FINAL

REVISED

PROPOSED PLAN

FOR LHAAP-29

FORMER TNT PRODUCTION AREA

GROUP 2

ISSUED BY: U.S. ARMY

Longhorn Army Ammunition Plant
Karnack, Texas

November 2018

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INTRODUCTION

The purpose of this Revised Proposed Plan is to present for public review the remedial alternatives for LHAAP-29. This Revised Proposed Plan supersedes the Proposed Plan completed for LHAAP-29 in 2011 (U.S. Army, 2011) and incorporates the results of data collection activities and evaluation of additional alternatives conducted subsequent to completion of the previous plan. This Revised Proposed Plan (hereafter referred to as Proposed Plan) identifies the Preferred Remedial Alternative for LHAAP-29, site of the former trinitrotoluene (TNT) Production Area, at Longhorn Army Ammunition Plant (LHAAP). The primary purpose of the Proposed Plan is to facilitate public involvement in the remedy selection process. The Proposed Plan provides the public with basic background information about LHAAP-29, identifies the preferred final remedy (page 21) for the potential threats posed by the chemical contamination at the site, explains the rationale for the preference, and describes other remedial options considered. The preferred alternative for LHAAP-29 is Alternative 4: excavation and off-site disposal for soil; flushing and plugging of the transite TNT wastewater pipeline and clay cooling water lines; in-situ thermal desorption (ISTD), monitored natural attenuation (MNA) and land use controls (LUCs) for intermediate zone groundwater; MNA and LUCs for shallow zone groundwater.

The U.S. Army is issuing this Proposed Plan for public review, comment, and participation to fulfill part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986, and under Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA prescribes a step-wise progression of activities to respond to risk posed by contaminated sites **(Figure 1)**.

The preparation and review of a Proposed Plan is a distinct step required by CERCLA. This Proposed Plan provides background information that can be found in greater detail in the Remedial Investigation (RI) Report, the Data Gaps Investigation, RI Addendum, the Feasibility Study (FS) (including the Natural Attenuation Evaluation Report and the Additional Investigation Data Summary Report), the Installation-Wide Baseline Ecological Risk Assessment (BERA), FS Addendum, and other supporting documents that are contained in the LHAAP-29 Administrative Record and is publicly available in the Marshall, Texas Public Library. The project management team, including the U.S. Army, U.S. Environmental Protection

Dates to remember: November 21 to December 21, 2018
MARK YOUR CALENDER

PUBLIC COMMENT PERIOD:
November 21 to December 21, 2018
The U.S. Army will accept written comments on the Proposed Plan during the public comment period.

PUBLIC MEETING: The U.S. Army will hold a public meeting to explain the Proposed Plan for LHAAP-29. Oral and written comments will be accepted at the meeting. The meeting will be held on December 6, 2018 from 6:00 p.m. to 7:30 p.m. at Karnack Community Center.

For more information, see the Longhorn AAP website: http://www.longhornaap.com/ or visit the Administrative Record at the following location:

Marshall Public Library
300 S. Alamo
Marshall, Texas 75670

Business Hours:
Monday, Tuesday, Thursday (9:30 AM – 7:30 PM)
Wednesday and Friday (9:00 AM – 5:30 PM)
Saturday (9:30 AM – 3:30 PM)

Agency (USEPA), and the Texas Commission on Environmental Quality (TCEQ), encourages the public to review these documents and comment on the alternatives presented in this Proposed Plan.

The U.S. Army is acting in partnership with USEPA Region 6 (lead oversight agency) and TCEQ (support agency). As the lead agency for environmental response actions at LHAAP, the U.S. Army is charged with planning and implementing remedial actions at LHAAP. The regulatory agencies assist the U.S. Army by providing technical support, project review, project comment, and oversight in accordance with CERCLA and the NCP as well as the Federal Facility Agreement (FFA).

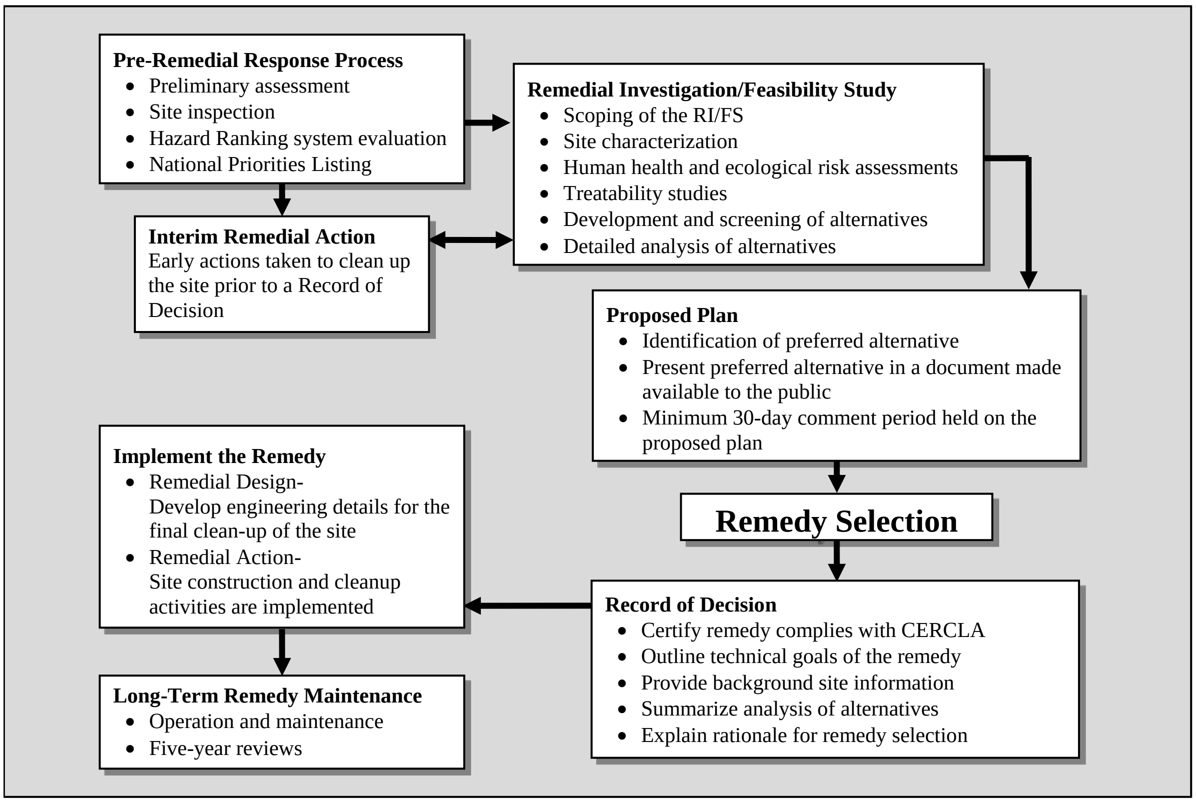


Figure 1. CERCLA Remedial Response Process for Site Cleanup

The Proposed Plan summarizes site characteristics, scope and role of the response action, and site risks. This is followed by a presentation of the remedial action objectives (RAOs) and a summary of remedial alternatives for LHAAP-29. Finally, an evaluation of alternatives and a summary of the preferred alternative are presented.

SITE BACKGROUND

LHAAP is located in central-east Texas in the northeastern corner of Harrison County **(Figure 2)**. The installation occupies approximately 1,300 of its former 8,416 acres between State Highway 43 at Karnack, Texas, and the western shore of Caddo Lake. The nearest cities are Marshall, Texas, approximately 14 miles to the southwest, and Shreveport, Louisiana, approximately 40 miles to the southeast. Caddo Lake, a large freshwater lake situated on the Texas-Louisiana border, bounds LHAAP to the north and east.

The U.S Army has transferred more than 7,100 acres to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge.

The property transfer process is continuing as responses are completed at individual sites. The local restoration advisory board has been kept informed of previous investigations at this site through quarterly meetings. Additionally, the administrative record is updated quarterly and is available at the local public library.

