :110	44	42	23		20	11	12.8
Selenium	0.6	<0.4	<0.4	<0.4 :<2	<0.4	<0.4	< 0.4		< 0.4	< 0.4	0.5
Zinc	63	100	45	65 :60	70	48	29		200	10	64
Explosives (ug/l) (2)	ND	ND	ND	ND	ND	ND	ND		ND		ND
VOCs (ug/l)											
Methylene Chloride	4200K:4820K (E)	17000K (E)	19 (B)(J)	58 (B)	14 (B)	88 (B)	< 250	18 (B)	< 480		5900
Acetone	< 100K:NA	< 100K	< 39	< 83	< 10	< 10	810	< 10	< 960		< 1000
1,2-Dichloroethene	< 50K:NA	< 50K	32	120	31	15	< 250	< 5	< 480		< 500
1,2-Dichloroethane	< 50K:< 28K	< 50K	< 19	< 42	4 (J)	< 5	< 250	< 5	< 480		< 500
Trichloroethene	200K:165K	1400K	550	1100	150	91	7600	10 (B)	13000		11000
Tetrachloroethane	< 50K:< 41K	17K (J)	< 19	< 42	< 5	< 5	< 250	< 5	< 480		< 1000

See notes, last page of Table 3-6-3.

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TABLE 3-6-1

SUMMARY OF 1988 GROUND-WATER ANALYTICAL RESULTS

LHAAP 18 & 24
BURNING GROUND NO. 3 & UEP
p. 2 of 3

WELL NO.	Equip Blank	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15	C-2	Travel Blank	C-3	Equip Blank	C-4	C-5
Chloride (mg/l)		310	40	260	240	660:1020	120	170		310		41	64
TOX (mg/l)		2.0	3.2 : 0.8	1.7	0.12	3.6	185.0	0.03		0.24		0.05	.03:<.005
Nitrates (mg/l)		<0.2	<0.2	2.0	2.4:<2.0	<0.2	<0.2	<0.2		2.3		<0.2	<0.2
Metals (ug/l)													
Silver	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		< 5.0	< 5.0
Arsenic	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4.3	3.0	< 1.0	8.8		2.5	1.6
Barium	14	640	67	560	280	1300	280	540	< 5.0	730		280	340
Cadmium	< 5.0	24	< 5.0	24	9.0	20	15	29	< 5.0	24		< 5.0	< 5.0
Chromium	< 5.0	7.0	8.2	9.2	6.5	7.5	8.0	7.8	5.0	8.0		6.8	5.8
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1	< 0.1
Lead	< 1.0	20	13	20	13	23	28	70	< 1.0	28		20	21
Nickel	< 5.0	28	18	18	6.5	16	20	5.8	< 5.0	7.8		8.5	5.8
Selenium	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		< 0.4	< 0.4
Zinc	32	130	30	120	18	110	220	260	9.0	94		92	29
Explosives (ug/l) (2)		ND	ND	ND	ND	ND	ND	ND		ND		ND	ND
VOCs (ug/l)													
Methylene Chloride		120 (B)	< 13	< 40	< 5	< 10	58	3 (J)		< 5	10	< 5	110
Acetone		< 10	< 25	< 81	< 10	< 21	< 25	< 10		< 10	< 10	< 10	< 10
1,2-Dichloroethene		< 5	16	57	< 5	< 10	< 13	< 5		< 5	< 5	< 5	< 5
1,2-Dichloroethane		< 5	52	< 40	< 5	< 10	< 13	< 5		< 5	< 5	< 5	< 5
Trichloroethene		61	770 (E)	1100	1 (J)	250	2 (J)	17		< 5	< 5	9	77
Tetrachloroethane		< 5	< 13	< 40	< 5	< 10	< 13	< 5		< 5	< 5	50	< 5

See notes, last page of Table 3-6-3.

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0000217

TABLE 3-6-1

SUMMARY OF 1988 GROUND-WATER ANALYTICAL RESULTS

LHAAP 18 & 24
BURNING GROUND NO. 3 & UEP

WELL NO.	109	120	123	124	125	Travel Blank	129
Chloride (mg/l)	760	720	3.9 : 13.8	5.9	19		290
TOX (mg/l)	12.7	2011.0	0.02	0.04	2.0		15.3
Nitrates (mg/l)	0.26	590:735	6.3	<0.2	0.28		14
Metals (ug/l)							
Silver	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		< 5.0
Arsenic	< 1.0	4.7	< 1.0	1.1	< 1.0	ND	< 1.0
Barium	1500	580	250	590	420		680
Cadmium	< 5.0	5.5	< 5.0	< 5.0	< 5.0		< 5.0
Chromium	6.2	11	6.2	5.5	8.2		7.5
Mercury	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1
Lead	18	34	12	47	20		31
Nickel	5.2	100	5.9	10	< 5.0		21
Selenium	< 0.4	0.5	2.6	0.4	< 0.4		< 0.4
Zinc	22	150	10	46	21		46
Explosives (ug/l) (2)	ND	ND	ND	ND	ND		ND
VOCs (ug/l)							
Methylene Chloride	9 (B)	310000	< 5	< 5	< 50	2 (B)(J)	< 33
Acetone	< 13	< 25000	< 10	< 10	< 100	< 13	< 67
1,2-Dichloroethene	11	< 13000	< 5	< 5	< 50	< 7	4 (J)
1,2-Dichloroethane	< 6	< 13000	< 5	< 5	< 50	< 7	35
Trichloroethene	190	32000	< 5	80	< 50	< 7	930
Tetrachloroethane	< 6	< 13000	< 5	< 5	2 (J)	< 7	4 (J)

NOTES:

(1) = Sampling performed Sept. 1988 (COE, 1989b)

(2) = Explosive cpds analyzed and respective calibration limits were HMX (26.0 ug/l), RDX (22.0 ug/l), tetryl (26.0 ug/l), TNT (14.0 ug/l), and 2,4 DNT (10.0 ug/l)

SYMBOLS:

< = Not detected. Calibration limit shown.
B = Possible laboratory blank contamination
E = Concentration exceeded calibration limit
J = Estimated concentration below calibration limit
K = x 1000
NA = No analysis
ND = Not detected below calibration limit.
: = Duplicate analysis

0004813
0000218

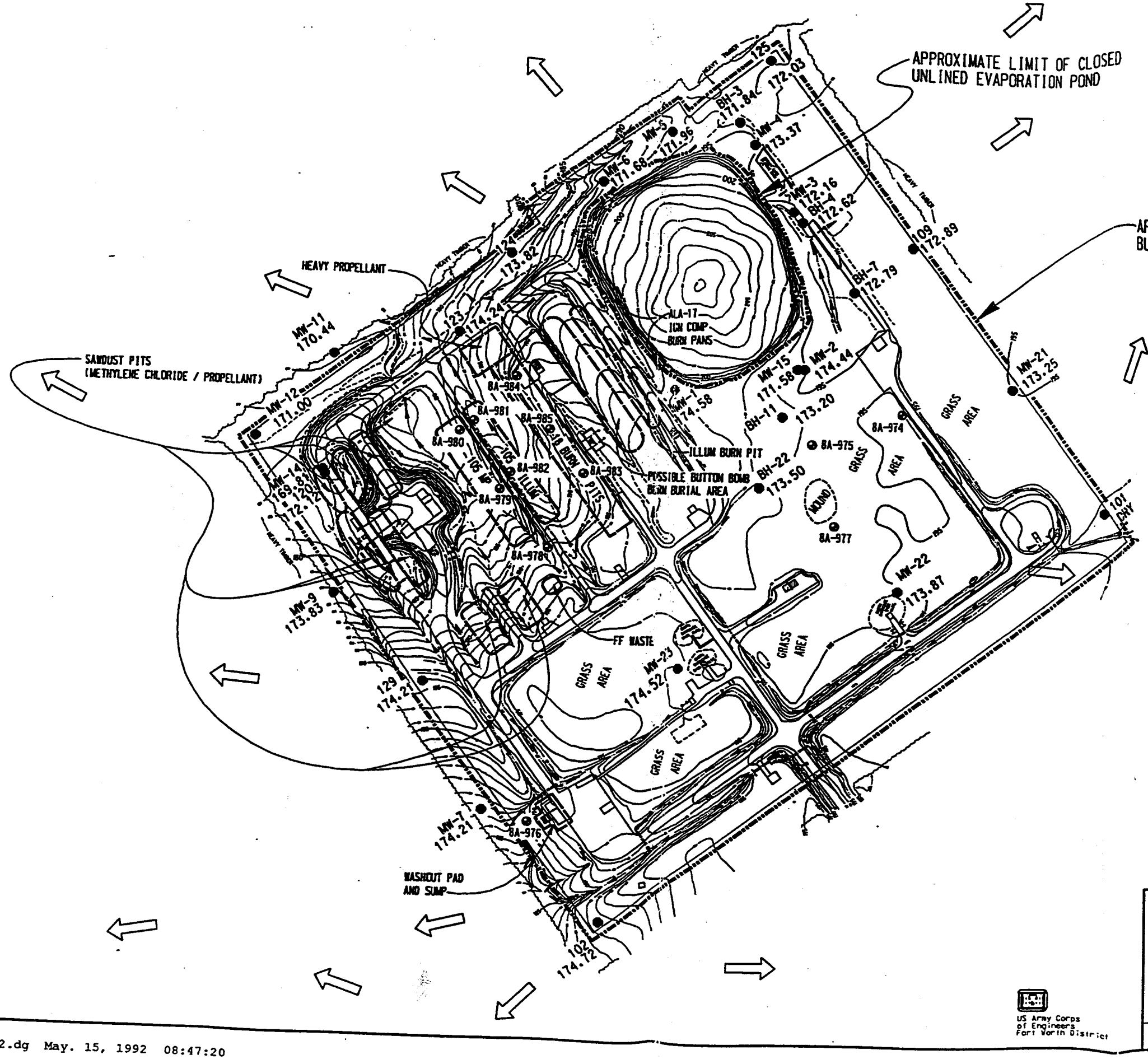
Phase I RFI, LHAAP changed over its quarterly monitoring program from the previously monitored wells to these 15 newly installed wells (MW-1 through MW-15). The same parameters continue to be analyzed and results are submitted annually to the TWC as LHAAP's "Annual Groundwater Report".

Additional investigations were performed by the Corps of Engineers, Fort Worth District, in 1989 as a phase II effort to further define the horizontal extent of the ground-water contaminant plume and to begin delineating its vertical extent, as well as to complete investigations of all possible solid waste management units (SWMUs) at the burning ground that may be contributing to the soil and ground-water contamination at the site. These investigations included installing eight more shallow wells (MW-16 through MW-23) to complete the horizontal definition of the contaminant plume, installing one deep monitoring well (C-4A) to monitor the base of the uppermost aquifer as it was defined in phase I, geophysically logging the deep well boring for C-4A, drilling and sampling 13 shallow soil borings to complete SWMU investigations, and sampling five surface water locations along Harrison Bayou to determine if contaminated ground water was discharging to surface water near the site. A sixth water sample was taken from a spigot at the site to insure no contamination had been introduced to the boreholes when this water was used for drilling. A report addressing these results was never prepared. However, the raw data were compiled into a document entitled "RCRA Facility Investigation for Active Burning Ground and Unlined Evaporation Pond, Phase II, Field Data, Longhorn Army Ammunition Plant, Karnack, Texas," (COE, 1989C). Monitoring well and surface water sampling locations are shown on Figure 3-6-6. A map depicting

soil boring locations is shown on Figure 3-6-9.

The newly installed wells have never been sampled. One soil boring (8A-975) encountered a burn/demolition pit containing empty munition casings and exhibiting high VOC concentrations down to the water table at a location south of the UEP. Soil samples taken in the other shallow soil borings at suspected SWMU locations showed VOC contamination in borings 8A-974, 8A-977, 8A-983, 8A-984, and 8A-985, and semi-volatile contamination in borings 8A-983, 8A-984, and 8A-985. Boring 974 was drilled at a suspected trench location. Boring 977 was drilled where a noted change in vegetation occurs. Borings 983, 984, and 985 were drilled along the row of suspected burn pits. All soil samples were analyzed for total metals, VOCs, and explosives. Soil samples taken along the row of suspected burn pits were also analyzed for semi-volatile organic compounds. Surface water samples were analyzed for VOCs, total metals, TOX, nitrates/nitrites, chlorides, and explosives. No contamination above background or detection limits was found in these surface water samples and the untreated water supply used for drilling at the site.

3.6.4 Assessment of Existing Data and Historic Records. The latest "Annual Groundwater Report" submitted by LHAAP to the TWC was dated 13 June 1991 (LHAAP, 1991) and documents both June and September 1990 sampling events for Wells MW-1 through MW-15. Results continue to be consistent with previous ground-water quality data with the exception of no metals exceeding SWDA MCLs. In all 15 wells, TCE exceeds TWC primary drinking water standards. Chloride concentrations exceed TWC secondary drinking water standards in many of the wells. Organic compounds detected were vinyl chloride, methylene chloride, 1,1-DCE, 1,1-DCA, trans-1,2-DCE, chloroform, 1,2-DCA, 1,1,1-TCA,



NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. LOCATIONS AND MATERIALS SHOWN ARE INTERPRETED FROM THE FOLLOWING SOURCES:
   A. 1954, 1963, 1970, 1978, AND 1985 AERIAL PHOTOS
   B. LHAAP FILES
   C. GROUND-WATER CONTAMINATION SURVEY NO. 38-26-0851-88, USAEHA, 18-22 MAY 1987
   D. COE, 1986b

LEGEND

- GROUND-WATER FLOW DIRECTION
- MW-11 170.44 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION
- SURFACE WATER FLOW DIRECTION
- APPROXIMATE LIMITS OF PAST DISPOSAL AREAS
- 8A-975 — BORING LOCATION AND NUMBER
- POINT OF COMPLIANCE

100 0 100 200
SCALE IN FEET

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
PHASE II RFI SOIL BORING LOCATIONS

DATE: JUNE 1992 | FIGURE 3-6-9

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carbon tetrachloride, TCE, styrene, xylenes, benzene, tetrachloroethylene (PCE), toluene, and ethylbenzene with 1,2-DCA also exceeding primary drinking water standards in a few of the wells. Point of compliance wells at the UEP detected methylene chloride at concentrations exceeding 6450 mg/l and TCE exceeding 190 mg/l. Both wells MW-1 and MW-2 continue to exhibit the highest concentrations of these chlorinated solvents. The deeper well, MW-15 at the MW-2 cluster location, detected methylene chloride at 3.2 mg/l and TCE at 0.33 mg/l, indicating contamination down at this depth. No explosive compounds have yet been detected in any of these wells.

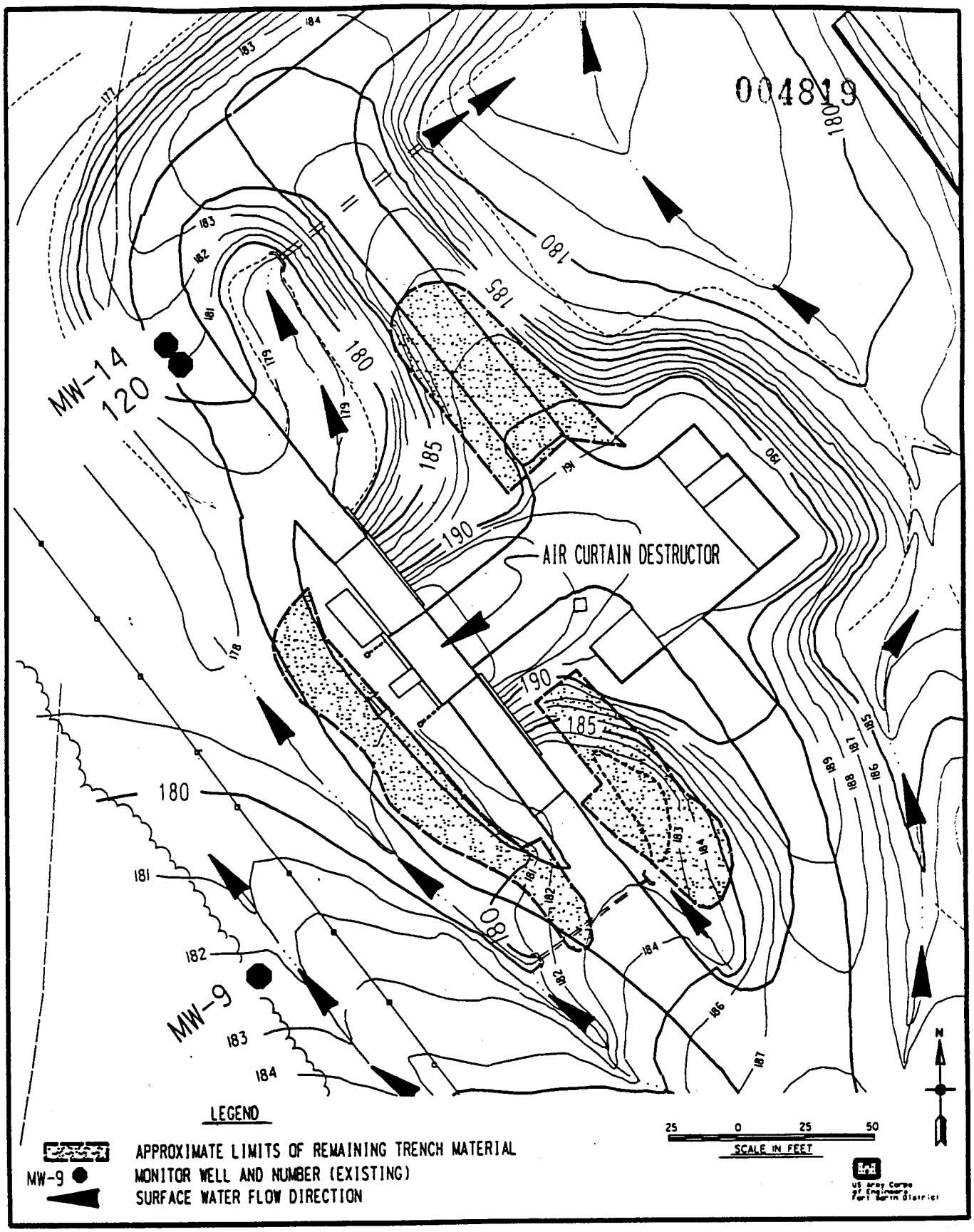
Other shallow wells installed to monitor ground-water contamination along the western edge of Burning Ground No. 3 continued to exhibit methylene chloride and TCE concentrations consistent with previous sampling data. Trichloroethene and 1,2-DCA exceed TWC primary drinking water standards, and chloride exceeds TWC secondary drinking water standards. Deeper well MW-14 located at Well 120 at the ACD showed TCE at a concentration of 8.2 mg/l and methylene chloride at a concentration of 0.007 mg/l. Chloride was present in excess of TWC secondary drinking water standards. Deeper well MW-13 located further downgradient from the ACD at cluster well location C-2 also showed TCE and methylene chloride present at concentrations of 0.11 mg/l and 0.062 mg/l, respectively.

Existing data show that at least two sources are contributing to the ground-water contamination beneath the Burning Ground No. 3 and UEP sites. The primary source is the past usage of the UEP. Concentrations of methylene chloride and TCE in wells installed at the point of compliance for this unit have been as high as 17,000 mg/l and 1,400 mg/l, respectively, with chlorides, barium, TCE, and 1-2 DCA

concentrations exceeding TWC drinking water standards. Poorly constructed well borings that have since been plugged may have provided an additional migration pathway for constituents into deeper ground water at the pond where solvent soaked sawdust was stockpiled along the berms. A second source is remnants of trenches still containing solvent wastes at the ACD location. The extent of these trenches and the wastes remaining were determined during Phase I RFI investigations (COE, 1989b) and is shown on Figure 3-6-10. Methylene chloride and TCE concentrations are somewhat lower in this area of the burning ground, with TCE, 1,2-DCA, chlorides, nitrates, and cadmium exceeding TWC drinking water standards. A third possible source for ground-water contamination is contaminated soils at various burn pit locations throughout the Burning Ground No. 3 confines.

Although there is more than one source contributing to the ground-water contamination in the burning ground area, the contoured concentrations of TCE appear to define a single plume, as determined by ground-water sampling results for 22 shallow wells sampled in September 1988 (COE, 1989b) and illustrated on Figure 3-6-11. The distribution of TCE concentrations verifies that the two primary sources of organics contamination are the UEP and the trenches at the ACD location. The highest concentrations of TCE appear centered around well MW-2 just southeast of the UEP on the point of compliance for that unit. Another area of high concentrations is illustrated as a "ridge" beginning at well 120 at the ACD and running south past wells MW-9 and MW-8, paralleling the 100-year floodplain contour of Harrison Bayou west of Burning Ground No. 3. Only part of the plume has been defined due to limited well sampling performed during previous investigations.

004819



LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
REMAINING TRENCH MATERIAL
FIGURE 3-6-10

0000224

Site characterization data determined from the previous investigations of the sites indicate that the ground-water contaminant plume is predominantly confined to an upper shallow ground-water zone and has moved less than 30 feet within the last 30 years. Surface water has not been impacted. The average ground-water velocity determined from the slug test and water level data obtained from the shallow screened wells MW-1 through MW-12 is 1.31×10^{-8} cm/sec, which equates to approximately 1.4 ft/year (COE, 1989b). It is important to note that this is only a rough estimate for characterizing the shallow saturated zone because of the heterogeneity of the materials screened for which slug tests were performed.

3.6.5 Potential Contaminants and Migration Pathways. Sources that have been identified as contributing to ground-water contamination existing beneath the burning grounds area are the contaminated ground water resulting from past operation of the UEP, remnants of trenches containing solvent soaked sawdust around the ACD, and contaminated soil from various burn pits and trenches. Contaminants already identified in the ground water are various VOCs, including very high concentrations of chlorinated solvents, metals, total nitrates, and chloride, all of which are consistent with the past waste management activities performed at the sites and the nature of the wastes treated and disposed here. The migration pathways for the contaminants resulting from these sources are described below.

3.6.5.1 Surface Water. The potential for surface water contamination exists from runoff across any contaminated surface soils remaining at the site. Surface water flow is intermittent from the burning ground area along natural and manmade drainage swales which ultimately lead to Harrison Bayou, then Caddo Lake. The extreme

western corner of Burning Ground No. 3 is also within the 100-year floodplain of the bayou. It is unclear whether the shallow soils previously identified as containing excessive concentrations of barium within surface drainage paths leading from the site were ever removed. If these soils remain, they may continue to contribute to surface water contamination possibly leaving the site.

3.6.5.2 **Sediment**. Sediment samples taken along surface drainage paths leading from past open burning sites within the burning ground showed elevated levels of barium. It is unclear as to whether these shallow soils containing excessive barium were ever removed and whether all sources have been eliminated. Intermittent surface water flow along these pathways could continue to carry these contaminated soils and redeposit them further away from the site.

3.6.5.3 **Soil**. Soils within old burn pits and trenches have already been determined to be contaminated with various types of volatile and semi-volatile organic compounds down to depths approximating the water table elevation, which creates a high potential for leaching contaminants into the ground water. Surface soils have not been investigated in recent studies to determine if contaminants are present and are therefore creating the potential for contaminating surface runoff from the site.

3.6.5.4 **Ground Water**. Ground water has already been determined to be contaminated with organic and inorganic compounds. Closure of the UEP removed the source of contamination existing beneath that site, but a secondary source of old hazardous waste still exists beneath the bottom of the UEP and the top of the ground water. However, remnants of trenches containing explosive waste residues and chlorinated solvents around the foundation of the ACD continue to actively contribute contaminants to the ground water along the western edge of the burning grounds. Soil contamination has

been identified at many locations within the burning grounds. In some areas, the depths at which this contamination exists makes it likely that contaminants have leached down to the water table. Along the row of former burn pits it appears that contaminated soil may be actively contributing to the ground-water contaminant plume. The contaminated ground water forms a single plume beneath Burning Ground No. 3 that is migrating very slowly to the west towards Harrison Bayou and to the north towards Caddo Lake. Although previous surface water sampling along Harrison Bayou has shown no impact from contaminated ground water discharge from the site, the potential exists for contaminants to migrate along this pathway and eventually impact the surface water regime.

3.6.5.5 **Air**. Contamination is confined to soil sand ground water and does not pose a threat to air unless contaminated soils are disturbed. The site is covered with vegetation except for the active burning facilities (ACD,open burning pans, etc.) The burning of material in the facilities conforms to appropriate air pollution regulations.

3.6.6 **Identification of Potential Receptors**. The general public does not have ready access to Burning Ground No. 3 and the UEP area because the sites are confined within secured LHAAP boundaries. Access to both sites is further restricted by a locked gate on the entrance road and tall fencing around the burning ground area. Although the sites are located in hunting zone 15, their use as a hunting ground is very limited. Therefore, the population having direct use of the immediate area is primarily limited to installation personnel conducting burning operations.

Because ground water occurs under unconfined conditions, discharge of contaminated ground water to the surface waters of Harrison Bayou poses a potential threat. To threaten any area public water supply wells, contaminants must first migrate downward to

elevations below which surface water discharge occurs to bypass any surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal distance that contaminants must travel to the nearest public supply well, Well 902, is approximately 2.6 miles southwest of the site area in the down-dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the sites will be developed for future use.

The site area is located in the Caddo Lake watershed and drains to the northwest into the nearby Harrison Bayou at a point approximately 1 mile upstream from Caddo Lake. There are no water bodies or watercourses running through the site. However, the western corner of the site is within the 100-year floodplain of Harrison Bayou. The burning ground area is mostly level with more relief near the western corner containing the ACD and near the northern corner containing the mounded surface of the former UEP site. The whole area is generally vegetated with grass and weeds. There are no signs of significant erosion. There are no activities planned that would significantly disturb the soil and cause sediment transport to downstream surface water and hence into Caddo Lake. However, the ground water is contaminated from substances previously buried and disposed. As a result, there is a relatively high potential for

contaminated leachate to enter the adjacent water course. Caddo Lake water, which ultimately supplies about 16,000 Louisiana residents, is not known to be affected by the contamination identified at this site.

Burning Ground No. 3 is primarily a large field dissected with dirt roads and vegetated with a variety of grasses and forbs. The area is virtually clear of all trees. The now mounded UEP is covered with short grass. Foxes have been sighted in the nearby tall grass. The surrounding field is vegetated with medium-height grass and forbs interspersed with taller Johnson grass. Along the surrounding fence line, taller grasses predominate. A relatively dense pine/hardwood lies outside the fenced area. Field mice and other small rodents are expected to inhabit the site area. Meadowlarks may winter or pass through the site area. However, smoke from burning cages may also discourage the presence of birds.

3.6.7 Initial Remedial Action. Ground water beneath the burning grounds area is contaminated with high concentrations of methylene chloride and TCE. Two areas of high concentrations have been identified within the ground-water contaminant plume. Both areas of high concentration coincide with the locations of the two major sources of this contamination - the UEP in the northern corner of the site, and the waste disposal trenches in the western corner of the site. Although no health and environmental impacts from this ground-water contamination have been noted on-site or downgradient of these areas, the need for interim remedial action to prevent further ground-water degradation should be evaluated for each of these hot spots in accordance with the guidelines presented by EPA in "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites," EPA/540/G-88/003.

3.6.7.1 **Former Unlined Evaporation Pond (UEP).** The primary source of ground-water contamination at the UEP was removed when this RCRA facility was closed in 1986. A secondary source of contamination may be present in the soil beneath the closed UEP. However, the dense nature of the chlorinated solvents which were disposed in the UEP have caused them to apparently pool on top of a discontinuous low permeability stratum in the vicinity of monitoring wells MW-1 and MW-2. One ground-water sample analysis shows the concentration of methylene chloride to be approximately 2% (>17,000 mg/l) in MW-2 (COE, 1989b). Sampling of the cluster well MW-15 monitoring ground water immediately beneath the low permeability stratum indicates TCE and methylene chloride have migrated vertically to the next water-bearing zone; however, concentrations are significantly lower, with methylene chloride at 3.2 mg/l and TCE at 0.33 mg/l (LHAAP, 1991). Isoconcentration lines to define the horizontal extent of the highest TCE concentrations in the uppermost water-bearing zone have not been fully delineated due to the limited ground-water sampling previously performed at this site, and the vertical extent has not been determined. Hydrogeologic data indicate that the confining layer is not continuous beneath the burning grounds site and is hydraulically connected with other stratigraphic units underlying the site. Data indicate that the plume is migrating at a rate of 1.4 ft/yr and does not immediately threaten drinking water wells (COE, 1989b). The closest domestic water well is 13,700 feet from this area.

Although no health and environmental impacts from this ground-water contamination have been noted, an interim remedial action to prevent further plume migration and ground-water degradation will be evaluated in accordance with the guidelines in EPA/540/G-88/003 due to the possibility of free solvents being pooled in the ground water with migration occurring both horizontally and vertically. Removal of the

highest concentrations of solvents present in this area of the burning ground could prevent further degradation of the ground water until remedial action for the entire site can be addressed. However, before a removal action is performed, it will be necessary to complete the delineation of the contaminant plume in the areas of highest concentration so the effects of any contaminant removal can be monitored for final remediation measures. This can be accomplished as early as possible during the RI by performing a complete round of ground-water sampling for all of the wells monitoring LHAAP 18 and 24. It will also be necessary to determine if an immediate threat to health or the environment exists for which an interim remedial action is necessary. The data obtained from a complete round of well sampling can then be used to calculate action levels for determining if this interim action is necessary prior to completing the RI/FS.

3.6.7.2 **Trenches at ACD Location.** Although no known health and environmental impacts have been noted on-site or downgradient of the ACD area, trench debris continues to contribute to ground-water contamination in the western corner of the site. In accordance with the guidelines presented in EPA/540/G-88/003, an interim remedial action to control this source of contamination should be evaluated prior to completing the RI/FS. To comply with this guidance, data pertaining to the soil and ground-water contamination associated with the trench debris at this location can be reviewed as early as possible during the RI following the guidelines in EPA/540/G-88/003 to determine if a threat to human health or the environment exists which would substantiate an interim remedial action to remove the trench debris remaining at the site. Data pertaining to other areas of contaminated soil within the burning grounds believed to be

contributing to ground-water contamination can also be reviewed to ensure that any removal action performed as an interim remedial action measure will be consistent with anticipated remedial action measures to be performed as a result of the RI/FS.

HPL + RCRA CH

3.7 LHAAP 29 - FORMER TNT PRODUCTION AREA

3.7.1 Site History. A TNT plant was operated in the former TNT Production Area from October 1942 until August 1945. The plant produced over 180 million kilograms of flake TNT from five regular production lines, A through E, and one stand-by line, F. Line A was the first into production in October 1942. By the end of March 1943, three additional lines, most likely Lines B through D, were producing TNT. In October 1944, the fifth regular production line, probably Line E, was added, and a few months later TNT production was at its all-time high. A rather detailed history of the TNT plant along with some discussion of production techniques can be found in an article that appeared in the Marshall News Messenger on 4 November 1945.

Chemicals used to produce 2,4,6-TNT during the plant's operation included nitric acid, toluene, sulfuric acid and/or oleum. Oleum is a solution of sulfur trioxide in sulfuric acid. A mixture of oleum and nitric acid is a more effective nitrating agent than nitric acid and sulfuric acid. This mixture was probably used at this plant.

The chemical used to purify the TNT flakes was most likely sellite, a 15 percent aqueous solution of sodium sulfite. Soda ash (sodium carbonate) may also have been used in the purification process.

Each production line was essentially the same and consisted of four main elements: an Unloading Area where acids and toluene were unloaded and held in tanks until ready for use; a Nitrating Area where

TNT flakes were produced by nitrating toluene with nitric acid; a Wash Area where the TNT flakes were washed to remove impurities and then dried; and a Loading Area where the cardboard-boxed TNT was loaded onto trucks.

Features of the Unloading Area included aboveground holding tanks for acids (Tanks 508 and 817) and toluene (Tank 804). The toluene holding tank was surrounded by an earthen dike to contain spills. Features of the Nitrating Area included the Mono House (Bldg. 801), the Di House (Bldg 803), the Tri House (Bldg 802) and the Recovery House (Bldg 812). Associated with these structures were numerous aboveground holding tanks and concrete-lined, partially and completely sunken pits up to 7 feet deep. The Wash Area included a Wash House (Bldg 806), several aboveground holding tanks, and shallow concrete-lined pits. A covered conveyor connected the Wash House with the Nail House (Bldg 808) in the Loading Area. Each Loading Area served two production lines.

The TNT wastewater (red liquor) generated at each of the Wash Areas was collected by a 12-inch underground wood stave pipeline. The red liquor flowed by gravity through the pipeline to a storage tank and pump house located on the northeastern end of the area adjacent to 16th Street, and then was pumped through a 6-inch underground bored wood pipeline to the TNT Waste Disposal Plant (LHAAP 32) located approximately 1/4 mile northwest of the site. A "yellow liquor" wastewater generated by the production plant was also pumped to the disposal plant through the bored pipeline. The probable composition of the red and yellow liquors is discussed in Para 3.9.1 for LHAAP 32, Former TNT Waste Disposal Plant.

Cooling water (blue water) drain lines from the former production

lines eventually emptied into an open ditch alongside 16th Street. This ditch conveyed the blue water, which was apparently contaminated by acids, to the Neutralization House where it was neutralized before being discharged to the natural surface water regime. The Neutralization House was located in the Toluene Bulk Storage Area, an area across Avenue D east of the production area. Toluene was stored in three very large aboveground storage tanks in this area.

An as-built map of the TNT Production Area showing all structures, production line facilities, and utilities is on Figure 3-7-1A. An as-built map of the Bulk Toluene Storage Area, which adjoins and is considered part of the production area, is on Figure 3-7-1B.

The TNT production plant was inactive from August 1945 until 1959 when most of its building and aboveground storage tanks were removed. Remaining on the site are concrete foundations, open-top concrete-lined pits, most of the underground utilities, some wood-frame buildings alongside the northwest site boundary, and a few aboveground storage tanks in the Line F area. There have been only limited activities at the site since World War II.

3.7.2 **Site Description**. The Former TNT Production Area is a heavily wooded 85-acre site located in the western central portion of LHAAP. The site location is shown on Figure 3-7-2. With the exception of the former Bulk Toluene Storage Area, the site is bounded by Avenue E on the southwest, 1st Street on the northwest, 18th Street on the southeast, and Avenue D on the northeast. The former Bulk Toluene Storage Area is a 500- by 500-foot wooded area located across Avenue D from the production area. This area is bounded by 33rd Street on the north, Avenue D on the west, and heavy timber on the east and south. A detailed map of the entire site showing boundary

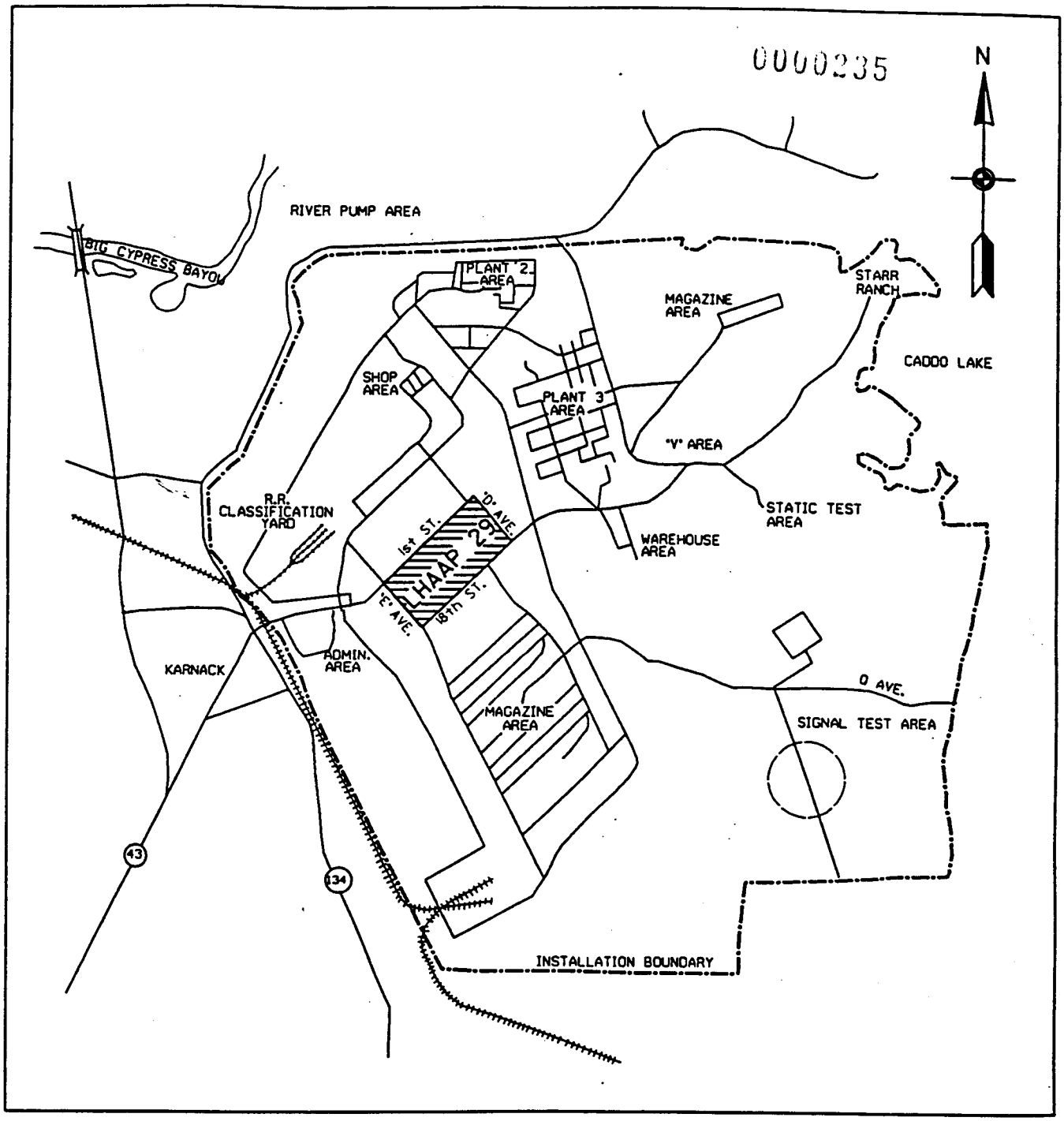


FIGURE 3-7-2 LOCATION MAP FOR LHAAP #29

US Army Corps of Engineers Fort Worth District

and existing conditions is shown on Figure 3-7-3.

Most of the surface water runoff from the site is collected by ditches constructed in 1942 when the plant was built. Runoff may also be entering the abandoned underground red liquor and blue water lines that remain throughout the site. Surface water runoff from the northern part of the site (about 40% of the site area) enters Goose Prairie Creek to the north and east of the site. In the southern part of the site (about 60% of the site area) surface water runoff flows into Central Creek southeast of the site.

Based on boring log data from wells installed at the site, the near surface soils typically consist of predominantly medium plasticity clays with some high plasticity zones (CL,CH) to depths of 5 to 10 feet. Below the surface stratum, and extending to depths in excess of 25 feet, the soils are typically low plasticity clays (CL) or silty, clayey sands (SC, SM, SM-SC) containing some medium to high plasticity clay zones. These materials are typical of the Wilcox Group.

Six wells were installed during past investigations to monitor the ground water at the site. Ground water occurs under unconfined conditions at an approximate depth of 20 feet. The direction of ground-water flow is to the east and to the southeast, towards Goose Prairie and Central Creeks, respectively, where it is possible that ground-water discharge occurs.

3.7.3 **Previous Investigations**. The Former TNT Production Area was originally investigated as a potentially contaminated site by EPS for USATHAMA, and a report was published in June of 1984 (EPS, 1984). Six monitoring wells (Wells 114, 115, 116, 117, 118 and 119) were installed during this investigation to sample the ground water for

TNT PRODUCTION LINES (1942 - 1945)

LINE A | LINE B | LINE C | LINE D | LINE E | LINE F (STAND-BY)

TO TNT DISPOSAL PLANT

NITRIC ACID UNLOADING AREA

FORMER BULK TOLUENE STORAGE AREA

FORMER TOLUENE TANK LOCATION

NITRATING AREA

FORMER TOLUENE STORAGE TANK LOCATIONS

POND

TNT PRODUCTION WASTEWATER (RED WATER) PIPELINE (UNDERGROUND)

TNT PURIFICATION (WASH) AREA

FORMER CONVEYOR FOR BOXED TNT

LOADING AREA

HEAVY TIMBER

HEAVY TIMBER & BRUSH

APPROXIMATE LIMITS OF FORMER TNT PRODUCTION AREA

N

NOTE:

1. GROUND-WATER ELEVATION NOV 89
2. PREVIOUS SAMPLING LOCATIONS ARE APPROXIMATE
3. PRODUCTION LINE A CONSTRUCTED FIRST AND OPERATED FROM OCTOBER 1942 TO AUGUST 1945

300 150 0 300
SCALE IN FEET

LEGEND

- MONITOR WELL AND NUMBER(EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- SOIL BORING AND NUMBER (PREVIOUS)
- SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- GROUND-WATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION
- POINT OF COMPLIANCE

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP-29
FORMER TNT PRODUCTION AREA
SITE MAP

DATE: JUNE 1992 | FIGURE 3-7-3

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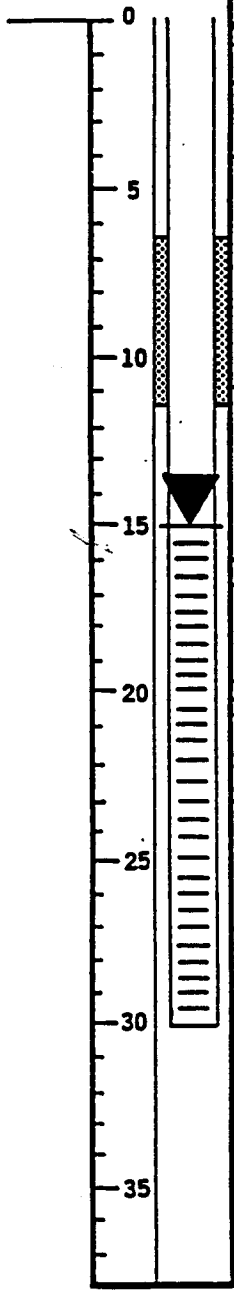
explosive compounds. All wells have 15-foot screens and are set from 10.2 - 25.2 to 22.5 - 37.5 feet. All wells monitor shallow ground water. The boring logs and well construction details for these wells are provided on Figures 3-7-4 through 3-7-9. Surface water and sediment samples were collected from two surface drainage paths (Stations 006 and 008) leading from the site towards Goose Prairie and Central Creeks, respectively. Sediment and surface water samples were also collected from a ditch along the southeast corner of the site (Station 007) and from pond water that now fills what was originally a pumphouse catchment around the former pumphouse (Station 005). All surface water and sediment samples were analyzed for explosive compounds. Sample location 005 was also analyzed for selected (total) metals and selected anions. Surface soil samples were collected to a depth of 1 foot at eight locations within the production area for explosive analyses only. All sample and well locations are shown on Figure 3-7-3.

A later investigation of the site to further characterize explosives contamination was performed by EPS, and their report was published in May 1988 (EPS, 1988). The six existing monitoring wells were sampled and analyzed for explosives and VOCs. Surface water samples were collected from each of the following areas: the pond at the former pumphouse location near the northeast corner of site (SS1); the headwall where the underground cooling water wastewater lines discharged to the ditch southeast of the former pumphouse location (SS2); the southeast corner of site (SS3); and the southwest corner of site (SS4). These surface water samples were analyzed for explosive compounds. A total of 35 soil borings were drilled to a depth of 42 inches at the approximate locations shown on Figure 3-7-3. One



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SM	8/12 13/7	Slightly silty sand	10	
SC		Clayey silty sand Very pale brown & yellowish brown	30	
SC	3/7 11/14	Very clayey sand §5% fine sand Light grey mottled w/red and yellowish brown	45	
SC-SM	7/11 13/17 6/11 13/15	Slightly clayey silty sand Light grey mottled w/yellowish brown 10% clay 15% silt	25	
CL+SM		Silty sand & sandy clay		
CL		Sandy clay 20% fine sand Light grey mottled w/yellowish brown		
ML		Black sandy silt		
	3/6	Slightly sandy clay seam		
SC	10/15	Clayey sand Light brownish grey & pale brown	40	
CL	6/10 /17	Slightly silty clay w/silty sand seams Pale brown & brownish yellow		
SM	27/35	Clayey silty sand Dark greyish brown 5% clay 20% silt	25	
	30/55	Greyish brown & yellowish brown		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 114 DATE DRILLED 7/15/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 243.96 ft
ELEVATION TOP OF PVC RISER = 242.88 ft
ELEVATION OF GROUND SURFACE = 241.13 ft

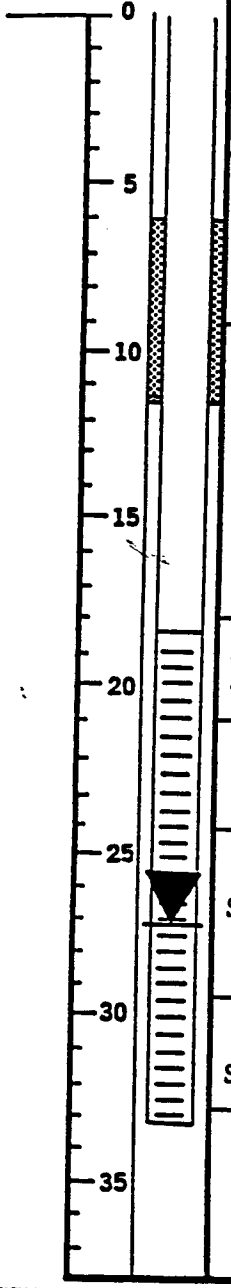
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-7-4
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 114

0000239



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/15 /17	Silty sand Pale brown mottled w/yellowish brown	15	
CL	5/7 11/14	Sandy clay 30% fine sand Grey mottled w/yellowish red		
SC	7/12 15/18	Clayey sand 60% fine sand Light brownish grey mottled w/yellowish brown		
	5/11 15/19	Clayey sand Light brownish grey mottled w/yellowish brown		
SC+ SC-SP	6/9	Clayey sand w/seams of slightly clayey sand Tl brownish grey w/yellowish brown		
CL	14/18	Sandy clay 25% fine sand w/seam of dark grey clay		
SM-ML	18/20 22/25	Clayey silty sand Dark greyish brown 5% clay 30% silt	35	
SM+CL	27/41	Silty sand w/some clay layers 80% fine sand Olive brown 20% clay		

*BLOWS PER 6 INCH USING 18. 24.or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 115 DATE DRILLED 7/14/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 224.88 ft
ELEVATION TOP OF PVC RISER = 224.38 ft
ELEVATION OF GROUND SURFACE = 221.90 ft

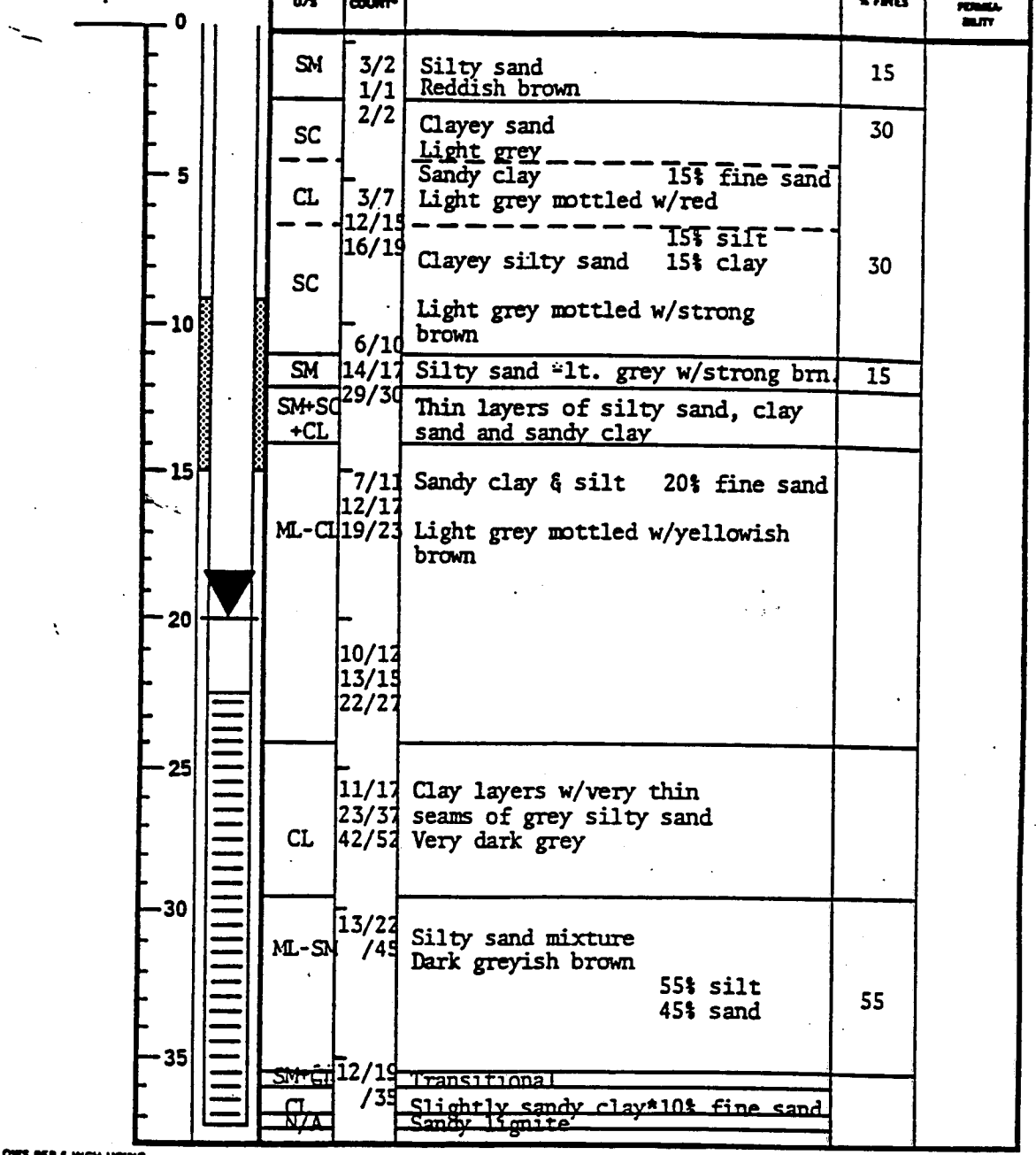
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

0000240

FIGURE 3-7-5
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 115



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	3/2 1/1	Silty sand Reddish brown	15	
SC	2/2	Clayey sand Light grey	30	
CL	3/7 12/15	Sandy clay 15% fine sand Light grey mottled w/red		
SC	16/19 6/10	Clayey silty sand 15% silt 15% clay Light grey mottled w/strong brown	30	
SM	14/17	Silty sand lt. grey w/strong brn.	15	
SM+SC +CL	29/30	Thin layers of silty sand, clay sand and sandy clay		
ML-CL	7/11 12/17 19/23 10/12 13/15 22/27	Sandy clay & silt 20% fine sand Light grey mottled w/yellowish brown		
CL	11/17 23/37 42/52	Clay layers w/very thin seams of grey silty sand Very dark grey		
ML-SM	13/22 /45	Silty sand mixture Dark greyish brown 55% silt 45% sand	55	
SM-CL	12/19 /35	Transitional		
CL		Slightly sandy clay*10% fine sand		
N/A		Sandy lignite		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 116 DATE DRILLED 6/3/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 216.32 ft
ELEVATION TOP OF PVC RISER = 216.21 ft
ELEVATION OF GROUND SURFACE = 213.47 ft

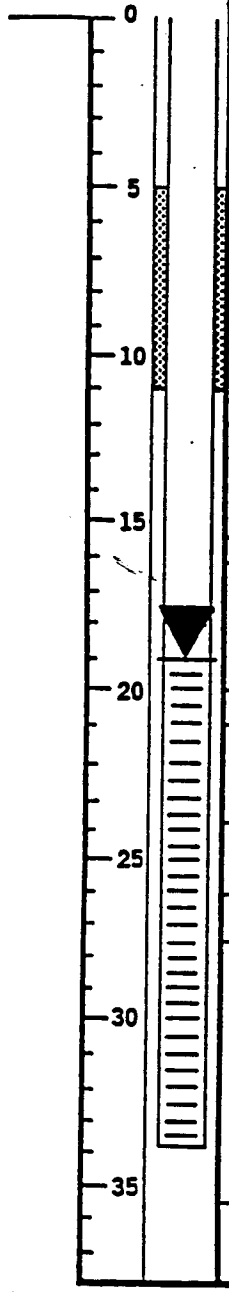
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-7-6
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 116

0000241



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/10 /8	Silty sand Light grey	30	
CL	8/18 /25	Sandy clay 30% fine sand Light grey mottled w/brownish yellow		
CL	5/12	Sandy clay 15% fine sand Light grey mottled w/brownish yellow		
SC-SP	18/2	Slightly clayey sand seam	10	
CL		Sandy clay Light grey mottled w/brownish yellow		
SC-SP	6/8	Slightly clayey sand seam	30	
CL+SC	9/10	Sandy clay w/clayey sand seams 15% fine sand Lt. grey w/brownish yellow		
SC	5/6	Clay sand	15	
CL	7/8	Sandy clay 20% fine sand Lt. grey w/brownish yellow		
SC	5/6	Clayey sand Lt. grey w/brownish yellow	15	
SC	7/7	Clayey sand	30	
SM	7/9 15/20	Slightly clayey silty sand Strong brown mottled with yellowish brown 5% clay 35% silt		
	15/25 /30			

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 117 DATE DRILLED 7/12/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 213.72 ft
ELEVATION TOP OF PVC RISER = 213.38 ft
ELEVATION OF GROUND SURFACE = 210.92 ft

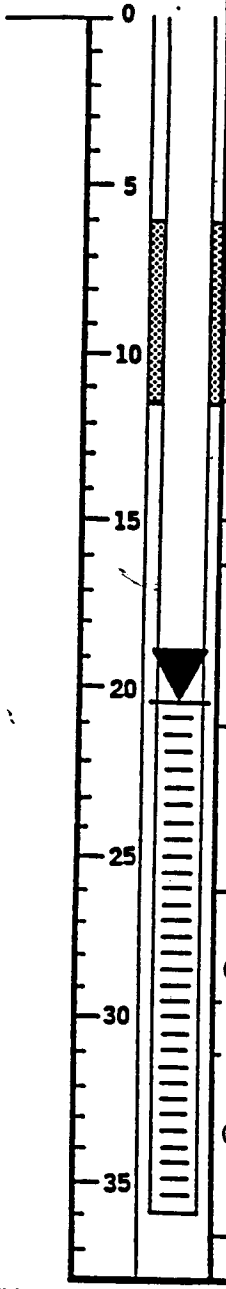
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-7-7
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 117

004838



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SC-CL	5/6 /5	Clayey sand 55% fine sand Reddish grey & red mottled	45	
SM		Dry silty sand Light grey	20	
SC-CL		Clayey sand Reddish grey & red mottled	45	
SM-SC	8/16 20/27 8/15	Slightly clayey silty sand 5% clay 25% silt Light yellowish brown mottled yellowish brown	30	
SM-SC	15/20	Clayey sand 80% fine sand Light yellowish brown mottled w/yellowish brown		
SM	8/15	Silty sand seam	15	
SM-SC	19/25	Slightly clayey silty sand 5% clay 25% silt Light yellowish brown mottled w/yellowish brown	30	
SM	6/11 15/20	Silty sand Yellowish brown	25	
CL+SM		Thinly bedded clay & silty sand		
SM	15/15 18/20	Seam of slightly clayey silty sand		
CL+SC		Clay & clayey sand Dark grey to light grey		
	15/25 /30			

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 118 DATE DRILLED 7/13/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 219.21 ft
ELEVATION TOP OF PVC RISER = 218.62 ft
ELEVATION OF GROUND SURFACE = 216.28 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-7-8
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO.118

0000243

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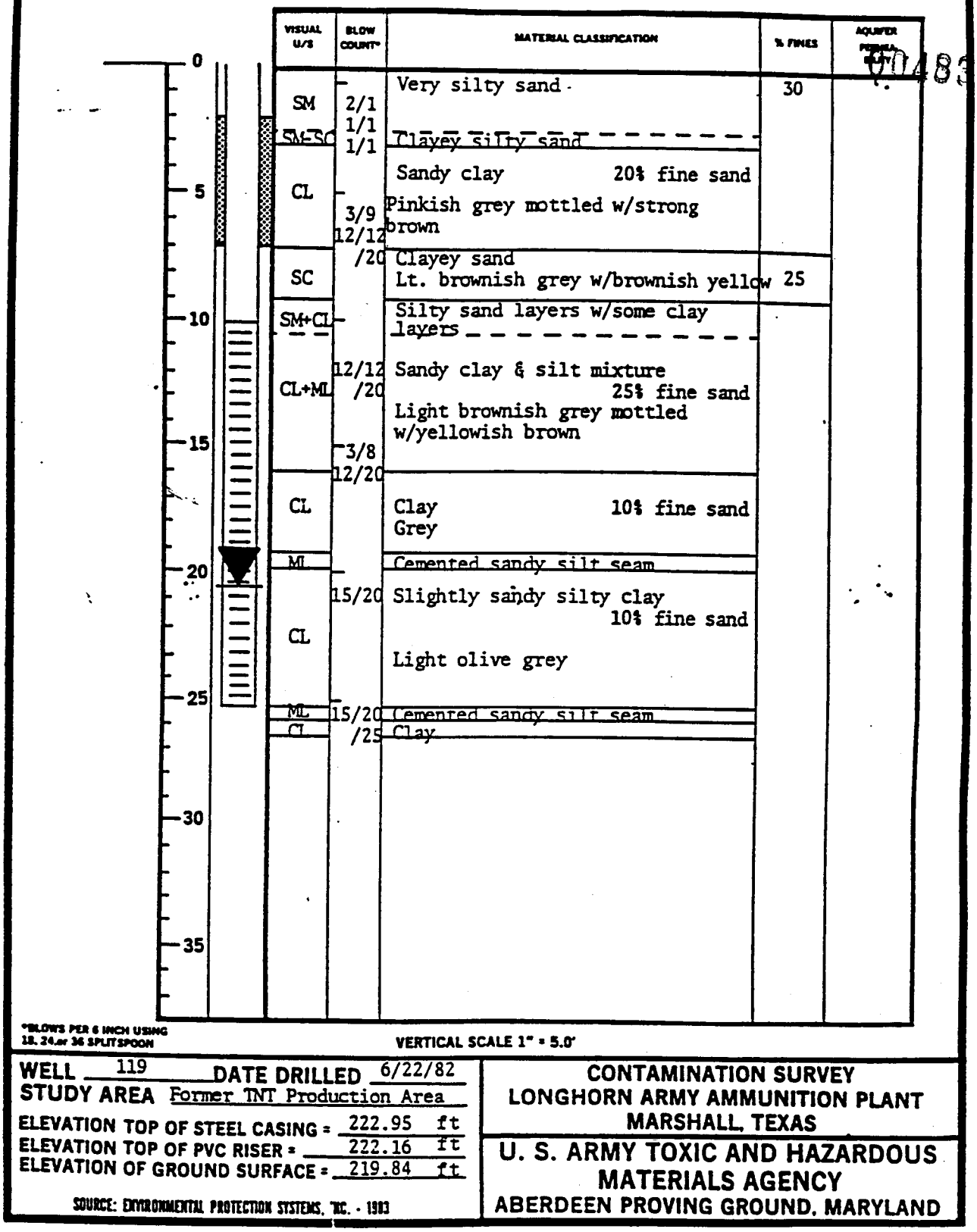

WELL 119 DATE DRILLED 6/22/82
STUDY AREA Former TNT Production Area
ELEVATION TOP OF STEEL CASING = 222.95 ft
ELEVATION TOP OF PVC RISER = 222.16 ft
ELEVATION OF GROUND SURFACE = 219.84 ft
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-7-9
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 119

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background boring was drilled off-site to the southwest. Four soil samples were taken per boring at depth increments of 0 to 6 inches, 12 to 18 inches, 24 to 30 inches, and 36 to 42 inches. Each sample was analyzed for explosives.

004840

3.7.4 Assessment of Existing Data and Historic Records.

Analytical results for ground-water sampling performed in 1984 are presented on Table 3-7-1. No explosives were detected in the 1984 ground-water samples. Only one of the four 1984 surface water and sediment sampling locations, Station 006, showed explosive compounds above detection limits. The surface water sample at this location showed 2,4,6-TNT at 206.9 ug/l, 2,4-DNT at 23.4 ug/l, and 2,6-DNT at 13.6 ug/l. The sediment sample contained 0.78 ug/g of 2,4,6-TNT. Results of these analyses are shown on Table 3-7-2. The concentration of 2,4,6-TNT in surface soil samples taken from the site ranged from below detection limits to over 7600 ug/g, as shown on Table 3-7-3, with no apparent pattern to the distribution. This explosive compound was identified at all but one sampling location. Other explosive compounds identified at various locations at much lower concentrations were 1,3,5-TNB and 2,4-DNT.

