



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

September 19, 2016

DAIM-ODB-LO

Mr. Rich Mayer
US Environmental Protection Agency
Federal Facilities Section R6
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Record of Decision, LHAAP-001-R (South Test Area/Bomb Test Area) and LHAAP-003-R (Ground Signal Test Area),
Longhorn Army Ammunition Plant, Karnack, Texas, August 2016

Dear Mr. Mayer,

The above-referenced document is being transmitted to you for your records. The Draft Final document was previously prepared and submitted by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility on September 27, 2011. The Final document has been updated by Army to address the EPA Administrator's decision resolving the dispute in a letter dated October 31, 2014.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

A handwritten signature in black ink, reading "Rose M. Zeiler", is positioned below the "Sincerely," text.

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:

A. Palmie, TCEQ, Austin, TX
P. Bruckwicki, Caddo Lake NWR, TX
R. Smith, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
N. Smith, USAEC, San Antonio, TX
D. Richmann, AECOM – San Antonio, TX (for project files)



DEPARTMENT OF THE ARMY
LONGHORN ARMY AMMUNITION PLANT
POST OFFICE BOX 220
RATCLIFF, AR 72951

September 19, 2016

DAIM-ODB-LO

Ms. April Palmie
Texas Commission on Environmental Quality Superfund Section, MC-136
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Re: Final Record of Decision, LHAAP-001-R (South Test Area/Bomb Test Area) and LHAAP-003-R (Ground Signal Test Area),
Longhorn Army Ammunition Plant, Karnack, Texas, August 2016

Dear Ms. Palmie,

The above-referenced document is being transmitted to you for your records. The Draft Final document was previously prepared and submitted by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility on September 27, 2011. The Final document has been updated by Army to address the EPA Administrator's decision resolving the dispute in a letter dated October 31, 2014.

The point of contact for this action is the undersigned. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

A handwritten signature in black ink, reading "Rose M. Zeiler".

Rose M. Zeiler, Ph.D.
Longhorn AAP Site Manager

Copies furnished:
R. Mayer, USEPA Region 6, Dallas, TX
P. Bruckwicki, Caddo Lake NWR, TX
R. Smith, USACE, Tulsa District, OK
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Bryan W. Shaw, Ph.D., P.E., *Chairman*
Toby Baker, *Commissioner*
Jon Niermann, *Commissioner*
Richard A. Hyde, P.E., *Executive Director*



20774079

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

September 6, 2016

Mr. Thomas E. Lederle
Chief, ACSIM BRAC Division
2530 Crystal Drive, Room 5000
Taylor Bldg./NC3
Arlington, Virginia 22202

Re: Record of Decision for LHAAP-001-R, South Test Area/Bomb Test Area,
and LHAAP-003-R, Ground Signal Test Area
Longhorn Army Ammunition Plant Superfund Site TX6213820529
Karnack, Harrison County, Texas

Dear Mr. Lederle:

The Texas Commission on Environmental Quality (TCEQ) received the final Record of Decision (ROD) for the LHAAP-001-R and LHAAP-003-R, South Test/Bomb Test and Ground Signal Test Areas, at the Longhorn Army Ammunition Plant Federal Superfund Site in Karnack, Texas on August 16, 2016. The TCEQ has completed the review of the above referenced document and concurs that the response action described in the ROD is the most appropriate remedy for LHAAP-001-R and LHAAP-003-R.

Sincerely,

A handwritten signature in black ink, appearing to read "R. A. Hyde". The signature is fluid and cursive, with the first letters of each name being capitalized and prominent.

Richard A. Hyde, P.E.
Executive Director

cc: Mr. Carl Edlund, P.E., Director, Superfund Division, U.S. Environmental Protection
Agency, Region 6

FINAL
RECORD OF DECISION
LHAAP-001-R (SOUTH TEST AREA/BOMB TEST AREA)
AND LHAAP-003-R (GROUND SIGNAL TEST AREA)
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



Prepared for
U.S. Army Corps of Engineers
Tulsa District
1645 South 101st East Avenue
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Prepared by
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MARC No. W912BV-07-D-2004, Task Order No. 0007
Shaw Project No. 133363

August 2016

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Glossary of Terms

Located at the end of this Decision Document

Acronyms and Abbreviations

µg/kg	microgram per kilogram
µg/L	microgram per liter
AM	action memorandum
BERA	baseline ecological risk assessment
bgs	below ground surface
BIP	blow-in-place
CD	cultural debris
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CTT	closed, transferring, and transferred
DNT	Dinitrotoluene
DoD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EPS	Environmental Protection Systems, Inc.
FFA	Federal Facility Agreement
Ft	foot/feet
GWP-Ind	soil MSC for industrial use based on groundwater protection
HMX	high-molecular-weight RDX or high melt explosive
HRR	historical records review
IRP	Installation Restoration Program
LHAAP	Longhorn Army Ammunition Plant
LUC	land use control
MC	munitions constituents
MCL	maximum contaminant level
MD	munitions debris
MEC	munitions and explosives of concern
Mm	Millimeter
MMRP	Military Munitions Response Program
MOA	memorandum of agreement
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MSC	medium-specific concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	national priorities list
OB/OD	open burn/open detonation
PCL	Protective Concentration Level
RAB	Restoration Advisory Board
RDX	research department explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)

Acronyms and Abbreviations *(continued)*

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
Shaw	Shaw Environmental, Inc.
SI	site inspection
STEP	Solutions to Environmental Problems
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TNT	Trinitrotoluene
TRRP	Texas Risk Reduction Program
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
WP	white phosphorus

1.0 Declaration

1.1 Site Name and Location

Military Munitions Response Program (MMRP) Sites LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area.

Longhorn Army Ammunition Plant (LHAAP)
Karnack, Texas

Comprehensive Environmental Response, Compensation, and Liability Information System, U.S. Environmental Protection Agency (USEPA) Identification Number: TX6213820529.

1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for LHAAP-001-R and LHAAP-003-R, located at the Longhorn Army Ammunition Plant in Karnack, Texas. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300.

The remedy selection was based on the Administrative Record file for these sites, including the Site Inspection (SI) Report (e²M, 2005), the Engineering Evaluation/Cost Analysis (EE/CA) (Cape, 2007) and Action Memorandum (AM) (U.S. Army, 2007), the Munitions Constituents (MC) Data Summary Report (Shaw Environmental, Inc. [Shaw], 2011), the Munitions and Explosives of Concern (MEC) Removal Action Report (EODT Technology, Inc. [EODT], 2009), the Installation-wide Baseline Ecological Risk Assessment (BERA) Report (Shaw, 2007), the Proposed Plan (U.S. Army, 2011), and other related documents contained in the Administrative Record for the Munitions Response Sites (MRS) LHAAP-001-R and LHAAP-003-R.

This document is issued by the U.S. Army, the lead agency for this installation. The U.S. Army, USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into the FFA for remedial activities at LHAAP which became effective on December 30, 1991. The USEPA Region 6 and the Texas Commission on Environmental Quality (TCEQ) are the regulatory agencies providing technical support, project review and comment, and oversight of the U.S. Army cleanup program at the former LHAAP. The USEPA and the Army jointly select the remedy and TCEQ concurs with LUCs and limited groundwater monitoring in this Record of Decision (ROD).

1.3 Assessment of the Site

The response action selected in this ROD is necessary to protect the public health and safety from explosive hazards that may have remained at the sites after the 2008 removal action and to confirm that the levels of perchlorate in groundwater are protective of human health.

1.4 Description of the Selected Remedy

The selected remedy for LHAAP-001-R and LHAAP-003-R is implementation of LUCs and limited groundwater monitoring for perchlorate, in addition to the completed removal action. The lead agency has determined that LUCs are necessary to protect public health and safety related to MC or MEC at LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area, and that limited groundwater monitoring for perchlorate will be conducted to confirm that the levels in groundwater are below 17 µg/L, the Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level (PCL) which is the state remedial standard utilized in the absence of a federal drinking water standard.

Throughout the ROD document for these two MRS, the term MC refers to the data gap constituent of white phosphorous (WP) and the emerging contaminant perchlorate. U.S. Army, regulators, and project stakeholders met in 2005 for technical planning meetings and agreed that metals and explosives, typically included as MCs, were addressed with the Installation Restoration Program (IRP) RODs signed in 1998 for Sites LHAAP-27 and LHAAP-54. These sites are co-located with MRS LHAAP-001-R and LHAAP-003-R, respectively.

MEC items were found at both sites during the EE/CA investigations. Subsequently, MEC items were located and removed during surface removals over the entire areas of LHAAP-001-R and LHAAP-003-R, and a subsurface removal to depth in the open burn/open detonation (OB/OD) area within LHAAP-001-R. Although these removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or material potentially presenting explosive hazard (MPPEH), there is the potential that some MEC remains. Therefore, the sites are not suitable for unrestricted use. LUCs for both LHAAP-001-R and LHAAP-003-R promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites.

LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7 and 2-8**. The locations of the signs are also shown on **Figures 2-7 and 2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive

subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. Limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the TRRP Tier 1 Groundwater Residential PCL, the state remedial standard utilized in the absence of federal drinking water standards, to verify protection of human health and the environment. If, after three rounds of groundwater sampling at LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R, the results that are evaluated on or before the first five year review indicate detections at levels below the TRRP Tier 1 Groundwater Residential PCL value of 17 micrograms per liter ($\mu\text{g/L}$) for perchlorate, groundwater monitoring will cease and the wells will be plugged and abandoned. Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective manner that ensures long-term protectiveness. Texas Administrative Code (TAC) §335.566, requires that the LUCs be filed in Harrison County. With the exception of the nonresidential LUC, the specific LUCs and implementation details are provided in the Final Work Plan for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54) (EODT, 2008). A LUC Remedial Design (RD) will be finalized as the land use component of the Remedial Design. Within 21 days of the issuance of the ROD, the Army will propose deadlines for completion of the RD Work Plan, RD, and Remedial Action Work Plan. The documents will be prepared and submitted to EPA and TCEQ pursuant to the FFA. The LUC RD will contain implementation and maintenance actions, including periodic inspections. The long-term groundwater and surface water monitoring and MNA performance monitoring plan will also be presented in the RD. LUC boundaries and sign locations are depicted on **Figures 2-7 and 2-8.**

The Army will implement, maintain, monitor, report on and enforce land use controls at Army-owned property. The Army shall perform those actions related to land use control activities described in this ROD and in the Remedial Design for the ROD. For portions of the Site subject to land use controls that are not owned by the Army, the Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with federal, state, and local governments and owners and occupants of properties subject to land use controls. The Army will provide notice of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. The Army will send these notices to the federal, state and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls. The Army shall provide the initial notice within 90 days of ROD signature. The frequency of subsequent notifications will be described in the Remedial Design for the ROD. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment. The Army will fulfill its

responsibility and obligations under CERCLA and the NCP as it implements, maintains, and reviews the selected remedy.

Upon transfer of Army-owned property, the Army will provide written notice of the land use controls to the transferee of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. Within 15 days of transfer, the Army shall provide EPA and TCEQ with written notice of the division of implementation, maintenance, and enforcement responsibilities unless such information has already been provided in the LUC RD. The LUC RD will address the procedures to be used by the Army and the transferee to document compliance with the LUCs described in this ROD. In the event property is transferred out of Federal control, the land use controls relating to property and groundwater restrictions shall be recorded in the deed and shall be enforceable by the United States and the state of Texas.

The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at these sites after they have been transferred.

1.5 Statutory Determinations

The statutory preference for treatment was addressed with the MEC removal action which removed source material from the site and destroyed MEC. The selected remedy, implementation of LUCs and limited groundwater monitoring for perchlorate are protective of human health and safety, complies with Federal and State requirements that are applicable or relevant and appropriate, and is cost effective. In addition, the remedy offers long-term effectiveness through the maintenance and implementation of LUCs that over the long term will reduce risk associated with potential MEC hazards that may have remained at the sites. The limited groundwater monitoring for perchlorate will confirm perchlorate level in groundwater is below the TRRP Tier 1 Groundwater Residential PCL which is the state remedial standard utilized in the absence of a federal drinking water standard.

Because explosive hazards may remain at the sites that do not allow for unlimited use and unrestricted exposure, five-year reviews will be conducted for MRS LHAAP-001-R and LHAAP-003-R to ensure protection of human health and safety under CERCLA §121(c), U.S. Code (USC) Title 42 §9621(c). LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7 and 2-8**. The locations of the signs are also shown on **Figures 2-7 and 2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents

a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for remedy integrity, per the FFA and CERCLA §121.


1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record for this site.


- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the streamlined risk assessment and ROD (**Section 2.6**).
- Potential land and groundwater use that will be available at the sites as a result of the selected remedy (**Section 2.6**).
- COCs and their concentrations (**2.7**).
- Baseline risk represented by the COCs (**2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Not Applicable**).
- How source materials constituting principal threats are addressed at this site (**Section 2.11**).
- Key factor(s) that led to selecting the remedy (**Section 2.12**).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**).

1.7 Authorizing Signatures

As the lead agency, the U.S. Army issues this ROD for LHAAP-001-R and LHAAP-003-R which documents the selected remedy. The undersigned is the appropriate approval authority for this decision.

 16 Aug 2016
Thomas E. Lederle (Date)
Division Chief
Base Realignment and Closure Division
Assistant Chief of Staff for Installation Management
U.S. Army

The U.S. Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-001-R and LHAAP-003-R.

 09/13/16
Carl E. Edlund, P.E. (Date)
Director
Superfund Division
U.S. Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-001-R, South Test Area/Bomb Test Area, and LHAAP-003-R, Ground Signal Test Area
Longhorn Army Ammunition Plant, Karnack, Texas

Comprehensive Environmental Response, Compensation, and Liability Information System
USEPA Identification Number: TX6213820529

Lead Agency: U.S. Army, Department of Defense (DoD)

Source of Cleanup Money: U.S. Army, DoD and MMRP

The former LHAAP is an inactive government-owned, formerly contractor-operated and maintained Department of Defense facility located in central east Texas in the northeast corner of Harrison County. As shown on **Figure 2-1**, LHAAP is approximately 14 miles northeast of Marshall, Texas. The facility is approximately 40 miles west of Shreveport, Louisiana. The former U.S. Army installation occupied nearly 8,416 acres between State Highway 43 at Karnack, Texas, and the southwestern shore of Caddo Lake and is accessed by State Highways 43 and 134.

LHAAP was placed on the National Priorities List (NPL) on August 9, 1990. Activities to remediate contamination began in 1990. After its listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into a CERCLA Section 120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991. LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property.

The sites addressed in this ROD are LHAAP-001-R and LHAAP-003-R, which are shown on **Figure 2-2** and discussed below.

LHAAP-001-R, the South Test Area/Bomb Test Area, is located in the southern portion of LHAAP and covers an area of approximately 79 acres. LHAAP-001-R was constructed in 1954 and used for testing photoflash bombs produced at the facility until about 1956. During the late 1950s, illuminating signal devices were also demilitarized within pits excavated in the vicinity of the test pad. During the early 1960s, leaking production items may have been demilitarized by detonation. Leaking WP munitions were supposedly disposed of although no primary source documentation concerning this effort was located. A 1984 LHAAP Contamination Survey stated the area had been relatively inactive since the early 1960s and no disposal or testing activities were carried out in this area. LHAAP-001-R is co-located with IRP site LHAAP-27.

LHAAP-003-R, the Ground Signal Test Area, is located in the southeastern portion of LHAAP and covers an area of approximately 80 acres. LHAAP-003-R was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, red phosphorus smoke wedges, infrared flares, illuminating mortar shells and cartridges, button bombs, and various types of explosive simulators. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors. From late 1988 through 1991, the site was also used for burn-out of Pershing missile rocket motors. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity. LHAAP-003-R is co-located with IRP site LHAAP-54.

These sites are surrounded by an area (approximately 7,000 acres) that was transferred by the U.S. Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge. The U.S. Army, the lead agency for environmental response actions at LHAAP, is acting in partnership with USEPA Region 6 and TCEQ in planning and implementing remedial actions at MRS LHAAP-001-R and LHAAP-003-R.

2.2 Site History and Enforcement Activities

2.2.1 Site History

LHAAP was established in December 1941 with the primary mission of manufacturing trinitrotoluene (TNT). Production of TNT began at Plant 1 in October 1942 and continued through World War II until August 1945, when the facility was placed on standby status until February 1952. In 1952, the facility was reactivated and production of pyrotechnic ammunition, such as photoflash bombs, simulators, hand signals, and tracers for 40 millimeter (mm) ammunition continued at Plant 2 through 1956.

In December 1954, a third facility, Plant 3, began production of solid-fuel rocket motors for tactical missiles. Rocket motor production at Plant 3 continued as the primary operation at LHAAP until 1965 when Plant 2 was reactivated for the production of pyrotechnic and illuminating ammunition. In the years following the Vietnam conflict, LHAAP continued to produce flares and other basic pyrotechnic or illuminating items for the DoD inventory. From September 1988 to May 1991, LHAAP was also used for the static firing and elimination of Pershing I and II rocket motors in compliance with the Intermediate-Range Nuclear Forces Treaty in effect between the United States and the former Union of Soviet Socialist Republics (USSR).

LHAAP-001-R: The site was identified in the U.S. Army Closed, Transferring, and Transferred (CTT) Range/Site Inventory as 6.75 acres in size; however, a 1981 aerial photograph, historical records, a site visit, and a teleconference on 17 May and 18 May 2005 between U.S. Army Corps of Engineers (USACE) and U.S. Army Environmental Center indicated the site should be 79 acres including Demolition Sub Areas 1, 2 and 3.

The LHAAP-001-R site was constructed in 1954 and used by Universal Match Corporation for testing M120A1 photoflash bombs produced at the facility until about 1956. The bombs were tested by exploding them in the air over an elevated, semi-elliptical earthen test pad. Bombs awaiting testing were stored in three earth-covered concrete bunkers. 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 fuze.

During the late 1950s, illuminating signal devices were also demilitarized within pits excavated in the vicinity of the test pad at the site. During the early 1960s, leaking production items such as XM40E5 "button bombs" may have been demilitarized by detonation in the South Test Area/Bomb Test Area (LHAAP-001-R) or the Ground Signal Test Area (LHAAP-003-R). The XM40E5 is a small (approximately 1- by 1.25-inch) anti-intrusion mine also referred to as a "Gravel" Mine, which explodes on impact. It is believed that leaking WP munitions were disposed of in this area although no primary source documentation concerning this effort was located. Occasional leaking WP munitions were burned at the site as a demilitarization activity. Other sources indicate that possibly 3- to 4-pound canisters of WP were demilitarized in the vicinity of the test pad. The 1984 LHAAP Contamination Survey (Environmental Protection Systems, Inc. [EPS], 1984) stated the area has been relatively inactive since the early 1960s and no disposal or testing activities were carried out in this area.

LHAAP-003-R: The site was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, 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. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors from Nike-Hercules, Pershing, and Sergeant missiles systems. Around 1970, a Sergeant rocket motor reportedly exploded in an excavated pit near the center of the site. Debris was reportedly placed in the resulting crater and backfilled. However, later MEC clearance to depth in the area found no rocket motor. From late 1988 through 1991, the site was also used for burn-out of rocket motors in Pershing missiles destroyed in accordance with the Intermediate-Range Nuclear Forces Treaty between the United States and the former USSR. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity.

2.2.2 Enforcement Activities

Due to the release of hazardous substances, pollutants, and contaminants from operation and maintenance activities at the facility, the USEPA placed LHAAP on the NPL on August 9, 1990. Activities to remediate contamination associated with the listing of LHAAP as an NPL site began in 1990. After the listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into a CERCLA Section 120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ and the Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-001-R and LHAAP-003-R, and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB meetings, and public meetings consistent with its public participation responsibilities under Sections 113 (k)(2)(B), 117(a), and 121(f)(1)(G) of CERCLA.

The Proposed Plan (U.S. Army, 2011) for the LUCs and limited groundwater monitoring for perchlorate for both LHAAP-001-R and LHAAP-003-R was released to the Administrative Record file and made available to the public for review and comment on July 13, 2011. A notice of availability of the Proposed Plan and other related documents in the Administrative Record file was published in the *Marshall News Messenger* on June 29, 2011. A 30-day public comment period for the Proposed Plan began on July 13, 2011. The public meeting was held on July 21, 2011. Written comments were received from the general public.

The Administrative Record may be found at the information repositories maintained at the following locations:

Public Library

Location: Marshall Public Library
300 S. Alamo
Marshall, Texas 75670

Business Hours: Monday – Thursday 10:00 a.m. – 8:00 p.m.
Friday – Saturday 10:00 a.m. – 5:00 p.m.

Longhorn Army Ammunition Plant

Location: U.S. Army Office Trailer
Longhorn Army Ammunition Plant
Karnack, Texas 75670

2.4 Scope and Role of Operable Unit or Response Action

The land on which these sites are located is excess to the U.S. Army's needs and is intended for transfer to the USFWS for incorporation into the Caddo Lake National Wildlife Refuge. Future anticipated use is consistent with an industrial/recreational level of exposure. These two sites can be addressed independent of response actions at other environmental sites at LHAAP.

2.5 Site Characteristics

This section of the ROD presents an overview of LHAAP-001-R and LHAAP-003-R site characteristics with respect to physical site features, known or suspected sources of contamination,

types of contamination, and affected media. Known or potential routes of contaminant migration are also discussed.