Due to releases of chemicals from facility operations, LHAAP was placed on the Superfund National Priorities List (NPL)

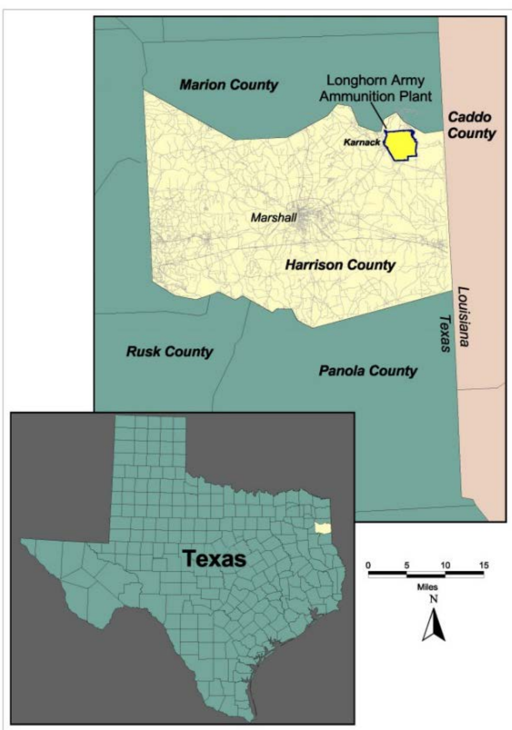


Figure 2. Location of the Longhorn Army Ammunition Plant, Harrison County, Texas

on August 9, 1990. Activities to remediate contamination associated with the listing of LHAAP as a Superfund site began in 1990. 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. LHAAP-29 was originally listed as an NPL site in the FFA due to threatened releases of hazardous substances, pollutants or contaminants. The shallow and intermediate groundwater zones and the soil at LHAAP-29 are contaminated.

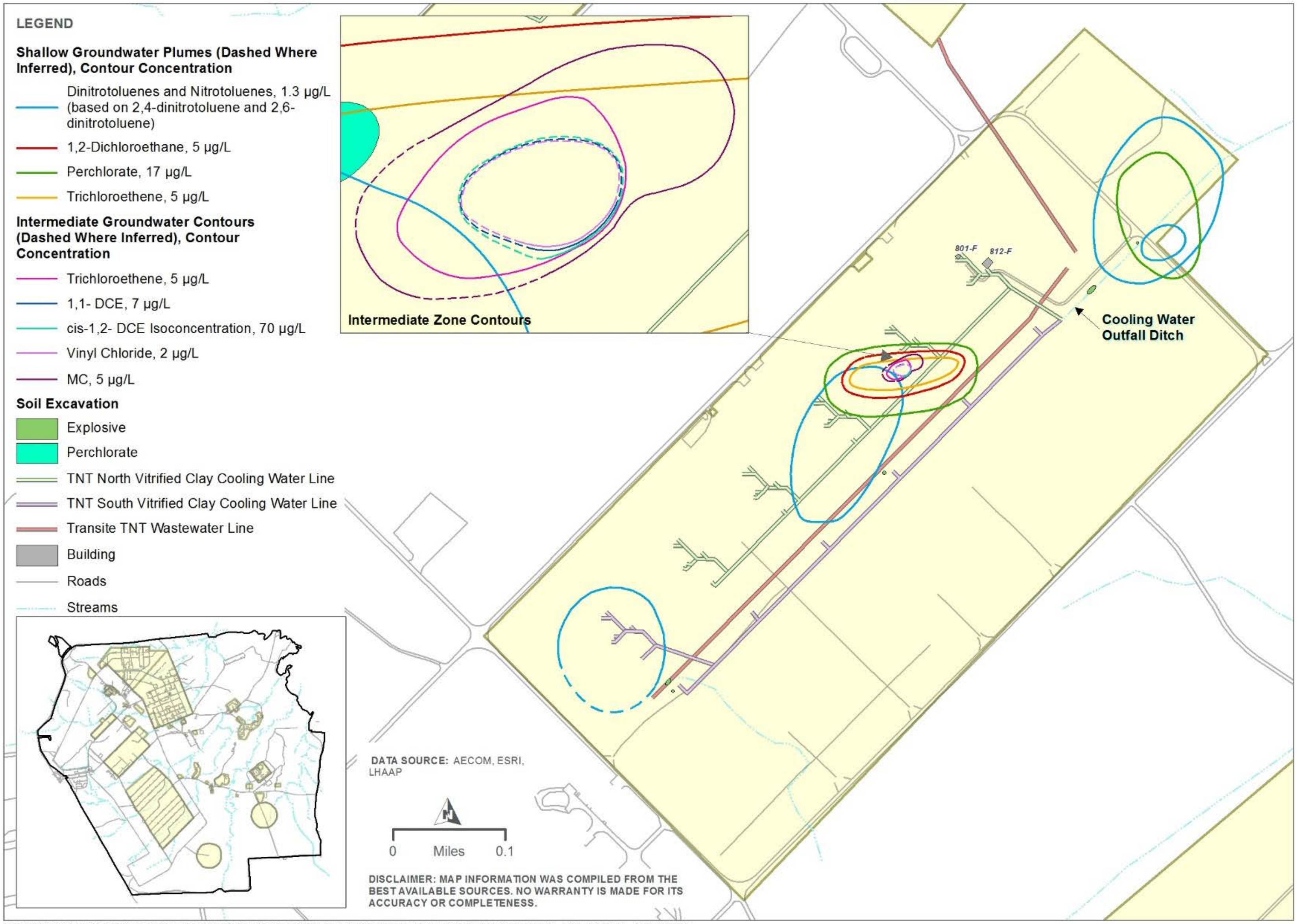
LHAAP-29, known as the former TNT Production Area, is located in the west-central portion of LHAAP **(Figure 3)**. The site covers approximately 85 acres.

The site was used as a TNT manufacturing facility from October 1942 to August 1945. The facility produced approximately 400 million pounds of flake TNT during its operation using six TNT production lines (five active and one stand-by). The TNT production facility was inactive from August 1945 to 1959. In 1959, most of the buildings and Above Ground Storage Tanks (ASTs) were removed. The debris was burned or flashed at Burning Ground No. 2/Flashing Area (LHAAP-17). Concrete foundations, open-top concrete-lined pits, most of the underground utilities, and a network of underground pipelines still remain at the site. Since the end of World War II, the only activity that has been documented to have occurred at LHAAP-29 is the "soak out" or solvent bath of out-of-specification rocket motors. This took place from 1959 to the mid-1970s and involved the use of a methylene chloride-based industrial solvent at tank 801-F. Waste from this operation was sent to LHAAP-18/24 (Jacobs, 2001).

Between 1984 and 2009, numerous investigations were conducted in a phased approach to determine the nature and extent of contamination at LHAAP-29. Media investigated included soil, groundwater, surface water, sediment, and residue in process lines. These investigations included a Pre-RI investigation in 1982 and 1987; and Phase I, Phase II, and Phase III RIs conducted in 1993, 1995, and 1998, respectively. The results of these investigations are summarized in the Final Remedial Investigation Report – Group 2 Sites (Group 2 RI) (Jacobs, 2001). The Baseline Human Health Risk Assessment (BHHRA) was performed using the data presented in the Group 2 RI (Jacobs, 2002). The BHHRA identified 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), 2,6-DNT, and perchlorate as chemicals of concern (COCs) for soil and dichloroethane (DCA), trichloroethene (TCE), DNT, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, methylene chloride, and perchlorate as COCs for groundwater at LHAAP-29. A Final Proposed Plan and a Draft Record of Decision were completed in 2011 based on the RI and other investigations, and further evaluation and remedial design (RD) requirements for the selected alternative. Subsequently, the U.S. Army, in response to concerns about the treatability study uncertainties related to DNAPL plume size and decreasing effectiveness of in-situ chemical oxidation (ISCO) with successive treatments, determined that additional data were needed to refine the extent of the intermediate zone methylene chloride plume and also to collect data to evaluate additional treatment technologies.

Additional investigations were conducted after the BHHRA was completed. In 2002, a site-wide perchlorate investigation was conducted and reported in the Final Project Report – Plant-Wide Perchlorate Investigation (STEP, 2005). In 2003-2004, an Environmental Site Assessment Phase I and II was conducted (Plexus, 2005).