Results of soil sample analyses from the 1988 sampling of the site are presented on Table 3-7-4. Low concentrations of 1,3,5-TNB (<913 ug/kg) were found randomly in the soil down to 42 inches throughout the site and was the most prevalently identified explosive compound. Low levels of 1,3-DNB (<52 ug/kg) were identified in the top 6 inches of soil at two locations. The compound 2,4-DNT was found at depth in three locations to a maximum concentration of 93 ug/kg. The highest concentration of explosives identified was 2,057 ug/kg of 2,4,6-TNT found at one sampling location. This compound was also

TABLE 3-7-1
SUMMARY OF 1984 GROUND-WATER ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA

Analyte	Units	Well 114	Well 115	Well 116	Well 117	Well 118	Well 119
1,3-DNB	ug/L	<1.68	<1.68	<1.68	<1.68	<1.68	<1.68
2,4,6-TNT	ug/L	<1.46	<1.46	<1.46	<1.46	<1.46	<1.46
1,3,5-TNB	ug/L	<1.08	<1.08	<1.08	<1.08	<1.08	<1.08
2,4-DNT	ug/L	<0.89	<0.89	<0.89	<0.89	<0.89	<0.89
2,6-DNT	ug/L	<1.20	<1.20	<1.20	<1.20	<1.20	<1.20
Nitrobenzene	ug/L	<1	<1	<1	<1	<1	<1

From EPS Inc. report dated May 1984

TABLE 3-7-2
SUMMARY OF 1984 SURFACE WATER AND SEDIMENT ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA

SAMPLING SITE	005		006		007		008	
Units	WATER (ug/l)	SEDIMENT (ug/g)	WATER (ug/l)	SEDIMENT (ug/g)	WATER (ug/l)	SEDIMENT (ug/g)	WATER (ug/l)	SEDIMENT (ug/g)
EXPLOSIVES								
1,3-DNB	<1.68	<0.5	<1.68	<0.5	<1.68	<0.5	<1.68	<0.5
2,4,6-TNT	<1.46	<0.73	206.90	0.78	<1.46	<0.73	<1.46	<0.73
1,3,5-TNB	<1.08	<0.71	<1.08	<0.71	<1.08	<0.71	<1.08	<0.71
2,4-DNT	<0.89	<0.5	23.40	<0.5	<0.89	<0.5	<0.89	<0.5
2,6-DNT	<1.2	<0.61	13.65	<0.61	<1.2	<0.61	<1.2	<0.61
ANIONS								
NITRATE	<500	<5	NA	NA	NA	NA	NA	NA
NITRITE	<250	<5	NA	NA	NA	NA	NA	NA
PHOSPHATES	<125		NA	NA	NA	NA	NA	NA
SULFATE	6410.00	152.81	NA	NA	NA	NA	NA	NA
CHLORIDE	8000.00	14	NA	NA	NA	NA	NA	NA
FLOURIDE	<500	5	NA	NA	NA	NA	NA	NA
CHROMATE	<500	<5	NA	NA	NA	NA	NA	NA
THIOCYANATE	<500	<10	NA	NA	NA	NA	NA	NA
CYANIDE	<600	<5	NA	NA	NA	NA	NA	NA
METALS								
ALUMINUM	<10	1007.8	NA	NA	NA	NA	NA	NA
ANTIMONY	<10.2	<.76	NA	NA	NA	NA	NA	NA
BARIUM	127.00	66.7	NA	NA	NA	NA	NA	NA
CADMIUM	<.28	<.5	NA	NA	NA	NA	NA	NA
CHROMIUM	<6.64	23.4	NA	NA	NA	NA	NA	NA
	8.8	21.4	NA	NA	NA	NA	NA	NA
MANGANESE	39	85.5	NA	NA	NA	NA	NA	NA
STRONTIUM	46	7	NA	NA	NA	NA	NA	NA
MERCURY	<1.3	<2.7	NA	NA	NA	NA	NA	NA
COPPER	<23.9	5.1	NA	NA	NA	NA	NA	NA
ZINC	<27.1	29.5	NA	NA	NA	NA	NA	NA
ARSENIC	<6	<3	NA	NA	NA	NA	NA	NA
BERYLLIUM	<10	<.5	NA	NA	NA	NA	NA	NA
NICKEL	62.+	7	NA	NA	NA	NA	NA	NA
SELENIUM	<6	<.5	NA	NA	NA	NA	NA	NA
SILVER	<10	<.5	NA	NA	NA	NA	NA	NA
THALLIUM	<50	<3	NA	NA	NA	NA	NA	NA

NOTE:
+ Exceeds limit of Aquatic Life Criteria or Human Health Criteria designated by U.S. E.P.A..
NA = Not analyzed
< = Below detection limits
From EPS Inc. report dated May 1984.

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TABLE 3-7-3
SUMMARY OF 1984 SURFACE SOIL ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA

	SOIL SAMPLES							
Sample Number Depth	301 0-1 ft	302 0-1 ft	303 0-1 ft	304 0-1 ft	305 0-1 ft	306 0-1 ft	307 0-1 ft	308 0-1 ft
EXPLOSIVES ug/g								
1,3-DNB	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-TNT	328.76	7645.68	42.44	0.90	6.03	<0.73	20.77	5588.82
1,3,5-TNB	10.35	64.65	<0.71	<0.71	2.82	<0.71	<0.71	17.55
2,4-DNT	<0.5	13.50	<0.5	<0.5	<0.5	<0.5	<0.5	16.80
2,6-DNT	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61	<0.61

< Below detection limits.

From EPS Inc. report dated May 1984.

TABLE 3-7-4
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA
(pg 1 of 3)

Sample/Depth	1,3-DNB ug/Kg	2,4-DNT ug/Kg	2,6-DNT ug/Kg	1,3,5-TNB ug/Kg	2,4,6-TNT ug/Kg
BG/0-6 in.	<10	<10	<10	<10	<10
BG/12-18 in.	<10	<10	<10	<10	<10
BG/24-30 in.	<10	<10	<10	<10	<10
BG/36-42 in.	<10	<10	<10	<10	<10
B1/0-6 in.	<10	<10	<10	30.00	<10
B1/12-18 in.	<10	<10	<10	<10	<10
B1/24-30 in.	<10	<10	<10	20.00	<10
B1/36-42 in.	<10	<10	<10	470.00	<10
B2/0-6 in.	<10	<10	<10	<10	<10
B2/12-18 in.	<10	<10	<10	<10	<10
B2/24-30 in.	<10	<10	<10	10.00	<10
B2/36-42 in.	<10	<10	<10	27.00	<10
B2/Rinsate (ug/L)	<1.0	<1.0	<1.0	<1.0	<1.0
B3/0-6 in.	<10	<10	<10	<10	<10
B3/12-18 in.	<10	<10	<10	27.00	<10
B3/24-30 in.	<10	<10	<10	67.00	<10
B3/36-42 in.	<10	<10	<10	34.00	<10
B4/0-6 in.	<10	<10	<10	<10	<10
B4/12-18 in.	<10	<10	<10	<10	<10
B4/24-30 in.	<10	<10	<10	<10	<10
B4/36-42 in.	<10	<10	<10	<10	<10
B5/0-6 in.	<10	<10	<10	<10	<10
B5/12-18 in.	<10	<10	<10	<10	<10
B5/24-30 in.	<10	<10	<10	<10	<10
B5/36-42 in.	<10	<10	<10	100.00	<10
B6/0-6 in.	35.00	<10	<10	913.00	2057.00
B6/12-18 in.	<10	<10	<10	87.00	200.00
B6/24-30 in.	<10	<10	<10	43.00	730.00
B6/36-42 in.	<10	<10	<10	<10	<10
B7/0-6 in.	<10	<10	<10	117.00	<10
B7/12-18 in.	<10	<10	<10	<10	<10
B7/24-30 in.	<10	<10	<10	<10	<10
B7/36-42 in.	<10	60.00	<10	<10	13.00
B8/0-6 in.	<10	<10	<10	100.00	<10
B8/12-18 in.	<10	93.00	<10	34.00	<10
B8/24-30 in.	<10	<10	<10	<10	<10
B8/36-42 in.	<10	<10	<10	<10	<10
B9/0-6 in.	<10	<10	<10	<10	<10
B9/12-18 in.	<10	<10	<10	<10	<10
B9/24-30 in	<10	25.00	<10	27.00	<10
B9/36-42 in.	<10	<10	<10	<10	<10
B10/0-6 in.	<10	<10	<10	13.00	<10
B10/12-18 in.	<10	<10	<10	<10	<10
B10/24-30 in.	<10	<10	<10	30.00	<10
B10/36-42 in.	<10	<10	<10	47.00	<10
B11/0-6 in.	<10	<10	<10	110.00	<10
B11/12-18 in.	<10	<10	<10	13.00	<10
B11/24-30 in.	<10	<10	<10	<10	<10
B11/36-42 in.	<10	<10	<10	<10	<10
B12/0-6 in.	52.00	<10	<10	21.00	23.00
B12/12-18 in.	<10	<10	<10	630.00	<10

TABLE 3-7-4
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA
(pg 2 of 3)

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Sample/Depth	1,3-DNB ug/Kg	2,4-DNT ug/Kg	2,6-DNT ug/Kg	1,3,5-TNB ug/Kg	2,4,6-TNT ug/Kg
B12/24-30 in.	<10	<10	<10	43.00	<10
B12/36-42 in.	<10	<10	<10	<10	<10
B13/0-6 in.	<10	<10	<10	<10	12.00
B13/12-18 in.	<10	<10	<10	<10	<10
B13/24-30 in.	<10	<10	<10	<10	<10
B13/36-42 in.	<10	<10	<10	<10	<10
B14/0-6 in.	<10	<10	<10	<10	<10
B14/12-18 in.	<10	<10	<10	<10	<10
B14/24-30 in.	<10	<10	<10	<10	<10
B14/36-42 in.	<10	<10	<10	<10	<10
B15/0-6 in.	<10	<10	<10	<10	<10
B15/12-18 in.	<10	<10	<10	<10	<10
B15/24-30 in.	<10	<10	<10	<10	<10
B15/36-42 in.	<10	<10	<10	<10	<10
B16/0-6 in.	<10	<10	<10	67.00	<10
B16/12-18 in.	<10	<10	<10	<10	<10
B16/24-30 in.	<10	<10	<10	23.00	<10
B16/36-42 in.	<10	<10	<10	<10	<10
B17/0-6 in.	<10	<10	<10	<10	<10
B17/12-18 in.	<10	<10	<10	<10	<10
B17/24-30 in.	<10	<10	<10	<10	<10
B17/36-42 in.	<10	<10	<10	<10	<10
B18/0-6 in.	<10	<10	<10	<10	66.00
B18/12-18 in.	<10	<10	<10	<10	<10
B18/24-30 in.	<10	<10	<10	<10	<10
B18/36-42 in.	<10	<10	<10	<10	<10
B19/0-6 in.	<10	<10	<10	<10	<10
B19/12-18 in.	<10	<10	<10	<10	<10
B19/24-30 in	<10	<10	<10	<10	<10
B19/36-42 in.	<10	<10	<10	<10	<10
B20/0-6 in.	<10	<10	<10	<10	<10
B20/12-18 in.	<10	<10	<10	<10	<10
B20/24-30 in.	<10	<10	<10	<10	<10
B20/36-42 in.	<10	<10	<10	<10	<10
B21/0-6 in.	<10	<10	<10	<10	<10
B21/12-18 in.	<10	<10	<10	<10	<10
B21/24-30 in.	<10	<10	<10	<10	<10
B21/36-42 in.	<10	<10	<10	<10	<10
B22/0-6 in.	<10	<10	<10	<10	<10
B22/12-18 in.	<10	<10	<10	<10	<10
B22/24-30 in.	<10	<10	<10	<10	<10
B22/36-42 in.	<10	<10	<10	<10	<10
B23/0-6 in.	<10	<10	<10	<10	<10
B23/12-18 in.	<10	<10	<10	<10	<10
B23/24-30 in.	<10	<10	<10	<10	<10
B23/36-42 in.	<10	<10	<10	<10	<10
B24/0-6 in.	<10	<10	<10	<10	<10
B24/12-18 in.	<10	<10	<10	<10	<10
B24/24-30 in.	<10	<10	<10	<10	<10
B24/36-42 in.	<10	<10	<10	<10	<10

TABLE 3-7-4
SUMMARY OF 1988 SOIL ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA
(pg 3 of 3)

Sample/Depth	1,3-DNB ug/Kg	2,4-DNT ug/Kg	2,6-DNT ug/Kg	1,3,5-TNB ug/Kg	2,4,6-TNT ug/Kg
B25/0-6 in.	<10	<10	<10	<10	<10
B25/12-18 in.	<10	<10	<10	<10	<10
B25/24-30 in.	<10	<10	<10	<10	<10
B25/36-42 in.	<10	<10	<10	<10	<10
B26/0-6 in.	<10	<10	<10	<10	<10
B26/12-18 in.	<10	<10	<10	<10	<10
B26/24-30 in.	<10	<10	<10	<10	<10
B26/36-42 in.	<10	<10	<10	<10	<10
B27/0-6 in.	<10	<10	<10	<10	<10
B27/12-18 in.	<10	<10	<10	<10	<10
B27/24-30 in.	<10	<10	<10	<10	<10
B27/36-42 in.	<10	<10	<10	<10	<10
B28/0-6 in.	<10	<10	<10	<10	15.00
B28/12-18 in.	<10	<10	<10	<10	<10
B28/24-30 in.	<10	<10	<10	<10	<10
B28/36-42 in.	<10	<10	<10	53.00	<10
B29/0-6 in.	<10	<10	<10	<10	<10
B29/12-18 in.	<10	<10	<10	<10	<10
B29/24-30 in	<10	<10	<10	<10	<10
B29/36-42 in.	<10	<10	<10	<10	<10
B30/0-6 in.	<10	<10	<10	<10	<10
B30/12-18 in.	<10	<10	<10	<10	<10
B30/24-30 in.	<10	<10	<10	<10	<10
B30/36-42 in.	<10	<10	<10	<10	<10
B31/0-6 in.	<10	<10	<10	<10	<10
B31/12-18 in.	<10	<10	<10	<10	<10
B31/24-30 in.	<10	<10	<10	<10	<10
B31/36-42 in.	<10	<10	<10	<10	<10
B32/0-6 in.	<10	<10	<10	<10	<10
B32/12-18 in.	<10	<10	<10	<10	<10
B32/24-30 in.	<10	<10	<10	<10	<10
B32/36-42 in.	<10	<10	<10	<10	<10
B33/0-6 in.	<10	<10	<10	<10	<10
B33/12-18 in.	<10	<10	<10	<10	<10
B33/24-30 in.	<10	<10	<10	<10	<10
B33/36-42 in.	<10	<10	<10	<10	<10
B34/0-6 in.	<10	<10	<10	<10	<10
B34/12-18 in.	<10	<10	<10	<10	<10
B34/24-30 in.	<10	<10	<10	<10	<10
B34/36-42 in.	<10	<10	<10	<10	<10
B35/0-6 in.	<10	<10	<10	<10	<10
B35/12-18 in.	<10	<10	<10	<10	<10
B35/24-30 in.	<10	<10	<10	<10	<10
B35/36-42 in.	<10	<10	<10	<10	<10

< = Below detection limit

From EPS Inc. report dated May 1988

identified at five other locations at significantly lower concentrations (<66 ug/kg).

The surface water sample SS2 at the location where blue water wastewater lines discharged to a drainage ditch showed 2,4,6-TNT at 116 ug/l, 2,4-DNT at 1.2 ug/l, and 2,6-DNT at 9.0 ug/l. The pond at the former pumphouse location, SS1, showed a concentration of 11 ug/l 2,4,6-TNT in the surface water sample taken there. Explosive concentrations in all other surface water samples were below detection limits. Results of the surface water analyses of the 1988 samples are shown on Table 3-7-5.

Ground-water samples from the six previously installed ground-water monitoring wells showed 1.4 ug/l 1,3,5-TNB in both Well 114, located upgradient of the site, and Well 118. No other contaminants were identified. Ground-water analytical results for the 1988 samples are shown on Table 3-7-6.

A draft document prepared by USATHAMA in March 1990 presented a RCRA Facility Investigation work plan for this site. This document reported that all contaminated soils had been removed from the pond existing at the former pumphouse location. However, no other documentation has been found to verify this.

Site visits were conducted by the U.S. Army Corps of Engineers in 1990 and 1991 to aid in development of RI/FS work plans for investigating the site. During the 1990 visit, suspected TNT crystals were found in the drainage ditch near the SS2 sampling location.

The combined results of previous investigations of the site indicate that some of the site's soils are contaminated to depths of at least 42 inches with explosive compounds. The distribution of explosive compounds identified in the soils to date appears to be

TABLE 3-7-5
SUMMARY OF 1988 SURFACE WATER ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA

Analyte	Units	SS1	SS2	SS3	SS4
1,3-DNB	ug/L	<1.0	<1.0	<1.0	<1.0
2,4-DNT	ug/L	<1.0	1.2	<1.0	<1.0
2,6-DNT	ug/L	<1.0	9.0	<1.0	<1.0
1,3,5-TN	ug/L	<1.0	<1.0	<1.0	<1.0
2,4,6-TN	ug/L	11	116	<1.0	<1.0

< Below detection limit
From EPS Inc. report dated May 1988

TABLE 3-7-6
SUMMARY OF 1988 GROUND-WATER ANALYSES
LHAAP 29
FORMER TNT PRODUCTION AREA

ANALYTE	UNITS	MONITORING WELLS					
		114	115	116	117	118	119
1,3-DNB	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2,4,6-TNT	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,3,5-TNB	ug/L	1.4	<1.0	<1.0	<1.0	1.4	<1.0
2,4-DNT	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2,6-DNT	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
VOL	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BN	ug/L	<0.01	<0.01	<0.01*	<0.01	<0.01	<0.01
AE	ug/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

NOTES:
VOL = VOLATILE ORGANICS
BN = BASE-NEUTRAL EXTRACTABLE ORGANICS
AE = ACID EXTRACTABLE ORGANICS
* 0.23 BIS(2-CHLOROETHOXY)ME; ALL OTHERS <0.01
< = BELOW DETECTION LIMIT

FROM EPS INC. REPORT DATED MAY 1988

random with little apparent relationship to TNT production activities. The explosive compound 1,2,5,-TNB is the most prevalent compound identified, and 2,4,6-TNT is the most highly concentrated, especially in the upper 12 inches of soil. Ponded water on the site contains some concentrations of explosives, and surface water draining the site in the northeasterly direction is also contaminated with low concentrations of explosives, as is the sediment in this drainage path. It is inconclusive whether ground water has been impacted at the site. The only explosive compound found in the 12 samples of ground water collected so far from the six monitoring wells at the site were the very low (just above detection limit) concentrations of 2,4,6-TNT in the 1988 samples from Wells 114 and 118. No TNT was detected in the 1984 samples from these same wells.

3.7.5 **Potential Contaminants and Migration Pathways**. The source of contaminants are the residues of explosive compounds and explosives manufacturing wastes scattered over the site and possibly concentrated in some of the lower-lying portions of the site. These residues and wastes are a result of the World War II TNT production at the site. Previous investigations have confirmed 2,4,6-TNT in surface soils at the site and in surface water and sediments leaving the site. Other explosive compounds identified in soils, surface water, and sediments are 2,4-DNT, 2,6-DNT, 1,3,5-TNB, and 1,3-DNB. Although not previously investigated, the soils and ground water in the Bulk Toluene Storage Area have the potential to be contaminated with this volatile organic compound. The potential migration pathways for these contaminants are described below.

3.7.5.1 **Surface Water**. The potential for surface water contamination exists from runoff across contaminated surface soils,

return flow of contaminated runoff intercepted by the remaining underground wastewater lines, and runoff passing over contaminated sediment in ditches on and downstream from the site. Previous investigations have shown surface water in a ditch collecting runoff from part of the northern portion of the site to be contaminated with explosive compounds. This runoff could eventually enter Caddo Lake via Goose Prairie Creek.

3.7.5.2 **Sediment**. Erosion of contaminated surface soils during heavy rainfall could produce contaminated sediment that would be carried by surface water runoff into the ditches on the site where it could deposit in these ditches or in the pond at the former pumphouse location. The potential also exists for contaminated sediments to be washed into the remaining underground pipe lines where they could be deposited or be returned to the surface water regime. Previous investigations have shown sediments to be contaminated with low levels of explosives in two locations at the northeastern end of the site. Based on field observations, most of the contaminated sediment would be deposited at the bottom of existing ditches, tanks, sumps, trenches and ponds, and very little, if any, would reach Caddo Lake via Goose Prairie or Central Creeks.

3.7.5.3 **Soil**. Previous investigations have shown low concentrations of explosives in some of the site's soils down to depths of at least 42 inches. Highest concentrations are generally within the top 12 inches of soil. Contaminated surface soils could contaminate surface water runoff. The existing heavy vegetation helps inhibit the production of contaminated sediment by erosion of contaminated surface soil. Water percolating downward through contaminated soils could eventually leach explosive or organic

contaminants into the ground water beneath the site.

3.7.5.4 **Ground Water**. Contaminants could be leached from the soils and eventually enter the ground water, which occurs about 20 feet beneath the site. Contaminated ground water could be discharged to surface water flow downstream from the site. Based on previously collected data, concentrations of explosive compounds generally decrease with depth, indicating low vertical mobility. This may decrease the potential for ground-water contamination at the site.

3.7.5.5 **Air**. The site is currently well protected from wind erosion by the heavy vegetative cover that exists over most of the site. Air could become a contaminant migration pathway if the vegetative cover was removed and contaminated soils were disturbed.

3.7.6 **Identification of Potential Receptors**. The general public does not have ready access to the Former TNT Production Area because the site is confined within secured LHAAP boundaries. Access to the site is not restricted except by one locked gate on the main entrance road to the site. The site is no longer active. Therefore, installation personnel have little opportunity to visit the site. The site is located in hunting zone 30. Therefore, the population having direct use of the site is primarily limited to the occasional hunter.

Because ground water occurs under unconfined conditions over much of the installation, discharge of contaminated ground water to the many surface water channels bisecting the installation poses a much greater threat. To threaten any area public water supply wells, contaminants must first migrate downward to elevations below which surface water discharge occurs to bypass surface drainage channels. Then they must migrate to even deeper depths to intercept supply well intakes at or near the base of the Cypress aquifer. The horizontal

distance that contaminants must travel to the nearest public supply well, Well 504, is approximately 0.9 mile west of the site in the down-dip direction of the Wilcox Group (i.e., the base of the Cypress aquifer). There are no public supply wells in the direction of regional ground-water flow towards Caddo Lake. The overall low hydraulic conductivities and the highly interbedded nature of the Wilcox strata also combine to strongly inhibit ground-water movement in both the vertical and horizontal directions. It is not anticipated that ground water in the vicinity of or downgradient to the site will be developed for future use.

The site is located in the Caddo Lake watershed and in the drainage areas of Goose Prairie and Central Creeks. The site is about 3.0 miles upstream of Caddo Lake. In the Former TNT Production Area there are storm sewers and ditches that currently hold water. However, because of silting and overgrowth of drainage ways, these storm sewers and ditches appear to drain slowly. Pieces of crystallized TNT have been recently found on the surface near a drainage culvert on the site. This may indicate the presence of larger quantities of TNT underlying the vegetative cover. Measurable concentrations of 2,4,6-TNT (206.9 ug/l), 2,4-DNT (23.4 ug/l), and 2,6-DNT (13.6 ug/l) have been found in surface water samples taken in a drainage path eventually leading to a nearby tributary of Goose Prairie Creek. However, there is no evidence of significant impacts to the Caddo Lake aquatic life or water supplies for 16,600 Louisiana residents. The site is relatively remote and is not expected to be developed as a drainage way or for surface water use. Furthermore, there are no activities planned that would disturb the soil and cause sediment transport to downstream surface water and hence into Caddo

Lake.

The site is characterized as pines/hardwood forest. The former TNT production line area now consists of mainly concrete pads shaded by overgrown pines and oaks. Concrete slabs in several areas limit the full growth of understory, but some woody shrubs and poison ivy still managed to emerge. In areas adjacent to the pads, woodlands are relatively natural with a variety of oaks and pines. Pine, sumac, sweet gum, and crepe myrtle are present along the area formerly cleared along the old red water pipeline serving the former production area. Although TNT was found on the surface in the site area, vegetation does not appear to be stressed by the explosives contamination identified to date.

3.7.7 **Initial Remedial Action.** Although explosives contamination has been defined in surface and shallow soils within the site, which in turn appears to be threatening surface water leaving the site, no environmental impacts have been noted on the site or downstream of the site at this time which would require initial remedial action.

NPL only

3.8 LHAAP 12 - ACTIVE LANDFILL

3.8.1 **Site History.** The Active Landfill is currently being used for disposal of non-hazardous industrial solid waste being generated at LHAAP under Texas Water Commission Registration No. 30990. Waste has been disposed at the Active Landfill site intermittently since about 1963. The types of wastes disposed over the past 28 years at the Active Landfill site are largely unknown. However, it is known that this site supplanted the Old Landfill (LHAAP 16) when its use was discontinued in the 1970s.

Much of the history of the site is revealed by aerial photographs

004855 0000260

taken in May 1954, April 1963, January 1970, December 1978, and February 1985. In 1954, photos indicate that warehouses were under construction approximately 2,000 feet north of the site. Also under construction was a north-northwest trending spur railroad track serving the new warehouses. This spur track is still in existence and it lies about 700 feet east-northeast of the site. As part of the 1954 construction, photos reveal that a ditch was excavated through a low ridge between Central Creek and one of its principal tributaries that collects surface runoff from the southern part of the Magazine Area. The ditch paralleled the railroad spur to the north-northwest and its apparent purpose was to divert the flow of the spur, thus eliminating the need for a bridge or large drainage structure where the railroad crossed the tributary stream. The total length of the diversion ditch was approximately 1,800 feet. Based on the aerial photos, its bottom width was about 20 feet and it had side slopes of approximately 5:1. The portion of the ditch through the low ridge was 750 feet long and up to 12.5 feet deep with a bottom elevation of about 189.0 at the upstream end, and a bottom elevation of about 188.0 at the downstream end of this segment. The 1954 aerial photos also show that the upstream end of the ditch was bordered to the northeast by a borrow area where a few feet of material had been excavated. The low-ridge segment of the ditch and part of the borrow area were subsequently filled with waste and soil to form the nucleus of the current Active Landfill site.

The diversion ditch remained functional until 1963 when aerial photographs show that waste materials had just begun to be disposed in the ditch about 350 feet downstream (north-northeast) from its confluence with the diverted tributary stream. Waste disposal in the

diversion ditch apparently continued for several years. An aerial photo taken in January 1970 indicates that enough waste had been disposed in the diversion ditch to block its flow, but the site does not appear to have been active at that time as evidenced by vegetation on the fill materials. Sometime between 1970 and 1978, the site was reactivated for waste disposal. By December 1978, aerial photographs show that a considerable volume of additional waste materials had been disposed in the former diversion ditch and had begun to be disposed on a previously undisturbed hillside adjoining the ditch that became the northeast part of the site. At that time, most of the original ditch through the low ridge and part of the former borrow area had been filled with waste materials.

Since 1978, the site has apparently been in continuous use for disposal of industrial solid wastes generated at LHAAP. During the early 1980s, a large area alongside the southeast margin of the former diversion ditch was cleared for future waste disposal. This area now receives most of the waste being disposed which consists of non-hazardous combustible and non-combustible wastes having no scrap value. The non-combustibles include residues from the thermo-decontamination operations at the active Burning Ground No. 3 (LHAAP 18).

3.8.2 **Site Description**. The Active Landfill is in the central portion of LHAAP, as shown on Figure 3-8-1. The center of the site is about 1,700 feet east-northeast of the intersection of Avenue P and Avenue Q. The entrance to the site's graveled access road is on Avenue Q about 0.2 mile east of Avenue P.

A detailed current map of the Active Landfill is provided in Figure 3-8-2. The map depicts detailed topography and surface

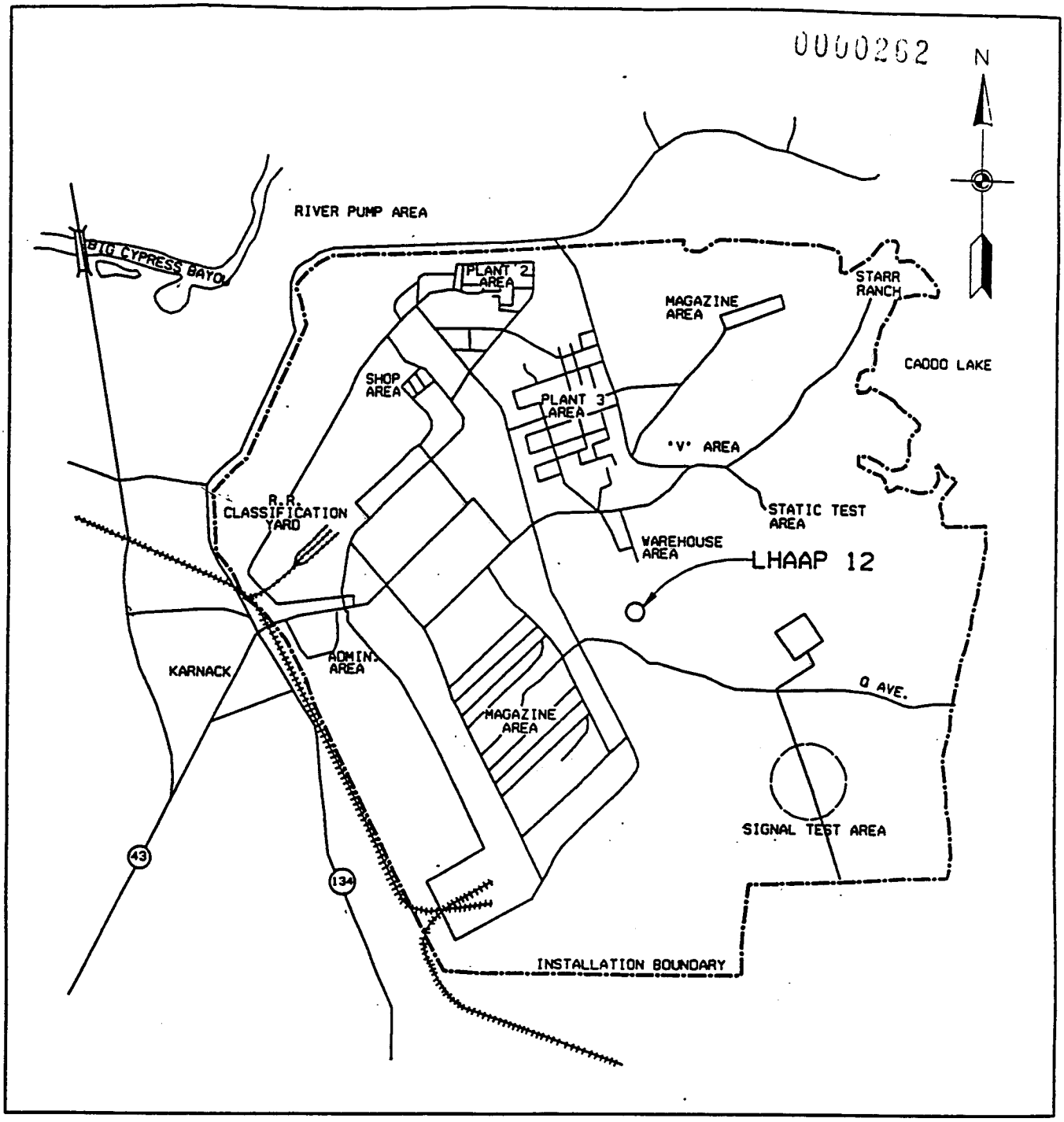


FIGURE 3-8-1 LOCATION MAP FOR LHAAP #12

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

APPROXIMATE LIMITS OF ACTIVE LANDFILL

BH-17

BH-18
180.57

103
180.53

BORROW AREA

UNNAMED CREEK

HEAVY TIMBER

BH-19

APPROXIMATE ℄ OF BURIED DIVERSION DITCH

FIRE LANE

CLUSTER PINES

12' HIGH DIRT PILE

5' HIGH DIRTPILE

121
182.26

17' WIDE GRAVEL ROAD

POST

℄ DITCH

TOE

TRAIL

SAWDUST & DIRT PILES 13' HIGH

SMALL TIMBER

3917

LANDFILL

TO CENTRAL CREEK
APPROX. 800'

3799
3800
3808

TO CENTRAL CREEK
APPROX. 600'

3795
3796
3797
3798
3806
3807

BH-20
182.46

6' HIGH DIRT PILE

4' HIGH DIRT PILE

COR. ● POST

APPROXIMATE LIMITS OF 1954 EXCAVATION FOR DIVERSION DITCH AND BORROW AREA

LEGEND

- GROUND-WATER FLOW DIRECTION DURING WET PERIODS
- SURFACE WATER FLOW DIRECTION
- 121 / 182.26 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- 3917 ■ — SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 3799 ● — SURFACE WATER / SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- POINT OF COMPLIANCE

NOTE:

GROUND-WATER ELEVATIONS NOV 89.

US Army Corps of Engineers Fort Worth District

50 0 50 100
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 12
ACTIVE LANDFILL
SITE MAP

DATE: JUNE 1992 | FIGURE 3-8-2

drainage patterns, estimated ground-water flow directions, locations of previous sampling points, the approximate limit of the Active Landfill, and limited vegetation information. The site boundary was based on a study of historical aerial photographs, current vegetation patterns, and field observations. The boundary encloses an area of approximately 7 acres.

General soil and geologic maps and the boring logs for monitor wells 103 and 121 indicate that the site is situated on the outcrop of the Wilcox Group of sediments typically consisting of interbedded sands, silts, and clays. The Wilcox materials at the site were originally overlain by a few feet of residually-derived soils comprised principally of silty to clayey sands. Excavations at the site in 1954 removed some of the residual soils and exposed the Wilcox sediments. Most of the excavated materials were later replaced with waste and soil fill materials.

The total volume of waste materials that have accumulated at the site since 1963 cannot be determined precisely from available data. Based upon current topography, it is obvious that most of the original diversion ditch crossing the site as well as part of the former borrow area have been landfilled. It is also obvious that landfilling has taken place in other parts of the site. For the past several years, industrial solid wastes have been disposed in pits excavated in the southeast part of the site and covered by excavated soils. If it is assumed that landfilled materials average 3.0 feet in thickness across the entire 7-acre site, approximately 33,900 cubic yards of such materials have been deposited. If two-thirds of this volume of material is assumed to be solid wastes, then approximately 22,600 cubic yards of such materials have been disposed on the site.

As shown on Figure 3-8-2, surface water runoff from the southeastern and southwestern portions of the site is generally toward the southeast and is primarily by sheet flow. The runoff from these portions of the site is eventually collected by a stream to the south of the site that is one of the principal tributaries of Central Creek. This is the tributary stream that was diverted across the site from 1954 to at least 1963. Surface water runoff from the remainder of the site is by sheet flow to the east and northeast. It is collected by the former diversion ditch which carries the runoff north-northeastward into Central Creek. All surface water runoff from the site eventually enters Caddo Lake via Central Creek. The total flow distance from the site to the lake is about 2.1 miles.

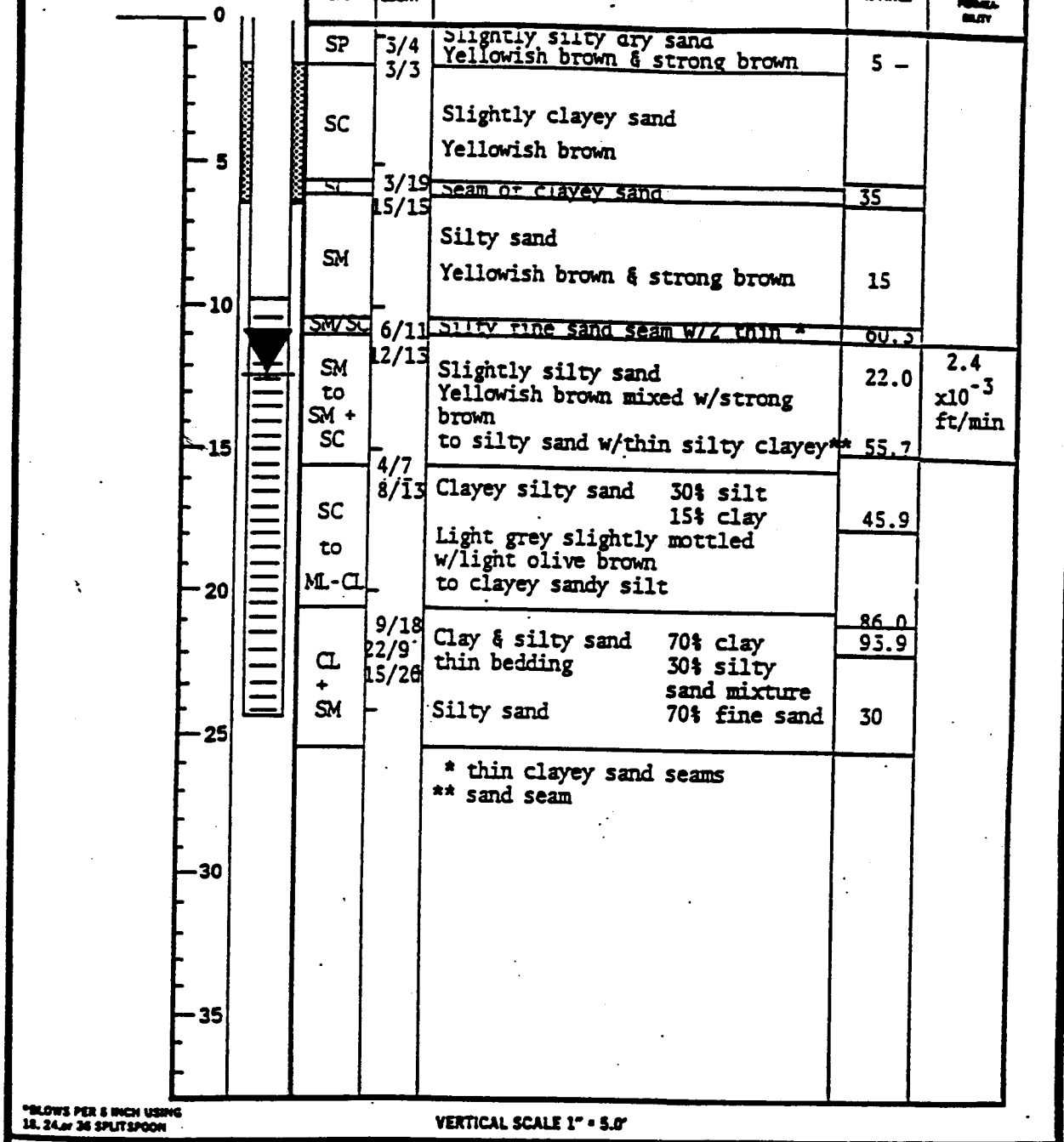
Based upon limited data from four of the monitoring wells on or near the site, depth to ground water probably averages about 15 feet with seasonal fluctuation expected. During dry periods when the ground-water table is below the bottom elevation of the former diversion ditch, ground-water flow direction across the site is expected to be controlled by the more regional flow direction to the east-northeast toward Caddo Lake. During wet periods when the water table rises to higher than the bottom elevation of the former diversion ditch (higher than approximate elevation 189.0), local ground-water flow directions on the site are suspected to be more topographically controlled and may swing toward the former ditch, especially near the upstream and downstream ends of the buried portion of the ditch (see Figure 3-8-2). During an extended wet period in the spring of 1991, leachate was observed to be discharging from the bottom of the former diversion ditch at the toe of a slope marking the northernmost filling of the ditch. This discharge occurred at

approximate elevation 188.5. By mid-July 1991, following a drier period, the surface discharge of leachate had ceased. The ground-water flow directions shown on Figure 3-8-2 are the roughly estimated directions during wetter periods, such as the one experienced in the spring of 1991.

3.8.3 **Previous Investigations**. This site was originally investigated by the USAEHA in 1980, who installed four ground-water monitoring wells, numbered BH-17 through BH-20, at the locations indicated on Figure 3-8-2. Documentation of the USAEHA investigation contains no construction details for the four wells installed (USAEHA, 1980). Field observations indicate that the wells are constructed of 2-inch PVC pipe and are still in place.

The Active Landfill site was included in the "LHAAP Contamination Survey" conducted under contract by EPS. A report of the survey was published in June 1984 (EPS, 1984). In June 1982, EPS installed monitoring wells 103 and 121 at the locations indicated on Figure 3-8-2. The logs of borings and construction details for these wells are provided on Figures 3-8-3 and 3-8-4, respectively. Well 103 has a screen setting from 9.5 to 21.5 feet. Well 121 has as screen setting from 19.0 to 34.0 feet. Both wells monitor shallow ground water. Based on static water levels determined on three different dates in 1982 and in November 1989, Well 103 is hydraulically downgradient from Well 121.

In November 1982, EPS obtained a sample of the ground water from each of the six wells at or near the site, and the samples were analyzed for explosives, selected metals (total), and selected anions. In addition, samples from five of the wells (BH-18, BH-19, BH-20, 103 and 121) were analyzed for PCBs and pesticides and samples from four



WELL 103 DATE DRILLED 7/8/82
STUDY AREA Active Landfill

ELEVATION TOP OF STEEL CASING = 196.10 ft
ELEVATION TOP OF PVC RISER = 194.80 ft
ELEVATION OF GROUND SURFACE = 192.66 ft

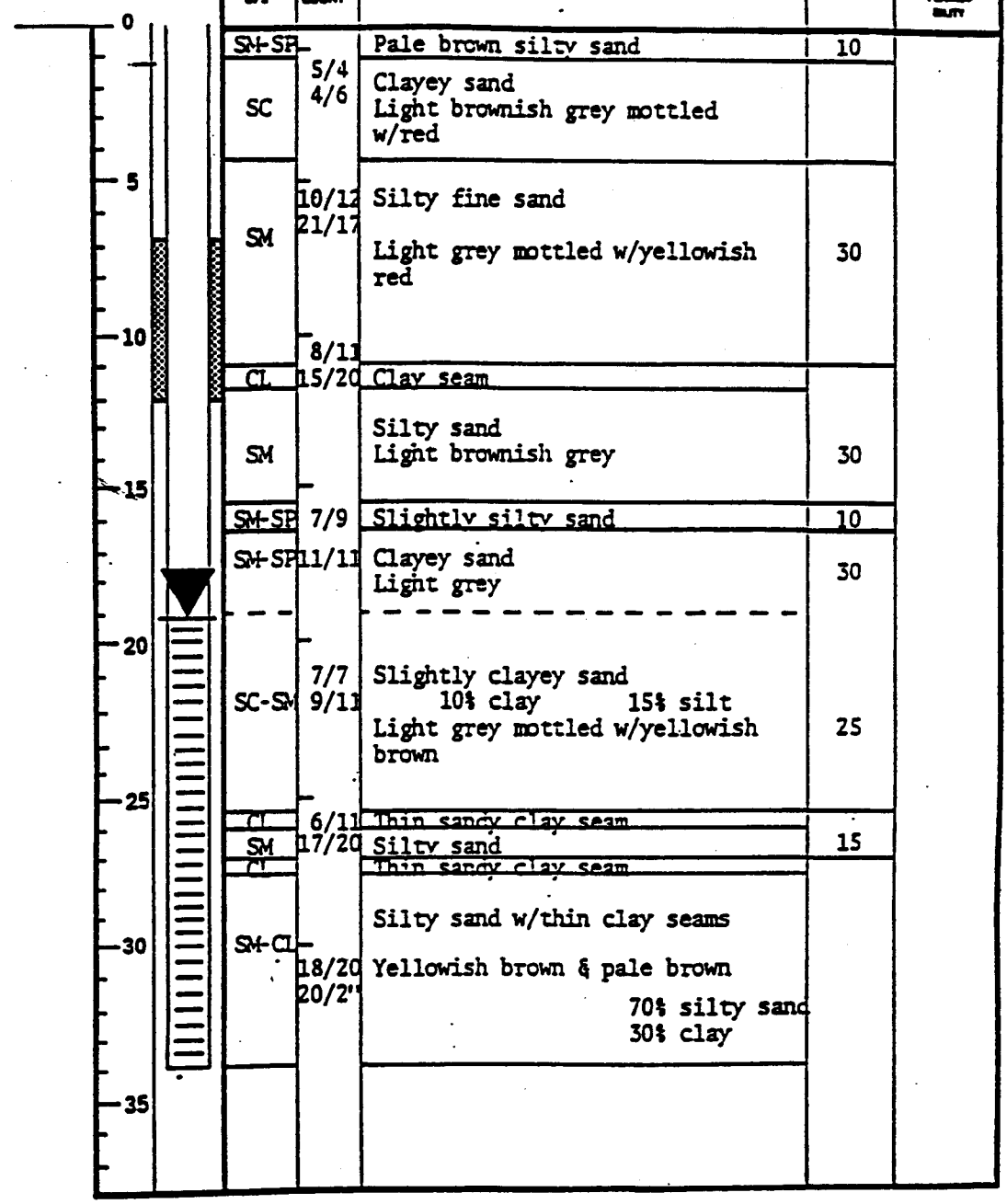
SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-8-3
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 103

0000267



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM-SP		Pale brown silty sand	10	
SC	5/4 4/6	Clayey sand Light brownish grey mottled w/red		
SM	10/12 21/17 8/11	Silty fine sand Light grey mottled w/yellowish red	30	
CL	15/20	Clay seam		
SM		Silty sand Light brownish grey	30	
SM-SP	7/9	Slightly silty sand	10	
SM-SP	11/11	Clayey sand Light grey	30	
SC-SM	7/7 9/11	Slightly clayey sand 10% clay 15% silt Light grey mottled w/yellowish brown	25	
CL	6/11	Thin sandy clay seam		
SM	17/20	Silty sand	15	
CL		Thin sandy clay seam		
SM-CL	18/20 20/2"	Silty sand w/thin clay seams Yellowish brown & pale brown 70% silty sand 30% clay		

*BLOWS PER 6 INCH USING 18, 24, or 30 SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 121 DATE DRILLED 7/2/82
STUDY AREA Active Landfill

ELEVATION TOP OF STEEL CASING = 203.22 ft
ELEVATION TOP OF PVC RISER = 203.12 ft
ELEVATION OF GROUND SURFACE = 199.92 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-8-4
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 121

0000268

of the wells (BH-17, BH-19, BH-20, and 103) were analyzed for volatile and semivolatile organic compounds (VOCs and SVOCs). A summary of sample analyses for the November 1982 ground-water sampling is presented in Table 3-8-1.

In the spring of 1991, Thiokol Corp. obtained surface water samples 3795, 3796, and 3806, and sediment samples 3797, 3798, and 3807, at the location shown on Figure 3-8-2. This sampling location was in the bottom of the former diversion ditch described in Paras. 3.8.1 and 3.8.2. Source of the surface water sampled at this point was ground water discharging into the ditch a few feet upstream from the sampling point. This leachate was flowing from the toe of a slope marking the northern limit of fill in the former diversion ditch. The surface water and sediment samples were analyzed for explosives, selected metals (total), selected anions, VOCs and SVOCs. In addition, a surface water sample was analyzed for total recoverable petroleum hydrocarbons. A summary of sample analyses for the samples taken in the former diversion ditch is provided in Table 3-8-2.

Also in the spring of 1991, Thiokol Corp. collected surface water samples 3799, 3800, and 3808 from Central Creek at a point located several hundred feet downstream from the sampling point for the ground-water discharge. The Central Creek sampling location was at a railroad siding bridge near Warehouse Building 46-W. The Central Creek samples were analyzed for selected metals (total), selected anions, VOCs, SVOCs, and total recoverable petroleum hydrocarbons. A summary of sample analyses for the Central Creek samples is presented in Table 3-8-2.

On 17 July 1991, Thiokol Corp. and the TWC each collected a sample of suspected sawdust waste material from a pile near the

TABLE 3-8-1

LONGHORN ARMY AMMUNITION PLANT
LHAAP 12 - ACTIVE LANDFILL

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.						Date of Sampling
NAME	TYPE	DETECTION LIMIT		GW BH-17	GW BH-18	GW BH-19	GW BH-20	GW 103	GW 121	
		ug/g	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
1,3 - DNB	EXP	0.50	1.68	<	2.25	<	<	<	<	NOV 82
2,4 - DNT	EXP	0.50	0.89	<	<	<	<	<	<	NOV 82
2,6 - DNT	EXP	0.61	1.2	<	<	<	<	<	<	NOV 82
Nitrobenzene	EXP	1.15	0.76	<	<	<	<	<	<	NOV 82
1,3,5 - TNB	EXP	0.71	1.08	<	<	<	<	<	<	NOV 82
2,4,6 - TNT	EXP	0.73	1.46	<	<	<	<	<	<	NOV 82
Aluminum	MET	0.36	10.	22.90	29.80	36.60	132.00	361.00	215.00	NOV 82
Antimony	MET	0.76	10.2	<	<	<	<	<	<	NOV 82
Arsenic	MET	0.3	6.	<	<	<	<	<	<	NOV 82
Barium	MET	0.99	11.4	<	14.70	20.20	49.70	32.00	75.10	NOV 82
Beryllium	MET	0.5	10.	<	<	<	<	<	<	NOV 82
Cadmium	MET	0.5	0.28		1.99	1.26	3.69	11.52	5.91	NOV 82
Chromium	MET	0.6	6.64	10.40	<	<	8.10	13.50	27.70	NOV 82
Copper	MET	0.5	23.9	<	<	<	<	<	<	NOV 82
Lead	MET	0.89	7.49	18.90	44.00	54.40	<	15.80	15.70	NOV 82
Manganese	MET	0.25	12.1	1990.00	36.00	16.00	193.00	169.00	126.00	NOV 82
Mercury	MET	2.7	1.3	<	<	<	<	<	<	NOV 82
Nickel	MET	0.5	30.	<	71.+	62.+	59.+	<	<	NOV 82
Selenium	MET	0.5	6.	<	<	<	<	<	<	NOV 82
Silver	MET	0.5	10.	<	<	<	<	<	<	NOV 82
Strontium	MET	0.5	25.	1100.00	960.00	1160.00	920.00	398.00	180.00	NOV 82
Thallium	MET	3.	50.	70.+	110.+	100.+	90.+	NR	<	NOV 82
Zinc	MET	0.5	27.1	<	<	<	<	<	<	NOV 82
Chloride	ANI	7	500	319000.	200000.	2725000.	227000.	41000.	82000.	NOV 82
Chromate	ANI	5	500	<	<	<	<	<	<	NOV 82
Cyanide	ANI	5	600	<	<	<	<	<	<	NOV 82
Fluoride	ANI	5	500	<	1000.	1000.	1000.	<	<	NOV 82
Nitrate	ANI	5	500	1120.	<	<	<	910.	<	NOV 82
Nitrite	ANI	5	250	<	<	<	<	<	<	NOV 82
Phosphates	ANI	NR	125	1890.	<	<	<	<	<	NOV 82
Sulfate	ANI	25	580	8570.	235000.	153400.	90500.	69820.	63700.	NOV 82
Thiocyanate	ANI	10	500	<	<	<	<	<	<	NOV 82
Aroclor 1016	PCB	0.6	0.6	NA	<	<	<	<	<	NOV 82
Aroclor 1260	PCB	0.7	1.	NA	<	<	<	<	<	NOV 82

TABLE 3-8-1 (Cont.)

LONGHORN ARMY AMMUNITION PLANT
LHAAP 12 - ACTIVE LANDFILL

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.						Date of Sampling
NAME	TYPE	DETECTION LIMIT		GW BH-17	GW BH-18	GW BH-19	GW BH-20	GW 103	GW 121	
		ug/g	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
alpha-BHC	PES	0.05	0.09	NA	<	<	<	<	<	NOV 82
delta-BHC	PES	NR	NR	NA	ND	ND	ND	ND	<	NOV 82
DDT	PES	NR	NR	NA	ND	ND	ND	ND	ND	NOV 82
p,p'-DDT	PES	NR	0.09	NA	<	<	<	<	<	NOV 82
Endrin	PES	NR	NR	NA	ND	ND	ND	ND	<	NOV 82
Heptachlor	PES	0.05	0.05	NA	<	<	<	<	<	NOV 82
Lindane	PES	0.05	0.09	NA	<	<	<	<	<	NOV 82
Toxaphene	PES	4.	4.	NA	<	<	<	<	<	NOV 82
										NOV 82
Benzene	VOC	NR	1.	<	NA	<	<	<	NA	NOV 82
1,1'-Bicyclohexyl	VOC	NR	10.	ND	NA	11.	ND	ND	NA	NOV 82
Chloroform	VOC	NR	1.	<	NA	<	<	<	NA	NOV 82
Dichloromethane	VOC	NR	10.	48.	NA	ND	ND	45.	NA	NOV 82
Pentane	VOC	NR	10.	ND	NA	ND	ND	<	NA	NOV 82
Trichloroethylene	VOC	NR	10.	<	NA	<	<	<	NA	NOV 82
o-Chlorophenol	SVOC	NR	10.	<	NA	<	<	<	NA	NOV 82
Dibutyl phthalate	SVOC	NR	10.	<	NA	<	<	<	NA	NOV 82
2,4-Dichlorophenol	SVOC	1.	1.	<	NA	<	<	<	NA	NOV 82
Diethyl phthalate	SVOC	1.	2.	<	NA	<	<	<	NA	NOV 82
Nitrobenzene	SVOC	0.6	1.	<	NA	<	<	<	NA	NOV 82
Pentachlorophenol	SVOC	1.	2.	<	NA	<	<	<	NA	NOV 82

ANALYTE ABBREVIATIONS :

ANI	Anion
DNB	Dinitrobenzene
DNT	Dinitrotoluene
EXP	Explosive
MET	Metal
PCB	Polychlorinated Biphynyl
PES	Pesticide
SVOC	Semivolatile Organic Compound
TNB	Trinitrobenzene
TNT	Trinitrotoluene
VOC	Volatile Organic Compound

OTHER ABBREVIATIONS :

<	Below Detection Limit
GW	Ground Water
NA	Not Analyzed
ND	Not Detected. Detection limit not known.
NR	No Record

SOURCE OF DATA : "LHAAP CONTAMINATION SURVEY", Environmental Protection Systems, Inc., June 1984.

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TABLE 3-8-2

LONGHORN ARMY AMMUNITION PLANT
LHAAP 12 - ACTIVE LANDFILL
SUMMARY OF 1991 SAMPLE ANALYSES

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ANALYTE				SAMPLE TYPE AND LOCATION NO.					
NAME	TYPE	DETECTION LIMIT		SW 3795 3796	SW 3806	SD 3797 3798	SD 3807	SW 3799 3800	SW 3808
		ug/g	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
2,4 - DNT	EXP	0.97	6.2	NA	<	NA	<	NA	NA
2,6 - DNT	EXP	0.64	5.8	NA	<	NA	<	NA	NA
HMX	EXP	0.84	4.2	NA	<	NA	<	NA	NA
RDX	EXP	0.33	1.6	NA	<	NA	<	NA	NA
Tetryl	EXP	9.20	3.7	NA	<	NA	<	NA	NA
2,4,6 - TNT	EXP	1.20	0.94	NA	<	NA	<	NA	NA
Aluminum	MET	0.05	5	3150	NA	1100	NA	380	NA
Arsenic	MET	0.03	3	<	NA	0.4	NA	<	NA
Barium	MET	0.05	200	<	NA	25	NA	<	NA
Cadmium	MET	0.1	10	10	NA	1.3	NA	<	NA
Chromium	MET	0.1	20	50	NA	4.6	NA	<	NA
Copper	MET	0.1	10	60	NA	5000	NA	<	NA
Iron	MET	0.5	50	2250000	NA	22800	NA	1810	NA
Lead	MET	0.01	4	12	NA	4.9	NA	4	NA
Mercury	MET	0.1	1	<	NA	<	NA	<	NA
Magnesium	MET	0.5	5000	25000	NA	2010	NA	<	NA
Nickel	MET	0.5	50	<	NA	1.0	NA	<	NA
Selenium	MET	0.03	3	<	NA	<	NA	<	NA
Silver	MET	0.1	10	<	NA	0.2	NA	<	NA
Thallium	MET	6	600	<	NA	<	NA	<	NA
Zinc	MET	0.1	10	580	NA	90	NA	20	NA
Chloride	ANI	--	500	NA	11000	NA	NA	NA	1700
Nitrate (as N)	ANI	--	50	NA	8200	NA	NA	NA	470
Sulfate	ANI	--	1000	NA	31000	NA	NA	NA	400
VOC Screen	VOC	0.001	0.1	NA	<	NA	<	NA	<
SVOC Screen	SVOC	0.01	10	<	NA	<	NA	<	NA
TRPH	SVOC	--	100	NA	<	NA	NA	NA	<
DATE OF SAMPLING				16 APR 91	1 MAY 91	16 APR 91	1 MAY 91	16 APR 91	1 MAY 91

ANALYTE ABBREVIATIONS:

ANI Anion
DNT Dinitrotoluene
EXP Explosive
HMX Cyclotetramethylenetetranitramine
MET Metal
RDX Cyclotrimethylenetrinitramine
SVOC Semivolatile Organic Compounds *
TNT Trinitrotoluene
TRPH Total Recoverable Petroleum Hydrocarbons
VOC Volatile Organic Compounds

OTHER ABBREVIATIONS:

< Below Detection Limit
NA Not Analyzed
SD Sediment
SW Surface Water

SOURCE OF DATA: Thiokol Corporation - EPS Analytical Services Laboratory
Reports No. 19391, 19392, 19393, 19696, 19736, and 19737.

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northwest boundary of the site. The samples were obtained by digging an 18-inch deep hole in the waste pile. The Thiokol sample was numbered 3917 and was analyzed for the constituents listed below.

Analyte Name	Detection Limit (mg/Kg)
Halogenated Volatile Organics	0.001
Aromatic Volatile Organics	0.001
Phenols	0.01
Phthalate Esters	0.1
Organochlorine Pesticides/PCBs	0.001
Nitroaromatics & Ketones	0.1
Polynuclear Aromatics	0.1
Chlorinated Hydrocarbons	0.1

Results of analyses by EPS Analytical Services in Report No. 21123 indicate that all analytes were below their corresponding detection limits. The TWC sample analyses were not performed because holding times were exceeded.

3.8.4 **Assessment of Existing Data and Historic Records**. Results of ground-water sample analyses summarized in Table 3-8-1 indicate that concentrations of metals were likely elevated above local background levels at the time of sampling in 1982 display a pattern related to the age and installer of the sampled wells. As previously noted, wells BH-17 through BH-20 were installed in 1980 by USAEHA and samples from these wells, as a group, exhibit the highest nickel, strontium, and thallium concentrations. Wells 103 and 121 were installed in 1982 by EPS and their samples, as a group, have the highest aluminum, barium, cadmium, and chromium levels. Such grouping may indicate metals contamination of ground water in individual wells during installation. The pattern of contamination may be caused by

spatial variances in the wastes. Although elevated, most of the metal concentrations in the ground-water samples are low, with lead slightly exceeding the SWDA MCL in BH-19.

In the ground-water samples from Wells BH-17 and BH-19, the chloride concentrations shown on Table 3-8-1 likely exceed the local background level, with the 2,725 mg/l of chloride in the Well BH-19 sample most notably elevated.

The only explosive compound above detection limits in any of the ground-water samples was a trace of 1,3-DNB in the sample from Well BH-18. This well is hydraulically downgradient from and closest to the nucleus of the landfill. Traces of a VOC were found in ground-water samples from Wells BH-17, BH-19, and 103.

Results of surface water and sediment sample analyses summarized in Table 3-8-2 indicate that concentrations of explosive, volatile organic, semivolatile organic, and petroleum hydrocarbon compounds are below detection limits, but concentrations of certain metals and anions are likely elevated above local background levels.

In sediment samples 3797, 3798, and 3807, concentrations of arsenic, cadmium, copper, iron, magnesium, and zinc are elevated above local background levels with copper, iron, and magnesium notable elevated at 5.0, 22.8, and 2.0 mg/l, respectively. These sediment samples were collected at the same point as the surface water samples comprised of the leachate discharging from the landfill.

The surface water samples obtained from Central Creek several hundred feet downstream from the site (samples 3799, 3800, and 3808) show elevated concentrations of aluminum, iron, and zinc that are likely attributable to the leachate discharging from the north end of the landfill at the time of sampling in April 1991.

Elevated concentrations of metals and anions found in many samples from this site, along with the trace of 1,3-DNB in one of the samples and the traces of VOCs in three of the samples, are most likely the result of waste disposal at the site. There do not appear to be any other waste disposal sites that could have contributed to this contamination.

Existing data are not adequate to firmly establish many of the site's characteristics, including the configuration of the filled diversion ditch, the nature and quantities of landfilled materials, the nature of undisturbed surficial soils and the underlying Wilcox Group sediments, the depth to ground water, and the directions of ground-water flow.

3.8.5 **Potential Contaminants and Migration Pathways**. The primary sources of potential contamination at this site are industrial solid wastes generated at LHAAP and disposed intermittently at the site since 1963. The types and quantities of wastes disposed at the site over the past 28 years are largely unknown.

As previously described, elevated concentrations of certain metals and anions and traces of an explosive compound and two VOCs have been found in various media at and near this site. Potential migration pathways for these and other potential contaminants are described below.

3.8.5.1 **Surface Water**. Rainfall runoff from surficial fill materials and soils on the site could pick up contaminants and transport them to collection ditches and streams. Leachate discharging into the surface water may contain contaminants. The ditches and streams would then convey the contaminated surface water into Central Creek and Caddo Lake.

3.8.5.2 **Sediments**. Erosion of contaminated fill materials

and soils during heavy rainfall could produce contaminated sediment that would be carried downstream. Based on field observations, most of this sediment would be deposited within downstream channels or adjoining floodplains and would not reach Caddo Lake. After deposition, the sediment could be further contaminated by precipitation of contaminants from surface water, especially where the water collects in potholes or swales.

3.8.5.3 **Soils**. Water percolating downward through contaminated fill materials and soils may leach contaminants and carry them into underlying soils where they could eventually reach the groundwater.

3.8.5.4 **Ground Water**. Ground water in each of the six monitoring wells at or near the site show some evidence of contamination, demonstrating that ground water is an important pathway for contaminant migration at this site. The relative shallowness of the water table and its seasonal fluctuation elevates its importance as a pathway. During wet periods when the water table rises to intercept the bottom of the former diversion ditch across the site, ground water has been observed to discharge to surface water flow at the north end of the landfill and likely discharges to surface water flow at the south end of the landfill near Well 103.