2.5.1 Physical Characteristics

2.5.1.1 LHAAP-001-R

LHAAP-001-R is located near the southern boundary of LHAAP (**Figure 2-2**). The surface features at LHAAP-001-R include a deteriorated asphalt and gravel road running from the entrance to the test pad. Concrete bunkers and the site of the demolished former observation building are located alongside the road about halfway between the entrance and the test pad. A circular, 50-foot (ft) wide fire lane with a 2,000-ft diameter is centered at the test pad. Since the observation building has been demolished, the site is currently overgrown with brush and small trees. Formerly cleared areas in the vicinity of the test pad and alongside the access road are also overgrown with vegetation.

Soil at the site consists of interbedded silty and clayey sands, sandy silts, and clays of the Wilcox Group. The topography slopes gently to the east and surface water runoff from the hillside flows generally to the southeast and into Harrison Bayou. Groundwater at the site was encountered between 7 and 9 ft below ground surface (bgs). Groundwater is topographically controlled with a general flow direction to the east toward the floodplain of Harrison Bayou.

2.5.1.2 LHAAP-003-R

LHAAP-003-R is located in the southeastern portion of LHAAP (**Figure 2-2**). Surface features at LHAAP-003-R include an asphalt road (Haystack Road) that intersects Long Point Road just east of its intersection with Avenue Q. The site is currently undeveloped and has become overgrown with woody vegetation.

The site is located within the watersheds of Saunders Branch and Harrison Bayou. Both Saunders Branch and Harrison Bayou flow into Caddo Lake. Surface water runoff from the site is towards drainage ditches located alongside the circular dirt road forming the outer margin of the site. The ditches converge to the northeast and the southwest directing surface water to Saunders Branch and Harrison Bayou, respectively.

Soil at the site consists of interbedded silty and clayey sands, sandy silts, and clays of the Wilcox Group. The depth to groundwater at the site averages about 15 feet bgs with some seasonal fluctuations. The regional groundwater flow direction is to the north-northeast toward Caddo Lake; however, during periods of high precipitation the groundwater flow direction in the southwestern portion of the site diverts to the northwest towards Harrison Bayou.

2.5.2 Nature and Extent of Contamination

MMRP sites LHAAP-001-R and LHAAP-003-R are co-located with the IRP sites LHAAP-27 and LHAAP-54, respectively. Between 1982 and 1996, several investigations were conducted in a phased approach to determine the nature and extent of contamination at LHAAP-27 and LHAAP-54. Media investigated included soil, groundwater, surface water, and sediment. Based on the results of the investigations and the risk assessment conducted for the sites, an IRP no further action (NFA) ROD under CERCLA for Hazardous, Toxic, and Radioactive Waste was signed with regulatory concurrence in January of 1998 for LHAAP-27 and LHAAP-54 (USACE, 1998).

From 2002 to 2007, investigations related to the MMRP were conducted at LHAAP. As a result of the records review for the U.S. Army CTT Range/Site Inventory in 2002, the South Test Area/Bomb Test Area and Ground Signal Area were designated LHAAP-001-R and LHAAP-003-R, respectively (e²M, 2002). For these two MRS, investigations were conducted to determine the presence or absence of MEC, and to address the identified data gaps including WP and perchlorate.

2.5.2.1 LHAAP-001-R

Perchlorate was identified as an emerging contaminant and perchlorate data for environmental media was collected after the 1998 NFA ROD was signed. In May and October 2000, a total of 26 soil samples were collected from 13 soil borings (27SB01 through 27SB13) and analyzed for perchlorate (Solutions to Environmental Problems [STEP], 2005). Two samples were collected from each boring from two depth intervals; 0 to 0.5 ft and 1 to 2 ft bgs. Perchlorate was detected in only one (27SB01 at depth of 0 to 0.5 ft) of the 26 soil samples at a concentration of 28.9 micrograms per kilogram ($\mu\text{g/kg}$), a level lower than the MSC for industrial use based on groundwater protection (GWP-Ind) value of 7,200 $\mu\text{g/kg}$.

During three consecutive quarterly sampling events, groundwater samples were collected from six existing shallow monitoring wells to determine whether perchlorate was present in the underlying groundwater as a result of past historical activities. The six monitoring wells are located in areas with the highest potential for impact from site activities and in the direction of flow across the site from west to east toward Harrison Bayou. During the first quarter (April to May 2000), four groundwater samples were collected from four existing monitoring wells (MW-131, MW-132, 27WW01, 27WW04). Perchlorate was detected in two of the wells, 27WW01 and 27WW04, at concentrations of 52.6 and 16.4 $\mu\text{g/L}$, respectively. One of the levels was above the TRRP Tier 1 Groundwater Residential PCL of 17 $\mu\text{g/L}$. No maximum contaminant level (MCL) exists for perchlorate. Perchlorate concentrations were below detection limits in all the six monitoring wells (MW-131, MW-132, 27WW01 through 27WW04) sampled during the second quarter (August through October 2000). During the third quarter, January through February 2001, perchlorate was not detected in the groundwater samples collected from three sampled wells, MW-131, 27WW01, and 27WW04. Two of the six wells at LHAAP-001-R were not sampled during two of the three sampling events.

In October 2009, USEPA collected additional groundwater samples from the existing six monitoring wells to confirm groundwater conditions at the site. Perchlorate was detected in three wells with only one of the three above the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L at a concentration of 76 µg/L. The USEPA's perchlorate detection of 76 µg/L was an estimate from a diluted sample. The U.S. Army collected split samples at the same time that the USEPA collected samples from the six monitoring wells. Perchlorate was detected in two wells for the U.S. Army split samples, with only one of the two above the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L.

In March 2003, USFWS conducted an investigation at the former LHAAP facility to determine contaminant levels in soil and sediment (USFWS, 2003). Soil samples were collected from five locations (FWS-055, -056, -058, -063, and -201) within LHAAP-001-R. Soil analytical results indicated that metals and semivolatile organic compounds were detected at low concentrations, but not above screening levels, and the site was not included as one of the areas requiring further evaluation. Perchlorate was not detected above the reporting limit.

Between 2002 and 2004, a MMRP SI was conducted for LHAAP-001-R to determine the presence or absence of MEC and/or MC at the site which may have remained from activities conducted by the DoD during operations of the MRS, and may pose a threat to human health and/or the environment (e²M, 2005).

Results of the historical records review (HRR) and a visual site inspection verified MEC presence at the site. Possible sources areas for MEC and MC identified during the SI included the following:

- Testing areas associated with the various suspected ordnance types.
- A Demolition Area located within the footprint of LHAAP-001-R. This area was reportedly designed for detonation of dangerous/unserviceable ammunition.
- Spent flares, a 155 mm WP projectile, shrapnel from photoflash bombs, and ordnance related scrap found on the site.

The SI identified a data gap in earlier soil sampling, in that, although demilitarization activities including open pit burning and explosive detonation were conducted at the site, no analysis for the munitions constituent WP was performed at the site. The SI recommended that further investigation be conducted to address the identified data gap.

In 2007, an EE/CA was conducted to facilitate completion of a non-time-critical removal action of MEC at the site (CAPE, 2007). Field activities conducted during the EE/CA characterized MEC and addressed the WP data gap at the site. Twenty-one (21) MEC and MPPEH items along with 700 pounds of munitions debris (MD) were recovered at the surface or within the top 6 inches of the soil. The items were clustered within an area suspected of the use of OB/OD activities,

although never permitted as an OB/OD unit. The suspected OB/OD area is approximately 14 acres in size.

Based on the heaviest MPPEH concentrations or historical detonations, soil samples were collected within LHAAP-001-R to determine if evidence of WP existed in areas where MC was most likely to exist. One soil sample (BTA-27-LHAAP-001-RS-01A) was collected near the center of the suspected OB/OD area. A second soil sample (BTA-27-LHAAP-001-RS-01B) was collected in a scarred area identified as the photo flash cartridge disposal area in the historical review. Both areas are near locations where MPPEH items were recovered during the field investigations. In addition, pre- and post-detonation samples were collected in association with explosive demolition of MPPEH recovered during the field activities. Soil samples were collected from 0 to 6-inches bgs. Analytical results indicated that neither WP nor explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-TNT, 2,4-dinitrotoluene (DNT), 2,6-DNT, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, 4-nitrotoluene, HMX, nitrobenzene, RDX, and tetryl) were identified at concentrations above detection limits in any soil samples at the site. In addition, there was no indication of the presence of explosives in any of the pre- or post-detonation samples. The removal action objective of protection of human health from WP and explosives at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. All site sample locations are shown on **Figure 2-3**.

The EE/CA recommended surface and subsurface removal of MEC items with LUCs to reduce the risk within LHAAP-001-R. Between August and November 2008, a MEC non-time-critical removal action was conducted and LUCs were developed for the site (EODT, 2009). Surface clearance of the entire site and subsurface clearance to the depth of detection was performed at LHAAP-001-R. Magnetometer-assisted surface clearance was performed for the entire site of approximately 79 acres. Site preparations included brush removal. The clearance team worked in grids and established 5-ft sweep lanes within each grid, removing and disposing of all surface MEC and MPPEH, MD, cultural debris (CD), and range-related debris. A total of 90 MEC/MPPEH items were located and destroyed, and a total of 6,742 pounds of MD and 154 pounds of CD were removed during the course of surface clearance.

Subsurface MEC removal was conducted for the suspected OB/OD area of approximately 14 acres within LHAAP-001-R. Magnetometers were utilized to detect surface and subsurface anomalies. Each detected anomaly was excavated until the item was located, identified, and a magnetic signature was no longer detected at the location. All MEC/MPPEH encountered were explosively destroyed to verify that no residual explosive hazard existed. A total of 294 MEC/MPPEH items and 14 inert items were located, excavated, and removed and a total of 15,397 pounds of MD and 1,722 pounds of CD were removed during the course of subsurface clearance. All MEC items were destroyed using the “blow-in-place” (BIP) method following approved demolition procedures. All debris was consolidated and relocated to the site lay down area. The debris was

stored in approved containers, inspected, verified and certified as free of explosives, and shipped off site for final disposition. Locations for the surface and subsurface clearance are shown on **Figure 2-4**.

LUCs were designed and constructed for the site consistent with recommendations of the EE/CA and AM that included:

Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.

Signage at the perimeter of LHAAP-001-R. Signs were installed at the perimeter of the site, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC and state the restriction against intrusive activities.

Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

2.5.2.2 LHAAP-003-R

Perchlorate was identified as an emerging contaminant, and perchlorate data for environmental media was collected after the 1998 NFA ROD was signed. Between May 2000 and February 2001, during three consecutive quarterly sampling events, groundwater samples were collected from three existing shallow monitoring wells to determine whether perchlorate contamination had occurred in the underlying groundwater as a result of past historical activities (STEP, 2005). The wells are located adjacent to the three surface water features that drain the entire LHAAP-003-R site. Because the shallow groundwater flow pattern is heavily influenced by surface flow in this area, the wells represent groundwater from the entire site. During the first quarter (April and May 2000), perchlorate was detected at concentrations of 26.8, 20.4, and 22.7 µg/L, in groundwater samples collected from monitoring wells MW-127, MW-128, and 18WW16, respectively. The detections were above the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L. No MCL exists for perchlorate. Perchlorate concentrations were below detection limits in the three monitoring wells during the second quarter (August through October 2000). During the third quarter, January through February 2001, perchlorate was detected in only one groundwater sample collected from well 18WW16 at a concentration of 8 µg/L, below the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L. No perchlorate was detected in the water samples from wells MW-127 and MW-128. Three of the seven wells at LHAAP-003-R were not sampled during two of the three sampling events. Groundwater samples were also collected from Geoprobe points (GPSAS54-01, -02, and -03) installed in June 2001. Perchlorate was below detection limits in all three grab samples.

In October 2009, USEPA collected additional groundwater samples from the existing four monitoring wells to confirm groundwater conditions at the site. Perchlorate was detected in only one well at a concentration that was below the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L. The U.S. Army collected split samples at the same time that the USEPA collected samples from the four monitoring wells. Perchlorate was detected in one well for the U.S. Army split samples at a concentration below the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L.

In March 2003, USFWS conducted an investigation at the former LHAAP facility to determine contaminant levels in soil and sediment (USFWS, 2003). Soil samples were collected from two locations (FWS-095 and FWS-223) within LHAAP-003-R. These two locations are along the surface drainage that flows toward Saunders Branch on the east side of the site. Soil analytical results indicated that metals were detected at low concentrations confirming previous findings. Perchlorate was not detected.

Between 2002 and 2004, a MMRP SI was conducted for LHAAP-003-R to determine the presence or absence of MEC and/or MC at the site which may have remained from activities conducted by the DoD during operations of the MRS. The SI verified MEC presence at the site (e²M, 2005).

Results of the HRR and a visual site inspection verified MEC presence at the site. Possible source areas for MEC and MC identified during the SI included: testing areas associated with the various suspected ordnance types; a confirmed mortar impact area on site with numerous unidentified ordnance item shapes on the surface and outside the mortar berm; a site reportedly used for the testing and burnout of Pershing and Sergeant rocket motors; and areas associated with past demilitarization activities. In addition, a Sergeant rocket motor reportedly exploded at the site around 1970 and debris was reportedly placed in the resulting crater and backfilled. It was also reported that occasionally WP munitions were burned at the site. It appears that most of the items tested at this location were statically fired and observed for adequate illumination and burn time and not launched by a weapons system.

The SI identified a data gap in earlier soil sampling, in that, although demilitarization activities were conducted at the site and occasionally demolition and burning of WP munitions were performed, no analysis for the munitions constituent WP was performed at the site. The SI recommended that further investigation be conducted to address the identified data gap.

In 2007, an EE/CA was conducted to facilitate completion of a non-time-critical removal action of MEC at the site (CAPE, 2007). Field activities conducted during the EE/CA characterized MEC and addressed the WP data gap at the site. Fourteen (14) MEC and MPPEH items along with 513 pounds of MD were recovered at the surface or within the top 6 inches of the soil. The items were clustered within the former Mortar Test Area. Based on the heaviest MPPEH concentrations or historical detonations, soil samples were collected within LHAAP-003-R to determine if evidence of WP existed in areas where MC was most likely to exist. One soil sample (BTA-54-LHAAP-

001-RS-01A) was collected within the area identified as the mortar firing range. A second soil sample (BTA-54-LHAAP-001-RS-01B) was collected in a scarred area identified as the Rocket Motor Area in the historical review. In addition, pre- and post-detonation samples were collected in association with explosive demolition of MPPEH recovered during the field activities. Soil samples were collected from 0 to 6-inches bgs. Analytical results indicated that no WP or explosives (1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, 4-nitrotoluene, HMX, nitrobenzene, RDX, and tetryl) were identified at concentrations above detection limits in any soil samples at the site. In addition, there was no indication of the presence of explosives in any of the pre- or post-detonation samples. The removal action objective of protection of human health from WP or explosives at unacceptable concentrations had been achieved as demonstrated by the soil analytical results. All site sample locations are shown on **Figure 2-5**.

The EE/CA recommended surface clearance of MEC items with LUCs to reduce the risk within LHAAP-003-R. Between August and November 2008, a MEC removal action was conducted and LUCs were developed for the site (EODT, 2009). Magnetometer-assisted surface clearance was performed at LHAAP-003-R for the entire site of approximately 80 acres. Site preparations included brush removal. The clearance team worked in grids and established 5-ft sweep lanes within each grid, removing and disposing of all surface MEC and MPPEH, MD, CD, and range-related debris. Twelve MEC/MPPEH items and one inert item were located and destroyed and 6,880 pounds of MD and 5,981 pounds of CD were removed during the course of surface clearance. All MEC items were destroyed using the BIP method following approved demolition procedures. All debris was consolidated and relocated to the site lay down area. The debris was stored in approved containers, inspected, verified and certified as free of explosives, and shipped off site for final disposition. Locations for the surface clearance are shown on **Figure 2-6**.

LUCs were designed and constructed for the site consistent with recommendations of the EE/CA and AM that included:

Restriction against intrusive activities. TAC § 335.569, Appendix III requires that the restriction be recorded in the Harrison County Clerk's Office, with the survey, map, and LUC language.

Signage at the perimeter of LHAAP-003-R. Signs were installed at the perimeter of the site, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The signs include warning of the potential presence of MEC and state the restriction against intrusive activities.

Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.

2.6 Current and Potential Future Site and Resource Uses

2.6.1 Current and Future Land Uses

LHAAP is located near the unincorporated community of Karnack, Texas. Karnack is a rural community with a population of 775 people. The incorporated community of Uncertain, Texas, population 205, is located to the northeast of LHAAP on the edge of Caddo Lake and is a resort area and an access point to Caddo Lake. The industries in the surrounding area consist of agriculture, timber, oil and natural gas production, and recreation.

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in 1997. The plant area has been relatively dormant since that time. LHAAP is surrounded by a fence (except on the border with Caddo Lake), and current security measures at the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the Refuge boundary.

The reasonably anticipated future use of LHAAP-001-R and LHAAP-003-R is as a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge and will be used to facilitate transfer of LHAAP-001-R and LHAAP-003-R. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. A change in use from wildlife refuge requires an act of Congress or the land is part of an exchange authorized by the Secretary of the Interior.

2.6.2 Current and Future Surface Water Uses

Streams on LHAAP currently support wildlife and aquatic life. While humans may have limited access to some streams during annual hunts, there is no routine human use of streams on LHAAP. The streams do not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the summer months, the streams cease flowing and/or dry up. The streams flow into Caddo Lake. Caddo Lake is a large recreational area that covers 51 square miles and has a mean depth of 6 ft. The watershed of the lake encompasses approximately 2,700 square miles. It is used extensively for fishing and boating. Caddo Lake is a drinking water supply for multiple cities in Louisiana, including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

The anticipated future uses of the streams and lake are the same as the current uses.

2.6.3 Current and Future Groundwater Uses

Groundwater in the deep aquifer (250-430 ft bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater,

which extends only to a depth of approximately 151 feet bgs. The deep zone groundwater and the drinking water aquifer are distinct from each other and there is no connectivity between the deep zone groundwater and the drinking water aquifer. There are currently five active water supply wells near LHAAP that are completed in the drinking water aquifer. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 ft bgs and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 2 miles southeast of town. This well is completed to approximately 430 ft bgs and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3 and are all hydraulically upgradient of LHAAP. Because of the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, there are several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 ft bgs.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station/Security Office approximately 2.3 miles north-northwest of LHAAP-001-R and 2.39 miles northwest of LHAAP-003-R. The second well is located approximately 0.35 miles southwest of the Fire Station/Security Office and 2.19 miles north-northwest of LHAAP-001-R and 2.39 miles northwest of LHAAP-003-R. The third well is located north of the administration building, near the entrance to LHAAP approximately 2.16 miles west-northwest of LHAAP-001 and 2.73 miles west-northwest of LHAAP-003-R. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. Although all three provide water at the tap, none are used for drinking water. None of the water supply wells is associated with the two sites addressed by this ROD Document.

Based on the anticipated future use of the facility (i.e., a wildlife refuge), the groundwater at the two sites will not be used in the future as a drinking water source. However, to be conservative, it is assumed that future use is industrial. The future industrial scenario for LHAAP conservatively assumes limited use of groundwater as a drinking water source. No WP or explosives were identified at detectable concentrations in any soil samples collected from LHAAP-001-R and LHAAP-003-R. Perchlorate was detected in only one soil sample at a concentration that was well below the GWP-Ind value at LHAAP-001-R. The soils at the two sites are not potential sources of contribution of perchlorate, WP, or explosives into the underlying groundwater. All perchlorate detections in groundwater at LHAAP-001-R were below the TRRP Tier 1 Groundwater Residential PCL value except for one detection in 2000 at a concentration of 52.6 µg/L and one detection by USEPA in 2009 at a concentration of 76 µg/L, above the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L in one well. The USEPA 2009 result was an estimate from a diluted sample. The U.S. Army's split sample for the same well indicated that perchlorate was detected at a concentration of 50 µg/L, above the TRRP Tier 1 Groundwater Residential PCL.

2.7 Summary of Site Risks

This section contains the results of the risk evaluation for LHAAP-001-R and LHAAP-003-R addressing WP and explosives and MEC risk to human health and safety.

2.7.1 Summary of Site Risk for LHAAP-001-R

2.7.1.1 MEC Risk to Human Safety

The risk evaluation for LHAAP-001-R addressed risks to human safety related to the potential presence of MEC.

The risk factors associated with MEC items were categorized in three classes: MEC factors, site characteristics factors, and human factors. MEC factors are related to the type of MEC, the sensitivity, the quantity (density), and the depth. Site characteristic factors include the accessibility and stability of areas where MEC items are located. Human factors are related to the population density and population activities.

During the EE/CA field activities, twenty one (21) MPPEH items along with 700 pounds of MD were recovered at LHAAP-001-R, with most of the items clustered in the suspected OB/OD area. The types of ordnance items found were pyrotechnic or illumination in nature; no high explosives or fuzed items were identified. All items were at the surface or within the top 6 inches of soil. Accordingly, the MEC density, ordnance-type hazard, and sensitivity factors were all assigned a value of 1. The site stability was rated stable, with the rating for contact level risk associated with future human activities as significant. Because the reasonably anticipated future land use is incorporation into the existing wildlife refuge and the significant refuge activities, the probable future population density at the site is low. Taking all risk factors into consideration, the risk assessment indicated moderate MEC risk to human safety for LHAAP-001-R.

Through the surface removal action MEC items were located and removed over the entire surface area, thereby reducing the risk to the future land user. The subsurface removal action located, excavated, and removed MEC or MPPEH items to a depth consistent with the expected future land use and the significant refuge activities, all of which are non-intrusive. The subsurface removal provided an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or MPPEH.

However, because there is a reasonable potential that some MEC remained after the removal action there is a potential risk to the public. Consistent with the recommendations of the EE/CA and the AM (U.S. Army, 2007), LUCs were identified to promote ongoing protection of human safety against potential explosive hazards that may have remained at the site.