Between 2004 and 2009, several follow-up investigations were performed to further delineate the extent of contamination identified during previous sampling events. These include the data gaps investigation in 2004 (Shaw, 2007a), additional explosives and perchlorate sampling in December 2004 and February 2005, and explosives sampling by USACE at a building foundation in February 2005 (Shaw, 2010), and the BERA in 2006 (Shaw, 2007b). Between August 2006 and February 2008, additional investigation activities for various environmental media were conducted. The objectives of these sampling events were to collect samples of the solid residue and liquid remaining in the transite wastewater line, sediment samples along the former cooling water ditch, and groundwater from existing and newly installed monitoring wells to further delineate the extent of contamination at the site. A treatability study was completed in 2006 to evaluate the effectiveness of chemical oxidation using activated sodium persulfate to treat the methylene chloride in the intermediate groundwater zone. Additional groundwater samples were collected and analyzed for metals and volatile organic compounds (VOCs) in the shallow and intermediate zones in October 2008 and January 2009 which are all reported in the Final Feasibility Study (FS) (Shaw, 2010). Additional wells were installed in the intermediate zone to define the extent of the methylene chloride plume inferred to be dense non-aqueous phase liquid (DNAPL), measure aquifer parameters, and evaluate thermal treatment of the methylene chloride plume and in-situ bioremediation potential. Additional soil sampling was performed



PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_PP_SITE_OVERVIEW.MXD - USER: KLOFGREN - DATE: 10/8/2018

Figure 3. Soil and Shallow/Intermediate Groundwater Contamination

to determine the source of the methylene chloride and refine the extent of explosives and perchlorate contamination. These data were collected during the supplemental investigation that was conducted in 2014. The results, which were reported in the RI and FS Addenda, were completed in 2016 and 2017, respectively (AECOM, 2016, 2017).

SITE CHARACTERISTICS

The surface features at LHAAP-29 include the foundations for the former production facilities and the underground pipe lines that were originally built for cooling water drainage and TNT wastewater conveyance. The site is currently heavily wooded. Surface runoff is collected by ditches constructed in 1942 when the production facility was built. Surface runoff from the northern part of the site (about 40 percent of the site) enters Goose Prairie Creek located approximately 1,500 feet to the north and east of the site. Surface water runoff in the southern portion of the site (about 60 percent of the site) flows into a tributary of Central Creek located near the southeast portion of the site. Eventually, runoff from the two creeks enters Caddo Lake. The lake is a source of drinking water for several neighboring communities in Louisiana.

Clay or silty layers separate the three groundwater zones at LHAAP-29: shallow, intermediate, and deep. Depth of the shallow groundwater at the site generally ranges from 17 to 45 feet below ground surface (bgs) because of variable ground surface elevations across the site. The intermediate zone is less defined, but its depth is measured to approximately 88 feet bgs. The deep groundwater zone extends to about 155 feet bgs.

Groundwater monitoring wells at LHAAP-29 consist of 29 shallow zone wells, 15 intermediate zone wells, and 3 deep zone wells. Based on the 2007 water levels and historic potentiometric maps, the predominant groundwater flow in the shallow zone is east/southeast and is east/northeast in the intermediate zone. The shallow groundwater flows to the southeast from the site towards Central Creek. Although the plume is expected to remain stable, to be conservative, modeling was conducted to evaluate a groundwater to surface water pathway. The results indicated that: 1) the VOC contaminants in the shallow zone will not reach Central Creek; and 2) if perchlorate were to reach the creek under that conservative scenario, the concentration in surface water will be below the surface water action level (Shaw, 2007c). On the eastern end of the site, there is a ditch that flows to Goose Prairie Creek. Based on data collected since 2000, the groundwater elevations have been at least six feet below the surface of the ditch. Thus, shallow groundwater will not impact surface waters.

The results of the additional data collected since the BHHRA did not change the overall outcome of the risk assessment, even though the list of COCs was modified. Although COCs have been detected in the shallow and intermediate groundwater zones beneath LHAAP-29, the horizontal extent of contamination is not widespread and appears to be isolated to a few specific areas at the site. The deep groundwater zone is not contaminated.

The COCs identified for the shallow groundwater zone are:

VOCs

- 1,2- dichloroethane (DCA)
- TCE

Explosives

- 2,4-DNT
- 2,6-DNT

- 2(o)-nitrotoluene
- 3(m)-nitrotoluene
- 4(p)-nitrotoluene

Anion

- Perchlorate

Metals

- Arsenic
- Mercury
- Nickel

The COCs in the intermediate zone are:

- Methylene chloride
- 1,2-DCA
- TCE
- Arsenic

The shallow zone has approximately 9 million gallons of contaminated groundwater in the nitrotoluene plume and 4 million gallons in the perchlorate plume (Shaw, 2010). The intermediate zone methylene chloride plume has approximately 650,000 gallons (AECOM, 2017).

Explosive compound releases resulting from the manufacturing process of TNT, releases from process tanks and process pipelines, are the suspected contamination sources. Potential sources of contamination at the site are co-located wood and transite TNT wastewater pipelines, cooling water lines and manholes, explosives compounds in stained soils around the foundation of buildings, isolated perchlorate-containing soils in the north-eastern portion of LHAAP-29, and TNT-contaminated sediment in the cooling water outfall ditch.

There are approximately 3,900 cubic yards of contaminated soil and sediment. This volume will need to be refined during the remedial design phase to address uncertainty in the volume of soil to be removed near Building 812F and in the cooling water outfall/ditch (AECOM, 2017). Additionally, as part of the RD, confirmation soil samples will be collected along the north and south cooling water lines as well as the TNT wastewater lines to confirm that leaching from the lines has not occurred, which may identify additional soil excavation areas. The COCs identified for soil in the FS are:

- 2,4,6-TNT
- 2,4-DNT
- Perchlorate
- 2,6-DNT
- 2-amino-4,6-DNT
- 4-amino-2,6-DNT

Additionally, contaminated solid residue and liquid were detected in the transite TNT wastewater line and the vitrified clay cooling water lines and include:

- 2,4,6-TNT
- 2,4-DNT
- 2,6-DNT
- 2-amino-4,6-DNT
- 4-amino-2,6-DNT
- 1,3-dinitrobenzene

The lines are buried and their contents are not subject to unintentional access and associated human exposure. The wooden TNT wastewater line was previously flushed and abandoned and results from limited soil samples collected near the line indicate there has not been a release to the surrounding soil.

Within the intermediate groundwater zone at LHAAP-29, methylene chloride concentrations have been consistently detected at very high concentrations with a maximum concentration of 10,300,000 micrograms per liter (µg/L) and a calculated solubility of 13,200,000 µg/L. The most recent maximum concentration reported during the 2014 supplemental investigation was 8,260,000 µg/L. There has been no direct observation of DNAPL, nor do groundwater data indicate that the methylene chloride plume is migrating. However, the groundwater concentrations indicate that soil in the saturated zone is likely to contain methylene chloride as residual source material in fractures and pores. Since there is a high cancer risk associated with exposure to groundwater from this region of the intermediate zone, such residual source material may be considered a principal threat waste.

SCOPE AND ROLE OF THE PROPOSED ACTION

The scope and role of the action discussed in this Proposed Plan includes all the remedial actions planned for this site. The recommended remedial action at LHAAP-29 will prevent potential risks associated with exposure to contaminated soil and groundwater in both the shallow and intermediate zones. Groundwater at Longhorn is not currently being used as drinking water, nor is it anticipated to be used in the future based on its reasonably anticipated future use as a national wildlife refuge. However, when establishing the Remedial Action Objectives (RAOs) for this response action, the U.S. Army has considered the NCP's expectation to return useable groundwater to its potential beneficial use wherever practicable, in a timeframe that is reasonable given the particular circumstances of the site (40 CFR 300.430(a)(1)(iii)(F)). The U.S. Army has also considered the State of Texas designation of all groundwater as potential drinking water, unless otherwise classified, consistent with Texas Administrative Code, Title 30, §335.563 (h)(1). The U.S. Army intends to return the contaminated shallow and intermediate groundwater zones at LHAAP-29 to its potential beneficial uses, which is considered to be the attainment of Safe Drinking Water Act maximum contaminant levels (MCLs) to the extent practicable, and consistent with the NCP (40 CFR §300.430(e)(2)(i)(B) and (C)). If an MCL is not available for a chemical, the Texas Risk Reduction Program (TRRP) Tier 1 Protective Concentration Level (PCL) for residential groundwater use (TRRP $^{GW}GW_{Ing}$ PCL) will be used. If return to potential beneficial use is not practicable, the NCP expectation is to prevent further migration of the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

Laboratory results from the groundwater at LHAAP-29 have indicated that possible "pools" of DNAPL may be residing as residual source material in fractures and pores in the subsurface. As a component of this groundwater, the hazardous contaminant methylene chloride is characterized as a highly toxic source material and, thus, potentially a principal threat waste (EPA, 1991). In accordance with the NCP, treatment alternatives have been evaluated through the remedy selection process. The preferred remedial alternative includes an active remedial component that will mitigate the potential principal threat. By instituting an in situ thermal desorption treatment of the groundwater, this active treatment will be applied to the highest concentration area (to be defined during the RD) in the methylene chloride groundwater plume and will comply with NCP expectations regarding treatment of affected media where principal threat waste may be present.