3.8.5.5 **Air**. Most of the site is currently well protected from wind erosion by vegetation. Parts of the site near the entrance road are devoid of vegetation and subject to wind erosion, but wind velocities are normally reduced to non-erosive levels by nearby stands of timber. Air could become a contaminant migration pathway if the stands of timber surrounding the site were removed.

3.8.6 **Identification of Potential Receptors**. The general public

does not have ready access to the site because it is located within the confines of LHAAP. Also, installation personnel and authorized visitors do not have ready access to the site and adjoining areas because they are enclosed by a fence with a locked access gate. The most frequent visitors to the site are installation personnel conducting the ongoing industrial landfilling operations. Occasionally, hunters visit the site and adjoining areas.

There are no public water supply wells located in the directions of expected ground-water flow from the site and none are expected to be installed. Ground-water flows from the site in a general east-northeasterly direction toward Caddo Lake except during wet periods when portions of the flow may be more topographically controlled and flow towards the north-northwest or south-southeast. The nearest public water supply well, Well 902, is approximately 2.3 miles southwest of, and hydraulically upgradient from, the site. A potential threat to public health and safety posed by contaminated ground water originating at this site could be its emergence into the surface water flow regime of Central Creek and its tributaries.

Accelerated soil erosion is occurring over about a third of the site where vegetation is absent or scanty. Future landfilling activities at the site may temporarily increase erosion and sediment yield until vegetation is re-established. There are no major watercourses or water bodies on the site and none are expected to be created. Most of the surface water runoff and part of the water-borne sediment derived from this site enter Caddo Lake which is used as a water supply for approximately 16,600 Louisiana residents. The flow distance from the site to Caddo Lake is about 2.1 miles. Caddo Lake is not known to have been affected by contaminants originating at this

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site.

Aerial photographs taken in 1954 indicate that the site was cleared of its native trees for agricultural purposes and part of the site was unvegetated because of borrow area excavation and ongoing construction of a diversion ditch. Currently, about one-third of the site is unvegetated or only scantily vegetated by grasses and forbs. The remainder of the site is vegetated by a variety of grasses and forbs, or by regrowth of small conifers or woody shrubs, sumac, and willows. The site is bordered to the southeast by an unvegetated remnant of the old borrow area. Bordering the remainder of the site is a forest comprised of pines and sweet gums with some oaks. Muscadine vines, ferns, and Virginia creeper occur along the margin of the forest. Within the forest near the north end of the site, grass and leaves of several trees and shrubs were observed to be brown and dead as the result of discharging landfill leachate/ground water flowing over a lowland area.

3.8.7 **Initial Remedial Action.** Based upon what is known about the site and the nature and extent of its contaminants, quick remedial action is not deemed necessary. The elevated levels of certain metals and anions found in the surface water and sediments at the north edge of the site and in the ground water at and near the site pose no seriously imminent threat to potential receptors at this time.

NPL may

3.9 LHAAP 32 - FORMER TNT WASTE DISPOSAL PLANT

3.9.1 **Site History.** The former TNT Waste Disposal Plant was constructed in 1942 to treat and dispose of wastewaters generated at the nearby former TNT Production Area (LHAAP 29). The disposal plant was operated by Monsanto Chemical Company from April 1943 until August 1945 and disposed of wastewaters resulting from the production of over

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397 million pounds (198,500 tons) of 2,4,6-TNT. The plant was not operated after August 1945. In 1959, most of the buildings and tanks used in the disposal process were removed, leaving only the concrete foundations, access roads, underground utilities, and constructed surface water drainageways.

A plan view of the TNT Waste Disposal Plant site as it appeared in January 1944 is provided on Figure 3-9-1. Major structures shown on the plan are:

2 - Settling Tanks, on-ground, wooden, 35'D x 7'H

1 - Raw Wastes Storage Tank, on-ground, wooden, 35'D x 7'H

2 - Temporary (Raw) Wastes Storage Tanks, on-ground, steel, 120'D 55,000 Bbl capacity

1 - Temporary (Raw) Wastes Storage Tank, on-ground, steel, 115'D, 68,000 Bbl capacity

1 - Change House, 1,500 SF

1 - Evaporator Building, with concrete foundation and partial basement and pits, 6,000 SF

2 - Caustic Soda Storage Tanks, supported aboveground by concrete saddles, 10'D x 32'L

2 - Thick Liquor Storage Tanks, on-ground, wooden, 25'D x 15'H

1 - Equalization Tank, concrete, divided into 2 bays, mostly underground, 20' x 30' x 9.5' deep

1 - Incinerator Facility including Incinerator Buildings, totaling 2,000 SF

1 - Condensate Storage Tank, on-ground, wooden, 30'D x 10'H

1 - Neutralized Wastes Storage Tank, on-ground, wooden, 81'D x 11.5'H

The disposal plant most likely operated in the following manner.

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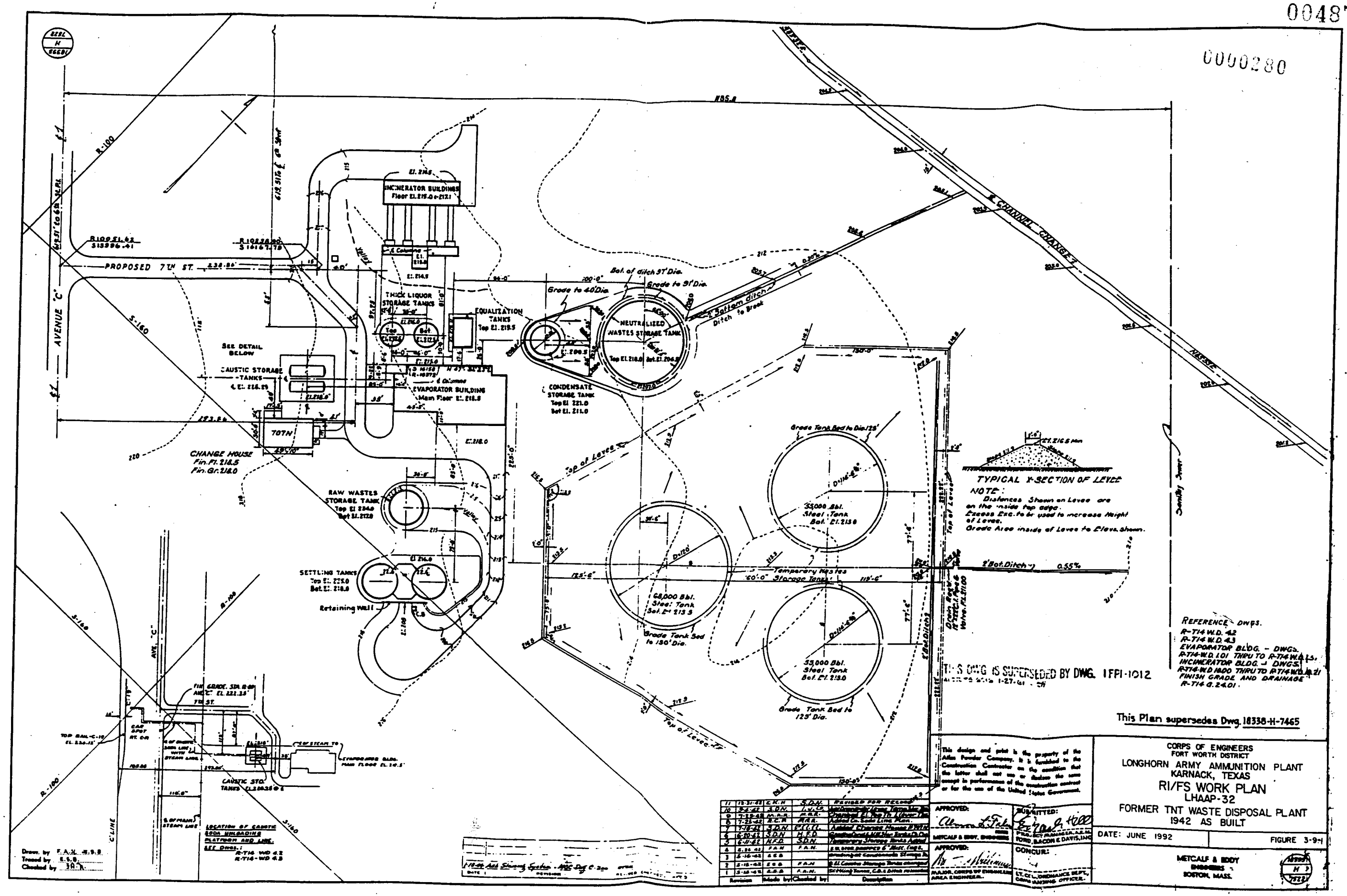

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APPROVED: METCALF & EDDY, ENGINEERS

APPROVED: MAJOR, CORPS OF ENGINEERS, AREA ENGINEER

SUBMITTED: FORD, BACON & DAVIS, INC.

CONCUR: LT. COL., ORDNANCE DEPT., CAMP LONGHORN OFFICER

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP-32
FORMER TNT WASTE DISPOSAL PLANT
1942 AS BUILT

DATE: JUNE 1992 | FIGURE 3-9-1

METCALF & EDDY ENGINEERS
BOSTON, MASS.

Waste "red and yellow liquors" were pumped from the production area to the disposal plant through a 6-inch bored wooden pipe. The pipe entered the disposal plant area near the location of the Settling Tanks and Raw Wastes Storage Tank. The waste liquors were stored in these tanks or, if the inflow exceeded the disposal plant capacity, in the Temporary (Raw) Wastes Storage Tanks. They were then piped to the Evaporator Building where the pH of these acidic liquids was increased by mixing with sodium hydroxide from the nearby Caustic Soda Storage Tanks. Following this process, the wastes were apparently stored in the Neutralized Wastes Storage Tank and then returned to the Evaporator Building for reduction of water content by an evaporation process aided by steam heat. Water condensed during the evaporation process was collected and piped to the Condensate Storage Tank, then was eventually released via a blue water ditch to Goose Prairie Creek.

The thickened and neutralized wastes were stored in the Thick Liquor Storage Tanks until they were burned in the Incinerator Facility. Resultant ashes were disposed in the Old Landfill (LHAAP 16) until early 1944 when an "Ash Sluicing System" was added. Operational details of this system are not available; however, the ashes were probably mixed with copious quantities of water and released via a ditch to Goose Prairie Creek.

3.9.2 Site Description. The site is situated in the west central portion of LHAAP, as shown on Figure 3-9-2. It is approximately 400 feet northwest of Avenue C and 600 feet southeast of 6th Street. The entrance to the site is on Avenue C about 0.2 mile northwest of its intersection with 1st Street.

A detailed current map of the former TNT Waste Disposal Plant and surrounding areas is provided on Figure 3-9-3. It depicts detailed

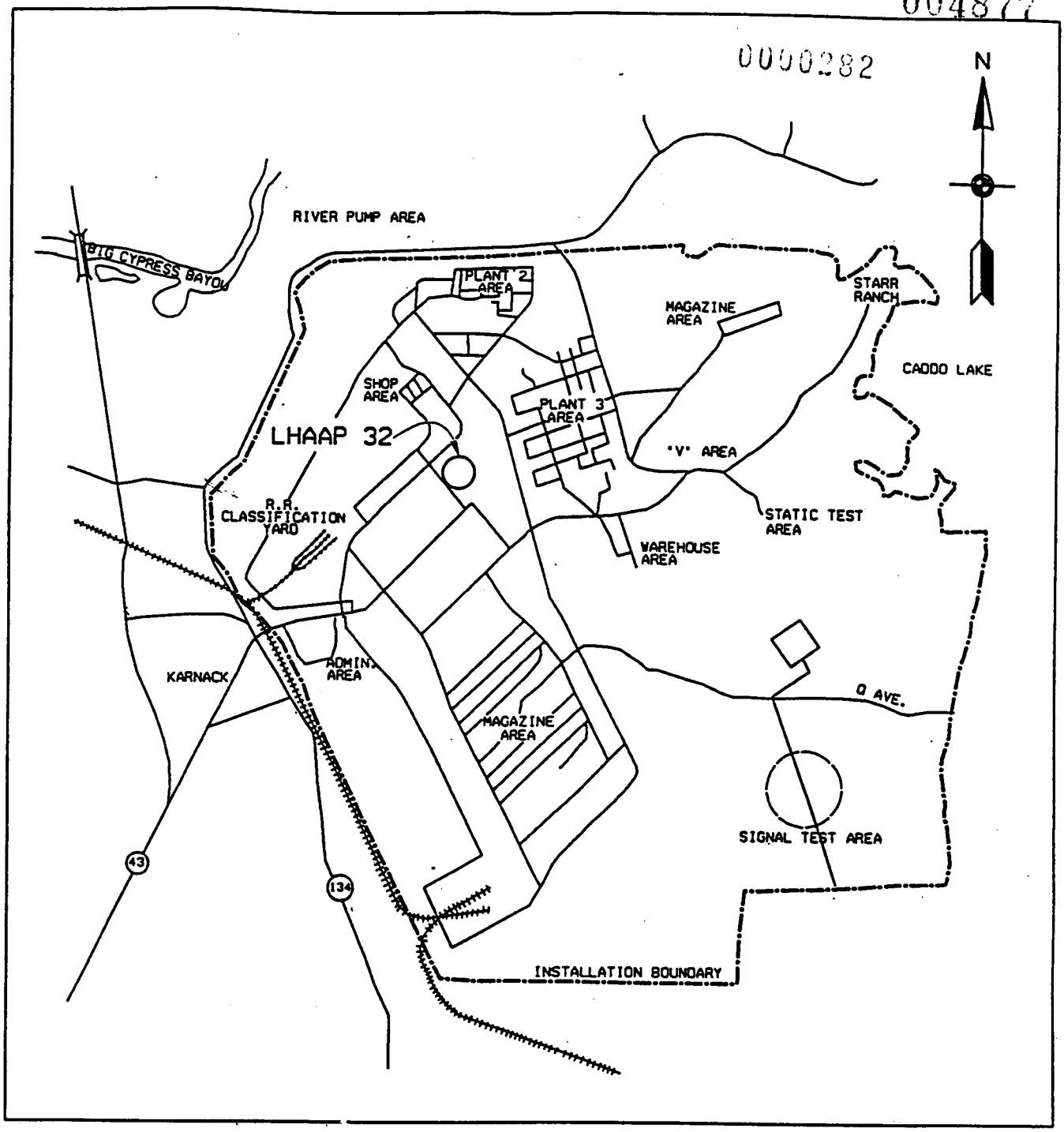

FIGURE 3-9-2 LOCATION MAP FOR LHAAP #32

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

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LEGEND

- GROUND WATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION
- 0201■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 004● SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- 113● 198.78 MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- POINT OF COMPLIANCE

NOTE:
GROUND-WATER ELEVATION NOV 89.

60 30 0 60 120
SCALE IN FEET

APPROXIMATE LIMIT OF FORMER TNT WASTE DISPOSAL PLANT

GOOSE PRAIRIE CREEK

003

HEAVY FOREST

HEAVY BRUSH & TIMBER

HEAVY TIMBER & BRUSH

FORMER "BLUE WATER" (COOLING WATER) DITCH

COOLING WATER NEUTRALIZATION PLANT (ABANDONED)

113 198.78

BARE AREAS

3919

FORMER EVAPORATOR BUILDING FOUNDATION W/ PARTIAL BASEMENT

FORMER INCINERATOR FACILITY FOUNDATIONS

CONCRETE ROOFED EQUALIZATION TANKS

0203

0202

004 3918

0201

DETENTION POND

"RED AND YELLOW LIQUOR" WASTEWATER PIPELINE

MET WELL

TANK SUPPORT PADS

FORMER CHANGE HOUSE FOUNDATION

APPROXIMATE LIMIT OF FORMER TNT WASTE DISPOSAL PLANT

AVE. "C"

AVE. "D"

1st STREET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 32
FORMER TNT WASTE DISPOSAL PLANT
SITE MAP

DATE: JUNE 1992 | FIGURE 3-9-3

/ed/drawing/longhorn/32site.dgn May. 15, 1992 09:42:41

topography and surface drainage patterns, estimated ground-water flow direction, location of previous sampling points, and the approximate limit of the site. Also shown are existing roads, utilities, and limited vegetation information with timber/brush areas differentiated from areas with little or no timber or brush. The site boundary is based on the 1944 plan view of the site, current vegetation patterns, and field observations. Current vegetation served as only a rough indicator of site limits because there has been considerable regrowth of trees and brush during the 46 years that have elapsed since the site was used for TNT waste treatment and disposal. The site covers an area of approximately 9 acres.

General soil and geologic maps and the boring log for on-site monitor well 113 indicate that the site is located on the outcrop of the Wilcox Group of sediments that typically consist of interbedded sands, silts, and clays. At this site, these sediments appear to be overlain by a few feet of residually-derived soils and/or fill materials. The fill materials are probably restricted to a few scattered small areas and resulted from grading operations during construction of the disposal plant. Depth to ground water probably averages about 10 feet with some seasonal fluctuation. The ground-water hydraulic gradient is expected to be topographically controlled, with the general flow directions indicated on Figure 3-9-3. The regional flow direction across the site is toward the east.

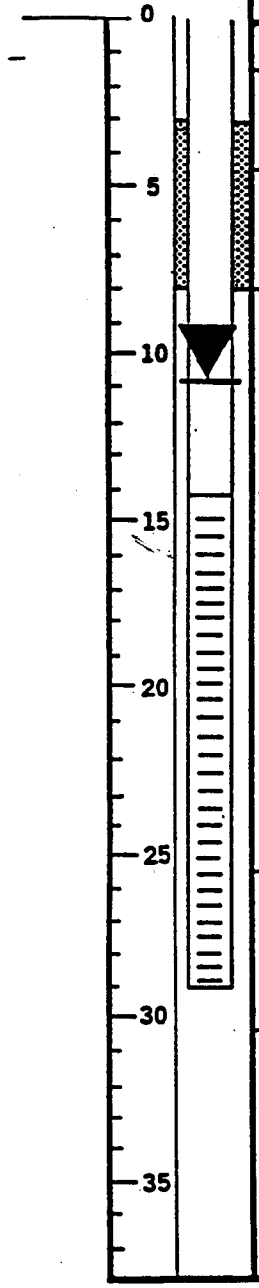
As shown on Figure 3-9-3, surface water runoff from the northwestern and north-central portions of the site is generally toward the north. The runoff is collected by three ditches that merge near the northern site boundary into a single ditch that conveys the runoff northward into Goose Prairie Creek. In the eastern and

southeastern portions of the site, surface runoff is overland in a generally eastward direction and is captured by small tributaries of Goose Prairie Creek to the east of the site. Surface water runoff from the south central and southwestern portions of the site is generally to the south or southeast. The runoff is eventually collected by a ditch along the south boundary of the site and conveyed to Goose Prairie Creek. This ditch was part of the "blue water" drainage system associated with both the former TNT Production Area and the Waste Disposal Plant. It apparently carried away waste "blue water" used for cooling purposes at the disposal plant along with the surface runoff from the south central and southwestern portions of the disposal plant site.

All surface water runoff from the site eventually enters Caddo Lake via Goose Prairie Creek. The total flow distance from the site to Caddo Lake is about 2.3 miles.

3.9.3 **Previous Investigations**. This site was investigated by EPS for USATHAMA, and a report of the survey was published in June 1984 (EPS, 1984). In June 1982, EPS installed monitoring well 113 at the location shown on Figure 3-9-3. It is assumed to be hydraulically downgradient from the extreme northern portion of the site. The log of the boring and construction details for this well are provided on Figure 3-9-4. Well 113 has a screen setting which monitors shallow ground water from depths between 14.0 and 29.0 feet. In November 1982, EPS obtained a sample of the ground water in Well 113, and the sample was analyzed for explosive compounds.

Also in November 1982, EPS collected surface water and sediment samples in Goose Prairie Creek approximately 400 feet downstream from the site, a sample of surface water impounded in the concrete-lined



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	7/11	Silty sand		
SC	9/7	Slightly clayey sand Brown mottled w/yellowish brown	25	
CL	5/7 9/13	Slightly sandy clay w/thin silty sand seams		
SM+CL	12/15 20/25	Silty sand layers & sandy clay layers 60% silty sand 40% clay Light brownish grey & yellowish brown		
SM+CL	10/15 19/23	Thin silty sand & clay layers Light brownish grey Dark greyish brown w/some iron stain 60% silty sand Yellowish brown 40% clay		
	19/35 25/3"	Dense silty sand & consolidated sandy clay Light brown silty sand Seams light grey & dark grey clay		
SM-ML	12/25 /30 19/29 50/4.5"	Slightly clayey silty sand Grey 5% clay 35% silt	40	

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 113 DATE DRILLED 6/29/82
STUDY AREA Former TNT Waste Disp. Plant
ELEVATION TOP OF STEEL CASING = 214.87 ft
ELEVATION TOP OF PVC RISER = 214.53 ft
ELEVATION OF GROUND SURFACE = 211.97 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-9-4
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO.113

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basement of the former Evaporator Building on the site, and three shallow soil samples in the vicinity of the main disposal plant facilities. Locations of these sampling points are shown on Figure 3-9-3. The shallow soil samples were obtained from 1-foot deep holes dug with a shovel. These samples, along with the surface water and sediment samples collected in Goose Prairie Creek, were analyzed for explosives. The surface water sample from the former Evaporator Building basement was analyzed for explosive compounds, selected (total) metals, and selected anions. A summary of all samples analyses conducted by EPS is provided in Table 3-9-1.

In July 1991, Thiokol Corporation and the TWC each collected samples of surface water impounded in the concrete-lined partial basement of the former Evaporator Building and surface water impounded in a concrete-lined sump immediately adjacent to the former Neutralized Wastes Storage Tank. Locations of these sampling points are indicated on Figure 3-9-3. Samples were analyzed for explosives. The Thiokol sample from the sump was also analyzed for lead and selenium. A summary of analyses for the Thiokol samples is provided in Table 3-9-2. The TWC samples were not analyzed because the holding times were exceeded.

3.9.4. <u>Assessment of Existing Data and Historic Records</u>. Results of sample analyses summarized in Tables 3-9-1 and 3-9-2 indicate that, with one exception, explosive compounds were below detection limits. The one exception was the 7.6 ug/l concentration of 2,4,6-TNT found in surface water sample 3918 which was obtained from a sump adjacent to the former Neutralized Wastes Storage Tank. In surface water sample 004, results of selected metals analyses indicate that concentrations of aluminum, chromium, lead, manganese, and nickel

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TABLE 3-9-1

LONGHORN ARMY AMMUNITION PLANT
LHAAP 32 - FORMER TNT WASTE DISPOSAL PLANT

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE AND LOCATION NO.						Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0202	SOIL 0203	GW 113	SW 003	SW 004	SD 003	
		ug/g	ug/l	ug/g	ug/g	ug/l	ug/l	ug/l	ug/g	
1,3 - DNB	EXP	0.50	1.68	<	<	<	<	<	<	Nov 82
2,4 - DNT	EXP	0.50	0.89	<	<	<	<	<	<	Nov 82
2,6 - DNT	EXP	0.61	1.20	<	<	<	<	<	<	Nov 82
Nitrobenzene	EXP	1.15	0.76	<	<	<	<	<	<	Nov 82
1,3,5 - TNB	EXP	0.71	1.08	<	<	<	<	<	<	Nov 82
2,4,6 - TNT	EXP	0.73	1.46	<	<	<	<	<	<	Nov 82
Aluminum	MET	0.36	10.	NA	NA	NA	NA	47.70	NA	Nov 82
Antimony	MET	0.76	10.2	NA	NA	NA	NA	<	NA	Nov 82
Arsenic	MET	0.3	6.	NA	NA	NA	NA	<	NA	Nov 82
Barium	MET	0.99	11.4	NA	NA	NA	NA	<	NA	Nov 82
Beryllium	MET	0.5	10.	NA	NA	NA	NA	<	NA	Nov 82
Cadmium	MET	0.5	0.28	NA	NA	NA	NA	<	NA	Nov 82
Chromium	MET	0.6	6.64	NA	NA	NA	NA	34.20	NA	Nov 82
Copper	MET	0.5	23.9	NA	NA	NA	NA	<	NA	Nov 82
Lead	MET	0.89	7.49	NA	NA	NA	NA	52.50	NA	Nov 82
Manganese	MET	0.25	12.1	NA	NA	NA	NA	34.00	NA	Nov 82
Mercury	MET	2.7	1.3	NA	NA	NA	NA	<	NA	Nov 82
Nickel	MET	0.5	30.	NA	NA	NA	NA	77.+	NA	Nov 82
Selenium	MET	0.5	6.	NA	NA	NA	NA	<	NA	Nov 82
Silver	MET	0.5	10.	NA	NA	NA	NA	<	NA	Nov 82
Strontium	MET	0.5	25.	NA	NA	NA	NA	<	NA	Nov 82
Thallium	MET	3.	50.	NA	NA	NA	NA	<	NA	Nov 82
Zinc	MET	0.5	27.1	NA	NA	NA	NA	<	NA	Nov 82
Chloride	ANI	7.	500.	NA	NA	NA	NA	1000.	NA	Nov 82
Chromate	ANI	5.	500.	NA	NA	NA	NA	<	NA	Nov 82
Cyanide	ANI	5.	600.	NA	NA	NA	NA	<	NA	Nov 82
Fluoride	ANI	5.	500.	NA	NA	NA	NA	<	NA	Nov 82
Nitrate	ANI	5.	500.	NA	NA	NA	NA	<	NA	Nov 82
Nitrite	ANI	5.	250.	NA	NA	NA	NA	<	NA	Nov 82
Phosphates	ANI	NR	125.	NA	NA	NA	NA	<	NA	Nov 82
Sulfate	ANI	25.	580.	NA	NA	NA	NA	1220.	NA	Nov 82
Thiocyanate	ANI	10.	500.	NA	NA	NA	NA	<	NA	Nov 82

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TABLE 3-9-1 (Cont.)

LONGHORN ARMY AMMUNITION PLANT
LHAAP 32 - FORMER TNT WASTE DISPOSAL PLANT

SUMMARY OF SAMPLE ANALYSES

ANALYTE ABBREVIATIONS :

ANI	Anion
DNB	Dinitrobenzene
DNT	Dinitrotoluene
EXP	Explosive
MET	Metal
TNB	Trinitrobenzene
TNT	Trinitrotoluene

OTHER ABBREVIATIONS :

<	Below Detection Limit
GW	Ground Water
NA	Not Analyzed
ND	Not Detected. Detection limit not known.
NR	No Record

SOURCE OF DATA : "LHAAP CONTAMINATION SURVEY",
Environmental Protection Systems, Inc., June 1984.

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TABLE 3-9-2

LONGHORN ARMY AMMUNITION PLANT
LHAAP 32 - FORMER TNT WASTE DISPOSAL PLANT

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE AND LOCATION NO.		Date of Sampling
NAME	TYPE	DETECTION LIMIT		SURFACE WATER 3918	SURFACE WATER 3919	
		ug/g	ug/l	ug/l	ug/l	
2,4-DNT	EXP	-	6.2	<	NA	JUL 91
2,6-DNT	EXP	-	5.8	<	NA	JUL 91
HMX	EXP	-	4.2	<	<	JUL 91
RDX	EXP	-	1.6	<	<	JUL 91
Tetryl	EXP	-	3.7	<	<	JUL 91
2,4,6-TNT	EXP	-	0.94	<	7.6	JUL 91
Lead	MET	-	0.001	NA	<	JUL 91
Selenium	MET	-	0.003	NA	<	JUL 91

ANALYTE ABBREVIATIONS :

DNT Dinitrotoluene
EXP Explosive
HMX Cyclotetramethylenetetranitramine
MET Metal
RDX Cyclotrimethylenetrinitramine
TNT Trinitrotoluene

OTHER ABBREVIATIONS:

< Below Detection Limit
NA Not Analyzed

SOURCE OF DATA : Thiokol Corporation - EPS Analytical Services
Laboratory Reports No. 21144 and 21145.

may be elevated above local background levels. Surface water sample 004 was obtained from the basement of the former Evaporator Building. Any elevated concentrations of explosives or metals in the samples listed on these tables may be indicative of releases at the former TNT Waste Disposal Plant. There does not appear to be any other known waste sources contributing to these elevated concentrations.

The history of past waste disposal operations is largely anecdotal and conjectural. It is known that the former TNT Waste Disposal Plant was used for over 2 years during World War II to treat and dispose very large quantities of wastewaters from the production of 2,4,6-TNT. The surviving 1944 plan view of the site provides valuable clues as to the methods of waste treatment and disposal, but specific operational details are lacking. Because of its nearness to later production areas and its relatively easy accessibility within LHAAP boundaries, it is possible that the site was occasionally used for disposal of small amounts of waste subsequent to deactivation of the disposal plant in 1945. There are no records of such disposal, and if it did occur, the types of wastes are unknown.

3.9.5 **Potential Contaminants and Migration Pathways**. The primary sources of potential contamination at this site are the explosive compounds and explosives manufacturing residues in the "red and yellow liquor" wastewaters and sludges that were treated and disposed at the site and the ashes resulting from incineration of the sludges produced by evaporating the wastewaters. Red water ("red liquor") generated by TNT manufacturing operations is EPA listed hazardous waste No. K047 under RCRA. The thickened red and yellow liquors generated at the site were essentially wastewater treatment sludges. Such sludges are now listed as EPA hazardous waste No. K044 under RCRA.

Based on analyses of red water generated at another Army ammunition plant (USATHAMA, April 1990), and assuming that a continuous type TNT purification process was employed, the "red liquor" generated at LHAAP during World War II was most likely a strongly acidic (pH of 3 to 4) wastewater containing approximately 15 percent total dissolved solids comprised of roughly equal parts of inorganic salts and nitrobodies. The inorganic salts were principally sodium sulfite, sodium sulfate, and sodium nitrite. The nitrobodies were sodium salts of dinitrotoluene sulfonic acids with traces of vocalent organic compounds such as TNT. Composition of the "yellow liquor" generated at LHAAP is uncertain. It may have been principally a mixture of water, nitric acid and sulfuric acid generated by washing crude TNT free of acids, hence the yellow color. The "yellow liquor" was likely compatible with the "red liquor" because it was pumped through the same wooden pipeline from the TNT Production Plant to the TNT Disposal Plant and was likely mixed with the "red liquor" at some point during the treatment and disposal process.

The LHAAP "red and yellow liquor" wastewaters likely contained low concentrations of metals derived from the source water and picked up during the TNT purification and wastewater treatment processes. Metals found in the red water analyzed at another plant (USATHAMA, April 1990) included calcium, iron, magnesium, potassium, aluminum, chromium, barium, copper, cadmium, and silver with the total calcium concentration highest at 346 mg/l, and the total silver concentration lowest at 0.40 mg/l. The evaporation and subsequent incineration processes used at the LHAAP TNT Waste Disposal Plant would have tended to increase the metal concentrations in the resultant ashes, some of which were disposed on-site as described in Para. 3-9-1.

During operation of the disposal plant, leakage from its many tanks and pipelines was reportedly a constant problem. Because of the large volumes of wastes that were handled, there were probably occasional spills resulting from overflows of tanks and manual handling of wastes. Previous sampling and analyses at this site have not revealed significant contamination by explosive compounds, but the sampling program was quite limited in the number of locations sampled and in the depths of soil and sediment sampling. The one ground-water monitoring well (Well 113) is hydraulically downgradient from only a small portion of the site.

Assuming that wastes containing explosive compounds and explosive manufacturing residues exist in the soils and ground water at the site, these contaminants could follow the potential migration pathways described below.

3.9.5.1 **Surface Water**. Runoff from surficial soils and fill materials could pick up contaminants and transport them to collection ditches or streams. Any residual contaminants in the various sumps and basements during or after heavy rains could be carried by overflow and contribute additional contamination to surface waters. These ditches and streams would then carry the contaminated surface water into Goose Prairie Creek and Caddo Lake.

3.9.5.2. **Sediment**. Erosion of contaminated soils and fill materials during heavy rainfall could produce contaminated sediment that would be carried by surface water runoff to receiving ditches and streams. Based on field observations, much of this sediment would be deposited in the bottoms of these drainageways and would not reach Caddo Lake. Also, sediment in the receiving drainageways could be further contaminated by precipitation of contaminants from surface water, especially where the water collects in potholes and swales in the drainageway.

3.9.5.3. **Soil**. Water percolating downward through contaminated soils may leach contaminants and carry them into underlying soils where they could eventually reach ground water.

3.9.5.4 **Ground Water**. Although ground water in the one monitoring well at the site has not shown contamination by explosive compounds, ground water is a potential pathway for contaminant migration. The relative shallowness of the water table and its expected seasonal fluctuation elevates its importance as a pathway. During wet periods when the water table may rise to intercept surface drainageways downgradient from the site, contaminated ground water could discharge to surface drainage.

3.9.5.5 **Air**. The site is currently well protected from wind erosion by vegetation. Air could become a pathway for contaminant migration if the vegetative cover was removed or contaminated soils were disturbed.

3.9.6 **Identification of Potential Receptors**. The general public does not have ready access to the site because it is located within the confines of LHAAP. Also, installation personnel and authorized visitors do not have ready access to the site, and adjoining areas are enclosed by a fence with a locked access gate. The site is seldom visited because it is not being used for anything except occasional hunting.

There are no public water supply wells located in the direction of expected ground-water flow from the site, and none are expected to be installed. Ground-water flow directions across the site are expected to vary from the north-northeast to the southeast, while the more regional direction is to the east toward Caddo Lake. The nearest public water supply well, Well 504, is approximately 1.4 miles

southwest of, and hydraulically upgradient from, the site. A potential threat to public health and the environment posed by contaminated ground water originating at this site appears to be its possible emergence into the surface water flow regime.

There is no accelerated soil erosion on the site and no activities are planned that would increase future soil erosion and sediment yield. There are no major watercourses or water bodies on the site; however, there are numerous small- to medium-size depressions in ditches on the site and numerous small swales elsewhere that retain water for varying lengths of time following excessive rainfall. Water is apparently ponded almost continuously in various concrete-lined pits, sumps and/or partial basements associated with remaining foundations in the main disposal plant area. The site is not expected to be developed as a drainage way or for surface water use. There are no obvious signs of ground water emerging into the drainage ditches that collect most of the surface water runoff from the site.

Surface water runoff and water-borne sediment derived from the site eventually enter Caddo Lake which is used as a water supply for approximately 16,600 Louisiana residents. The flow distance from the site to Caddo Lake is about 2.3 miles. Caddo Lake is not known to have been affected by contaminants originating at this site.

Aerial photographs indicate that the site was essentially cleared of larger vegetation during operation of the disposal plant and remained cleared until 1959 when most of the plant structures were removed. Since 1959, the site has been allowed to revegetate. Now most of the site is sparsely to heavily wooded, with small shrubs and grasses found in the sparsely wooded areas. Most of the area

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immediately surrounding the concrete foundations and access roads in the main disposal plant area is vegetated by grasses, small shrubs, trumpet vines, and a few ash and willow trees. The adjacent woodland area is vegetated with larger pines, sweet gum, oak, and some black tupelo. Parts of the site provide good cover and browse for deer. The only areas on the site exhibiting signs of vegetation distress are alongside and mostly south of a deteriorated asphalt/gravel road that probably served as an entrance and exit road for trucks hauling ashes away from the former Incinerator Facility. The road appears to have had a "turn-around" cul-de-sac for the trucks in the immediate vicinity of Well 113. There are two small areas within the stressed areas of vegetation that are completely devoid of vegetation. These bare areas are shown on Figure 3-9-3. The vegetation stress could be the result of spillage or dumping of wastes that inhibits plant growth. The spillage or dumping could have occurred over 46 years ago when the disposal plant was in operation or it could have occurred much more recently.

3.9.7 Initial Remedial Action. Based upon what is known about the site and the nature and extent of its contaminants, quick remedial action is not deemed necessary. The slightly elevated levels of metals found in one of the previous surface water samples and the very low concentration of 2,4,6-TNT found in another surface water sample pose no imminent threat to potential receptors at this time.

NPL only

3.10 LHAAP 1 - INERT BURNING GROUNDS

3.10.1 Site History. The Inert Burning Grounds was originally used during World War II by Monsanto Chemical Company for burning trash, ashes, scrap lumber, and waste from burned 2,4,6-TNT. Bulk 2,4,6-TNT may also have been burned at the site. The site was not

used between August 1945 and February 1952 when LHAAP was in a standby status. Universal Match Corporation later used the site to burn wastes, including photo flash powder, for a few years during the 1950s until most burning operations were transferred to the Burning Ground No. 2/Flashing Area (LHAAP 17) located on the installation. Intermittent, small-scale burning operations may have continued at the site into the early 1960s. It is suspected that burning operations were conducted in one or more burn pits or pans that were subsequently filled or covered. Burn residues were most likely not removed. It is also suspected that some wastes may have been dumped without burning and were subsequently covered by or mixed with fill material.

3.10.2 **Site Description**. The site is situated in the extreme northwestern portion of LHAAP, as shown on Figure 3-10-1. Only approximately one third of the site has been defined from previous investigations and is currently addressed in this RI work plan. The center of this southernmost portion of the site is at least 2,000 feet from the LHAAP boundary and approximately 400 feet west of the intersection of Avenue P and 32nd Street. The remainder of the site appears to encompass an additional area to the west and northwest approximately twice as large as the site as it has previously been defined.

A detailed map of the southernmost portion of the Inert Burning Grounds and surrounding area is shown on Figure 3-10-2. It depicts detailed topography and surface drainage patterns, estimated groundwater flow direction, location of previous sampling points, and the suspected limit of the site. Also shown are roads, fences, and limited vegetation information with heavily timbered areas differentiated from lightly or nontimbered areas. The limits of this

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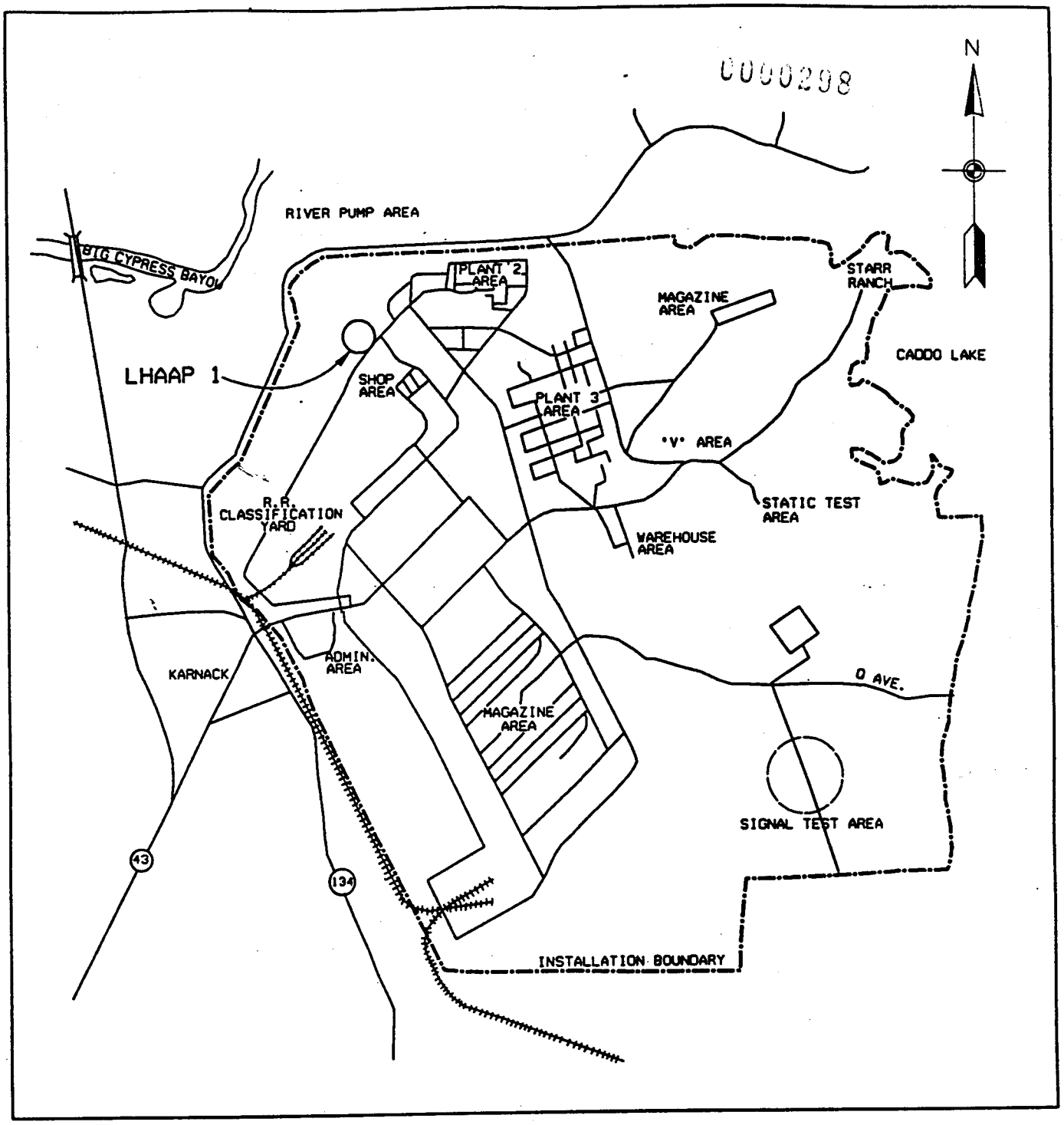

FIGURE 3-10-1 LOCATION MAP FOR LHAAP #1

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

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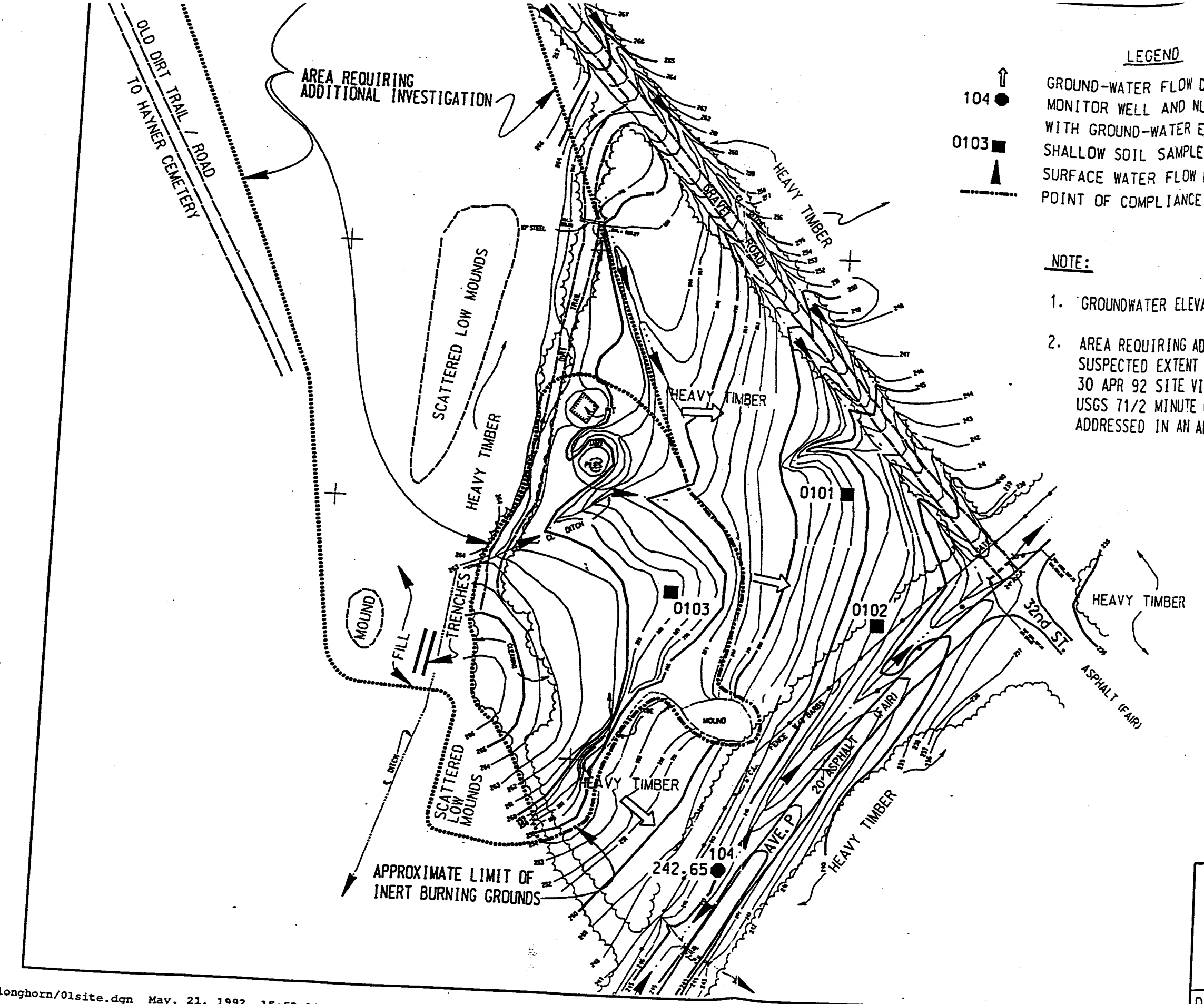
LEGEND

104 ● GROUND-WATER FLOW DIRECTION
MONITOR WELL AND NUMBER (EXISTING)
WITH GROUND-WATER ELEVATION (SEE NOTE)
0103 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
SURFACE WATER FLOW DIRECTION
POINT OF COMPLIANCE

0000299

NOTE:

1. GROUNDWATER ELEVATION NOV 1989.
2. AREA REQUIRING ADDITIONAL INVESTIGATION SHOWS SUSPECTED EXTENT OF INERT BURNING GROUNDS BASED ON 30 APR 92 SITE VISIT, AERIAL PHOTOS, AND 1963 USGS 71/2 MINUTE QUAD. THIS AREA WILL BE ADDRESSED IN AN ADDENDUM TO THE RI/FS WORK PLAN.



CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 1
INERT BURNING GROUNDS
SITE MAP

DATE: JUNE 1992 | FIGURE 3-10-2

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area of the site were established on the basis of field observations, detailed topographic information, and vegetation patterns. Current vegetation patterns serve as only a rough indicator of past disposal areas because there has been considerable regrowth of trees during the 25 or more years that have elapsed since the site was used for waste disposal. This portion of the site covers an area of approximately 1.5 acres.

General soil and geologic maps and the boring log data for nearby monitoring well 104 indicate the site is located within the outcrop of the Wilcox Group of sediments that typically consist of interbedded sands, silts, and clays. At this site, these sediments appear to be overlain by a few feet of residually-derived soils and/or fill materials. Depth to ground water probably averages about 5 feet with some seasonal fluctuation. The ground-water hydraulic gradient is expected to be topographically controlled, with the general flow directions as indicated on Figure 3-10-2. The regional flow direction across the site is assumed to be toward the southeast.

As shown on Figure 3-10-2, surface drainage from the site collects in ditches alongside Avenue P and 32nd Street, then passes through either the concrete culvert across 32nd Street at its intersection with Avenue P or the concrete culvert across Avenue P near well 104. The site's surface drainage eventually enters Goose Prairie Creek, which flows into Caddo Lake. The total flow distance from the site to Caddo Lake is approximately 3 miles.

Included on Figure 3-10-2 is the estimated limit of the additional site which was discovered during the review of the RI work plan for this site. An additional site visit, review of aerial photographs, review of the U.S. Geological Survey (USGS) 1978 Karnack,

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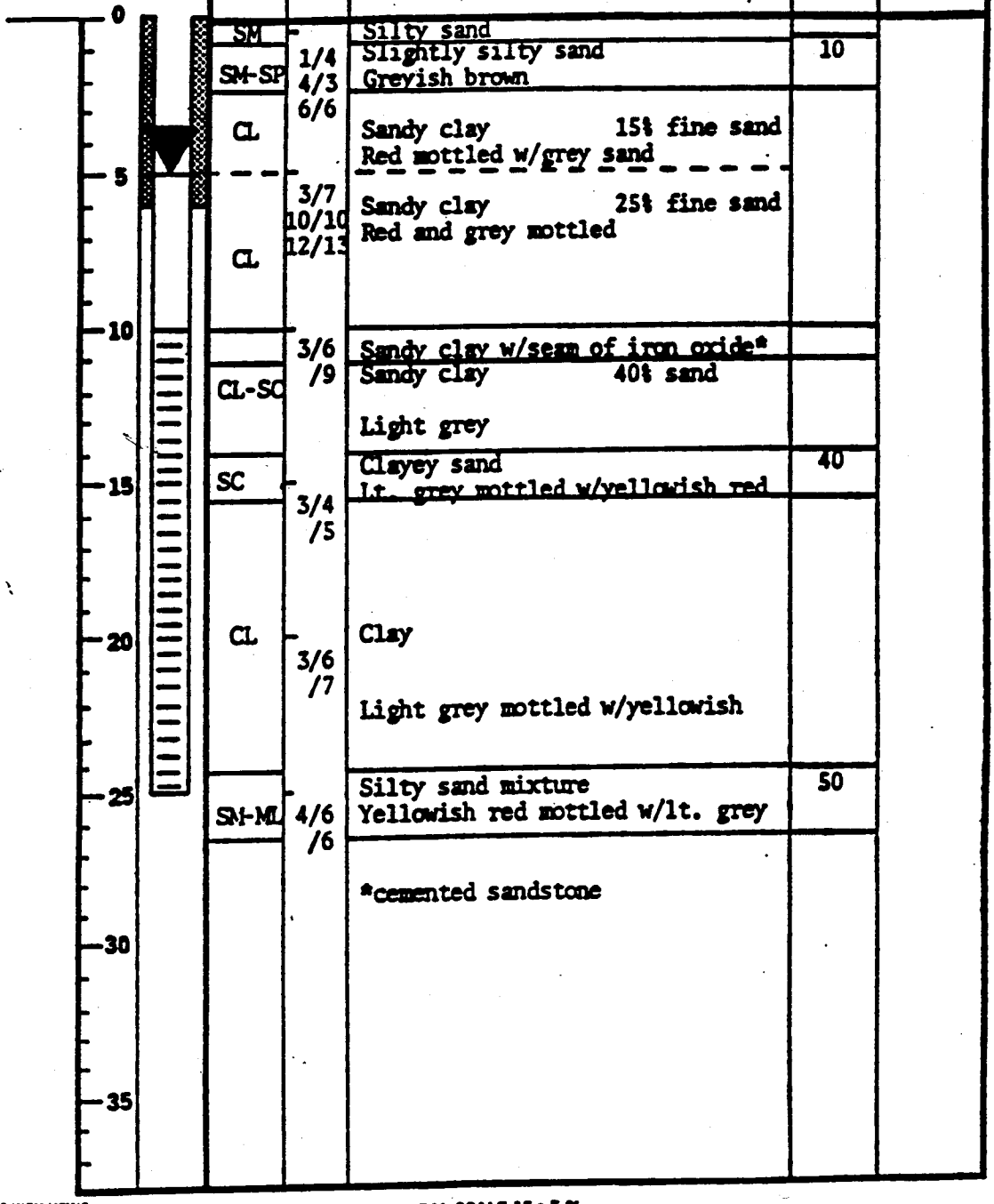
Texas, 7.5 minute quadrangle, and additional interviews with installation personnel indicate that the actual areal extent of the Inert Burning Ground site may be beyond the western and northwestern limits of the previously identified area. Physical evidence such as mounds of debris and evidence of trenches indicate some type of waste management activities were once performed in this area. Because of a lack of detailed topography for the site for developing a plan of investigation, and the uncertainty of the nature of activities once performed in this area, the RI work plan presented in this document will address only the southernmost portion of the site which has been previously investigated and identified as the Inert Burning Ground. The additional area or site recently identified will be addressed in a later addendum to this RI/FS Work Plan.

3.10.3 **Previous Investigations**. This site was investigated by EPS for USATHAMA, and a report was published in June of 1984 (EPS, 1984). In April 1982, EPS installed monitoring well 104 at the location indicated on Figure 3-10-2. It is assumed to be hydraulically downgradient from the site. The log of the boring and construction details for this well are provided on Figure 3-10-3. Well 104 screens shallow ground water from 10.0 to 25.0 feet. In November 1982, EPS collected three surface soil samples by digging 1-foot deep holes with a shovel at the locations indicated on Figure 3-10-2, and obtained a sample of the ground water in Well 104. The soil and ground-water samples were analyzed for explosive compounds, selected (total) metals, and selected anions. Ground-water samples were also analyzed for VOCs and SVOCs. A summary of the sample analyses is provided on Table 3-10-1. No other investigations have been performed at the site.



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PENETRATED
SM		Silty sand		
SM-SP	1/4 4/3 6/6	Slightly silty sand Greyish brown	10	
CL		Sandy clay 15% fine sand Red mottled w/grey sand		
CL	3/7 10/10 12/13	Sandy clay 25% fine sand Red and grey mottled		
	3/6	Sandy clay w/seam of iron oxide*		
CL-SC	/9	Sandy clay 40% sand Light grey		
SC		Clayey sand Lt. grey mottled w/yellowish red	40	
	3/4 /5			
CL		Clay		
	3/6 /7	Light grey mottled w/yellowish		
SM-ML		Silty sand mixture Yellowish red mottled w/lt. grey	50	
	4/6 /6	*cemented sandstone		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 104 DATE DRILLED 5/19/82
STUDY AREA Inert Burning Grounds
ELEVATION TOP OF STEEL CASING = 248.27 ft
ELEVATION TOP OF PVC RISER = 247.53 ft
ELEVATION OF GROUND SURFACE = 245.37 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-10-3
BORING LOG AND WELL
CONSTRUCTION DETAIL FOR
MONITORING WELL NO. 104

TABLE 3-10-1

LONGHORN ARMY AMMUNITION PLANT
LHAAP 01 - INERT BURNING GROUNDS

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.				Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0101	SOIL 0102	SOIL 0103	GW 104	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	
1,3 - DNB	EXP	0.50	1.68	<	<	<	<	Nov 82
2,4 - DNT	EXP	0.50	0.89	<	<	<	<	Nov 82
2,6 - DNT	EXP	0.61	1.20	<	<	<	<	Nov 82
Nitrobenzene	EXP	1.15	0.76	<	<	<	1.82	Nov 82
1,3,5 - TNB	EXP	0.71	1.08	<	<	<	9.74	Nov 82
2,4,6 - TNT	EXP	0.73	1.46	<	<	<	<	Nov 82
Aluminum	MET	0.36	10.	1361.4	1435.	1128.6	372.0	Nov 82
Antimony	MET	0.76	10.2	<	<	<	<	Nov 82
Arsenic	MET	0.3	6.	<	<	<	<	Nov 82
Barium	MET	0.99	11.4	102.6	106.6	98.4	67.00	Nov 82
Beryllium	MET	0.5	10.	<	<	<	<	Nov 82
Cadmium	MET	0.5	0.28	<	<	<	0.97	Nov 82
Chromium	MET	0.6	6.64	11.2	12.3	14.4	45.70	Nov 82
Copper	MET	0.5	23.9	8.1	17.4	15.4	<	Nov 82
Lead	MET	0.89	7.49	29.4	26.1	28.4	34.30	Nov 82
Manganese	MET	0.25	12.1	49.8	99.4	122.1	85.00	Nov 82
Mercury	MET	2.7	1.3	<	<	<	<	Nov 82
Nickel	MET	0.5	30.	6.	5.	5.	57.+	Nov 82
Selenium	MET	0.5	6.	<	<	<	<	Nov 82
Silver	MET	0.5	10.	<	<	<	<	Nov 82
Strontium	MET	0.5	25.	10.1	9.5	9.4	96.00	Nov 82
Thallium	MET	3.	50.	<	<	<	<	Nov 82
Zinc	MET	0.5	27.1	25.4	56.4	47.2	<	Nov 82
Chloride	ANI	7.	500.	6.	5.	7.	8000.	Nov 82
Chromate	ANI	5.	500.	<	<	<	<	Nov 82
Cyanide	ANI	5.	600.	<	<	<	<	Nov 82
Fluoride	ANI	5.	500.	7.	8.	9.	<	Nov 82
Nitrate	ANI	5.	500.	<	<	8.33	3500.	Nov 82
Nitrite	ANI	5.	250.	<	<	<	<	Nov 82
Phosphates	ANI	NR	125.	NA	NA	NA	<	Nov 82
Sulfate	ANI	25.	580.	40.0	29.7	40.48	5710.	Nov 82
Thiocyanate	ANI	10.	500.	<	<	<	<	Nov 82
Aroclor - 1016	PCB	0.6	0.6	NA	NA	NA	<	Nov 82
Aroclor - 1260	PCB	0.7	1.	NA	NA	NA	<	Nov 82
alpha - BHC	PES	0.05	0.09	NA	NA	NA	<	Nov 82
p,p' - DDT	PES	0.09	0.05	NA	NA	NA	<	Nov 82
Dieldrin	PES	0.05	0.09	NA	NA	NA	<	Nov 82
Heptachlor	PES	0.05	0.05	NA	NA	NA	<	Nov 82

TABLE 3-10-1 (Cont.)

LONGHORN ARMY AMMUNITION PLANT
LHAAP 01 - INERT BURNING GROUNDS

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.				Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0101	SOIL 0102	SOIL 0103	GW 104	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	
Lindane	PES	0.05	0.09	NA	NA	NA	<	Nov 82
Toxaphene	PES	4.	4.	NA	NA	NA	<	Nov 82
Benzene	VOC	NR	1.	NA	NA	NA	<	Nov 82
1,1' - Bicyclohexyl	VOC	NR	10.	NA	NA	NA	ND	Nov 82
Chloroform	VOC	NR	1.	NA	NA	NA	<	Nov 82
Dichloromethane	VOC	NR	10.	NA	NA	NA	<	Nov 82
Pentane	VOC	NR	10.	NA	NA	NA	ND	Nov 82
Trichloroethane	VOC	NR	10.	NA	NA	NA	ND	Nov 82
Trichloroethene	VOC	NR	1.	NA	NA	NA	ND	Nov 82
Trichloromethane	VOC	NR	10.	NA	NA	NA	ND	Nov 82
1-Bromo-2-meth-oxycyclopentane	SVOC	NR	10.	NA	NA	NA	ND	Nov 82
o-Chlorophenol	SVOC	NR	10.	NA	NA	NA	<	Nov 82
Dibutyl phthalate	SVOC	NR	10.	NA	NA	NA	<	Nov 82
Di-n-butyl phthalate	SVOC	0.7	2.	NA	NA	NA	ND	Nov 82
2,4 - Dichlorophenol	SVOC	1.	1.	NA	NA	NA	<	Nov 82
Diethyl phthalate	SVOC	1.	2.	NA	NA	NA	<	Nov 82
2 - (1,1 - Dimethyl-ethoxy) - ethanol	SVOC	NR	10.	NA	NA	NA	ND	Nov 82
Glycine, N-acetyl-N-(TFA)-methylester	SVOC	NR	10.	NA	NA	NA	ND	Nov 82
Nitrobenzene	SVOC	0.6	1.	NA	NA	NA	<	Nov 82
Pentachlorophenol	SVOC	1.	2.	NA	NA	NA	<	Nov 82

ANALYTE ABBREVIATIONS :

ANI	Anion
DNB	Dinitrobenzene
DNT	Dinitrotoluene
EXP	Explosive
MET	Metal
PCB	Polychlorinated Biphynyl
PES	Pesticide
SVOC	Semivolatile Organic Compound
TFA	Trifluoroacetyl
TNB	Trinitrobenzene
TNT	Trinitrotoluene
VOC	Volatile Organic Compound

OTHER ABBREVIATIONS :

<	Below Detection Limit
GW	Ground Water
NA	Not Analyzed
ND	Not Detected. Detection limit not known.
NR	No Record

SOURCE OF DATA : "LHAAP CONTAMINATION SURVEY", Environmental Protection Systems, Inc., June 1984.

3.10.4 **Assessment of Existing Data and Historic Records.** Results of analyses summarized on Table 3-10-1 indicate that in the soil samples, concentrations of aluminum, barium, lead, manganese, zinc, and sulfate may be elevated above local background levels. In soil sample 0103, the only sample taken within the preliminary site boundary, nitrate may be slightly elevated. Results of analyses also indicate that in the ground-water sample from Well 104, concentrations of aluminum, barium, chromium, lead, manganese, and nitrate may exceed local background levels, and the explosives nitrobenzene and 1,3,5-TNB exceed background concentrations at 1.82 and 9.74 ug/l, respectively. Any elevated concentrations of metals, anions, and explosive compounds in the soil and ground-water samples listed on Table 3-10-1 may be the result of past waste disposal at the Inert Burning Grounds. There do not appear to be any other waste disposal sites that could contribute to these elevated concentrations.

Existing data are not adequate to firmly establish many of the site's characteristics, including the nature of the surficial soils/fill materials and the underlying Wilcox Group materials, the depth to ground water, and the direction of ground-water flow.

The history of past waste disposal operations at this site is mostly anecdotal, and it is therefore not possible to name or quantify all the types of wastes that were disposed. It does appear that the elevated metals, anions, and explosives concentrations are in general agreement with the history of the site except that 2,4,6-TNT, an expected waste constituent, was not detected in any samples taken.

3.10.5 **Potential Contaminants and Migration Pathways.** The suspected source of contamination is burned explosive waste residues and possibly bulk explosive wastes that have been covered or mixed

with full materials. Previous investigations have not confirmed the presence of explosive compounds in the soils, and only trace amounts of nitrobenzene and 1,3,5-TNB have been found in the ground water assumed to be downgradient of the site. Assuming that explosive compounds and other related contaminants exist in the soils at the site, these contaminants could follow the potential migration pathways described below.

3.10.5.1 **Surface Water**. Runoff from surficial fill materials could pick up contaminants and transport them to the collection ditches. These ditches would then carry the contaminated surface water into Goose Prairie Creek and Caddo Lake. Also, during periods of heavy rainfall, water could percolate downward through contaminated materials, collect and flow along the contact between the fill and underlying undisturbed soils, and then emerge as contaminated ground water along the toe of the relatively steep slopes that mark the edge of suspected fill areas on the site (see Figure 3-10-2). This contaminated ground water would then enter the surface runoff regime.