2.7.1.2 MC Risk to Human Health

The MC risk to human health at LHAAP-001-R refers to the risk to human health from exposure to WP and explosives in soil and groundwater. The risk evaluation is based on the reasonably anticipated future use as a national wildlife refuge and does not address unrestricted use.

During the EE/CA investigation activities, no WP or explosives were identified at detectable concentrations in any soil samples collected and there was no indication of the presence of explosives in any pre- or post-detonation samples. There is not a complete pathway for WP or explosives. Therefore, there is no risk associated with WP or explosives.

Additional sampling conducted by the USEPA in 2009 resulted in a detection of perchlorate at a concentration of 76 µg/L, above the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L in one well. The result was an estimate from a diluted sample. The U.S. Army's split sample for the same well indicated that perchlorate was detected at a concentration of 50 µg/L, above the TRRP Tier 1 Groundwater Residential PCL.

2.7.1.3 Ecological Risk

The ecological risk for LHAAP-001-R was addressed in the installation-wide BERA (Shaw, 2007). For the BERA, the entire installation was divided into three large sub-areas (i.e., the Industrial Sub-Area, Waste Sub-Area, and Low Impact Sub-Area) for the terrestrial evaluation. The individual sites at LHAAP were grouped into one of these sub-areas, which were delineated based on commonalities of historic use, habitat type, and spatial proximity to each other. Conclusions for individual sites and the potential for detected chemicals to adversely affect the environment were made in the context of the overall conclusions of the sub-area in which the site falls. Site LHAAP-001-R lies within the Low Impact Sub-Area, and the BERA concluded that no unacceptable risk was present in the Low Impact Sub-Area (Shaw, 2007).

Summary results from the BERA indicated that perchlorate was not selected as a final constituent of potential ecological concern because all estimated receptor ecological effects quotient were less than 1 and there was no evidence of a perchlorate source area. In addition, during the EE/CA, no WP or explosives were identified in any soil samples and there was no indication of the presence of explosives in any pre- or post-detonation samples confirming the determination of no risk to the environment for LHAAP-001-R.

2.7.2 Summary of Site Risk for LHAAP-003-R

2.7.2.1 MEC Risk to Human Safety

The risk factors associated with MEC items were categorized into three classes: MEC factors, site characteristics factors, and human factors. MEC factors are related to the type of MEC, the sensitivity, the quantity (density), and the depth. Site characteristic factors include the accessibility

and stability of areas where MEC items are located. Human factors are related to the population density and population activities.

During the EE/CA field activities, fourteen (14) MPPEH items along with 513 pounds of MD were recovered at LHAAP-003-R with most items clustered in the former Mortar Test Area. The types of ordnance items found were pyrotechnic or illumination in nature except the miscellaneous fuzes. All fuzes were inspected and were determined to have functioned as designed. All items were at the surface or within the top 6 inches of soil. Accordingly, the MEC density, ordnance-type hazard, and sensitivity factors were all assigned a value of 1. The site stability was rated stable, with the rating for contact level risk associated with future human activities as significant. Because the reasonably anticipated future land use is incorporation into the existing wildlife refuge and the significant refuge activities (all of which are non-intrusive), the probable future population density at the site is low. Taking all risk factors into consideration, the risk assessment indicated low MEC risk to human safety for LHAAP-003-R.

Through the surface removal action MEC items were located and removed over the entire site thereby reducing the risk to the future land user.

However, because there is a reasonable potential that some MEC remained after the removal action there is a potential risk to the public. Consistent with the recommendations of the EE/CA and the AM (U.S. Army, 2007), LUCs were identified for the site to promote ongoing protection of human safety against potential explosive hazards that may have remained at the site.

2.7.2.2 MC Risk to Human Health

The MC risk to human health at LHAAP-003-R refers to the risk to human health from exposure to WP and explosives in soil and groundwater. The risk evaluation is based on the reasonably anticipated future use as a national wildlife refuge and does not address unrestricted use.

During the EE/CA investigation activities, no WP or explosives were identified at detectable concentrations in any soil samples collected and there was no indication of the presence of explosives in any pre- or post-detonation samples. There is not a complete pathway for WP or explosives. Therefore, there is no risk associated with WP or explosives.

The additional groundwater sampling conducted by the USEPA and U.S. Army in 2009 indicated that perchlorate was detected in one well at a concentration below the TRRP Tier 1 Groundwater Residential PCL, and therefore there was no need to evaluate risk associated with perchlorate.

2.7.2.3 Ecological Risk

The ecological risk for LHAAP-003-R was addressed in the installation-wide BERA (Shaw, 2007). For the BERA, the entire installation was divided into three large sub-areas (i.e., the Industrial Sub-Area, Waste Sub-Area, and Low Impact Sub-Area) for the terrestrial evaluation.

The individual sites at LHAAP were grouped into one of these sub-areas, which were delineated based on commonalities of historic use, habitat type, and spatial proximity to each other. Conclusions for individual sites and the potential for detected chemicals to adversely affect the environment were made in the context of the overall conclusions of the sub-area in which the site falls. Site LHAAP-003-R lies within the Low Impact Sub-Area, and the BERA concluded that no unacceptable risk was present in the Low Impact Sub-Area (Shaw, 2007).

In addition, during the EE/CA, no WP or explosives were identified in any soil samples and there was no indication of the presence of explosives in any pre- or post-detonation samples confirming the determination of no risk to the environment for LHAAP-003-R.

2.8 Remedial Action Objectives

The remedial action objective for LHAAP-001-R and LHAAP-003-R is protection of human health and safety from explosive hazards that may have remained at the sites after the MEC removal action and confirmation that perchlorate is present in groundwater at levels below the chemical specific criterion. Per the selected remedial action and consistent with the NCP, the groundwater will be monitored to ensure that it can be utilized for its beneficial uses as a drinking water source. The groundwater monitoring level for perchlorate at the Sites is the TRRP PCL residential groundwater cleanup level, 17 ug/L, and is protective of human health and the environment.

2.9 Description of Alternatives

Two alternatives (including No Action) have been evaluated. This section introduces the remedy components, identifies the common elements and distinguishing features of each alternative, and describes the expected outcomes of each.

2.9.1 Description of Remedy Components

Alternative 1 – No Action

The no action alternative provides a comparative baseline against which the other risk-reduction alternatives can be evaluated. No alternative technology is associated with this alternative and no risk-reduction measures resulting in the treatment, containment, removal of, or limited exposure to MEC would take place. No actions would be implemented to reduce existing or potential future exposure to human receptors. Limited sampling of groundwater would not be conducted.

The no action alternative is appropriate for sites where no MEC has been found; where there is no documented evidence of MEC firing, burial, or impact areas; or where the nature and extent of exposure (e.g., small arms ammunition) poses minimal threat to those who may encounter MEC.

LHAAP-001-R and LHAAP-003

Estimated Capital Present Worth Cost: \$0

Estimated O&M Present Worth Cost: \$0

Cost Estimate Duration: \$0

Estimated Present Worth Cost: \$0

Alternative 2 – Land Use Controls and Limited Groundwater Monitoring

LUCs are MEC response actions intended to mitigate or reduce potential residual risk remaining after completion of munitions response actions. Selected LUCs may also be used to supplement removal actions. As a stand-alone response action, LUCs do not result in the removal of additional MEC. To the extent the controls are effective and are maintained, the threat to human safety is reduced. The level of protection is greater than that provided by Alternative 1 (No Action) because informing the public of dangers related to ordnance reduces the likelihood of accidental exposure to MEC that may remain after the 2008 removal action.

LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7** and **2-8**. The locations of the signs are also shown on **Figures 2-7** and **2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

The details of the LUCs will be included in the Remedial Design.

To confirm that perchlorate in groundwater at LHAAP-001-R and LHAAP-003-R is present at levels that are below the chemical-specific remedial goal, limited groundwater monitoring would be conducted. Three rounds of groundwater sampling at LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R will be conducted and the results compared to the TRRP Tier 1 Groundwater Residential PCL of 17 micrograms per liter (µg/L) for perchlorate.

LHAAP-001-R

Estimated Capital Present Worth Cost: \$18,199

Estimated O&M Present Worth Cost: \$106,675

Cost Estimate Duration: 30 years

Estimated Present Worth Cost: \$124,874

LHAAP-003-R

Estimated Capital Present Worth Cost: \$12,169

Estimated O&M Present Worth Cost: \$77,950

Cost Estimate Duration: 30 years

Estimated Present Worth Cost: \$90,120

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Only Alternative 2, LUCs and Limited Groundwater Monitoring meets the RAO. LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7 and 2-8**. The locations of the signs are also shown on **Figures 2-7 and 2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

The details of the LUCs will be included in the Remedial Design. LUCs that were designed and constructed for the site consistent with recommendations of the EE/CA and AM include MEC warning signs spaced every 100 feet, information pamphlets and a MEC safety video to present MEC hazards and safety to the public and site workers.

The Army will implement, maintain, monitor, report on and enforce land use controls at Army-owned property. The Army shall perform those actions related to land use control activities described in this ROD and in the Remedial Design for the ROD. For portions of the Site subject to land use controls that are not owned by the Army, the Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with federal,

state, and local governments and owners and occupants of properties subject to land use controls. The Army will provide notice of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. The Army will send these notices to the federal, state and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls. The Army shall provide the initial notice within 90 days of ROD signature. The frequency of subsequent notifications will be described in the Remedial Design for the ROD. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment. The Army will fulfill its responsibility and obligations under CERCLA and the NCP as it implements, maintains, and reviews the selected remedy.

Upon transfer of Army-owned property, the Army will provide written notice of the land use controls to the transferee of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. Within 15 days of transfer, the Army shall provide EPA and TCEQ with written notice of the division of implementation, maintenance, and enforcement responsibilities unless such information has already been provided in the LUC RD. The LUC RD will address the procedures to be used by the Army and the transferee to document compliance with the LUCs described in this ROD. In the event property is transferred out of Federal control, the land use controls relating to property and groundwater restrictions shall be recorded in the deed and shall be enforceable by the United States and the state of Texas.

Only Alternative 2 includes a provision for limited groundwater monitoring for perchlorate to confirm the levels are protective of human health.

2.10 Summary of Comparative Analysis of Response Alternatives

Nine criteria identified in the NCP §300.430(e)(9)(iii) are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy for each MRS. This section profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below. **Table 2-1** summarizes the comparative analysis of the alternatives for LHAAP-001-R and LHAAP-003-R.

2.10.1 Overall Protection of Human Health and Safety

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Overall protection of human safety measures how well each alternative reduces public exposure and interaction with MEC, the reduction in terms of possible injury or death to humans, and protection of the environment. The following factors are evaluated for this criterion:

- Net reduction in MEC
- Estimated quantity of residual MEC
- Expected depth of residual MEC
- Potential exposure pathway between humans and MEC for projected future land use
- Potential for an individual to interact with MEC if an exposure occurs.

Although a MEC removal action was conducted at LHAAP-001-R and LHAAP-003-R, some MEC may have remained. The No action alternative does not reduce MEC risk to potential onsite receptors. The LUCs of Alternative 2 are protective of human safety because they cut off the exposure pathway.

The limited groundwater monitoring for perchlorate that is part of Alternative 2 provides overall protection of human health by confirming that perchlorate in groundwater does not exceed the TRRP Tier 1 Groundwater Residential PCL, which is protective of the future intended user. The No Action alternative has no provision for limited groundwater monitoring. Alternative 2 meets the RAOs.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations, which are collectively referred to as “ARARs”, unless such ARARs are waived under CERCLA Section 121(d)(4).

Compliance with the ARARs criterion measures how well an alternative meets chemical-, action-, and location-specific ARARs (federal, state, and local). Chemical-specific ARARs exist for MEC sites and are related to the presence of MC and the protection of human health. The screening of MC and WP sampling data at LHAAP-001-R indicated they were not constituents of concern. However, the level of perchlorate in groundwater requires confirmation that it is protective of human health. Only Alternative 2 provides a means to confirm the level of perchlorate in groundwater is protective of human health.

An action specific ARAR, 30 TAC 335, is applicable to well abandonment. Only Alternative 2 would address this requirement.

No location-specific ARARs are identified for these two sites.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation, and the adequacy and reliability of controls.

No action is the lowest ranked alternative for long-term effectiveness because it does not reduce the potential for exposure to any remaining MEC over the long term nor does it confirm that perchlorate in groundwater is not present at levels that may present a risk to human health. The LUCs of Alternative 2 can provide risk reduction over the long term by cutting off the exposure pathway. LUCs reduce risk associated with MEC hazards as long as they are effectively maintained.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Because the screening of MC and WP sampling data at LHAAP-001-R and LHAAP-003-R indicated they were not constituents of concern, treatment technology was not necessary. This includes perchlorate in groundwater, which only requires confirmation that it meets the TRRP Tier 1 Groundwater Residential PCL.

Alternatives 1 and 2 do not include treatment and would not result in reduction of toxicity, mobility, or volume reduction of MEC. The completed MEC removal action removed source material from the sites.

2.10.5 Short-Term Effectiveness

Short-term effectiveness criteria measures how well an alternative meets the exposure and interaction reduction objectives during its implementation and is characterized by:

- The ability of the alternative to reduce risk during implementation
- The potential for adverse effects on the environment during the implementation
- The time required to implement the alternative
- The potential for adverse effects on humans, including the community and personnel involved in implementation of the alternative.

Neither Alternative 1 nor Alternative 2 involve active remedial measures. No activities are associated with Alternative 1 and the activities associated with Alternative 2 are protective to the surrounding community from short-term risks.

Alternative 2 contains the LUCs as the remedy and would provide almost immediate protection through implementation of the LUC that prohibits intrusive activities. The LUCs and limited groundwater monitoring of Alternative 2 would provide short-term risk reduction by informing workers of hazards associated with MEC potentially at the site during groundwater monitoring activities and with the potential presence of perchlorate in groundwater at levels exceeding the TRRP Tier 1 Groundwater Residential PCL. There would be no exposure for workers repairing/maintaining signs which are located just outside the perimeters of LHAAP-001-R and LHAAP-003-R.

2.10.6 Implementability

Implementability is a measure of whether a MEC response action alternative can be physically and administratively implemented, maintained, and enforced. It is also a measure of the availability of the services and materials needed to implement the alternative. Another consideration for implementability is regulatory agency and community acceptance of a given alternative. For implementability, the response alternatives are ranked by technical and administrative feasibility, the availability of services and materials and the regulatory agency and community acceptance of the alternative.

The no action alternative is the easiest alternative to implement in terms of both technical and administrative feasibility. Under the no action alternative no services or materials are required.

The technology associated with implementing the LUCs alternative (i.e., sign maintenance) is reliable, readily accessible, and easily implemented. There should be no implementation safety concerns related to the MEC warning sign repair/maintenance at both sites, as this will occur outside the perimeter of the sites. Groundwater monitoring of the existing wells is easily implemented as no additional services or materials are required beyond sampling requirements and it is known to meet regulatory and community acceptance.

2.10.7 Cost

Cost estimates are used in the CERCLA process to eliminate those remedial alternatives that are significantly more expensive than competing alternatives without offering commensurate increases in performance or overall protection of human health or the environment. The cost estimates developed are preliminary estimates with an intended accuracy range of -30 to +50 percent.

The benefit of the investment in risk reduction is considered when ranking the alternatives. This involves evaluating the reduction in risk to the public versus the cost of implementing the alternative. There is no investment cost associated with no action, however, the no action alternative does not provide any MEC risk reduction at LHAAP-001-R and LHAAP-003-R or confirmation groundwater sampling. LUCs costs include maintenance costs for LUCs (e.g.,

replacing weathered signs), groundwater sampling and monitoring well abandonment, and five-year reviews. The LUCs provide the greatest reduction of risk.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented LUCs with limited groundwater monitoring as the preferred alternative. Comments received from the USEPA and TCEQ during the Proposed Plan development have been incorporated. Both agencies concur with the selected remedial action.

2.10.9 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. One set of written public comments was received during the 30-day public comment period; there were no verbal comments from the July 21, 2011 public meeting. The topics of the comments included: monitoring metals in groundwater, detection limits for metals in soil and sediment, groundwater flow, adequacy of monitoring well coverage, and perchlorate standard in groundwater. The written comments received and their responses are presented in the Responsiveness Summary (**Section 3.0**).

2.11 Principal Threat Wastes

Between August and November 2008, a MEC removal action was conducted for LHAAP-001-R and LHAAP-003-R to remove potential explosive hazards and a potential source of munitions constituents. For LHAAP-001-R, surface removal was conducted for the entire site and subsurface removal for the suspected OB/OD area. For LHAAP-003-R, surface clearance was conducted for the entire site. In addition, screening of MC and WP sampling data indicated they were not constituents of concern at LHAAP-001-R and LHAAP-003-R, although a requirement to confirm that perchlorate in groundwater does not exceed the TRRP Tier 1 Groundwater Residential PCL was identified. There are currently no known principal threat wastes at these two MRS sites (LHAAP-001-R-01 MMRP and LHAAP-003-R-01 MMRP).

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Implementation of LUCs and limited groundwater monitoring for perchlorate in addition to the completed removal action is the selected remedy for LHAAP-001-R and LHAAP-003-R and is consistent with the intended future use of the site as a national wildlife refuge. The presence of MEC items at LHAAP-001-R and LHAAP-003-R was confirmed during the EE/CA investigation, therefore, a MEC removal was implemented for the MRS sites. MEC items were located and removed during surface removals over the entire areas of LHAAP-001-R and LHAAP-003-R, and a subsurface removal to depth in the OB/OD area within LHAAP-001-R. Although the removal action provided an effective solution for reducing risk of exposure by reducing the potential for

any direct contact with MEC, there is the potential that some MEC remains. Therefore, the sites are not suitable for unrestricted use. LUCs for both LHAAP-001-R and LHAAP-003-R promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites and satisfy the RAO for the sites.

Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. Limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the TRRP Tier 1 Groundwater Residential PCL, the state remedial standard utilized in the absence of a federal drinking water standard, to verify protection of human health and the environment.

The selected alternative offers a high degree of long-term effectiveness, can be readily implemented, and is cost-effective.

The U.S. Army believes the selected alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected alternative will: 1) be protective of human health and safety; 2) comply with ARARs; 3) be cost-effective; and 4) utilize a permanent solution; by 5) reducing the volume of the potential source for MEC contaminants and pollutants.

LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7 and 2-8**. The locations of the signs are also shown on **Figures 2-7 and 2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

Five-year reviews will be performed to document that the remedy remains protective of human health and safety.

2.12.2 Description of the Selected Remedy

The selected remedy for LHAAP-001-R and LHAAP-003-R is implementation of LUCs and limited groundwater monitoring in addition to the completed removal action.

Between August and November 2008, a MEC non-time critical removal action was conducted for the LHAAP-001-R and LHAAP-003-R. Surface clearance was performed at LHAAP-001-R and LHAAP-003-R for the entire sites and subsurface clearance to depth of detection was performed at LHAAP-001-R in the OB/OD area. The MEC removal action located and removed MEC items thereby reducing the risk to the future land user. Although these removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC or MPPEH, there is the potential that some MEC remains. Therefore, LUCs will be implemented for the sites.

The major components of the selected remedy include:

Land Use Control. LUCs were designed and constructed to promote ongoing protection of human safety against potential explosive hazards that may remain at the MMRP sites. The LUCs' performance objectives are to prohibit the development and use of the property for residential housing, elementary and secondary schools, and child care facilities and playgrounds, and to prohibit intrusive activities such as digging or any other activity which could result in explosive safety risks. The recordation notification for the sites which will be filed with Harrison County will include a description of the LUCs. The boundary of the LUCs encloses the site boundaries shown on **Figures 2-7 and 2-8**. The locations of the signs are also shown on **Figures 2-7 and 2-8**. The details for the LUCs will be included in the RD. The LUC to prohibit residential land use will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. The LUC restricting land use to nonresidential will remain in place until it is demonstrated that the MEC no longer presents a threat to public/human safety. A LUC to prohibit intrusive subsurface activities, including digging, will remain in place until it is demonstrated that the MEC no longer present an explosive hazard. However, intrusive subsurface activities may occur provided that the Army and the EPA approve such intrusive subsurface activities before they are commenced and provided that they are undertaken by qualified personnel who are trained in explosives safety measures.

LUCs that were prepared and constructed during the 2008 removal action include the following:

- The survey including legal description and plat of the LUC boundaries and locations of signs prepared in accordance with TAC § 335.569, Appendix III in preparation for recordation in the Harrison County Clerk's Office.
- Signage at the perimeter of LHAAP-001-R and LHAAP-003-R. Signs are in place at the perimeter of the sites, serving as the physical demarcation of the controlled areas. The signs have visibility from one sign to the next with a maximum spacing of 100 ft. The

signs include warning of the potential presence of MEC, state the restriction against intrusive activities, and provide a contact number.

- Education program for future refuge visitors, staff, and volunteers. The program includes informational pamphlets and safety video warning of the potential presence of MEC and presenting examples of MEC that were or may be found at the site.
- **Limited Groundwater Monitoring.** Environmental sampling results at LHAAP-001-R and LHAAP-003-R indicate that there is no risk to human health and safety from perchlorate or WP. However, limited groundwater monitoring is intended to confirm perchlorate levels in groundwater are below the TRRP Tier 1 Groundwater Residential PCL to verify protection of human health and the environment. If, after three rounds of groundwater sampling at LHAAP-001-R and one round of groundwater sampling at LHAAP-003-R, the results that are evaluated on or before the first five year review indicate detections at levels below the PCL value of 17 micrograms per liter (µg/L) for perchlorate, groundwater monitoring will cease and the wells will be plugged and abandoned.