The preferred remedial action will include groundwater monitoring to demonstrate that the plume is not migrating and to verify that contaminant levels are being reduced. LUCs that restrict groundwater use may be terminated when COCs in soil and groundwater remaining at the site are reduced below levels that will support unlimited use and unrestricted exposure.

The removal of source soils will positively impact groundwater by eliminating the potential for the leaching of contaminants from the soil into groundwater and will remove the contamination that poses a risk to ecological receptors. Flushing the transite TNT wastewater line and cooling water lines with water followed by visual inspections will ensure solid residue and/or liquid is not left in the lines. The inspection and closure details will be included in the RD and may include techniques such as sampling of flush water and video camera inspection if there is any uncertainty about the effectiveness of the flushing. Plugging the inlets and outlets of the underground lines with a bentonite slurry mix including the manholes of the process cooling water lines will mitigate infiltration.

SUMMARY OF SITE RISKS

The reasonably anticipated future use of this site is nonresidential use as part of the Caddo Lake 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 which documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge. Presently the Caddo Lake National Wildlife Refuge occupies over 7,000 acres of the former installation. Under this MOA, the property must be kept as a national wildlife refuge unless there is an act of Congress which removes the parcel or the land is exchanged in accordance with the National Wildlife Refuge System Administration Act of 1966 and the National Wildlife Refuge System Act Amendments of 1974.

As part of the RI/FS, a BHHRA and screening ecological risk assessment were conducted for LHAAP-29 to determine current and future effects of contaminants on human health and the environment to support technical review and risk management decisions.

Human Health Risks

Using data presented in the RI, the baseline risk assessment estimates the risk that the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The applicable receptor scenario for future use as a national wildlife refuge is a hypothetical future maintenance worker. For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen and are expressed in scientific notation (e.g., 1×10^{-6}). USEPA's acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}, or one-in-ten thousand to one-in-one million for the excess lifetime cancer risk. The potential for non-cancer effects is expressed by a ratio of the exposure to the toxicity. An individual chemical ratio less than 1 indicates that toxic non-cancer effects from that chemical are unlikely. A non-cancer hazard index (HI) is calculated when all the ratios for the individual chemicals are summed. An HI greater than 1 indicates that site-related exposures may present a risk to human health. Thus, an HI of less than 1 is acceptable since it indicates toxic non-cancer effects are unlikely.

The cancer risk and the non-cancer HI were calculated based on a hypothetical future maintenance worker exposure to the site environmental media (e.g., soil and groundwater) under an industrial scenario. The human health risk assessment concluded that chemicals in soil pose an unacceptable non-cancer hazard

(HI of 1.3) for a hypothetical future maintenance worker under an industrial scenario. The groundwater was also determined to pose an unacceptable cancer risk (3.9×10^{-1}) and an unacceptable non-cancer hazard (HI of 3,000) to a hypothetical future maintenance worker. The risk and HI values are based on the industrial exposure scenario that includes drinking the water or using the water for hand washing or showering. Soil contaminants retained as COCs in the FS are 2,4,6-TNT, 2,4-DNT, 2,6-DNT, and perchlorate.

Soil

The potential soil-to-groundwater pathway was evaluated for the contaminant perchlorate (found in ground-water) and the explosives posing risks or hazards in soil. The concentrations of these chemicals were compared to their TCEQ soil Medium-specific Concentrations (MSCs) for industrial use based on groundwater protection (GWP-Ind), which are more stringent than the soil MSCs for industrial use based on inhalation, ingestion, and dermal contact (TCEQ, 2006). Because the GWP-Ind MSC values are more stringent, they are the proposed soil cleanup levels for human health. The maximum detected concentrations of the COCs and GWP-Ind (proposed as the cleanup levels) are presented in **Table 1**.

Table 1. Soil Chemicals of Concern

Chemical	Maximum Concentration (mg/kg)	GWP-Ind MSC (mg/kg)
2,4,6-Trinitrotoluene	26,000	5.1
2,4-Dinitrotoluene	17,100	0.042
2,6-Dinitrotoluene	15	0.042
Perchlorate	8.6	7.2

Notes:
mg/kg milligrams per kilogram
GWP-Ind Texas Commission on Environmental Quality soil MSC for industrial use based on groundwater protection
Results for samples collected 12/2004 and 2/2005

Since these soil cleanup levels apply to the soil-to-groundwater pathway and not direct human contact, they will apply to soil at a depth interval from the surface down to where groundwater is encountered.

Groundwater

Groundwater contaminants identified as COCs contributing to human health cancer risk and non-cancer hazard are methylene chloride, TCE, 1,2-DCA, 2,4-DNT, 2,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, and perchlorate. TCE degrades to cis-1,2-dichloroethene (DCE) and vinyl chloride, which are also considered COCs. Metals, including nickel, arsenic, and mercury also had sporadic detections above MCLs, or in the case of nickel, above the PCL, but their distribution does not define a plume; therefore, they were included as provisional COCs and the extent of contamination will be assessed during the remedial design. The proposed cleanup level is the MCL, where it exists. Where an MCL has not been promulgated, the TRRP PCL for residential groundwater use (TRRP $^{GW}GW_{Ing}$ PCL) is the proposed cleanup level. Separate lists of COCs have been identified for the shallow and intermediate zone groundwater. The maximum detected concentrations of the COCs from the most recent sampling event and the MCLs or TRRP $^{GW}GW_{Ing}$ PCL for the shallow and intermediate zones are presented in **Tables 2** and **3**, respectively.

Table 2. Shallow Groundwater Zone Chemicals of Concern

Chemical	Maximum Concentration (µg/L)	MCL (µg/L)
Trichloroethene	344	5
1,2-Dichloroethane	8180	5
cis-1,2-Dichloroethene*	below MCL	70
trans-1,2-Dichloroethene*	below MCL	100
Vinyl chloride*	below MCL	2
Arsenic	141	10
Mercury	6.1	2
		TRRP $^{GW}GW_{Ing}$ PCL (µg/L)
2,4-Dinitrotoluene	50.9	1.3
2,6-Dinitrotoluene	239	1.3
2-(o)Nitrotoluene	8,140	4.1
3-(m)Nitrotoluene	451	240
4-(p)Nitrotoluene	1,400	57
Perchlorate	16,800	17
Nickel	8,400	490

Notes:
* trichloroethene daughter products
TRRP $^{GW}GW_{Ing}$ PCL from April 2018 TRRP PCLs,
https://www.tceq.texas.gov/remediation/trrp/trrppcls.html
µg/L micrograms per liter
MCL maximum contaminant level
Samples collected 5/2005 and 2/2007

Table 3. Intermediate Groundwater Zone Chemicals of Concern

Chemical	Maximum Concentration (µg/L)	MCL (µg/L)
Methylene chloride	8,260,000	5
Trichloroethene	28,100	5
1,2-Dichloroethane	below MCL	5
1,1-Dichloroethene	68.2	7
cis-1,2-Dichloroethene*	333	70
trans-1,2-Dichloroethene*	below MCL	100
Vinyl chloride*	18	2
Arsenic	44	10

Notes:
* trichloroethene daughter products
µg/L micrograms per liter
MCL maximum contaminant level
Samples collected 10/2014

Cooling and Wastewater Lines

At LHAAP-29 there are transite and wooden TNT wastewater lines and vitrified clay cooling water lines with manholes (north and south). The transite TNT wastewater line and north and south cooling water lines have solid residues contaminated with explosives at concentrations above the GWP-Ind MSC, as shown in **Table 4** and **5**, respectively. The wooden TNT wastewater line was flushed and abandoned. The north and south cooling water lines also have liquid contaminated with explosives. During typical flushing operations, the flush water will be sampled, analyzed and tested using the Toxic Characteristics Leaching Procedure (TCLP) (or the TCEQ equivalent test) to determine whether residual explosives represent hazardous waste. The water will be handled and disposed as required based on the TCLP results.