3.10.5.2 **Sediment**. Erosion of contaminated materials during heavy rainfall could produce contaminated sediment that would be carried by surface water runoff to the collection ditches adjacent to the site. Based on field observations, much of this sediment would be deposited in the bottom of these ditches. Also, sediment in the ditches could be further contaminated by precipitation of contaminants from surface water, especially where the water collects in potholes and swales in the ditches.

3.10.5.3 **Soil**. Water percolating downward through contaminated fill and soils may leach contaminants and carry them into

the underlying soils where they could eventually reach the ground-water table.

3.10.5.4 **Ground Water**. Ground water in Well 104, a short distance from the site and assumed to be hydraulically downgradient, shows some evidence of contamination, demonstrating that ground water is an important pathway for contaminant migration at this site. The relative shallowness of the water table and its expected seasonal fluctuation elevates its importance as a pathway. During wet seasons when the water table may rise to intercept surface drainageways downgradient from the site, contaminated ground water could discharge to surface drainage.

3.10.5.5 **Air**. The site is currently well protected from wind erosion by vegetation. Air could become a contaminant migration pathway if the vegetative cover was removed or contaminated soils were disturbed.

3.10.6 **Identification of Potential Receptors**. The general public does not have ready access to the site because it is located within the confines of LHAAP. Also, installation personnel and authorized visitors do not have ready access to the site because the site and adjoining areas are enclosed by a security fence with a locked access gate. The site is seldom visited because it is not being used for anything except occasional hunting.

There are no water supply wells located in the direction of expected ground-water flow from the site and none are expected to be installed. Ground-water flow direction across the site is probably to the southeast, while the more regional direction is to the east toward Caddo Lake. The nearest public water supply well, Well 502, is about 1.0 mile west-southwest of and hydraulically upgradient from the site.

A potential threat to public health and the environment posed by contaminated ground water originating at this site appears to be its possible emergence into the surface water flow regime.

There is no accelerated soil erosion on the site and no activities are planned that would increase future soil erosion and sediment yield. There are no water bodies or major watercourses on the site; however, there is one small excavated pit on the site and several small depressions in nearby downstream ditches that retain water for varying lengths of time following excessive rainfall. The site is not expected to be developed as a drainage way or for surface water use. There are no obvious signs of ground water emerging into the drainage ditches that first collect surface runoff from the site.

Surface water runoff and water-borne sediment derived from the site eventually enter Caddo Lake which is used as a water supply for approximately 16,600 Louisiana residents. The flow distance from the site to Caddo Lake is about 3 miles. Caddo Lake is not known to have been affected by contaminants originating at this site.

The site is a relatively natural area with no obvious signs of plant stress. The site area is mostly overgrown with woodland except for the trail on the western side of the site and the broader clearing located on the trail. The trail is vegetated with grass and forbs. Along woodland edges of the trail and clearing are greenbriar and muscadine vines. On the west side of the trail, there are a man-made pit and a dirt pile under the tree canopy, but there is no evidence of vegetative stress. Predominant trees in the site area are pine and sweet gum. Understory is generally limited to poison ivy and an occasional oak seedling. The area has generally good cover and browse for deer.

3.10.7 **Initial Remedial Action.** Based upon what is known about the site and the nature and extent of its contaminants, quick remedial action is not deemed necessary. The elevated levels of constituents found in the surface soils at the site and the low levels of explosive compounds found in the ground water pose no imminent threat to potential receptors at this time.

CERCLA MIY

3.11 LHAAP XX - GROUND SIGNAL TEST AREA

3.11.1 **Site History.** The Ground Signal Test Area is currently used for aerial and on-ground testing of various pyrotechnic, illuminant, and signal devices manufactured at LHAAP. Since late in 1988, the site has also been used for the burn-out of rocket motors in Pershing missiles destroyed in accordance with the INF Treaty.

The site has been used intermittently since April 1963 for aerial and on-ground testing and destruction of a variety of devices, including red phosphorus smoke wedges, infrared flares, illuminating 60 and 81 mm mortar shells, illuminating 40 to 155 mm cartridges, button bombs, and various types of explosive simulators. Prior to the recent rocket motor burn-outs at the site for the INF Treaty, the site was used intermittently over a 20-year period for testing and burn-out of rocket motors from Nike-Hercules, Pershing, and Sargent missiles. About 1970, one of the Sargent rocket motors was inadvertently destroyed when it exploded in an excavated pit near the center of the site just west of the road crossing the site. Debris from the explosion was reportedly placed in the resulting crater and the crater was backfilled.

Historically, the testing and destruction of pyrotechnics and illuminant and signal devices have been almost entirely restricted to an area situated to the east of the aforementioned road. A small area

west of the road near the southwestern boundary of the site was used intermittently during the 1970s for testing the 60 and 81 mm illuminating mortar shells.

With the exception of the Sargent rocket motor which exploded in about 1970, rocket motor testing and burn-outs have apparently been conducted from a stand situated alongside the road near the center of the site. Another rocket motor stand located in the southwestern part of the site near the former Mortar Test Area was constructed a few years ago, but has reportedly never been used.

3.11.2 **Site Description**. The Ground Signal Test Area is in the southeastern portion of LHAAP, as shown on Figure 3-11-1. Access to the site is provided by an asphalt gravel road that intersects Long Point Road just east of its intersection with Avenue Q. The access road proceeds in a general south-southeasterly direction for about 0.4 mile to the center of the site. It then continues for another 0.7 mile to the southern LHAAP boundary.

A detailed current map of the Ground Signal Test Area is provided on Figure 3-11-2. The map depicts detailed topography, general surface water flow directions and surface drainage patterns, estimated ground-water flow direction, locations of previous sampling points, and the approximate limit of the Ground Signal Test Area. Also shown is the access road crossing the site, the circular fire lane and dirt road that forms the site boundary, and limited vegetation information. The site inside the projected point of compliance encompasses an area of approximately 80 acres.

General soil and geologic maps and the boring logs of on-site monitor wells 127 and 128 indicate the site is located on the outcrop of the Wilcox Group of sediments that typically consist of interbedded

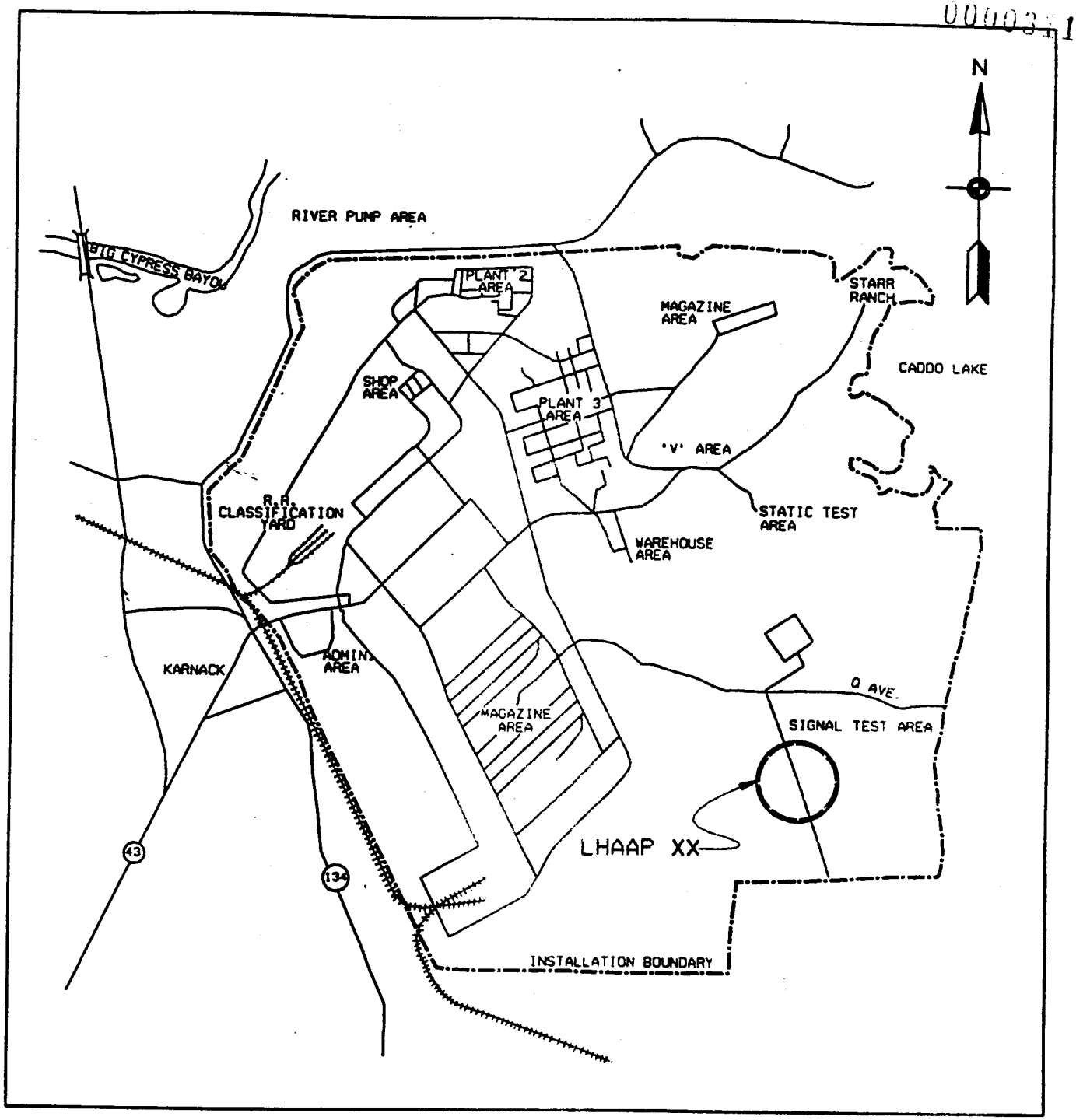


FIGURE 3-11-1 LOCATION MAP FOR LHAAP *XX

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

004907

APPROXIMATE LIMITS OF GROUND SIGNAL TEST AREA

TO HARRISON BAYOU (APPROX. 2000')

TO SAUNDERS BRANCH (APPROX. 1200')

OBSERVATION STATIONS

EARTHEN-WOODEN BUNKER (ABANDONED)

128 173.84

HAND SIGNAL LAUNCHER

0501

0502

0503

CONCRETE BUNKERS (ABANDONED)

ROCKET MOTOR STAND

CLEARING FOR ROCKET MOTOR BLAST

CLEARING FOR LINE-OF-SIGHT OBSERVATION

SAUNDERS BRANCH WATERSHED

HARRISON BAYOU WATERSHED

ROCKET MOTOR BLAST AREA

TO HARRISON BAYOU (APPROX. 1300')

127

FORMER MORTAR TEST AREA (1970'S)

APPROXIMATE DRAINAGE DIVIDE

ROCKET MOTOR STAND (NEVER USED)

LEGEND

- GROUND WATER FLOW DIRECTION
- 0501 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 128 173.84 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- SURFACE WATER FLOW DIRECTION
- POINT OF COMPLIANCE

NOTE: GROUND-WATER ELEVATION NOV 89

00003:2

N

250 0 250 500

SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - XX
GROUND SIGNAL TEST AREA
SITE MAP

DATE: JUNE 1992 | FIGURE 3-11-2

:/ed/drawing/longhorn/xxsite.dgn May. 15. 1992 10:29:34

sands, silts and clays. At this site, these sediments are overlain by a few feet of residually-derived soils consisting of silty to clayey sands.

Approximately 70 percent of the site is located within the watershed of Saunders Branch. The remaining 30 percent lies within the watershed of Harrison Bayou. Both of these streams flow into Caddo Lake. The total surface water flow distance from the site to Caddo Lake via Saunders Branch and its tributaries is about 2.0 miles and via Harrison Bayou and its tributaries is about 2.3 miles. The drainage divide between the Saunders Branch and Harrison Bayou watersheds across the site is indicated on Figure 3-11-2.

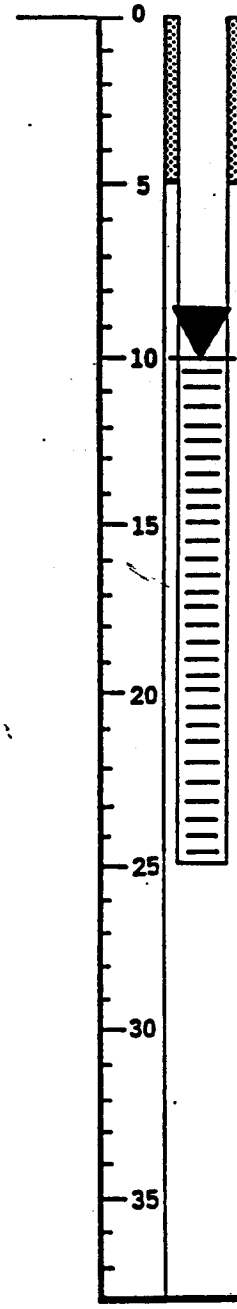
Surface water runoff from the Saunders Branch watershed portion of the site is collected by drainage ditches alongside the circular dirt road forming the outer margin of the site. These ditches converge near Well 128 to form a northeast-trending drainage way that carries the runoff to Saunders Branch. Surface water runoff from the remainder of the site is collected by drainage ditches alongside the circular road or by drainage ways extending into the southwestern part of the site. The drainage ditches and drainage ways converge near Well 127 where they form a drainage way that conveys the runoff onto the floodplain of Harrison Bayou.

Depth to ground water on the site averages about 15 feet with some seasonal fluctuation. The ground-water hydraulic gradient across the site is expected to be normally controlled by the regional flow direction to the north-northeast toward Caddo Lake. During very wet periods when the water table may rise several feet, the hydraulic gradient in the more steeply sloping southwestern part of the site may become topographically controlled and the flow direction in this area

may swing to the northwest toward Harrison Bayou. The ground-water flow directions shown on Figure 3-11-2 are the estimated normal directions during dryer periods.

3.11.3 **Previous Investigations**. The Ground Signal Test Area was included in the "LHAAP Contamination Survey" conducted under contract to USATHAMA by EPS. A report of the survey was published in June 1984 (EPS, 1984). As part of this study, EPS installed monitoring wells 127 and 128 in July 1982 at the locations indicated on Figure 3-11-2. The logs of the borings and construction details for these wells are provided on Figures 3-11-3 and 3-11-4. Well 127 has a screen setting from 10.0 to 25.0 feet. Well 128 has a screen setting from 17.5 to 32.5 feet. Both wells monitor shallow ground water and are approximately 2,030 feet apart. In November 1982, EPS obtained a sample of the ground water in each well and the samples were analyzed for explosive compounds, selected metals (total), and selected anions. In addition, the sample from Well 128 was analyzed for VOCs and SVOCs. Also in November 1982, EPS collected three shallow soil samples at the locations indicated on Figure 3-11-2. These samples were obtained from 1-foot deep holes dug with a shovel and were analyzed for explosives, selected metals (total) and selected anions. A summary of all sample analyses conducted by EPS is provided in Table 3-11-1.

3.11.4 **Assessment of Existing Data and Historic Records**. Results of sample analyses summarized in Table 3-11-1 indicate that concentrations of certain metals and anions in soil and ground-water samples are likely elevated above local background levels. The results also indicate that explosive compounds were below detection limits in all samples and that VOCs and SVOCs were not detected or were below detection limits in the one ground-water sample analyzed



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	3/3 3/3	Silty sand Light yellowish brown and yellowish brown	20	
SC	6/7 7/10	Clayey sand Light brownish grey mottled w/yellowish brown	25	
SM-SC	4/5 7/7	Clayey silty sand 15% silt Light brownish grey w/less mottling of yellowish brown	25	
SM	2/3 3/3	Very silty sand Light brownish grey to	40	
	2/3 3/3	Very silty sand Light brownish grey mottled w/yellowish brown		
SM+SC		Seam of clayey silty sand		
SM	6/16 /20 20/4.5"	Lt. grey silty sand	20	

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

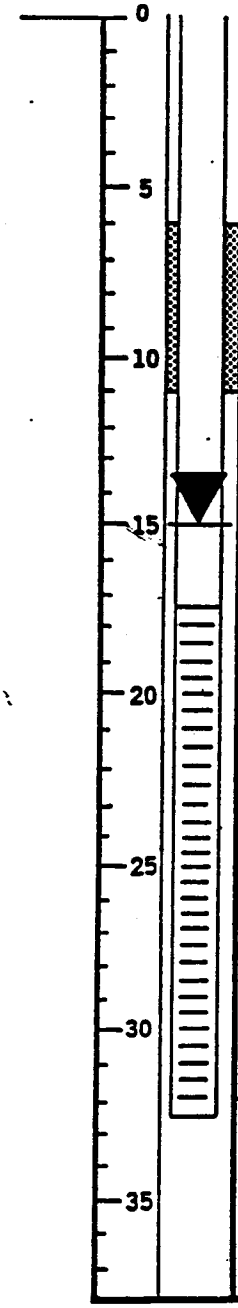
WELL 127 DATE DRILLED 7/9/82
STUDY AREA Ground Signal Test Area
ELEVATION TOP OF STEEL CASING = 188.63 ft
ELEVATION TOP OF PVC RISER = 188.45 ft
ELEVATION OF GROUND SURFACE = 185.58 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-11-3
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 127



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	4/4 4/2	Silty sand Light olive grey mottled w/dark yellowish brown	20	
SM-SC	4/8 10/15	Slightly clayey silty 20% silt sand 10% clay Greyish brown w/yellowish brown	30	
SM-SP	18/22 /20	Sand Light grey	10	
SM+CL	13/15 18/20	Silty sand & clay Light grey & brownish yellow 80% silty sand 20% clay		
CL+SM	6/9 12/16	Clay thinly bedded w/silty sand 80% clay 20% silty sand		
CL+SM	12/18 /25 15/25 20/4'	Thinly bedded clay w/some silty sand seams 90% Black clay 10% Brownish yellow silty sand		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 128 DATE DRILLED 7/9/82
STUDY AREA Ground Signal Test Area
ELEVATION TOP OF STEEL CASING = 192.01 ft
ELEVATION TOP OF PVC RISER = 191.73 ft
ELEVATION OF GROUND SURFACE = 189.05 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-11-4
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 128

0000316

TABLE 3-11-1

LONGHORN ARMY AMMUNITION PLANT
LHAAP XX - GROUND SIGNAL TEST AREA

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.					Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0501	SOIL 0502	SOIL 0503	GW 127	GW 128	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	ug/l	
1,3 - DNB	EXP	0.50	1.68	<	<	<	<	<	Nov 82
2,4 - DNT	EXP	0.50	0.89	<	<	<	<	<	Nov 82
2,6 - DNT	EXP	0.61	1.20	<	<	<	<	<	Nov 82
Nitrobenzene	EXP	1.15	0.76	<	<	<	<	<	Nov 82
1,3,5 - TNB	EXP	0.71	1.08	<	<	<	<	<	Nov 82
2,4,6 - TNT	EXP	0.73	1.46	<	<	<	<	<	Nov 82
Aluminum	MET	0.36	10.	1128.6	1105.5	3.6	36.90	353.00	Nov 82
Antimony	MET	0.76	10.2	<	<	<	<	<	Nov 82
Arsenic	MET	0.3	6.	<	<	<	<	<	Nov 82
Barium	MET	0.99	11.4	227.8	165.8	61.0	46.00	51.50	Nov 82
Beryllium	MET	0.5	10.	<	<	<	<	<	Nov 82
Cadmium	MET	0.5	0.28	<	<	<	9.99	4.69	Nov 82
Chromium	MET	0.6	6.64	8.4	9.2	9.4	11.60	<	Nov 82
Copper	MET	0.5	23.9	3.3	2.7	2.0	<	<	Nov 82
Lead	MET	0.89	7.49	27.6	26.5	26.6	<	<	Nov 82
Manganese	MET	0.25	12.1	742.0	499.5	140.8	1860.00	1088.00	Nov 82
Mercury	MET	2.7	1.3	<	<	<	<	<	Nov 82
Nickel	MET	0.5	30.	4.	5.	4.	157.+	82.+	Nov 82
Selenium	MET	0.5	6.	<	<	<	<	<	Nov 82
Silver	MET	0.5	10.	<	<	<	<	<	Nov 82
Strontium	MET	0.5	25.	9.4	11.8	3.9	3360.00	4120.00	Nov 82
Thallium	MET	3.	50.	<	<	<	140.+	110.+	Nov 82
Zinc	MET	0.5	27.1	6.3	10.1	11.1	<	<	Nov 82
Chloride	ANI	7.	500.	5.	<	<	832000	1000000	Nov 82
Chromate	ANI	5.	500.	<	<	<	<	<	Nov 82
Cyanide	ANI	5.	600.	<	<	<	<	<	Nov 82
Fluoride	ANI	5.	500.	6.	6.	<	1000.00	<	Nov 82
Nitrate	ANI	5.	500.	8.00	7.41	<	<	<	Nov 82
Nitrite	ANI	5.	500.	<	<	<	<	<	Nov 82
Phosphates	ANI	NR	125.	NR	NR	<	<	<	Nov 82
Sulfate	ANI	25.	580.	61.93	28.83	41.04	1622000	559000	Nov 82
Thiocyanate	ANI	10.	500.	<	<	<	<	<	Nov 82
Benzene	VOC	NR	1.	NA	NA	NA	NA	<	Nov 82
Chloroform	VOC	NR	1.	NA	NA	NA	NA	<	Nov 82
Dichloromethane	VOC	NR	10.	NA	NA	NA	NA	ND	Nov 82
Trichloroethene	VOC	NR	1.	NA	NA	NA	NA	ND	Nov 82

TABLE 3-11-1 (Cont.)

LONGHORN ARMY AMMUNITION PLANT
LHAAP XX - GROUND SIGNAL TEST AREA

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.					Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0501	SOIL 0502	SOIL 0503	GW 127	GW 128	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	ug/l	
o-Chlorophenol	SVOC	NR	10.	NA	NA	NA	NA	<	Nov 82
Dibutyl phthalate	SVOC	NR	10.	NA	NA	NA	NA	<	Nov 82
2,4 - Dichlorophenol	SVOC	1.	1.	NA	NA	NA	NA	<	Nov 82
Diethyl phthalate	SVOC	1.	2.	NA	NA	NA	NA	<	Nov 82
2 - (1,1 - Dimethyl-ethoxy) - ethanol	SVOC	NR	10.	NA	NA	NA	NA	ND	Nov 82
Nitrobenzene	SVOC	0.6	1.	NA	NA	NA	NA	<	Nov 82
Pentachlorophenol	SVOC	1.	2.	NA	NA	NA	NA	<	Nov 82
Tetrahydrofuran	SVOC	NR	10.	NA	NA	NA	NA	ND	Nov 82

ANALYTE ABBREVIATIONS :

ANI	Anion
DNB	Dinitrobenzene
DNT	Dinitrotoluene
EXP	Explosive
MET	Metal
PCB	Polychlorinated Biphynyl
PES	Pesticide
SVOC	Semivolatile Organic Compound
TNB	Trinitrobenzene
TNT	Trinitrotoluene
VOC	Volatile Organic Compound

OTHER ABBREVIATIONS :

<	Below Detection Limit
GW	Ground Water
NA	Not Analyzed
ND	Not Detected. Detection limit not known.
NR	No Record

SOURCE OF DATA : "LHAAP CONTAMINATION SURVEY", Environmental Protection Systems, Inc., June 1984

for these compounds.

In the shallow soil samples, concentrations of barium, lead, manganese, zinc and sulfate appear to be elevated above likely background levels. Aluminum, strontium, and nitrate concentrations are likely elevated in soil samples 0501 and 0502. The highest concentrations of aluminum, barium, lead, manganese, nitrate, and sulfate were found in soil sample 0501, with aluminum and manganese notably elevated. This soil sample was collected close to the rocket motor testing blast area, as shown on Figure 3-11-2. Aluminum concentration was also notably elevated and strontium was at its highest level in soil sample 0502. Zinc concentration was highest in soil sample 0503. Soil samples 0502 and 0503 were collected in the area where aerial and on-ground testing and destruction of non-rocket items have been concentrated during the past 28 years.

In the ground-water samples from Wells 127 and 128, concentrations of barium, cadmium, manganese, nickel, strontium, and thallium are likely elevated above local background levels. In addition, the aluminum concentration in the Well 128 sample and the chromium concentration in the Well 127 sample also appear to be elevated. The pattern of metals contamination in each of the well samples is somewhat different, and this may be due to the well's positioning with respect to past activities on the site. The aluminum concentration was almost 10 times higher in the Well 128 sample than in the Well 127 sample, while the concentrations of cadmium and chromium were considerably higher in the Well 127 sample. Well 128 is located hydraulically downgradient from much of the eastern portion of the site where the majority of aerial and on-ground testing and destruction of non-rocket items have occurred. These activities

possibly produced the metals concentrations observed in Well 128. Well 127 is located very near the Mortar Test Area used during the 1970's. Metals concentrations observed in this well may be related to the testing of the illuminating mortar shells.

Chloride and sulfate concentrations were notably high in samples from the two wells on this site and are substantially higher than the TWC recommended maximum levels for public water systems of 300 mg/l chloride and 300 mg/l sulfate. The high chloride and sulfate concentrations at this site are likely a local background phenomenon as found in some of the background wells along the LHAAP boundary.

Elevated concentrations of metals and anions found in samples from this site may be the result of the aerial and on-ground testing and destruction of various devices and the burn-out of rocket motors at the site. There do not appear to be any other waste disposal sites that could have contributed to this contamination.

Existing data are not adequate to firmly establish many of the site's characteristics, including the nature and quantities of contaminating metals and anions in the unsaturated zone and ground water, the nature of the surficial soils and the underlying Wilcox Group sediments, the depth to ground water and the direction of ground-water flow.

The history of past rocket motor activities at the site is not fully known. Additional knowledge of probable operations was gained by careful study of aerial photographs of the site taken in May 1954, April 1963, January 1970, December 1978, and February 1985.

3.11.5 **Potential Contaminants and Migration Pathways**. The primary sources of potential contamination at this site are the burn residues and non-burned fragments of various pyrotechnic and

illuminant and signal devices that have been tested and destroyed on the site, and the residues from burn-out of rocket motors on the site. Elevated concentrations of certain metals and anions have been found in the soils and ground water at this site and are believed to be chief contaminants produced by the aforementioned residues and fragments. There is no evidence of contamination by explosive compounds, VOCs, or SVOCs. Potential migration pathways for the metal and anion contaminants identified are described below.

3.11.5.1 **Surface Water**. Rainfall runoff from surficial soils on the site could pick up contaminants and transport them to collection ditches and drainageways. The ditches and drainageways would then convey the contaminated surface water into Saunders Branch or Harrison Bayou and then into Caddo Lake.

3.11.5.2 **Sediments**. Erosion of contaminated surficial soils during heavy rainfall could produce contaminated sediment that would be carried downstream. Based on field observations, most of this sediment would be deposited within downstream channels and floodplains of Saunders Branch or Harrison Bayou and would not reach Caddo Lake. After deposition, the sediment could be further contaminated by precipitation of contaminants from surface water, especially where the water collects in potholes or swales.

3.11.5.4 **Ground Water**. Ground water in Wells 127 and 128 shows some evidence of contamination, demonstrating that ground water is an important pathway for contaminant migration at this site. The relative shallowness of the water table and its seasonal fluctuation elevates its importance as a pathway. During wet periods when the water table may rise to intercept drainageways downgradient from the site, contaminated ground water could discharge to surface drainage

3.11.5.5 **Air**. The site is currently well protected from wind erosion by vegetation. Air could become a contaminant migration if the vegetative cover was removed or contaminated soils exposed.

3.11.6 **Identification of Potential Receptors**. The general public does not have ready access to the site because it is located within the confines of LHAAP. Access is further restricted when the site is being used for signal devices or rocket motor activities.

There are no public water supply wells located in the directions of expected ground water flow from the site and none are expected to be installed. Ground water normally flows from the site in a north-northeasterly direction toward Caddo Lake. During very wet periods, ground-water flow direction in the more steeply sloping southwestern part of the site may be more topographically controlled with flow locally diverted to the northwest toward Harrison Bayou. The nearest public water supply well, Well 902, is approximately 2.3 miles west-southwest of, and hydraulically upgradient from, the site. A potential threat to public health and safety posed by contaminated ground water originating at this site is its possible emergence into the surface water flow regime of Saunders Branch and its tributaries and, during very wet periods, into the surface water flow regime of Harrison Bayou.

There is no substantial amount of accelerated soil erosion on the site. Part of the rocket motor testing blast area shown on Figure 3-11-2 is devoid of vegetation, but the area is nearly level and does not appear to be eroding excessively. There are minor amounts of accelerated erosion in the ditches alongside the dirt road that encircles the site. The ditch erosion is most pronounced in the more steeply sloping southwestern part of the site where there are also

some small, sparsely vegetated areas being subjected to accelerated soil erosion. There are no activities planned that increase future soil erosion and sediment yield.

There are no major watercourses or water bodies on the site and none are expected to be created. Most of the surface water runoff and part of the water-borne sediment derived from this site enters Caddo Lake via Saunders Branch or Harrison Bayou. Caddo Lake is used as a water supply for approximately 16,600 Louisiana residents. The flow distance from the site to Caddo Lake is at least 2.0 miles. Caddo Lake is not known to have been affected by contaminants originating at this site.

Except for the entrance area on the northeast side, the site is surrounded by a relatively thick woodland predominated by pines with a few oaks. The woodland projects into parts of the southeastern and northeastern portions of the site and covers much of the western one-third of the site. Trees on the site are mostly pines and sweet gums with a few oaks. The remainder of the site is vegetated by grasses. The only obvious sign of plant stress is within the rocket motor testing blast area shown on Figure 3-11-2. In this area, the ground is bare close to the rocket motor stand. Further to the west-southwest in the direct path of blasts are several dead or stressed trees.

3.11.7 Initial Remedial Action. Based upon what is known about the site and the nature and extent of its contaminants, quick remedial action is not deemed necessary. The elevated levels of certain metals and anions fund in soils and ground water on the site pose no imminent threat to potential receptors at this time.

NPL only

004919

0000324

3.12 LHAAP 27 - SOUTH TEST AREA

3.12.1 Site History. The South Test Area was constructed in 1954 and was used by Universal Match Corporation for testing photoflash bombs that were produced at LHAAP until about 1956. The bombs were tested by exploding them in the air over an elevated, semi-elliptical earthen Test Pad within the floodplain of Harrison Bayou. Testing was observed and controlled from a building on a hilltop 1,000 feet west-northwest of the test pad. Bombs awaiting testing were apparently stored in three earth-covered concrete bunkers a few hundred feet west of the Observation Building. The bombs tested were 150-pound M120/M120A photoflash bombs filled with photoflash powder and containing a black powder booster charge for bursting the bomb and a timed nose fuse. A small reinforced concrete building with blast shield once used for temporary storage of these bombs as they were awaiting testing has been removed from its original location on the test pad and now sits in the floodplain east of the site.

During the late 1950s, illuminating (signal) devices were demilitarized within pits excavated in the vicinity of the Test Pad. During the early 1960s, leaking production items (possibly 3- to 4-pound canisters of white phosphorus) were demilitarized in the vicinity of the Test Pad. In the early 1980s, approximately 52,000 1/2- and 1-pound photoflash cartridges were demilitarized in a 500-square foot area situated about 300 feet east of the Observation Building and immediately north of the road running from the Observation Building to the Test Pad.

Aerial photographs taken in April 1954 when the South Test Area was under construction indicate an area of apparent vegetation distress centered about 400 feet south-southeast of the center of the

Test Pad. The vegetation distress has persisted for over 37 years.

Approximately 100 feet northwest of this patch of distressed vegetation are eight empty 30-gallon steel drums of unknown age or origin. The area immediately around the drums is essentially devoid of vegetation which may be indicative of waste disposal or drum leakage.

The South Test Area has apparently not been used since the early 1980s. Vegetation has encroached on many of the formerly cleared areas in the vicinity of the Test Pad and alongside the access road.

3.12.2 **Site Description**. The South Test Area is in the south central portion of LHAAP, as shown on Figure 3-12-1. The earthen test pad is approximately 2,000 feet southeast of Avenue P and the Magazine Area. The entrance to the Test Area is on Avenue P about 1,700 feet northeast of its intersection with Avenue E. A deteriorated asphalt and gravel road runs from the entrance to the Test Pad. The concrete bunkers and Observation Building described in Para. 3.12.1 are situated alongside the road about halfway between the entrance and the Test Pad. A circular, 50-foot wide fire lane with a 2,000-foot diameter is centered at the Test Pad. The fire lane was constructed in 1954 and was apparently maintained until the early 1960s. It is now partially overgrown with brush and small trees.

A detailed current map of the Test Pad and contiguous areas where explosives appear to have been demilitarized or where toxic wastes may have been disposed is provided on Figure 3-12-2. The map depicts detailed topography, general surface water flow directions, estimated ground-water flow directions, location of previous sampling points, and the approximate limit of the site for RI/FS Work Plan purposes. The site boundary is based on a study of historical aerial

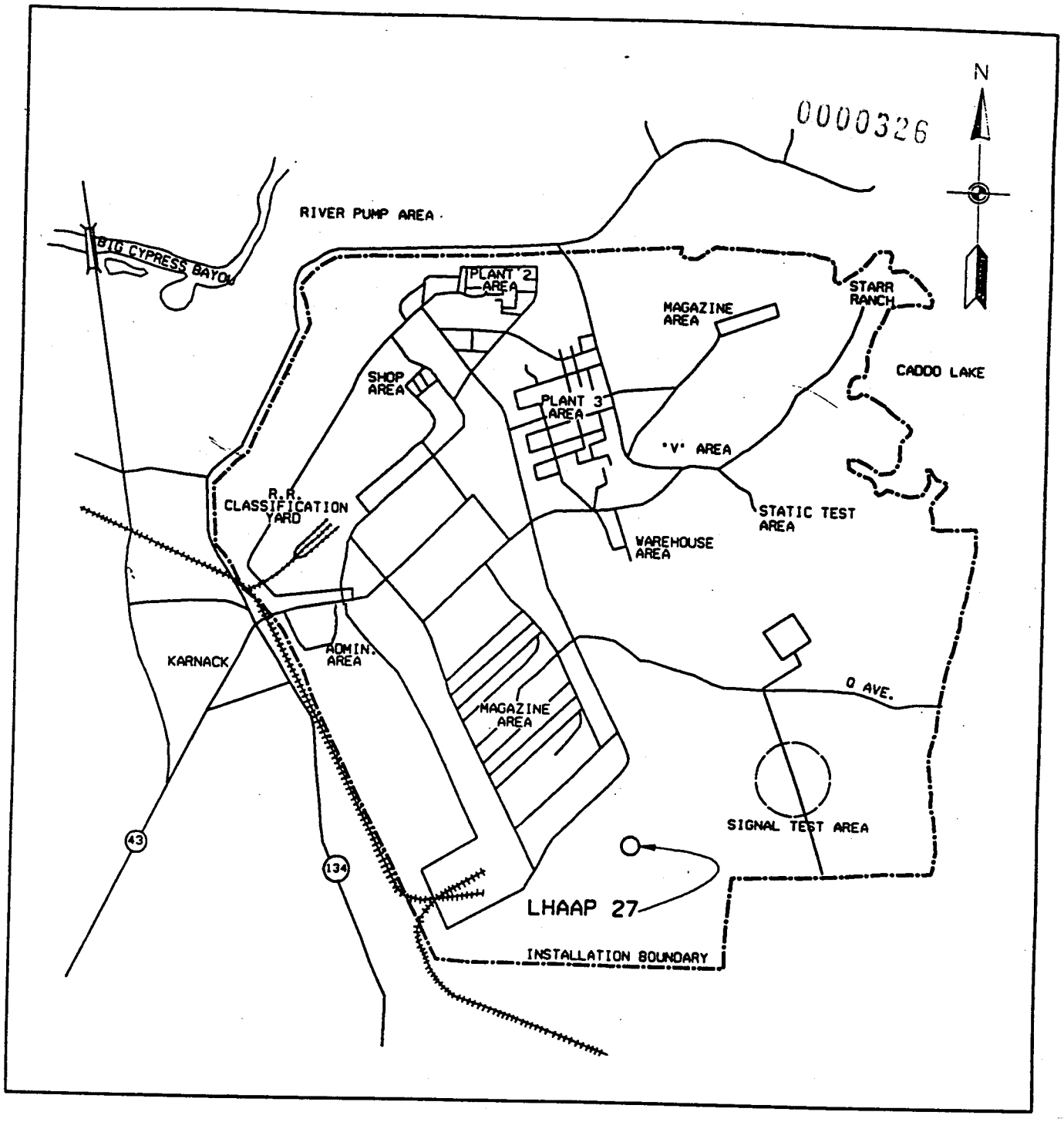


FIGURE 3-12-1 LOCATION MAP FOR LHAAP #27

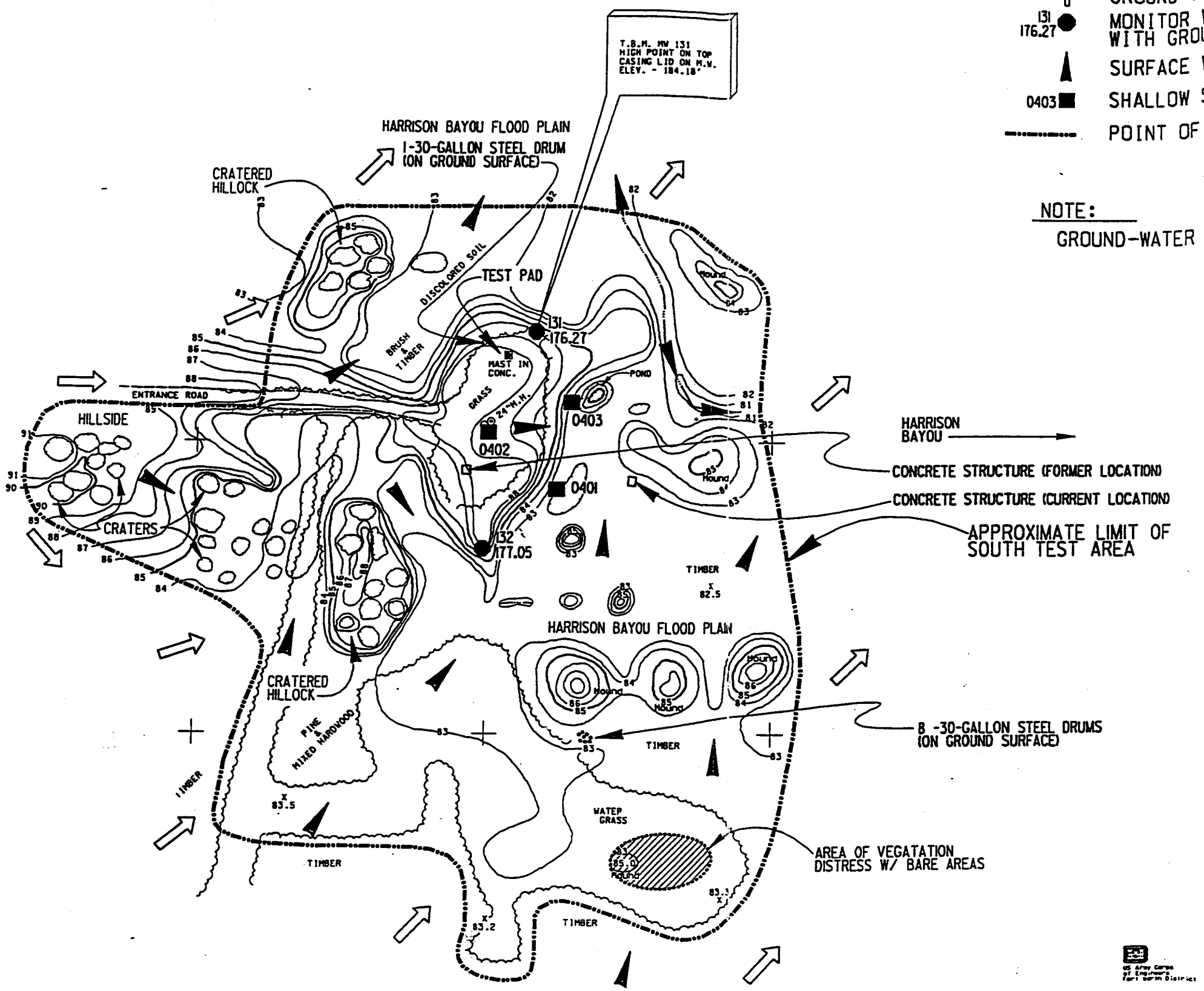
US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

LEGEND

- GROUND WATER FLOW DIRECTION
- 131 / 176.27 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- SURFACE WATER FLOW DIRECTION
- 0403 — SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- ---------- POINT OF COMPLIANCE

NOTE:

GROUND-WATER ELEVATION NOV 89.



N

50 0 50 100

SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 27
SOUTH TEST AREA
SITE MAP

DATE: JUNE 1992 | FIGURE 3-12-2

:/ed/drawing/longhorn/27site.dgn May. 15, 1992 10:57:50

photographs, current vegetation patterns, and field observations. The site covers an area of approximately 6.6 acres.

General soil and geologic maps and the boring logs for on-site monitor wells 131 and 132 indicate that most of the site is situated on Recent alluvium deposited in the floodplain of nearby Harrison Bayou. These alluvial deposits consist of silty to very silty sands that extend to a depth of about 18 feet below the natural flatter portions of the floodplain surface. Small earthen mounds that project 3 to 5 feet above the floodplain surface in the eastern part of the site (see Figure 3-12-1) are thought to be natural features resulting from accumulation of sediment and vegetation debris on natural obstructions to flow such as fallen trees. Such mounds are sometimes erroneously identified as "Indian mounds" (or "middens").

General soil and geologic maps indicate that the more steeply-sloping western portion of the site is located on the outcrop of the Wilcox Group of sediments that typically consist of interbedded sands, silts, and clays. The Wilcox materials on the western hillside are likely mantled by a few feet of residually-derived soils or by terrace deposits. The Wilcox sediments also extend beneath the Recent floodplain alluvium found across the remainder of the site and probably comprise the lowermost 3 feet of material encountered in the boring for monitor well 132.

The Test Pad and its access road within the site are elevated up to 6 feet above the surrounding floodplain of Harrison Bayou. Based upon 1954 aerial photographs, the building-up of the Test Pad and road bed was accomplished by importation of fill material derived from excavation of drainage ditches alongside the access road and concrete bunkers to the west of the site. It is possible that one or more of

the natural floodplain mounds described previously may have been incorporated into the Test Pad. The upstream (southwestern and southeastern) margins of the Test Pad appear to have been eroded by flood waters over the 37 years since its construction. An elevated protrubance from the northeastern margin of the Test Pad appears to be fill material imported sometime after 1970, based on study of aerial photographs.

The origin of the cratered hillocks to the southwest and northwest of the Test Pad (see Figure 3-12-2) is uncertain. Based on study of 1954 and 1963 aerial photographs, it appears that the hillocks may be remnants of excess fill material from the 1954 construction activities. The hillocks have obviously been used for testing or demilitarizing explosive devices as evidenced by the presence of numerous small craters. There are similar cratered areas to the west of the southwestern hillock. Judging by the size of trees growing within the cratered areas, the craters are over 25 years old.

Depth to ground water in the more steeply-sloping western portion of the site likely exceeds 5 feet and the depth is expected to fluctuate seasonally. The ground-water hydraulic gradient in this hillside portion of the site is expected to be topographically controlled with a general flow direction to the east toward the floodplain of Harrison Bayou. Surface water runoff from the hillside flows generally to the southeast and onto the floodplain.

Based on data from the two monitor wells, the depth to ground water below the flatter portions of floodplain surface averages about 4 feet with pronounced seasonal fluctuations. During the cool wet winters and spring when the floodplain is frequently flooded, the water table is at or near the ground surface. The ground water

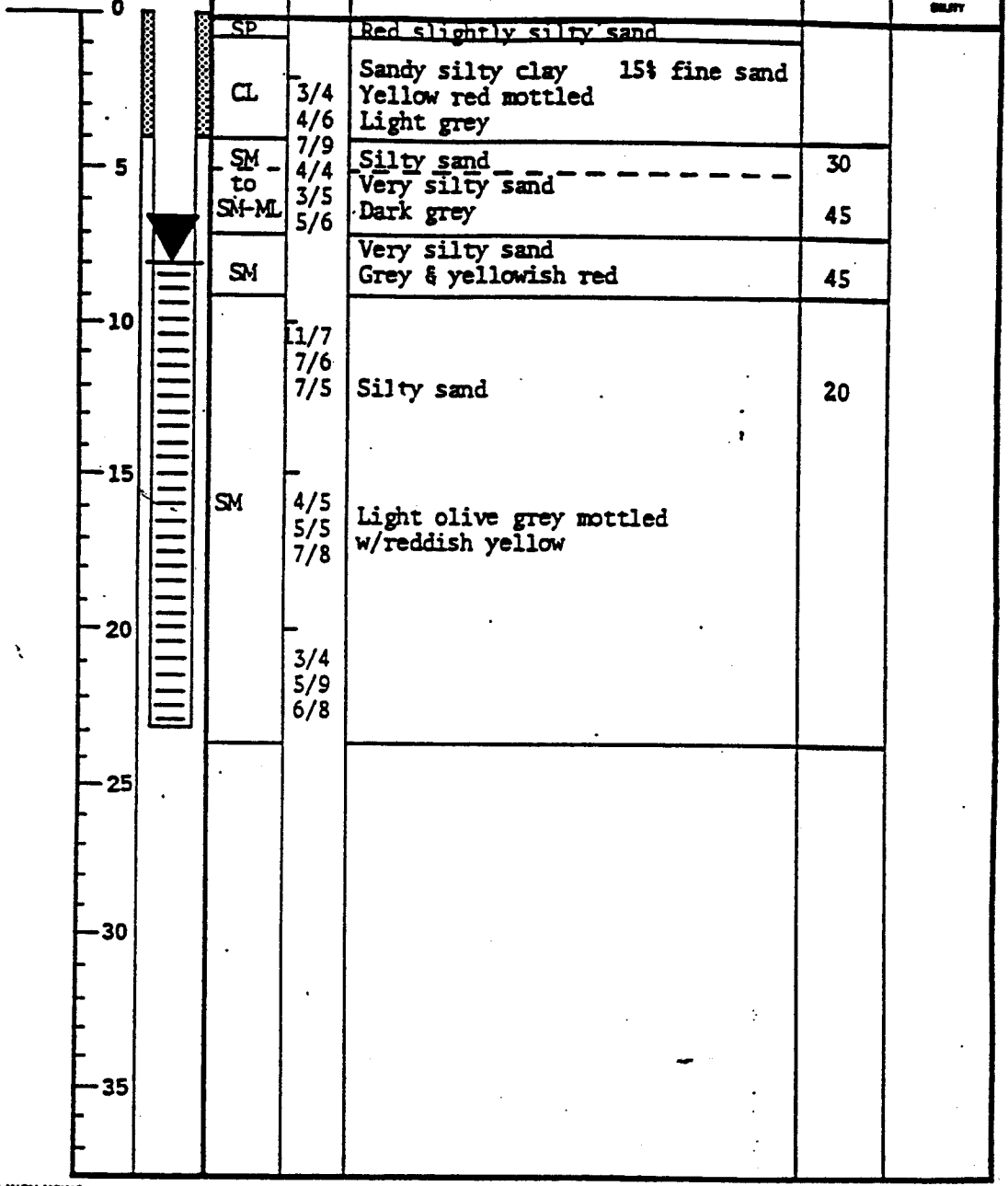
hydraulic gradient in the floodplain may be locally controlled by the overall gently sloping floodplain surface. The general ground-water flow direction in the floodplain is to the northeast toward Caddo Lake.

All surface water runoff from the site eventually enters Caddo Lake via Harrison Bayou. The total flow distance to Caddo Lake is about 2.5 miles.

3.12.3 **Previous Investigations**. This site was investigated by EPS for USATHAMA, and a report of the survey was published in June 1984 (EPS, 1984). In June 1982, EPS installed monitoring wells 131 and 132 at the locations indicated on Figure 3-12-2. The logs of the borings and construction details for these wells are provided on Figures 3-12-3 and 3-12-4. Well 131 has a screen setting from 8.0 to 23.0 feet. Well 132 has a screen setting from 9.2 to 24.2 feet. Both wells monitor shallow ground water. Based on static water levels determined at the time of installation and in November 1989, Well 131 is hydraulically downgradient from Well 132. In November 1982, EPS obtained a sample of the ground water in each well and the samples were analyzed for explosive compounds, selected metals (total), and selected anions. The sample from Well 131 was also analyzed for PCBs, pesticides, and VOCs, and SVOCs.

Also in November 1982, EPS collected three shallow soil samples at the locations indicated on Figure 3-12-2. These samples were obtained from 1-foot deep holes dug with a shovel and were analyzed for explosives, selected metals (total), and selected anions. A summary of all sample analyses conducted by EPS is provided in Table 3-12-1.

3.12.4 **Assessment of Existing Data and Historic Records**.



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SP		Red slightly silty sand		
CL	3/4 4/6 7/9	Sandy silty clay 15% fine sand Yellow red mottled Light grey		
SM to SM-ML	4/4 3/5 5/6	Silty sand Very silty sand Dark grey	30 45	
SM		Very silty sand Grey & yellowish red	45	
SM	11/7 7/6 7/5	Silty sand	20	
	4/5 5/5 7/8	Light olive grey mottled w/reddish yellow		
	3/4 5/9 6/8			

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 131 DATE DRILLED 6/8/82
STUDY AREA South Test Area

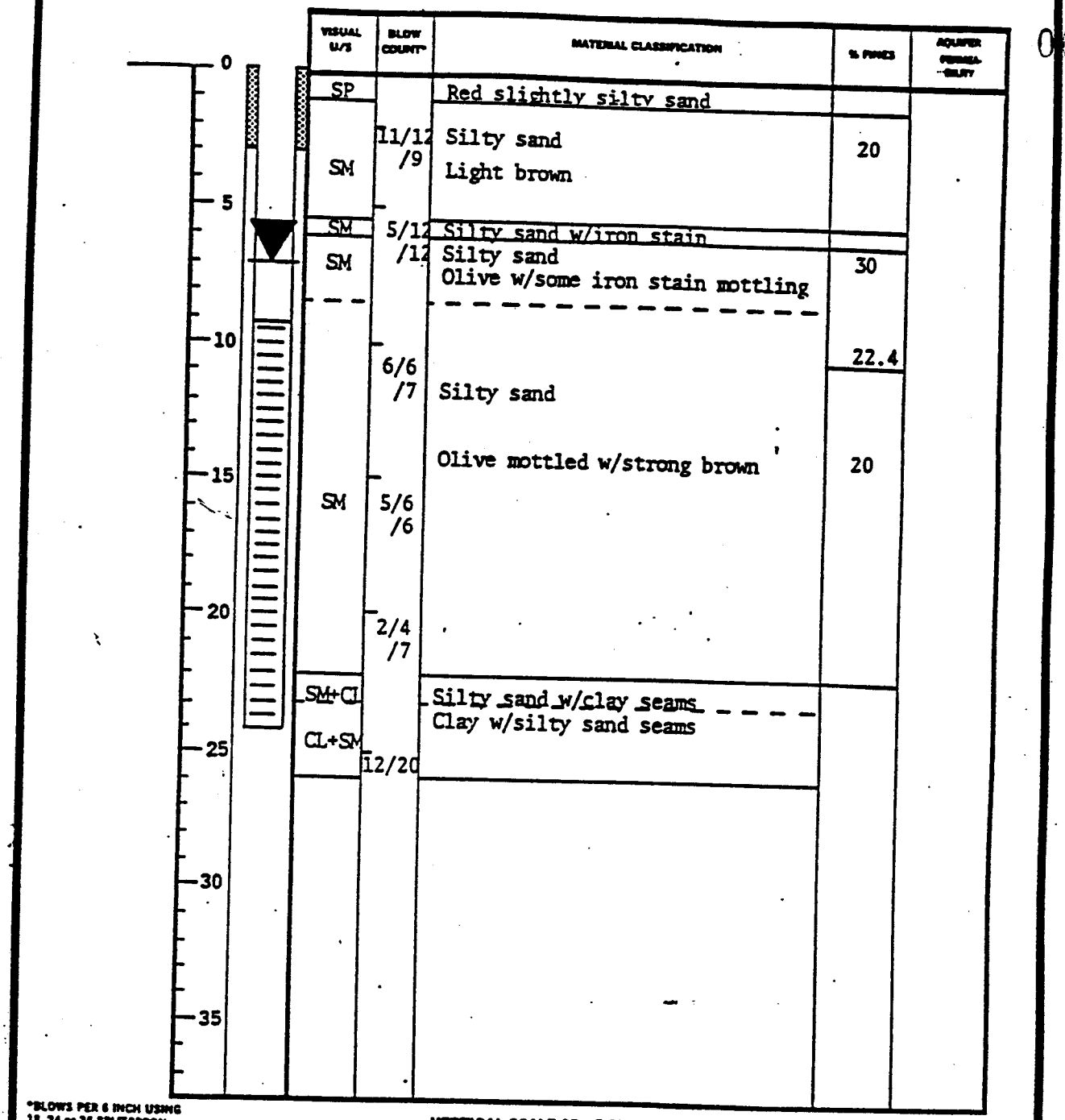
ELEVATION TOP OF STEEL CASING = 189.16 ft
ELEVATION TOP OF PVC RISER = 188.87 ft
ELEVATION OF GROUND SURFACE = 186.31 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-12-3
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 131



WELL 132 DATE DRILLED 6/9/82
STUDY AREA South Test Area

ELEVATION TOP OF STEEL CASING = 188.34 ft
ELEVATION TOP OF PVC RISER = 188.01 ft
ELEVATION OF GROUND SURFACE = 185.51 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

FIGURE 3-12-4
BORING LOG AND WELL CONSTRUCTION DETAIL FOR MONITORING WELL NO. 132

0000332

TABLE 3-12-1

004928

LONGHORN ARMY AMMUNITION PLANT
LHAAP 27 - SOUTH TEST AREA

0000333

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.					Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0401	SOIL 0402	SOIL 0403	GW 131	GW 132	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	ug/l	
1,3 - DNB	EXP	0.50	1.68	<	<	<	<	<	Nov 82
2,4 - DNT	EXP	0.50	0.89	<	<	<	<	<	Nov 82
2,6 - DNT	EXP	0.61	1.20	<	<	<	<	<	Nov 82
Nitrobenzene	EXP	1.15	0.76	<	<	<	<	<	Nov 82
1,3,5 - TNB	EXP	0.71	1.08	<	<	<	<	<	Nov 82
2,4,6 - TNT	EXP	0.73	1.46	10.15	4.61	<	<	<	Nov 82
Aluminum	MET	0.36	10.	1099.8	1386.4	1426.1	222.00	232.00	Nov 82
Antimony	MET	0.76	10.2	<	<	<	<	<	Nov 82
Arsenic	MET	0.3	6.	<	<	<	<	<	Nov 82
Barium	MET	0.99	11.4	87.0	136.6	57.2	47.80	53.40	Nov 82
Beryllium	MET	0.5	10.	<	<	<	<	<	Nov 82
Cadmium	MET	0.5	0.28	<	<	<	0.93	9.24	Nov 82
Chromium	MET	0.6	6.64	16.3	12.3	10.3	<	14.50	Nov 82
Copper	MET	0.5	23.9	2.7	41.1	2.8	<	<	Nov 82
Lead	MET	0.89	7.49	25.5	26.3	24.6	<	16.30	Nov 82
Manganese	MET	0.25	12.1	90.0	199.2	137.5	<	1448.00	Nov 82
Mercury	MET	2.7	1.3	<	<	<	<	<	Nov 82
Nickel	MET	0.5	30.	1.	4.	2.2	53.+	102.+	Nov 82
Selenium	MET	0.5	6.	<	<	<	<	<	Nov 82
Silver	MET	0.5	10.	<	<	<	<	<	Nov 82
Strontium	MET	0.5	25.	5.0	9.0	4.3	1340.00	2640.00	Nov 82
Thallium	MET	3.	50.	<	<	<	80.+	100.+	Nov 82
Zinc	MET	0.5	27.1	8.1	17.4	9.2	<	<	Nov 82
Chloride	ANI	7.	500.	<	<	<	27850000	10330000	Nov 82
Chromate	ANI	5.	500.	<	<	<	<	<	Nov 82
Cyanide	ANI	5.	600.	<	<	<	<	<	Nov 82
Fluoride	ANI	5.	500.	6.	5.	6.	1000.	1000.	Nov 82
Nitrate	ANI	5.	500.	15.8	22.3	9.96	<	<	Nov 82
Nitrite	ANI	5.	250.	<	<	<	<	<	Nov 82
Phosphates	ANI	NR	125.	NR	NR	NR	<	<	Nov 82
Sulfate	ANI	25.	580.	38.2	37.5	33.25	216600	337000	Nov 82
Thiocyanate	ANI	10.	500.	<	<	<	<	<	Nov 82
Aroclor - 1016	PCB	0.6	0.6	NA	NA	NA	ND	NA	Nov 82
Aroclor - 1260	PCB	0.7	1.	NA	NA	NA	ND	NA	Nov 82
alpha-BHC	PES	0.05	0.09	NA	NA	NA	ND	NA	Nov 82
p,p'-DDT	PES	0.09	0.05	NA	NA	NA	ND	NA	Nov 82
Dieldrin	PES	0.05	0.09	NA	NA	NA	ND	NA	Nov 82

TABLE 3-12-1 (Cont.)

LONGHORN ARMY AMMUNITION PLANT
LHAAP 27 - SOUTH TEST AREA

SUMMARY OF SAMPLE ANALYSES

ANALYTE				SAMPLE TYPE & LOCATION NO.					Date of Sampling
NAME	TYPE	DETECTION LIMIT		SOIL 0401	SOIL 0402	SOIL 0403	GW 131	GW 132	
		ug/g	ug/l	ug/g	ug/g	ug/g	ug/l	ug/l	
Heptachlor	PES	0.05	0.05	NA	NA	NA	ND	NA	Nov 82
Lindane	PES	0.05	0.09	NA	NA	NA	ND	NA	Nov 82
Toxaphene	PES	4.	4.	NA	NA	NA	ND	NA	Nov 82
Benzene	VOC	NR	1.	NA	NA	NA	<	NA	Nov 82
1,1' - Bicyclohexyl	VOC	NR	10.	NA	NA	NA	<	NA	Nov 82
Chloroform	VOC	NR	1.	NA	NA	NA	<	NA	Nov 82
Dichloromethane	VOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
Pentane	VOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
Trichloroethane	VOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
Trichloroethene	VOC	NR	1.	NA	NA	NA	ND	NA	Nov 82
Trichloromethane	VOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
1-Bromo-2-meth-oxycyclopentane	SVOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
o-Chlorophenol	SVOC	NR	10.	NA	NA	NA	<	NA	Nov 82
Dibutyl phthalate	SVOC	NR	10.	NA	NA	NA	<	NA	Nov 82
Di-n-butyl phthalate	SVOC	0.7	2.	NA	NA	NA	ND	NA	Nov 82
2,4 - Dichlorophenol	SVOC	1.	1.	NA	NA	NA	<	NA	Nov 82
Diethyl phthalate	SVOC	1.	2.	NA	NA	NA	52.	NA	Nov 82
2 - (1,1 - Dimethyl-ethoxy) - ethanol	SVOC	NR	10.	NA	NA	NA	24.	NA	Nov 82
Glycine, N-acetyl-N-(TFA)-methylester	SVOC	NR	10.	NA	NA	NA	ND	NA	Nov 82
Nitrobenzene	SVOC	0.6	1.	NA	NA	NA	<	NA	Nov 82
Pentachlorophenol	SVOC	1.	2.	NA	NA	NA	<	NA	Nov 82

ANALYTE ABBREVIATIONS :

ANI	Anion
DNB	Dinitrobenzene
DNT	Dinitrotoluene
EXP	Explosive
MET	Metal
PCB	Polychlorinated Biphynyl
PES	Pesticide
SVOC	Semivolatile Organic Compound
TFA	Trifluoroacetyl
TNB	Trinitrobenzene
TNT	Trinitrotoluene
VOC	Volatile Organic Compound

OTHER ABBREVIATIONS :

<	Below Detection Limit
GW	Ground Water
NA	Not Analyzed
ND	Not Detected. Detection limit not known.
NR	No Record

SOURCE OF DATA : "LHAAP CONTAMINATION SURVEY", Environmental Protection Systems, Inc., June 1984.

Results of sample analyses summarized in Table 3-12-1 indicate that in the shallow soil samples, concentrations of aluminum, barium, chromium, lead, manganese, zinc, nitrate, and sulfate are likely elevated above local background levels. Overall, concentrations of metals and anions are highest in soil sample 0402, and this may be due to its location almost directly beneath the photoflash bomb detonations that occurred during the 1950's (see Para. 3.12.1). Results of analyses also indicate very low levels of 2,4,6-TNT contamination in soil samples 0401 and 0402. The origin of the TNT is uncertain because the M120/M120A photoflash bomb specifications do not list TNT as an ingredient.

Concentrations of explosive compounds, including 2,4,6-TNT, were below detection limits in the ground-water samples. In the ground-water sample from Well 132, concentrations of aluminum, barium, cadmium, chromium, lead, manganese, nickel, strontium, thallium, and chloride are likely elevated above local background levels, and concentrations of manganese and chloride are notably elevated at 1.448 mg/l and 10,330 mg/l, respectively.

In the ground-water sample from Well 131, concentrations of aluminum, barium, nickel, strontium, thallium, and chloride are likely elevated above local background levels. Also found were traces of two SVOCs. As in the sample from Well 132, the concentration of chloride in ground water sampled from Well 131 is notably elevated, but the concentration of manganese was below detection limit. The sources for elevated metals found in the ground water at this site may be the metallic photo flash powder and various metal components of the M120/M120A bombs exploded in the air over the site and the metallic powder and metal parts of the illuminating devices demilitarized on

the site. The sources of the elevated chloride concentrations cannot be determined.