The Army will implement, maintain, monitor, report on and enforce land use controls at Army-owned property. The Army shall perform those actions related to land use control activities described in this ROD and in the Remedial Design for the ROD. For portions of the Site subject to land use controls that are not owned by the Army, the Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with federal, state, and local governments and owners and occupants of properties subject to land use controls. The Army will provide notice of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. The Army will send these notices to the federal, state and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls. The Army shall provide the initial notice within 90 days of ROD signature. The frequency of subsequent notifications will be described in the Remedial Design for the ROD. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment. The Army will fulfill its responsibility and obligations under CERCLA and the NCP as it implements, maintains, and reviews the selected remedy.

Upon transfer of Army-owned property, the Army will provide written notice of the land use controls to the transferee of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the ROD. Within 15 days of transfer, the Army shall provide EPA and TCEQ with written notice of the division of implementation, maintenance, and enforcement responsibilities unless such information has already been provided in the LUC RD. The LUC RD will address the procedures to be used by the Army and the transferee to document compliance with the LUCs described in this ROD. In the event property is transferred out of Federal control, the land use controls relating to property and groundwater restrictions shall be

recorded in the deed and shall be enforceable by the United States and the state of Texas. The internal control mechanism for this closed installation is the “Comprehensive Land Use Control (LUC) Management Plan, Former Longhorn Army Ammunition Plant, Karnack, Texas,” to which the final approved LUC RD will be added.

The details and description of the LUCs implementation and maintenance actions were presented in the LUC Plan (EODT, 2008) associated with the 2008 removal action. A LUC Remedial Design (RD) will be finalized as the land use component of the Remedial Design. Within 21 days of the issuance of the ROD, the Army will propose deadlines for completion of the RD Work Plan, RD, and Remedial Action Work Plan. The documents will be prepared and submitted to EPA and TCEQ pursuant to the FFA. The LUC RD will contain implementation and maintenance actions, including periodic inspections. The long-term groundwater and surface water monitoring and MNA performance monitoring plan will also be presented in the RD. The LUC RD will be the 2008 LUC Plan revised and finalized as the LUC RD. A recordation of the area with the prohibition of intrusive activity and residential land use will be filed in the Harrison County Courthouse in accordance with TAC § 335.569, Appendix III. The recordation will include the locations of the signs and a description of the educational material available. To transfer this property (LHAAP-001-R-01 & LHAAP-003-R-01), an Environmental Condition of Property (ECP) document would be prepared and the Environmental Protection Provisions from the ECP would be attached to the letter of transfer. The ECP would include the LUCs as part of the Environmental Protection Provisions. The property would be transferred subject to the LUCs identified in the ECP.

Five-Year Reviews will be conducted to ensure that the LUCs are specified, implemented, monitored, reported on, and enforced in an efficient, cost effective manner that ensures long-term protectiveness. Texas Administrative Code (TAC) §335.566, requires that the LUCs be filed in Harrison County.

2.12.3 Cost Estimate for the Selected Remedy

Tables 2-2 and 2-3 are the cost estimate summary tables for LHAAP-001-R and LHAAP-003-R, respectively. The information in the tables is based on the best available information regarding the anticipated scope of the selected remedy. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements may occur as a result of new information and data collected during the O&M of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

The total project present worth cost of the selected remedy is approximately \$124,874 and \$90,120 for LHAAP-001-R and LHAAP-003-R, respectively, using a discount rate of 2.3%. The capital

cost is estimated at \$18,199 and \$12,169, for LHAAP-001-R and LHAAP-003-R, respectively. The total O&M present value cost is estimated at approximately \$106,675 and \$77,950 for LHAAP-001-R and LHAAP-003-R, respectively. The O&M costs includes three quarters of perchlorate sampling for LHAAP-001-R and one quarter of sampling for LHAAP-003-R, semiannual mowing and signage maintenance for both sites for 30 year. O&M would support the required CERCLA five-year reviews.

2.13 Expected Outcomes of Selected Remedy

The purpose of this remedial action is to attain the RAO of protecting human health and safety from explosive hazards that may have remained at the sites. The LUCs will promote ongoing protection of human safety against potential explosive hazards that may have remained at the site. The limited groundwater monitoring for perchlorate will confirm levels in groundwater are below the TRRP Tier 1 Groundwater Residential PCL, the state remedial standard utilized in the absence of a federal drinking water standard, to verify protection for human health and the environment.

2.14 Statutory Determinations

Under CERCLA §121 and the NCP, the U.S. Army must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets the statutory requirements.

2.14.1 Protection of Human Health and the Environment

The selected remedy, LUCs and limited groundwater monitoring will achieve the RAO. The LUCs provide an effective solution for reducing the risk of exposure by reducing the potential for any direct contact with MEC remaining at the sites after the 2008 removal action. Because of the reasonable potential that some MEC may remain, the sites are not suitable for unrestricted use. The LUCs at both LHAAP-001-R and LHAAP-003-R will promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites. Notification of the LUCs will be recorded with Harrison County. The limited groundwater monitoring for perchlorate provides overall protection of human health by assuring that perchlorate in groundwater does not exceed the TRRP Tier 1 Groundwater Residential PCL, which is protective of human health.

A site-wide ecological baseline risk assessment has been performed for LHAAP. As noted in **Sections 2.7.1.3, and 2.7.2.3** the BERA concluded that no unacceptable ecological risk was present at LHAAP-001-R and LHAAP-003-R.

2.14.2 Compliance with ARARs

The selected remedy complies with all ARARs. The ARARs are presented below and in **Table 2-4**.

Chemical-specific ARARs

Because the screening of MC and WP sampling data at LHAAP-001-R and LHAAP-003-R indicated they were not constituents of concern, the RAO was met and the addition of MC-related ARARs is not necessary. A requirement to confirm that perchlorate in groundwater does not exceed 17 µg/L was identified, which is the state remedial standard utilized in the absence of a federal drinking water standard.

Location-specific ARARs

There are no location-specific ARARs.

Action-specific ARARs

The selected remedy triggers an action-specific ARAR related to well abandonment. Available standards for well plugging/abandonment would provide ARARs for such actions. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to plugging/abandonment of water wells. In particular, 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*) provides ARARs for the plugging/abandonment of groundwater monitoring wells.

2.14.3 Cost-Effectiveness

There are no costs associated with the no action alternative. **Tables 2-2** and **2-3** present cost estimates for the LUCs and groundwater monitoring for LHAAP-001-R and LHAAP-003-R, respectively. Completion of the MEC removal action and the design and construction of LUCs under the 2008 removal action lowered costs for the sites.

2.14.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The U.S. Army has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. The MEC removal action provided an effective solution for reducing risk of exposure by reducing the volume of the potential source of MEC contaminant and pollutants and for any direct contact with MEC or MPPEH. LUCs provide immediate protection. Maintenance of this control would be required as long as there is a potential of hazards from MEC that might have remained at the site.

2.14.5 Preference for Treatment as a Principal Element

The statutory preference for treatment was addressed with the MEC removal action which removed source material from the site and destroyed MEC. The LUCs do not include treatment of MEC but will promote ongoing protection of human safety against potential explosive hazards that may have remained at the sites.

2.14.6 Five-Year Review Requirements

Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) provide the statutory and legal basis for conducting five-year reviews. Although the MEC removal actions provide an effective solution for reducing risk of exposure by reducing the potential for any direct contact with MEC, there is the potential that some MEC remains. Therefore, the sites are not suitable to allow unlimited use and unrestricted exposure. A review will be conducted at least every five years to confirm that the remedy continues to provide adequate protection of human health and safety.

2.15 Documentation of Significant Changes

The Proposed Plan for LHAAP-001-R and LHAAP-003-R was released for public comment in July 2011. The Proposed Plan included the LUCs in Alternative 2 as well as limited groundwater monitoring for perchlorate. No significant changes have been made to the proposed plan for the sites. Written comments were received during the public comment period. It was determined that no significant changes to the decision, as originally identified in the Proposed Plan, were necessary or appropriate.

**Table 2-1
Comparative Analysis of Alternatives**

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Land Use Controls and Limited Groundwater Monitoring
Overall protection of human health and safety	No protection. Does not achieve RAOs.	Protection of human health and safety provided by maintenance of LUCs that cuts off the exposure pathway. Includes groundwater monitoring to confirm the levels of perchlorate in groundwater are protective of human health. Achieves the RAOs.
Compliance with ARARs	Does not comply with ARARs	Complies with ARARs.
Long-term effectiveness and permanence	Not effective due to the presence of residual MEC that may have remained at the site.	High in effectiveness by prohibiting use of the site and educating the public of the potential hazards.
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	No active reduction.
Short-term effectiveness	No reduction in risk in the short term.	LUCs provide short-term risk reduction by informing workers conducting groundwater monitoring activities of the potential MEC hazards and of the use restrictions. .
Implementability	Readily implemented.	Readily implemented, technical needs are not complex.
Costs *		
LHAAP-001-R		
Capital Expenditure	\$0	\$18,199
O & M Expenditure	\$0	\$106,67
Total Present Worth	\$0	\$124,874
LHAAP-003-R		
Capital Expenditure	\$0	\$12,169
O & M Expenditure	\$0	\$77,980
Total Present Worth	\$0	\$90,120

Table 2-2
Remediation Cost Table, Selected Remedy (LHAAP-001-R)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas									DATE: June 2016		
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
		Other	LTM					Total	2.3%		
									NPV	18,219	106,69
2016	18,219	0	39,757					39,757			
2017	0	0	1,473					1,473			
2018	0	0	9,664					9,664			
2019	0	0	1,473					1,473			
2020	0	0	1,473					1,473			
2021	0	0	1,473					1,473			
2022	0	0	1,473					1,473			
2023	0	0	9,664					9,664			
2024	0	0	1,473					1,473			
2025	0	0	1,473					1,473			
2026	0	0	1,473					1,473			
2027	0	0	1,473					1,473			
2028	0	0	9,664					9,664			
2029	0	0	1,473					1,473			
2030	0	0	1,473					1,473			
2031	0	0	1,473					1,473			
2032	0	0	1,473					1,473			
2033	0	0	9,664					9,664			
2034	0	0	1,473					1,473			
2035	0	0	1,473					1,473			
2036	0	0	1,473					1,473			

Table 2-2 (continued)
Remediation Cost Table, Selected Remedy (LHAAP-001-R)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas									DATE: June 2016		
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
		Other	LTM					Total	2.3%		
									NPV	18,219	106,69
2037	0	0	1,473					1,473			
2038	0	0	9,664					9,664			
2039	0	0	1,473					1,473			
2040	0	0	1,473					1,473			
2041	0	0	1,473					1,473			
2042	0	0	1,473					1,473			
2043	0	0	9,664					9,664			
2044	0	0	1,473					1,473			
2045	0	0	1,473					1,473			
Total Expenditures	18,219	0	131,620					131,620			\$124,912

Notes:

The discount rate of 2.3% is based on OMB Circular A-94 Appendix C, Revised December 2010.

Costs have been escalated to bring FY10 dollars to FY15 dollars using escalation rate of 1.0794 and escalated to bring FY15 dollars to FY16 dollars using escalation rate of 1.0157

LTM long-term monitoring

LUC land use control

NPV net present value

O&M operation & maintenance

Table 2-3
Remediation Cost Table, Selected Remedy (LHAAP-003-R)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas								DATE: June 2016		
			O & M Costs					Present Value (NPV)		
FY	Capital Costs	Capital Costs						Discount Rate	Capital	O & M
		Other	LTM					2.3%		
								NPV	12,146	77,980
2016	12,146	0	11,044				11,044			
2017	0	0	1,473				1,473			
2018	0	0	9,664				9,664			
2019	0	0	1,473				1,473			
2020	0	0	1,473				1,473			
2021	0	0	1,473				1,473			
2022	0	0	1,473				1,473			
2023	0	0	9,664				9,664			
2024	0	0	1,473				1,473			
2025	0	0	1,473				1,473			
2026	0	0	1,473				1,473			
2027	0	0	1,473				1,473			
2028	0	0	9,664				9,664			
2029	0	0	1,473				1,473			
2030	0	0	1,473				1,473			
2031	0	0	1,473				1,473			
2032	0	0	1,473				1,473			
2033	0	0	9,664				9,664			
2034	0	0	1,473				1,473			
2035	0	0	1,473				1,473			
2036	0	0	1,473				1,473			
2037	0	0	1,473				1,473			
2038	0	0	9,664				9,664			

Table 2-3 (continued)
Remediation Cost Table, Selected Remedy (LHAAP-003-R)
Present Worth Analysis

PROJECT LOCATION: Karnack, Texas									DATE: June 2016		
			O & M Costs						Present Value (NPV)		
FY	Capital Costs	Capital Costs							Discount Rate	Capital	O & M
		Other	LTM					Total	2.3%		
									NPV	12,146	77,980
2039	0	0	1,473					1,473			
2040	0	0	1,473					1,473			
2041	0	0	1,473					1,473			
2042	0	0	1,473					1,473			
2043	0	0	9,664					9,664			
2044	0	0	1,473					1,473			
2045	0	0	1,473					1,473			
Total Expenditures	12,146	0	102,908					102,908			\$90,126

Notes and Abbreviations:

The discount rate of 2.3% is based on OMB Circular A-94 Appendix C, Revised December 2010.

Costs have been escalated to bring FY10 dollars to FY15 dollars using escalation rate of 1.0794 and escalated to bring FY15 dollars to FY16 dollars using escalation rate of 1.0157

LTM long-term monitoring
 LUC land use control
 NPV net present value
 O&M operation & maintenance

Table 2-4
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
Wells		
Well Construction Standards—Monitoring or Injection Wells 16 TAC 76.1000	Construction of water wells— applicable to construction of new monitoring or injection wells, if needed.	Wells shall be abandoned in accordance with the technical requirements of Section 76.1004, as appropriate.

Figure 2-1
Location of Longhorn AAP

Figure 2-2
Site Location Map LHAAP-001-R and LHAAP-003-R

Figure 2-3
Sampling Locations South Test Area/Bomb Test Area LHAAP-001-R

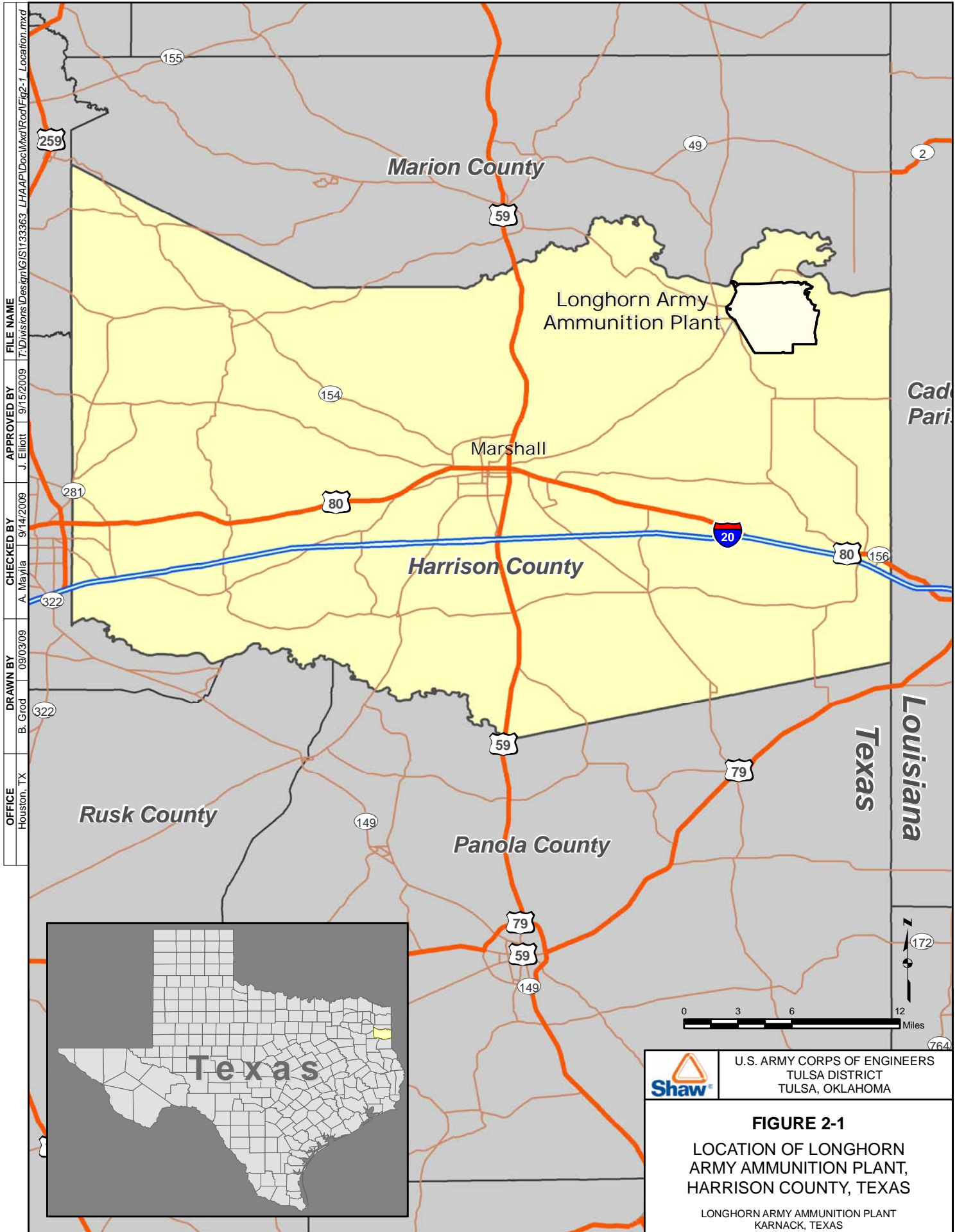
Figure 2-4
MEC/MPPEH Location Map South Test Area/Bomb Test Area LHAAP-001-R