Table 4. Transite TNT Wastewater Line Solid Residue Chemicals of Concern

Chemical	Maximum Concentration (mg/kg)	GWP-Ind MSC (mg/kg)
1,3-Dinitrobenzene	1.08	1
2,4,6-Trinitrotoluene	526	5.1
2,4-Dinitrotoluene	89	0.042
2-amino-4,6-Dinitrotoluene	19 JH	1.7
4-amino-2,6-Dinitrotoluene	13.3	1.7

Notes:
GWP-Ind Soil MSC for industrial use based on groundwater protection
JH concentration is estimated and biased high
mg/kg milligrams per kilogram
Samples collected 12/2004 and 2/2005

Table 5. Vitrified Clay Cooling Water Drain Line Solid Residue Chemicals of Concern

Chemical	Maximum Concentration (mg/kg)	GWP-Ind MSC (mg/kg)
2,4,6-Trinitrotoluene	11	5.1
2,4-Dinitrotoluene	1.1	0.042
2,6-Dinitrotoluene	0.30 J	0.042
2-amino-4,6-Dinitrotoluene	9	1.7
4-amino-2,6-Dinitrotoluene	7.8	1.7

Notes:
J concentration is estimated
mg/kg milligrams per kilogram
GWP-Ind Soil MSC for industrial use based on groundwater protection
Samples collected 12/2004 and 2/2005

Ecological Risks

The ecological risk for LHAAP-29 was addressed in the installation-wide BERA (Shaw, 2007b). 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. The conclusions regarding the potential for chemicals detected at individual sites 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-29 lies within the Industrial Sub-Area.

The ecological Hazard Quotients (HQs) are simple ratios of an ecological receptor's estimated chemical intake (in units of milligrams of chemical ingested per kilograms of receptor body weight per day) to either an assumed safe- or effect-level dose of the same chemical, in the same units as the chemical intake. HQs have a number of limitations, primary among them that they are not measures of risk. Even though the BERA concluded that ecological hazards were acceptable for the Industrial Sub-Area, elevated concentrations of nitrotoluenes (2,4-DNT, 2,6-DNT, and 2,4,6-TNT) and dioxin were identified at one location (Shaw, 2007b). The HQ screening values for these three constituents at LHAAP-29 were greater than 1 (9,682, 18,844, and 16.9, respectively). Detected concentrations of these chemicals in soil in one hot spot exceeded the Industrial Sub-Area ecological preliminary remediation goal and are targeted for excavation. Some of the areas are co-located with excavation for human health. For ecological receptors, the depth of excavation varies since they are based on the different ecological receptors (deer mouse from 0 to 0.5 feet and the short-tailed shrew from 0 to 3 feet).

Proposed soil cleanup levels for the ecological receptors are as follows:

- 2,4,6-TNT – 6.1 mg/kg (0 to 0.5 feet)
  4.7 mg/kg (0 to 3 feet)
- 2,4-DNT – 12 mg/kg (0 to 3 feet)
- 2,6-DNT – 2.7 mg/kg (0 to 0.5 feet)
  6.8 mg/kg (0 to 3 feet)

It is the current judgment of the U.S. Army that the preferred alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

REMEDIAL ACTION OBJECTIVES

The RAOs for LHAAP-29, which address contamination associated with the environmental media at the site and take into account the future uses of LHAAP surface water, land, and groundwater are:

- Protection of human health by preventing human exposure to the contaminants in the soil, sediment, transite TNT wastewater line, vitrified clay cooling water lines, and groundwater;

- Protection of human health and the environment by preventing the migration of contaminants to groundwater and surface water from potential sources in the soil, sediment, and process lines (TNT wastewater and cooling water);
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water;
- Protection of ecological receptors by preventing exposure to the contaminated soil and sediment; and
- Return groundwater to its beneficial uses, wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

SUMMARY OF REMEDIAL ALTERNATIVES

The FS and FS Addendum identified and screened remedial technologies and associated process options that may be appropriate for satisfying the RAOs for LHAAP-29 with respect to effectiveness, implementability, and cost. The following remedial alternatives were developed from the retained remedial technologies carried forward after the initial screening:

- Alternative 1 – No Action
- Alternative 2 – Excavation and Off-site Disposal and LUCs for Soil; Plug Lines; In Situ Chemical Oxidation, MNA and LUCs for Intermediate Zone Groundwater, and MNA and LUCs for Shallow Zone Groundwater
- Alternative 3 – Excavation and Off-site Disposal and LUCs for Soil; Plug Lines; Intermediate Zone Groundwater Extraction, MNA and LUCs for Shallow and Intermediate Zone Groundwater
- Alternative 4 - Excavation and Off-site Disposal and LUCs for Soil; Plug Lines; ISTD, MNA and LUCs for Intermediate Zone Groundwater; MNA and LUCs for Shallow Zone Groundwater.

Under Alternative 4, two ISTD technologies were evaluated to thermally treat the high dissolved methylene chloride and inferred DNAPL in the intermediate zone groundwater. Alternative 4 was subdivided into Alternatives 4a and 4b to reflect these two technologies as follows:

- Alternative 4a would use Electrical Resistance Heating (ERH) to thermally treat intermediate zone groundwater.
- Alternative 4b would use Thermal Conduction Heating (TCH) to thermally treat the intermediate zone groundwater.

Common Elements. Five elements (i.e., MNA, LUCs, inspection and long-term monitoring, plugging lines, and soil excavation and off-site disposal) are common to Alternatives 2, 3, and 4. These elements are described below.

Monitored Natural Attenuation. MNA is a passive remedial action that relies on natural biological, chemical, and physical processes to reduce the mass and concentration of groundwater COCs under favorable conditions. MNA will assure the protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to MCLs, or TRRP $^{GW}GW_{Ing}$ PCL. Historical data in conjunction with two years of quarterly sampling results will be evaluated for monitoring the degradation of contaminant concentrations in accordance with standard MNA practices.

Land Use Controls. The LUCs will be implemented to support the RAOs. The U.S. Army will be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUCs. The U.S. Army intends to provide details of the LUC implementation actions in a remedial design (RD) document. Until cleanup levels are met in the groundwater for Alternatives 2, 3, and 4, the LUCs will prevent human exposure to residual groundwater contamination presenting an unacceptable risk to human health by ensuring there is no withdrawal or use of groundwater beneath the sites for anything other than treatment, environmental monitoring, or testing.

The LUC objectives include maintaining the integrity of any current or future remedial or monitoring systems, and preventing the use of groundwater contaminated above cleanup levels as a potable water source.

- LUC to restrict land use to non-residential use until it is demonstrated that the COCs in soil and groundwater are at levels that allow for unlimited use and unrestricted exposure.
- LUC prohibiting potable use of groundwater above cleanup levels until it is demonstrated that the COCs are at levels that allow for unlimited use and unrestricted exposure.
- LUC to maintain the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels, and cleanup levels have been achieved.

In addition, the Texas Department of Licensing and Regulation will be requested to notify well drillers of groundwater restrictions. The recordation of the LUCs with the Harrison County Courthouse will be completed and will include a map showing the areas of groundwater restriction at the site. These restrictions will prohibit or restrict property uses that may result in exposure to the contaminated groundwater.

In order to transfer this property (LHAAP-29), an environmental condition of property (ECP) document will be prepared and the Environmental Protection Provisions from the ECP will be attached to the letter of transfer. The ECP will include LUCs for groundwater soil, and the remedial and monitoring system as part of the Environmental Protection Provisions. The property will be transferred subject to the LUCs identified in the ECP. These restrictions will prohibit or restrict property uses that may result in exposure to the contaminated groundwater and any residual soil contamination greater than levels that allow for unlimited use and unrestricted exposure. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army will retain ultimate responsibility for remedy integrity.

Inspection and Long-term Monitoring. Alternatives 2, 3 and 4 include inspection and long-term groundwater monitoring activities. Monitoring will be continued as required to demonstrate effectiveness of the remedies, to demonstrate compliance with applicable or relevant and appropriate requirements (ARARs), to-be-considered requirements, and RAOs, and to support CERCLA Five-Year Reviews. After the initial MNA monitoring period of 2 years, semiannual monitoring will be continued for 3 years. Then sampling frequency will be reduced to annually until the next CERCLA Five-Year Review. Future sampling frequencies will be evaluated in the CERCLA Five-Year Review.

Plug and Abandon Lines. The transite TNT wastewater line will be flushed with water, then the inlets and outlets will be inspected and plugged with a bentonite slurry mix or equivalent. The cooling water lines will be evaluated further during the RD in order to base the remedial action on up-to-date data. The lines will be flushed with water, inspected and plugged using a bentonite slurry mix or equivalent. Rinsate water will be containerized and characterized for waste handling. The rinsate will be tested using TCLP to determine the proper disposal method. The visual inspection and closure details will be included in the RD.