Existing subsurface data are inadequate to firmly establish characteristics of the entire site because the subsurface data are restricted to the Test Pad and its eastern margin. The history of use of the site for bomb testing, demilitarization of explosive devices, and possible disposal of other types of wastes is mostly anecdotal and conjectural.

3.12.5 **Potential Contaminants and Migration Pathways**. The primary sources of potential contamination at this site are the various components of the photoflash bombs, the illuminating devices, and other explosives that have been exploded and burned at the site. This would include metals comprising the ignitable powders in the photoflash bombs illuminating devices; metals comprising the casings, containers, and other parts of the bombs, illuminating devices, and other explosives; and explosive residues from fuses and booster charges in the bombs and illuminating devices. A possible source of potential contamination is the suspected dumping of wastes in a cleared area to the south and southeast of the Test Pad. Based upon study of historical aerial photographs and judging by the still existing vegetation distress in parts of this area, dumping of liquid wastes is suspected. Such dumping may have occurred as early as 1954 during construction of the South Test Area. As described in Para. 3.12.4, elevated concentrations of certain metals and anions and traces of TNT and SVOCs have been found in the soils and ground water at this site. The potential migration pathways for these contaminants are described below

3.12.5.1 **Surface Water**. Rainfall runoff from, or flood water

flowing over, surficial soils and fill materials on the site could pick up contaminants and transport them down the Harrison Bayou floodplain into Caddo Lake.

3.12.5.2 **Sediment**. Erosion of contaminated soils and fill material during heavy rainfall or by flowing flood water could produce contaminated sediment that would be carried downstream. Most of this sediment would be deposited within the floodplain or channel of Harrison Bayou and would not reach Caddo Lake. Also, sediments in the floodplain or channel could be further contaminated by precipitation of contaminants from surface water, especially where the water collects in potholes and swales.

3.12.5.3 **Soil**. Water percolating downward through contaminated soil materials may leach contaminants and carry them into underlying soils where they could eventually reach the ground water table.

3.12.5.4 **Ground Water**. Ground water in Wells 131 and 132 shows some evidence of contamination, demonstrating that ground water is an important pathway for contaminant migration at this site. The relative shallowness of the water table and its seasonal fluctuation elevates its importance as a pathway. During wet periods when the water table rises to intercept the nearby channel of Harrison Bayou, contaminated ground water could be discharged to surface water flow.

3.12.5.5 **Air**. The site is currently well protected from wind erosion by vegetation. Air could become a contaminant migration pathway if the vegetative cover was removed and contaminated soils were disturbed.

3.12.6 **Identification of Potential Receptors**. The general

public does not have ready access to the site because it is located within the confines of LHAAP. Also, installation personnel and authorized visitors do not have ready access to the site because its one access road is secured by a locked gated. The site is seldom visited and is not being used for anything but occasional hunting.

There are no public water supply wells located in the direction of expected ground-water flow from the site and none are expected to be installed. Ground-water flows from the site in a general northeasterly direction toward Caddo Lake. The nearest public water supply well, Well 902, is approximately 1.6 miles west of, and hydraulically upgradient from, the site. A potential threat to public health and safety posed by contaminated ground water originating at this site appears to be its possible emergence into the surface water flow regime of Harrison Bayou.

There is no accelerated soil erosion on the site and no activities are planned that would increase future soil erosion and sediment yield. Most of the site is situated in the floodplain of Harrison Bayou and the lower-lying, flatter areas are subject to frequent inundation by flood water. The channel of Harrison Bayou is located several hundred feet east of the site. The adjacent floodplain lands that receive the surface water runoff from the site are marked by numerous small depressions and swales that retain water for varying lengths of time following excessive rainfall and flood events. There are a few of these depressions and swales in the floodplain portion of the site. One of the deeper depressions near the eastern margin of the Test Pad apparently ponds water for long periods (see Figure 3-12-2). Improved drainage ways are not expected to be constructed across the site and there are no plans to use

surface water at the site.

Surface water runoff and water-borne sediment derived from the site eventually enter Caddo Lake which is used as a water supply for approximately 16,600 Louisiana residents. The flow distance from the site to Caddo Lake is about 2.5 miles. Caddo Lake is not known to have been affected by contaminants originating at this site.

Aerial photographs taken during construction of the South Test Area in 1954 indicate that approximately 40 percent of the site was cleared of its native bottomland hardwood forest. It appears that part of the clearing had been accomplished many years earlier for agricultural purposes when the land was privately owned. Currently, the margins of the formerly cleared area have been revegetated with pine trees and an understory of sweet gum, poison ivy, green briar, and trumpet vine; but there are areas south and southeast of the Test Pad that support only grasses or that are devoid of vegetation. Some of the grasses and small hardwoods show signs of distress.

3.12.7 **Initial Remedial Action.** Based upon what is known about the site and the nature and extent of its contaminants, quick remedial action is not deemed necessary. The elevated levels of certain metals and anions and the trace amounts of 2,4,6-TNT found in shallow soils, and the elevated levels of certain metals and chloride found in the ground water at the site, pose no imminent threat to potential receptors at this time.

SECTION 4.0

PLAN OF INVESTIGATIONS

Each plan of investigation described below is designed to obtain site-specific data to best characterize both the physical and chemical characteristics for the location being investigated based on the data presented for each site in Section 3.0. Unless otherwise stated, the following parameters will be analyzed for all soil, sediment, surface water, and monitor ground-water samples: pH; specific conductance; volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); high explosives; antimony; arsenic; barium; cadmium; chromium; lead; mercury; nickel; selenium; silver; thallium; nitrate; sulfate; and chloride. Additional analyses for pesticides/herbicides are specified for certain sites within their respective plans for investigation. All physical analyses for soil boring samples will include, at a minimum, visual classification, moisture content, gradation, plastic limit, and liquid limit tests. Ground-water samples from soil borings will be analyzed for the following indicator parameters: total organic halides (TOX); total organic carbon (TOC); explosives; nitrate; sulfate; chloride; and total phenols. All sampling and analyses described in each plan of investigation will be performed in accordance with the procedures outlined in the Chemical Data Acquisition Plan (CDAP) and the Site Safety and Health Plan (SSHP).

Field investigations for each site will consist of two phases. The first phase of investigations, RI Phase I, will be performed to obtain the data requirements to complete the site characterization. The estimated number and types of samples to be taken during the RI Phase I investigation for each site are shown on Table 4-1. As a

TABLE 4-1
CHEMICAL SAMPLING PLAN SUMMARY
RI PHASE I FIELD INVESTIGATIONS

SITE	TYPE OF SAMPLE																								
	SURFACE WATER			SEDIMENT			SHALLOW SOIL / WASTE			SOIL FROM SOIL BORINGS (SB) AND WELL BORINGS (MW)									GROUND WATER FROM SOIL BORINGS (SB) AND WELLS (MW)					TRAVEL BLANK	EQUIP. BLANK
LHAAP NO.	SAMPLE TYPE			SAMPLE TYPE			SAMPLE TYPE			LOCATION		EST. AVG. DEPTH TO WTR.	EST. AVG. DEPTH		SAMPLING FREQUENCY	SAMPLE TYPE			LOCATION		SAMPLE TYPE			TB	EB
	WATER	QA	QC	SOIL	QA	QC	SOIL	QA	QC	SB	MW		SB	MW		SOIL	QA	QC	SB	MW	WATER	QA	QC		
	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	FEET	FEET	FEET	FEET	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY
11	2	0	0	2	0	0	0	0	0	6	0	16	18	-	5.0	30	3	3	6	0	6	1	1	4	2
13	0	0	0	0	0	0	0	0	0	4	1	25	27	45	5.0	30	3	3	4	1	5	1	1	4	2
14	0	0	0	0	0	0	0	0	0	2	1	24	26	45	5.0	18	2	2	2	1	3	1	1	3	2
16	5	1	1	5	1	1	0	0	0	4	11	19	21	40	5.0	75	8	8	25	12	37	4	4	12	4
17	3	2	0	3	0	0	0	0	0	7	1	5	7	25	2.5	24	3	3	7	3	10	1	1	6	3
18 & 24	8	1	1	8	1	1	0	0	0	0	0	-	-	-	-	0	0	0	0	39	39	4	4	13	3
29	17	2	2	17	2	2	8	1	1	15	0	20	22	-	5.0	75	8	8	15	6	21	3	3	10	4
12	3	0	0	3	0	0	2	0	0	0	7	18	-	40	5.0	35	4	4	0	9	9	1	1	8	3
32	7	1	1	7	1	1	4	0	0	13	0	10	12	-	2.5 & 5.0	39	4	4	8	1	9	1	1	7	3
1	7	1	1	7	1	1	0	0	0	8	0	5	7	-	2.5	24	3	3	8	1	9	1	1	7	2
XX	7	1	1	7	1	1	0	0	0	7	0	20	22	-	2.5 & 5.0	29	3	3	4	2	6	1	1	6	2
27	4	0	0	4	0	0	4	1	1	10	0	8	10	-	5.0	30	3	3	10	2	12	2	2	6	3
TOTALS	63	7	7	63	7	7	18	2	2	76	21	-	-	-	-	409	44	44	89	77	166	21	21	86	33

- DENOTES NOT APPLICABLE

NOTES:

1. ALL SAMPLES WILL BE ANALYZED FOR VOLATILE ORGANIC COMPOUNDS (VOC'S), SEMIVOLATILE ORGANIC COMPOUNDS (SVOC'S), EXPLOSIVE COMPOUNDS, 11 SELECTED METALS, NITRATE, CHLORIDE, AND SULFATE, WITH THE FOLLOWING EXCEPTIONS:
   a. TRIP BLANKS WILL BE ANALYZED FOR VOC'S ONLY.
   b. GROUND WATER FROM SOIL BORINGS WILL BE ANALYZED FOR TOTAL ORGANIC HALIDES (TOX), TOTAL ORGANIC HALIDES (TOX), EXPLOSIVE COMPOUNDS, NITRATE, CHLORIDE. SULFATE, AND TOTAL PHENOLS ONLY.
2. SITES LHAAP 13, 32, AND 27 WILL INCLUDE PESTICIDES AND HERBICIDE ANALYSES.
3. BACKGROUND MONITOR WELL GROUND-WATER SAMPLE AT LHAAP 16 WILL BE ANALYZED FOR VOCS, SVOCS, EXPLOSIVE COMPOUNDS, 11 SELECTED METALS, NITRATE, CHLORIDE, SULFATE, TOX, TOC, AND TOTAL PHENOLS.
4. SITE LHAAP 16 ALSO INCLUDES THREE 150-FT DEEP STRATIGRAPHIC TEST BORINGS FOR GEOPHYSICAL LOGGING. GROUND-WATER SAMPLES WILL BE TAKEN EVERY 20 FEET.

result of completing the first phase field efforts, a second phase of investigations, RI Phase II, will be performed in which ground-water monitoring wells will be installed to more fully assess the ground-water impact at each site and soil borings will be drilled to determine the full extent of soil contamination, if necessary. Depending on the information obtained during RI Phase I, wells will be installed either within the waste unit to characterize the nature of the ground-water contaminants or along the point of compliance to help characterize the extent of ground-water contamination.

NPL & RCRA CA

4.1 LHAAP 11 - SUSPECTED TNT BURIAL SITE AT AVENUES P & Q

4.1.1 Data Requirements for Site Characterization. The exact location and nature of explosive waste disposal for this site have not been verified by previous investigations. Borings were shallow and did not encounter any evidence other than very low concentrations of explosive compounds in the soil to indicate whether explosive waste disposal occurred at this site. The borrow area north of the designated suspected burial site has not been eliminated as a possible waste disposal location.

A non-intrusive preliminary survey, e.g., an electromagnetic survey, to screen the site for burial locations would aid in identifying a likely location to perform further subsurface investigations. Contaminants of concern are explosive compounds. Investigation for these contaminants will identify either the disposal location or the migration pathway from the disposal site.

Explosive compounds have already been identified in surface soils in the vicinity of the site. The most likely and threatening contaminant migration pathway to be followed is leaching of contaminants from contaminated soils into the groundwater. Therefore,

soil borings taken to depths where ground water is encountered and exceeding expected waste burial depths, can be used for obtaining both soil and ground-water samples for chemical analysis to aid in identifying a burial location.

At least three borings will be necessary to determine a direction of ground-water flow. Then, if ground-water is found to be contaminated and no source of contamination is found in the soils at the site, additional investigations can be directed in the upgradient direction to locate the contaminant source. Soil boring samples can also be used for characterizing the physical nature of the soils for developing fate and transport models and for addressing remediation measures, should they be necessary.

Should the depth to ground water actually be about 3 feet and the direction of ground-water flow is to the east, it is possible that ground water may be discharging to the drainage ditch running along the southern edge of the site adjacent to Avenue Q. Therefore, surface water and sediment samples taken downstream and downgradient of the site may also indicate whether ground-water or surface soil contaminants are migrating in this direction from this location.

4.1.2 **General Plan for Site Investigation - RI Phase I**. The overall objectives in performing the first phase of field investigations for the RI at the Suspected TNT Burial Site are to identify the presence of any explosive contaminants in the soils, to determine whether ground water has been impacted by leaching of these contaminants, to determine whether surface water has been impacted by contaminated runoff or ground-water discharge, to determine the depth to ground water, to determine the direction of ground-water flow, and to assess soil and geologic conditions at the site. To accomplish

these objectives, a field investigations plan has been developed that includes the following:

1 - Site Screening Survey

6 - 18-foot soil borings*

6 - Ground-water grab samples from soil borings*

2 - Surface water/sediment sample locations

*Includes one background location.

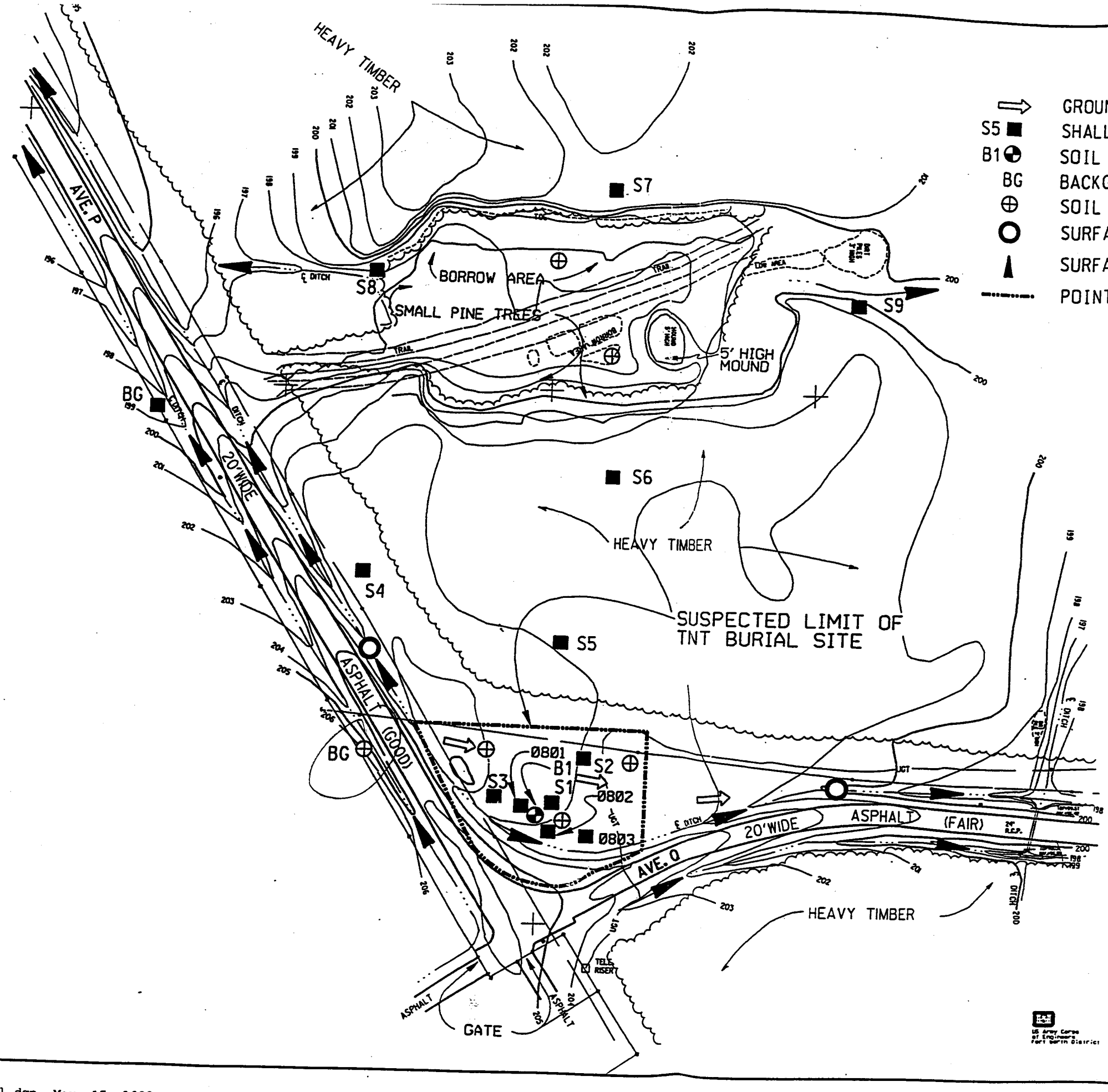
Boring depths are estimated based on an anticipated depth to ground water of 16 feet with borings continuing at least 2 feet into ground water to allow for sampling and water level measurements. Actual depths may vary based on subsurface conditions encountered during investigations. Proposed sample locations are shown on Fig. 4-1-1. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

4.1.2.1 Site Screening Survey. - Prior to siting and drilling soil borings, an electromagnetic survey, or other non-intrusive screening method, will be performed to identify any anomalies which may indicate an explosive waste burial location. The survey will be performed within the limits of the suspected TNT Burial Site as they are shown on Figure 4-4-1.

4.1.2.2 Soil Borings. A total of six soil borings will be drilled. Three borings will be drilled within the site boundary. These borings will be located at anomalies identified by the site screening survey. Should no anomalies be identified, these borings will be drilled at the location shown on Figure 4-1-1. Two will be located within the borrow area for the purpose of possibly locating the waste disposal location as well as to sample soils and ground water for explosive compounds. One boring will be located outside of

LEGEND

- GROUND WATER FLOW DIRECTION
- S5 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- B1 ◒ SOIL BORING AND NUMBER (PREVIOUS)
- BG BACKGROUND SAMPLE
- ⊕ SOIL BORING (PROPOSED)
- ○ SURFACE WATER / SEDIMENT SAMPLE (PROPOSED)
- SURFACE WATER FLOW DIRECTION
- POINT OF COMPLIANCE



50 0 50 100
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP – 11
SUSPECTED TNT BURIAL SITE
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-1-1

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the suspected waste disposal area for the purpose of establishing site-specific background concentrations. All proposed boring locations are shown on Figure 4-1-1. Borings will be drilled to a depth at least 2 feet past where ground water is encountered. The depth to ground water, as documented in previous studies, is 3 feet, but may occur as deep as 16 feet at this location.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth, beginning at the ground surface.

4.1.2.3 Surface Water and Sediment Samples. Two surface water and sediment samples will be taken at the locations shown on Figure 4-1-1. One location will be downstream and downgradient of the intersection of Avenues P & Q in the drainage ditch north of Avenue Q. The other location will be downslope of the intersection of Avenues P&Q in the drainage ditch east of Avenue P.

4.1.2.4 Monitoring Wells and Ground-Water Samples. No ground-water monitoring wells will be installed during initial field investigations at the site. However, a grab sample of the ground water encountered in each soil boring will be taken.

4.1.3 General Plan for Site Investigation - RI Phase II. If evidence of explosive waste burial is found during the RI Phase I, a monitoring well will be installed within the waste unit location. Sampling of this well will characterize the nature of the contaminants entering the ground water from this source.

If no evidence of an explosive waste burial unit is found during RI Phase I efforts, three monitoring wells will be installed along the

point of compliance as it is shown on Figure 4-1-1 to determine any ground-water impact at the site. The depth to ground water and the direction of ground-water flow obtained from soil borings drilled during the RI Phase I will be used to site one upgradient and at least two downgradient wells along the point of compliance.

All wells will be installed to a maximum depth of 20 feet into ground water or to a depth where a confining material at least 2 feet thick occurs, whichever is shallower, and will screen the entire saturated zone above the confining material. Soil sampling will be performed for the same parameters and at the same frequency described for the RI Phase I efforts. Wells will be slug tested and sampled as soon as installation is complete. Ground-water samples will be analyzed for the entire list of parameters. Wells will continue to be sampled at least monthly until the RI field work for all sites is complete.

4.2 LHAAP 13 - SUSPECTED TNT BURIAL SITE BETWEEN OLD AND ACTIVE LANDFILLS/ACID DUMP

4.2.1. Data Requirements for Site Characterization. The Suspected TNT Burial Site has never been investigated. The only evidence of waste disposal occurring at the site are patches of the ground surface where stressed vegetation and no vegetation occur, with aerial photos showing past activities at these same locations. These areas are candidates for investigation to determine whether contamination is present and the nature of these contaminants. Suspected contaminants are explosive compounds, associated acidic wastes, and/or pesticides and herbicides. Suspected methods of disposal are burial or dumping. Soil borings located within the limits of these areas of stressed vegetation and taken to depths where ground water is encountered, exceeding expected waste burial depths,

can be used for obtaining both soil and ground-water samples for analysis of these contaminants. Soil borings outside these suspect areas can help determine the horizontal extent of any contamination present. A monitoring well installed within the limits of one of the suspect locations can identify any ground-water impact which may have occurred at this site. If contaminants are found at the site, additional monitoring wells can then be sited properly to determine the extent of the ground-water contaminant plume by using the ground-water data obtained from the soil borings and the monitoring well. Soil and well boring samples can also be used for characterizing the physical nature of the soils for developing fate and transport models to address remediation measures, should they be necessary.

4.2.2 **General Plan for Site Investigation - RI Phase I**. The overall objectives in performing the first phase of field investigations for the RI at the Suspected TNT Burial Site/Acid Dump are to identify the presence of any explosive, acidic, or pesticide/herbicide contaminants in the soils within the areas of stressed vegetation, to determine whether ground water has been impacted by leaching of these constituents, to determine depth to ground water, to determine the direction of ground-water flow, and to assess soil and geologic conditions at the site. To accomplish these objectives, a field investigations plan has been developed which includes the following:

4 - 27-foot soil borings*

4 - Ground-water grab samples from soil borings*

1 - 45-foot monitoring well to be installed

1 - Monitoring well to be sampled

*Includes one background location.

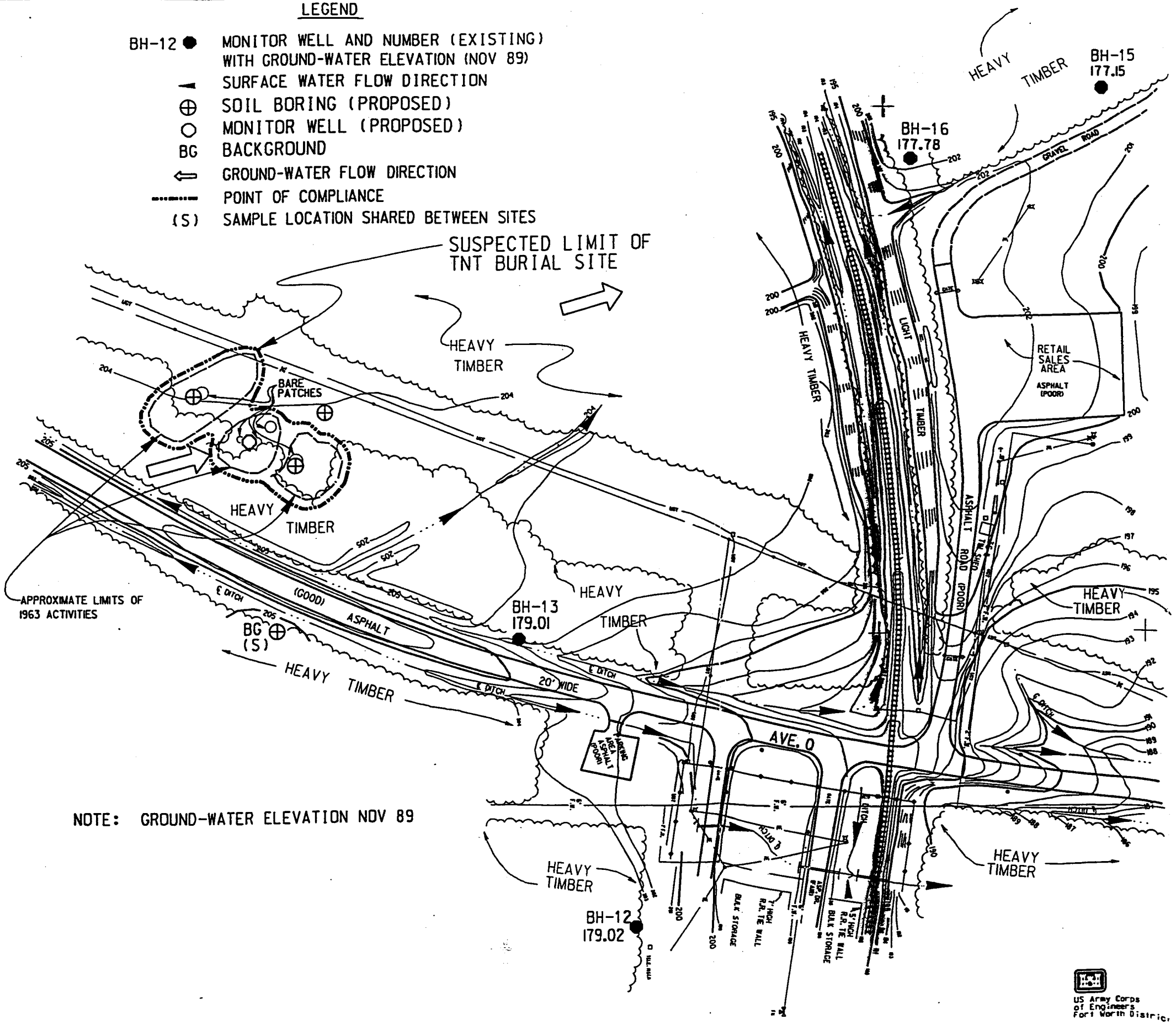
Boring depths are estimated based on an anticipated depth to ground water of 25 feet, with borings continuing at least 2 feet into ground water to allow for ground-water measurements and sampling. Actual depths may vary due to subsurface conditions encountered during investigations. All background boring location is the same as for LHAAP 14 investigations. Proposed sample locations are shown on Fig. 4-2-1. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0. All samples, with the exception of ground-water grab samples from soil borings, will also be analyzed for pesticides and herbicides.

4.2.2.1 **Soil Borings**. A total of four soil borings will be drilled at the site. One boring each will be drilled in the center of the two outermost existing patches showing stressed vegetation for the purpose of sampling soils and ground water to determine the nature and the vertical extent of contaminants at these locations. A third boring will be located outside the suspected former extent of these waste units to determine the horizontal extent of contamination. The fourth boring will be located outside the site boundary for the purpose of establishing site-specific background concentrations. The background boring will be common with the boring to be drilled and sampled for LHAAP 14 and will be located south of Avenue Q across from the site. Proposed boring locations are shown on Figure 4-2-1. Borings will be drilled to a depth at least 2 feet past where ground water is encountered. The anticipated depth to ground water is 25 feet.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials,

LEGEND

- BH-12 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (NOV 89)
- SURFACE WATER FLOW DIRECTION
- ⊕ SOIL BORING (PROPOSED)
- ○ MONITOR WELL (PROPOSED)
- BG BACKGROUND
- ⇦ GROUND-WATER FLOW DIRECTION
- ---------- POINT OF COMPLIANCE
- (S) SAMPLE LOCATION SHARED BETWEEN SITES



NOTE: GROUND-WATER ELEVATION NOV 89

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 13
TNT BURIAL SITE
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-2-1

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whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth, beginning at the ground surface.

4.2.2.2 **Monitoring Wells and Ground-Water Samples.** One ground-water monitoring well will be installed within an area of stressed vegetation in the center of the site. Sampling of this well will characterize the nature of any contaminants entering the ground water from these suspect areas. Grab samples of the ground water from the four soil borings will also be taken to determine the impact of any ground-water contamination at the site.

4.2.2.2.1 **Monitoring Well Installation.** One well will be installed in the center of the area showing stressed vegetation occurring in the center of the site at the approximate location shown on Figure 4-2-1. The well will be installed to a maximum depth of 20 feet into ground water or to a depth where a confining material at least 2 feet thick occurs, whichever is shallower, and will screen the entire saturated zone above the confining material.

Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings to be drilled at the site, with the exception that soil samples for chemical analyses will be taken only from the unsaturated zone. Analytical parameters will be the same.

4.2.2.2.2 **Ground-Water Sampling.** The newly installed monitoring well will be slug tested and sampled. Grab samples of the ground water from the four soil borings will also be taken.

4.2.3 **General Plan for Site Investigation - RI Phase II.** If evidence of waste disposal is identified during the RI Phase I investigation, additional soil borings will be sited to determine the

areal extent of soil contamination and at least three additional monitoring wells will be installed to help determine the extent of ground-water contamination. Wells will be sited along the point of compliance as it is determined from RI Phase I data, with one well upgradient of the site and two wells downgradient of the site.

If no evidence of explosive or acid waste disposal is found during RI Phase I efforts, the one newly installed monitoring well will continue to be sampled at least monthly until RI field work is complete to verify that the suspected areas are not impacting ground water at the site.

Additional well installations will be performed in the same manner as those installed during the RI Phase I and will be sampled at least monthly until the RI field work for all sites is complete.

4.3 LHAAP 14 - AREA 54 BURIAL GROUND.

4.3.1 Data Requirements for Site Characterization. Evidence of use of the Area 54 Burial Ground has never been verified. The current location of the parking lot was once designated for the disposal of demolition debris, explosive wastes, and acidic wastes; however, it is not known if disposal ever occurred. A geophysical survey across the site would aid in defining any disturbed areas where disposal may have occurred. After a survey is performed, soil borings could be sited to investigate the anomalies observed. If no anomalies are observed, soil borings should be located at random locations across the site.

All soil borings should be taken to depths where ground water is encountered to exceed expected burial depths. Borings can be used for obtaining both soil and ground-water samples for analysis of contaminants. At least three borings are needed to determine the direction of ground-water flow. Chemical constituents of concern

should include at least explosive compounds, associated acidic wastes, and any other associated parameters that may indicate a release of contaminants. Then, if ground water is found to be contaminated, additional investigations can be directed in the upgradient direction to locate the contaminant source.

At least one monitoring well should be installed within the parking lot limits because this was the area designated for waste disposal. Soil sampling in the well boring can determine if buried wastes or contaminants are present, and ground-water sampling can determine any ground-water impact at the site. Besides chemical analyses to determine the nature of contaminants, soil boring samples can also be used for characterizing the physical nature of the soils for developing fate and transport models and for addressing remediation measures, should they be necessary.

The nature of contaminants identified in either soil or ground-water samples should be evaluated against the contaminants previously identified in Well BH-12 (see Tables 3-4-1 and 3-4-4) to determine if the sources contributing to these two locations are related. Direction of ground-water flow should also be taken into consideration. Although lack of construction details significantly inhibits the use of this well for contamination investigation, any data may be useful in determining the waste disposal location for the Area 54 Burial Ground, if it is not found at the parking lot location.

4.3.2 General Plan for Site Investigation - RI Phase I. The overall objectives in performing the first phase of field investigations for the RI at the Area 54 Burial Ground is to identify the presence of any explosive, acidic, or associated waste contaminants in soils, to determine whether ground water has been

impacted by leaching of these constituents, to determine the depth to ground water, to determine the direction of ground-water flow, and to assess soil and geologic conditions at the site. To accomplish these objectives, a field investigations plan has been developed that includes the following:

1 - Site Screening Survey

3 - 26-foot soil borings*

3 - Ground-water grab samples from soil borings*

1 - 45-Foot monitoring well to be installed

1 - Monitoring well to be sampled

*Includes one background location.

Boring depths are estimated on an anticipated depth to ground water of 24 feet with borings continuing at least 2 feet into ground water to allow for ground-water measurements and sampling. The background boring is the same as for LHAAP 13 investigations. Actual depths will vary based on subsurface conditions encountered during investigations. Proposed sample locations are shown on Fig. 4-3-1. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

4.3.2.1 Site Screening Survey. Prior to siting and drilling soil borings, an electromagnetic survey, or other geophysical screening method, will be performed to identify any anomalies which may indicate a waste disposal location. The survey will be performed within the limits of the Area 54 Burial Ground shown on Figure 4-3-1.

4.3.2.2 Soil Borings. A total of three soil borings will be drilled at the site. Two borings will be located at anomalies identified by the site screening survey near the site boundary but outside the limits of the parking lot. Should no anomalies be

LEGEND

BH-12 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (NOV 89)

◄ SURFACE WATER FLOW DIRECTION

⊕ SOIL BORING (PROPOSED)

○ MONITOR WELL (PROPOSED)

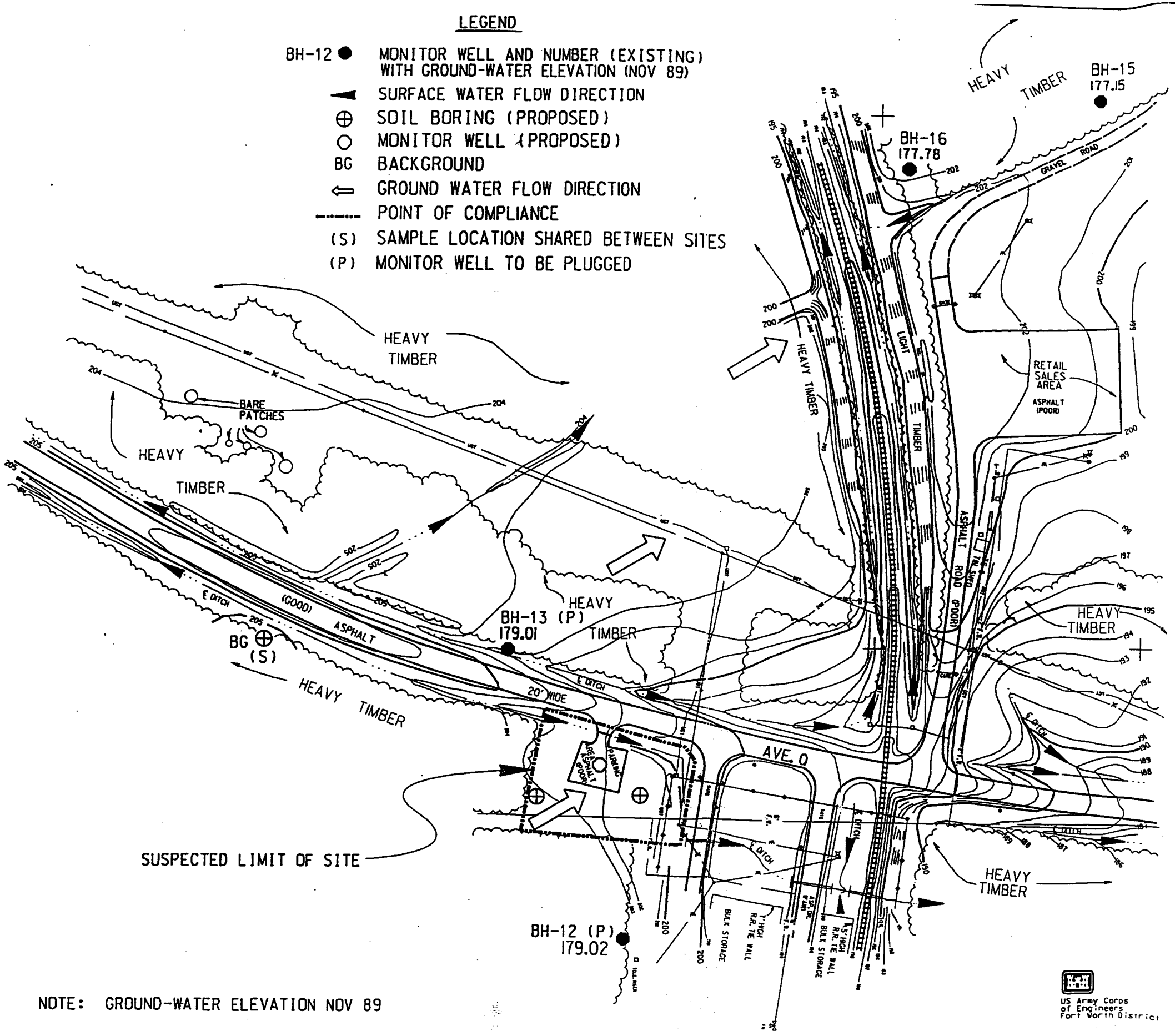
BG BACKGROUND

⇦ GROUND WATER FLOW DIRECTION

---- POINT OF COMPLIANCE

(S) SAMPLE LOCATION SHARED BETWEEN SITES

(P) MONITOR WELL TO BE PLUGGED



NOTE: GROUND-WATER ELEVATION NOV 89

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 14
TNT BURIAL SITE
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-3-1

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identified, the two borings will be drilled at the locations shown on Figure 4-3-1. The purpose of these two borings is to possibly locate the waste disposal unit as well as to sample soils and ground water for contaminants. The third boring will be located outside the suspected waste disposal area for the purpose of establishing site-specific background concentrations. The background boring will be the same as that drilled and sampled for LHAAP 13. Proposed boring locations are shown on Figure 4-3-1. Borings will be drilled to a depth at least 2 feet past where ground water is encountered. The anticipated depth to ground water is 24 feet.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet, beginning at the ground surface except within the parking lot area, where sampling will begin beneath the paving fill material.

4.3.2.3 Monitoring Wells and Ground-Water Samples. One monitoring well will be installed within the limits of the parking lot for the purpose of determining if waste was buried at this location. Soil samples from the well boring will characterize any wastes buried at the site. Sampling of this well will characterize any contaminants entering the ground water at this site. Grab samples of the ground water from the three soil borings will also be taken to determine the extent of any ground-water contamination which may exist at the site. Existing wells BH-12 and BH-13 will be closed by plugging.

4.3.2.3.1 Monitoring Well Installation. One well will be installed within the limits of the parking lot at the approximate location shown on Figure 4-3-1. The well will be

installed to a maximum depth of 20 feet into ground water or to a depth where a confining material at least 2 feet thick occurs, whichever is shallower, and will screen the entire saturated zone above the confining material.

Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings to be drilled at the site with the exception that soil samples for chemical analyses will be taken only from the unsaturated zone. Analytical parameters will be the same.

4.3.2.3.2 **Ground-Water Sampling.** The newly installed monitoring well will be slug tested and sampled. Grab samples of the ground water from the three soil borings will also be taken.

4.3.2.3.3 **Monitoring Well Plugging.** The two existing monitoring wells installed by USAEHA in 1980, BH-12 and BH-13, will be plugged in accordance with 31 TAC, Chapter 287 procedures. These wells may be up to 50 feet deep and they penetrate "undesirable water" as defined in 31 TAC 287.2. Plugging of these wells is necessary because construction details and boring logs for the wells have not been found. Also, they do not appear to have been constructed in accordance with current standards.

4.3.3 **General Plan for Site Investigation - RI Phase II.** If evidence of waste disposal is identified during the RI Phase I investigation, one upgradient and two downgradient wells will be installed along the point of compliance for the purpose of determining the extent of ground-water contamination at the site. These additional wells will be sited using the ground-water depths and direction of flow determined from the RI Phase I soil borings and monitoring well. Additional well installations will be performed in the same manner as during the RI Phase I and will be sampled at least

monthly until the RI field work for all sites is complete.

If no evidence of waste disposal is found during the RI Phase I efforts, the one newly installed monitoring well will continue to be sampled at least monthly until RI field work is complete to verify that the suspected waste disposal unit is not impacting ground water at the site.

4.4 LHAAP 16 - OLD LANDFILL

4.4.1 Data Requirements for Site Characterization. The approximate limits of previous waste treatment and disposal activities performed within the area defined as the Old Landfill are shown on Figure 4-4-1. The nature of the wastes treated and/or disposed at these locations has not been fully characterized from past investigations of the site. Soil borings to a maximum suspected depth of landfilled material at random locations across the site showed low concentrations of the explosives 1,3,5-TNB, 2,6-DNT, and 2,4,6-TNT, and low concentrations of the organic compounds TCE, DCE, vinyl chloride, and 1,1-DCA in soils down to depths of 15 feet. No subsurface geotechnical data were recorded for these borings, and the actual depth of landfilled material across the site is uncertain.

Deep stratigraphic test borings outside the perimeter of the landfill are required for performing downhole geophysical logging. Data obtained from these geophysical logs will supplement the stratigraphic information to be obtained from soil borings drilled on the landfill and will help determine the existence and location of any additional deeper water-bearing zones for installing cluster wells to determine the vertical extent of the ground-water contaminant plume.

Soil borings taken to the bottom of landfilled material or to the depth at which ground water is encountered, whichever is deeper, are

004954
0000359

LEGEND

- GROUND WATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION
- BH-14 176.53 — MONITOR WELL. NUMBER. AND GROUND-WATER ELEVATION (EXISTING)
- SOIL BORING (PREVIOUS) SEE NOTE
- 017 — SURFACE WATER / SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- SOIL BORING (PROPOSED)
- SURFACE WATER/SEDIMENT SAMPLE (PROPOSED)
- MONITOR WELL CLUSTER (PROPOSED)
- BG — BACKGROUND SAMPLE LOCATION
- APPROXIMATE LIMITS OF DISPOSAL SITES
- (P) — MONITOR WELL TO BE PLUGGED
- DEEP STRATIGRAPHIC TEST BORING (PROPOSED)
- POINT OF COMPLIANCE

BH-14 (P) 176.53
BH-15 (P) 177.15
BH-16 (P) 177.78
BH-13 179.01
BH-12 179.02
122 173.55
701
702
703
704
705
017
BG
HEAVY TIMBER
GRAVEL ROAD
RETAIL SALES AREA
ASPHALT (GOOD)
EXCAVATION AREA
LIGHT INDUSTRIAL
AVE. Q
20' WIDE
30' WIDE
BULK STORAGE
C DITCH
UCT
TOE

APPROXIMATE LIMITS OF INACTIVE LANDFILL SITE

NOTES:

1. GROUND-WATER ELEVATION NOV 89
2. SEE FIG. 3-4-4 FOR DISPOSAL SITE DETAILS
3. SEE FIG. 6-4-2 FOR ADDITIONAL PROPOSED SAMPLE LOCATIONS
4. APPROXIMATE 100-YEAR FLOODPLAIN ELEVATION 185 MSL

60 0 60 120
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 16
OLD LANDFILL

PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-4-1

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required within the limits of the former landfill to determine the thickness of landfilled materials and to obtain soil and ground-water samples for chemical and physical analyses. Soil and ground-water samples obtained from these borings can more fully characterize the explosive and organic wastes remaining in the soil and the degree to which they have impacted the ground water beneath the site. Soil boring samples can also be used for characterizing the physical nature of the soils for developing fate and transport models and for addressing remediation measures, should they be necessary.

Additional ground-water monitoring wells are required to monitor downgradient of the site because there is only one well located in this direction and ground-water contamination has already been identified. Additional wells are required to monitor both the shallow saturated zone and any deeper zones because of the potential for chlorinated solvents leaching from already identified contaminated soils within the landfill. Therefore, cluster wells should be installed at all new well locations to begin determining both the horizontal and vertical extent of ground-water contamination.

Additional monitoring wells will also provide necessary data for characterizing the stratigraphy and hydrogeology of the site and the degree to which ground water has been impacted by the migration of contaminants. Ground-water sampling and analyses from soil borings, existing Well 122, and the newly installed monitoring wells will more fully characterize the nature and extent of ground-water contamination at the site. Wells BH-14, BH-15, and BH-16 should be plugged because their construction is not in accordance with current criteria and they are not located downgradient of the landfill.

Because surface soils have been identified as being contaminated

with explosive and organic compounds, and because the potential for surface water contamination exists from the runoff and flooding of these soils, surface drainage pathways should be more fully identified and then sampled to determine if contaminated surface water and sediments are leaving the site and impacting Harrison Bayou.

4.4.2 General Plan for Site Investigation - RI Phase I. To accomplish the overall objectives in performing the first phase of field investigations for the RI at the Old Landfill, a field investigations plan has been developed which includes the following:

3 - 150-foot deep stratigraphic test borings

4 - 21-foot soil borings

4 - Ground-water grab samples

5 - Surface water/sediment sample locations*

5 - 40-foot monitoring wells to be installed*

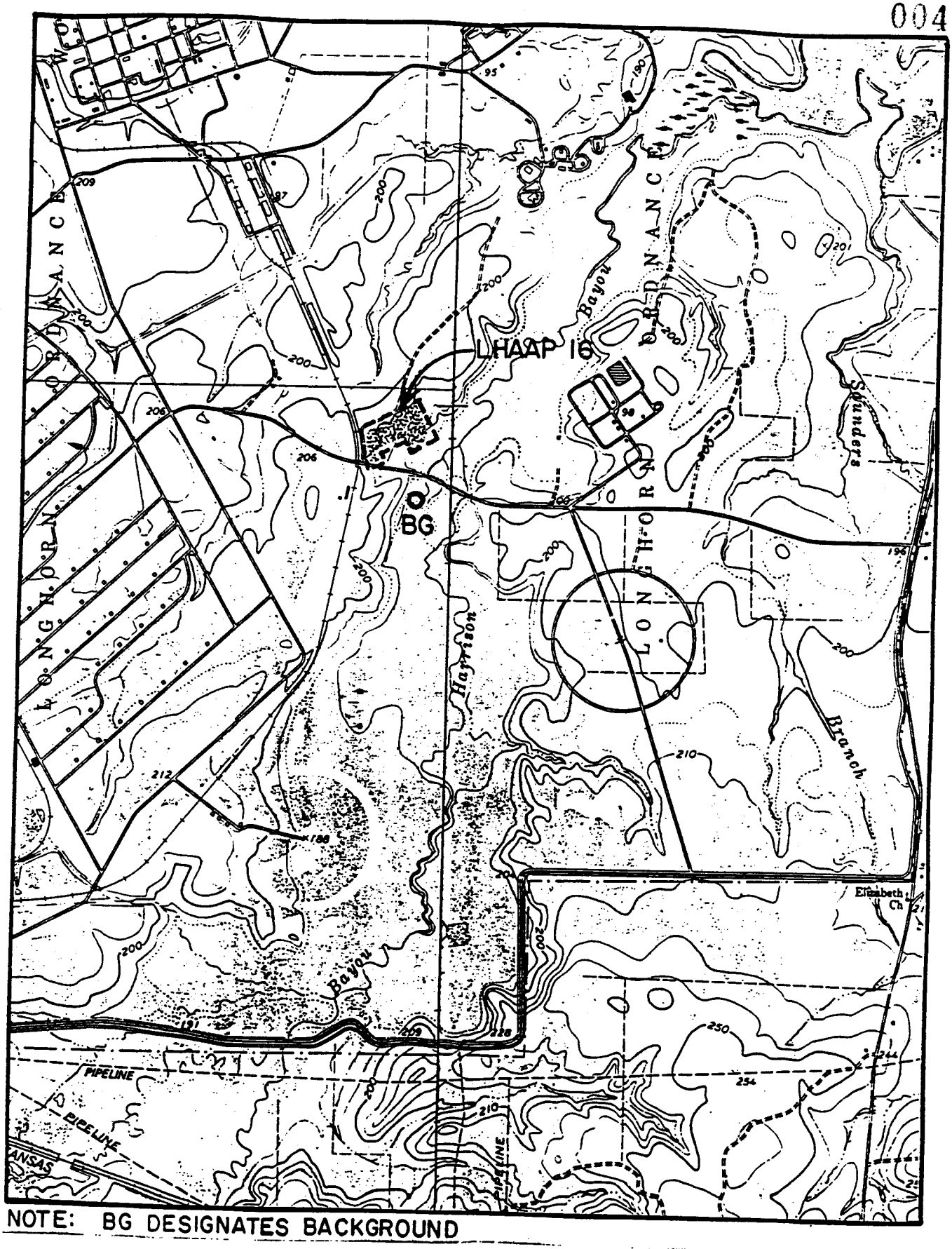
6 - 40+-foot deep monitoring wells to be installed

12 - Monitoring wells to be sampled*

3 - Monitoring wells to be plugged

*Includes one background location

Boring and monitoring well depths are estimated based on a maximum anticipated average depth to ground water of 19 feet, with borings continuing at least 2 feet into ground water to allow for ground-water measurements and sampling. Actual depths will vary based on subsurface conditions encountered during investigations. The background monitoring well boring will serve as a background boring for both soil and ground-water analyses. Proposed sample locations are shown on Fig. 4-4-1 and 4-4-2. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.



NOTE: BG DESIGNATES BACKGROUND

FIGURE 4 - 4 - 2
LHAAP 16
PROPOSED SURFACE WATER / SEDIMENT
SAMPLING LOCATION

0000302

4.4.2.1 **Deep Stratigraphic Test Borings.** Three deep stratigraphic test borings will be drilled at the locations shown on Figure 4-1-1. Each boring will be drilled to a maximum depth of 150 feet. Drilling will be performed upgradient and outside the limits of the landfill to prevent cross-contamination of water-bearing zones. If necessary, borings will be telescoped, with casing being grouted in each upper water-bearing zone to preclude downward migration of ground-water contaminants. Continuous sampling will be attempted in at least one boring to provide visual descriptions of the materials encountered during drilling and to obtain soil samples for physical analyses from low permeability zones. No soil samples will be taken for chemical analyses; however, soil samples for physical analyses will be taken at a frequency of once every 5 feet for the entire thickness of each low permeability material encountered within the saturated zone during drilling. Grab samples of the ground water will be taken approximately once every 20 feet of boring advancement for each of the three borings and will be analyzed for indicator parameters. A resistivity, a spontaneous potential, and a natural gamma radiation log will be obtained for the total depth of each boring. Geophysical logs will be phased with the placement of casing in the borings so that the entire depth of each boring is logged. When geophysical logging is complete, each boring will be plugged in accordance with 31 Texas Administrative Code, Chapter 287.

4.4.2.2 **Soil Borings.** Four soil borings will be drilled within the limits of the former landfill at the locations shown on Figure 4-4-1. Each boring will be located within the suspected limits of a former waste disposal activity for the purpose of characterizing any waste constituents present in the soils. Three of these borings will also be located along the east-west centerline of the landfill in an effort to profile the depth to in situ material across the site. The fourth boring will be located along the northern end of the landfill within one of the former burn pit locations for both chemical and stratigraphic purposes.

Each boring will be drilled to a depth beneath the waste unit and at least 2 feet past where ground water is encountered. Anticipated

depth to ground water is approximately 25 feet at the eastern end of the site and approximately 15 at the western end of the site on top of the landfill.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth, beginning at the ground surface.

4.4.2.3 **Surface Water and Sediment Samples**. A total of five surface water and sediment sampling locations will be sampled at the locations shown on Figures 4-4-1 and 4-4-2. Two locations will be in the drainage ditch south of the landfill along the northern side of Avenue Q. Another location will be off the southeast corner of the landfill within a drainage path leading south to the Harrison Bayou tributary. The fourth location will be downslope of the landfill directly east of the easternmost proposed monitoring well within the tributary of Harrison Bayou. The exact location will be determined in the field. These four locations should best reflect which contaminants are migrating along surface drainage paths leading from the site.

One location will also be sampled to establish background concentrations of constituents along these drainage pathways. This location will be within the tributary of Harrison Bayou which passes closest to the toe of the landfill. This location will be south of Avenue Q and is shown on Figure 4-4-2.

4.4.2.4 **Monitoring Wells and Ground-Water Samples**. Five additional monitoring wells will be installed to monitor the uppermost saturated zone at the site. Another six wells will be installed as

cluster wells to monitor the next deeper saturated zone at the site. Cluster wells will be installed at the five new well locations and at existing Well 122. Existing wells BH-14, BH-15, and BH-16 will be closed by plugging. Water in existing Well 122 will be sampled along with the water from the 11 new wells to be installed. All 12 wells will be slug tested. Ground-water grab samples from the four soil borings will also be taken.

4.4.2.4.1 Monitoring Well Installations. A total of 11 new monitoring wells will be installed at six locations to form six cluster wells at the site. Five of the six locations will be downgradient of the landfill along the point of compliance as it is shown on Figure 4-4-1. One of these locations is Well 122, at which a deeper well will be installed to form a cluster because Well 122 has shown contamination and will continue to be used for monitoring the site. The other four downgradient locations will be evenly spaced along the eastern toe of the landfill at the approximate locations shown on Figure 4-4-1. Analytical data from these wells should characterize the nature and extent to which the ground water leaving the site has been impacted.

The sixth proposed cluster well location is northwest of and hydraulically upgradient from the site, as shown on Figure 4-4-1. It is an area that does not appear to have been affected by waste disposal operations and should serve as a background sampling location for both soils and ground water.

Each of the new five monitoring wells to be installed for monitoring the shallow saturated zone at the site will be installed to a maximum depth of 20 feet into ground water or to a depth where a confining layer at least 2 feet thick occurs as determined from the downhole geophysical

logs, whichever is shallower. The shallow wells will screen the entire upper saturated zone above the confining layer.

The six additional deeper wells will be installed at the same locations as the shallow wells at the site. Cluster wells will be installed in separate well borings located 10 feet from any other well at the cluster location. If a shallow confining bed is identified from the downhole geophysical logs and other subsurface data gathered at the site, the deeper wells will be installed beneath this confining layer at the base of the next lower saturated zone, with the upper zone sealed off to preclude cross-contamination when penetrating the confining bed. If the deeper saturated zone is less than 20 feet thick, the well will screen the entire water-bearing interval. If the deeper zone is greater than 20 feet thick, the well will screen the bottom 20 feet of the interval. The depth of each well screen placement will depend on the stratigraphy identified from the geophysical data obtained at the site.

Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings to be drilled at the site with the exception that soil samples for chemical analyses will only be taken from the unsaturated zone. Analytical parameters will be the same.

4.4.2.4.2 Ground-Water Sampling. The eleven newly installed monitoring wells and the one existing Well 122 will be sampled and slug tested. Grab samples of the ground water encountered in each of the four soil borings will also be taken.

4.4.2.4.3 Monitoring Well Plugging. The three existing monitoring wells installed by USAEHA in 1980 (BH-14, BH-15,

and BH-16) will be plugged in accordance with 31 Texas Administrative Code (TAC), Chapter 287 procedures. These wells may be up to 50 feet deep and they penetrate "undesirable water" as defined in 31 TAC, Para 287.2. Plugging of these wells is necessary because construction details and boring logs for the wells have not been found. Also, they do not appear to have been constructed in accordance with current standards.

4.4.3 General Plan for Site Investigation - RI Phase II. Additional monitoring wells and soil borings will be sited based on the data obtained during the RI Phase I should it be necessary to further define the nature and extent of soil and ground-water contamination at the site.

4.5 LHAAP 17 - BURNING GROUND NO. 2/FLASHING AREA

4.5.1 Data Requirements for Site Characterization. The approximate limits of the suspected burn pit and trench locations at the Burning Ground No. 2/Flashing Area are shown on Figure 4-5-1. The nature of the explosive waste residues buried at these locations has not been fully determined during past investigations. Only one soil boring was drilled within the limits of these waste management areas. Because explosive compounds and VOCs were found to the depth investigated at this one location, it is feasible to investigate the other suspected pit or trench areas to fully determine the nature of the wastes remaining and the extent to which constituents have migrated. Soil borings drilled within the limits of each of the burn pit or trenches shown on the western side of the site would characterize the contaminants disposed in each of these units. No investigations have been performed within the confines of the formerly fenced flashing area on the eastern side of the site. Soil sampling

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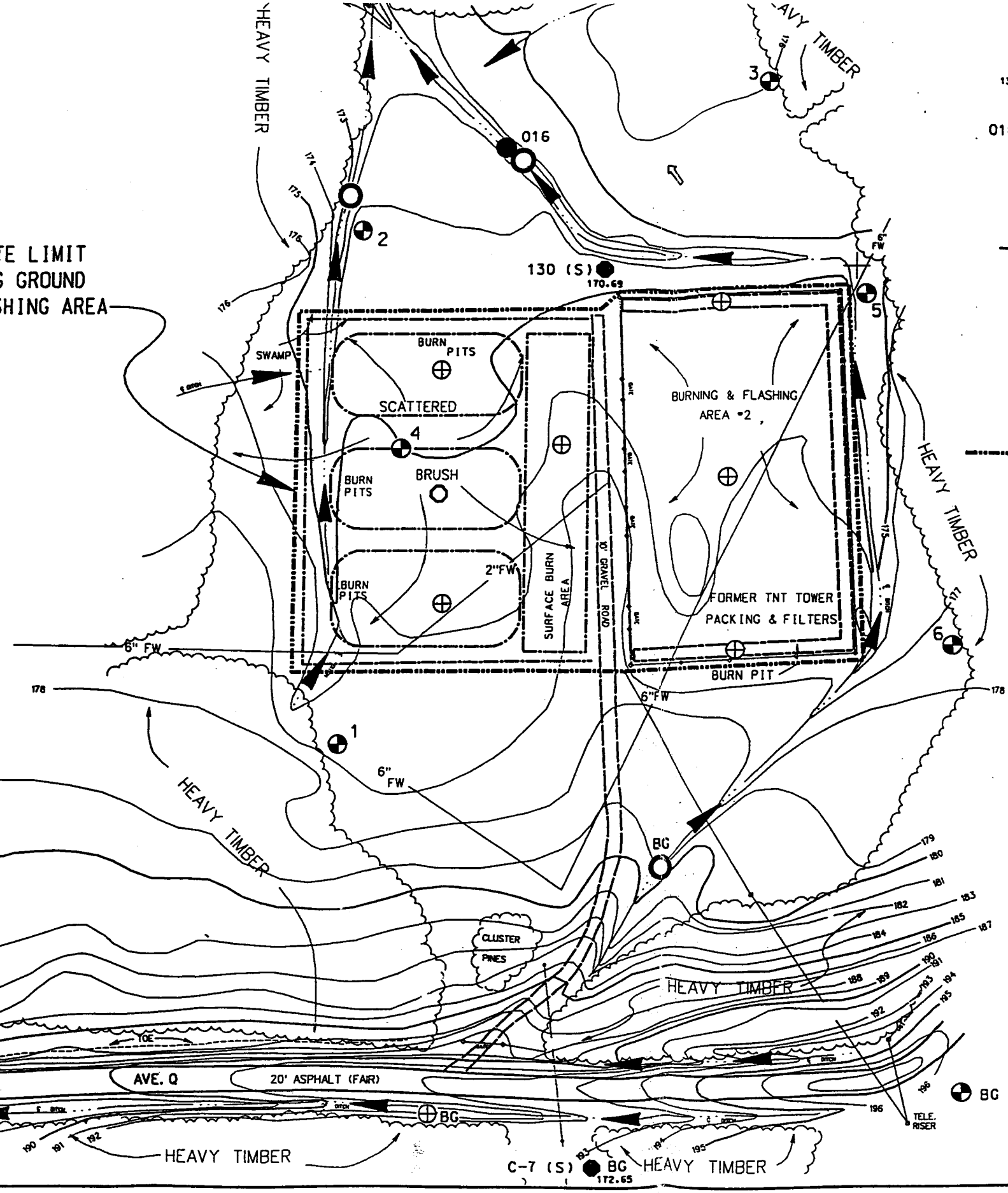
0000368

APPROXIMATE LIMIT
OF BURNING GROUND
NO. 2/FLASHING AREA



LEGEND

- GROUND WATER FLOW DIRECTION
- 130 / 170.69 — MONITOR WELL, NUMBER, AND GROUND-WATER ELEVATION (EXISTING)
- 016 — SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- 5 — SOIL BORING AND NUMBER (PREVIOUS)
- SURFACE WATER FLOW DIRECTION
- APPROX. LIMITS OF BURN PITS/TRENCHES
- SOIL BORING (PROPOSED)
- SURFACE WATER/SEDIMENT SAMPLE (PROPOSED)
- MONITOR WELL (PROPOSED)
- BG — BACKGROUND SAMPLE LOCATION
- POINT OF COMPLIANCE
- (S) — SAMPLE LOCATION SHARED BETWEEN SITES

NOTES:

1. GROUND-WATER ELEVATIONS NOV 89
2. PREVIOUS SAMPLE LOCATIONS ARE APPROXIMATE
3. WELL C-7 IS BG FOR LHAAP 17 AND LHAAP 18 & 24. WELL 130 IS DOWN GRADIENT OF LHAAP 18 & 24.
4. APPROXIMATE 100-YEAR FLOODPLAIN ELEVATION 185 MSL

N

50 0 50 100
SCALE IN FEET

US ARMY CORPS OF ENGINEERS FORT WORTH DISTRICT

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 17
BURNING GROUND NO. 2/FLASHING AREA
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-5-1

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performed here will determine the presence and nature of any wastes disposed of in these trenches.

Soil borings taken to at least 2 feet past the depth at which ground water is encountered, exceeding expected burn pit and trench depths, can be used for obtaining both soil and ground-water samples for chemical analyses. Soil and ground-water samples obtained from these borings will determine if explosive waste residues or process wastes still remain in the soil and whether they have impacted the ground water beneath the site. Soil boring samples can also be used for characterizing the physical nature of the soils for developing fate and transport models and for addressing remediation measures, should they be necessary.

Because surface soils have been identified as being contaminated with explosive compounds, and because the potential for surface water contamination exists from the runoff and flooding of these soils, surface drainage pathways should be identified and sampled to determine if contaminated surface water and sediments are leaving the site and entering Harrison Bayou.

Previous investigations showed that ground water has not been impacted by past activities at the site. However, existing Well 130 is downgradient of only the former flashing area on the eastern half of the site and not the burn pit area on the western side. A monitoring well should be installed in the burn pit area to determine if these previous activities have impacted ground water. Well 130 should also be sampled as part of this investigation to verify previous analytical data. The installation of any additional ground-water monitoring wells should not be necessary unless ground-water contamination is verified.

4.5.2 General Plan for Site Investigation - RI Phase I. The overall objectives in performing the first phase of field investigations for the RI at the Burning Ground No. 2/Flashing Area are to identify the presence of explosive compounds and possibly VOC waste contamination in suspected burn pit or trench locations, to determine the vertical extent of any soil contamination due to the constituents identified, to determine whether ground water has been impacted by leaching of these constituents, to determine if surface water drainage paths have been impacted, to gather additional ground-water data, and to assess soil and geologic conditions at the site. To accomplish these objectives, a field investigations plan has been developed that includes the following:

7 - 7-foot soil borings*

7 - Ground-water grab samples from soil borings*

3 - Surface water/sediment sample locations*

1 - 25-foot monitoring well to be installed

3 - Monitoring wells to be sampled*

*Includes one background location.

Boring and monitoring well depths are estimated based on an anticipated depth to ground water of 5 feet, with soil borings continuing at least 2 feet into ground water to allow for ground-water measurements and sampling. Actual depths may vary depending on the subsurface conditions encountered during investigations. Sample locations are shown on Fig. 4-5-1. The background well location for ground-water sampling, C-7, is the same as for LHAAP 18 and 24 investigations. All samples from each medium will be analyzed for the respective list of parameters stated in introductory paragraph of Section 4.0.

4.5.2.1 Soil Borings. Six soil borings and one background boring will be drilled at least 2 feet past the depth where ground water is encountered. Anticipated depth to ground water is approximately 5 feet at the site. Two of the borings will be located within the suspected burn trench locations within the previously fenced flashing area. A third boring will be located at the center of the previously fenced flashing area. Three other borings will be located within suspected burn pit or trench locations on the western half of the site. A background boring will be located immediately opposite the site south of Long Point Road for the purpose of establishing site-specific background concentrations.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 2.5 feet of boring depth, beginning at the ground surface.

4.5.2.2 Surface Water and Sediment Samples. A total of three surface water and sediment samples will be taken at the locations shown on Figure 4-5-1. One location will be in the surface drainage path draining the western side of the site downstream from the burn pit/trench area. Another location will be in the surface drainage path collecting drainage from the flashing area on the eastern side of the site at the approximate location previously sampled by EPS (EPS, 1988). A third will serve as a background location in the same eastern drainage path upstream of the site and removed from previous waste handling activities.

4.5.2.3 Monitoring Wells and Ground-Water Samples. One additional monitoring well will be installed in the center trench

location in the former burn pit area near the location where explosive compounds and VOCs were detected in the soil (EPS, 1988). Analytical data from this well should verify the nature of contaminants at this location and determine if they have impacted ground water. Existing wells 130 and C-7 will be sampled and slug tested along with the newly installed monitoring well. Grab samples of the ground water from the seven soil borings will also be taken.

4.5.2.3.1 **Monitoring Well Installation.** The monitoring well will be installed at the location shown on Figure 4-5-1. The well will be installed to a depth no greater than 20 feet below the top of ground water. Should a confining layer at least 2 feet thick be encountered prior to reaching this depth, the well will be installed with the well screen extending through the entire saturated zone above the confining unit.

Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings to be drilled at the site, with the exception that soil samples for chemical analyses will be taken only in the unsaturated zone. Analytical parameters will be the same.

4.5.2.3.2 **Ground-Water Sampling.** The newly installed monitoring well and existing Wells 130 and C-7 will be sampled and slug tested. Grab samples of the ground water encountered in each of the seven soil borings will also be taken.

4.5.3 **General Plan for Site Investigation - RI Phase II.** If evidence of waste disposal is identified within the former Flashing Area during the RI Phase I investigation, a monitoring well will be installed within the waste unit to determine the nature of any ground-water impact.

If it is determined during the RI Phase I field investigations that ground water has been impacted by any unit at the site, two downgradient wells will be installed along the point of compliance for the waste unit where the impact has occurred. These additional wells will be sited using the ground-water depths and direction of flow determined from the RI Phase I soil borings and monitoring well data. Additional well installations will be performed in the same manner as during the RI Phase I.

If no evidence of waste disposal is found during the RI phase I efforts, the one newly installed monitoring well and wells 130 and C-7 will continue to be sampled at least monthly until RI field work is complete to verify that the suspected waste disposal unit is not impacting ground water at the site.

4.6 LHAAP 18 - BURNING GROUND NO.3 AND LHAAP 24 - UNLINED EVAPORATION POND/ROCKET MOTOR WASHOUT FACILITY

4.6.1 Data Requirements for Site Characterization. Because the Burning Ground No. 3 and UEP sites have been so heavily investigated, additional data required for site characterization are limited. It has already been determined that the two primary sources for ground-water contamination occurring beneath the sites are the previous disposal activities at the UEP and the trenching activities in the vicinity of the ACD. Although it is possible that all pit and trench locations have not been identified during previous investigations at the burning ground, enough soil sampling has been performed to assume that a third likely source are these various locations within the confines of the burning ground. No sources outside the fenced area were found during previous drilling and sampling efforts.

A summary of the site characterization data obtained from

previous investigations is provided under Para 3.6.2 of this work plan. A ground-water contaminant plume has been identified and wells have been put in place in an effort to complete both the horizontal and vertical extent of contamination. A complete round of well sampling, including the latest nine wells installed, is necessary to obtain the chemical data necessary to complete the plume definition. Slug testing of at least wells C-4A and MW-16 through MW-21 is necessary to develop hydraulic conductivity data used to determine the rate of movement for the plume. No new wells are necessary until it has been determined from sampling of all existing wells whether the full extent of the contaminant plume has been defined. Existing Well C-7 will be designated as the background well for all shallow ground-water quality determinations, and existing Well C-10 will be designated as the background well for all deeper ground-water quality determinations.

Although the site has been investigated heavily, little data have been obtained from surface soils both within the confines of the burning ground area and along surface drainage pathways leaving the area. Because the western corner of the burning ground is within the 100-year floodplain of Harrison Bayou, and because the channel of the bayou itself is so close to the burning ground, previous evidence of shallow soil contamination due to barium should be further investigated to ensure contaminants are not leaving the site as sediments or runoff along these surface drainage pathways. Therefore, surface water and sediment in these drainage paths should be sampled. Not only metals, but explosive compounds as well should be analyzed.

A thorough review of existing data for the site should yield the information necessary to determine if removal of trench debris in the

vicinity of the ACD is necessary as an interim remedial action. The nature, extent, and quantity of contaminated soil previously identified at other locations within the burning ground should also be reviewed to determine if removal of a single area of contaminated soil is sufficient to prevent further ground-water degradation when several other areas of contaminated soil may also be contributing to the ground-water contaminant plume. Prior to completing the RI, all pit and trench locations should be investigated to ensure remediation alternatives are evaluated properly. Any removal action for contaminated soil at the burning grounds which is considered as an interim action measure should be consistent with any remedial actions anticipated as a result of the RI/FS.

4.6.2 **General Plan for Site Investigation - RI Phase I**. In order to gather the site characterization data necessary to complete the definition of the ground-water contaminant plume and to determine if any potentially contaminated surface soils are leaving the site along surface drainage paths, a field investigation plan has been developed that incorporates surface water and sediment sampling along surface drainage paths leaving the burning ground site and ground-water sampling of existing monitoring wells. Some existing wells that have historically proved to be inadequate for ground-water monitoring at the site will be plugged. The sampling plan includes the following:

8 - Surface water/sediment sample locations*

41 - Monitoring wells to be sampled**

7 - Monitoring wells to be plugged

*Includes one background sampling location.

**Includes two background sampling locations.

One background (C-7) and one downgradient (130) monitoring well location are the same used for LHAAP 17 investigation. Proposed surface water/sediment sampling locations and well plugging locations

are shown on Figure 4-6-1. Well sampling locations are shown on Figure 4-6-2. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

The RI Phase I will also include an evaluation of the need for performing initial remedial action as a source control measure for the areas of highest concentrations of ground-water contamination at the UEP and the ACD, and for all former pit and trench locations where contaminated soil or debris are contributing to ground-water contamination.

4.6.2.1 **Surface Water and Sediment Samples**. A total of eight surface water and sediment samples will each be taken at the locations shown on Figure 4-6-1 for the purpose of determining if contaminated runoff is being generated by and leaving the Burning Ground No. 3 area. Four locations will be where surface drainage leaves the fenced area of the burning ground compound at the eastern, western, and southern corners of the site. Three locations will also be sampled within the confines of the site in an effort to isolate the source of any contaminants that may be identified migrating from a given the area. One location will be where drainage is directed off the eastern quadrant of the burning ground. The other two locations will be along pathways draining the southern quadrant. An eighth location will be sampled outside the Burning Ground No. 3 compound within a drainage ditch prior to its entering the site to establish background concentrations for the constituents to be analyzed. Because surface water flow is intermittent along any of these ditches and pathways, efforts will be made to sample immediately after rainfall has occurred.

4.6.2.2 **Monitoring Wells and Ground-Water Samples**. No new

0000377

APPROXIMATE LIMITS OF CLOSED UNLINED EVAPORATION POND

APPROXIMATE LIMITS OF BURNING GROUND NO. 3

HARRISON BAYOU

100 YEAR FLOODPLAIN

HEAVY TIMBER

GRASS AREA

MOUND

PINE FOREST

BH-3 (P)

BH-4 (P)

BH-7 (P)

BH-11 (P)

BH-22 (P)

123 (P)

101 (P)

BG

LEGEND

BH-11 (P) ●	MONITOR WELL AND NUMBER TO BE PLUGGED
◄	SURFACE WATER FLOW DIRECTION
⇦	GROUND-WATER FLOW DIRECTION
O	SURFACE WATER / SEDIMENT SAMPLE LOCATION (PROPOSED)
BG	BACKGROUND SAMPLE LOCATION
·····●·····	POINT OF COMPLIANCE

N

100 0 100 200
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
PROPOSED SURFACE WATER/SEDIMENT SAMPLE LOCATIONS
AND MONITOR WELLS TO BE PLUGGED

DATE: JUNE 1992 | FIGURE 4-6-1

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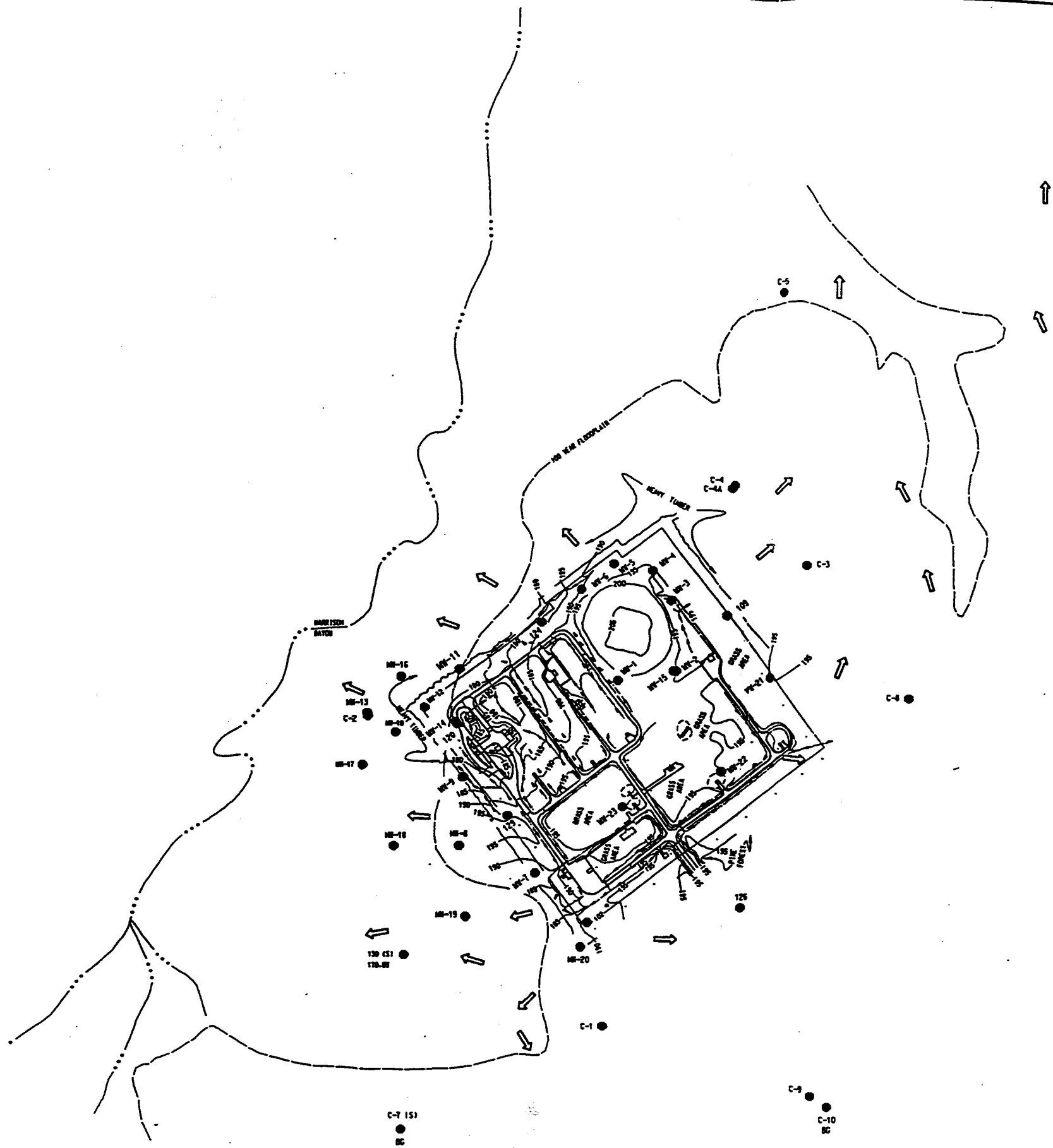

LEGEND

- ⇧ GROUND-WATER FLOW DIRECTION
- MW-14 ● MONITOR WELL AND NUMBER
- ▲ SURFACE WATER FLOW DIRECTION
- BG BACKGROUND SAMPLE LOCATION
- (S) SAMPLE LOCATION SHARED BETWEEN SITES

NOTE:

1. ONLY WELLS TO BE SAMPLED ARE SHOWN.
2. WELL C-7 IS BG FOR LHAAP 17 AND LHAAP 18 & 24. WELL 130 MONITORS LHAAP 17.

N

250 0 250 500
SCALE IN FEET

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 18 AND 24
BURNING GROUND NO. 3 AND
UNLINED EVAPORATION POND
PROPOSED GROUND-WATER
SAMPLING LOCATIONS

DATE: JUNE 1992 | FIGURE 4-6-2

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monitoring wells will be installed. A complete round of ground-water sampling will be performed on 41 existing wells. A total of seven wells will be slug tested. Seven other existing wells will be plugged.

4.6.2.2.1 **Ground-Water Sampling**. The following 41 existing wells will be sampled: MW-1 through MW-23, C-1 through C-10, C-4A, 102, 109, 120, 124, 126, 129, and 130. The following seven wells will be slug tested: C-4A, and MW-16 through MW-21.

4.6.2.2.2 **Monitoring Well Plugging**. The five remaining wells installed by USAEHA in 1980, BH-3, BH-4, BH-7, BH-11, and BH-22, as well as two wells installed by EPS in 1982, Wells 101 and 123, will be plugged in accordance with 31 Texas Administrative Code, Chapter 287. These well locations are shown on Figure 4-6-1. The USAEHA wells may be up to 50 feet deep and they penetrate "undesirable water" as defined in 31 TAC, Subsection 287.2. Plugging of these wells is necessary because construction details are not known. Also, they do not appear to have been constructed in accordance with current standards. Well 101 will be plugged because historical water level data indicates that the well is improperly constructed with a poor seal. Well 123 will be plugged because the well appears to be too shallow to pick up ground-water contaminants at the sites.

4.6.2.3 **Initial Remedial Action Evaluation.** The need for interim remedial action to be performed at the two known sources of ground-water contamination at Burning Ground No. 3 will be evaluated using existing data and data generated during the RI Phase I field efforts following EPA/540/G-88/003 guidance. All existing data will also be reviewed to attempt to identify all former pit and trench locations where contaminated soil or debris may be contributing to ground-water contamination. Data needs to further investigate and characterize these suspected source areas will also be identified.

4.6.2.3.1 **Former Unlined Evaporation Pond (UEP).** The

analytical data obtained during the RI Phase I field efforts will be used to complete the contaminant plume delineation. Water level data, slug test data, and the distribution of contaminant concentrations both vertically and horizontally will be used to determine an estimated rate of plume migration. The rate of migration, the extent to which the plume has been delineated, and the contaminant concentrations present will be evaluated with all other available data following the guidelines of EPA/540/G-88/003 to determine if an initial remedial action is necessary to prevent further ground-water degradation at the site while the RI/FS is being completed.

4.6.2.3.2 **Trenches at ACD and Other Locations.** Existing data for the burning grounds will be reviewed per guidelines in EPA/540/G-88/003 to determine if an initial remedial action is necessary for the trench debris remaining in the vicinity of the ACD and for any other former pit and trench locations where contaminated soil may be contributing to ground-water contamination.

4.6.3 **General Plan for Site Investigation - RI Phase II.** If the ground-water data obtained during the RI Phase I efforts are not adequate to close the contours of the ground-water contaminant plume, additional wells will be installed and sampled to obtain these data. Once the extent of the ground-water contaminant plume is adequately defined, a pump test will be designed to determine the hydraulic characteristics for evaluating a pump and treat remedial action alternative.

If data are found to be incomplete for quantifying and characterizing contaminated soil and its impact on ground water at former pit and trench locations, soil borings will be proposed to obtain the data necessary for evaluating remediation alternatives. The required additional soil borings will be drilled during the RI Phase II. If interim remedial action evaluations indicate an interim remedial action is necessary at the site, design will proceed to allow for implementation prior to completion of the RI/FS.

4.7 LHAAP 29 - FORMER TNT PRODUCTION AREA.

4.7.1 **Data Requirements for Site Characterization.** In the Former TNT Production Area, additional data are required to establish whether there are significant concentrations of TNT production residues in deeper soils above the

deeper soils above the water table and in the surface water and sediment in ditches close to key facilities along at least one of the former TNT production lines. Production Line A is a prime candidate for obtaining additional data because it was the first into production and likely produced more TNT than any of the other lines. Additional data are also required along a production line to establish depths to ground water and the approximate contaminant levels in the ground water.

The reason for selecting one production line for an intensive investigative and sampling program is that previous soil sampling at the site was restricted to the upper 42 inches of soil using a drilling and sampling program established on an arbitrarily established grid system. This system was not closely related to actual production operations during World War II. Borings were drilled along the approximate centerline of Lines B through E, but lines of borings intended to represent conditions along Lines A and F were significantly offset from the approximate centerlines of these production activities. The distance between the borings on each of the six lines of borings was fixed at 396 feet; therefore, individual borings were not ideally positioned with respect to past production operations. For example, alongside Line A, the first boring, No. 28, was apparently drilled on the old railroad grade that served the Nitric Acid Unloading Area. The second boring, No. 1, was drilled about 150 feet south of the center of the Nitrating Area complex. The third boring, No. 2, was drilled on higher ground about 130 feet south of the TNT Purification (Wash) Area, and the fourth boring, No. 3, was drilled about 350 feet southwest of the Loading Area that served Lines A and B. Similar boring location problems exist along the other

former production lines, although the second borings along Lines B through G were apparently within the Nitrating Area complex. The third borings along these same lines are closer to the TNT Purification (Wash) Area, but are still on higher ground than these areas.

Data are needed to determine whether contaminants are present in soils within the Bulk Toluene Storage Area. There has been no previous soil sampling within this area. Toluene is likely the only potential contaminant in this area. The depths to ground water and the approximate contaminant levels of the ground water also need to be determined.

A soil boring is required near the site at a location upstream and hydraulically upgradient from the site to establish local background conditions of soils unaffected by any past waste disposal operations.

Data are required to determine whether contaminated surface water and sediment are exiting the site and have affected soils underlying the ditches. Samples from a boring in a ditch bottom would be needed for this determination. The best location for the boring would be on the northeast site boundary just upstream from previous surface water/sediment sample No. 006, where surface water and sediments have been identified as contaminated with explosive compounds.

In addition to the need for surface water and sediment sampling in ditches close to a production line, additional surface water and sediment sampling and analyses are needed where ditches conveying surface water and sediment from the site cross the site boundary. Although a few such locations were previously sampled and analyzed, the sampling locations are questionable and inadequate in number.

Also required is a background surface water and sediment sampling location in a ditch that does not receive runoff from the site.

It is also necessary to verify the existence and condition of the underground pipelines that carried the TNT production wastewaters, i.e., red and yellow liquors. Reportedly, these lines periodically became plugged by TNT crystals and other impurities during the TNT plant's operation. It is therefore possible that the lines, if still in place, may still contain these contaminants. Based upon field observations, it appears that the manholes and other openings of the red and yellow liquor pipelines have been sealed by earth. This sealing was probably done as part of reported decontamination operations shortly after the end of World War II. Careful digging with a backhoe or similar piece of equipment at scattered points along the original pipeline location should expose enough of the line for visual inspection. Analyses of samples of the pipeline contents, if any, and of the immediately surrounding soil should suffice to determine whether the pipeline contains explosive substances.

The six existing monitoring wells are very close to the site boundary and are deemed adequate for monitoring ground water quality until completion of the RI Phase I. Ground water in these wells should be sampled and analyzed during the Phase I site investigation. If the very low level of 1,3,5-TNB found in the 1988 sample from Well 114 is found during the Phase I investigation, a new upgradient well will need to be installed.

4.7.2 General Plan for Site Investigation - RI Phase I. - The overall objectives in performing the first phase of field investigations for the RI at the former TNT Production Plant are to:

- Establish the vertical extent and degree of TNT production

residue contamination of soils.

- Determine the approximate degree of possible contamination of ground water within the site boundary.
- Verify the existence and establish whether contamination is present within and surrounding the underground red and yellow liquor wastewater pipelines.
- Establish whether contamination is present in surface water and sediment in all ditches collecting the site's runoff.
- Obtain additional data pertaining to the site's soils, geology, and hydrogeology.

To accomplish the objectives, a field investigation plan has been developed that includes the following:

4 - Waste line and soil sample locations

15 - 22-foot soil borings*

15 - 15 Ground-water grab samples from soil borings*

17 - Surface water/sediment sampling locations**

6 - Monitoring wells to be sampled*

* - Includes one background location

** - Includes two background locations

The boring depth of 22 feet is an average based on an anticipated average depth to ground water of 20 feet, with each boring continuing 2 feet below the water table to permit water level determination and ground water sampling. Actual depths may vary depending on subsurface conditions encountered during investigations. For Phase I purposes, 10 of the borings are proposed within the site boundary along the former TNT production line, Line A, with the findings from these borings intended to be representative of the other five production lines, Lines B through F, at the site.

Proposed sampling locations are indicated on Fig. 4-7-1 and Fig. 4-7-2. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

4.7.2.1 Waste Line Soil Samples. Four locations along the underground wood-stave wastewater pipelines will be investigated by exposing the lines with a backhoe or other excavating equipment. Three of the locations will be along the red liquor wastewater pipeline that runs southwest to northeast across the site. The fourth location will be along the red and yellow liquor wastewater pipeline that runs northwestward toward the former TNT Disposal Plant (LHAAP 32). Estimated burial depth of the pipelines is 5 feet. The pipelines likely contain TNT crystals and residues of other explosive compounds and inorganic salts. Excavation at each sampling location will proceed until the line or evidence of the line is encountered. Efforts will be made to totally expose the line to assess its physical condition. The soil surrounding the line will be sampled. Efforts will then be made to penetrate the line for sampling of any included waste materials.

4.7.2.2 Soil Borings. A total of 15 borings will be drilled at the site. Each boring will be drilled to at least 2 feet below the water table which is expected to be encountered at an average depth of 20 feet.

Ten borings will be drilled along Line A, the TNT production line that apparently produced TNT longer, and in probably greater quantity, than any of the other production lines during World War II. Three of

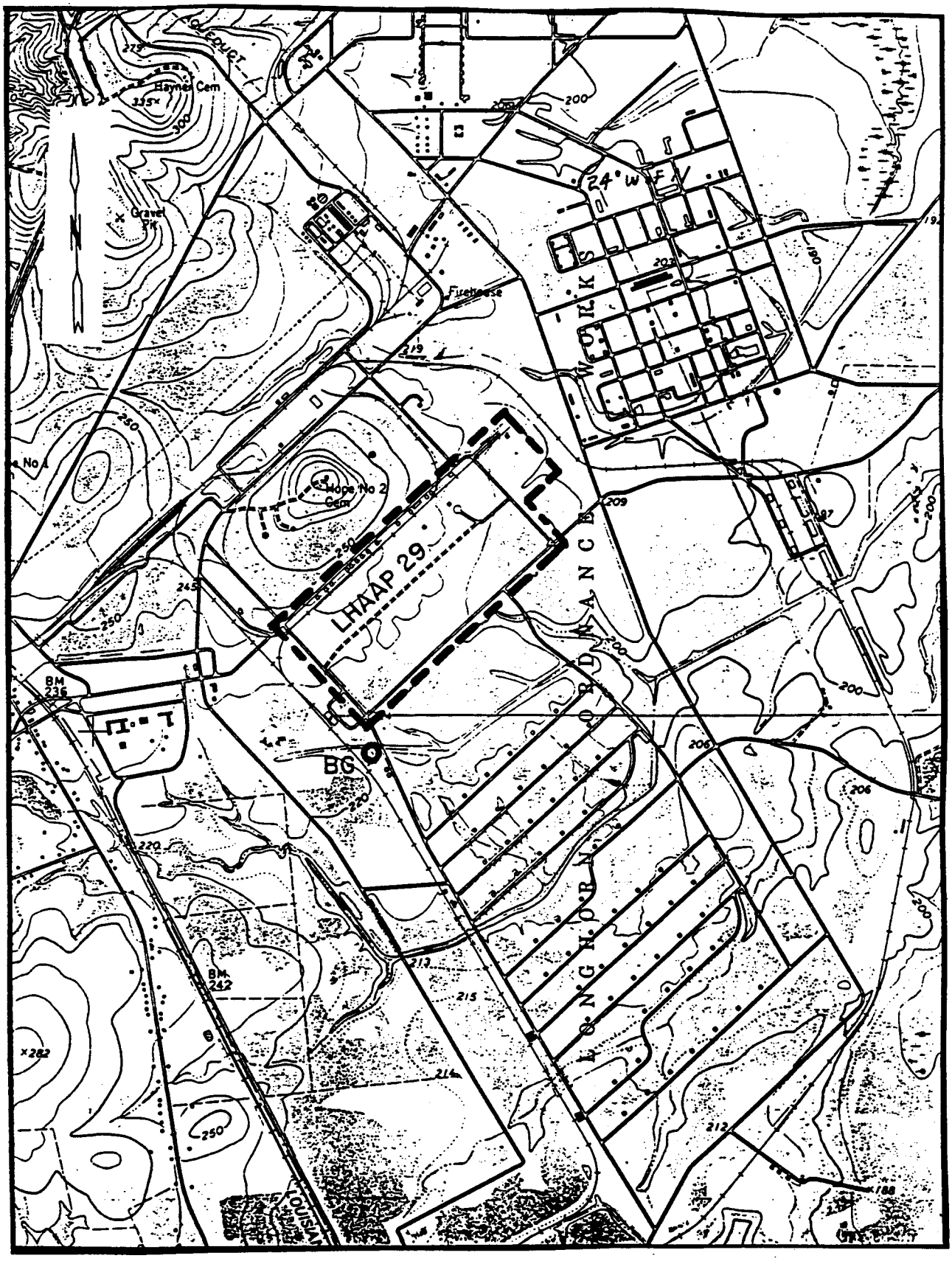

FIGURE 4-7-2
PROPOSED BACKGROUND SURFACE
WATER/SEDIMENT SAMPLING
LOCATION FOR LHAAP 29

0000396

these borings will be in the Nitric Acid Unloading Area at the head of the production line. Two borings will be at or near probable aboveground acid holding tank locations, and one boring will be near the center of a former aboveground toluene holding tank location. Another four borings will be next to each of the four major structures in the Nitrating Area Complex, namely, the Mono, Di, Tri, and Recover Houses. Two more borings will be drilled on opposite sides of the Wash House in the TNT Purification (Wash) Area. This area is suspected to have the highest potential for explosives contamination of soils. One of these borings will be very close to the underground red liquor wastewater line that received wastewater from the Wash House. The tenth boring will be drilled near the center of the TNT Loading Area that served Lines A and B.

Three borings will be drilled in the Bulk Toluene Storage Area at the locations of the three former aboveground toluene storage tanks. The borings will be in the approximate center of each tank pad.

One boring will also be drilled in the bottom of the blue water discharge ditch at the site boundary near the location of previous sampling location 006 and Well 116.

A background boring will be drilled west of the site near the intersection of 1st Street and Avenue E. This location is upstream and hydraulically upgradient from the site and appears to be in an area that has not been affected by waste disposal.

Soil samples for physical analyses will be obtained from each of the 15 borings beginning at the ground surface, then once every 5 feet or change of materials, whichever occurs more frequently. Samples of unsaturated soils for chemical analyses will be obtained from each boring at least every 5 feet or boring depth, beginning at the ground

surface.

4.7.2.3 **Surface Water and Sediment Samples**. Surface water and sediment samples will be obtained from a total of 17 locations at and near the site. Sixteen of the locations will be within ditches. The remaining location will be in the pond at the discharge point of the former TNT production wastewater (red liquor) pipeline.

Four of the sampling locations are in the interior of the site in ditches that collect surface water runoff from most of Line A. These locations are close to this former production line.

Nine of the sampling locations are at the site boundary in ditches conveying the site's surface water runoff to nearby creeks. One of these locations is in a ditch on the boundary between the TNT production plant area and the adjoining Bulk Toluene Storage Area/

Two more sampling locations are in ditches upstream from the site. Samples from these locations should serve to establish background conditions for surface water and sediment. One location is in a tributary of Central Creek and is shown on Fig. 4-7-2. The other location is in a ditch near the north corner of the site. This ditch carries surface water runoff from an area northwest of the site including the area occupied by the former TNT Disposal Plant (LHAAP 32). The ditch also served to convey blue water discharge from LHAAP 32 during its operation in World War II.

4.7.2.4 **Monitoring Wells and Ground-Water Samples**. No additional monitoring wells will be installed. The six existing wells, 114 through 119, will be sampled and slug tested. Also a grab sample of the ground water will be obtained from each of the 15 soil borings.

4.7.3 **General Plan for Site Investigation - RI Phase II.** If the

proposed RI Phase I investigation reveals elevated levels of any of the listed parameters in the deeper soils immediately above the water table or in the ground-water samples from the borings or existing monitoring wells, an appropriate number of monitoring wells will be installed at each revealed area of contamination.

All wells will be installed to a maximum depth of 20 feet into ground water or to a depth where a confining material at least 2 feet thick occurs, whichever is shallower, and will screen the entire saturated zone above the confining unit. Soil sampling will be performed for the same parameters and at the same frequency described for the RI Phase I efforts, with soil samples for chemical analyses to be taken from the unsaturated zone only. Wells will be slug tested and sampled as soon as installation is complete. Ground-water samples will be analyzed for the entire list of parameters. Wells will continue to be sampled at least monthly until the RI field work for all sites is complete.

4.8. LHAAP 12 - ACTIVE LANDFILL

4.8.1 Data Requirements for Site Characterization. Additional data are required to fully characterize the soils, geology, and hydrogeology at the site and immediately adjoining areas that may be affected by migration of site contaminants. Additional data are also required to more firmly establish the nature and extent of contamination already found at and near the site and to determine the thickness and nature of waste materials in the former diversion ditch across the site.

Additional shallow soil sampling of the sawdust and dirt piles at the northern end of the site is necessary to verify that no contaminants are present. Samples should be taken at more than one location to increase the chance of encountering contamination, if

present.

Surface water and sediment in the ditch that collects surface water runoff from the southern portion of the site need to be sampled and chemically analyzed. This ditch and creek have not been sampled previously. Surface water and sediment previously sampled from the leachate location at the northern end of the landfill should be sampled again to determine any variations in the nature and concentrations of previously detected constituents. For determination of background conditions, surface water and sediment in the unnamed creek need to be sampled and chemically analyzed at a point located upstream from the site.

Borings are required along the centerline of the former diversion ditch to ascertain the thickness and nature of the fill materials in the ditch and to obtain samples of the fill materials and ground water for chemical analyses and limited physical tests and analyses. A boring is also required in the previously uninvestigated southwestern portion of the site where waste disposal commenced only a few years ago. The purpose of this boring is to obtain samples of possible waste materials, underlying soil materials, and ground water for chemical and physical analyses. Monitoring wells installed in these borings will allow for characterizing the nature of any ground-water impact by the waste units at the site. Additional ground-water monitoring wells are also required to replace the four USAEHA monitoring wells whose construction is not in accordance with current criteria. The additional monitoring wells and their borings will provide higher quality data needed for full characterization of the soils, geology, hydrogeology, and contaminants at and near the site. Sampling and analyses of ground water in existing Wells 103 and 121

and in the additional monitoring wells will also complete the acquisition of ground-water quality data for site characterization.

4.8.2 **General Plan for Site Investigation - RI Phase I**. To accomplish the overall objectives in performing the first phase of field investigations for the RI at the Active Landfill, a field investigations plan has been developed that incorporates the following:

2 - 1-foot shallow soil samples

3 - Surface water/sediment sample locations*

7 - 40-foot monitoring wells to be installed*

9 - Monitoring wells to be sampled*

4 - Monitoring wells to be plugged

*Includes one background location.

Well depths are estimated based on an anticipated average depth to ground water of 20 feet. Actual depths may vary depending on the subsurface conditions encountered during investigations. The background monitoring well boring will serve as a background boring for both soil and ground-water analyses. Proposed sample locations are shown on Fig. 4-8-1. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

4.8.2.1 **Shallow Soil Samples**. Two shallow soil samples will be taken at two different locations within the sawdust and dirt piles at the northern end of the site. Samples shall be taken at least 1 foot into each pile to obtain a representative sample of volatile organic contaminants suspected to be present. Approximate locations are shown on Figure 4-8-1, but actual locations will be determined in the field to best represent the materials contained within these piles. Analyses of

APPROXIMATE LIMITS OF ACTIVE LANDFILL

BH-17 (P)

BORROW AREA

103
180.53

BH-18 (P)
180.57

UNNAMED CREEK

BG

HEAVY TIMBER

BH-19 (P)

APPROXIMATE ℄ OF BURIED DIVERSION DITCH

LANDFILL

121
182.26

POST

CLUSTER PINES

TO CENTRAL CREEK
APPROX. 800'

3799
3800
3808

3795
3796
3797
3798
3806
3807

BH-20 (P)
182.46

TO CENTRAL CREEK
APPROX. 600'

APPROXIMATE LIMITS OF 1954 EXCAVATION FOR DIVERSION DITCH AND BORROW AREA

NOTE:
GROUND-WATER ELEVATION NOV 89.

LEGEND

- GROUND-WATER FLOW DIRECTION DURING WET PERIODS
- SURFACE WATER FLOW DIRECTION
- 121 / 182.26 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- 3917 — SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 3799 — SURFACE WATER / SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- SURFACE WATER / SEDIMENT SAMPLE (PROPOSED)
- MONITOR WELL (PROPOSED)
- SHALLOW SOIL SAMPLE (PROPOSED)
- BG — BACKGROUND SAMPLING LOCATION
- (P) — MONITOR WELL TO BE CLOSED BY PLUGGING
- POINT OF COMPLIANCE

US Army Corps of Engineers Fort Worth District

50 0 50 100
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 12
ACTIVE LANDFILL
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-8-1

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these samples will characterize the nature of the materials comprising these mounds.

4.8.2.2 **Surface Water and Sediment Samples**. One of the three proposed surface water and sediment sampling locations is in the ditch that collects surface water runoff from the southern part of the site. The exact location of this sampling point will be determined in the field at the time of sampling. It will be situated far enough downstream to be below the probable confluence with a tributary ditch that passes just west of existing Well 121. Analyses of samples from this ditch should serve to indicate whether this surface drainage pathway exiting the site is contaminated.

The second surface water and sediment sample will be taken at the northern end of the landfill where leachate has been observed and sampled previously. Analyses of these samples will be compared to previous test results to monitor concentrations of constituents migrating along this drainage pathway.

Surface water runoff from the southern part of the site eventually enters an unnamed creek to the south of the site. For establishing background conditions, a third surface water and sediment will be sampled in the bottom of this creek at a point immediately upstream from where the site runoff first enters the creek. If surface water is not present at this point, the sampling location will be moved upstream to the nearest water in the creek.

4.8.2.3 **Monitoring Wells and Ground-Water Samples**. Seven additional monitoring wells will be installed and four of the six existing wells, BH-17, BH-18, BH-19, and BH-20, will be closed by plugging. Water in existing wells 103 and 121 will be sampled along with water from the four new wells to be installed.

4.8.2.3.1 **Monitoring Well Installations**. Two monitoring wells will be installed along the centerline of the filled diversion ditch which crosses the site. It is anticipated that these well borings will penetrate approximately 11 feet of landfilled materials before encountering Wilcox Group sediments which are believed to underlie the bottom of the filled ditch. A third well boring will be located in the southwestern portion of the site hydraulically downgradient from an area which may have been used for waste disposal during the past 10 years. Another three wells will be located hydraulically downgradient from the site as replacements for the substandard USAEHA monitoring wells that are to be plugged. Samples of ground water from these new wells, along with samples from existing Wells 103 and 121, should suffice for characterization of ground water quality downgradient from the site.

The seventh proposed monitoring well will be to the west of and hydraulically upgradient from the site. It is in an area that does not appear to have been affected by waste disposal operations and should serve as a background sampling location for both soils and ground water.

All wells will be installed to a maximum depth of 20 feet into ground water or to a depth where a confining material at least 2 feet thick occurs, whichever is shallower, and will screen the entire saturated zone above the confining unit. Soil samples will be taken for physical analyses beginning at the ground surface, then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of unsaturated boring depth, beginning at the ground surface.

4.8.2.3.2 **Ground-Water Sampling**. The seven newly

installed monitoring wells and the two existing wells 103 and 121 will be sampled and slug tested.

4.8.2.3.3 **Monitoring Well Plugging**. The four existing monitoring wells installed by USAEHA in 1980, BH-17, BH-18, BH-19, and BH-20 will be plugged in accordance with 31 Texas Administrative Code, Chapter 287. These wells may be up to 50 feet deep and they penetrate "undesirable water" as defined in 31 TAC, Subsection 287.2. Plugging of these wells is necessary because construction details and boring logs for the wells have not been found. Also, they do not appear to have been constructed in accordance with current standards.

4.8.3 **General Plan for Site Investigation - RI Phase II.** If evidence of waste disposal is found in any of the well borings drilled along the perimeter of the landfill site during the RI Phase I effort, additional soil borings will be sited further from the disposal site in an effort to determine the areal extent of landfilled material. Soil borings will be drilled 2 feet past the depth where ground water occurs. Soil samples for physical and chemical analyses will be taken in the same manner as described for well borings. A grab sample of ground water will also be taken. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

Should the landfill limits exceed those shown on Figure 4-8-1, additional monitoring wells will be placed along the newly defined point of compliance to determine the nature of any ground-water contamination which may be leaving the site.

4.9 LHAAP 32 - FORMER TNT WASTE DISPOSAL PLANT

4.9.1. **Data Requirements for Site Characterization**. Additional

data are required to fully characterize the soils, geology, and hydrogeology at the site and immediately adjoining areas that may be affected by migration of site contaminants. Additional data are also required to establish whether there are significant concentrations of contaminants at the site derived from the treatment and disposal of very large quantities of TNT manufacturing wastewaters. The additional contaminant data are needed for all site media, i.e., soils, fill materials, Wilcox Group materials, surface water, sediment, and ground water. Additional data will serve as a basis for the determination of contaminant persistence and migration, including migration rates.

Borings are required on the site to characterize the natural soils and underlying Wilcox materials and to determine the depth to ground water. The borings will permit sampling of these media for chemical analyses. One boring is needed near the site at a location upstream and hydraulically upgradient to establish local background conditions unaffected by any past waste disposal activities. Grab sampling of ground water in soil borings can be performed in lieu of installing additional ground-water monitoring wells until a need for additional monitoring is established. Water sampling in Well 113 is required to complete the ground-water data acquisition for site characterization.

It is also necessary to verify the existence and condition of the remaining underground waste line leading into the site. Careful digging with a backhoe or similar piece of equipment at various locations along this line should expose enough of the line for visual inspection. Chemical analyses of the contents and surrounding soil will help characterize any potential threat posed by this structure or

the wastes it once carried.

Additional surface water and sediment sampling for chemical analyses is necessary in the ditches on and near the site that initially collect most of the site's surface water runoff and water-borne sediment. One surface water and sediment sampling location needs to be near the site in a ditch upstream and hydraulically upgradient to establish local background conditions unaffected by past waste disposal operations.

4.9.2 **General Plan for Site Investigation - RI Phase I.** To accomplish the overall objectives in performing the first phase of field investigations for the RI at the Former TNT Waste Disposal Plant, a field investigations plan has been developed that includes the following:

2 - Waste line and soil sample locations

5 - 5-foot soil borings

8 - 12-foot soil borings*

8 - Ground-water grab samples from soil borings*

7 - Surface water/sediment sample locations*

1 - Monitoring well to be sampled

*Includes one background location.

Boring depths are estimated based on an anticipated depth to ground water of 10 feet with borings continuing at least 2 feet into ground water to allow for ground-water measurements and sampling. Actual depths may vary depending on the subsurface conditions encountered during investigations. Proposed sample locations are shown on Fig. 4-9-1. All samples from each medium will be analyzed for the complete list of parameters stated in the introductory paragraph of Section 4.0.

LEGEND

- GROUND WATER FLOW DIRECTION
- SURFACE WATER FLOW DIRECTION
- 0201 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 004 ● SURFACE WATER/SEDIMENT SAMPLE AND NUMBER (PREVIOUS)
- 113 / 198.78 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- 5' ⊕ SOIL BORING AND DEPTH (PROPOSED)
- ○ SURFACE WATER/SEDIMENT SAMPLE (PROPOSED)
- BG BACKGROUND SAMPLE LOCATION
- BH ⊕ BACKHOE SAMPLE LOCATION (PROPOSED)
- POINT OF COMPLIANCE

60 30 0 60 120
SCALE IN FEET

NOTE:
GROUND-WATER ELEVATION NOV 89.

GOOSE PRAIRIE CREEK
APPROXIMATE LIMIT OF FORMER TNT WASTE DISPOSAL PLANT
HEAVY FOREST
HEAVY BRUSH & TIMBER
COOLING WATER NEUTRALIZATION PLANT (ABANDONDED)
FORMER "BLUE WATER" (COOLING WATER) DITCH
FORMER EVAPORATOR BUILDING FOUNDATION W/ PARTIAL BASEMENT
BARE AREAS
FORMER INCINERATOR FACILITY FOUNDATIONS
CONCRETE ROOFED EQUALIZATION TANKS
DETENTION POND
"RED AND YELLOW LIQUOR" WASTEWATER PIPELINE
WET WELL
TANK SUPPORT PADS
FORMER CHANGE HOUSE FOUNDATION
HEAVY TIMBER & BRUSH (MOSTLY PINES)
APPROXIMATE LIMIT OF FORMER TNT WASTE DISPOSAL PLANT
AVE. "C"
AVE. "D"
1st STREET
ASPHALT
GRAVEL ROAD
0201
0202
0203
004 3918
0919
113 198.78
BG
BH

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 32
FORMER TNT WASTE DISPOSAL PLANT
PROPOSED SAMPLE LOCATIONS
DATE: JUNE 1992 | FIGURE 4-9-1

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Samples from two 5-foot soil boring will also be analyzed for pesticides and herbicides.

4.9.2.1 **Waste Line Soil Samples.** Two locations along the underground red and yellow liquor waste line leading from the former TNT Production Area (LHAAP 29) will be investigated and sampled. A backhoe or similar piece of equipment will be used to expose the line at these locations. Estimated burial depth is 5 feet. It is anticipated that TNT wastes have pooled within the line. Digging will proceed until the line or evidence of the line is encountered. Efforts will be made to totally expose the line to assess its physical condition. A soil sample will be taken from the material surrounding the line for the purpose of determining if leakage has occurred. Once the integrity of the line is assessed, efforts will be made to enter the line and sample any contents found.

4.9.2.2 **Soil Borings**. A total of 13 soil borings will be drilled at the site. Five of these borings will be drilled to a depth of only 5 feet to characterize suspected shallow soil contamination. For this reason, soil samples for chemical analyses will be taken at 2.5-foot intervals, beginning at the ground surface. Soil samples for physical analyses will be taken for every change in materials.

Two of the 5-foot soil borings are located in the vegetation-bare areas shown on Figure 4-9-1. The purpose of these borings is to determine the reasons for the absence of vegetation. Chemical analyses of soil samples from these two borings will include pesticides and herbicides.

Another two of the 5-foot soil boring locations are in an excavated, oval-shaped pit that contained the large wooden Neutralized

Wastes Storage Tank and the smaller Condensate Storage Tank, described in Para 3.9.1. These proposed borings are in the approximate center of each tank location. Analyses of the soil samples will indicate whether leakage or spillage from these tanks contaminated immediately underlying soils.

The fifth proposed 5-foot soil boring location is near the eastern corner of a leveed area that once contained three very large Temporary (Raw) Wastes Storage Tanks, described in Para 3.9.1. Only remnants remain of the earthen levee that apparently served to contain leaks and spills from the tanks. The proposed 5-foot boring is located is immediately downstream from the outlet of a 12-inch pipe that passes through a remnant of the levee. The pipe was most likely equipped with a manually-operated valve to drain accumulated surface water runoff from the southeastern half of the leveed area while preventing escape of any wastewaters that may have leaked/spilled from the storage tanks. Sample analyses should indicate whether leakage or spillage from the wastewater storage tanks exited the leveed area via the 12-inch pipe.

The remaining eight proposed soil borings will be drilled at least 2 feet past the depth where ground water is encountered. The depth to ground water is expected to average about 10 feet across the site, but seasonal fluctuation is possible. Specific purposes of individual borings or groups of borings are described below.

Two of the deeper proposed borings are located within the main disposal plant area. One will be drilled at the approximate center of one of the former Thick Liquor Storage Tank locations. Analyses from this boring should establish whether possible leakage or spillage of the "red and yellow liquor" sludges stored in these tanks contaminated

underlying soils and ground water. The other boring will be drilled on the northern edge of the excavated, oval-shaped pit that once contained the large Neutralized Wastes Storage Tank and the smaller Condensate Storage Tank. This location is hydraulically downgradient from the excavated pit and much of the main disposal plant area, including the former Evaporator Building and the existing Equalization Tanks. Analyses of these samples should indicate whether possible leakage or spillage from the tanks contaminated nearby deeper soils and ground water.

Two other borings will be drilled in the vicinity of a former disposal plant complex comprised of Settling Tanks, Raw Wastes Storage Tank and Detention Pond which was located southeast of the Evaporator Building. Its wooden tanks were removed in about 1959, but associated concrete structures and the Detention Pond still exist. The two proposed borings are hydraulically downgradient from the complex. Analyses of these samples should establish whether nearby deeper soil and ground water have been contaminated by possible leakage or spillage of explosives manufacturing wastewaters from the tanks or by seepage of water from the Detention Pond.

Another two borings are located within the former leveed area described in Para 3.9.1. One of the borings will be drilled at the approximate center of the former location of one of the very large Temporary (Raw) Wastes Storage Tanks. Analyses of samples from this boring should indicate whether possible leakage or spillage of explosives manufacturing wastewaters from the tank contaminated underlying soils and ground water. If contamination is found, it may be indicative of similar problems at the other two tank locations. The second boring will be drilled very close to the location where a

valved drain pipe was originally designed through the levee (see Figure 3-9-1). Based upon field observations, it appears this drain pipe and its associated drainage ditch were not installed. Instead, the drainage system, as constructed, consisted of valved drain pipes through the levee at the 90-degree corners shown on Figure 3-9-1. The drain pipe through the eastern corner is still inplace in a remnant of the levee, as described in Para. 4.9.3. The northern corner of the levee has been removed, but broken pieces of its drain pipe lie nearby on the ground. The boring proposed near the originally designed drain pipe is downslope and relatively close to the locations of the former Temporary (Raw) Wastes Storage Tanks. It is also hydraulically downgradient from the tank locations. Analyses of samples from the boring should establish whether possible leakage or spillage of explosives manufacturing wastewaters from the tanks have contaminated nearby deeper soils and ground water.

One more boring will be drilled alongside and hydraulically downgradient from the 6-inch bored wooden pipeline that was used to pump the "red and yellow liquor" wastewaters from the former TNT Production Area (LHAAP 29) to the former TNT Waste Disposal Plant. The pipeline apparently was buried several feet deep and is still inplace. It is included as part of the disposal plant site from 1st Street to its terminus near the location of the Settling Tanks and Raw Wastes Storage Tanks shown on Figure 3-9-1. If analyses of samples from this boring indicates significant explosives contamination, additional borings and possibly ground-water monitoring wells will be required to establish the extent of contamination. There is a potential for pipe leakage to have occurred because of the wooden construction and the pressure pumping. Information about the

composition of the wastewaters pumped through the pipeline can be found in Para. 3.9.5.

The eighth proposed soil boring is upstream and hydraulically upgradient from the site near the main entrance off Avenue C. It is an area that does not appear to have been affected by waste disposal operations and will serve as a background sampling location.

Soil samples from each of the eight deeper borings will be taken for physical analyses beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth in each of the eight deeper borings, beginning at the ground surface.

4.9.2.3 **Surface Water and Sediment Samples**. One of the seven proposed surface water and sediment sampling locations is in a small, excavated Detention Pond situated immediately downstream from a concrete retaining wall. Immediately upstream from the retaining wall is the location of the former (Raw Wastes) Settling Tanks and some remaining associated concrete structures, including two 7.5 feet deep pits with overflow outlets into the pond. Because of the pond's proximity to the Settling Tanks and its likely use to temporarily store overflows of "red and yellow liquor" TNT wastewaters, this sampling location may show explosives contamination.

The Detention Pond also appears to have been the upstream terminus of the blue water ditch that carried the disposal plant's acidic cooling water and part of its surface runoff to a Neutralization Plant at the former TNT Production Area (LHAAP 29). A proposed surface water and sediment sampling location is in the bottom of this former ditch about 630 feet downstream from the pond to

identify the presence of any explosives contamination.

Four of the seven proposed surface water and sediment sampling locations are in the bottom of excavated ditches that collect surface water runoff from most of the northern and western portions of the site, including runoff from the areas surrounding the main disposal plant structures. The sampling location nearest to the former Incinerator Facility is in a ditch immediately downstream from the discharge of a 15-inch concrete pipe that may have been part of the incinerator Ash Sluicing System described in Para 3.9.1. The samples from this location may show some explosives and metal contamination from residual ashes if this ditch was part of the sluicing system. Samples from the remaining three ditch sampling points on the site may show some contamination by explosives and metals.

The seventh proposed surface water and sediment sampling location is upstream and hydraulically upgradient from the site in a ditch alongside the entrance road to the disposal plant. It is in an area that does not appear to have been affected by waste disposal activities and should serve as a background sampling location.

4.9.2.4 **Monitoring Wells and Ground-Water Samples.** No additional monitoring wells will be installed. However, a grab sample of ground water will be obtained from each of the eight deeper soil borings, and from each of the shallow 5-foot borings, if ground water is encountered. The ground water in existing Well 113 will be sampled. Well 113 will also be slug tested.

4.9.3 **General Plan for Site Investigation - RI Phase II.** If evidence of waste disposal is identified within any of the units investigated during the RI Phase I, a monitoring well will be installed within the waste unit location. Sampling of this well will

characterize the nature of the contaminants entering the ground water from this source.

If no evidence of waste disposal is identified within any of the units investigated during the RI Phase I, at least four new monitoring wells will be installed along the point of compliance as it is shown on Figure 4-9-2 to determine any ground-water impact at the site. One upgradient and three downgradient wells will be sited using the ground-water data obtained during the RI Phase I efforts.

All wells to be installed during the RI Phase II will be installed to a depth no greater than 20 feet below the top of ground water. Should a confining layer at least 2 feet thick be encountered prior to reaching this depth, the well will be installed with the well screen extending through the entire saturated zone above this unit. Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings drilled at the site, with soil samples for chemical analyses to be taken only in the unsaturated zone. Analytical parameters will also be the same. All new wells installed will be slug tested, then sampled at least monthly until the RI field work for all sites is complete.

4.10 LHAAP 1 - INERT BURNING GROUNDS

4.10.1 Data Requirements for Site Characterization. Ground water in Well 104 has shown explosive compounds and possibly elevated concentrations of metals and nitrates which may have migrated from the Inert Burning Grounds area. However, soil and ground-water data are insufficient to make this determination. Therefore, additional data are required to fully characterize the soils, geology, and hydrogeology at the site and at adjoining areas affected by migration of site contaminants. Additional data are also required to firmly

establish the nature and extent of contamination in the fill materials, soils, Wilcox Group materials, surface water, sediment, and ground water. The additional data will serve as a basis for the determination of contaminant persistence and migration, including migration rates.

Borings are required on and near the site to establish the thickness and nature of fill materials, to characterize the natural soils and underlying Wilcox materials, and to determine the depth to ground water. The borings will permit for sampling of these media for chemical analyses and for performing limited physical tests and analyses. One boring near the site is needed upstream and hydraulically upgradient from but near the site to establish local background conditions unaffected by past waste disposal activities. Grab sampling of ground water in soil borings can be performed in lieu of installing additional ground-water monitoring wells until a need for additional monitoring is established. Water sampling in Well 104 is required to complete the ground-water data acquisition for site characterization.

Surface water and sediment sampling for chemical analyses is necessary in the drainage ditches along Avenue P and 32nd Street that initially collect the surface water runoff and water-borne sediment derived from the site. One surface water and sediment sampling location needs to be near the site in a ditch upstream and hydraulically upgradient from and near the site to establish local background conditions.

4.10.2 **General Plan for Site Investigation - RI Phase I**. The overall objectives in performing the first phase of field investigations for the RI at the Inert Burning Grounds are to identify

the presence of any explosive contaminants in the soils, to determine whether ground water has been impacted by leaching of these constituents, to determine the depth to ground water and the direction of ground-water flow, to determine if surface water and sediments have been impacted by contaminants migrating from the site, and to assess the soil and geologic conditions at the site. To accomplish these objectives, a field investigations plan has been developed that includes the following:

8 - 7-foot soil borings*

8 - Ground-water grab samples from soil borings*

7 - Surface water/sediment sample locations*

1 - Monitoring well to be sampled

*Includes one background location.

Boring depths are estimated based on an anticipated depth to ground water of 5 feet, with borings continuing at least 2 feet past the depth where ground water is encountered. Actual depths may vary depending on the subsurface conditions encountered during investigations. Proposed sample locations are shown on Figure 4-10-1. All samples from each medium will be analyzed for the respective list of parameters as stated in the introductory paragraph of Section 4.0.

4.10.2.1 Soil Borings. A total of eight soil borings will be drilled at the site at the locations shown on Figure 4-10-1. Each boring will be drilled 2 feet past where ground water is first encountered. The depth to the water table is expected to be about 5 feet, but seasonal fluctuation is possible. Four of the proposed borings are located within the suspected limit of the Inert Burning Grounds and are expected to penetrate a few feet of potentially waste-contaminated fill before reaching undisturbed materials. Three more

0000408

005003

LEGEND

- GROUND-WATER FLOW DIRECTION
- 104 ● MONITOR WELL AND NUMBER (EXISTING)
- 0103 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- ⊕ SOIL BORING (PROPOSED)
- ○ SURFACE WATER / SEDIMENT SAMPLE (PROPOSED)
- BG BACKGROUND SAMPLE
- SURFACE WATER FLOW DIRECTION
- POINT OF COMPLIANCE

NOTES:

1. GROUNDWATER ELEVATION NOV 1989.
2. AREA REQUIRING ADDITIONAL INVESTIGATION SHOWS SUSPECTED EXTENT OF INERT BURNING GROUNDS BASED ON 30 APR 92 SITE VISIT, AERIAL PHOTOS, AND 1963 USGS 71/2 MINUTE QUAD. THIS AREA WILL BE ADDRESSED IN AN ADDENDUM TO THE RI/FS WORK PLAN.
3. BG SURFACE WATER / SEDIMENT SAMPLE LOCATION AND SOIL BORING WILL BE SITED UP SLOPE AND UPSTREAM OF THE NORTHERN PRELIMINARY SITE BOUNDARY USING CRITERIA DESCRIBED IN PARA 4. 10.

OLD DIRT TRAIL / ROAD TO HAYNER CEMETERY
AREA REQUIRING ADDITIONAL INVESTIGATION
BG SAMPLE LOCATIONS SEE NOTE 3
SCATTERED LOW MOUNDS
HEAVY TIMBER
GRAVEL ROAD
DIRT TRAIL
0101
0102
0103
104
32nd ST.
ASPHALT (FAIR)
AVE. P
20' ASPHALT (FAIR)
DITCH
MOUND
FILL
TRENCHES
APPROXIMATE LIMIT OF INERT BURNING GROUNDS

N

50 0 50 100
SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 1
INERT BURNING GROUNDS
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-10-1

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borings are proposed along the downgradient perimeter of the site for the purpose of determining the areal extent of potentially contaminated soil and for determining if contaminated ground water is leaving the site. An eighth boring will serve as a background sampling location and will be located north of the site in an area that does not appear to have been affected by solid waste disposal activities. The background boring will be sited during investigations north of the suspected extent of the additional site area to be later investigated.

Soil samples for physical analyses will be taken beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 2.5 feet of boring depth, beginning at the ground surface.

4.10.2.2 Surface Water and Sediment Samples. A total of seven surface water and sediment samples each will be taken in ditches alongside Avenue P and 32nd Street at the locations shown on Figure 4-10-1. One sampling location will serve as a background location alongside 32nd Street north of the site in an area that does not appear to have been affected by solid waste disposal activities. This background location will be sited, during investigations, north of the suspected extent of the additional site area to be later investigated.

4.10.2.3 Monitoring Wells and Ground-Water Samples. No additional monitoring wells will be installed. However, a ground-water sample will be taken from well 104 and a grab sample of the ground water will be obtained from each soil boring. Well 104 will also be slug tested.

4.10.3 General Plan for Site Investigation - RI Phase II. If

evidence of waste disposal is identified within any of the units investigated during the RI Phase I, a monitoring well will be installed within the waste unit location. Sampling of this well will characterize the nature of the contaminants entering the ground water from this source.

If no evidence of waste disposal is identified within any of the units investigated during the RI Phase I, at least four new monitoring wells will be installed along the point of compliance as it is shown on Figure 4-10-1 to determine any ground-water impact at the site. One upgradient and three downgradient wells will be sited using the ground-water data obtained from soil borings drilled during the RI Phase I efforts.

All wells to be installed during the RI Phase II will be installed to a depth no greater than 20 feet below the top of ground water. Should a confining layer at least 2 feet thick be encountered prior to reaching this depth, the well will be installed with the well screen extending through the entire saturated zone above this unit. Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings drilled at the site, with soil samples for chemical analyses to be taken in the unsaturated zone only. Analytical parameters will be the same. All new wells installed will be slug tested, then sampled at least monthly until the RI field work for all sites is complete.

4.11 LHAAP XX - GROUND SIGNAL TEST AREA

4.11.1 Data Requirements for Site Characterization. Additional data are required to fully characterize the soils, geology, and hydrogeology at the Ground Signal Test Area and immediately adjoining areas that may have been affected by migration of site contaminants.

Additional data are also required to more firmly establish the nature and extent elevated concentrations of metals and anions contamination already found at the site.

Borings are required in two areas on the site where contaminants are expected to be concentrated based upon the history of site usage. One of the borings will be in the east central part of the site where the majority of aerial and on-ground testing and destruction of non-rocket items have occurred. The other boring will be in the approximate center of the rocket motor testing blast area near the center of the site. Primary purposes of these borings are to obtain samples of soil and ground water for chemical and physical analyses and to establish depths to ground water.

A boring is required north-northeast of the former Mortar Test Area in the southwestern part of the site. The primary purpose of this boring is to determine depth to ground water to aid in establishing the hydraulic gradient in this part of the site. It is suspected that the proposed boring location is hydraulically downgradient from the former test area except during very wet periods when the hydraulic gradient may be more topographically controlled as explained in Para. 3.11.2. A secondary purpose of this boring is to obtain samples of the soils and ground water for chemical and physical analyses. These soils may be contaminated by explosive residues, metals, and anions from aerial and on-ground testing of the illuminating mortars in the nearby test area. If the ground water at the proposed boring location is normally hydraulically downgradient from the former Mortar Test Area, it may be similarly contaminated.

A boring is required hydraulically upgradient from the site in an area that has not been significantly affected by aerial drift of

0000412

contaminants to establish background soil and ground-water conditions. A location near the southern boundary of the site should meet these requirements.

005007

Grab sampling of ground water in each of the borings can be performed in lieu of installing additional monitoring wells until a need for additional monitoring is established. Sampling and analyses of water in existing Wells 127 and 128 are required to complete the acquisition of ground-water quality data for site characterization.