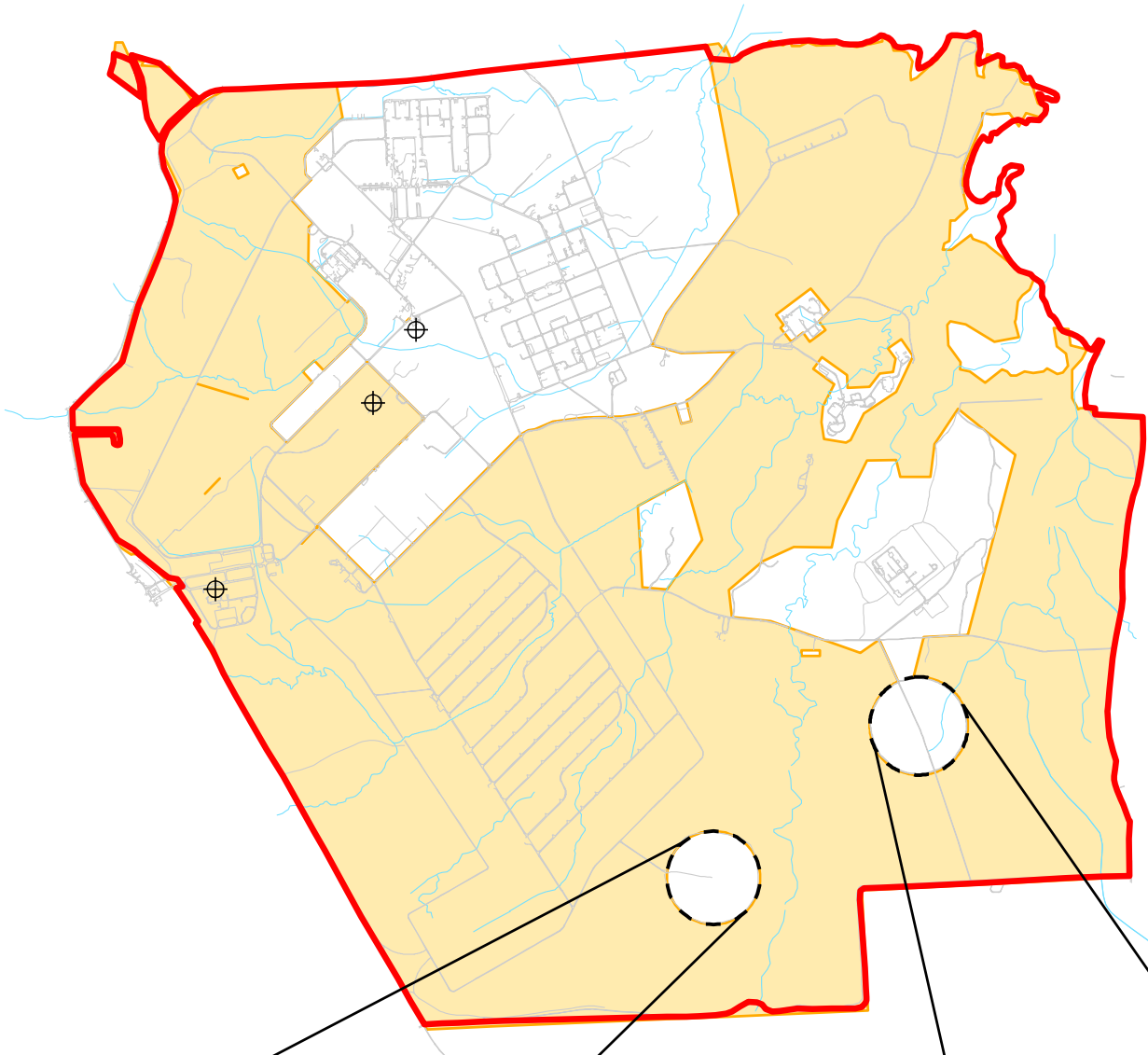
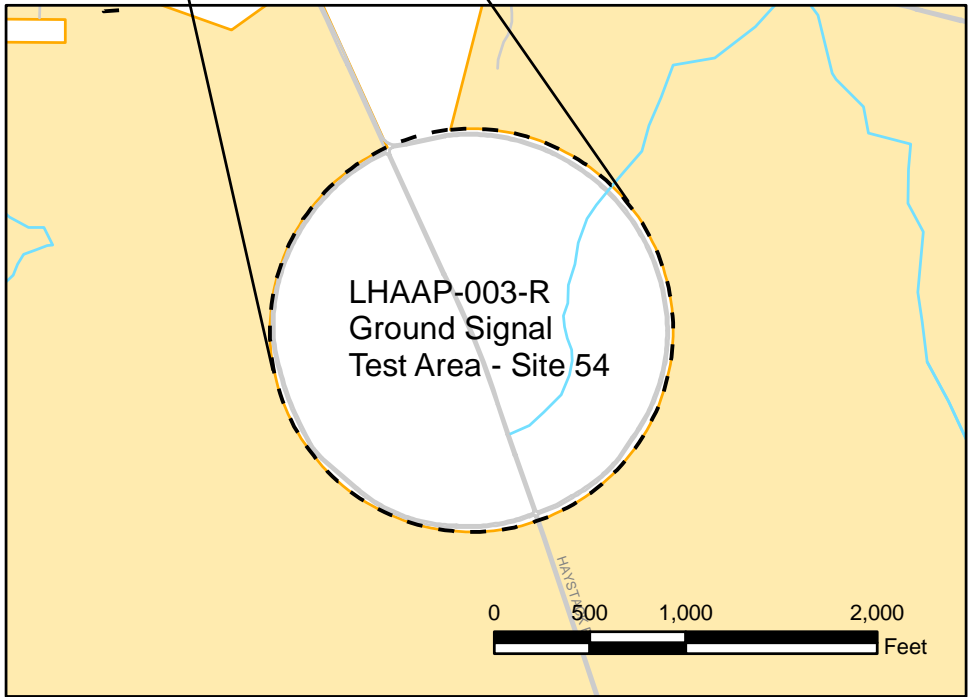
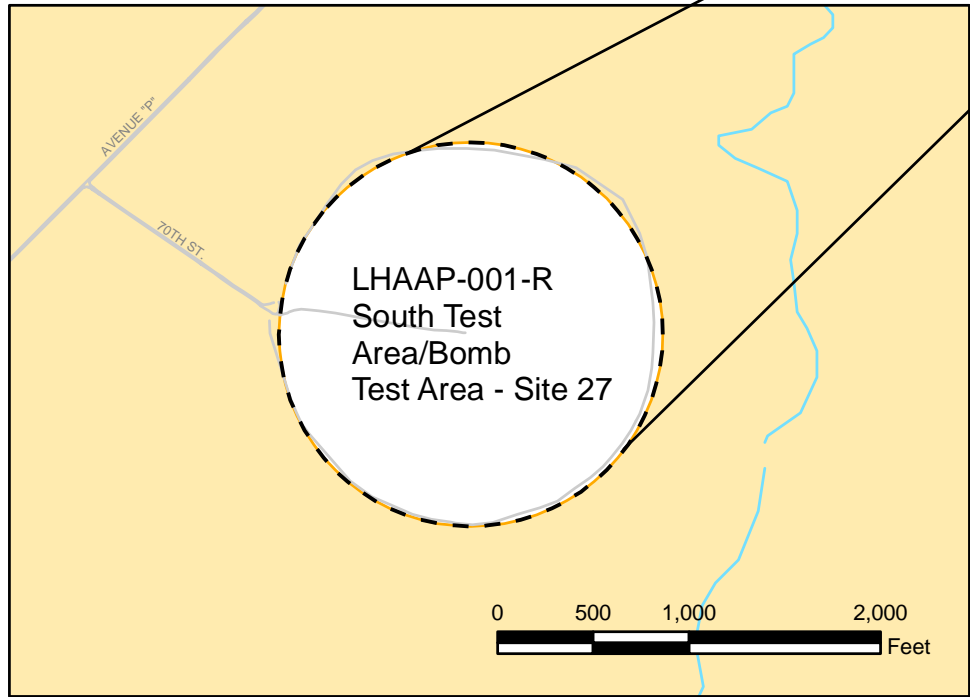
Figure 2-5
Sampling Locations Ground Signal Test Area LHAAP-003-R

Figure 2-6
MEC/MPPEH Location Map Ground Signal Test Area LHAAP-003-R

Figure 2-7
LUC Boundary for LHAAP-001-R

Figure 2-8
LUC Boundary for LHAAP-003-R





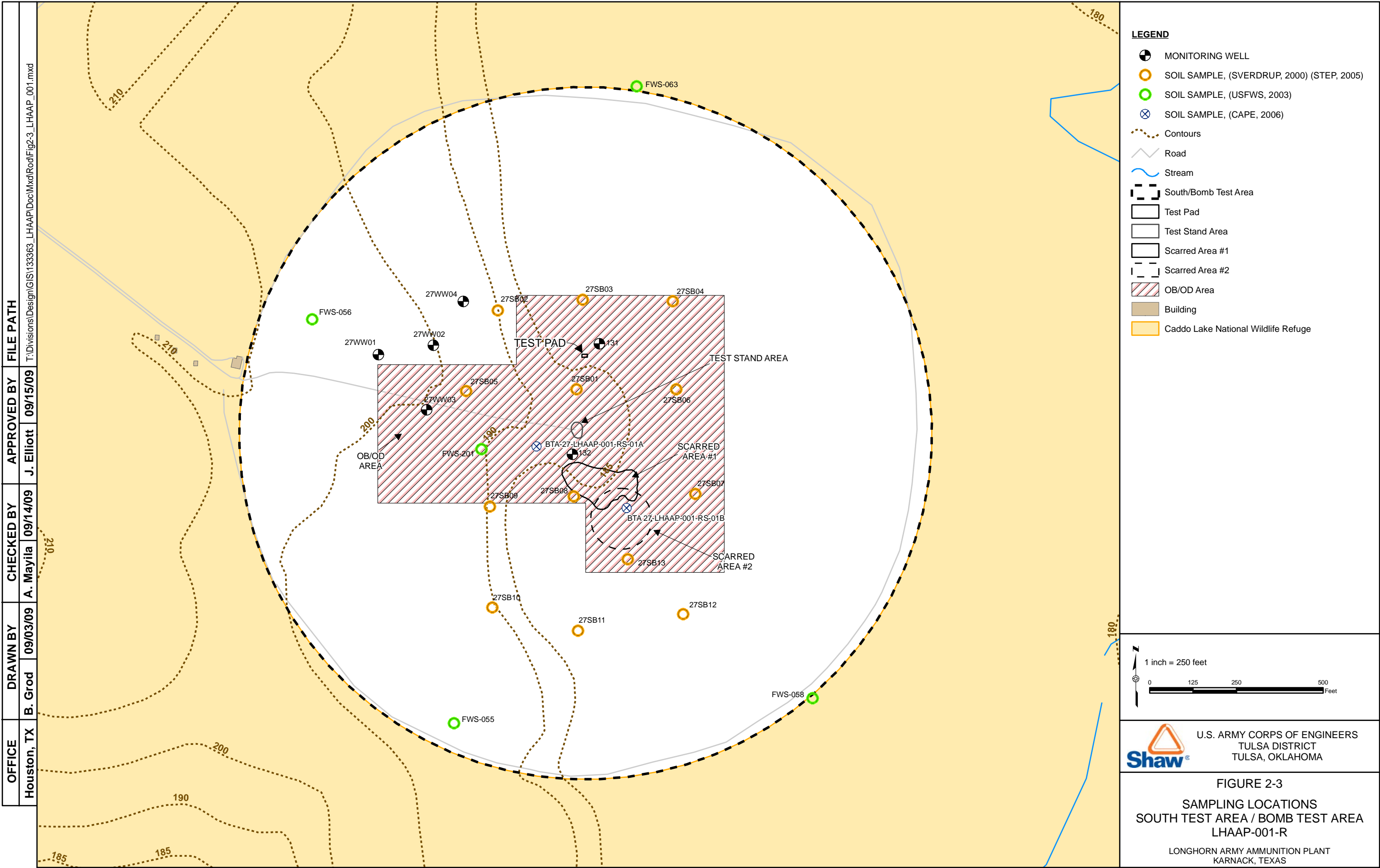
LEGEND

- LHAAP Water Supply Well
- Road
- Stream
- MUNITIONS RESPONSE SITES
- Longhorn Base Boundary
- Caddo Lake National Wildlife Refuge

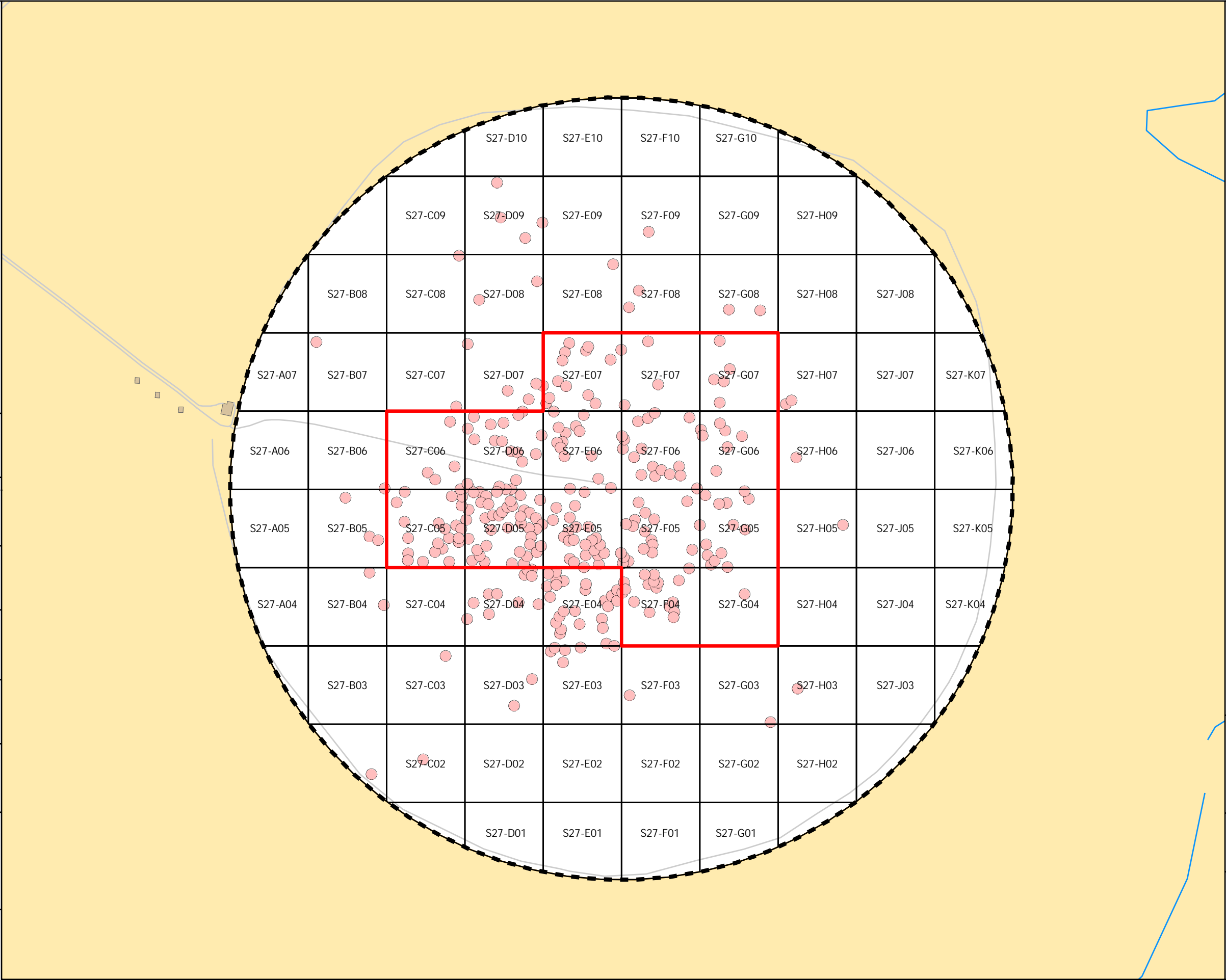


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TULSA, OKLAHOMA

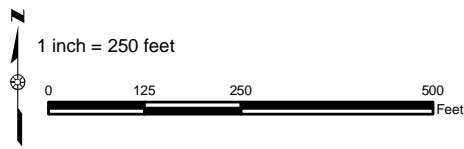
FIGURE 2-2
SITE LOCATION MAP
LHAAP-001-R and LHAAP-003-R
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod	A. Mayila	J. Elliott	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\Rod\Fig2-3_001MEC.mxd



- LEGEND**
- MEC/MPPEH Items
 - Road
 - Stream
 - South/Bomb Test Area
 - Investigated Grid
 - OB/OD Area
 - Building
 - Caddo Lake National Wildlife Refuge




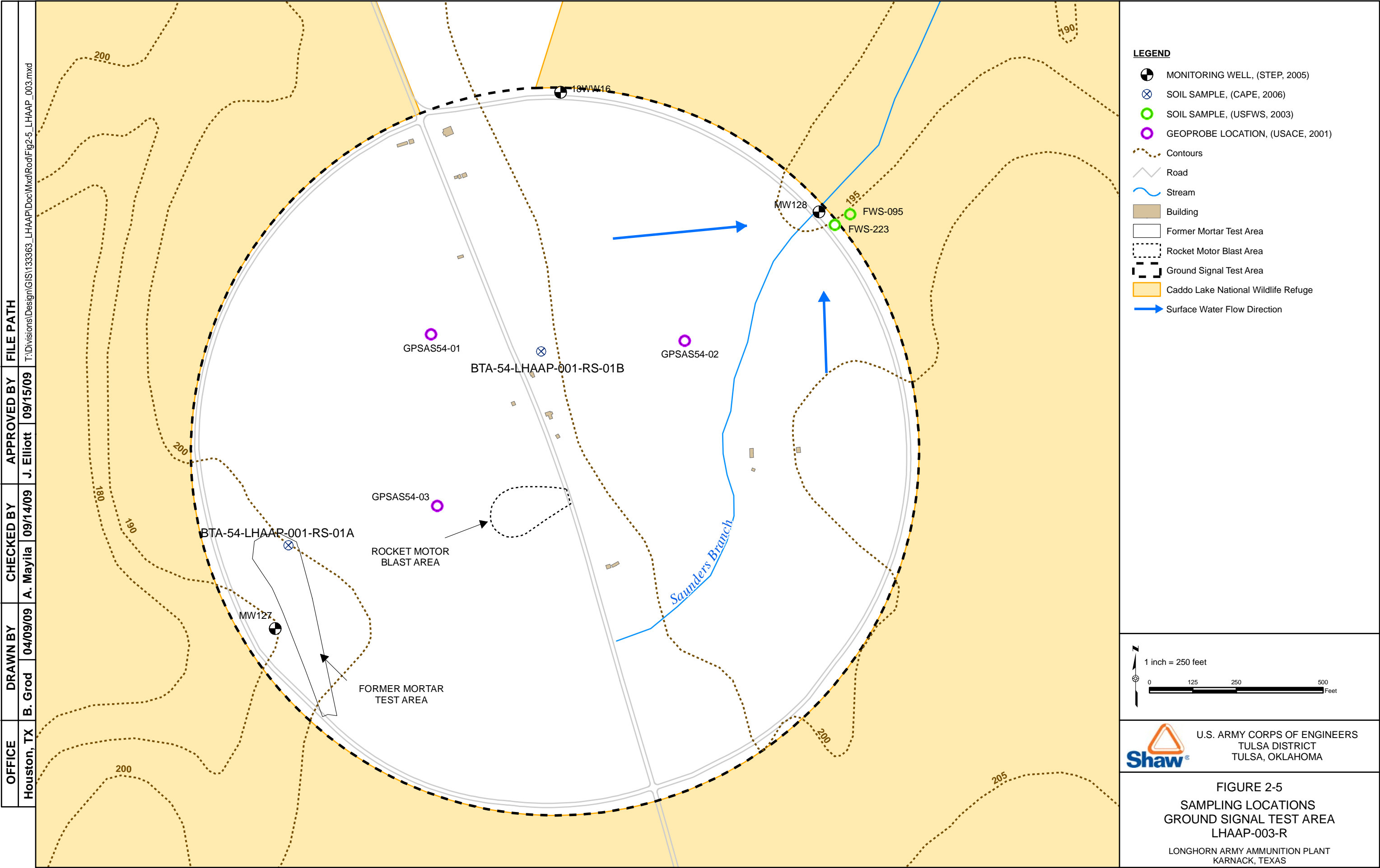
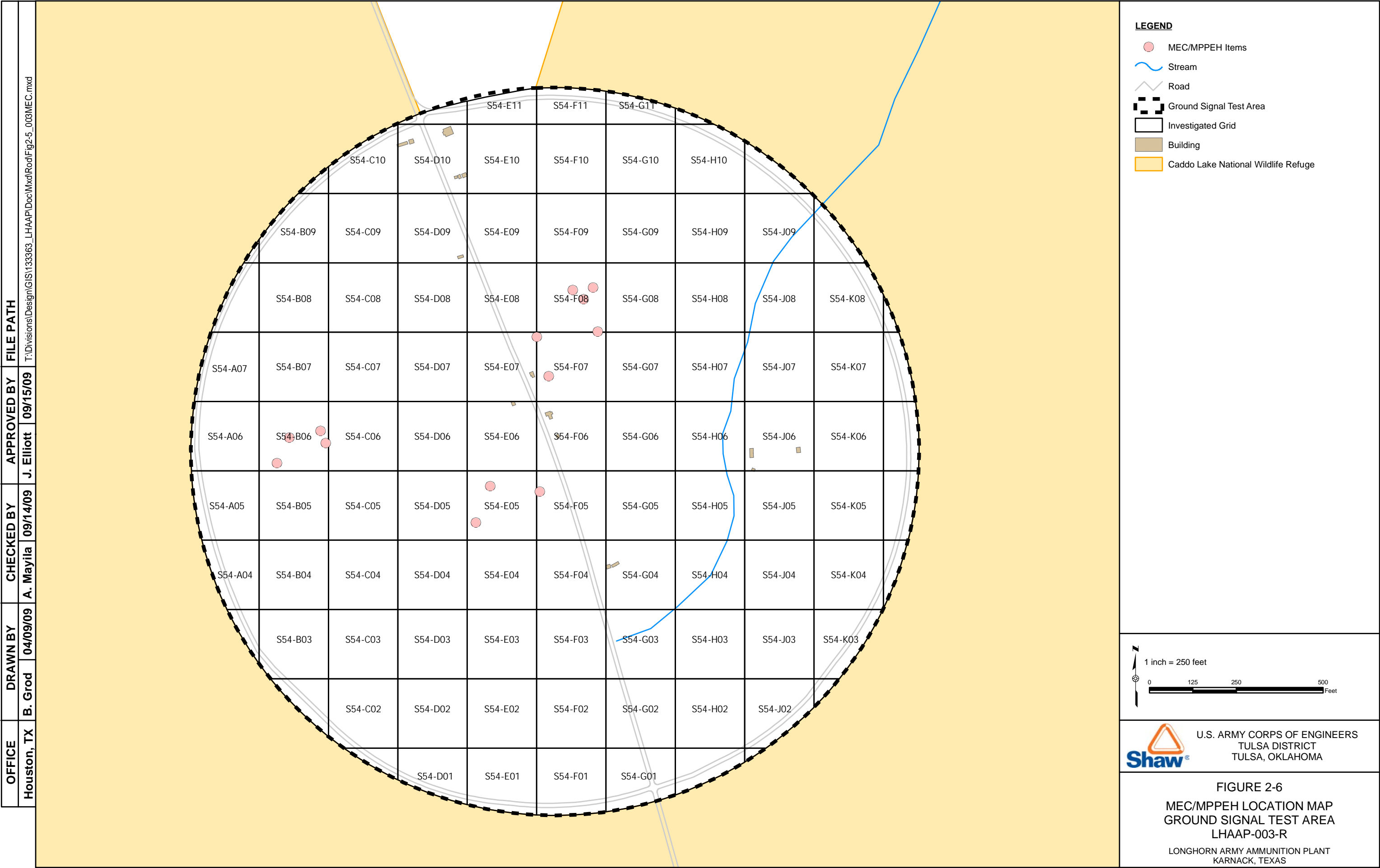
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TULSA, OKLAHOMA

FIGURE 2-4
MEC/MPPEH LOCATION MAP
SOUTH TEST AREA / BOMB TEST AREA
LHAAP-001-R
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