Excavation and Off-site Disposal of Contaminated Soil. Contaminated soil will be excavated at LHAAP-29 under Alternatives 2, 3, and 4, and disposed off-site. This action will eliminate ecological risk from direct contact as well as human health risk associated with both direct contact and the soil-to-groundwater pathway.

Contamination is primarily present from the surface to where groundwater is encountered. The soil will be excavated in several small areas, totaling approximately 3,900 cubic yards. The total volume to be excavated will be refined during the remedial design. Soil removal would be followed by a LUC to restrict land use to nonresidential uses until it is demonstrated that COCs are at levels that allow for unlimited use and unrestricted exposure.

Alternative 1 – No Action

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, the groundwater would be left "as is" without implementing any additional containment, removal, treatment, or other mitigating actions. No other actions would be implemented to prevent potential human exposure to contaminated groundwater. Contaminated soil and liquids or residues in the cooling water and wastewater lines would not be removed. Compliance with the ARARs would not be achieved.

Estimated Capital Present Worth Cost: $0

Estimated Operation and Maintenance (O&M) Present Worth Cost: $0

Estimated Duration: Not Applicable since active remediation is not conducted

Estimated Total Present Worth Cost: $0

Alternative 2 – Excavation and Off-site Disposal for Soil; Plug Lines; In Situ Chemical Oxidation, MNA and LUCs for Intermediate Zone Groundwater, and MNA and LUCs for Shallow Zone Groundwater

Alternative 2 would include excavation of the contaminated soil from LHAAP-29, followed by a LUC to restrict land use to nonresidential uses until it is demonstrated that COCs in soil and groundwater are at levels that allow for unlimited use and unrestricted exposure. The transite TNT wastewater line would be flushed, plugged, and abandoned in place. The vitrified clay cooling water lines would be inspected, flushed, plugged, and abandoned in place. MNA would be used for the contaminated shallow groundwater. In the intermediate groundwater zone, ISCO would be used to treat the highest concentration area in the methylene chloride plume. During in ISCO, the target zone would be heated to 40 degrees C and chemical oxidant would be injected in targeted locations to oxidize organic constituents in the saturated zone. Groundwater would be extracted to help distribute the oxidant. The extracted groundwater would be conveyed to the on-site groundwater treatment plant for treatment and discharge. Monitoring of both the shallow and intermediate zones would confirm that groundwater contamination remains localized and degrades over time. Monitoring of the intermediate zone would also confirm that the concentrations have been reduced to a level conducive to natural attenuation. MNA is estimated to take approximately 70 years in the shallow groundwater zone based on the attenuation of 1,2-DCA. The in situ treatment in the intermediate zone is estimated to take approximately 3 years. In situ treatment would be followed by MNA in the intermediate zone, which is estimated to take about 90 years based on the attenuation of TCE. Other COCs are expected to require less time to attenuate. MNA would continue until cleanup levels are met. LUCs would be implemented to prevent exposure to the contaminated shallow and intermediate groundwater until COCs are at levels that allow for unlimited use and unrestricted exposure. Compliance with ARARs is expected to be achieved.

Estimated Capital Present Worth Cost: $8,070,000

Estimated O&M Present Worth Cost: $1,070,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: $9,140,000

Alternative 3 – Excavation and Off-site Disposal of Soil; Plug Lines; Intermediate Zone Groundwater Extraction and Treatment, MNA and LUCs for Intermediate and Shallow Zone Groundwater

As with Alternative 2, contaminated soil would be removed, followed by a LUC to restrict land use to nonresidential uses until it is demonstrated that COCs in soil and groundwater are at levels that allow for unlimited use and unrestricted exposure and contamination in the lines would be mitigated. Groundwater contamination would be reduced throughout the intermediate zone groundwater contaminant plume via groundwater extraction until VOC levels are reduced. The extracted groundwater would be conveyed to the onsite groundwater treatment plant for treatment. Monitoring of both the shallow and intermediate zones would confirm that groundwater contamination remains localized and degrades over time to a level conducive to natural attenuation. MNA is estimated to take approximately 70 years in the shallow groundwater zone based on the attenuation of 1,2-DCA. The extraction in the intermediate zone is estimated to take approximately 3 years followed by MNA. MNA is estimated to take about 90 years in the intermediate zone based on the attenuation of TCE. As in Alternative 2, LUCs would be implemented to prevent exposure to the contaminated shallow and intermediate groundwater until COCs are at levels that allow for unlimited use and unrestricted exposure. Compliance with ARARs is expected to be achieved.

Estimated Capital Present Worth Cost: $1,550,000

Estimated O&M Present Worth Cost: $1,780,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: $3,330,000

Alternative 4 - Excavation and Off-site Disposal for Soil; Plug Lines; ISTD, MNA and LUCs for Intermediate Zone Groundwater; MNA and LUCs for Shallow Zone Groundwater

As with Alternatives 2 and 3, contaminated soil would be removed and contamination in the lines would be mitigated. Shallow zone groundwater contamination would be addressed by MNA. MNA is estimated to take approximately 70 years in the shallow groundwater zone based on the attenuation of 1,2-DCA. Under Alternative 4, one of two ISTD process options would be selected to treat the intermediate zone groundwater where methylene chloride DNAPL is inferred. One of two process options, ERH (Alternative 4a) or TCH (Alternative 4b) will be selected during the remedial design phase. Extraction may be implemented as part of the in-situ treatment to physically remove mass and to control the hydraulic gradient. Active treatment duration is estimated at 65-87 days for Alternative 4a, and 180 days for Alternative 4b. Duration of MNA and LUCs for the intermediate zone groundwater is expected to be 5-10 years following active remediation for both Alternative 4a and 4b. After in-situ treatment, the effectiveness of MNA in both the shallow and intermediate zone groundwater will be evaluated to confirm that contaminant concentrations are being reduced over time. LUCs for surface soil, subsurface soil, shallow groundwater, and intermediate groundwater will be maintained until COCs are at levels that allow for unlimited use and unrestricted exposure.

Compliance with ARARs is expected to be achieved.

Alternative 4a:
Estimated Capital Present Worth Cost: $3,710,000

Estimated O&M Present Worth Cost: $1,030,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: $4,740,000

Alternative 4b:
Estimated Capital Present Worth Cost: $4,530,000

Estimated O&M Present Worth Cost: $1,190,000

Cost Estimate Duration: 30 years

Estimated Total Present Worth Cost: $5,720,000

EVALUATION OF ALTERNATIVES

Nine criteria identified in the NCP, 40 CFR §300.430(e)(9)(iii), are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. This section profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other alternatives under consideration. The nine evaluation criteria are discussed below. The "Detailed Analysis of Alternatives" can be found in the FS for LHAAP-29 (Shaw, 2010).

1. Overall Protection of Human Health and the Environment

The four alternatives provide varying levels of human health protection. Alternative 1, no action, does not achieve the RAOs and provides the least protection of all the alternatives; it provides no reduction in risks to human health or the environment because no measures would be implemented to eliminate the pathway for human exposure to soil or to the groundwater contamination. Additionally, the soil pathway for ecological receptors would not be addressed. Although natural attenuation will continue to occur under Alternative 1 that would result in contaminant reduction, the possibility that the RAO would be achieved in a timely manner is least likely since the potential principal threat waste source remains in place.

Alternative 2 may not achieve the RAOs because of the uncertainty between the ISCO bench scale testing and full-scale in-situ application for treatment of the intermediate zone DNAPL. Alternative 3 may not achieve the RAOs due to the difficulty in removing DNAPL using groundwater extraction, which typically requires perpetual groundwater pumping and is more appropriately used as a containment strategy. Alternative 4 is expected to meet the RAOs since ISTD has the ability to treat the methylene chloride in dissolved, sorbed, and DNAPL phases.

Alternatives 2, 3, and 4 would remove the contaminated soil and residue in lines and provide access and use restrictions for residual contamination. Alternatives 2, 3, and 4 would also rely on LUCs to prevent access to shallow and intermediate groundwater until cleanup levels are achieved by MNA. Only Alternative 4 is expected to provide effective treatment of the primary COC, methylene chloride, in the intermediate zone. Alternatives 2 and 3 provide a similar level of overall protection. Alternative 4 is expected to achieve the methylene chloride cleanup within 5-10 years for MNA following the ISTD treatment in the intermediate zone.