Shallow 5-foot borings are required in three areas of the site for different purposes. One of the 5-foot soil borings is needed at the confluence of two swales that collect the surface water runoff and sediment from the central part of the site, including the rocket motor testing blast area, and most of the east-central part of the site that has been used intensively for aerial and on-ground testing and destruction of non-rocket items. A 5-foot soil boring is needed downwind and northeast of the aforementioned testing areas where air-borne contaminants have likely settled following testing activities. In the former Mortar Test Area in the southwestern part of the site, a 5-foot soil boring is needed near an earthen "backstop" where the illuminating mortar shells were aerially exploded during the 1970s.

Surface water and sediment in the three drainageways that convey almost all of the surface water runoff and water-borne sediment from the site need to be sampled and chemically analyzed. There is no satisfactory background surface water and sediment sampling location for the site's drainageways because the site is situated on a drainage divide and has no drainageways entering the site.

Surface water and sediment samples are required in Saunders Branch and Harrison Bayou at locations immediately upstream from the

point where surface water runoff derived from the site first enters these streams. These sampling locations will serve to establish background conditions in each stream. It should be pointed out that the background location in Harrison Bayou for the Ground Signal Test Area will be downstream from the South Test Area (LHAAP 27) and possibly affected by contaminants derived from that site. There are no known contaminant producing sites upstream from the background location in Saunders Branch.

Surface water and sediment samples are also required in Saunders Branch and Harrison Bayou a short distance downstream from where all surface water runoff derived from the site has entered these streams. Chemical analyses of these samples, when compared to analyses of the upstream background samples, should serve to determine the site's impact on surface water quality of the two major receiving streams.

4.11.2 **General Plan for Site Investigation - RI Phase I**. To accomplish the overall objectives in performing the first phase of field investigations for the RI at the Ground Signal Test Area, a field investigations plan has been developed that incorporates the following:

3 - 5-foot shallow soil sample locations

4 - 20-foot soil borings*

4 - Ground-water grab samples from soil borings*

7 - Surface water/sediment sample locations**

2 - Monitoring wells to be sampled

* Includes one background location.

** Includes two background locations.

Boring depths are estimated based on an anticipated depth to ground water of 20 feet, with borings continuing at least 2 feet past where

ground water is encountered. Actual depths may vary depending on the subsurface conditions encountered during investigations. Proposed sample locations are shown on Figs. 4-11-1 and 4-11-2. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0.

4.11.2.1 Shallow Soil Samples. A total of seven soil borings will be drilled at the site. Three of these borings will be drilled to a depth of only 5 feet to characterize suspected shallow soil contamination resulting from migration or settlement of airborne contaminants resulting from surface activities at the site. Soil samples for chemical analyses in these shallow borings will be taken at 2.5-foot intervals, beginning at the ground surface. Soil samples for physical analyses will be taken for every change in materials.

One of the proposed 5-foot soil samples will be drilled in a swale in the northeastern part of the site that collects surface water runoff and sediments from the central portion of the site. Analyses of these soil samples will serve to indicate whether contaminants have concentrated in this swale by accumulation of contaminated sediment.

Another 5-foot soil boring will be drilled in the northwestern part of the site alongside the entrance road to determine if shallow soils have been impacted by settlement of airborne contaminants carried by commonly prevailing winds from the south and southeast. The rocket motor testing blast area and the area where most aerial and on-ground testing and destruction of non-rocket devices are located upwind from this proposed boring location.

A third 5-foot soil boring will be drilled in the former Mortar Test Area in the southwestern part of the site to establish whether residues resulting from past testing of illuminating mortar shells are

005010

APPROXIMATE LIMITS OF GROUND SIGNAL TEST AREA

TO HARRISON BAYOU (APPROX. 2000')

TO SAUNDERS BRANCH (APPROX. 1200')

OBSERVATION STATIONS

EARTHEN-WOODEN BUNKER (ABANDONED)

128 173.84

5'

5'

SAUNDERS BRANCH WATERSHED

HARRISON BAYOU WATERSHED

CLEARING FOR LINE-OF-SIGHT OBSERVATION

CLEARING FOR ROCKET MOTOR BLAST

HAND SIGNAL LAUNCHER

0501

0502

0503

ROCKET MOTOR STAND

CONCRETE BUNKERS (ABANDONED)

ROCKET MOTOR BLAST AREA

APPROXIMATE DRAINAGE DIVIDE

TO HARRISON BAYOU (APPROX. 1300')

127

FORMER MORTAR TEST AREA (1970'S)

ROCKET MOTOR STAND (NEVER USED)

BG

LEGEND

- GROUND WATER FLOW DIRECTION
- 0501 ■ SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- 128 173.84 ● MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- SURFACE WATER FLOW DIRECTION
- ○ SURFACE WATER/SEDIMENT SAMPLE (PROPOSED)
- 5' ⊕ SOIL BORING AND DEPTH (PROPOSED)
- BG BACKGROUND SAMPLE LOCATION
- ·-·-·-· POINT OF COMPLIANCE

0000415

NOTE: GROUND-WATER ELEVATION NOV 89

N

250 0 250 500

SCALE IN FEET

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - XX
GROUND SIGNAL TEST AREA
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-11-1

US Army Corps of Engineers Fort Worth District

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NOTE: BG DESIGNATES BACKGROUND

FIGURE 4-11-2

0000416

LHAAP XX

GROUND SIGNAL TEST AREA

PROPOSED SURFACE WATER/SEDIMENT

SAUNDERS BRANCH & HARRISON BAYOU

present in shallow soils under the burst point of the shells. The exact point of sampling will be determined in the field by selection of the area appearing to have the highest concentration of residues as evidenced by metal fragments, soil discoloration, and vegetation stress.

The four remaining proposed soil borings will be drilled to approximate elevation 170.0 so that the soils, geology, and hydrogeology of the site can be adequately characterized and to delineate lateral correlation with the materials and ground water encountered in existing monitoring wells.

A boring will be drilled and sampled within the rocket motor testing blast area to determine whether contaminants from the rocket motor burn-outs have contaminated deeper soils and ground water. This is also the suspected location of the burial site for the Sargent rocket motor which exploded around 1970. Elevated concentrations of certain metals and anions have been found in nearby shallow soil sample 0501. A magnetometer survey conducted as part of the routine UXO clearance to be performed prior to drilling in this area should find this burial location. The boring to be drilled in this area will be sited in the field either next to the rocket motor burial location, if it is found, or within the center of the blast area, as shown on Figure 4-11-1.

A boring will be drilled and sampled in the east-central part of the site to establish whether contaminants from aerial and on-ground testing and destruction of non-rocket items have contaminated soils and ground water in this part of the site. The boring location was selected on the basis of its positioning near the center of the area where such testing and destruction have been historically

concentrated. It is also in one of the swales that collects runoff from this area.

In the western part of the site, a boring will be drilled and sampled to the north-northeast of the former Mortar Test Area for the purpose of acquiring ground-water data, as described in Para. 4-11-1. If initial water level data from this boring reveals that its location is not hydraulically downgradient from the former Mortar Test Area, an additional boring that is downgradient may be needed for soil and ground-water sampling.

A boring to establish background soil and ground-water conditions is proposed near the southern boundary of the site. The proposed location is hydraulically upgradient from the site and in an area that does not appear to have been significantly affected by airborne contaminants from the Ground Signal Test Area or by any other waste disposal activities.

Soil samples from each of the four deeper borings will be taken for physical analyses beginning at the ground surface, then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth beginning at the ground surface and continuing to the water table.

4.11.2.2 Surface Water and Sediment Samples. Three of the proposed surface water and sediment sampling locations are in drainageways that initially collect surface water runoff from the site. Analyses of samples from these near-site locations should serve to indicate whether contaminants are leaving the site in surface water and sediment.

Two of the proposed surface water and sediment sampling locations

are off-site in the channel of Saunders Branch, and there are two comparable sampling locations in the channel of Harrison Bayou. The location requirements for these samples are given in Para. 4.11.1. Analyses of the downstream samples, when compared to the upstream sample analyses, should serve to indicate whether contaminants originating at the site are impacting on the surface water quality of Saunders Branch and Harrison Bayou.

The exact location of each sampling point will be determined in the field at the time of sampling. If surface water is not present in the channel at a background sampling location as shown on Figure 4-11-2, the sampling location will be moved upstream to the nearest water in the channel. If surface water is not present in the channel at a downstream sampling location as shown on Figure 4-11-2, the sampling location will be moved downstream to the nearest channel water. It is anticipated that any required movement of sampling locations will be for a minimal distance.

4.11.2.3 Monitoring Wells and Ground-Water Samples. No new monitoring wells will be installed. However, ground water in existing Wells 127 and 128 will be sampled, and grab samples of ground water in each of the four deeper soil borings will be obtained. Grab samples of ground water will also be taken from each of the 5-foot deep soil borings if ground water is encountered. Both wells will also be slug tested.

4.11.3 General Plan for Site Investigation - RI Phase II. If evidence of waste disposal is identified within any of the units investigated during the RI Phase I, a monitoring well will be installed within the waste unit location. Sampling of this well will characterize the nature of the contaminants entering the ground water

from this source.

If no evidence of waste disposal is identified within any of the units investigated during the RI Phase I, at least four new monitoring wells will be installed along the point of compliance as it is shown on Figure 4-11-1 to determine any ground-water impact at the site. One upgradient and three downgradient wells will be sited using the ground-water data obtained the RI Phase I efforts.

All wells to be installed during the RI Phase II will be installed to a depth no greater than 20 feet below the top of ground water. Should a continuing layer at least 2 feet thick be encountered prior to reaching this depth, the well will be installed with the well screen extending through the entire saturated zone above this unit. Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings drilled at the site. Analytical parameters will also be the same. All new wells installed will be slug tested, then sampled at least monthly until the RI field work for all sites is complete.

4.12 LHAAP 27 - SOUTH TEST AREA

4.12.1 Data Requirements for Site Characterization. Additional data are required to fully characterize the soils, geology, and hydrogeology of the site. Additional data are also required to more firmly establish the nature and extent of contamination already found in the Test Pad area, and to determine whether contamination is present in the cratered areas to the west of the Test Pad, in the drum disposal area south of the pad, and in the areas exhibiting vegetation stress to the south and southeast of the Test Pad.

Borings are required on the site to characterize the natural soils and underlying Wilcox materials and to determine the depth to

ground water. The borings will permit sampling of these media for chemical and physical analyses. One boring near the site is needed upstream and hydraulically upgradient from the site to establish local background conditions unaffected by past waste disposal and explosives testing activities. Grab sampling of ground water in soil borings can be performed in lieu of installing additional ground-water monitoring wells until a need for additional monitoring is established. Water sampling in Wells 131 and 132 is required to complete the ground-water data acquisition for site characterization.

Additional shallow soil sampling for chemical analyses is required in the bottom of deeper craters in cratered areas on the site. The craters have not been sampled previously.

Only a limited number of surface water and sediment samples for chemical analyses are required on-site because there is only one defined drainageway and one depression with ponded water in the floodplain portion of the site. Almost all of the surface water movement across the site is by sheet flow that also carries most of the sediment.

Surface water and sediment samples in Harrison Bayou at locations both immediately upstream and downstream from the point where surface water runoff derived from the site first enters this stream will serve to establish the site's impact on the surface water quality of the bayou. The upstream location will serve to establish background conditions in Harrison Bayou. There are no known contaminant producing sites upstream from the background sampling location.

4.12.2 General Plan for Site Investigation - RI Phase I. To accomplish the overall objectives in performing the first phase of field investigations for the RI at the South Test Area, a field

investigations plan has been developed which incorporates the following:

4 - 1-foot shallow soil sample locations

10 - 10-foot soil borings*

10 - Ground-water grab samples from soil borings*

4 - Surface water/sediment sample locations*

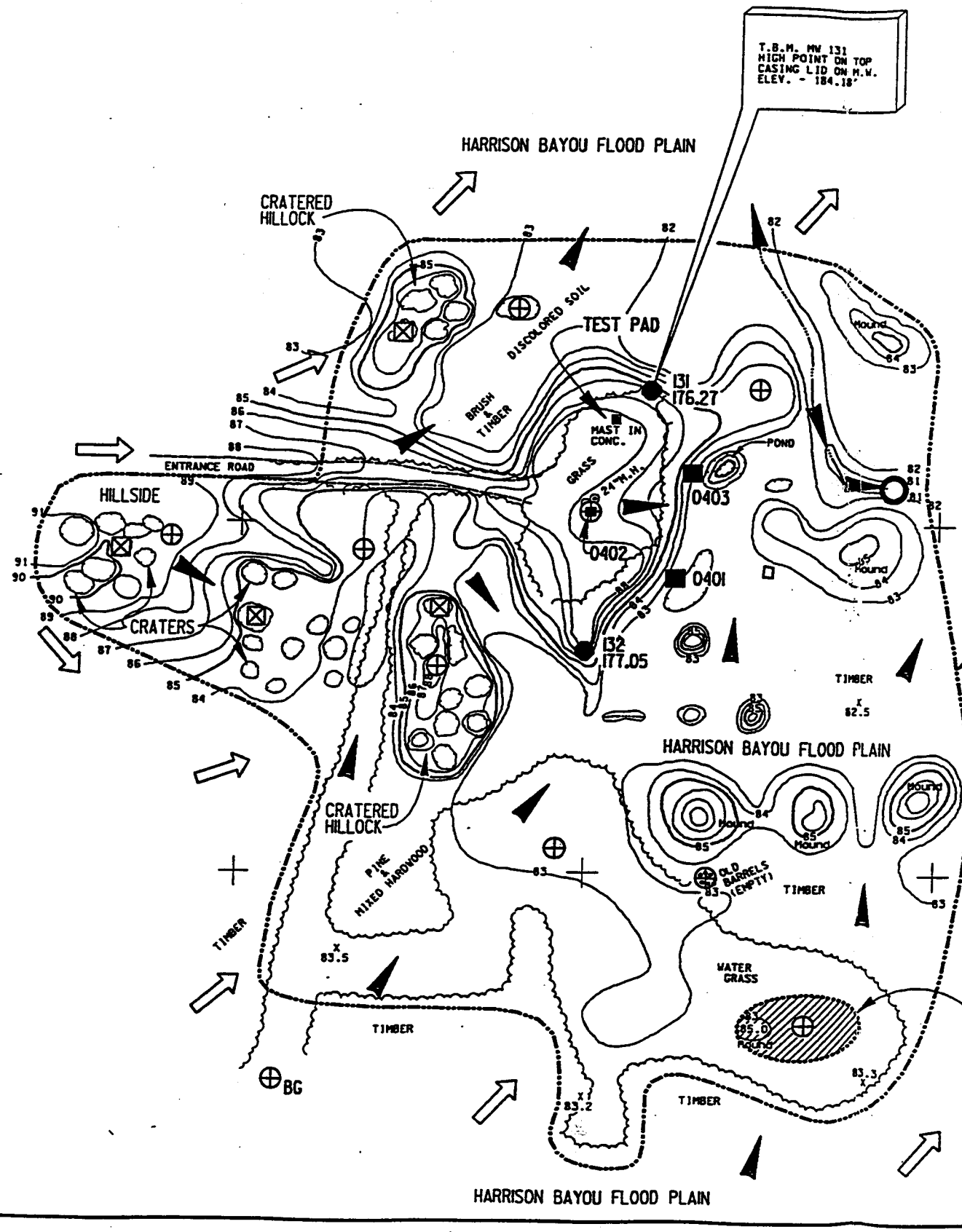
2 - Monitoring wells to be sampled

*Includes one background location.

Boring depths are estimated based on an anticipated depth to ground water of 8 feet, with borings continuing at least 2 feet past the depth where ground water is encountered. Actual depths may vary depending on the subsurface conditions encountered during investigations. Proposed sample locations are shown on Figs. 4-12-1 and 4-12-2. All samples from each medium will be analyzed for the respective list of parameters stated in the introductory paragraph of Section 4.0. Analyses for four of the soil borings will also include pesticides/ herbicides.

4.12.2.1 Shallow Soil Samples. The proposed shallow soil sampling locations are in the bottom of one of the deeper craters in each of the four cratered areas west of the Test Pad. The craters appear to have been created by medium-size explosives that were tested or disposed by detonation on or just below the ground surface. Each of the samples will be obtained from the uppermost 1.0 foot of material in the crater bottom. Analyses of these samples should indicate whether contaminants remain from the detonations and aid in identification of the explosive or explosives that were detonated.

4.12.2.2 Soil Borings. A total of 10 soil borings will be drilled at the site. Each soil boring will be drilled at least 2 feet



HARRISON BAYOU →

APPROXIMATE LIMIT OF SOUTH TEST AREA

AREA OF VEGATATION DISTRESS W/ BARE AREAS

LEGEND

- GROUND WATER FLOW DIRECTION
- 131 176.27 — MONITOR WELL AND NUMBER (EXISTING) WITH GROUND-WATER ELEVATION (SEE NOTE)
- SURFACE WATER FLOW DIRECTION
- 0403 — SHALLOW SOIL SAMPLE AND NUMBER (PREVIOUS)
- SOIL BORING (PROPOSED)
- SURFACE WATER / SEDIMENT SAMPLE (PROPOSED)
- SHALLOW SOIL SAMPLE (PROPOSED)
- BG — BACKGROUND SAMPLE LOCATION
- POINT OF COMPLIANCE

NOTE:
GROUND-WATER ELEVATION NOV 89.

N

50 0 50 100
SCALE IN FEET

US Army Corps of Engineers Fort Worth District

CORPS OF ENGINEERS
FORT WORTH DISTRICT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
RI/FS WORK PLAN
LHAAP - 27
SOUTH TEST AREA
PROPOSED SAMPLE LOCATIONS

DATE: JUNE 1992 | FIGURE 4-12-1

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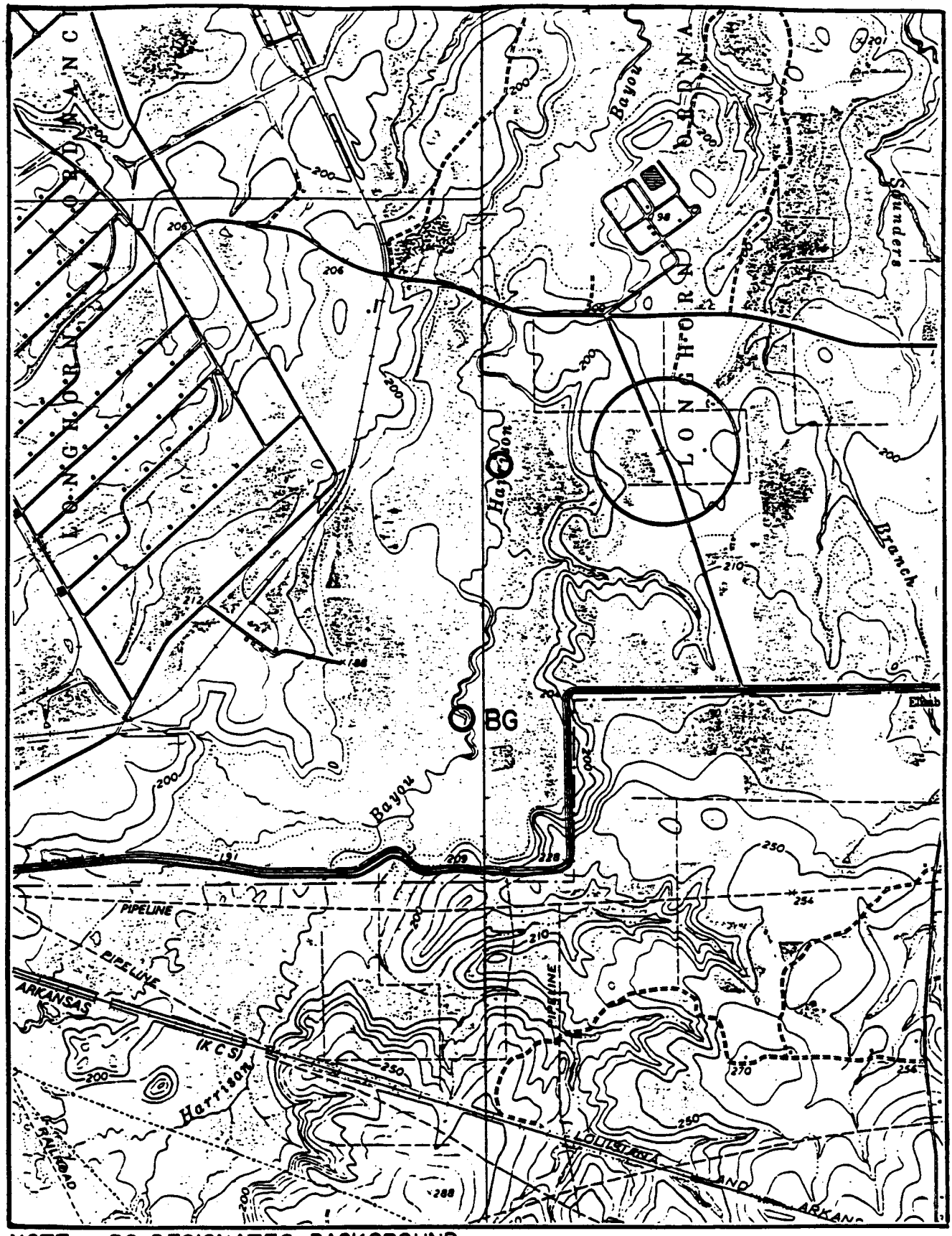

NOTE: BG DESIGNATES BACKGROUND

0000424

FIGURE 4-12-2
LHAAP 27
SOUTH TEST AREA
PROPOSED SURFACE WATER/SEDIMENT
SAMPLING LOCATIONS IN HARRISON BAYOU

past the depth where ground water is encountered. Approximate depth to ground water is less than 10 feet across the site.

One boring is proposed near the center of the Test Pad at the location of previous shallow soil sample 0402. Analyses from this boring will further characterize the contamination found in the shallow soil (fill) sample and will provide additional chemical data for the deeper fill and soils beneath the surface of the Test Pad.

Another boring is proposed on the elevated protuberance on the northeast flank of the Test Pad that appears to be fill material added after about 1970. It is possible that this fill may contain contaminants. The boring is also hydraulically downgradient from the central part of the Test Pad. Analyses of samples from the boring should serve to determine whether contaminants found at the Test Pad have migrated into nearby deeper soils and ground water.

A third boring is proposed in an area of discolored soil northwest of the Test Pad and east of one of the cratered areas. The soils and ground water in this area could possibly be contaminated by wastes originating at the nearby cratered hillock, at the Test Pad, or from possible dumping of liquid wastes at the upstream end of the area near the road. Soil analyses for this boring will include pesticides/herbicides.

A fourth boring is proposed within the drum disposal area. The purpose of this boring is to determine if any contamination is present from drum contents which may have been released. It is not known if drums were empty when they were disposed. The content of the drums is also unknown. Because there is no vegetation around the drum area, soil analyses for this boring will also include pesticides/herbicides.

Borings are also proposed in each of the three cratered areas

situated to the southwest and west of the Test Pad. A discussion of the origin of the craters can be found in Paras. 3.12.2 and 4.12.3. One of the borings is on top of a cratered hillock and is close to one of the proposed shallow soil sampling points in the bottom of an associated crater. The other two borings are immediately downstream and hydraulically downgradient from each of the westernmost cratered areas. The surficial and possibly deeper soils and ground water in the cratered areas could be contaminated by detonated explosives waste, including certain metals and anions.

Two other borings are proposed in a formerly cleared area to the south and southeast of the Test Pad where toxic wastes may have been disposed. One of the borings is in the approximate center of an area with obvious vegetation distress and bare areas, as shown on Figure 4.12.1. The other boring is almost due south of the Test Pad in an area with little sign of vegetation distress but has not revegetated as well as would be expected in the 37 years that have elapsed since the last known use of the area. Analysis of samples from both borings will include pesticides/herbicides and should reveal the reasons for the observed vegetation problems.

The tenth boring is near the southwest corner of the site. It is upstream and hydraulically upgradient from the site in an area that does not appear to have been affected by waste disposal operations. This boring will serve as a background sampling location.

Soil samples from each of the ten borings will be taken for physical analyses beginning at the ground surface then once every 5 feet or change in materials, whichever occurs more frequently. Soil samples for chemical analyses will be taken at least every 5 feet of boring depth, beginning at the ground surface.

4.12.2.3 **Surface Water and Sediment Samples**. Two of the four proposed surface water and sediment sampling locations are located at the South Test Area site. One of these on-site locations is in a small pond near the eastern margin of the Test Pad. The origin of the depression containing the ponded water is uncertain. It appears to have been excavated. Sampling and analyses will verify whether the depression was used for waste disposal or has collected contaminants.

The other on-site surface water and sediment sampling location is in the bottom of a shallow ditch in the northeastern corner of the site. This ditch is the only significant drainage channel on the site and it apparently collects most of the surface water runoff from the southwestern and central portions of the site, including runoff from most of the Test Pad. Analyses of samples from the ditch should serve to indicate whether surface water and sediment exiting the site via this ditch (or surface water/sediment being collected by similar off-site ditches) are contaminated.

The other two proposed surface water and sediment sampling locations are in the channel of Harrison Bayou, as described in Para 4.12.1. The exact location of each sampling point will be determined in the field at the time of sampling. If surface water is not present in the Harrison Bayou channel at the background sampling location, the location will be moved upstream to the nearest water in the channel. If surface water is not present in the Harrison Bayou channel at the downstream sampling location, this location will be moved downstream to the nearest channel water. It is anticipated that any required movement of sampling locations will be for a minimal distance. Analyses of the downstream samples, when compared to the upstream

sample analyses, will serve to indicate whether contaminants originating at the South Test Area site are impacting the surface water quality of Harrison Bayou.

4.12.2.4 Monitoring Wells and Ground-Water Sampling. No additional monitoring wells will be installed. However, a grab sample of ground water will be obtained from each of the ten soil borings. Existing Wells 131 and 132 will also be sampled and slug tested.

4.12.3 General Plan for Site Investigation - RI Phase II. If evidence of waste disposal is identified within any of the units investigated during the RI Phase I, a monitoring well will be installed within the waste unit location. Sampling of this well will characterize the nature of the contaminants entering the ground water from this source.

If no evidence of waste disposal is identified within any of the units investigated during the RI Phase I, at least four new monitoring wells will be installed along the point of compliance as it is shown on Figure 4-12-1 to determine any ground-water impact at the site. One upgradient and three downgradient wells will be sited using the ground-water data obtained from soil borings drilled during the RI Phase I efforts.

All wells to be installed during the RI Phase II will be installed to a depth no greater than 20 feet below the top of ground water. Should a confining layer at least 2 feet thick be encountered prior to reaching this depth, the well will be installed with the well screen extending through the entire saturated zone above this unit. Soil sampling for both physical and chemical analyses will be performed following the same procedures described for sampling the soil borings drilled at the site with soil samples for chemical analyses to be taken from the

unsaturated zone only. Analytical parameters will be the same. All new wells installed will be slug tested, then sampled at least monthly until the RI field work for all sites is complete.

SECTION 5.0

FEASIBILITY STUDY ACTIVITIES

The Feasibility Study will develop, analyze, and identify remedial alternatives for contaminated soil, sediment, surface water, and groundwater at each of the areas on the LHAAP. Remedial alternatives will be developed and initially screened to reduce the number of alternatives that will be analyzed in detail. A detailed analysis will be conducted on each of the remedial alternatives passing the screening process. Treatability studies will be done where additional data is needed to analyze alternatives in detail. Procedures for the FS will be in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

Several reports will be submitted as part of the FS phase. These include the Initial Screening of Alternatives Report, a primary document; the Post-Screening Investigation Work Plan, a secondary document; the Treatability Study Report, a secondary document; the Detailed Analysis of Alternatives Report, a secondary document; and the complete Feasibility Study Report, a primary document.

There will be an Initial Screening of Alternatives Report for all thirteen areas. Operable units will be identified as early as possible in the RI/FS process. The Post Screening Investigation Work Plan will be completed after the Initial Screening of Alternatives. One work plan will be prepared that covers activities at all operable units. The work plan will describe whether a treatability study is required for detailed analysis of alternatives. A separate report will be submitted for each operable unit that requires a treatability study. A Detailed Analysis of Alternatives Report and Feasibility Study Report will be submitted for each operable unit.

5.1 **Development and Initial Screening of Alternatives**. The first activity for the FS is the initial screening of alternatives, task 8 of the remedial activities for LHAAP. The task will start as soon as the RI/FS Work Plans are approved and will involve developing and screening several alternatives for each of the areas. An Initial Screening of Alternatives Report will be done when alternatives have been developed and screened. The Initial Screening of Alternatives Report is a primary document required by the FFA. There will be one Initial Screening of Alternatives Report for each operable unit identified.

5.1.1 **Development of Alternatives**. Alternatives will be developed according to the site characteristics, site contamination, and available and applicable controls and technologies. Appropriate controls and technologies will be combined for each site to develop complete, potentially protective alternatives for remediation. The alternative development process consist of six steps: (1) Development of Remedial Action Objectives; (2) Development of General Response Actions; (3) Identify Volume and Area of Contaminated Media; (4) Identify and Screen Technologies; (5) Evaluate Process Options; and (6) Assemble Alternatives.

5.1.1.1 **Development of Remedial Action Objectives**. The remedial action objectives will specify the contaminants and media of concern, possible exposure pathways, and preliminary remediation goals. The objectives will permit the development of a range of treatment and/or containment alternatives. The objectives will be based on the ARARs, risk assessment conducted during the RI, expected exposure pathways, and other regulations, criteria, and guidelines applicable to the site.

5.1.1.2 **Development of General Response Actions**. The general response actions will satisfy the remedial action objectives. The media-specific actions will define the containment, treatment, removal, and/or disposal that may be used to meet the remedial action objectives. The alternatives may be used singly or in combination with other alternatives.

5.1.1.3 **Identify Volume and Area of Contaminated Media**. The volume or area of contaminated media to which the general response actions might be applied will be defined. Remediation goals, exposure routes, and the physical and chemical characteristics of the site will be considered.

5.1.1.4 **Identify and Screen Technologies**. Technologies will be identified and screened based on technical implementability. The technology must be applicable to the contaminant type, contaminant concentration, affected media, and physical characteristics of the site.

5.1.1.5 **Evaluate Process Options**. A representative process for each technology type will be selected. These processes are intended to represent the broader range of process options for each technology type. The process options are evaluated on effectiveness, implementability, and cost.

5.1.1.6 **Assemble Alternatives.** The general response actions and process options for each technology will be combined to form remedial alternatives.

5.1.2 **Screening of Alternatives**. The screening of alternatives may be necessary to streamline the detailed analysis of alternatives process. The screening of alternatives will be based on cost, implementability, and effectiveness. Cost comparison will be in order

of magnitude, but will include estimates of the operation and maintenance cost. The evaluation of implementability may include constructability; opposition from the public; impact on the mission of the LHAAP; compatibility with present and future land use; and availability of material, equipment, technical expertise or off site treatment and disposal facilities. The ability of the alternatives to achieve the remediation goals and possibility of adverse environmental impacts will be considered in evaluating an alternatives effectiveness. Upon completion of the screening of alternatives process, the most promising alternatives will be selected for the detailed analysis of alternatives. The range of alternatives for detailed analysis will include the following types of alternatives:

(1) A treatment alternative that would eliminate or minimize the need for long term monitoring or maintenance.

(2) An alternative that will treat the principal threat of the site, but requires long term monitoring or maintenance.

(3) An alternative that will contain the waste with little or no treatment but will protect the human health and the environment.

(4) A no action alternative.

5.1.3 Initial Screening of Alternatives Report. An Initial Screening of Alternatives Report is a primary document required by the FFA. The report will include a discussion on the development and initial screening of alternatives, a list of alternatives developed, a discussion of the screening of alternatives, determine whether a treatability study is needed, and a describe the alternatives retained for detailed analysis.

5.2 Treatability Studies. Treatability studies are task 9 of the remedial activities for LHAAP. The Post-Screening Investigation Work

Plan and the Treatability Study Report, both secondary documents, will be generated as part task 9. A Treatability Study Report will be specific to an operable unit and a technology. Treatability studies probably will not be required at all operable units.

Treatability studies in the RI/FS phase will be used for remedy screening and remedy selection. They will be done to provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis phase and to reduce cost and performance uncertainties. The results of the treatability study will be used to improve scale-up of designs or additional pilot studies if the remedial design uses the technology studied.

The need for a treatability study will be determined in the initial screening of alternatives. A decision tree that outlines the steps to determine if a treatability study is needed is given in Figure 5-1.

5.2.1 Post Screening Investigation Work Plan. The Post Screening Investigation Work Plan is a required secondary document. One work plan will be submitted that describes work required to complete the FS at all operable units. The work plan will describe procedures to obtain the additional data needs for detailed analysis of alternatives. It will also describe the work elements of any treatability studies required and whether a pilot-scale or bench-scale study is required.

Areas that will addressed in a treatability study portion of the work plan are given below.

(1) Project Description and Site Background.

(2) Remedial Technology Description.

(3) Test Objectives.

(4) Specialized Equipment and Materials (bench-scale) or Plant Installation and Start-up (pilot-scale).

(5) Laboratory Test (bench-scale) or Plant Operation and Maintenance Procedures (pilot scale).

(6) Treatability Test Plan.
(7) Analytical Methods and Sampling Plan.

(8) Data Management.

(9) Data Analysis and Interpretation.

(10) Health and Safety.

(11) Residual Management.

(12) Schedule.

5.2.2 **Treatability Study Report**. A separate Treatability Study Report will be completed for each operable unit and each technology tested, if appropriate. The Treatability Study Report is a secondary document. The report will describe the testing that was done, the results of the tests, an interpretation of how the results affect evaluation of the alternatives. The effectiveness of the technology and an evaluation of how it will affect treatment costs will also be presented in the report.

5.3 **Detailed Analysis of Alternatives**. The detailed analysis of alternatives is task 10 of the remedial activities for LHAAP. It will include further definition of the alternatives, an assessment and summary of each alternative against nine criteria, and a comparative analysis of the alternatives with respect to the nine evaluation criteria. Upon completion of the detailed analysis of alternatives, a Detailed Analysis of Alternatives Report will be completed.

5.3.1 **Further Definition of the Alternatives**. Based on additional site characterization and treatability studies, the alternatives will be further refined. The alternatives will address the remediation of the entire operable unit.

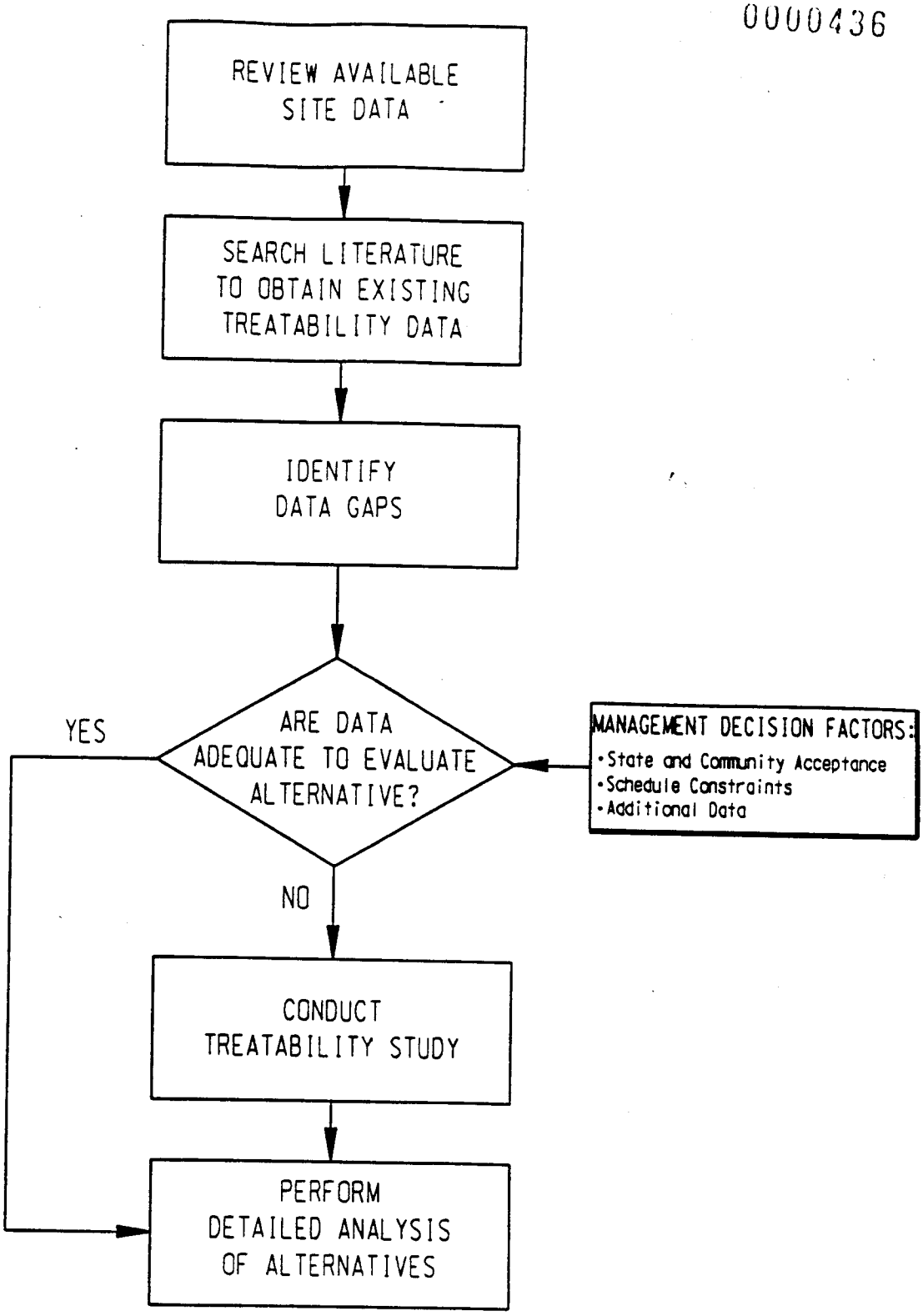

FIGURE 5-1 Decision Tree to Determine if a Treatability Study is Needed

5.3.2 **Nine Evaluation Criteria**. Each alternative is evaluated according to nine evaluation criteria. The nine evaluation criteria are categorized into threshold criteria, primary balancing criteria, and modifying criteria. The evaluation criteria are listed below.

Threshold Criteria

(1) Compliance with ARARs.

(2) Overall Protection of Human Health and the Environment.

Primary Balancing Criteria

(3) Short-term Effectiveness.

(4) Long-term Effectiveness.

(5) Reduction of Toxicity, Mobility, and Volume.

(6) Implementability.

(7) Cost.

Modifying Criteria

(8) Support Agency Acceptance.

(9) Community Acceptance.

5.3.2.1 **Compliance with ARARs**. The compliance with ARARs criterion will address whether each alternative meets its Federal and State ARARs, and other requirements "to be considered" in the evaluation. This criterion will address the compliance with contaminant specific, location specific, and action specific ARARs. The evaluation will also include a discussion of any appropriate ARAR waivers. The final determination of which ARARs pertain to each alternative will be made by the EPA Region VI and the appropriate State of Texas agencies.

5.3.2.2 **Overall Protection of Human Health and the Environment**. This criterion will address and describe how existing

and potential risks from pathways of concern are eliminated, reduced or controlled through treatment and engineering and/or institutional controls. This criterion will address the overall protectiveness of each alternative with respect to each pathway addressed in the FS.

5.3.2.3 **Short-Term Effectiveness**. This criterion addresses the impacts on human health and the environment during construction and implementation of the alternatives. Potential impacts on the community and the workers during implementation, potential environmental impacts of the remedial action, and the time required to meet the remedial objectives will be considered.

5.3.2.4 **Long-Term Effectiveness**. The evaluation of alternatives using this criterion will address the performance of the alternatives in protecting human health and the environment after response objectives have been met. The criterion will address the magnitude of residual risk from untreated waste and the residuals from treated waste, and adequacy and reliability of engineering and institutional controls used to manage the untreated waste and treatment residuals.

5.3.2.5 **Reduction of Toxicity, Mobility, and Volume**. This evaluation criterion will assess the performance of each alternative in terms of reducing the toxicity, mobility, or volume of hazardous substances through treatment. This criterion will be applied to alternatives with treatment as their principal element. Each alternative will be evaluated by the six factors listed below.

(1) Treatment process and amount of material to be treated.

(2) Amount of hazardous material that will be destroyed or reduced.

(3) Degree of toxicity, mobility, or volume reduction.

(4) Degree to which treatment is irreversible.

(5) Type and quantity of residuals resulting from the treatment process.

(6) Whether or not statutory preference for treatment as a principal element is satisfied.

5.3.2.6 Implementability. This evaluation criterion will assess the degree of difficulty and uncertainties associated with undertaking specific technical and administrative steps and the availability of various services and materials.

The technical feasibility will be evaluated on the following:

(1) Difficulties and unknowns associated with the technology.

(2) Reliability of the technology.

(3) Ease of undertaking additional actions as necessary.

(4) Reliability/Effectiveness of monitoring.

The evaluation of administrative feasibility will include:

(1) Ability and time required to coordinate with other offices and agencies.

(2) Time required to obtain permits for off-site actions.

The availability of sources and materials will be evaluated on:

(1) Treatment, storage, and disposal capacity.

(2) Existence of multiple vendors.

(3) Availability of needed equipment and experts.

(4) Timing of availability of the technologies.

5.3.2.7 Cost. The criterion will address capital, annual operation and maintenance, and present worth cost. Capital costs will include direct cost (equipment, labor, and materials necessary to install the remedial action) and indirect cost (engineering, financial, management, and other sources not a part of the construction). Operation and maintenance cost will include the cost

required to ensure the continued effectiveness of the remedial action. An estimate of the present worth of the alternatives will be computed using the capital cost and operation and maintenance cost to compare the alternatives.

5.3.2.8 **Support Agency Acceptance**. This criterion evaluates the technical and administrative issues and concerns the support agency may have regarding each of the alternatives. Complete evaluation of this criterion will require comments from the support agency on the RI/FS and the Proposed Plan. Therefore, this criterion will be addressed in full in the Record of Decision (ROD).

5.3.2.9 **Community Acceptance**. This criterion will be addressed in full in the ROD due to the requirement of comments from the community on the RI/FS and Proposed Plan. It will evaluate any issues and concerns the community has for each alternative.

5.3.3 **Comparative Analysis of Alternatives**. An evaluation of the relative performance of the alternatives in relation to each of the nine criteria will be conducted. The advantages and disadvantages of each alternative will be identified along with key uncertainties which could change the expected relative performance of an alternative.

5.3.4 **Detailed Analysis of Alternatives Report**. A Detailed Analysis of Alternatives report will be prepared for each operable unit. The report will include a discussion of the refinement of the alternatives, describe the evaluation by the nine criteria for each alternative, and the comparative analysis of the alternatives. The detailed analysis of alternatives report is a secondary document, therefore all comments will be incorporated into the FS Report.

5.4 **Feasibility Study Report**. An FS Report will be done after the

Detailed Analysis of Alternatives Report. An FS Report will be done for each operable unit. The FS report will include information from both the Initial Screening of Alternatives Report, the Treatability Study Report, and the Detailed Analysis of Alternatives Report. The FS report is a primary document required by the FFA.

SECTION 6.0

RISK ASSESSMENT

6.1 General. The Baseline Risk Assessment will consist of two basic assessments - a Health Risk Assessment and an Ecological Risk Assessment. The Health Risk Assessment is discussed in Sections 6.2 through 6.3, and the Ecological Risk Assessment is discussed in Section 6.4.

Individual site-specific risk assessments and a comprehensive installation risk assessment are both needed to determine potential environmental and health risks. The individual site-specific risk assessments will be completed first, and pertinent information from these investigations will then be integrated into the installation risk assessment. Figure 6-1 conceptually illustrates potential exposure pathways, release mechanisms, and receptors associated with a partially buried contaminant source. This concept drawing is only an example of basic exposure routes potentially involved at a specific site. During risk assessment site-specific exposure routes will be reviewed and integrated together to determine contamination accumulation points for the installation area.

In addition, it is also very important to consider both existing future land use of individual sites, the installation as a whole, and surrounding properties. In general, changes to residential land use would increase the opportunity for further exposure. The risk assessment will include the consideration of both existing and reasonable future land use conditions to determine potential risks. In addition, changes in water use will also be considered. For example, in the future the city of Shreveport, Louisiana, is constructing a pipeline to Caddo Lake to obtain another water supply

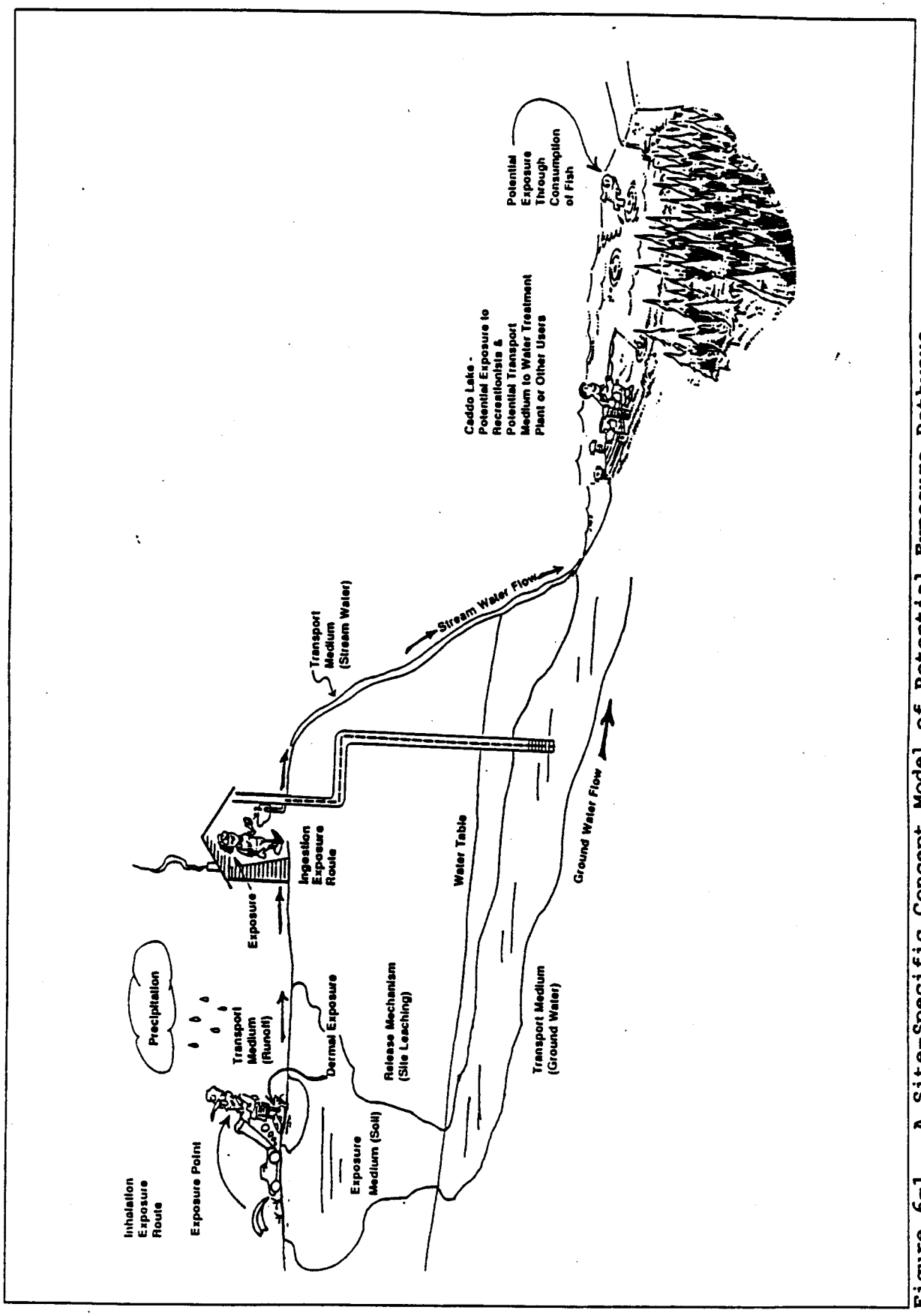

Figure 6-1. A Site-Specific Concept Model of Potential Exposure Pathways

source to supplement its principle water supply (Mr. Evanoff, City of Shreveport, May 1992). Therefore, in the future if Caddo Lake becomes contaminated, a portion of Shreveport's population would be subject to exposure if contaminants elude treatment. The future land use scenario will be clearly defined and supported with information on reasonable population trends.

6.2 **Site-Specific Risk Assessments**. The following discussion addresses the work required to perform risk assessments at the individual sites. If sampling indicates contaminants are present in significant concentrations and are migrating, additional water samples will be needed to perform modeling for risk characterization. To support the modeling effort for ground-water migration, 3 or 4 sampling sets (1 set for each quarter or 3-month period) are required. Data from previous ground-water samples and proposed screening samples may be used toward this requirement if sampling information is usable for model calibration and for determining plume direction. For surface water migration, 2 or 3 sets of water samples will be taken during wet and dry seasons, and if possible, multiple samples will be taken during a storm event. Review of past and new surface water sampling data may reduce the need for additional surface water tests and stream modeling. Modeling of Caddo Lake will only be conducted if contaminant loads to the lake are significant. For minor contaminant concentrations, modeling of Caddo Lake will be deferred until cumulative lake effects are addressed in the installation risk assessment.

During risk assessment, soil-to-air migration will be reviewed for each site. Existing and the required future sampling data for surface soils will be reviewed. Initially, site-specific sampling

data and future land use information will be used to determine the need for further soil sampling, air sampling, and/or air modeling.

If modeling is required for site-specific investigations, models will be chosen that are approved by U.S. Environmental Protection Agency and Texas Water Commission.

The following subsections present further site-specific details.

6.2.1 LHAAP 11 - Suspected TNT Burial Site at Avenues P & Q

6.2.1.1 Contaminants of Concern. The presence of two hazardous wastes, 2,4,6-trinitrotoluene (TNT) and 1,3,5-trinitrobenzene (1,3,5-TNB), were identified in soil samples of previous investigations. TNT was identified in one composite site soil sample (1.86 ug/g at 2.5-5 feet) at one of three site locations sampled in a 1984 study, but was not discovered in any of the soil samples taken at 10 locations in and around the site during a later study in 1988. In the 1988 study, 1,3,5-TNB was identified in soil in 3 of 4 sample locations at the site but was also found at 5 of the 6 sample areas nearby. The highest 1,3,5-TNB concentration on the site itself was 40 ug/kg; however, higher 1,3,5-TNB concentrations ranging from 70 to 117 ug/kg were found in the shallow (0-18 inches) soil samples taken north of the site.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a

result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.1.2 **Exposure Assessment.** Since surface soils contain low concentrations of 1,3,5-TNB, surface water, ground water, and air are the potential transport media of concern. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to adjacent collection ditches. Hence, flows carrying these contaminants could eventually reach Central Creek and possibly enter into Caddo Lake downstream. However, there is a good stand of vegetation that retains the soil and prevents erosion by water. Water percolating through the soils may leach contaminants into the shallow ground water (observed within 3 feet of soil surface). Previous investigations did not detail site-specific hydrogeologic conditions to fully ascertain underground flow patterns. Direction of ground-water flow is assumed to be topographically controlled, flowing in an eastward direction. Existing vegetative ground cover potentially limits wind erosion, but changes in land use could possibly cause air dispersal of contaminants.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would involve contaminants carried from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-

gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. Lawn and utility maintenance personnel may be incidentally exposed during work activities on site. Mowing and utility repair along the road may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, the frequency for utility maintenance activities requiring soil excavation is low, and lawn mowing activities are not expected to significantly disperse contaminated dust.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.1.3 Toxicity Assessment. 1,3,5-trinitrobenzene and 2,4,6-trinitrotoluene are both hazardous for their reactivity and toxicity. TNT is considered as a possible human carcinogen (Class C carcinogen). The munition health advisory for ingestion of TNT in water is 20 micrograms per liter (ug/L) for short (1- and 10-day interval) and longer exposure term and 2 ug/L for lifetime exposure with 20 % contributed from other sources besides drinking water (EPA Office of Drinking Water, 1990). It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.1.4 Risk Characterization. Based on the limited toxicity and exposure information, it is difficult to characterize potential human health and environmental risk without additional information. Additional toxicological information will be sought for TNT, 1,3,5-TNB, and other identified contaminants of concern before a risk characterization is conducted. Additional sampling will be conducted as described in 7.2.1.6 below. Contaminants of concern that

exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will be the same as that used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.1.5 **Risk Assessment Report Requirements**. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.1.6 **Risk Assessment Data Requirements and Data Quality Objectives**. Additional data are needed to determine if a health risk assessment is necessary. Previous sampling for explosives is inclusive and does not necessarily indicate that the site was once used for burial of TNT. Additional soil and water samples will be taken at depths greater than 2.5 feet to determine if the previous sample containing TNT is an anomaly. Because of the presence of 1,3,5-TNB in shallow soil samples (0-18 inches), deeper soil samples will also be taken in the background and borrow pit areas located north of the site. Since no water samples have been taken, ground-water samples will also be taken. All sample analyses will include TNT and other explosives. See previous Section 4.1 for further information on the proposed sampling plan. If TNT or other explosives are not found in these soil and water samples, a risk assessment will

not be needed.

If after further testing the explosive concentrations are measurable, additional sampling from monitoring wells will be performed to determine migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the additional testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.2 LHAAP 13 - Suspected TNT Burial Site between Old and Active Landfills/Acid Dump

6.2.2.1 Contaminants of Concern. There has been no previous sample collection and testing at this site. Suspected contaminants include explosive compounds, associated acidic wastes, and/or pesticides/herbicides. No specific contaminants of concern can be identified until samples are taken and tested. Suspected methods of disposal are burial or dumping.

After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation

Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.2.2 **Exposure Assessment**. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to adjacent collection ditches. Hence, flows carrying these contaminants could eventually reach Central Creek and possibly into Caddo Lake downstream. Although there are a few bare spots at the site, there is a good surrounding vegetation that slows surface water migration. Water percolating through the soils may leach contaminants into the ground water (no water depth observations in area). Future investigations will need to better define site-specific hydrogeologic conditions to fully ascertain ground-water flow patterns. Direction of ground-water flow is assumed to be topographically controlled, following an eastward direction. Small bare spots may be subject to some wind erosion.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the

likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. Lawn and utility maintenance personnel may be incidentally exposed during work activities on site. Mowing and utility repair along the road may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, the frequency for utility maintenance activities requiring soil excavation is low and lawn mowing activities are not expected to significantly disperse contaminated dust.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard

Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.2.3 Toxicity Assessment. Toxicity cannot be addressed until specific contaminants of concern are identified. Once these substances are identified, human health and environmental effects will be addressed. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.2.4 Risk Characterization. The approach for risk characterization cannot be determined until the specific contaminants of concern are first identified and quantified, the toxicity assessment is performed, and contaminant concentrations are determined at the point of intake. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will be the same as that used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.2.5 Risk Assessment Report Requirements. The risk

assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.2.6 **Risk Assessment Data Requirements and Data Quality Objectives.** Soil boring and ground-water samples will be taken to determine the presence and quantity of contaminants. One monitoring well is proposed. Parameters to be tested will include pH, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosives, nitrates, pesticides, herbicides, and the following metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. See previous Section 4.2 for further information on the proposed sampling plan.

If contaminants are present and toxic concentrations are measurable, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will

be taken to provide a reliable evaluation of potential risks.

6.2.3 LEAAP 14 - Area 54 Burial Ground

6.2.3.1 Contaminants of Concern. There has been no previous sample collection and testing at this site. Suspected contaminants include explosive compounds, associated acidic wastes, and contaminated demolition debris. No specific contaminants of concern can be identified until samples are taken and tested. Suspected method of disposal is burial.

After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.3.2 Exposure Assessment. Potential contaminants of concern could be transported by ground water and possibly by surface water. The asphalt parking lot cap overlies the site and prevents any significant erosion from occurring.. However, there are a few seeps in the pavement which may allow some limited migration of contaminants to the surface. Runoff from heavy rains could then carry these surface contaminants to adjacent collection ditches. Hence, flows carrying these contaminants could eventually reach Harrison Bayou and possibly into Caddo Lake downstream. With the paved cap on the site, there is very little or no opportunity to transport contaminants to the air.

Water percolating through soils from areas adjacent to the site may leach contaminants into the ground water, which is approximately 7 to 8 feet below the surface. Investigations need to better define site-specific hydrogeologic conditions to fully ascertain ground-water flow patterns. Direction of ground-water flow is assumed to be topographically controlled, flowing eastward toward Harrison Bayou.

Potential human exposure pathways include consumption of well water and Caddo Lake water. Inhalation of contaminated dust or dermal contact with contaminants at the site is not expected to occur because of the paved cap. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells downgradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A)

(EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.3.3 Toxicity Assessment. Toxicity can not be addressed until specific contaminants of concern are identified. Once these substances are identified, human health and environmental effects will be addressed. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.3.4 Risk Characterization. The specific approach for risk characterization can not be defined until the specific contaminants of concern are first identified and quantified, the toxicity assessment is performed, and contaminant concentrations are determined at the point of intake. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and

noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will be the same as that used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.3.5 **Risk Assessment Report Requirements.** The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.3.6 **Risk Assessment Data Requirements and Data Quality Objectives.** Soil boring and ground-water samples will be taken to determine the presence and quantity of contaminants. One monitoring well is proposed. Parameters to be tested will include pH, VOCs, SVOCs, explosives, nitrates, and the following metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. See previous Section 4.3 for further information on the proposed sampling plan.

If contaminants are present and toxic concentrations are measurable, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.4 LHAAP 16 - Old Landfill

6.2.4.1 Contaminants of Concern. Major contaminants of concern identified in ground water taken from a well downgradient of the site include 2,6-DNT, vinyl chloride (concentration in one sample exceeded EPA drinking water standard), and cadmium (concentrations in two samples exceeded EPA drinking water standard). From the same well, other contaminants of lesser concern were also detected in the ground water. These contaminants include antimony, chromium, manganese, strontium, barium, beryllium, copper, aluminum, and zinc. Contaminants found in sediment samples from Harrison Bayou include 2,4,6-TNT, 1,3-DNB, and 2,6-DNT. Other contaminants detected in soil samples at the site included 2,4-DNT, 1,3,5-TNB, arsenic, lead, mercury, and silver.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a

result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.4.2 **Exposure Assessment.** Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to adjacent collection ditches. Hence, flows carrying these contaminants could reach Harrison Bayou and possibly Caddo Lake downstream. Although there are a few bare spots on the landfill surface, there is a good surrounding vegetation that slows surface migration. Water percolating through the soils may leach contaminants into the ground water. Ground water carrying the contaminants flows eastward towards Harrison Bayou where discharge could occur to surface drainage.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for storage or other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated

work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. There are no known plans to use the site for other purposes.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.4.3 Toxicity Assessment. The major contaminants to be assessed for toxicity should include 2,6-DNT, vinyl chloride, and cadmium. The explosive 2,6-DNT is listed as a probable human carcinogen and is listed for regulation by EPA but no standards or health advisories have been established. The EPA drinking water maximum contaminant level for vinyl chloride, a human carcinogen, is 2

ug/L. The EPA drinking water maximum contaminant limit for cadmium is 5 ug/L. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.4.4 **Risk Characterization**. After sampling is completed and parameters of potential concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.4.5 **Risk Assessment Report Requirements**. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part

A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.4.6 **Risk Assessment Data Requirements and Data Quality Objectives**. Additional monitoring wells are proposed. Parameters to be tested in the ground water will include VOCs, explosives, and at least the following metals: antimony, arsenic, barium, cadmium, chromium, lead, mercury, and silver. In addition to the one existing downgradient well, three new monitoring wells are proposed downgradient of the landfill site.

Additional surface water samples along drainage ditches and the adjacent stream are also proposed to determine possible inflow of contaminants from the site. At least four samples will be taken along the surface water courses.

If after further testing toxic concentrations are measurable, additional water and/or sediment sampling will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will

be taken to provide a reliable evaluation of potential risks.

6.2.5 LHAAP 17 - Burning Ground No. 2/ Flashing Area

6.2.5.1 Contaminants of Concern. Major contaminants of concern identified in ground water taken from a monitoring well at the site include antimony (concentration in one sample exceeded proposed EPA drinking water standard), cadmium (concentration in one sample exceeded EPA drinking water standard), lead (concentration in one sample exceeded EPA drinking water standard), thallium (concentration in one sample exceeded proposed EPA drinking water standard), and dichloromethane (concentration in one sample exceeded proposed EPA drinking water standard). One sampling area located near the center of the site had metal, explosive, and VOC concentrations that exceeded background soil sample concentrations. In the creek downstream of the site, traces of toxic contaminants were found in sediment.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.5.2 Exposure Assessment. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the

contaminated surface soil as sediment to adjacent collection ditches. Hence, flows carrying these contaminants could reach Harrison Bayou and possibly enter Caddo Lake downstream. Although there are bare spots on the surface of the site, there is a good surrounding vegetation that slows surface migration. Water percolating through the soils may leach contaminants into the ground water. Ground water flows northwest towards Harrison Bayou where discharge likely occurs to surface drainage.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells downgradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for storage or other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. There are no known plans to use the site for other purposes.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of

exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.5.3 **Toxicity Assessment**. The major contaminants to be assessed for toxicity will include antimony, cadmium, lead, thallium, and dichloromethane. The EPA drinking water maximum contaminant limit for both cadmium and lead is 5 ug/L. The proposed EPA drinking water maximum contaminant limits for antimony, thallium, and dichloromethane are 5 (or 10) ug/L, 1 (or 2) ug/L, and 5 ug/l, respectively. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002,

December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.5.4 **Risk Characterization.** After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. Risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.5.5 **Risk Assessment Report Requirements.** The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.5.6 **Risk Assessment Data Requirements and Data Quality Objectives.** The proposed sampling scheme is identified in Section 4.5. Soil boring (8 borings), surface water (3 locations), sediment

(3 locations), and ground-water (existing wells and boreholes) samples are proposed. Parameters to be tested in the ground water will include VOCs and at least the following metals: antimony, cadmium, lead, and thallium.

If after testing toxic concentrations are measurable at perimeter locations, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.6 LHAAP 18 - Burning Ground No. 3 and LHAAP 24 - Unlined Evaporation Pond/Rocket Motor Washout Facility

6.2.6.1 Contaminants of Concern. Primary contaminants of concern are arsenic, barium, lead, chromium, cadmium, mercury, nickel, thallium, nitrates, 1,2-dichloroethene, 1,2-dichloroethane, methylene chloride (dichloromethane), tetrachloroethane, 1,1,2-trichloroethane, and trichloroethene. These contaminants exceeded EPA drinking water criteria or ambient water quality criteria for aquatic life in at least one or more ground-water samples taken at the site.

The list above is a preliminary list of contaminants of concern.

After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.6.2 **Exposure Assessment.** Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to adjacent Harrison Bayou. Hence, creek flows would carry these contaminants into Caddo Lake downstream. Although there are few bare spots at the site, there is a good surrounding vegetation that slows surface water migration. Water percolating through the soils may leach contaminants into the ground water. Ground water carrying the contaminants flows northwest toward Harrison Bayou where discharge likely occurs.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public

consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for storage or other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. There are no known plans to use the site for other purposes.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.6.3 **Toxicity Assessment.** The major contaminants to be assessed for toxicity will include arsenic, barium, chromium, cadmium, lead, mercury, nickel, thallium, nitrates, 1,2-dichloroethene, 1,2-dichloroethane, methylene chloride, 1,1,2-trichloroethane, trichloroethene, and tetrachloroethane. Arsenic is a known carcinogen and toxin with a current drinking water maximum contaminant level of 50 ug/L (under review). Methylene chloride, trichloroethene, 1,2-dichloroethane, and lead are probable carcinogens that each have proposed or final maximum contaminant levels of 5 ug/L. Lead has additional adverse health effects. Nitrates in excess of 10 mg/l will have detrimental fatal effects to newborn infants. Barium, cadmium, chromium, mercury, nickel, thallium, and 1,2-dichloroethene have maximum contaminant levels of 2000 ug/L (proposed), 5 ug/L, 100 ug/L, 2 ug/L, 100 ug/L (proposed), 2-1 ug/L (proposed), and 70/100 ug/L (cis-/trans-), respectively. Tetrachloroethane and 1,1,2-trichloroethane are possible carcinogens that are listed for regulation. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for

toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.6.4 Risk Characterization. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.6.5 Risk Assessment Report Requirements. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.6.6 Risk Assessment Data Requirements and Data Quality Objectives. Ground-water samples will be taken from 40 of the existing wells in the site area. Surface water and sediment samples will be taken along surface drainage paths leaving the site. Parameters to be tested will include VOCs, nitrates, and at least the following metals: arsenic, barium, cadmium, chromium, lead, mercury, nickel, and thallium. Test data from the monitoring wells will be used in ground-water modeling.

If sampling indicates significant ground-water migration toward

the adjacent creek, additional sampling of surface water will also be performed. The number and location of sample sites, frequency of sampling, and parameters to be tested will depend on the results of the well sample testing discussed in the previous paragraph above.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.7 LHAAP 29 - Former TNT Production Area

6.2.7.1 Contaminants of Concern. Primary contaminants of concern are 2,4,6-TNT, 1,3,5-TNB, 2,4-DNT, 2-6-DNT, and lead, which were found in previous surface water samples. In addition, 1,3-DNB was found in soil samples.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.7.2 Exposure Assessment. Potential contaminants of concern could be transported by surface water, ground water, and

possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to adjacent Harrison Bayou. Hence, creek flows would carry these contaminants into Caddo Lake downstream. There is a good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soils may leach contaminants into the ground water. Ground water carrying potential contaminants flows to the east and to the southeast, toward Goose Prairie and Central Creeks, where discharge may occur.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for storage or other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. There are no known plans to use the site for other purposes.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.7.3 Toxicity Assessment. 1,3,5-trinitrobenzene and 2,4,6-trinitrotoluene are both hazardous for their reactivity and toxicity. TNT is considered as a possible human carcinogen (Class C carcinogen). The munition health advisory for ingestion of TNT in water is 20 micrograms per liter (ug/L) for short (1- and 10-day interval) and longer exposure term and 2 ug/L for lifetime exposure with 20 % contributed from other sources besides drinking water (EPA Office of Drinking Water, 1990). Lead, a probable human carcinogen and toxin, has a proposed EPA drinking water maximum contaminant level of 5 ug/L. It is important to note that the list of contaminants of

concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.7.4 Risk Characterization. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.7.5 Risk Assessment Report Requirements. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-

89/001, March 1989), or to subsequent revisions of these two documents.

6.2.7.6 **Risk Assessment Data Requirements and Data Quality Objectives.** Additional water, soil, and sediment sampling is proposed. Parameters to be tested in the ground water will include explosives, and at least the metal lead. A detailed sampling plan is identified in Section 4.7.

If after further testing toxic concentrations are measurable, additional water and/or sediment sampling will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested would depend on geology and the results of the additional testing discussed in the previous paragraph above. Test data from these monitoring wells would be used in ground water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.8 LHAAP 12 - Active Landfill

6.2.8.1 **Contaminants of Concern.** Primary contaminants of concern found in ground water are 1,3-DNB, cadmium, lead, thallium, and dichloromethane. Aluminum and manganese were also identified in elevated concentrations in ground water.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form

appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.8.2 **Exposure Assessment.** Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soils. Runoff could consequently carry the contaminated surface soil as sediment to Central Creek. Hence, creek flows would carry these contaminants into Caddo Lake downstream. There is a good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soils may leach contaminants into the ground water. It is not certain whether ground water carrying potential contaminants flows northward to Central Creek or eastward to Harrison Bayou.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-

gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for storage or other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. Other landfill activities may also increase the potential for dermal contact. However, there are no immediate plans to use the site for purposes other than a landfill.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.8.3 Toxicity Assessment. The major contaminants to be assessed for toxicity will include 1,3-DNB, cadmium, lead, thallium, and dichloromethane. The health advisory for lifetime exposure through ingestion of 1,3-DNB is 1 ug/L. Dichloromethane is a probable carcinogen that has an EPA drinking water maximum contaminant levels of 5.0 ug/L. Lead is toxic and is also classed as a probable carcinogen. The EPA proposed maximum contaminant level for lead and thallium are 5.0 ug/L and 2-1 ug/L, respectively. The EPA maximum contaminant level for cadmium is 5 ug/L. Health advisories or maximum contaminant levels have not yet been established for aluminum or manganese. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.8.4 Risk Characterization. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic

and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.8.5 **Risk Assessment Report Requirements.** The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.8.6 **Risk Assessment Data Requirements and Data Quality Objectives.** Additional water and soil samples will be taken to better define the existing contaminant conditions. Surface water and sediment samples will be taken in the ditches near the northwestern and southwestern ends of the active landfill. Ground-water samples will be taken from existing wells and from new bore holes. Parameters to be tested will include VOCs, explosives, and at least the metals cadmium, lead and thallium. If after further testing toxic concentrations are measurable, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.9 LHAAP 32 - Former TNT Waste Disposal Plant

6.2.9.1 Contaminants of Concern. Lead and 2,4,6-TNT are the principal contaminants of concern. These contaminants were found primarily in surface water samples and not in ground water sampled in the one existing well at the site. However, other explosives will also considered since the site was once used as a TNT disposal plant. In addition, an area of stressed vegetation may be a result of other contaminants.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.9.2 Exposure Assessment. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen

contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment to Goose Prairie Creek. Hence, creek flows would carry these contaminants into Caddo Lake downstream. There is a good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soil may leach contaminants into the ground water. Ground-water flow direction across the site is expected to vary from the north-northeast to the southeast, while the more regional direction is to the east toward Caddo Lake.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, there are no immediate plans to use the site.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of

exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.9.3 Toxicity Assessment. The explosive 2,4,6-trinitrotoluene is hazardous for its reactivity and toxicity. TNT is considered a possible human carcinogen (Class C carcinogen). The munition health advisory for ingestion of TNT in water is 20 micrograms per liter (ug/L) for short (1- and 10-day interval) and longer exposure terms and 2 ug/L for lifetime exposure with 20 % contributed from other sources besides drinking water (EPA Office of Drinking Water, 1990). Lead, a toxin and probable carcinogen, has an EPA proposed drinking water maximum contaminant level of 5.0 ug/L. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for

risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.9.4 **Risk Characterization**. After sampling is completed and parameters of potential concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. Risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.9.5 **Risk Assessment Report Requirements**. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two

documents.

6.2.9.6 Risk Assessment Data Requirements and Data Quality Objectives. Additional water, sediment, and soil samples are proposed. Parameters to be tested will include VOCs, explosives, and at least the metal lead. VOCs will be included because they were not included in previous testing and because of the presence of an area of vegetative stress. This may be attributed to separate dumping activities. The ground water from the existing well and eight new soil borings will be tested. Surface water and sediment will also be sampled at seven different locations. Additional details of the proposed sampling plan for this site is discussed in Section 4.9. If after further testing contaminant concentrations are measurable, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.10 LEAAP 1 - Inert Burning Grounds

6.2.10.1 Contaminants of Concern. Lead and the explosives nitrobenzene and 1,3,5-TNB, found in ground water, are the principal

contaminants of concern. Elevated concentrations of aluminum, barium, lead, manganese, and nitrates were also discovered in ground water.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.10.2 Exposure Assessment. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry this contaminated surface soil as sediment to Goose Prairie Creek. Hence, creek flows would carry these contaminants into Caddo Lake downstream. There is a good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soils may leach contaminants into the ground water. Ground-water flow direction across the site is expected to vary from the north-northeast to the southeast, while the more regional direction is to the east toward Caddo Lake.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of

contaminants from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, there are no immediate plans to use the site.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by

supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.10.3 Toxicity Assessment. Lead, a toxin and probable carcinogen, has an EPA proposed drinking water maximum contaminant level of 5.0 ug/L. 1,3,5-trinitrobenzene and nitrobenzene are hazardous for their reactivity and toxicity. Currently, there are no drinking water standards or health advisories for either of the two explosives. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.10.4 Risk Characterization. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization

method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.10.5 Risk Assessment Report Requirements. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.10.6 Risk Assessment Data Requirements and Data Quality Objectives. Additional soil, water, and sediment samples are proposed for the site. Sampling will involve six surface water samples and grab ground-water samples from 5 bore holes and an existing monitoring well. Parameters proposed for sampling will include explosives, nitrates, and at least the metals barium and lead. If after testing toxic concentrations are measurable, additional water and/or sediment sampling will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested would depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.11 LHAAP XX - Ground Signal Test Area

6.2.11.1 Contaminants of Concern. Principal contaminants of concern are cadmium and nickel, which were found in groundwater. Elevated concentrations of aluminum, manganese, and strontium were also discovered in ground water. In addition, previous static Pershing rocket firings could have emitted toxic substances not previously tested for (e.g., benzene, hydrocyanic acid, carbon tetrachloride, and chloroform).

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.11.2 Exposure Assessment. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment either into Saunders Branch to the east or into Harrison Bayou to the west. Hence, creek flows would carry these contaminants into Caddo Lake downstream. Except for a

large bare area behind the central rocket motor fire pad, there is a good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soils may leach contaminants into the ground water. Ground water is expected to flow toward Saunders Branch on the east side of the site and toward Harrison Bayou on the west of the site.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would involve contaminants carried from the site by percolating ground water, runoff, or a combination of the two routes to Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells down-gradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for other activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, there are no immediate plans to use the site for other than its present use.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and

potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.11.3 Toxicity Assessment. The EPA drinking water maximum contaminant level for cadmium is 5.0 ug/L. The proposed EPA drinking water maximum contaminant level for nickel is 100 ug/L. It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the

Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.11.4 Risk Characterization. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.11.5 Risk Assessment Report Requirements. The risk assessment report will be completed according to EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.11.6 Risk Assessment Data Requirements and Data Quality Objectives. Additional data are needed to determine if a health risk is necessary. Previous sampling is limited to two ground-water samples (one sample taken at two separate wells). There was no past surface water sampling to indicate any prolonged effects of signal testing on the two adjacent water courses. Surface water and sediment samples will be taken for the drainage areas of Harrison Bayou and Sanders Branch adjacent to the signal test site. In addition, further

ground-water and soil samples are needed to determine the extent of any ground-water contamination and potential migration. Water samples are proposed to be taken from the two existing wells and from a borehole along the circumference of the site. Parameters to be tested will include at least the metals cadmium and nickel.

If after further testing toxic concentrations are measurable, additional sampling from monitoring wells will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the testing discussed in the previous paragraph above. Test data from these monitoring wells would be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.2.12 LEAAP 27 - South Test Area

6.2.12.1 Contaminants of Concern. - Lead, cadmium, and nickel are the primary contaminants of concern. Elevated concentrations of aluminum, manganese, and strontium were also discovered in ground water.

The list above is a preliminary list of contaminants of concern. After site sampling completed, all data will be organized into a form appropriate for baseline risk assessment. Data evaluation will follow the procedural steps outlined in Chapter 5 of EPA Risk Assessment

Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Prior to conducting any of these steps, the EPA remedial project manager will be consulted to determine if certain steps will be modified, added, or deleted as a result of specific conditions. In this process, the appropriate contaminants will be selected based this evaluation approach.

6.2.12.2 **Exposure Assessment**. Potential contaminants of concern could be transported by surface water, ground water, and possibly wind. Erosion caused by heavy rainfall could loosen contaminated surface soil. Runoff could consequently carry the contaminated surface soil as sediment eastward toward Harrison Bayou. Hence, creek flows would carry these contaminants into Caddo Lake downstream. There is good vegetative cover that prevents erosion and slows runoff potentially carrying contaminants. Water percolating through the soils may leach contaminants into the ground water. Ground water flows to the east toward Harrison Bayou.

Potential human exposure pathways include consumption of well water and Caddo Lake water, inhalation of contaminated dust at the site, and dermal contact with soil at the site. The pathway for public consumption of lake water would require migration of contaminants carried from the site via ground water, runoff, or a combination of the two routes to the Caddo Lake water, which after treatment would be consumed by approximately 16,600 Louisiana residents. However, the likelihood of significant contaminant loads reaching the public consumer is expected to be low. There are no known wells downgradient of the site that are being used for human consumption. Wells located upgradient of the site are not expected to be affected by contamination. If the land surface is used for other

activities in the future, workers clearing the area or lawn maintenance personnel may be incidentally exposed during associated work. Mowing or clearing vegetation may disturb the soil and allow opportunities for dermal contact of contaminated soil or inhalation of contaminated dust. However, there are no immediate plans to use the site.

Although some of the above pathways seem minor in nature, future land use changes may significantly increase the opportunities of exposure. The increase in land use conversion from rural use to residential use would increase the size of population at risk and potentially increase individual risks depending on type of land development incurred. Therefore, all potential exposure pathways will be reviewed again in the early phases of the risk assessment.

Further pathway review and exposure assessment will be conducted in accordance with Chapter 6 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Exposure will be quantified in accordance with the statistical guidelines presented in Section 6.4 of this manual. Uncertainties for exposure assessment will be evaluated in accordance with Section 6.8 of this manual. Unless there is alternate or site-specific values that can be clearly justified by supporting data, the exposure assessment will be conducted using the Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors" (OSWER Directive 9285.6-03, March 25, 1991).

6.2.12.3 Toxicity Assessment. The EPA drinking water maximum contaminant level for cadmium is 5.0 ug/L. The proposed EPA drinking water maximum contaminant levels for nickel and lead are 100 ug/L and 5.0 ug/L, respectively. Cadmium and nickel are known for

their toxic properties. Lead is known for toxic properties and is considered as a probable human carcinogen (Class B2 carcinogen). It is important to note that the list of contaminants of concern may change with data evaluation (described above). As result, toxicity information will be retrieved for all contaminants carried forward for risk assessment. The toxicity assessment will be performed in accordance to Chapter 7 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Toxicity information will also be retrieved from sources prioritized in Subsection 7.4.1 of this manual. The EPA Remedial Project Manager will be consulted regarding chemicals for which no reference dose (RfD) or cancer slope factor (CSF) are available from the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Table (HEAST). Uncertainties for toxicity assessment will be evaluated in accordance with Section 7.6 of this manual.

6.2.12.4 **Risk Characterization**. After sampling is completed and parameters of concern are assessed for exposure and toxicity, a detailed risk assessment will be performed. Contaminants of concern that exceed EPA acceptable risk criteria for carcinogenic and noncarcinogenic effects will undergo risk characterization after proper data evaluation has been completed. The risk characterization method will the same as used in Chapter 8 of EPA Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989). Uncertainties will be addressed in accordance with Section 8.4 of this manual.

6.2.12.5 **Risk Assessment Report Requirements**. The risk assessment report will be completed according to EPA Risk Assessment

Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December 1989) and EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989), or to subsequent revisions of these two documents.

6.2.12.6 **Risk Assessment Data Requirements and Data Quality Objectives**. Additional data are needed to determine if a health risk assessment is necessary. Previous sampling is limited to two ground-water samples (one sample taken at two separate wells). There are no past surface water sampling to indicate any prolonged effects of signal testing on the two adjacent water courses. Surface water and sediment samples will be taken for adjacent drainage areas of Harrison Bayou. In addition, further ground-water and soil samples are needed to determine any extent of ground-water contamination and migration. Water samples are proposed to be taken from the two existing wells and from a borehole along the circumference of the site. Parameters to be tested will include at least the metals lead, cadmium, and nickel. If after further testing toxic concentrations are measurable, additional water and/or sediment sampling will be performed to determine the migration pattern. The number and location of monitoring wells, frequency of sampling, and parameters to be tested will depend on the geology of the site and the results of the additional testing discussed in the previous paragraph above. Test data from these monitoring wells will be used in ground-water modeling.

If migration is occurring and toxic concentrations are comparable to EPA criteria from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or other EPA-approved documentation, a health risk assessment will be performed.

In all sampling and testing, quality control/quality assurance will be maintained. A sufficient number and frequency of samples will be taken to provide a reliable evaluation of potential risks.

6.3 **Installation Risk Assessment**. After each site is investigated separately, LHAAP will be studied for the cumulative risks of all installation contaminated sites. The overall movement of ground and surface waters from LHAAP to Caddo Lake and private wells will be analyzed to properly characterize health and environmental risks. This comprehensive installation study will be primarily based on the information provided by the individual site-specific investigations. This study would involve a detailed re-analysis of contaminant ground and surface water migration routes addressed in the site-specific investigations.

If site-specific information indicates that contaminants are in significant concentrations and that there is evidence of contaminant migration, risk characterization will be necessary. After review of site-specific sampling and other historical data, additional ground-water sample locations may be added to quantify contamination at potential accumulation points of contaminant plumes. For ground-water migration, 3 or 4 sampling sets (1 set for each quarter or 3-month period) are recommended. Ground water models approved by the U.S. Environmental Protection Agency and Texas Water Commission will used to determine plume movement. Fewer ground-water sampling sets will be needed if previous sampling information is usable for model calibration and for determining to plume direction. For surface water migration, 2 or 3 sets of water samples will be taken during wet and dry seasons and if possible, multiple samples will be taken during a storm event. Review of new surface water sampling data may reduce the

need for additional surface water tests and stream modeling. Surface water samples and sediment samples, if needed, will be taken along the major creeks upstream of Caddo Lake to better determine extent of contaminant migration along these routes. Modeling of Caddo Lake would only be conducted if cumulative contaminant loads to the lake are significant.

If modeling is required for surface water or air, models will be chosen that are approved by U.S. Environmental Protection Agency and Texas Water Commission.

6.4 **Ecological Risk Assessment**. The ecological risk assessment will include an evaluation of each site and the installation as a whole. The ecological risk assessment will be conducted and prepared in accordance with EPA Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual (EPA/540/1-89/001, March 1989). EPA Region 6 Biological Technical Assistance coordinators will be consulted regarding the planning of the Ecological Risk Assessment. After completion of evaluation of previous sampling and proposed sampling data outlined in Section 4.0 of this work plan, supplemental sampling may be required to determine the effects on flora and fauna. Supplemental sampling will be conducted according to the Sampling and Analysis Plan prepared as cited in the Environmental Evaluation Manual.

The ecological risk assessment will be coordinated with U.S. Fish and Wildlife Service and Texas Department of Parks and Wildlife for information on potential effects on threatened and endangered species.

SECTION 7.0

PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

7.1 Introduction. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (Public Law 96-510) is the basis on which this section is prepared. Section 121(d)(2)(A) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499), states that any remedial actions selected under CERCLA must comply with all legally applicable or relevant and appropriate requirements (ARARs) of any standard, requirement, criteria, or limitation under any Federal or consistently-enforced State environmental law. Where these laws conflict, the more stringent ARAR must be met.

7.2 Definitions and Types of ARARs.

7.2.1 Definitions. A requirement under other environmental laws may be either "applicable" or "relevant and appropriate", but not both. Identification of ARARs must be done on a site-specific basis and involves a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate.

7.2.1.1 Applicable requirements. Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

7.2.1.2 Relevant and appropriate requirements. Cleanup standards, standards of control, and other substantive environmental

protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

7.2.1.3 **To-Be-Considered materials (TBCs)**. Non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

7.2.2 **Types**. There are several different types of requirements with which CERCLA actions may have to comply. The classification of types of ARARs given in this section are not definitive, as some requirements may not fall distinctly into the specified categories of this system.

7.2.2.1 **Chemical-specific**. Requirements that are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

7.2.2.2 **Action-specific**. Requirements that are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste.

7.2.2.3 **Location-specific**. Requirements that are restrictions placed on the concentration of hazardous substances or

the conduct of activities solely because they occur in special locations.

7.3 **Selection of ARARs**. The ARARs addressed in this section were selected using analytical data obtained from former investigations at the sites, as well as knowledge of former site activities. As investigations of all sites at LHAAP progress and additional statutes are analyzed, these ARARs will be re-evaluated.

7.3.1 **Chemical-specific**. Former test and monitoring data were used to compile a list of contaminants of concern shown on Table 7-1. Section 3.0 of this Work Plan contains all previous analytical data available for each site. Chemicals identified in water samples as exceeding existing or proposed regulatory thresholds are listed on Table 7-1. Chemicals identified in soils and having existing or proposed regulatory thresholds are also listed on Table 7-1. For those sites not previously investigated, the chemicals suspected to be present are listed. For those chemicals having regulatory thresholds, the minimum action level specified by the ARAR is the minimal level of concentration used for listing the chemical on Table 7-1. Section 6.0 of this Work Plan specifies the methodology and information used to identify contaminants and their relative toxicities. The list of chemical-specific ARARs is included as Table 7-2.

7.3.2 **Action-specific**. The list of action-specific ARARs is included as Table 7-3.

7.3.3 **Location-specific**. The list of location-specific ARARs is included as Table 7-4.

005100
0000505

TABLE 7-1

CONTAMINANTS OF CONCERN*

CONTAMINANT	LHAAP SITES											
	11	13	14	16	17	18 & 24	29	12	32	1	XX	27
Explosive Compounds	C	P	P	C	C	C	C	C	C	C	P	C
2,4,6-TNT	C			C	C		C		C			C
1,3,5-TNB	C			C	C		C			C		
2,4-DNT				C	C		C					
2,6-DNT				C	C		C					
Nitrobenzene										C		
1,3-DNB				C	C		C	C				
Nitrates						C	P		P	P		
Pesticides/Herbicides		P							P			P
Arsenic (As)				P		C						
Barium (Ba)				P		C				P		
Cadmium (Cd)				C	C	C		C			C	C
Chromium (Cr)				P		C						
Lead (Pb)				P	C	C	C	C	C	C		C
Mercury (Hg)				P		C						
Silver (Ag)				P								
Antimony (Sb)				P	C							
Nickel (Ni)						C					C	C
Thallium (Tl)					C	C		C				
VOCs				C	C	C		C				
Vinyl Chloride				C		C						
Methylene chloride					C	C		C				
Trichloroethene (TCE)				C	C	C						
1,1,1-Trichloroethane						C						
Tetrachloroethane (PCE)						C						
1,1,2-Trichloroethane						C						
1,1-Dichloroethene						C						
1,1-Dichloroethane				C								
1,2-Dichloroethene				C		C						
1,2-Dichloroethane						C						
1,4-Dichlorobenzene					C	C						
Carbon Tetrachloride						C						
Styrene						C						
Benzene						C						

TABLE 7-1 (cont)

CONTAMINANTS OF CONCERN*

CONTAMINANT	LHAAP SITES											
	11	13	14	16	17	18 & 24	29	12	32	1	XX	27
Toluene						C	P					
Ethylbenzene						C						
Xylene						C						

C = Contaminant has been identified at the site. Concentration exceeds MCLs or proposed MCLs, or is high enough to pose a possible potential threat to health and the environment.
P = Contaminant has been identified at the site at concentrations below MCLs or is suspected to be found.

TABLE 7-2

CHEMICAL-SPECIFIC ARARs

Reference	Description
FEDERAL	
Safe Drinking Water Act (40 USC Section 300)	
National Primary Drinking Water Standards (40 CFR Part 141)	Health-based standards for public water systems (Maximum Contaminant Levels - MCLs)
Clean Air Act (42 USC Section 7401-7642)	
National Primary and Secondary Ambient Air Quality Standards (NAAQS) (40 CFR Part 50)	Standards for ambient air quality to protect public health and welfare
National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61)	Emission standards for toxic or hazardous air pollutants for stationary facilities
EPA Test Procedures for the Analysis of Pollutants (40 CFR Part 61)	Test procedures for the analysis of pollutants
STATE	
Texas Water Commission, Water Hygiene Division (31 TAC Chapter 290)	Drinking water standards governing drinking water quality and reporting requirements for public water supply systems
Texas Water Commission (TWC) (31 TAC Chapter 307)	Texas surface water quality standards
Texas Groundwater Protection Bill (HB 1458, Section 1, Chapter 26, Water Code, Subchapter J)	Protection of present and future groundwater supplies
Texas Water Code	Requirements for discharge of waste into or adjacent to waters in the state
Texas Water Well Drillers Board (31 TAC Chapter 287)	Procedures and standards for reporting, drilling, completion, and plugging water wells; licensing procedures
Texas Air Pollution Regulations (31 TAC Chapters 101, 111, 112, 113, and 115)	Regulations and standards for air emissions
Industrial Solid Waste and Municipal Hazardous Waste Rules (31 TAC Chapter 335)	Solid waste notification and classification requirements
TBCs	
EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9347.3-06FS	Treatment levels for contaminated soils and sediments
EPA OSWER Directive 9355.02	MCLs for contaminants
MCL Goals (MCLGs) (Public Law 99-339, 100 Statute 642, 1986)	Drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety
Federal Ambient Water Quality Criteria (FAWQC)	Protection of aquatic organisms and human health from contaminants in sediments

TABLE 7-3

ACTION-SPECIFIC ARARs

Reference	Description
FEDERAL	
Resource Conservation and Recovery Act (RCRA) of 1976 (40 CFR Part 264) Amended by the Hazardous and Solid Waste Amendments of 1984 (42 USC Sections 6901-6987)	
Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257)	Specify design, groundwater, monitoring, closure and post-closure care for specific types of facilities and specifies wastes acceptable for land disposal
40 CFR Parts 264.228, 264.258, 264.310 and 264.117	Requirements for design of capping of surface impoundments, waste piles and landfills. These address stabilization of waste before capping, use of property after capping, runon/runoff prevention, and maintenance of surveyed benchmarks
40 CFR Parts 264.110-120 Subpart G and 264.11	Clean closure standards for land-based units. Elimination of postclosure escape of contaminants
40 CFR Parts 264.111, 178, 197, and 258	Closure performance standards which may apply to surface impoundments and contaminated soils
40 CFR Part 264.111(b)	Human health and environment must be protected
40 CFR Part 268	Land disposal restrictions
National Environmental Policy Act (NEPA) (40 CFR Parts 1500-1508)	Requires consideration of environmental factors in Federal actions and providing public disclosure of proposed actions
EPA Designation, Reportable Quantities and Notification (40 CFR Part 302)	Specification of these requirements for hazardous substances under CERCLA
Clean Water Act National Pollutant Discharge Elimination System (NPDES) Program Requirements (40 CFR Part 122)	Requirements include discharge monitoring with records and compliance with water quality standards
Department of Transportation (DOT) Rules for Transportation of Hazardous Wastes (40 CFR Parts 170-172, 175, 178-179 and 262)	Requirements for packaging, preparing, labeling, manifesting, and transporting hazardous materials
STATE	
Industrial Solid Waste and Municipal Waste (31 TAC Chapter 335)	Regulations and standards for handling and Hazardous disposal of industrial solid and municipal hazardous wastes
Texas Water Code	Requirements for discharge of waste into or adjacent to waters in the state
TBCs	
52 FR 8712 (March 19, 1987) (Proposed rule)	Hybrid closure (Closure with waste in place) for removal of majority of contaminated materials. Addresses postclosure monitoring based on exposure pathways of concern
EPA Groundwater Protection Strategy	Policy direction for EPA programs with groundwater responsibilities

TABLE 7-4

LOCATION-SPECIFIC ARARs

Reference	Description
FEDERAL	
Endangered Species Act (16 USC 1531, et seq.) and (50 CFR Parts 17, 226 and 227)	Requires action to avoid jeopardizing the continued existence or habitat of listed endangered or threatened species
Clean Water Act (Section 404) and (40 CFR Part 230 and 33 CFR Parts 320-330)	Requirements that involve discharge of dredge or fill material into wetlands. No activity which affects a wetland will be permitted if a practicable alternative that has less effect is available
Archaeological and Historic Preservation Act (16 USC 469a-c) and (40 CFR 6.301)	Requires that alteration of terrain which might cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data be suryeyed. The Secretary of the Interior must be advised of the presence of such data
National Historic Preservation Act (16 USC 470a-w) and (36 CFR 800 and EO 11593)	Requires identification, determination of effects of proposed actions on federally owned, administered or controlled prehistoric or historic resources or the likelihood of undiscovered resources
Archaeological Resources Recovery Act of 1979 (43 CFR Part 7)	Requirements for steps that protect archaeological resources and sites on public land
RCRA Location Standards (40 CFR Part 264.18)	Requirements for RCRA-defined listed or characteristic hazardous waste or constructing a RCRA facility within the 100 year floodplain
NEPA (40 CFR Part 6)	Policy for carrying out provisions of the Wetlands/Floodplains Management Executive Order. Requires that Floodplains Assessment be incorporated with the RI/FS
STATE	
(TAC Section 67.001, et seq.)	Requirement that actions which may jeopardize an endangered or threatened species or its habitat must be avoided or mitigated. (Consultation with the responsible state agency is strongly recommended for on-site actions)
Texas Civil Statutes (Title 26, art. 912a-1, et seq.)	Prohibits any thoroughfare across a cemetery dedicated under state law
TBCs	
Wetlands Executive Order (EO 11990)	Requirement that federal agencies minimize the destruction, loss or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands
Floodplains Executive Order (EO 11988)	Requirements to reduce the risk of flood loss, minimize impacts of floods, and preserve the natural and beneficial value of floodplains

SECTION 8.0

BUDGET AND SCHEDULE

8.1 **Budget**. All remedial activities at LHAAP will be funded by the Defense Environmental Restoration Account (DERA) through the United States Army. Funding to the DERA is appropriated by Congress annually. The Army will seek sufficient funding for execution of all remedial activities at LHAAP in a timely manner.

Funding for remedial activities at Army installations is done on a priority basis. Because of the number of Army installations requiring environmental restoration work and the limited amount of funding, not all work is funded immediately. Funding for Phase 1 Investigations is expected in fiscal year 1992.

8.2 **Schedule**. A schedule of 87 months is proposed for remedial activities at LHAAP. The schedule includes all activities for project planning through the completion of the remedial design. The submittal dates for the secondary and both draft and final primary documents is presented in Table 8-1. Several assumptions were used to develop the remedial activities schedule. These assumptions are presented in Table 8-2. A listing of the project activities, durations, and start and finish dates are included in Table 8-3.

A key assumption of the schedule is that funding will be readily available for remedial activities. Execution of the remedial activities according to schedule will require sufficient and timely funding. If funding is not available or is delayed, the schedule will change.

The schedule also will be revised when operable units are identified. Operable units will be identified as early as possible. A separate schedule will then be developed for each operable unit.

Due to the expanded area of LHAAP 1 - Inert Burning Grounds, a work plan addendum will be developed for investigation of the expanded area. A schedule for development of this work plan addendum is presented in Table 8-4.

The preliminary schedule for the interim remedial action at LHAAP 18 and 24 - Burning Ground 3/Unlined Evaporation Pond is presented in Table 8-5. The

Phase 1 investigations and analysis of available data will be conducted prior to development of the Interim Remedial Action Plan. Upon completion of the Interim Remedial Action Plan, the schedule for design of the Interim Remedial Action may be revised.

TABLE 8-1
Deadlines for Primary and Secondary Documents

Initial Activities:	
Community Relations Plan: (primary document)	
Draft submitted	February 29, 1992
Final	July 7, 1992
RI/FS Work Plan: (primary document)	
Draft submitted	February 29, 1992
Final	September 13, 1992
Initial RA/DQO: (secondary document) submitted	March 14, 1992
Remedial Investigation Activities:	
Phase 1 Field Investigations	September 13, 1992 - January 9, 1993
Phase 2 Work Plan	
Draft submitted	July 30, 1993
Final	August 30, 1993
Phase 2 Field Investigations	August 30, 1993 - December 28, 1993
Sampling and Data Results: (secondary document) submitted	June 2, 1994
Site Characterization Summary: (secondary document) submitted	September 30, 1994
Remedial Investigation Report: (primary document)	
Draft submitted	February 19, 1995
Final	May 21, 1995
Feasibility Study Activities:	
Initial Screening of Alternatives Report: (primary document)	
Draft submitted	February 11, 1993
Final	May 13, 1993
Post-Screening Investigation Work Plan: (secondary document) submitted	November 6, 1994

TABLE 8-1
Deadlines for Primary and Secondary Documents

Feasibility Study Activities (continued)	
Treatability Study Report: (secondary document) submitted	October 3, 1995
Detailed Analysis of Alternatives Report: (secondary document) submitted	February 1, 1996
Feasibility Study Report: (primary document)	
Draft submitted	June 1, 1996
Final	August 31, 1996
Risk Assessment Report: (primary document)	
Draft submitted	December 30, 1994
Final	March 31, 1995
Proposed Plan: (primary document)	
Draft submitted	September 30, 1996
Final	December 30, 1996
Responsiveness Summary: (primary document)	
Draft submitted	April 1, 1996
Final	July 1, 1997
Record of Decision: (primary document)	
Draft submitted	May 1, 1997
Final	July 31, 1997
Remedial Design Work Plan: (primary document)	
Draft submitted	September 1, 1997
Final	December 1, 1997
Remedial Design Activities:	
30% Remedial Design: (secondary document) submitted	December 2, 1997
60% Remedial Design: (secondary document) submitted	February 1, 1998
90% Remedial Design: (secondary document) submitted	April 2, 1998

Lead Time?

TABLE 8-1
Deadlines for Primary and Secondary Documents

Remedial Design Activities (continued)	
Remedial Design: (primary document)	
Final	July 3, 1998
Remedial Action Work Plan: (primary document)	
Draft submitted	July 2, 1998
Final	April 20, 1997

TABLE 8-2
Assumptions Made to Develop the Schedule of Remedial Activities

1. Funding is available and remedial activities will not be delayed because of lack of funding.

2. The 30 day review period and 30 day comment resolution/ revision period is not extended.

3. Additional field work will not be required beyond Phase 1 and 2.

4. Initial Screening of Alternatives will start immediately after the RI/FS Work Plan is final. Existing information will be used for the initial development and screening.

5. Treatability studies, if required, will be completed before the Detailed Analysis of Alternatives is completed.

6. The Remedial Design will continue while the 30% design and 60% design are under review.

7. Dispute resolution will not be invoked.

8. The RI/FS Work Plans are being developed in-house. All other submittals will be completed by A-E contractors. Work completed by the A-E contractors will be reviewed by the COE and revised by the A-E contractor before being submitted to EPA and TWC.

9. Feasibility Study activities assume all 13 sites will be one operable unit. Operable units will be identified in the Initial Screening of Alternatives Report. When additional operable units are identified, a schedule will be developed for each.

10. A special project managers meeting on Applicable, or Relevant and Appropriate Requirements (ARARs) is not required. Discussion on ARARs will be done during the monthly project managers meetings.

11. A minimum of 90 days is required from submittal of a draft primary document to a final document. This applies to all primary documents.

TABLE 8-2
Assumptions Made to Develop the Schedule of Remedial Activities

12. For work done by A-E contractors, a minimum of 90 days is required after receipt of comments on a secondary document to submit a subsequent primary or secondary document. The 90 days consists of 30 days for resolution of EPA and TWC comments and incorporation by an A-E into the subsequent document, 30 days for COE review of the subsequent document, and 30 days for incorporation of COE comments into the document. This applies to documents in the RI/FS phase of remedial activities.

13. The EPA, TWC, LHAAP, and COE will conduct a scoping meeting prior to development of the Phase 2 Work Plan Addendum. The Phase 2 Work Plan Addendum will be approved by the EPA and TWC within 30 days.

14. Adequate information will be available to complete the Post Screening Work Plan once the Site Characterization Summary is complete.

TABLE 8-3
Listing of Remedial Activities

JOB#	JOB NAME	DURATION	SCHEDULED START	SCHEDULED FINISH	% COMPLETE
1	TASK 1 - PROJECT PLANNING	0d	08/01/91	08/01/91	0%
2	DEVELOP INITIAL RA/DQO	220d	08/01/91	03/13/92	100%
3	SUBMIT INI RA/DQO FOR REV	1d	03/13/92	03/14/92	100%
4	ARMY REVIEW INITIAL RA/DQO	31d	03/14/92	04/14/92	100%
5	EPA REVIEW INITIAL RA/DQO	31d	03/14/92	04/14/92	100%
6	TWC REVIEW INITIAL RA/DQO	19d	03/14/92	04/02/92	100%
7	RESOLVE CMTS/REVISE RA/DQO	30d	04/14/92	05/14/92	100%
8	DEVELOP RI/FS WORK PLAN	206d	08/01/91	02/28/92	100%
9	DEVELOP ARARS LIST - ARMY	60d	12/01/91	01/31/92	100%
10	DEVELOP STATE ARARS - TWC	60d	12/01/91	01/31/92	100%
11	PROJECT MGRS MEETING ON ARARS	1d	02/05/92	02/06/92	100%
12	REVISE & PUT ARARS IN WP	21d	02/06/92	02/27/92	100%
13	SUBMIT DRAFT RI/FS WP	1d	02/27/92	02/28/92	100%
14	ARMY REVIEW DRAFT PLANS	31d	02/28/92	03/30/92	100%
15	EPA REVIEW DRAFT PLANS	31d	02/28/92	03/30/92	100%
16	TWC REVIEW DRAFT PLANS	34d	02/28/92	04/02/92	100%
17	RESOLVE CMTS/REVISE DRAFT WP	70d	04/02/92	06/11/92	100%
18	SUBMIT DR FINAL PLANS: EPA,TWC	1d	06/11/92	06/12/92	100%
19	TWC REVIEW DRAFT FINAL PLANS	32d	06/12/92	07/14/92	100%
20	EPA REVIEW DRAFT FINAL PLANS	32d	06/12/92	07/14/92	100%
21	RESOLVE COMTS/REVISE WP	30d	07/14/92	08/13/92	100%
22	TWC REVIEW FINAL PLANS	30d	08/13/92	09/12/92	0%
23	EPA REVIEW FINAL PLANS	30d	08/13/92	09/12/92	0%
24	FINAL RI/FS WORKPLANS	1d	09/12/92	09/13/92	0%
25		0d	09/13/92	09/13/92	0%
26	TASK 2 - COMMUNITY RELATIONS	0d	08/01/91	08/01/91	0%
27	CONDUCT PUBLIC INTERVIEWS	14d	08/01/91	08/15/91	100%
28	DEV. COMMUNITY RELATIONS PLAN	189d	08/15/91	02/25/92	100%
29	SUBMIT DRAFT COMM REL PLAN	1d	02/25/92	02/26/92	100%
30	ARMY REVIEW DRAFT CRP	34d	02/25/92	03/30/92	100%
31	TWC REVIEW DRAFT CRP	30d	02/26/92	03/27/92	100%
32	EPA REVIEW DRAFT CRP	34d	02/25/92	03/30/92	100%
33	RESOLVE COMMENTS/ REVISE CRP	49d	03/30/92	05/18/92	100%
34	EPA REVIEW DRAFT FINAL CRP	11d	05/18/92	05/29/92	100%
35	TWC REVIEW DRAFT FINAL CRP	30d	05/18/92	06/17/92	100%
36	FINAL COMMUNITY RELATIONS PLAN	20d	06/17/92	07/07/92	100%
37		0d	09/12/92	09/12/92	0%
38	TASK 3 - INVEST. & ANALYSIS	0d	09/12/92	09/12/92	0%
39	PHASE 1 FIELDWORK	130d	09/13/92	01/21/93	0%
40	PHASE 1 SAMPLE ANALYSIS	105d	12/02/92	03/17/93	0%
41	REVIEW/SUMMARIZE PHASE 1 DATA	90d	01/31/93	05/01/93	0%
42	REVIEW DATA WITH EPA & TWC	30d	05/01/93	05/31/93	0%
43	RI/FS WORK PLAN ADDENDUM	60d	05/31/93	07/30/93	0%
44	TWC REVIEW WP ADDENDUM	30d	07/30/93	08/29/93	0%
45	EPA REVIEW WP ADDENDUM	30d	07/30/93	08/29/93	0%
46	RI/FS WP ADDENDUM APPROVAL	1d	08/29/93	08/30/93	0%
47	PHASE 2 FIELDWORK	120d	08/30/93	12/28/93	0%
48	PHASE 2 SAMPLE ANALYSIS	150d	09/19/93	02/16/94	0%
49		0d	11/27/92	11/27/92	0%
50	TASK 4 - DATA VALIDATION	0d	07/01/92	07/01/92	0%
51	DATA VALIDATION (QA)	210d	10/19/93	05/17/94	0%
52	ASSEMBLE DATA RESULTS	105d	02/16/94	06/01/94	0%
53	SUBMIT SAMPLE AND DATA RESULT	1d	06/01/94	06/02/94	0%
54	COMMENT ON SAMPLE RESULTS-TWC	30d	06/02/94	07/02/94	0%
55	COMMENT ON SAMPLE RESULTS-EPA	30d	06/02/94	07/02/94	0%
56	RESPOND TO SAMPLE COMMENTS	30d	07/02/94	08/01/94	0%
57		0d	07/12/93	07/12/93	0%
58	TASK 5 - DATA EVAL. & SCS	0d	08/16/92	08/16/92	0%
59	DATA EVALUATION	166d	02/16/94	08/01/94	0%
60	PREPARE SITE CHARAC SUM (SCS)	390d	09/05/93	09/30/94	0%
61	SUBMIT SCS FOR REVIEW	1d	09/30/94	10/01/94	0%
62	ARMY REVIEW SCS	30d	10/01/94	10/31/94	0%
63	EPA REVIEW SCS	30d	10/01/94	10/31/94	0%
64	TWC REVIEW SCS	30d	10/01/94	10/31/94	0%
65		0d	10/11/93	10/11/93	0%
66	TASK 6 - RI REPORT	0d	10/11/93	10/11/93	0%
67	RESOLVE CMTS/REVISE SCS	30d	10/31/94	11/30/94	0%
68	DEVELOP DRAFT RI REPORT	530d	09/06/93	02/18/95	0%
69	SUBMIT DRAFT RI FOR REVIEW	1d	02/18/95	02/19/95	0%

TABLE 8-3
Listing of Remedial Activities

JOB#	JOB NAME	DURATION	SCHEDULED START	SCHEDULED FINISH	% COMPLETE
70	ARMY REVIEW DRAFT RI	30d	02/19/95	03/21/95	0%
71	EPA REVIEW DRAFT RI	30d	02/19/95	03/21/95	0%
72	TWC REVIEW DRAFT RI	30d	02/19/95	03/21/95	0%
73	RESOLVE CMTS/REVISE DRAFT RI	30d	03/21/95	04/20/95	0%
74	EPA APPROVE DRAFT FINAL RI	30d	04/20/95	05/20/95	0%
75	TWC APPROVE DRAFT FINAL RI	30d	04/20/95	05/20/95	0%
76	FINAL RI REPORT	1d	05/20/95	05/21/95	0%
77		0d	04/11/94	04/11/94	0%
78	TASK 7 - RISK ASSESSMENT	0d	07/12/93	07/12/93	0%
79	DEV.DRAFT RISK ASSESS. REPORT	150d	08/01/94	12/29/94	0%
80	SUBMIT DRAFT RISK ASSESSMENT	1d	12/29/94	12/30/94	0%
81	ARMY REVIEW DRAFT RA	30d	12/30/94	01/29/95	0%
82	EPA REVIEW DRAFT RA	30d	12/30/94	01/29/95	0%
83	TWC REVIEW DRAFT RA	30d	12/30/94	01/29/95	0%
84	RESOLVE CMT/REVISE DRAFT RA	30d	01/29/95	02/28/95	0%
85	EPA APPROVE DRAFT FINAL RA	30d	02/28/95	03/30/95	0%
86	TWC APPROVE DRAFT FINAL RA	30d	02/28/95	03/30/95	0%
87	FINAL RISK ASSESSMENT	1d	03/30/95	03/31/95	0%
88		0d	03/11/94	03/11/94	0%
89	TASK 8 - INIT SCREEN OF ALT	0d	05/31/92	05/31/92	0%
90	DEV. & INIT. SCREEN. OF ALT.	150d	09/13/92	02/10/93	0%
91	SUBMIT DR INIT SCR OF ALT	1d	02/10/93	02/11/93	0%
92	ARMY REVIEW INI SCR ALT	30d	02/11/93	03/13/93	0%
93	EPA REVIEW INIT SCR ALT	30d	02/11/93	03/13/93	0%
94	TWC REVIEW INIT SCR ALT	30d	02/11/93	03/13/93	0%
95	RES CMTS ON INIT SCR ALT	30d	03/13/93	04/12/93	0%
96	EPA APP DR FIN INIT SCR ALT	30d	04/12/93	05/12/93	0%
97	TWC APP DR FIN INIT SCR ALT	30d	04/12/93	05/12/93	0%
98	FINAL INITIAL SCREEN ALT	1d	05/12/93	05/13/93	0%
99		0d	01/28/93	01/28/93	0%
100	TASK 9 - TREAT STUDY	0d	12/28/92	12/28/92	0%
101	DEVELOP P-S INVESTIGATION WP	105d	07/23/94	11/05/94	0%
102	SUBMIT P-S INV WP	1d	11/05/94	11/06/94	0%
103	ARMY REVIEW DRAFT P-S WP	30d	11/06/94	12/06/94	0%
104	EPA REVIEW DRAFT P-S WP	30d	11/06/94	12/06/94	0%
105	TWC REVIEW DRAFT P-S WP	30d	11/06/94	12/06/94	0%
106	RESOLVE CMTS/REVISE DR PS WP	30d	12/06/94	01/05/95	0%
107	TREATABILITY STUDIES	270d	01/05/95	10/02/95	0%
108	SUBMIT TREAT STUDY	1d	10/02/95	10/03/95	0%
109	ARMY REVIEW DRAFT TS	30d	10/03/95	11/02/95	0%
110	EPA REVIEW DRAFT TS	30d	10/03/95	11/02/95	0%
111	TWC REVIEW DRAFT TS	30d	10/03/95	11/02/95	0%
112	RES CMTS/REV DRAFT TREAT STUDY	30d	11/02/95	12/02/95	0%
113		0d	05/09/94	05/09/94	0%
114	TASK 10 - DET ANAL OF ALT	0d	04/14/93	04/14/93	0%
115	DEV DETAILED ANAL OF ALT	450d	11/07/94	01/31/96	0%
116	SUBMIT DET ANAL OF ALT	1d	01/31/96	02/01/96	0%
117	ARMY REVIEW DET ANAL ALT	30d	02/01/96	03/02/96	0%
118	EPA REV DET ANAL ALT	30d	02/01/96	03/02/96	0%
119	TWC REV DET ANAL ALT	30d	02/01/96	03/02/96	0%
120	RES CMTS/REVISE DET ANAL ALT	30d	03/02/96	04/01/96	0%
121		0d	09/07/94	09/07/94	0%
122	TASK 11 - FS REPORT	0d	08/08/94	08/08/94	0%
123	PREPARE DRAFT FS REPORT	90d	03/02/96	05/31/96	0%
124	SUBMIT DRAFT FS REPORT	1d	05/31/96	06/01/96	0%
125	ARMY REVIEW DRAFT FS REPORT	30d	06/01/96	07/01/96	0%
126	EPA REVIEW DRAFT FS	30d	06/01/96	07/01/96	0%
127	TWC REVIEW DRAFT FS	30d	06/01/96	07/01/96	0%
128	RESOLVE COMTS/REVISE DR FS	30d	07/01/96	07/31/96	0%
129	TWC APPROVE DR FINAL FS	30d	07/31/96	08/30/96	0%
130	EPA APPROVE DR FINAL FS	30d	07/31/96	08/30/96	0%
131	FINAL FS REPORT	1d	08/30/96	08/31/96	0%
132		0d	02/06/95	02/06/95	0%
133	TASK 12 - PROPOSED PLAN	0d	12/07/94	12/07/94	0%
134	PREPARE DRAFT PROPOSED PLAN	90d	07/01/96	09/29/96	0%
135	SUBMIT DRAFT PROPOSED PLAN	1d	09/29/96	09/30/96	0%
136	ARMY REV DRAFT PROPOSED PLAN	30d	09/30/96	10/30/96	0%
137	EPA REVIEW DRAFT PROPOSED PLAN	30d	09/30/96	10/30/96	0%
138	TWC REVIEW DRAFT PROPOSED PLAN	30d	09/30/96	10/30/96	0%
139	RESOLVE CMTS/REVISE DR PRO PL	30d	10/30/96	11/29/96	0%
140	EPA APPROVE DR FINAL PRO PLAN	30d	11/29/96	12/29/96	0%
141	TWC APPROVE DR FINAL PRO PLAN	30d	11/29/96	12/29/96	0%

TABLE 8-3
Listing of Remedial Activities

JOB#	JOB NAME	DURATION	SCHEDULED START	SCHEDULED FINISH	% COMPLETE
142	FINAL PROPOSED PLAN	1d	12/29/96	12/30/96	0%
143	PUBLIC COMMENT PERIOD	60d	12/30/96	02/28/97	0%
144	PUBLIC MEETING	1d	01/29/97	01/30/97	0%
145		0d	07/08/95	07/08/95	0%
146	TASK 13 - RESPONSIVE SUMM.	0d	08/07/95	08/07/95	0%
147	PREPARE DRAFT RSP	30d	03/01/97	03/31/97	0%
148	SUBMIT DRAFT RSP	1d	03/31/97	04/01/97	0%
149	ARMY REVIEW DRAFT RSP	30d	04/01/97	05/01/97	0%
150	EPA REVIEW DRAFT RSP	30d	04/01/97	05/01/97	0%
151	TWC REVIEW DRAFT RSP	30d	04/01/97	05/01/97	0%
152	RESOLVE CMTS/REV DRAFT RSP	30d	05/01/97	05/31/97	0%
153	EPA APPROVE DR FINAL RSP	30d	05/31/97	06/30/97	0%
154	TWC APPROVE DR FINAL RSP	30d	05/31/97	06/30/97	0%
155	FINAL RSP	1d	06/30/97	07/01/97	0%
156		0d	12/07/95	12/07/95	0%
157	TASK 14 - RECORD OF DECISION	0d	08/07/95	08/07/95	0%
158	PREPARE DRAFT ROD	60d	03/01/97	04/30/97	0%
159	SUBMIT DRAFT ROD	1d	04/30/97	05/01/97	0%
160	ARMY REVIEW DRAFT ROD	30d	05/01/97	05/31/97	0%
161	EPA REVIEW DRAFT ROD	30d	05/01/97	05/31/97	0%
162	TWC REVIEW DRAFT ROD	30d	05/01/97	05/31/97	0%
163	RESOLVE CMTS/REV DRAFT ROD	30d	05/31/97	06/30/97	0%
164	EPA APPROVE DR FINAL ROD	30d	06/30/97	07/30/97	0%
165	TWC APPROVE DR FINAL ROD	30d	06/30/97	07/30/97	0%
166	FINAL ROD	1d	07/30/97	07/31/97	0%
167		0d	01/06/96	01/06/96	0%
168	TASK 15- REMEDIAL DESIGN WP	0d	12/16/95	12/16/95	0%
169	DEVELOP RD/RA TARGET DATES	21d	07/10/97	07/31/97	0%
170	SUBMIT RD/RA TARGET DATES	1d	07/31/97	08/01/97	0%
171	EPA REVIEW RD/RA TARGET DATES	15d	08/01/97	08/16/97	0%
172	TWC REVIEW RD/RA TARGET DATES	15d	08/01/97	08/16/97	0%
173	RES CMTS/REV TARGET DATES	15d	08/16/97	08/31/97	0%
174	PREPARE DRAFT RD WP	75d	06/17/97	08/31/97	0%
175	SUBMIT DRAFT RD WP	1d	08/31/97	09/01/97	0%
176	ARMY REVIEW DRAFT RD WP	30d	09/01/97	10/01/97	0%
177	EPA REVIEW DRAFT RD WP	30d	09/01/97	10/01/97	0%
178	TWC REVIEW DRAFT RD WP	30d	09/01/97	10/01/97	0%
179	RESOLVE CMTS/REV DRAFT RD WP	30d	10/01/97	10/31/97	0%
180	EPA APPROVE DRAFT FINAL RD WP	30d	10/31/97	11/30/97	0%
181	TWC APPROVE DRAFT FINAL RD WP	30d	10/31/97	11/30/97	0%
182	FINAL RD WORKPLAN	1d	11/30/97	12/01/97	0%
183		0d	05/08/96	05/08/96	0%
184	TASK 16 - REMEDIAL DESIGN	0d	02/08/96	02/08/96	0%
185	PREPARE 30% PLANS AND SPECS	90d	09/02/97	12/01/97	0%
186	SUBMIT 30% PLANS AND SPECS	1d	12/01/97	12/02/97	0%
187	ARMY REVIEW 30%	30d	12/02/97	01/01/98	0%
188	EPA REVIEW 30%	30d	12/02/97	01/01/98	0%
189	TWC REVIEW 30%	30d	12/02/97	01/01/98	0%
190	RESPOND TO COMTS ON 30%	30d	01/01/98	01/31/98	0%
191	PREPARE 60% PLANS AND SPECS	60d	12/02/97	01/31/98	0%
192	SUBMIT 60% PLANS AND SPECS	1d	01/31/98	02/01/98	0%
193	ARMY REVIEW 60%	30d	02/01/98	03/03/98	0%
194	EPA REVIEW 60%	30d	02/01/98	03/03/98	0%
195	TWC REVIEW 60%	30d	02/01/98	03/03/98	0%
196	RESPOND TO CMTS ON 60%	30d	03/03/98	04/02/98	0%
197	PREPARE 90% PLANS AND SPECS	60d	01/31/98	04/01/98	0%
198	SUBMIT 90% PLANS AND SPECS	1d	04/01/98	04/02/98	0%
199	ARMY REVIEW 90%	30d	04/02/98	05/02/98	0%
200	EPA REVIEW 90%	30d	04/02/98	05/02/98	0%
201	TWC REVIEW 90%	30d	04/02/98	05/02/98	0%
202	RES TO CMTS/REV 90%RD	30d	05/02/98	06/01/98	0%
203	SUBMIT DRAFT FINAL RD	1d	06/01/98	06/02/98	0%
204	EPA REVIEW DRAFT FINAL RD	30d	06/02/98	07/02/98	0%
205	TWC REVIEW DRAFT FINAL RD	30d	06/02/98	07/02/98	0%
206	FINAL REMEDIAL DESIGN	1d	07/02/98	07/03/98	0%
207		0d	12/08/96	12/08/96	0%
208	TASK 17 - REMEDIAL ACTION WP	0d	10/07/96	10/07/96	0%
209	PREPARE REMEDIAL ACTION WP	60d	05/02/98	07/01/98	0%
210	SUBMIT RA WP	1d	07/01/98	07/02/98	0%
211	ARMY REVIEW DRAFT RA WP	30d	07/02/98	08/01/98	0%
212	EPA REVIEW DRAFT RA WP	30d	07/02/98	08/01/98	0%
213	TWC REVIEW DRAFT RA WP	30d	07/02/98	08/01/98	0%

TABLE 8-3
Listing of Remedial Activities

JOB#	JOB NAME	DURATION	SCHEDULED START	SCHEDULED FINISH	% COMPLETE
214	RESOLVE CMTS/REVISE RA WP	30d	08/01/98	08/31/98	0%
215	EPA APPROVE DRAFT FINAL RA WP	30d	08/31/98	09/30/98	0%
216	TWC APPROVE DRAFT FINAL RA WP	30d	08/31/98	09/30/98	0%
217	FINAL REMEDIAL ACTION WP	1d	09/30/98	10/01/98	0%
218		0d	03/08/97	03/08/97	0%
219	TASK 18 - REMEDIAL ACTION	1d	10/01/98	10/02/98	0%

TABLE 8-4
Inert Burning Ground
Work Plan Addendum Schedule

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Job#	Name	1992 MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	1993 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	DEVELOP SCOPE FOR CONTRACT	08/10/92						10/09/92										
2	AE DEVELOP WORKPLAN					10/09/92			11/08/92									
3	COE REVIEW WP						11/08/92			12/08/92								
4	REVISE/DRAFT WP							12/08/92			01/07/93							
5	REG REVIEW DRAFT WP								01/07/93			02/06/93						
6	REVISE/DRAFT FINAL WP									02/06/93			03/08/93					
7	DRAFT FINAL WP										03/08/93			04/07/93				
8	REG REVIEW DRAFT FINAL WP											04/07/93			05/07/93			
9	REVISE/FINAL WP												05/07/93			06/06/93		

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Interim Reme[illegible]action Schedule
Burning Ground 3/Unnmed Evaporation Pond

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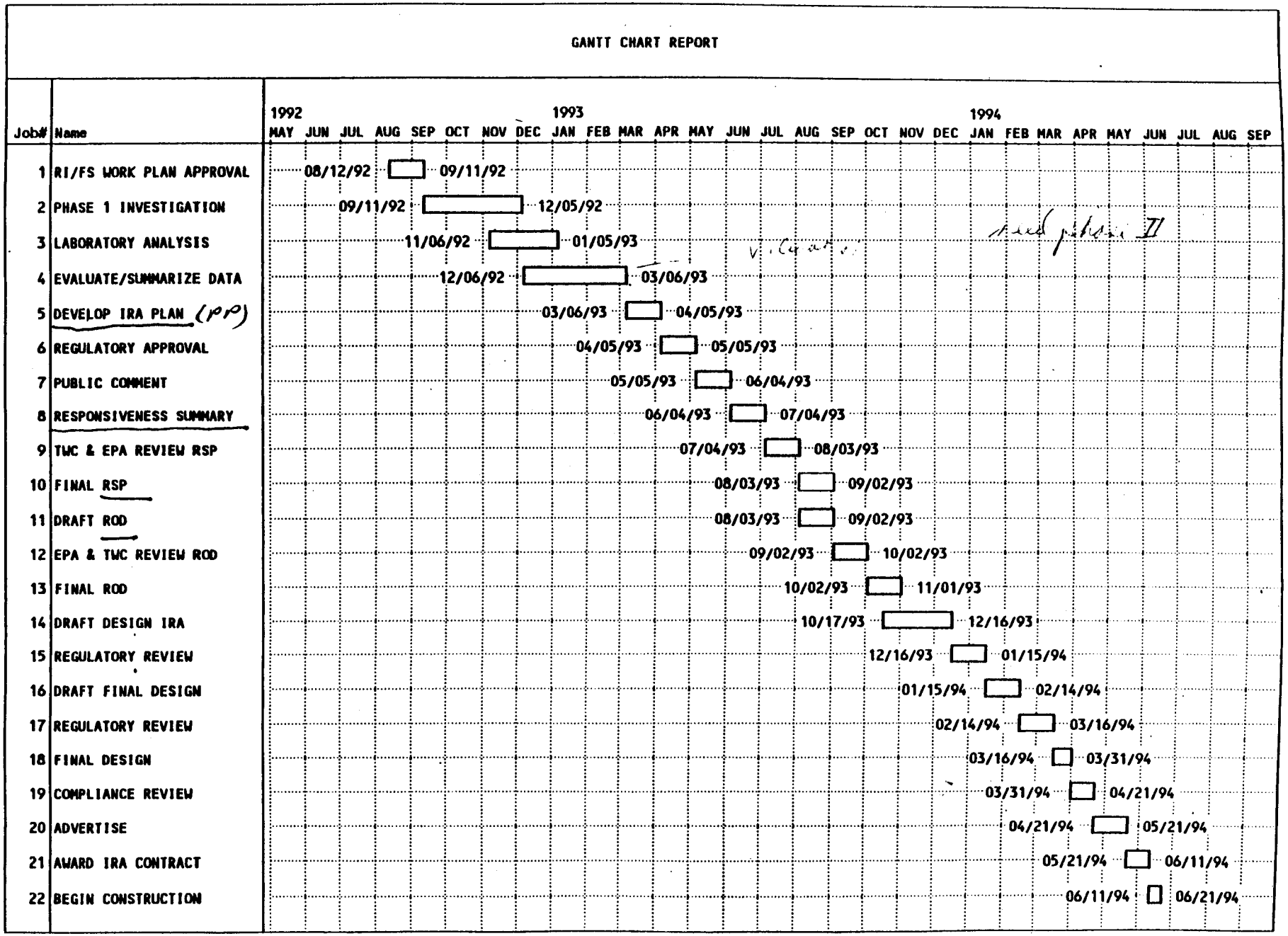

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