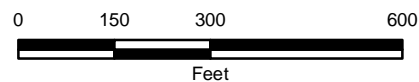




DESCRIP	NORTHING	EASTING
SIGN 01	3613016.8	393564.7
SIGN 02	3612986.7	393560.5
SIGN 03	3612956.4	393563.9
SIGN 04	3612926.3	393568.9
SIGN 05	3612896.4	393574.2
SIGN 06	3612866.9	393581.7
SIGN 07	3612839.1	393594.1
SIGN 08	3612812.3	393608.5
SIGN 09	3612785.5	393622.9
SIGN 10	3612762.6	393643.0
SIGN 11	3612742.6	393666.0
SIGN 12	3612724.3	393690.2
SIGN 13	3612708.3	393716.2
SIGN 14	3612695.4	393743.8
SIGN 15	3612683.8	393771.9
SIGN 16	3612675.9	393801.4
SIGN 17	3612672.1	393831.6
SIGN 18	3612670.0	393862.0
SIGN 19	3612669.6	393883.3
SIGN 20	3612679.6	393912.1
SIGN 21	3612684.9	393942.1
SIGN 22	3612693.6	393971.2
SIGN 23	3612701.9	393987.0
SIGN 24	3612726.1	394005.4
SIGN 25	3612738.3	394033.3
SIGN 26	3612738.6	394049.3
SIGN 27	3612758.1	394072.6
SIGN 28	3612780.3	394093.6
SIGN 29	3612805.5	394110.5
SIGN 30	3612832.3	394124.9
SIGN 31	3612860.1	394137.3
SIGN 32	3612889.8	394143.8
SIGN 33	3612919.7	394149.8
SIGN 34	3612949.8	394154.5
SIGN 35	3612980.2	394156.4
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SIGN 38	3613071.3	394151.2
SIGN 39	3613100.5	394142.6
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SIGN 41	3613150.7	394108.5
SIGN 42	3613173.2	394088.0
SIGN 43	3613195.6	394069.6
SIGN 44	3613211.6	394044.1
SIGN 45	3613216.5	394024.9
SIGN 46	3613221.1	394007.6
SIGN 47	3613232.4	393979.3
SIGN 48	3613244.4	393951.4
SIGN 49	3613253.3	393922.2
SIGN 50	3613257.5	393892.0
SIGN 51	3613259.5	393861.7
SIGN 52	3613261.2	393831.2
SIGN 53	3613256.8	393801.1
SIGN 54	3613253.2	393770.8
SIGN 55	3613242.5	393742.2
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SIGN 57	3613213.7	393688.6
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SIGN 59	3613169.6	393648.3
SIGN 60	3613147.5	393627.4
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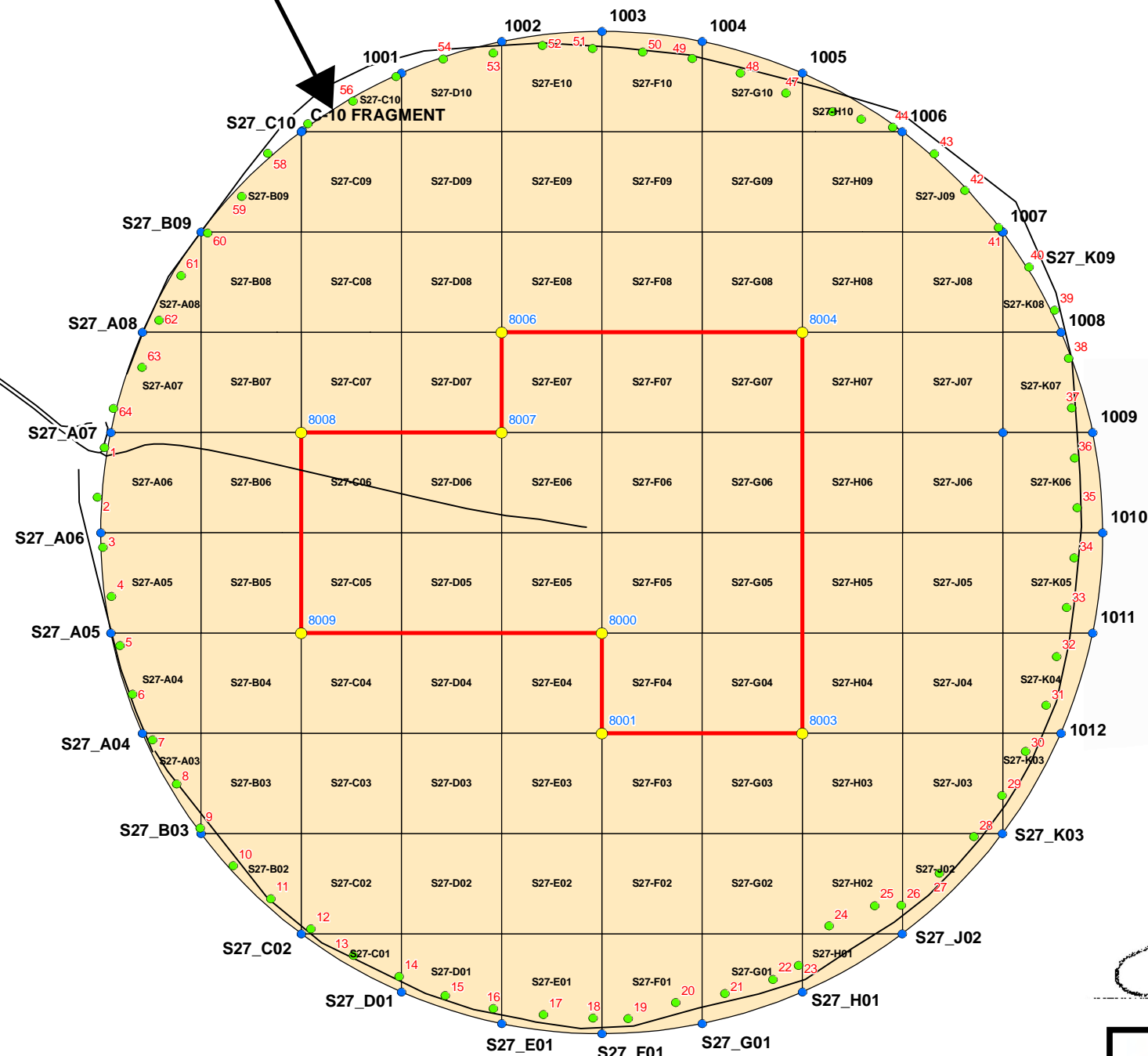
Legend

- OBOD Corners
- UXO Sign
- Boundary Stakes
- Roads
- OBOD
- Investigated Grids



Datum: NAD83 UTM
Monument: Longhorn Army Ammunition Plant
Monument BG-1 with coordinates
NORTHING-3614801.46,
EASTING-395385.09

Boundary of nonresidential use
restriction and restriction
against intrusive activities



DESCRIP	NORTHING	EASTING	DESCRIP	NORTHING	EASTING
8000	3612904.2	393867.3	1001	393745.4	3613244.5
8001	3612843.2	393867.3	1002	393806.4	3613263.8
8003	3612843.2	393869.2	1003	393867.3	3613269.9
8004	3613087.0	393869.2	1004	393928.3	3613263.8
8006	3613087.1	393806.4	1005	393989.2	3613244.5
8007	3613026.1	393806.4	1006	394050.1	3613209.0
8008	3613026.1	393864.4	1007	394111.0	3613148.0
8009	3612904.2	393864.4	1008	394146.5	3613087.0

1009	394165.8	3613026.1
1010	394171.9	3612965.1
1011	394165.8	3612904.2
1012	394146.5	3612843.2
C-10 FRAGMENT	39385.2	3613209.4
S27_A04	393588.0	3612843.2
S27_A05	393568.7	3612904.2
S27_A06	393562.5	3612965.1
S27_A07	393568.6	3613026.1
S27_A08	393587.9	3613087.1
S27_B03	393623.5	3612782.3
S27_B09	393623.5	3613148.0
S27_C02	393684.6	3612721.3
S27_C10	393684.4	3613209.0
S27_D01	393745.4	3612685.9
S27_E01	393806.4	3612666.6
S27_F01	393867.3	3612660.5
S27_G01	393928.3	3612667.7
S27_H01	393989.3	3612686.0
S27_J02	394049.9	3612721.3
S27_K03	394110.9	3612782.3
S27_K07	394111.2	3613026.1
S27_K09	394111.2	3613147.9



I, David R. Collins, Registered Professional Land
Surveyor No. 1954, do hereby certify that this plat
correctly represents the results of a survey made
under my supervision August 4 through
September 23, 2008.



U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-7

LUC BOUNDARY MAP
LHAAP-001-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

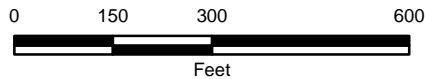
Boundary of nonresidential use
restriction and restriction
against intrusive activities



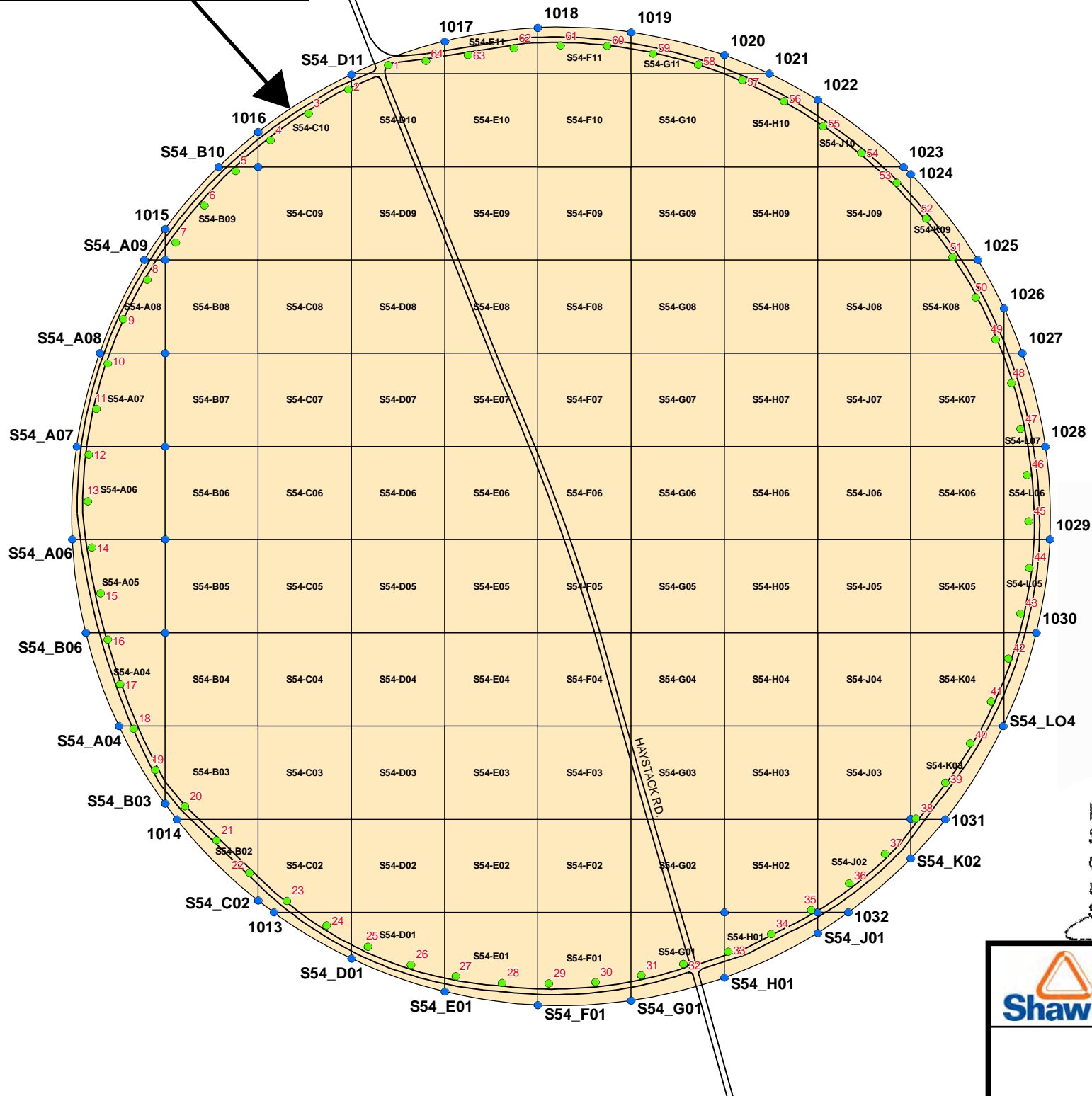
DESCRIP	NORTH	EAST	DESCRIP	NORTHIN	EASTING
SIGN 1	3614179.4	395143.2	1013	395068.6	3613625.2
SIGN 10	3613984.2	394959.8	1014	395005.1	3613686.2
SIGN 11	3613954.6	394952.4	1015	394997.4	3614072.1
SIGN 12	3613924.6	394947.4	1016	395058.4	3614135.6
SIGN 13	3613894.1	394947	1017	395180.3	3614195.0
SIGN 14	3613863.7	394949.6	1018	395241.3	3614203.9
SIGN 15	3613833.8	394955.1	1019	395302.2	3614200.9
SIGN 16	3613803.8	394959.8	1020	395363.2	3614185.9
SIGN 17	3613774.4	394967.8	1021	395392.4	3614173.9
SIGN 18	3613745.2	394976.7	1022	395424.1	3614156.7
SIGN 19	3613718.3	394991.2	1023	395480.2	3614112.9
SIGN 2	3614163.4	395117.3	1024	395485.1	3614108.0
SIGN 20	3613694.6	395010.3	1025	395528.9	3614051.9
SIGN 21	3613672.4	395031.1	1026	395546.1	3614020.2
SIGN 22	3613651.1	395052.8	1027	395558.0	3613991.0
SIGN 23	3613632.6	395077	1028	395573.1	3613930.0
SIGN 24	3613616.8	395103.1	1029	395576.0	3613869.1
SIGN 25	3613602.8	395130	1030	395567.2	3613808.1
SIGN 26	3613591	395158.1	1031	395507.7	3613686.2
SIGN 27	3613583.5	395187.6	1032	395444.2	3613625.2
SIGN 28	3613579.1	395217.8	S54_A04	394967.3	3613747.1
SIGN 29	3613578.7	395248.2	S54_A06	394936.8	3613869.1
SIGN 3	3614147.8	395091.2	S54_A07	394939.8	3613930.0
SIGN 30	3613579.6	395278.7	S54_A08	394954.8	3613991.0
SIGN 31	3613584.2	395308.8	S54_A09	394983.9	3614051.9
SIGN 32	3613591.4	395336.3	S54_B03	394997.4	3613696.4
SIGN 33	3613599.5	395365.6	S54_B06	394997.4	3613808.1
SIGN 34	3613611	395393.8	S54_B06	394945.7	3613808.1
SIGN 35	3613626.8	395419.8	S54_B06	394997.4	3613869.1
SIGN 36	3613644.2	395444.8	S54_B07	394997.4	3613930.0
SIGN 37	3613663.6	395468.2	S54_B08	394997.4	3613991.0
SIGN 38	3613686.5	395488.2	S54_B09	394997.4	3614051.9
SIGN 39	3613710.2	395507.5	S54_B10	395032.6	3614112.9
SIGN 4	3614130.2	395066.2	S54_C02	395058.4	3613633.0
SIGN 40	3613735.9	395523.8	S54_C10	395058.4	3614112.9
SIGN 41	3613763	395537.5	S54_D01	395119.3	3613595.1
SIGN 42	3613791.2	395548.8	S54_D11	395119.4	3614173.3
SIGN 43	3613820.6	395556.7	S54_E01	395180.3	3613573.5
SIGN 44	3613850.5	395562.3	S54_F01	395241.3	3613564.6
SIGN 45	3613880.9	395562.2	S54_G01	395302.2	3613567.6
SIGN 46	3613911.3	395561	S54_H01	395363.2	3613582.6
SIGN 47	3613941.4	395556.7	S54_H02	395363.1	3613625.2
SIGN 48	3613971.3	395550.8	S54_J01	395424.1	3613611.8
SIGN 49	3613999.9	395540.5	S54_J02	395424.1	3613625.2
SIGN 5	3614110.1	395043.4	S54_K02	395485.1	3613660.5
SIGN 50	3614027.4	395527.5	S54_K03	395485.1	3613686.2
SIGN 51	3614053.7	395512.2	S54_LO4	395545.5	3613747.1
SIGN 52	3614078.9	395495.2			
SIGN 53	3614102.3	395475.8			
SIGN 54	3614122	395452.6			
SIGN 55	3614139.3	395427.5			
SIGN 56	3614155.8	395401.9			
SIGN 57	3614169.5	395374.8			
SIGN 58	3614179.6	395346			
SIGN 59	3614186.8	395316.5			
SIGN 6	3614087.5	395022.9			
SIGN 60	3614191.9	395286.4			
SIGN 61	3614192.1	395255.9			
SIGN 62	3614190.3	395225.5			
SIGN 63	3614185.9	395195.4			
SIGN 64	3614182	395167.9			
SIGN 7	3614063.3	395004.4			
SIGN 8	3614039.1	394985.8			
SIGN 9	3614013.1	394969.9			

Legend

- UXO Signs
- Boundary Stakes
- Roads
- Investigated Grids



Datum: NAD83 UTM
Monument: Longhorn Army Ammunition Plant
Monument BG-1 with coordinates
NORTHING-3614801.46,
EASTING-395385.09



I, David R. Collins, Registered Professional Land Surveyor No. 1954, do hereby certify that this plat correctly represents the results of a survey made under my supervision August 4 through September 23, 2008.



U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-8

LUC BOUNDARY MAP
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

3.0 Responsiveness Summary

The Responsiveness Summary serves three purposes. First, it provides the U.S. Army, USEPA, and TCEQ with information about community concerns with the remedy at LHAAP-001-R and LHAAP-003-R as presented in the Proposed Plan. Second, it shows how the public's comments were considered in the decision-making process for selection of the remedy. Third, it provides a formal mechanism for the U.S. Army to respond to public comments.

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-001-R and LHAAP-003-R through public meetings, the Administrative Record file for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-001-R and LHAAP-003-R, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on July 21, 2011
- Presentation slides from the July 21, 2011 public meeting
- Questions and comments from the public during the public comment period, and the response to comments from the U.S. Army dated July 27, 2011.

Written comments were received from the general public during the public comment period and Proposed Plan meeting in July 2011 for LHAAP-001-R and LHAAP-003-R. The Proposed Plan was finalized without revision. **Appendix A** contains the public announcement for the Proposed Plan meeting and public comment period.

3.1 Stakeholder Issues and Lead Agency Responses

This section responds to significant issues raised by stakeholders including the public and community groups that were received in written or verbal form.

Question/comment: High concentrations (greater than the MCL) of metals have been found in groundwater at both sites since the early 1980s. In the most recent round of groundwater sampling (2009), high concentrations of beryllium and chromium were detected at site 001-R, and high concentrations of arsenic and chromium were detected at site 003-R.

However, the Army does not intend to monitor metals in groundwater at either site. This is despite the fact that the EPA sent the Army a letter that recommended monitoring metals in groundwater. Letters between the EPA and Army are reproduced in appendix 1.

The Army should monitor metals in groundwater at both sites.

Response: Perchlorate and white phosphorus (WP) are the data gap contaminants of concern for LHAAP-001-R and LHAAP-003-R under the Military Munitions Response Program (MMRP). Metals were addressed at sites LHAAP-27 and LHAAP-54, which are co-located with LHAAP-001-R and LHAAP-003-R respectively, under the 1998 Installation Restoration Program (IRP) ROD. Therefore any metals issues/concerns for these two sites must be addressed with respect to the 1998 IRP ROD and would not be included in this Proposed Plan. Army is in the process of reviewing the new metal results and historical results and has committed to respond to EPA and TCEQ under a path separate from the MMRP.

Question/comment: Soils at sites 001-R and 003-R are contaminated with a variety of metals (e.g., arsenic, barium, cadmium, lead). However, the Army does not plan to remove contaminated soil from either site.

According to the Army, the contaminants do not represent a threat to human health. However, there are problems with the Army's human health risk assessment (HHRA).

First, many of the soil analyses are not useful because of high detection limits (see below).

Second, the HHRA was performed in 1997. Therefore, it did not use the most recent data. The more recent data shows that some metal concentrations are significantly higher than those used in the HHRA (**Table 3-1**). Also, perchlorate was not included in the HHRA.

Table 3-1
Contaminant Concentrations Used in HHRA
Old and New Maximums

Contaminant/Site	Old Maximum (mg/kg)	New Maximum (mg/kg)
Barium/001-R	123	639
Copper/001-R	18.7	41.1
Lead/001-R	18	26.3
Nickel/001-R	2.41	18.6
Thallium/003-R	-	0.2
Perchlorate/001-R	-	28.9 (µg/kg)

The Army should remove contaminated soils from both sites.

Response: Please see response to the first comment above.

Question/comment: In some cases, the Army used detection limits for metals in soil and sediment that are higher than the standards established to protect human health (see **Table 3-2**). Thus, the Army cannot know whether these contaminants are present in concentrations that threaten human health.

Table 3-2
Detection Limits for Metals in Soil and Sediment

Contaminant	Site	Date	Detection Limit (mg/kg)	Standard (TCEQ GWP-Ind, mg/kg)
Antimony	001-R & 003-R	1982	0.76	0.6
	001-R & 003-R	1993	1	0.6
	001-R	1994	1.1-1.3	0.6
	001-R	1996	10.3-10.9	0.6
	003-R	1996/1997	1.1-1.2	0.6
Arsenic	001-R & 003-R	1982	0.3	1
	001-R & 003-R	1993	0.1-1	1
	001-R	1996	2.58-2.74	1
	003-R	1996/1997	0.596-58.7	1
	001-R & 003-R	2003	0.52-0.54	1
Beryllium	001-R & 003-R	1982	0.5	0.4
	001-R	1997	0.62-0.77	0.4
	001-R & 003-R	2003	0.20-0.22	0.4
Cadmium	001-R & 003-R	1982	0.5	0.5
	001-R & 003-R	1993	1	0.5
	001-R	1994	0.56-0.63	0.5
	001-R	1996	2.06-2.19	0.5
	003-R	1996/1997	2.22-2.38	0.5
	001-R & 003-R	2003	0.25-0.27	0.5
Thallium	001-R & 003-R	1982	3	0.2
	001-R & 003-R	1993	0.2	0.2
	001-R	1994	0.55-1.2	0.2
	001-R	1996	15.5-16.4	0.2
	003-R	1996/1997	0.6	0.2

The Army should re-sample soil and sediment at both sites. The samples should be analyzed using detection limits that are lower than the human health-based standards.