2. Compliance with ARARs

The "Applicable or Relevant and Appropriate Requirements" can be found in the FS for LHAAP-29 (Shaw, 2010). Alternative 1 does not comply with chemical-specific ARARs as no remediation of soil or groundwater will be conducted. Alternatives 2, 3 and 4 comply with all chemical-specific ARARs for soil and groundwater, as well as the location-specific and action-specific ARARs.

3. Long-Term Effectiveness and Permanence

Alternative 1 would be the least effective and permanent in the long term because no contaminant source removal or treatment would take place and no measures would be implemented to control exposure risks posed by contaminated site soil, sediment, surface water and groundwater. Although natural attenuation will continue to occur resulting in reduction of contaminant concentrations, the likelihood that the RAO would be achieved in a timely manner is remote unless the source is removed.

Alternatives 2, 3, and 4 would provide long-term effectiveness for soil and shallow groundwater contamination by removing the source soils and providing restoration of the shallow groundwater by MNA.

Alternatives 2 and 3 may not significantly and permanently reduce groundwater contaminant concentrations in the intermediate zone to the preliminary cleanup levels and, therefore, have a low likelihood of achieving long-term effectiveness and permanence.

Alternative 4 is able to significantly and permanently reduce groundwater contaminant concentrations to the preliminary cleanup levels and, therefore, has the highest likelihood of achieving long-term effectiveness and permanence. Alternative 4 provides the highest level of effectiveness compared to Alternatives 2 and 3 since the intermediate zone groundwater would reach concentrations amenable to natural attenuation in a shorter time frame.

Alternatives 2, 3, and 4 rely on LUCs for the protection of human health exposure until concentrations of COCs are at levels that allow for unlimited use and unrestricted exposure. LUCs would be required for groundwater for the protection of human health exposure. As is consistent with the required 5-year CERCLA reviews, the effectiveness of Alternatives 2, 3, and 4 would be monitored and performance of controls will be assessed, in compliance with the risk reduction goals.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not employ treatment and would not result in a reduction of toxicity, mobility, or volume of contaminants.

Natural attenuation and ISCO, pumping/treatment, or ISTD, coupled with excavation would permanently reduce the mass and concentration of contaminants and, therefore, the toxicity, mobility, and volume of the contaminants. MNA is a passive remedial action and ISCO and ISTD are active treatment processes.

Alternatives 2 and 3 would generate daughter products that may temporarily increase toxicity or mobility of the contaminant plume, with ISCO working in a shorter time frame and pumping and treatment working to reduce concentrations initially. The alternatives include monitoring so TCE daughter products would be quantified, documented and evaluated. Daughter product concentrations would be reduced under these alternatives to levels below their cleanup levels to return groundwater to its potential beneficial use as drinking water wherever practicable.

Alternative 4 provides the highest degree of permanent reduction in toxicity and volume of the groundwater contaminants.

The soil excavation in Alternatives 2, 3 and 4 would reduce mobility because perchlorate and explosive contaminated soils would be removed from the site and placed in a permitted disposal facility. Toxicity and volume would not be reduced by the excavation portion of the alternatives as the form and quantity of the contaminants would not be altered.

There is an NCP expectation to use treatment to address principal threat wastes, wherever practicable. Remedial Alternative 4, and Alternatives 2 and 3 to a lesser extent, as presented in this Proposed Plan, satisfy the NCP expectation by including treatment components that address the potential for principal threat wastes associated with the high concentrations of methylene chloride in the intermediate zone.

5. Short-Term Effectiveness

Alternative 1 would not involve any remedial measures; therefore, no short-term risk to workers, the community or the environment would be addressed. The activities associated with Alternatives 2, 3, and 4 would be protective to the surrounding community from short-term risks except for minimal potential short-term risks during transport (possible accident when soil is transported off site) of perchlorate and explosive contaminated soil.

Alternatives 2, 3, and 4 would involve potential short-term risks to workers associated with exposure to contaminated groundwater from monitoring and/or operation of drilling/construction equipment.

Alternative 2 would have short-term risks to remediation workers associated with exposure while performing ISCO activities, including handling of additives/materials and heating of the target zone to 40 degrees C. Alternative 4 would pose similar short-term risks related to the ISTD process that requires heating of the target zone and potential exposure to power sources and hot fluids extracted during treatment. In addition, workers could be exposed to toxic air emissions during ISTD operations.

Alternatives 2, 3, and 4 include LUCs as elements of their remedies and would provide almost immediate protection from the contaminated groundwater in the shallow and intermediate zones by prohibiting installation of potable water wells through relatively quick LUC implementation. The time period to achieve groundwater cleanup levels is the most significant difference between Alternative 1 versus Alternatives 2, 3, and 4. Alternatives 2, 3 and 4 are expected to take less time to achieve RAOs for both shallow and intermediate groundwater than Alternative 1.

Alternative 3 would have short-term risks to the workers associated with exposure during increased operations at the LHAAP groundwater treatment system, which include chemical handling and operation of a high-temperature catalytic oxidizer. The implementation of Alternative 3 would require more time than Alternatives 2 and 4.

6. Implementability

Under Alternative 1, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. For Alternatives 2, 3, and 4, soil excavation would require extensive coordination between excavation, sampling, transportation, and disposal.

Alternatives 2 and 3 are also technically implementable, but the hydrogeologic conditions (low hydraulic conductivity) of the intermediate zone and particularly the inferred presence of DNAPL could limit the ability of ISCO or groundwater extraction to reduce contaminant levels sufficiently to reach concentrations amenable to MNA. The thermal treatment component of Alternative 4 is a much more robust technology that will be able to overcome the low hydraulic conductivity of the formation as well as any methylene chloride as DNAPL that may be present in the target zone.

Alternative 3 would involve the use of a groundwater treatment system which currently exists at the LHAAP and is easily accessible to the site; therefore, groundwater extraction for Alternative 3 technically would be readily implementable.

Administratively, all of the alternatives are implementable.

7. Cost

Cost estimates are used in the CERCLA FS process to eliminate those remedial alternatives that would be 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. Final costs will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables.

The cost estimates include capital costs (including fixed-price remedial construction) and long-term O&M costs (post-remediation). Overall present worth costs are developed for each alternative assuming a discount rate of 2.8 percent. The duration used for the estimates is a 30-year period.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 3, Alternative 4a, Alternative 4b, and Alternative 2. No costs are associated with Alternative 1 because no remedial activities would be conducted.

Alternative 3 has the lowest present worth of the active remedial alternatives, and capital costs are equivalent to the capital costs for Alternative 2 because of the presence of the existing groundwater treatment system at LHAAP. Alternative 3 estimates assume a 3-year duration for extraction; however the presence of inferred DNAPL and sorbed methylene chloride is expected to require extraction for a longer period of time. Alternative 2 costs did not include costs for heating the target zone to 40 degrees C or for additional ISCO injections expected to be required to treat the inferred DNAPL, so the capital costs for Alternative 2 also are an underestimate.

Alternative 4a and 4b costs are higher than Alternative 3, but substantially lower than Alternative 2.

8. State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan. Comments received from the USEPA and TCEQ during the Proposed Plan development have been incorporated. Both agencies concur with the preferred alternative.

9. Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the Record of Decision (ROD) for the site.

SUMMARY OF THE PREFERRED ALTERNATIVE

Alternative 4 (excavation and off-site disposal and LUCs for surface and subsurface soil; plug lines; ISTD using either ECH or TCH, MNA and LUCs for intermediate zone groundwater, MNA and LUCs for shallow zone groundwater) is the preferred alternative for LHAAP-29 and is consistent with the intended future use of the site as a national wildlife refuge. This alternative will satisfy the RAOs for the site through the following:

- Contaminated soil and sediment removal with off-site disposal to protect the hypothetical future maintenance worker and ecological receptors and eliminate the soil-to-groundwater pathway, followed by LUCs;
- Inspection, flushing and plugging of the transite TNT wastewater line and the vitrified clay cooling water lines to eliminate potential exposure from residual contamination;
- ISTD treatment of the methylene chloride DNAPL in the intermediate zone to reduce concentrations to levels amenable to MNA;
- MNA for both shallow and intermediate zone groundwater (after ISTD treatment) to reduce contaminant levels to cleanup levels and confirm the contaminated groundwater remains localized with minimal migration; and
- LUCs for shallow and intermediate zone groundwater and soil that will ensure protection of human health by preventing exposure until levels that allow for unlimited use and unlimited exposure have been attained.

Long-term monitoring and reporting will continue until the cleanup levels are achieved.

The ISTD treatment using either ERH or TCH will reduce methylene chloride concentrations in the intermediate zone to make conditions more amenable for MNA of TCE. Alternative 4a, which uses ERH as the process option to implement ISTD for treatment of the methylene chloride plume in intermediate zone groundwater, is expected to be the most cost effective remedial alternative for LHAAP-29. However, the TCH conceptual design under Alternative 4b appears to be more robust. Therefore, the decision to use either ERH or TCH to implement the ISTD technology should be made during the remedial design phase.

The selected alternative offers a high degree of long-term effectiveness and can be easily and immediately implemented.

Based on information currently available, the U.S. Army believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) requirement used to evaluate remedial alternatives. The preferred alternative will: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize a permanent solution; and 5) utilize an active treatment as a principal element. The selected remedy addresses the statutory preference for treatment to the maximum extent possible.

The U.S. Army intends to present details of the soil excavation plan, groundwater treatment plan, LUCs implementation plan, groundwater monitoring plan, and MNA remedy implementation in the RD for LHAAP-29.

The remedy selected in the ROD may change from the preferred alternative presented here, based on public comment.

Notification that the site is suitable for nonresidential use will accompany all transfer documents and will be recorded in the Harrison County Courthouse. CERCLA Five-Year Reviews will be performed to determine whether the remedy remains protective of human health and the environment.

COMMUNITY PARTICIPATION

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-29 through public meetings, the Administrative Record file for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers.

The dates for the public comment period, the date, location, time of the public meeting, and the locations of the Administrative Record files are provided on the front page of this Proposed Plan.

Any significant changes to the Proposed Plan, as presented in this document, will be identified and explained in the ROD.

PRIMARY REFERENCE DOCUMENTS FOR LHAAP-29

AECOM Technical Services (AECOM), 2016, Draft Final Remedial Investigation Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. July.

AECOM, 2017, Draft Final Feasibility Study Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. August.

Jacobs Engineering Group, Inc. (Jacobs), 2001, *Final Remedial Investigation Report for the Group 2 Sites Remedial Investigation (Sites 12, 17, 18/24, 29, and 32) at the Longhorn Army Ammunition Plant, Karnack, Texas,* April.

Jacobs, 2002, *Draft Baseline Human Health and Screening Ecological Risk Assessment for the Group 2 Sites (Sites 12, 17, 18/24, 29, 32, 49, Harrison Bayou and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas,* February.

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Shaw Environmental, Inc. (Shaw), 2007a, *Final Data Gaps Investigation Report, Longhorn Army Ammunition Plant, Karnack, Texas,* April.

Shaw, 2007b, *Installation-Wide Baseline Ecological Risk Assessment, Longhorn Army Ammunition Plant, Karnack, Texas, Volume I: Step 3 Report*, Houston, Texas, November.

Shaw, 2007c, *Final Modeling Report, Derivation of Soil and Groundwater Concentrations Protective of Surface Water and Sediment, Longhorn Army Ammunition Plant, Karnack, Texas* April.

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Solutions to Environmental Problems, Inc. (STEP), 2005, *Final Plant-Wide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas, Oak Ridge, Tennessee,* April.

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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, 2011, Final Proposed Plan for LHAAP-29 Former TNT Production Area, Group 2. March.

U.S. EPA, 1991, A Guide to Principal Threat and Low Level Threat Wastes. 9380.3-06FS. November.

GLOSSARY OF TERMS

Administrative Record—The body of reports, official correspondence, and other documents that establish the official record of the analysis, cleanup, and final closure of a CERCLA site.

ARARs—Applicable or relevant and appropriate requirements. Refers to the federal and state requirements that a selected remedy will attain.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—This law authorizes the Federal Government to respond directly to releases (or threatened releases) of hazardous substances that may be a danger to public health, welfare, or the environment. The U.S. Army currently has the lead responsibility for these activities.

Daughter Product—A compound that results directly from the degradation of another through chemical, biological, or physical action on a chemical compound.

DNAPL—A liquid that is both denser than water and is immiscible in or does not dissolve in water.

Environmental Media—Major environmental categories that surrounds or contact humans, animals, plants, and other organisms (e.g., surface water, ground water, soil or air) and through which chemicals or pollutants move.

ERH—An intensive in situ environmental remediation method that uses the flow of alternating current electricity to heat soil and groundwater and evaporate contaminants.

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, lung, digestive tract, etc.) and available for absorption.

FS—The process used for the development, screening, and detailed evaluation of alternative remedial actions.

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

Hazard Index—The hazard index is the sum of the hazard quotients for all chemicals to which an individual is exposed. A hazard index value of 1.0 or less indicates that no adverse non-cancer human health effects are expected to occur. Each hazard quotient is a comparison of an estimated chemical intake (dose) with a reference dose level below which adverse health effects are unlikely. Each hazard quotient is expressed as the ratio of the estimated intake (numerator) to the reference dose (denominator). The value is used to evaluate the potential for non-cancer health effects, such as organ damage, from chemical exposures.

ISCO—An environmental remediation technique based on advanced oxidation processes and advanced oxidation technology for soil and/or groundwater remediation.

ISTD—An intensive thermally enhanced environmental remediation technology that uses conductance or resistance heating elements to directly transfer heat to environmental media.

LUC—Administrative and legal controls or engineered and physical barriers to restrict land use that are put in place to minimize the potential for exposure to contamination and/or protect the integrity of a response action.

Maximum Contaminant Level (MCL)—The MCL is based on the National Primary Drinking Water Standard. The TCEQ has adopted MCLs at the regulatory cleanup level for both industrial and residential uses. Any detected compound in the groundwater samples with an MCL was evaluated by comparing it to its associated MCL.

MNA—The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation.

Proposed Plan—A report for public comment highlighting the key factors that form the basis for the selection of the preferred remediation alternative.

Remedial Action—The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.

RD—The phase of the CERCLA process that follows the selection of a remedial action and includes development of technical specifications and engineering drawings and other requirements for implementing cleanup remedies and technologies.

RI—An in-depth study designed to gather data needed to determine the nature and extent of contamination at a CERCLA site.

Risk Assessment—An analysis of the potential adverse health effects (current and future) caused by hazardous substances at a site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). The assessment contributes to decisions regarding appropriate response alternatives.

ROD—A public document that explains the cleanup method that will be used at a Superfund site, based on USEPA studies, public comments, and community concerns.

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.

TCH—An in-situ thermal desorption remediation process whereby heat is applied to subsurface soils and groundwater through an array of vertical or horizontal heater wells placed in the subsurface that heat the impacted area to temperatures that volatize the compounds of concern.

Thermal Desorption—An environmental remediation technology that utilizes heat to increase the volatility of contaminants such that they can be removed from the solid matrix. The volatilized contaminants are then either collected or thermally destroyed.

Transite—An asbestos-cement composite material (12-50% asbestos fiber) previously used for insulation, siding, pipes, and other construction materials.

ACRONYMS

ARARs	applicable or relevant and appropriate requirements
AST	Above Ground Storage Tank
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DNT	dinitrotoluene
ECP	environmental condition of property
ERH	electrical resistance heating
FFA	Federal Facility Agreement
FS	Feasibility Study
GWP-Ind	soil MSC for industrial use based on groundwater protection
$^{GW}GW_{ing}$	PCL for residential groundwater use
HI	hazard index
HQ	hazard quotient
ISCO	in-situ chemical oxidation
ISTD	in-situ thermal desorption
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MOA	Memorandum of Agreement
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MSC	medium-specific concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PCL	protective concentration level
Plexus	Plexus Scientific Corporation
RAO	remedial action objective
RD	remedial design
RI	remedial investigation
ROD	record of decision
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TCH	thermal conductance heating
TCLP	Toxic Characteristics Leaching Procedure
TNT	trinitrotoluene
TRRP	Texas Risk Reduction Program
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

COMMENTS FORM

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for LHAAP-29 is important to the U.S. Army. Comments provided by the public are valuable in helping the U.S. Army select a final remedy for these sites.

You may use the space below to write your comments, then fold and mail to Dr. Rose M. Zeiler, P.O. Box 220, Ratcliff, Arkansas 72951. Comments must be postmarked by December 21, 2018. If you have questions about the comment period, please contact Dr. Rose M. Zeiler directly at (479) 635-0110. Those with electronic communications capabilities may submit their comments to the U.S. Army via Internet at the following e-mail address: rose.m.zeiler.civ@mail.mil