Response: Please see response to the first comment above.

Question/comment: The Army does not appear to have done the work required to determine groundwater flow directions at either site. Effective and efficient groundwater monitoring cannot be performed unless groundwater flow directions are known.

The Army should produce maps showing groundwater flow directions at each site.

Response: Hydrogeology was already addressed at sites 001-R and 003-R under the 1998 IRP ROD (see 1997 Remedial Investigation Report). Based on the Hydrogeological Assessment, the groundwater and surface flow direction at LHAAP-003-R are to the northwest and parallel to Sanders Branch and Harrison Bayou and at LHAAP-001-R groundwater flow is northerly. In addition, groundwater surface data from May 2000 (attached) for monitoring wells 127, 128 and 18WW16 at site LHAAP-003-R has been evaluated and confirms a northwest groundwater flow direction. Groundwater surface data from May 2000 for monitoring wells 27WW01, 27WW02, 27WW03, 27WW04, 131 and 132 at site LHAAP-001-R confirm a groundwater flow direction to the northeast. Maps showing groundwater flow direction at each site are attached as **Appendix B**.

Question/comment: There are six monitor wells at site 001-R, and four monitor wells at site 003-R. In addition, one-time grab samples were obtained from borings at each site.

The Army does not know whether there are a sufficient number of monitor wells at each site because it does not know whether the wells are down gradient of contaminated areas (see above comment on groundwater flow directions). The Army should evaluate the need for additional monitor wells after it has determined groundwater flow directions at each site.

Response: Please see the above response. Hydrogeology was already addressed at these sites.

Question/comment: The Army is using a groundwater standard for perchlorate of 72 µg/L. However, the EPA health reference level (HRL) for perchlorate is 15 µg/L. In addition, the EPA has decided to establish a primary drinking water standard (MCL) for perchlorate. When established, the perchlorate MCL will probably be similar to the HRL.

If the Army abandons the monitor wells based on the 72 µg/L standard, it may have to re-install monitor wells when the EPA establishes an MCL for perchlorate.

Until the EPA establishes an MCL for perchlorate, the Army should use a standard that is no greater than 15 µg/L.

Response: The Army is using the TRRP Tier 1 Groundwater Residential PCL of 17 µg/L for comparison of perchlorate in groundwater.

Question/comment: The Army has analyzed soil and water samples for two isomers of dinitrotoluene (DNT): 2,4-DNT and 2,6-DNT. These are the most common isomers in technical grade DNT. However, there are four other isomers of DNT (2,3-DNT; 2,5-DNT; 3,4-DNT; and 3,5-DNT). All of the isomers are toxic.

At the Badger Army Ammunition Plant, high concentrations of the other isomers have been found in groundwater. In some cases, concentrations of the other isomers are significantly higher than the concentrations of 2,4-DNT and 2,6-DNT.

The Army should analyze soil and water samples for all isomers of DNT, not just the 2,4-DNT and 2,6-DNT isomers.

Response: At this time, there are no Federal or State of Texas promulgated screening levels for DNT isomers, other than for 2,4-DNT and 2,6-DNT. However, as part of the CERCLA process, the statutory five-year reviews will evaluate the effectiveness of the remedy, including any changes in ARARs concerning DNT isomers, and would recommend implementation of other measures if needed.

Question/comment: The Army has developed source-receptor conceptual site models for munitions constituents and OE at LHAAP sites 001-R and 003-R. The Army should also develop source-receptor conceptual site models for metals at both sites.

Response: Please see response to the first comment above.

Question/comment: The following documents were listed as primary reference documents in the Final Proposed Plan. However, they do not appear to have been included in the Army Administrative Record.

- CAPE, 2007b, Final Engineering Evaluation/Cost Analysis Action Memorandum Revision 1, Longhorn Army Ammunition Plant, Karnack, Texas, Signed by Thomas Lederle, BRAC Division, ACSIM, United States Army, 5 December.
- Environmental Protection Systems, Inc. (EPS), 1984, Longhorn Army Ammunition Plant Contamination Survey, June.
- EODT Technology, Inc., (EODT), 2009, Final Site Specific Final Report for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas, September.

The Army should ensure that all documents referred to in the Proposed Plan are included in the Administrative Record. If any document has been misfiled or mislabeled in the Administrative Record, the Army should so indicate when referring to that document.

Response: The Final Engineering Evaluation/Cost Analysis Action Memorandum, signed by Thomas Lederle 5 December 2007, is located in the Administrative Record in Volume 9, Year 2008. It is listed out of date in sequence.

The other two references appear to have been overlooked and will be incorporated into the Administrative Record.

4.0 References

CAPE, 2007, *Final Engineering Evaluation/Cost Analysis: Report, Longhorn Army Ammunition Plant, Karnack, Texas*, January.

e²M, 2002, *Final U.S. Army Closed, Transferring and Transferred Range/Site Inventory for Longhorn Army Ammunition Plant, Texas*, 15 September.

e²M, 2005, *Final Site Inspection Report, Military Munitions Response Program Sites, Longhorn Army Ammunition Plant, Texas*, June.

Environmental Protection Systems, Inc. (EPS), 1984, *Longhorn Army Ammunition Plant Contamination Survey*, June.

EODT Technology, Inc., (EODT), 2008, *Final Work Plan for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas*, July.

EODT, 2009, *Final Site Specific Final Report for the MEC Removal Action at the Former Longhorn Army Ammunition Plant, LHAAP-001-R (Site 27) and LHAAP-003-R (Site 54), Karnack, Texas*, September.

Shaw Environmental, Inc. (Shaw), 2007, *Installation-Wide Baseline Ecological Risk Assessment, Volume 1: Step 3 Report, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas*, November.

Shaw, 2011, *Munitions Constituents Data Summary Report, South Test Area/Bomb Test Area, LHAAP-001-R and Ground Signal Test Area, LHAAP-003-R, Longhorn Army Ammunition Plant, Karnack, Texas, Houston, Texas*, June.

Solutions to Environmental Problems (STEP), 2005, *Plant-wide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas*, April.

U.S. Army, 2004, *Memorandum of Agreement Between the Department of the Army and the Department of the Interior for the Interagency Transfer of Lands at the Longhorn Army Ammunition Plant for the Caddo Lake National Wildlife Refuge, Harrison County, Texas*, signed by the Department of the Interior on April 27, 2004 and the Army on April 29, 2004.

U.S. Army, 2007, *Action Memorandum for Three Munitions Response Sites: South Test Area/Bomb Test Area, Static Test Area, and Ground Signal Test Area, Longhorn Army Ammunition Plant, Karnack, Texas*, August. Signed 5 December 2007 by Thomas E. Lederle.

U.S. Army, 2011, *Final Proposed Plan for LHAAP-001-R, South Test Area/Bomb Test Area and LHAAP-003-R, Ground Signal Test Area, Longhorn Army Ammunition Plant, Karnack, Texas*, June.

U.S. Army Corps of Engineers (USACE), Tulsa District, 1998, *Record of Decision at Group 1 Sites (Sites 11, 1, XX, 27), Longhorn Army Ammunition Plant, Karnack, Texas*, January.

U.S. Department of the Army (Army), Longhorn Army Ammunition Plant, 2011, “Army Response to EPA Letter of June 2010: Munitions Constituents Data Summary Report Response to Comments, Longhorn Army Ammunition Plant, Karnack, Texas”, Letter from Rose M. Zeiler, Longhorn Army Ammunition Plant Site Manager to Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division, March 10.

U.S. Environmental Protection Agency (USEPA), 2010, “Munitions Constituents Data Summary Report, Longhorn Army Ammunition Plant, Karnack, Texas”, Letter from Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division to Rose M. Zeiler Longhorn Army Ammunition Plant Site Manager, June 11.

U.S. Environmental Protection Agency (USEPA), 2011, “Army Response to EPA Letter of June 2010: Munitions Constituents Data Summary Report, Longhorn Army Ammunition Plant, Karnack, Texas,” Letter from Stephen Tzhone, Remedial Project Manager of USEPA, Region 6, Superfund Division to Rose M. Zeiler Longhorn Army Ammunition Plant Site Manager, June 03.

U.S. Fish and Wildlife Service (USFWS), 2003, *Contaminant Investigation of Northern, Central, and Eastern Portions of Caddo Lake National Wildlife Refuge, Texas*, November.

Glossary of Terms

Administrative Record File – The body of reports, official correspondence, and other documents that establish the official record of the analysis, clean up, and final closure of a site.

Characterization – The compilation of all available data about the waste unit to determine the rate and extent of contaminant migration resulting from the waste site, and the concentration of any contaminants that may be present.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – CERCLA was enacted by Congress in 1980 and was amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Exposure – Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.

Federal Facility Agreement – A legal binding agreement among USEPA, TCEQ, and U.S. Army that sets the standards and schedules for the comprehensive remediation of Longhorn Army Ammunition Plant.

Groundwater – Underground water that fills pores in soil or openings in rocks to the point of saturation.

Human Health Risk Assessment – A study conducted as part of a remedial investigation to determine the risk posed to human health by site-related chemicals.

Land Use Controls – Physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property in order to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and/or physical barriers to limit access to property, such as fences or signs.

Material That Potentially Presents an Explosive Hazard (MPPEH) – Material potentially containing explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris), or material potentially containing a high enough concentration of explosives such that the material presents an explosive hazard.

Munitions and Explosives of Concern - This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means:

(A) Unexploded Ordnance (UXO), as defined in 10 U.S.C. 2710 (e) (9);
(B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710 (e) (2); or
(C) Explosive munitions constituents (e.g., TNT, RDX) present in high enough concentrations to pose an explosive hazard.

Munitions Constituents - Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

Munitions Debris (MD) – Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

Munitions Response Site (MRS) – A discrete location within a munitions response area that is known to require a munitions response.

National Priorities List (NPL) – The USEPA’s list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for remedial action.

Responsiveness Summary – A summary of oral and/or written comments received during the proposed plan comment period and includes responses to these comments. The responsiveness summary is a key part of a decision document highlighting community concerns.

Proposed Plan – A plan for a site cleanup that proposes a recommended or preferred remedial alternative. The Proposed Plan is available to the public for review and comment and the preferred alternative may change based on public and other stakeholder input.

Superfund Amendments and Reauthorization Act (SARA) – Amended CERCLA in 1986. SARA resulted in more emphasis on permanent remedies for cleaning up hazardous waste sites, increased the focus on human health problems posed by hazardous waste sites, and encouraged greater citizen participation in making decisions on how sites should be cleaned up.

Surface Media – The soil (surface or subsurface), surface water, and sediment present at a site as applicable. The source material in the surface media may be contributing to groundwater contamination.

Superfund – The common name used for CERCLA; also referred to as the Trust Fund. The Superfund Program was established to help fund cleanup of hazardous waste sites. It also allows legal action to force those responsible for sites to clean them up.

Appendix A

Public Announcement

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT
ON THE PROPOSED PLAN FOR MUNITIONS RESPONSE SITES LHAAP-001-R
AND LHAAP-003-R,
LONGHORN ARMY AMMUNITION PLANT, TEXAS

PUBLIC MEETING ON JULY 21, 2011
AT THE KARNACK COMMUNITY CENTER, KARNACK, TEXAS

The U.S. Army, as lead agency for environmental response actions at Longhorn Army Ammunition Plant (LHAAP), in partnership with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency Region 6, has developed a proposed plan for the following sites: LHAAP-001-R and LHAAP-003-R. Beginning on July 13, 2011, copies of the Proposed Plan and supporting documentation will be available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. The public comment period is July 13, 2011, through August 13, 2011. A public meeting for the public to view information and ask questions will be held on July 21, 2011 from 6:00 to 7:30 p.m. at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas. Questions, comments, and responses on the Proposed Plan will be recorded by a court reporter during the public meeting. Written comments will be accepted throughout the public comment period.

LHAAP-001-R, the South Test Area/Bomb Test Area, is located in the southern portion of LHAAP and covers an area of approximately 79 acres. LHAAP-001-R was constructed in 1954 and used for testing photoflash bombs produced at the facility until about 1956. During the late 1950s, illuminating signal devices were also demilitarized within pits excavated within the vicinity of the test pad. During the early 1960s, leaking production items may have been demilitarized by detonation. Leaking white phosphorus (WP) munitions were supposedly disposed of although no primary source documentation concerning this effort was located. A 1984 LHAAP Contamination Survey stated the area had been relatively inactive since the early 1960s and no disposal or testing activities were carried out. LHAAP-001-R is co-located with the Installation Restoration Program (IRP) site LHAAP- 27.

LHAAP-003-R, the Ground Signal Test Area, is located in the southeastern portion of LHAAP and covers an area of approximately 80 acres. LHAAP-003-R was used intermittently starting in April 1963 for aerial and on-ground testing and destruction of a variety of devices, including pyrotechnic signal devices, red phosphorus smoke wedges, infrared flares, illuminating mortar shells and cartridges, button bombs, and various types of explosive simulators. The site was also used intermittently over a 20-year period for testing and burn-out of rocket motors. From late 1988 through 1991, the site was also used for burn-out of rocket motors in Pershing missiles. Occasionally, leaking WP munitions were burned at the site as a demilitarization activity. LHAAP-003-R is co-located with the IRP site LHAAP-54.

The Proposed Plan documents a 2008 removal action of munitions and explosives of concern (MEC) at LHAAP-001-R and LHAAP-003-R and proposes limited groundwater monitoring for perchlorate at these sites beyond the land use controls (LUCs) already in place as a result of the 2008 removal action. The purpose of the additional monitoring is to confirm perchlorate levels in groundwater are below groundwater MSC for industrial use (GW-Ind). Furthermore, implementation, maintenance, inspection, reporting and enforcement of the LUCs will continue to promote the ongoing protection of human safety against explosive hazards that may have remained at the sites in the subsurface.

The U.S. Army is soliciting public review and comment on the recommendation of limited groundwater monitoring for perchlorate for LHAAP-001-R and LHAAP-003-R. Copies of the Proposed Plan and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670.

The U.S. Army encourages the public to participate in the decision-making process by offering comments on the Proposed Plan. For further information, contact: Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas, 72951; phone number 479-635-0110 or e-mail rose.zeiler@us.army.mil.

Appendix B

Water Level Measurements for May 2000 and Maps Showing Groundwater Flow Direction

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
01MW01	5/18/00	278.47	10:27	28.51	249.96
01MW02	5/18/00	273.23	10:24	23.65	249.58
01MW03	5/18/00	260.1	10:15	13.66	246.44
01MW04	5/18/00	273.93	10:03	23.79	250.14
01MW05	5/18/00	257.08	10:10	7.65	249.43
01WW01	5/18/00	247.49	10:19	2.67	244.82
101	5/20/00	197.53	10:31	5.13	192.4
102	5/20/00	194.62	13:08	19.44	175.18
104	5/18/00	248.73	9:43	2.72	246.01
105	5/17/00	199.41	15:06	16.04	183.37
106	5/19/00	179.05	10:52	8.04	171.01
107	5/17/00	178.32	11:30	5.92	172.4
108	5/19/00	175.99	15:25	5.63	170.36
109	5/20/00	197.02	10:38	27.83	169.19
110	5/17/00	189.53	14:22	6.42	183.11
111	5/17/00	221.64	13:47	5.92	215.72
112	5/17/00	252.63	13:58	7.77	244.86
113	5/18/00	215.03	13:42	20.11	194.92
114	5/18/00	244.47	13:03	26.19	218.28
115	5/18/00	225.16	12:23	28.64	196.52
116	5/18/00	216.43	11:09	19.56	196.87
117	5/18/00	214.19	10:55	20.56	193.63
118	5/18/00	219.67	12:26	21.48	198.19
119	5/18/00	222.93	12:49	20.91	202.02
11WW01	5/18/00	208.79	17:51	15.86	192.93
11WW02	5/18/00	207.38	17:48	17.67	189.71
11WW03	5/18/00	207.06	17:45	10.87	196.19
120	5/20/00	184.19	12:58	11.3	172.89
123	5/20/00	186.21	12:49	12.38	173.83
125	5/20/00	196.28	10:42	24.57	171.71
126	5/20/00	199.37	14:45	26.58	172.79
127	5/19/00	188.91	14:37	10.06	178.85
128	5/19/00	192.26	14:43	14.85	177.41
129	5/20/00	197.24	13:06	25.89	171.35
12PZ02	5/18/00	191.86	17:40	7.32	184.54
12WW01	5/18/00	204.19	15:27	21.99	182.2
12WW02	5/18/00	202.45	15:31	20.18	182.27
12WW05	5/18/00	190.52	15:07	6.58	183.94
12WW08	5/18/00	203.54	15:14	21.07	182.47
12WW09	5/18/00	204.04	15:38	16.58	187.46
12WW10	5/18/00	203.21	15:29	20.58	182.63
12WW11	5/18/00	203.51	15:21	21.47	182.04
12WW12	5/18/00	203.04	15:17	20.56	182.48
12WW13	5/18/00	203.24	15:18	20.86	182.38
12WW14	5/18/00	193.07	15:10	10.18	182.89
12WW15	5/18/00	193.11	15:09	7.1	186.01
12WW16	5/18/00	202.43	15:24	20.76	181.67
12WW17	5/18/00	203.5	15:20	21.45	182.05
12WW18	5/18/00	204.26	15:34	22.16	182.1
12WW19	5/18/00	204.74	15:35	22.61	182.13
130	5/20/00	177.73	14:23	4.39	173.34

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
131	5/19/00	189.3	14:08	8.07	181.23
132	5/19/00	188.59	14:12	6.31	182.28
133	5/18/00	315.63	9:50	7.18	308.45
133	5/18/00	315.63	9:51	71.18	244.45
134	5/18/00	316.35	9:51	72.07	244.28
13WW01	5/18/00	207.23	15:44	25.91	181.32
14MW01	5/18/00	204.53	15:47	23.14	181.39
16PZ01	5/18/00	199.44	16:22	25.82	173.62
16PZ02	5/18/00	199.75	16:23	26.19	173.56
16PZ03	5/18/00	198.61	16:24	24.99	173.62
16PZ04	5/18/00	198.81	16:24	25.21	173.6
16PZ05	5/18/00	198.31	16:28	24.86	173.45
16PZ06	5/18/00	198.61	16:27	25.12	173.49
16PZ07	5/18/00	200.1	16:22	26.38	173.72
16PZ08	5/18/00	199.93	16:21	26.39	173.54
16PZ09	5/18/00	196.49	16:32	24.72	171.77
16PZ10	5/18/00	196.65	16:31	23.34	173.31
16PZ11	5/18/00	198.88	16:25	25.11	173.77
16PZ12	5/18/00	199	16:25	25.21	173.79
16PZ13	5/18/00	196.58	16:30	22.96	173.62
16PZ14	5/18/00	196.09	16:29	22.64	173.45
16PZ15	5/18/00	191.93	16:35	18.44	173.49
16PZ16	5/18/00	190.79	16:34	17.41	173.38
16PZ17	5/18/00	186.67	16:40	14.39	172.28
16PZ18	5/18/00	185.99	16:39	13.3	172.69
16PZ19	5/18/00	183.98	16:47	11.12	172.86
16PZ20	5/18/00	183.12	16:46	11.14	171.98
16WW05	5/18/00	204.62	15:51	25.52	179.1
16WW06	5/18/00	205.03	15:50	26.01	179.02
16WW12	5/18/00	188.81	16:53	15.62	173.19
16WW13	5/18/00	178.47	16:04	4.68	173.79
16WW14	5/18/00	198.87	17:15	23.03	175.84
16WW15	5/18/00	198.75	17:16	21.85	176.9
16WW16	5/18/00	195.64	15:57	19.54	176.1
16WW17	5/18/00	197.98	16:58	22.02	175.96
16WW18	5/18/00	185.41	16:02	8.19	177.22
16WW19	5/18/00	182.21	16:00	6.73	175.48
16WW20	5/18/00	199.17	17:18	22.79	176.38
16WW21	5/18/00	198.06	16:59	23.04	175.02
16WW22	5/18/00	200.13	17:00	26.16	173.97
16WW23	5/18/00	177.98	16:08	3.99	173.99
16WW24	5/18/00	177.95	16:07	4.31	173.64
16WW25	5/18/00	188.77	16:38	14.68	174.09
16WW26	5/18/00	188.83	16:37	15.25	173.58
16WW27	5/18/00	177.31	16:12	4.01	173.3
16WW28	5/18/00	176.97	16:11	4.69	172.28
16WW29	5/18/00	178.24	16:44	4.85	173.39
16WW30	5/18/00	178.47	16:43	5.16	173.31
16WW31	5/18/00	202.78	17:06	28.28	174.5
16WW32	5/18/00	202.86	17:05	28.4	174.46

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
16WW33	5/18/00	203.09	17:11	28.16	174.93
16WW34	5/18/00	203.08	17:09	28.17	174.91
16WW35	5/18/00	191.23	16:17	16.11	175.12
16WW36	5/18/00	190.94	16:16	15.48	175.46
16WW37	5/18/00	201.97	15:55	25.41	176.56
16WW38	5/18/00	201.92	15:56	25.24	176.68
17WW01	5/20/00	179.01	14:29	5.75	173.26
17WW02	5/20/00	177.21	14:19	3.94	173.27
17WW03	5/20/00	179.2	14:31	6.1	173.1
17WW04	5/20/00	180.21	14:26	6.93	173.28
17WW05	5/20/00	182.73	14:14	9.61	173.12
17WW06	5/20/00	179.36	14:17	5.93	173.43
17WW07	5/20/00	179.68	14:38	6.92	172.76
17WW08	5/20/00	179.94	14:37	6.58	173.36
17WW09	5/20/00	181.43	14:10	8.48	172.95
17WW10	5/20/00	181.55	14:09	8.06	173.49
17WW11	5/20/00	180.95	14:06	7.3	173.65
17WW12	5/20/00	180.32	14:05	7.35	172.97
17WW13	5/20/00	179.14	14:34	6.18	172.96
17WW14	5/20/00	181.9	14:12	8.44	173.46
18WW01	5/19/00	201.38	14:46	25.89	175.49
18WW02	5/20/00	179.54	13:38	6.62	172.92
18WW03	5/19/00	195.68	15:04	23.66	172.02
18WW04	5/19/00	183.86	15:44	13.05	170.81
18WW05	5/19/00	189.61	15:37	19.7	169.91
18WW06	5/20/00	179.74	13:37	7.43	172.31
18WW07	5/19/00	183.65	16:26	12.34	171.31
18WW08	5/19/00	177.72	16:18	6.54	171.18
18WW09	5/19/00	177.49	16:17	5.71	171.78
18WW10	5/20/00	182.36	13:48	9.99	172.37
18WW11	5/20/00	182.35	13:49	9.79	172.56
18WW14	5/19/00	186.54	14:26	13.56	172.98
18WW15	5/19/00	186.33	14:25	13.24	173.09
18WW16	5/19/00	201.97	14:48	26.42	175.55
18WW17	5/19/00	196.93	15:56	26.4	170.53
18WW18	5/19/00	196.79	15:57	24.84	171.95
18WW19	5/19/00	179.86	16:38	8.16	171.7
18WW20	5/19/00	180.66	16:37	9	171.66
27WW01	5/19/00	195.1	13:58	11.88	183.22
27WW02	5/19/00	187.35	14:03	4.73	182.62
27WW03	5/19/00	188.84	14:05	6.08	182.76
27WW04	5/19/00	186.19	14:02	3.94	182.25
29WW01	5/18/00	242.27	12:58	25.59	216.68
29WW02	5/18/00	235.77	12:40	30.09	205.68
29WW03	5/18/00	237.79	12:53	23.76	214.03
29WW04	5/18/00	236.88	12:55	44.03	192.85
29WW05	5/18/00	216.51	11:07	16.02	200.49
29WW06	5/18/00	217.84	12:05	22.78	195.06
29WW07	5/18/00	220.05	12:10	19.67	200.38
29WW08	5/18/00	220.08	12:11	29.54	190.54

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
29WW09	5/18/00	216.23	10:58	22.2	194.03
29WW10	5/18/00	212.47	11:03	20.18	192.29
29WW11	5/18/00	213.08	11:45	19.04	194.04
29WW12	5/18/00	223.27	11:58	19.78	203.49
29WW13	5/18/00	222.92	11:59	30.08	192.84
29WW14	5/18/00	220.31	12:12	26.36	193.95
29WW15	5/18/00	232.98	13:26	22.6	210.38
29WW16	5/18/00	231.53	13:27	38.09	193.44
29WW17	5/18/00	230.48	13:34	18.15	212.33
29WW18	5/18/00	231.18	13:30	16.06	215.12
29WW19	5/18/00	220.69	12:22	18.65	202.04
29WW20	5/18/00	235.7	13:20	21.85	213.85
29WW21	5/18/00	235.17	13:23	42.24	192.93
29WW22	5/18/00	236.1	13:22	22.29	213.81
29WW23	5/18/00	226.63	12:31	22.04	204.59
29WW24	5/18/00	226.14	12:32	29.37	196.77
29WW25	5/18/00	227.37	12:34	23.97	203.4
29WW26	5/18/00	237.21	13:16	26.08	211.13
29WW27	5/18/00	238.02	13:14	24.7	213.32
29WW28	5/18/00	235.38	12:41	38.59	196.79
29WW29	5/18/00	242.91	12:37	30.26	212.65
29WW30	5/18/00	241.47	13:07	27.15	214.32
29WW31	5/18/00	240.97	13:08	26.78	214.19
29WW32	5/18/00	229.09	12:44	25.07	204.02
29WW33	5/18/00	237.67	12:54	23.89	213.78
32WW01	5/18/00	219.84	13:38	31.07	188.77
32WW02	5/18/00	216.31	13:44	28.19	188.12
35AWW01	5/16/00	218.03	15:24	29.79	188.24
35AWW02	5/16/00	218.05	15:23	35.22	182.83
35AWW03	5/16/00	219.66	15:17	15.91	203.75
35AWW04	5/16/00	220.66	15:12	18.98	201.68
35BWW01	5/17/00	202.88	15:29	6.84	196.04
35BWW02	5/17/00	203.95	16:41	11.79	192.16
46WW01	5/16/00	212.82	16:02	14.54	198.28
46WW02	5/16/00	212.21	16:03	24.23	187.98
46WW03	5/16/00	212.47	16:04	28.82	183.65
46WW04	5/16/00	215.39	16:17	13.84	201.55
47WW01	5/19/00	194.4	10:08	12.53	181.87
47WW02	5/16/00	197.23	16:53	12.24	184.99
47WW03	5/19/00	195.24	10:13	15.19	180.05
47WW04	5/19/00	190.9	10:25	9.79	181.11
47WW05	5/17/00	198.55	14:55	14.96	183.59
47WW06	5/17/00	199.02	14:56	15.41	183.61
47WW07	5/17/00	199.24	14:58	15.83	183.41
47WW08	5/16/00	199.45	16:57	14.64	184.81
47WW09	5/17/00	201.04	15:56	15.46	185.58
47WW11	5/17/00	199.14	16:07	14.78	184.36
47WW12	5/17/00	202.27	15:15	15.95	186.32
47WW13	5/17/00	204.97	15:40	15.93	189.04
47WW14	5/17/00	205	15:39	16.03	188.97

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
47WW15	5/17/00	205.17	15:38	19.23	185.94
47WW16	5/17/00	203.73	15:21	15.23	188.5
47WW17	5/17/00	201.76	16:27	14.37	187.39
47WW18	5/17/00	199.69	16:14	14.52	185.17
47WW19	5/17/00	198.93	16:13	13.87	185.06
47WW20	5/17/00	198.78	16:12	15.97	182.81
47WW21	5/19/00	187.59	10:33	7.33	180.26
47WW22	5/19/00	195.62	10:40	15.47	180.15
47WW23	5/19/00	197.86	10:37	14.68	183.18
49WW01	5/17/00	232.01	14:34	20.66	211.35
49WW02	5/17/00	232.92	14:38	20.48	212.44
49WW03	5/17/00	232.09	14:47	19.11	212.98
50WW01	5/17/00	198.5	16:54	10.68	187.82
50WW02	5/17/00	200.74	16:59	13.44	187.3
50WW03	5/17/00	202.94	17:04	14.8	188.14
50WW04	5/17/00	204.51	17:07	17.32	187.19
AWD-1	5/20/00	182.27	13:02	8.99	173.28
AWD-2	5/20/00	186.95	12:52	15.52	171.43
AWD-3	5/20/00	200.13	13:14	27.93	172.2
AWD-4	5/19/00	193.85	16:12	21.44	172.41
C-01	5/20/00	193.89	14:43	21.03	172.86
C-02	5/20/00	175.95	13:42	3.42	172.53
C-03	5/19/00	196.34	15:51	24.43	171.91
C-04	5/19/00	194.64	15:48	22.85	171.79
C-05	5/19/00	180.74	15:44	9.89	170.85
C-06	5/19/00	192.22	15:09	22.39	169.83
C-07	5/19/00	196.8	14:29	23.76	173.04
C-08	5/19/00	192.65	15:02	21.37	171.28
C-09	5/19/00	202.35	14:54	29.39	172.96
C-10	5/19/00	201.86	14:55	28.59	173.27
C-4A	5/19/00	194.61	15:49	22.7	171.91
EW-1	5/20/00	198.61	11:10	28.58	170.03
G4WW01	5/19/00	201.07	11:31	18.63	182.44
G4WW02	5/19/00	199.79	11:35	17.19	182.6
G4WW03	5/19/00	200.32	11:25	17.92	182.4
LHSMW01	5/16/00	214.43	13:35	5.64	208.79
LHSMW02	5/16/00	215.43	15:32	7.33	208.1
LHSMW03	5/16/00	217.26	15:29	16.71	200.55
LHSMW04	5/16/00	216.95	15:27	16.55	200.4
LHSMW05	5/16/00	217.59	15:22	16.71	200.88
LHSMW06	5/16/00	223.18	15:15	14.68	208.5
LHSMW07	5/16/00	221.27	15:13	15.63	205.64
LHSMW08	5/16/00	207.85	15:46	16.84	191.01
LHSMW09	5/16/00	210.68	15:48	11.92	198.76
LHSMW10	5/16/00	214.58	15:44	16.22	198.36
LHSMW11	5/16/00	212.91	15:41	15.73	197.18
LHSMW12	5/16/00	209.02	15:51	11.45	197.57
LHSMW13	5/16/00	209.5	15:52	8.29	201.21
LHSMW14	5/16/00	244.78	16:13	10.78	234
LHSMW15	5/16/00	226.65	16:09	16.52	210.13

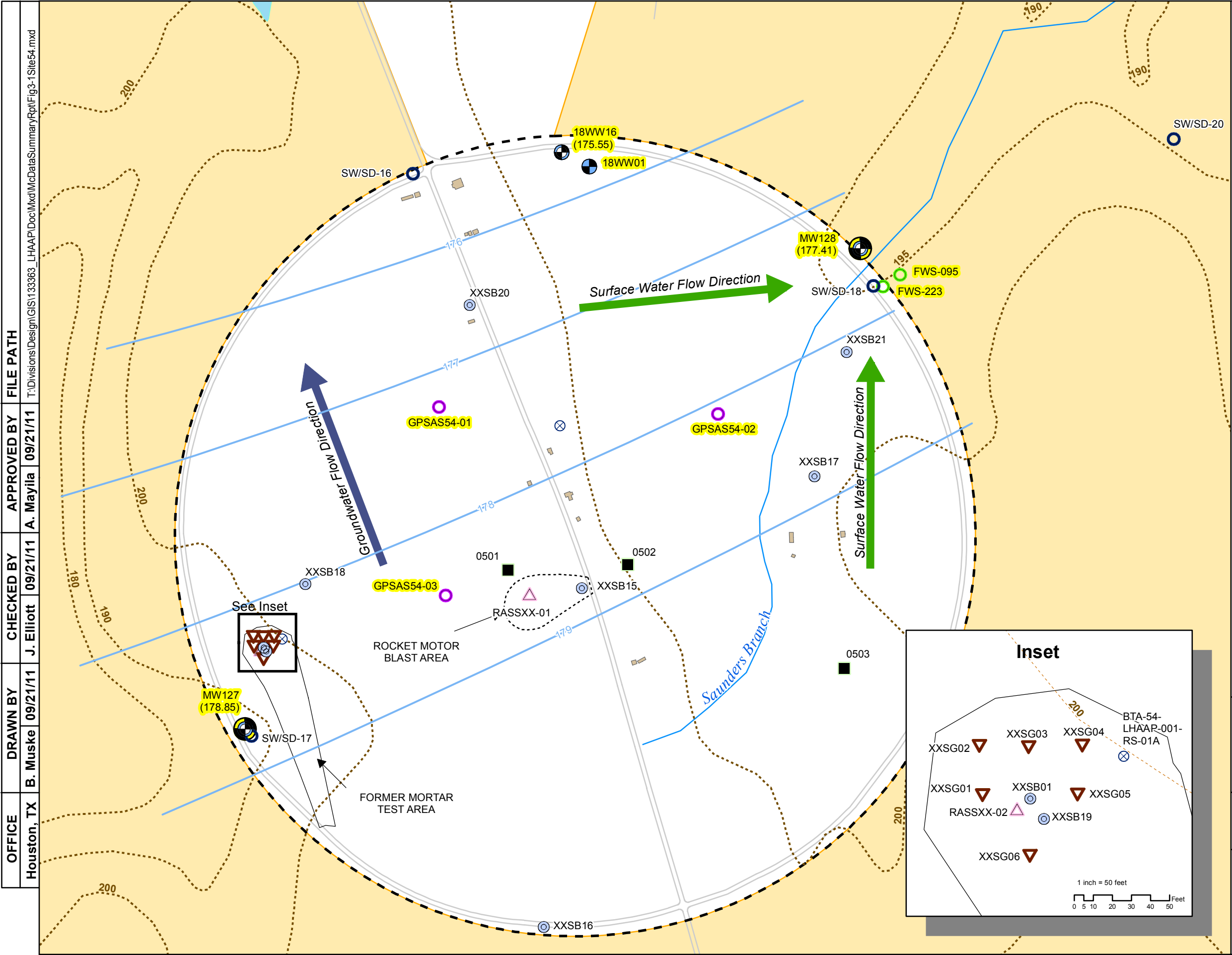
Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
LHSMW16	5/16/00	232.19	16:11	8.86	223.33
LHSMW17	5/16/00	214.58	15:55	13.49	201.09
LHSMW18	5/16/00	215.35	15:57	15.04	200.31
LHSMW19	5/16/00	212.96	16:00	12.91	200.05
LHSMW20	5/16/00	209.29	16:24	14.96	194.33
LHSMW21	5/16/00	207.67	16:21	12.59	195.08
LHSMW22	5/16/00	209.6	16:25	16.64	192.96
LHSMW23	5/16/00	208.82	16:27	18.62	190.2
LHSMW24	5/16/00	203.84	16:29	15.47	188.37
LHSMW25	5/16/00	201.97	16:33	17.78	184.19
LHSMW26	5/16/00	204.72	16:35	17.93	186.79
LHSMW27	5/16/00	202.1	16:36	14.96	187.14
LHSMW28	5/16/00	205.52	17:06	16.46	189.06
LHSMW29	5/16/00	203.24	17:04	15.85	187.39
LHSMW30	5/16/00	203.74	17:02	17.07	186.67
LHSMW31	5/16/00	201.03	16:41	15.04	185.99
LHSMW32	5/16/00	200.18	16:44	13.32	186.86
LHSMW33	5/16/00	199.39	16:55	14.68	184.71
LHSMW34	5/16/00	198.59	16:46	13.74	184.85
LHSMW35	5/16/00	198.37	16:47	13.87	184.5
LHSMW36	5/16/00	196.53	16:52	12.6	183.93
LHSMW37	5/16/00	195.18	16:49	11.45	183.73
LHSMW38	5/16/00	200.84	16:39	13.68	187.16
LHSMW39	5/17/00	198.71	15:01	15.2	183.51
LHSMW40	5/17/00	199.99	15:03	16.61	183.38
LHSMW41	5/17/00	199.85	15:03	16.61	183.24
LHSMW41	5/17/00	199.85	15:08	15.42	184.43
LHSMW42	5/17/00	200.29	15:12	15.51	184.78
LHSMW43	5/17/00	200.26	15:55	14.94	185.32
LHSMW44	5/17/00	200.36	15:13	14.36	186
LHSMW45	5/17/00	201.39	15:18	14.99	186.4
LHSMW46	5/17/00	201.72	15:52	15.11	186.61
LHSMW47	5/17/00	200.54	15:48	13.41	187.13
LHSMW48	5/17/00	202.06	16:01	11.55	190.51
LHSMW49	5/17/00	201.74	15:43	11.97	189.77
LHSMW50	5/17/00	205.17	16:25	15.41	189.76
LHSMW51	5/17/00	208.5	15:23	18.32	190.18
LHSMW52	5/17/00	205.91	16:30	14.94	190.97
LHSMW53	5/17/00	197.61	16:48	11.31	186.3
LHSMW54	5/17/00	193.71	16:20	8.33	185.38
LHSMW55	5/17/00	199.76	16:24	14.19	185.57
LHSMW56	5/17/00	198.59	16:17	13.48	185.11
LHSMW57	5/17/00	200.53	16:09	5.71	194.82
LHSMW58	5/17/00	203.56	15:33	11.89	191.67
LHSMW59	5/17/00	204.18	15:31	12.56	191.62
LHSMW60	5/17/00	199.28	16:45	11.33	187.95
LHSMW61	5/19/00	198.29	10:47	21.05	177.24
LHSMW62	5/19/00	192.2	11:16	17.61	174.59
LHSMW63	5/19/00	194.06	11:12	18.89	175.17
LHSMW64	5/19/00	191.42	11:19	17.73	173.69

Longhorn Army Ammunition Plant
Facility Wells
Table A-3
Water Level Measurements for May 2000

SITE	DATE	MP	TIME	DEPTH TO WATER	WATER ELEV.
LHSMW65	5/19/00	194.31	11:04	17.27	177.04
LHSMW66	5/19/00	195.11	11:08	18.1	177.01
LHSMW67	5/17/00	185.57	11:37	12.7	172.87
LHSMW68	5/17/00	189.65	11:38	16.03	173.62
LHSMW69	5/17/00	183.27	11:41	10.62	172.65
LHSMW70	5/17/00	183.62	11:26	10.56	173.06
LHSMW71	5/17/00	183.73	11:24	12.16	171.57
MW-1	5/20/00	199.31	12:45	28.58	170.73
MW-10	5/20/00	178.12	13:40	5.74	172.38
MW-11	5/20/00	184.65	12:29	12.13	172.52
MW-12	5/20/00	178.54	12:56	6.53	172.01
MW-13	5/20/00	176.72	13:43	4.33	172.39
MW-14	5/20/00	186.19	12:59	10.82	175.37
MW-16	5/20/00	178.64	13:33	6.17	172.47
MW-17	5/20/00	179.03	13:53	6.56	172.47
MW-18	5/20/00	178.58	13:55	5.85	172.73
MW-19	5/20/00	178.6	14:01	5.81	172.79
MW-2	5/20/00	196.92	11:05	27.08	169.84
MW-20	5/20/00	186.64	13:17	10.11	176.53
MW-21	5/20/00	198.7	10:34	29.45	169.25
MW-22	5/20/00	197.51	12:43	28.99	168.52
MW-23	5/20/00	198.79	13:11	27.86	170.93
MW-3	5/20/00	196.52	10:57	25.09	171.43
MW-4	5/20/00	197.27	10:53	26.13	171.14
MW-5	5/20/00	194.97	10:46	23.14	171.83
MW-6	5/20/00	192.18	10:49	20.15	172.03
MW-7	5/20/00	188.47	13:20	16.68	171.79
MW-8	5/20/00	187.13	13:58	16.24	170.89
MW-9	5/20/00	184.73	13:22	12.97	171.76

Measurements Based on Mean Sea Level



LEGEND

MONITORING WELL, (STEP, 2005)

MONITORING WELL, (USEPA, US ARMY, 2009)

MONITORING WELL, (EPS 1982, EBASCO 1993)

SHALLOW SOIL SAMPLE, (EPS, 1982)

SOIL BORING, (EBASCO, 1993)

SOIL GAS SAMPLE, (SVERDRUP, 1994)

SOIL SAMPLE, (CAPE, 2006)

SURFACE SOIL SAMPLE, (USACE, 1996/97)

SURFACE WATER/SEDIMENT, (EBASCO, 1993)

SOIL SAMPLE, (USFWS, 2003)

GEOPROBE LOCATION, (USACE, 2001)

Groundwater Elevation Contour

Groundwater Flow Direction

Contours

Former Mortar Test Area

Rocket Motor Blast Area

Ground Signal Test Area

Stream

Road

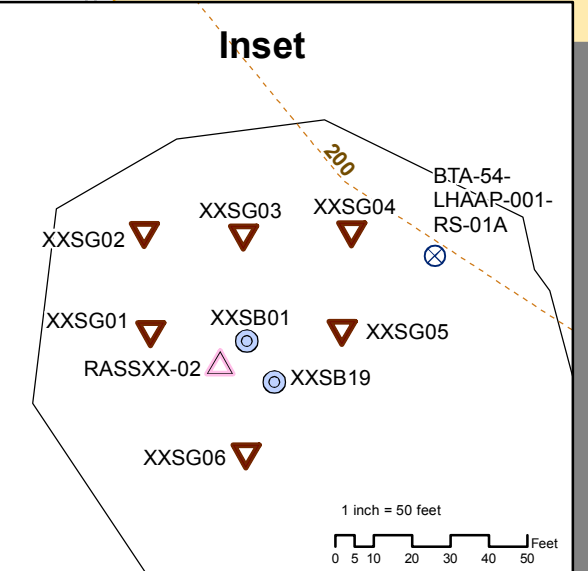
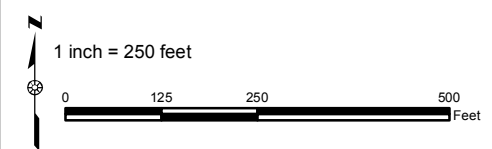
Lake

Building

Caddo Lake National Wildlife Refuge

Surface Water Flow Direction

Note: The locations of perchlorate samples for all media are **highlighted** to present the wide coverage of perchlorate samples.



OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske	J. Elliott	A. Mayila	T:\Divisions\Design\GIS\133363_LHAAP\Doc\Mxd\McDataSummaryRpt\Fig3-1Site54.mxd

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 3-1
SITE MAP WITH SAMPLING LOCATIONS
GROUND SIGNAL TEST AREA
LHAAP-003-R

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS