FINAL
PROPOSED PLAN
FOR
LHAAP-16

ISSUED BY: U.S. ARMY

Longhorn Army Ammunition Plant
Karnack, Texas

September 2010

INTRODUCTION

Dates to remember: October 10, 2010, to November 8, 2010
MARK YOUR CALENDER

PUBLIC COMMENT PERIOD:
October 10, 2010, to November 8, 2010
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-16. Oral and written comments will be accepted at the meeting. The meeting will be held on October 19, 2010, from 7:00 p.m. to 9.00 p.m. at the Caddo Lake State Park Group Recreation Hall Center.

For more information, see the Administrative Record at the following location:

Marshall Public Library
300 S. Alamo
Marshall, Texas 75670

Business Hours:
Monday – Thursday (10:00 a.m. – 8:00 p.m.)

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The purpose of this Proposed Plan is to present for public review the Preferred Remedial Alternative for LHAAP-16, also known as the Old Landfill. LHAAP-16 is a capped landfill of approximately 20 acres in size and is located in the south-central part of the Longhorn Army Ammunition Plant (LHAAP) in central-east Texas. This plan includes summaries of other potential remedial alternatives evaluated for implementation at the site. 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-16, identifies the preferred final remedy for potential threats posed by the chemical contamination at the site, explains the rationale for the preference, and describes other remedial options that were considered. The preferred alternative for LHAAP-16 is Alternative 7: maintenance of existing landfill cap; land use controls (LUCs); in situ enhanced bioremediation; passive biobarriers; and monitored natural attenuation (MNA).

The U.S. Army is issuing this Proposed Plan for public review, comment, and participation to fulfill part of its public participation responsibilities under Sections 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). The 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 summarizes information that can be found in greater detail in the Remedial Investigation (RI) Report, the Feasibility Study (FS) Report, the Addendum to the FS Report (which includes the Natural Attenuation Evaluation Report), the Baseline Human Health Risk Assessment (BHHRA), the Installation-Wide Baseline Ecological Risk Assessment (BERA), and other supporting documents that are contained in the Administrative Record for LHAAP-16 that is publicly available in the Marshall Public Library. The project management team, including the U.S. Army, U.S. Environmental Protection

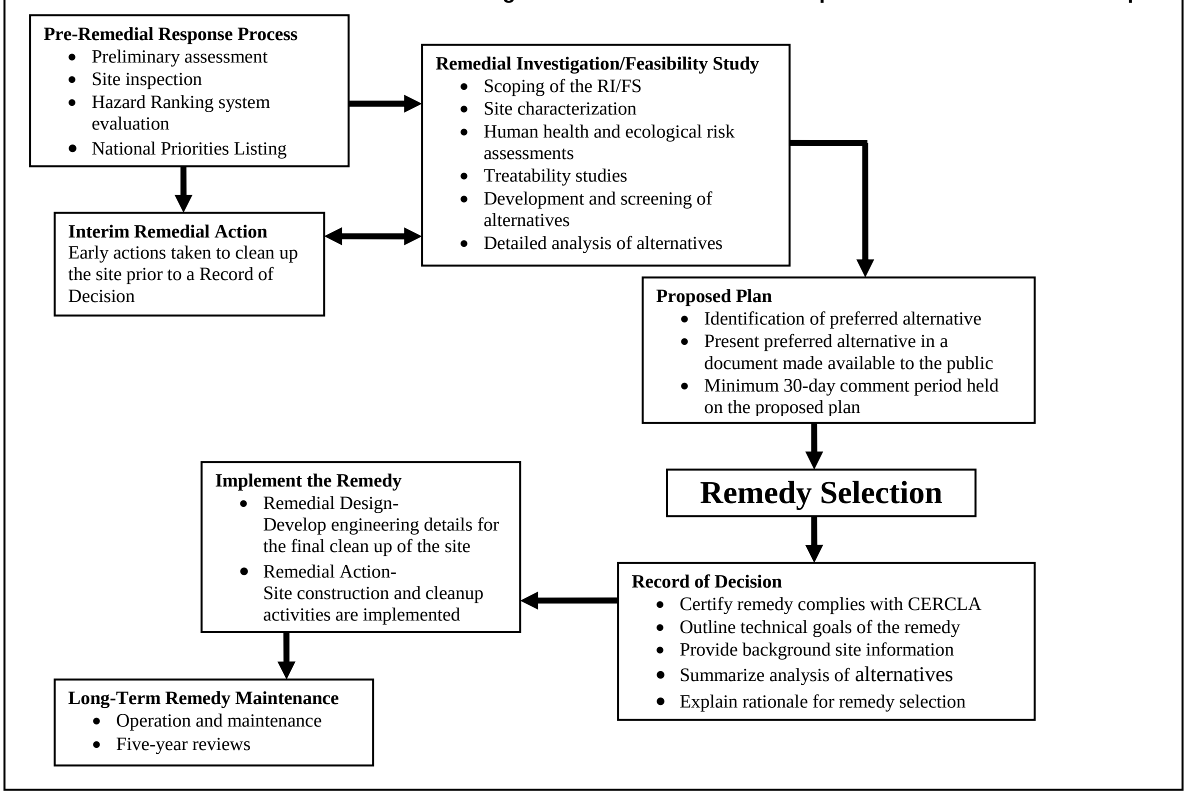


Figure 1. CERCLA Remedial Response Process for Site Cleanup

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

The U.S. Army is acting in partnership with USEPA Region 6 and TCEQ. As the lead agency for environmental response actions at LHAAP-16, 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). The FFA is discussed further in the next section.

The proposed plan summarizes the site characteristics, scope and role of response action, and summary of site risks. This is followed by a presentation of the remedial action objectives (RAOs) and summary of remedial alternatives for LHAAP-16. 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 1,400 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 nearly 7,000 acres to the U.S. Fish and Wildlife Service

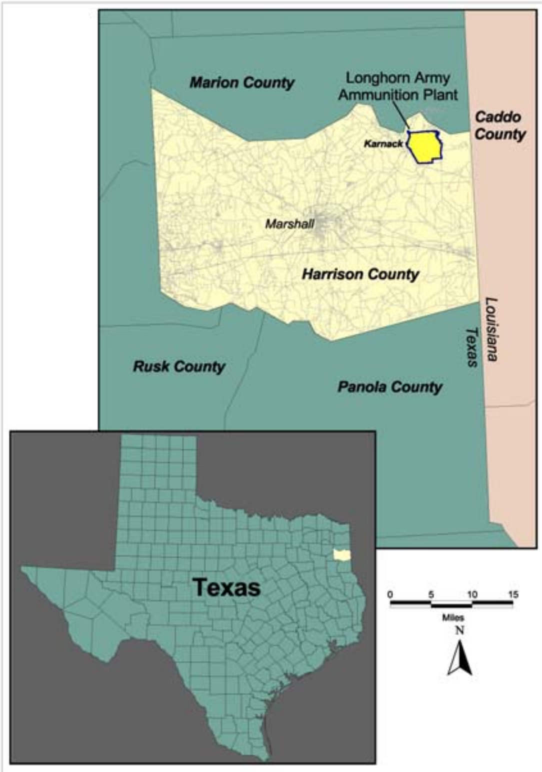


Figure 2 Location of the Longhorn Army Ammunition Plant, Harrison County, Texas

(USFWS) for management as the Caddo Lake National Wildlife Refuge. The property transfer process is continuing as response is completed at individual sites. The local restoration advisory board has been kept informed of previous investigations at this site through regularly held quarterly meetings. Additionally, the administrative record is updated at least twice per year and is available at the local public library.

Due to releases of chemicals from operations at the facility, LHAAP was placed on the Superfund National Priorities List on August 9, 1990. Activities to remediate contamination associated with the National Priorities List listing of LHAAP began in 1990. The U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) have entered into a CERCLA Section 120 FFA since that time for remedial activities at LHAAP. Referred to as the Old Landfill, LHAAP-16 was specifically identified in the FFA as an area "having threatened releases of hazardous substances or pollutants or contaminants." 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-16, a capped landfill, is located in the south-central portion of LHAAP and covers an area of approximately 20 acres **(Figure 3)**. Harrison Bayou runs along the northeastern edge of LHAAP-16. The landfill was established in the 1940s and was used for the disposal of solid and industrial wastes until the 1980s when disposal activities were terminated.

The USEPA has established containment as the presumptive remedy under CERCLA for municipal landfills (USEPA, 1993) and for military landfills (USEPA, 1996). The construction of a landfill cap over the site was completed in 1998 as part of an interim remedial action (IRA). The IRA is consistent with the USEPA presumptive remedy guidance. The capped area is fenced.

A groundwater extraction system was voluntarily installed by the Army in 1996 and 1997 as a treatability study to prevent the groundwater plume from migrating to Harrison Bayou. Groundwater is extracted at LHAAP-16 and pumped to the existing groundwater treatment plant at LHAAP-18/24.

Between 1980 and 2009, numerous investigations were conducted to determine if the releases of potential contamination from landfill operations had affected the environmental media.

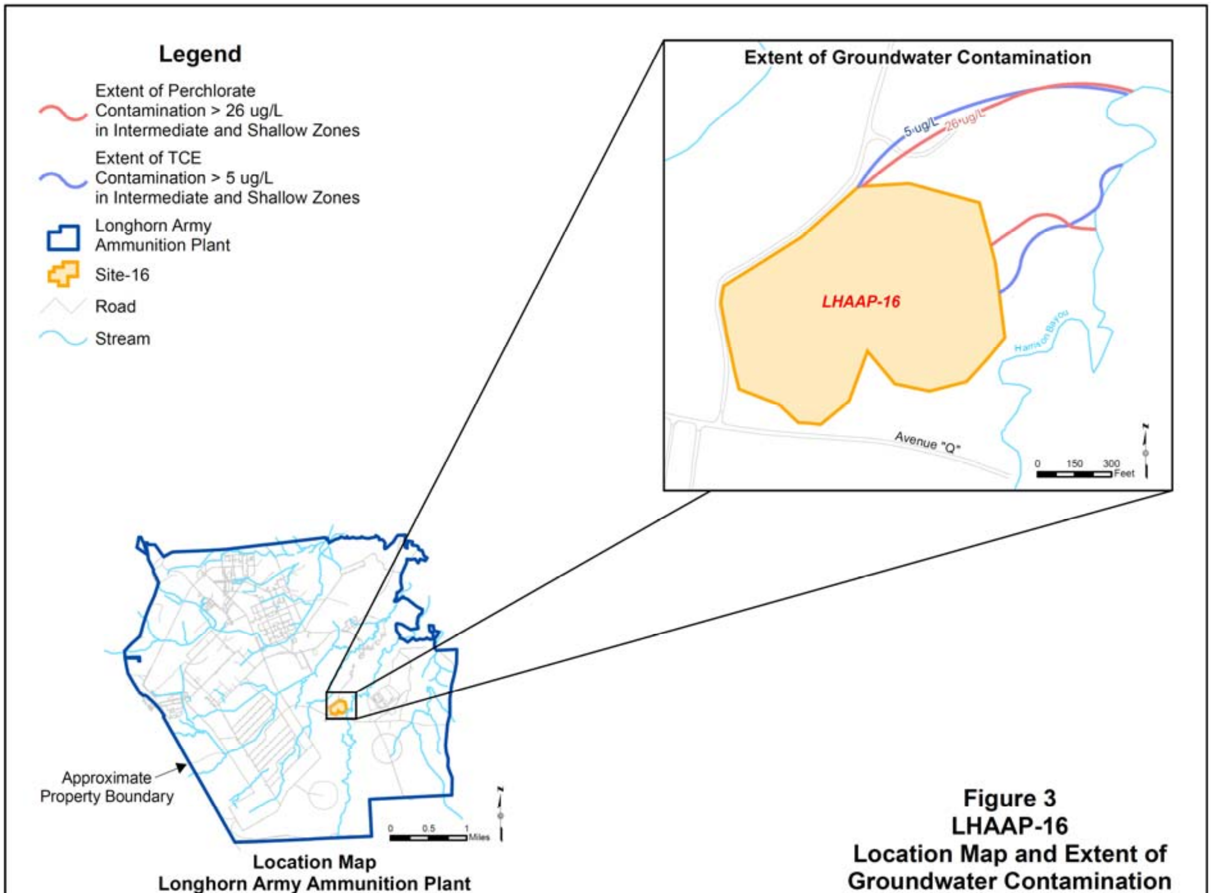


Figure 3
LHAAP-16
Location Map and Extent of Groundwater Contamination

These investigations included Pre-Phase I investigations in 1980, 1982 and 1987; Phase I through III RIs conducted in 1993, 1995 to 1996, and 1997 to 1998 (Jacobs, 2000); quarterly Harrison Bayou surface water sampling initiated in 1995; the groundwater treatability study initiated in 1996; and perchlorate investigations conducted by Jacobs in 2000 and 2001. Media investigated included soil, surface water, sediment, and groundwater. Based on the results from the investigations and the completion of the landfill cap, no further investigation was recommended for the soil, sediment and surface water. Multiple constituents were detected in the underlying groundwater. The groundwater contamination was likely caused by historic leaching of contaminants from the landfill waste to the groundwater via rainwater infiltration prior to the capping of the landfill.

The Final BHHRA (Jacobs, 2001) used data from the investigations conducted through 2001. Additional investigations were conducted between 2002 and 2009, after the BHHRA was finalized, to provide additional information regarding LHAAP-16 groundwater contamination identified during previous sampling events. The results of the 2002 perchlorate investigation were presented in the Plant-wide Perchlorate Investigation Report (STEP, 2005). Groundwater monitoring results from sampling conducted during Spring 2003, Spring 2004, and Winter 2004 were presented in the Groundwater Monitoring Report (USACE and ALL Consulting, 2007). Natural attenuation and geochemical evaluation in 2007, installation and sampling of wells near Harrison Bayou in 2007, installation and sampling of wells to address data gaps in 2008, and groundwater sampling for metals, perchlorate, and volatile organic compounds in 2009 are included in the Final Addendum to Final FS (Shaw, 2010). The Addendum to the FS also included the findings of the BERA.

SITE CHARACTERISTICS

Much of LHAAP-16 is relatively flat. The outer edges of the site are forested, and the land becomes steeper near Harrison Bayou. Much of the site was a disposal area and is now capped and covered with grass. Surface drainage from LHAAP-16 flows mostly through small gullies and ditches to Harrison Bayou. Harrison Bayou flows into Caddo Lake to the northeast of the site. The lake is a source of drinking water for several neighboring communities in Louisiana.

The subsurface at the site is composed of medium plastic sandy silt, fine sands, and clay. The clay layers tend to separate the groundwater into shallow, intermediate, upper deep and deep zones. While flow is primarily horizontal in these zones, vertical interaction between the shallow and intermediate zones is evidenced by pumping test results as well as the presence of contamination in both zones. Such interconnection is consistent with soil layers formed in fluvial depositional environments. The groundwater flow direction is northeast toward Harrison Bayou in the shallow, intermediate and deep zones, while flow direction is southeast toward Harrison Bayou in the upper deep groundwater zone. Overall, the groundwater flow is toward Caddo Lake.

Groundwater flow between the landfill and Harrison Bayou is also influenced by the presence of an extraction well system consisting of four wells in the shallow groundwater zone and four wells in the intermediate groundwater zone. The wells were installed in 1996 and 1997 as part of a treatability study.

The contaminated media at LHAAP-16 include buried source material (landfill waste under the cap) and the shallow and intermediate groundwater beneath the landfill. Prior to the construction of the cap, the landfill was a known disposal site with contaminated groundwater beneath it and potential to contaminate nearby surface water by surface runoff or groundwater discharge. To mitigate the risk to human and ecological receptors, the U.S. Army and USEPA determined that an early interim action was warranted to address the contamination present at LHAAP-16.

The early interim action included placement of a multilayer cap at the LHAAP-16 landfill. That cap prevents rainfall from infiltrating and leaching contaminants from principal threat wastes within the landfill. However, groundwater with elevated levels of contamination appears still to be migrating from beneath the landfill.

The major chemicals of concern (COCs) for LHAAP-16 identified in the FS are volatile organic compounds (VOCs), including trichloroethene (TCE), cis-1,2-dichloroethene (DCE), vinyl chloride and perchlorate in the shallow and intermediate groundwater. The approximate extent of VOC and perchlorate contamination in the shallow and intermediate zones is shown in **Figure 3**. Data collected from the upper deep groundwater zone indicate that no groundwater contamination has been detected since 1997. Data also confirm that VOCs have not migrated down to the deep zone.

Four metals (arsenic, chromium, manganese, and nickel) had sporadic elevated detections and were retained as COCs. While the occurrence of these chemicals does not appear to be associated with widespread contamination from the landfill, further monitoring is warranted.

SCOPE AND ROLE OF THE PROPOSED ACTION

The scope and role of the action discussed in this proposed plan includes all remedial actions planned for this site. In 1995, the U.S. Army and USEPA signed a Record of Decision (ROD) establishing an early interim remedial action for LHAAP-16 to mitigate potential risks posed by buried source material at the site (U.S. Army and EPA, 1995). The interim RAO stated in the ROD was to provide long-term protection by minimizing vertical infiltration of water into the landfill and to reduce the possibility of contaminant transport into surface water bodies. The IRA included the construction of a landfill cap. The cap construction began in 1996 and was completed in 1998.

A multilayer cap and cover system was constructed using a double barrier consisting of a sodium bentonite geocomposite liner and a geosynthetic membrane liner. Placement of a multilayer cap isolated the wastes in the LHAAP-16 landfill. In addition, the U.S. Army implemented land use controls by properly maintaining and routinely inspecting the landfill cap and cover system to protect the remedy and monitor the effectiveness of the cap. A groundwater extraction system was installed as a treatability study to prevent the groundwater plume from migrating to Harrison Bayou.

The potential exists for the landfill waste material to pose an unacceptable risk to human health should the existing cap be allowed to deteriorate. The potential also exists for groundwater contaminants to pose an unacceptable human health risk and to discharge to the nearby surface water body, which could ultimately affect Caddo Lake, should the extraction system prove ineffective in preventing the plume migration.

The groundwater at LHAAP is not currently being used as drinking water and may not be used in the future based on its reasonably anticipated use as a national wildlife refuge. When establishing the 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. 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 Army intends to return the groundwater in the contaminated shallow and intermediate zones at LHAAP-16 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 Code of Federal Regulations, Title 40, §300.430(e)(2)(i)(B&C). If an MCL is not available for a chemical, the promulgated TCEQ medium-specific concentration for groundwater that could be used for residential purposes will be used. If a return to potential beneficial uses is not practicable, the NCP expectation is to prevent further migration of the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

The preferred final remedial action at LHAAP-16 will address the protection of the existing landfill cap, prevent potential exposure risks associated with the contaminated groundwater, and demonstrate through groundwater and surface water monitoring activities that the nearby surface water body, Harrison Bayou, is protected from exceedances of cleanup levels. Land use controls (LUCs) may be terminated when there is no further threat of releases of contaminated groundwater into surface water and when the groundwater contaminants are reduced to cleanup levels.

SUMMARY OF SITE RISKS

The construction of the cap under the IRA eliminated the direct exposure pathway to source area waste material, prevented contaminant transport to surface water via surface runoff, and reduced leaching of contaminants to the groundwater, resulting in an overall reduction of risk to human and ecological receptors.

The reasonably anticipated future use of this site is nonresidential as part of the Caddo Lake National Wildlife Refuge. This anticipated future use is based on a Memorandum of Agreement (U.S. Army, 2004) between the USFWS and the 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 nearly 7,000 acres of the former installation. 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 baseline human health risk assessment and a baseline ecological risk assessment were conducted for LHAAP-16 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

The baseline risk assessment estimates the risk that the site poses if no action is 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}, i.e., one-in-ten thousand to one-in-one million. 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 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.

Using data presented in the RI, the cancer risk and the non-cancer HI were calculated based on hypothetical future maintenance worker exposure to the site environmental media (e.g., soil, groundwater, and Harrison Bayou surface water and sediment) under an industrial scenario. The human health risk assessment did not include contaminant concentrations in the waste material within the landfill because the exposure pathway to the waste material has been eliminated. The baseline human health risk assessment indicated that the cancer risk for the hypothetical maintenance worker was at the lower end of or below the target risk range for surface soil (1.3×10^{-6}), surface/subsurface soil (8.1×10^{-6}) and Harrison Bayou sediment (1.0×10^{-6}). The non-carcinogenic risk estimates were below 1 for surface soil, surface/subsurface soil, Harrison Bayou surface water, sediment and fish ingestion. The carcinogenic risk estimates were driven almost entirely by arsenic. A soil background evaluation indicated that when inorganic constituents that were detected on-site below background levels (including arsenic) were eliminated as constituents of interest from the soil risk estimates, all soil risk estimates were well below the cancer risk and non-cancer hazard thresholds of 1×10^{-6} and 1.0, respectively. However, the groundwater was determined to pose an unacceptable cancer risk of 1.4×10^{-1} and a hazard index of 1,230 to the hypothetical future maintenance worker. Groundwater analytical results obtained from post risk assessment groundwater samples do not alter the conclusion that groundwater poses risk.

The primary COCs in groundwater contributing to cancer risk and non-cancer hazard are TCE, cis-1,2-DCE, and vinyl chloride. The primary contributor to the cancer risk is vinyl chloride. The primary contributors to the non-cancer hazard are cis-1,2 DCE and TCE. Perchlorate concentrations in the groundwater at the site exceed the recommended screening level, therefore, perchlorate is identified as a COC.

MCLs are proposed as groundwater cleanup levels for the COCs. Perchlorate does not have an MCL, but perchlorate concentrations in the groundwater at LHAAP-16 exceed the TCEQ promulgated perchlorate groundwater medium-specific concentration for residential use. Perchlorate was detected at a maximum concentration of 5,990 micrograms per liter (µg/L) which exceeds the groundwater medium-specific concentration of 26 µg/L for residential use. The maximum detected concentration of TCE was 70,600 µg/L which exceeds the MCL of 5 µg/L, a federal and state drinking water standard. The maximum concentrations of cis-1,2-DCE and vinyl chloride were observed at 275,000 and 11,000 µg/L, which exceed the MCLs of 70 µg/L and 2 µg/L, respectively.

The State of Texas requires that a notification be filed with Harrison County per Texas Administrative Code §335.566, stating that the site is suitable for nonresidential use, because the risk evaluation exposure to surface soil was based on the reasonably anticipated future use of the site as a part of a national wildlife refuge. Additionally, limited monitoring in the form of Five-Year Reviews will serve to document that the use of the site remains consistent with the industrial/recreational exposure scenario evaluated in the risk assessment.

Ecological Risks

The ecological risk for site LHAAP-16 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 must be made in the context of the overall conclusions of the sub-area in which the site falls. Site LHAAP-16 lies within the Waste Sub-Area.

The BERA evaluated potential ecological risk to a number of endpoint receptors, as well as terrestrial plant and invertebrate communities. Endpoint receptors were evaluated using a food chain model that estimated a daily dose intake, which was subsequently compared with toxicity reference values to generate a hazard quotient. Terrestrial communities were evaluated through comparisons of detected concentrations to conservative benchmarks. Multiple lines of evidence (e.g., spatial distribution of concentrations, etc.) were also considered. After evaluating all lines of evidence, the BERA concluded that there were potential ecological concerns in the Waste Sub-Area associated with barium, 2,4-dinitrotoluene (DNT), 2,6-DNT, 2,4,6-trinitrotoluene, and dioxin (Shaw, 2007b). The BERA evaluated eleven soil samples collected during the RI from outside the landfill. Results indicated that the ecological preliminary remediation goal was exceeded by barium in only one sample in surface soil but not in total soil. Removal or treatment of barium-impacted soil at LHAAP-16 would not appreciably lower the 95 percentile upper confidence limit for the barium exposure point concentration in the Waste Sub-Area (Shaw, 2010). Therefore, it was concluded that barium within the Waste Sub-Area will be addressed at LHAAP-17, another site within the Waste Sub-Area. Trinitrotoluene and DNT were below detection limits; therefore, these explosive compounds do not contribute to ecological risk at the Waste Sub-Area. Based on detected congeners, dioxins and furans in the soil at the LHAAP-16 do not exceed ecological criteria (Shaw, 2007b). In summary, no action is needed at LHAAP-16 for the protection of ecological receptors.

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

Within the FS (Jacobs, 2002), interim RAOs were established for LHAAP-16. The interim RAOs did not address ecological risk or the extent of groundwater remediation at the site. The final RAOs for LHAAP-16 were developed within the Addendum to the FS (Shaw, 2010), which incorporated the findings of the BERA and addressed the aquifer as a potential source of drinking water. The final RAOs largely focus on goals to protect human health, since the need to address ecological risk is only to ensure that ecological receptors do not come in contact with landfill wastes that are currently covered by the cap at LHAAP-16. The final RAOs also focus on protecting the surface water adjacent to LHAAP-16.

The Army recognizes USEPA’s policy to return all groundwater to potential beneficial uses, based on the non-binding programmatic expectation in the NCP. The final RAOs for LHAAP-16, which address contamination associated with the media at the site and take into account the future uses of LHAAP streams, land, and groundwater, are:

- Protection of human health and the environment by preventing exposure to landfill contents.
- Protection of human health and the environment by reducing leaching and migration of landfill hazardous substances into the groundwater.
- Protection of human health by preventing human exposure to groundwater contaminated with COCs.
- Protection of human health and the environment by preventing groundwater contaminated with COCs from migrating into nearby surface water.
- Return groundwater in the shallow and intermediate zones to its potential beneficial use as drinking water, wherever practicable, within a reasonable time period given the particular site circumstances.

SUMMARY OF REMEDIAL ALTERNATIVES

The FS (Jacobs, 2002) identified and screened remedial technologies and associated process options that may be appropriate for satisfying the interim RAOs for LHAAP-16 with respect to effectiveness, implementability, and cost. Within the Addendum to the FS (Shaw, 2010), the interim RAOs were replaced with final RAOs and additional remedial alternatives were developed to meet the final RAOs. The following remedial alternatives were developed from the retained remedial technologies carried forward after the initial screening:

- Alternative 1 – No Further Action
- Alternative 2 – Cap, Enhanced Groundwater Extraction, and LUCs
- Alternative 3a – Cap, Monitored Natural Attenuation (MNA), and LUCs
- Alternative 3b – Cap, Hot spot Extraction, MNA, and LUCs
- Alternative 4 – Cap, Passive Groundwater Treatment, and LUCs
- Alternative 5a – Landfill Hot Spot Removal, Passive Groundwater Treatment, and LUCs
- Alternative 5b – Complete Landfill Removal, Passive Groundwater Treatment, and LUCs
- Alternative 6 – Landfill Source Treatment (in situ), MNA, and LUCs
- Alternative 7 – Cap, MNA, LUCs, In Situ Enhanced Bioremediation, Passive Biobarriers.

Common Elements. LUCs are common to all alternatives, MNA is common to Alternatives 3, 6, and 7 and inspection/long-term monitoring (LTM) is common to Alternatives 2 through 7. These elements are described below.

Land Use Controls

Because contamination would be left in place at LHAAP-16 for Alternatives 1, 2, 3, 4, 6, and 7 and because contamination would be present for the duration of remedial activities in Alternatives 5, LUCs would be a common component of all alternatives. The LUCs include groundwater use restriction, and protection and maintenance of the existing landfill cap. The LUCs would prevent human exposure to landfill contents and residual groundwater contamination that may present an unacceptable risk to human health, and would ensure that there is no withdrawal or use of groundwater beneath the site for anything other than environmental monitoring and testing. LUCs would support the RAOs.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUCs. The details of the LUCs implementation and maintenance actions are provided in the remedial design of the LHAAP-16 cap

(Final Project Work Plans, Interim Remedial Action, Landfills 12 & 16 Caps Report, June 1996). The Final FS for LHAAP-16 further expands on the description of the LUCs (Shaw 2010). Access controls would include land use and groundwater use restrictions. The groundwater restriction LUCs would be maintained until there is no further threat of releases of contaminated groundwater into the surface water and the groundwater can be used without restrictions. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and the LUCs recorded in the Harrison County Courthouse would include a map showing the areas of groundwater restriction at the site.

In order to transfer LHAAP-16, an Environmental Condition of Property (ECOP) document would be prepared and attached to the letter of transfer. The ECOP will include land use and groundwater use restrictions as part of the Environmental Protection Provisions. The property would be transferred subject to the land use controls that are identified in the ECOP. These restrictions would prohibit or restrict property uses that may result in damage to the existing remedy (landfill cap) or exposure to the contaminated groundwater (e.g., drilling restrictions, drinking water well restrictions).

Monitored Natural Attenuation

MNA is common to Alternatives 3, 6, and 7. 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. A preliminary natural attenuation evaluation indicates that MNA is a feasible remedy for certain portions of the site but not as a sole remedy due to migration concerns for the shallow groundwater zone at LHAAP-16 (Shaw, 2010). Natural attenuation would reduce contaminant concentrations to groundwater cleanup levels. The LUCs would remain in effect until there is no further threat of releases of contaminated groundwater into the surface water and the contaminants in groundwater have been reduced to cleanup levels.

Inspection and Long-Term Monitoring

Alternatives 2 through 7 include inspection and long-term groundwater monitoring activities. The long-term reliability of the LHAAP-16 landfill cap to control infiltration, contaminant runoff, and contaminant exposure depends on adequate long-term inspection and maintenance. Further groundwater and surface water monitoring would be used to evaluate contaminant migration, ensure that the COCs in the groundwater plumes continue to degrade or remain stable, and verify that contaminant levels in Harrison Bayou do not exceed the cleanup levels. The eventual groundwater concentration goal is to reduce COC concentrations to below groundwater cleanup levels. The LUCs, cap maintenance, and long-term monitoring would be continued as required to demonstrate effectiveness of the remedy, compliance with applicable or relevant and appropriate requirements (ARARs), to-be-considered requirements, and RAOs, and to support CERCLA Five-Year Reviews. The Five-Year Reviews may indicate the need for components of the alternatives to be maintained, modified, or replaced.

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.

Alternative 1 – No Further Action.
A No Further Action alternative is required by the NCP to provide a comparative baseline against which the action alternatives can be evaluated. At LHAAP-16, an interim remedy (landfill cap) has already been implemented and maintenance of that remedy is a legal requirement per the 1995 ROD. Therefore, the comparative baseline is considered to be "No Further Action." Under this alternative the existing landfill cap would be left in place and the landfill waste material, surface water, and groundwater would be left "as is," without implementing additional containment, removal, treatment, or other mitigating actions. The existing landfill cap would be maintained to hydraulically isolate the landfill, and land use controls would be implemented to protect the existing remedy (landfill cap). The existing groundwater extraction process and media monitoring would be discontinued. No other actions, including monitoring, would be implemented to reduce existing or potential future exposure to human and ecological receptors.

Estimated Capital Cost: $0

Estimated Operation and Maintenance (O&M) Present Worth Cost: $630,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $630,000

Alternative 2 – Maintenance of Existing Landfill Cap, Enhanced Groundwater Extraction and Land Use Controls.

The goals of this alternative are to protect the industrial worker by protecting the existing remedy (landfill cap), preventing exposure to landfill waste and contaminated groundwater and to prevent further degradation of Harrison Bayou water quality through groundwater extraction. In addition to maintenance of the cap (similar to Alternative 1), Alternative 2 includes enhanced groundwater extraction and LUCs. The existing groundwater extraction system would be enhanced to increase reliability of the extraction wells and related equipment to treat contaminated groundwater from the shallow and intermediate groundwater plumes before it discharges to Harrison Bayou preventing surface water from exceeding water quality standards in Harrison Bayou. Because the landfill source term would remain in place and groundwater upgradient of the groundwater extraction system would remain contaminated, LUCs would be maintained to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste and residual groundwater contamination within untreated areas.

Estimated Capital Present Worth Cost: $760,000

Estimated O&M Present Worth Cost: $9,050,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $9,820,000

Alternative 3a – Maintenance of Existing Landfill Cap, Monitored Natural Attenuation and Land Use Controls.

Alternative 3b – Maintenance of Existing Landfill Cap, Hot spot Extraction, Monitored Natural Attenuation and Land Use Controls.

The goals of this alternative are to protect the industrial worker by protecting the existing remedy (landfill cap), preventing exposure to landfill waste and contaminated groundwater, and to prevent further degradation of Harrison Bayou water quality by natural attenuation of contaminated groundwater. Alternative 3a includes maintenance of the existing cap to hydraulically isolate the landfill, discontinued use of the existing groundwater extraction system, and monitored natural attenuation to assure the protection of human health and the environment by documenting that the contaminated shallow and intermediate groundwater zones remain localized with minimal migration and that contaminant concentrations are being reduced to groundwater cleanup levels before discharging to Harrison Bayou. Because the landfill source term would remain in place and groundwater contamination would remain until natural biological and chemical processes degrade the contaminants in the groundwater to cleanup levels, LUCs would be maintained to protect the existing remedy (landfill cap) and prevent human exposure to landfill waste and residual groundwater contamination that may present an unacceptable risk to human health.

Alternative 3b is identical to Alternative 3a except an extraction well network would be operated in the groundwater hot spot for approximately 5 years to reduce contaminant mass followed by MNA throughout the rest of the O & M period.

Estimated Capital Present Worth Cost:
(a) $620,000
(b) $1,290,000

Estimated O&M Present Worth Cost:
(a) $2,100,000
(b) $2,140,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost:
(a) $2,710,000
(b) $3,430,000

Alternative 4 – Maintenance of Existing Landfill Cap, Passive Groundwater Treatment and Land Use Controls.

The goals of this alternative are to protect the industrial worker by protecting the existing remedy (landfill cap), preventing exposure to landfill waste and contaminated groundwater and to prevent further degradation of Harrison Bayou water quality through groundwater treatment. Alternative 4 includes maintenance of the existing cap, discontinued use of the groundwater extraction system and installing an in situ permeable reactive barrier across the heart of the shallow groundwater plume that is discharging to Harrison Bayou. The permeable reactive barrier would consist of a gravel-filled groundwater collection trench with a reactive media bed located at the downslope discharge point of the collection trench. The highly permeable gravel in the trench would channel the shallow groundwater to the reactive media contained in a buried treatment vessel. The collection trench would be sized to intercept only that part of the shallow groundwater plume with the highest contaminant concentrations, likely having the greatest impact on contaminant levels in Harrison Bayou. Installation of the trench would create a preferential flow path. The actual size and location of the trench would be determined during design. The collection trench would be placed upgradient to Harrison Bayou near the discharge location.

A perforated pipe would be buried at the bottom of the collection trench to convey the collected groundwater to a non-perforated connector pipe and subsequently to the reactive media treatment vessel. The treatment vessel would be filled with the reactive media and sized to ensure the requisite residence time for the contaminants to be treated. The treatment vessel would discharge to a buried drain field, allowing the treated groundwater to drain into the soil down-slope of the treatment vessel. The placement of the reactive media in a treatment vessel instead of the entire collection trench reduces the overall media cost and facilitates the replacement of the media when it is expended. The contaminants to be treated by this reactive media are trichloroethene and perchlorate. The treatment process would be anaerobic biological degradation that uses a combination of gravel and various organic media. The organic media would serve as a carbon source for the anaerobic microbes.

Maintenance of the existing cap would hydraulically isolate the landfill, and LUCs would be continued to protect the existing remedy (landfill cap) and to prevent human exposure to the landfill waste and residual groundwater contamination that may present an unacceptable risk to human health. Because the landfill source term would remain in place and groundwater upgradient of the in situ permeable reactive barrier would remain contaminated, land use would be restricted to industrial use for as long as the residual contamination remains a threat.

Estimated Capital Present Worth Cost: $2,540,000

Estimated O&M Present Worth Cost: $2,020,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $4,560,000

Alternative 5a – Landfill Hot Spot Removal, Passive Groundwater Treatment, Off-Site Disposal and Land Use Controls.

Alternative 5b – Complete Landfill Removal, Passive Groundwater Treatment, Off-Site Disposal and Land Use Controls.

The goals of Alternative 5a are to protect the industrial worker by preventing exposure to the remaining landfill waste and contaminated groundwater, and meet cleanup levels in Harrison Bayou through source removal and in situ groundwater treatment. This alternative includes removal of the landfill hot spots, repairing the cap, discontinued use of the existing groundwater extraction system, and installing an in situ permeable reactive barrier across the portion of the shallow groundwater plume with the highest contaminant concentrations, reducing the contaminant mass discharging to Harrison Bayou. This permeable reactive barrier would operate identically to the barrier proposed in Alternative 4.

Hot spot locations would be confirmed by excavating trenches at various locations across the landfill biased by the results of the soil gas survey conducted during the RI (Jacobs, 2000). The excavated waste would be field screened and the results used to define the location and nature of hot spot material to focus the excavation efforts and detail the waste handling and treatment process.

Alternative 5a also includes maintenance of the existing cap to hydraulically isolate the landfill, and LUCs to protect the existing remedy (landfill cap) and to prevent human exposure to the remainder of the landfill waste and residual groundwater contamination that may present an unacceptable risk to human health.

Alternative 5b is identical to 5a in all respects except that all of the landfill wastes would be removed. Because this alternative does not leave any waste in place, there are no long-term cap maintenance and landfill LUC requirements. However, groundwater

LUCs would remain in effect until groundwater cleanup levels are met.

Estimated Capital Present Worth Cost:
(a) $3,080,000
(b) $106,110,000

Estimated O&M Present Worth Cost:
(a) $9,990,000
(b) $9,490,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost:
(a) $13,070,000
(b) $115,610,000

Alternative 6 – Landfill Source In Situ Treatment, Monitored Natural Attenuation and Land Use Controls.

The goals of this alternative are to protect the industrial worker by protecting the existing remedy (landfill cap), preventing exposure to landfill waste and contaminated groundwater and to prevent further degradation of Harrison Bayou water quality through landfill source treatment and natural attenuation of contaminated groundwater. This alternative includes in situ treatment of the landfill hot spots, repairing the landfill cap, discontinuing use of the existing groundwater extraction system, and monitoring for natural attenuation. Alternative 6 also includes maintenance of the existing cap to hydraulically isolate the landfill, and LUCs to protect the existing remedy (landfill cap). In situ treatment of landfill hot spots by soil vapor extraction would reduce contaminant concentrations in target areas. The target areas have the highest concentrations and in situ treatment would rapidly reduce these highest concentrations. The contaminants in the groundwater beneath and downgradient of the landfill would decrease over time from natural degradation and chemical processes. The combination of source term treatment and the natural degradation of groundwater contaminants would ensure that Harrison Bayou is not further degraded. LUCs would also be maintained to prevent human exposure to landfill waste and contaminated groundwater.

Estimated Capital Present Worth Cost: $2,750,000

Estimated O&M Present Worth Cost: $3,650,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $6,400,000

Alternative 7 – Cap, Land Use Controls, In Situ Enhanced Bioremediation, Passive Biobarriers, and Monitored Natural Attenuation.

The goals of this alternative are to protect human health by implementation of LUCs prohibiting unauthorized use of the cap and groundwater, reduce contaminant concentrations in the groundwater plume and prevent discharge of contamination to Harrison Bayou. To achieve these goals, this alternative utilizes continued maintenance of the existing cap, groundwater use restrictions, installation of a biobarrier in the shallow groundwater zone adjacent to the landfill, in situ enhanced bioremediation in the shallow and intermediate groundwater zones, installation of a second biobarrier in the shallow groundwater zone near Harrison Bayou, and MNA of the shallow and intermediate groundwater zones.

In situ bioremediation would be implemented in the most contaminated portion of the shallow and intermediate groundwater zones in conjunction with phased shut down of the existing groundwater extraction system. Bioremediation would involve the injection of a carbon substrate and a bioaugmentation culture. Because contaminant concentrations in wells near the landfill consistently exceed groundwater cleanup levels, this alternative would include installation of a passive biobarrier near the fence line of the landfill to degrade contaminants in groundwater. Because concentrations in wells near Harrison Bayou also currently exceed groundwater cleanup levels this alternative would include installation of a second passive biobarrier near Harrison Bayou to further degrade contaminants. A row of injection points perpendicular to groundwater flow direction would be installed close to Harrison Bayou. The biobarrier would consist of emulsified oil that will enable ambient microorganisms to create favorable conditions and a bioaugmentation culture (e.g., SDC-9) to ensure that a microbial species is present that is able to completely degrade TCE to ethene. The emulsified oil is a slow-release carbon source with an enhanced subsurface longevity; it would be injected to provide a long-lasting source of fermentable carbon to stimulate the biological reduction of perchlorate and TCE and its daughter products. Following the reductions in contaminant concentrations caused by the in situ bioremediation and the passive biobarriers, natural attenuation would further reduce the concentrations of contaminants in the groundwater so that surface water in Harrison Bayou does not exceed cleanup levels. A monitoring program would be implemented within this alternative to confirm the effectiveness of the various technologies. LUCs would be maintained to protect the existing remedy (landfill cap) and to prevent human exposure to landfill waste and residual groundwater contamination.

Estimated Capital Present Cost: $390,000

Estimated O&M Present Worth Cost: $1,590,000

Estimated Duration: 30 years

Estimated Total Present Worth Cost: $1,980,000

EVALUATION OF 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. 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. The “Detailed Analysis of Alternatives” can be found in the FS for the site (Jacobs, 2002) and the Addendum to the FS (Shaw, 2010).

1. Overall Protection of Human Health and the Environment

Alternative 1, the No Further Action alternative, does not protect human health or the environment because no remedial activities would be conducted and no LUCs (except for cap maintenance) would be maintained. Therefore, LHAAP-16 contamination would present unacceptable risks to human health and the environment through ingestion of groundwater. The other six alternatives, collectively referred to as the action alternatives, would provide engineering controls, treatment, containment, or removal and disposal of the waste material to levels protective of human health and Harrison Bayou.

The six action alternatives would provide access and use restrictions, capping of buried wastes (the entire landfill excavation option of Alternative 5 excepted), and long-term media monitoring. The landfill cap and LUCs would prevent exposure to landfill wastes and contaminated groundwater.

Alternatives 2, 3, 4, 6, and 7 would maintain Harrison Bayou water quality through a variety of means. Alternative 2 maintains the current actions of capping and groundwater extraction to contain the plume and prevent it further impacting Harrison Bayou. Alternatives 3, 4, and 7 are similar to Alternative 2 in that they all maintain the cap, but they all discontinue the groundwater extraction system (Alternative 3b after an estimated 5 years). Alternative 4 uses an in situ permeable reactive barrier installed parallel to Harrison Bayou, and Alternatives 3, 6, and 7 use MNA to assure protection of Harrison Bayou. Alternative 6 couples vapor extraction of the landfill hot spots with groundwater natural attenuation. Alternative 7 utilizes in situ bioremediation of target areas and passive biobarriers in conjunction with groundwater natural attenuation.

Alternative 5a is the second most aggressive of all the alternatives in that it removes the landfill hot spots (conventional excavation, off-site disposal) and installs a permeable reactive barrier to treat groundwater before it discharges to Harrison Bayou. Alternative 5b, the most aggressive alternative, removes all of the landfill waste and uses the same reactive barrier as in Alternative 5a. All alternatives are protective, though Alternative 5b is most reliable in the long term because it has less reliance on long-term LUCs.

2. Compliance with ARARs

Except for Alternative 1, which does not comply with the chemical-specific ARARs, all of the action alternatives meet the required chemical-, location-, and action-specific ARARs. None of the alternatives require a waiver.

3. Long-Term Effectiveness and Permanence

The no further action alternative would not be effective in the long term, because the baseline risk assessment indicates that the current groundwater conditions are not protective of human health and the environment, and no remedial activities would be conducted to address groundwater under this alternative.

All alternatives except Alternative 5b rely on LUCs and source isolation (i.e., capping) to isolate the residual waste from potential receptors. With the exception of the complete landfill excavation option for Alternative 5b, all action alternatives would leave waste on site. Because Alternative 5b removes the entire landfill source term, it is the most reliable in long-term protection of future human receptors. Alternatives 5a and 6 are the next most reliable in the long term because of their removal and in situ treatment, respectively, of the hot spot wastes. The long-term cap maintenance and LUCs offered by Alternatives 2, 3, 4, 5a, 6, and 7 restricting access to the contaminated media would adequately maintain residual risks below acceptable levels. If cap maintenance and monitoring programs are maintained and the owner of LHAAP-16 maintains the LUCs, the cap and LUC programs can reliably maintain residual risks at acceptable levels.

The permeable reactive barriers used in Alternatives 5a and 5b to meet drinking water standards in Harrison Bayou may be effective and relatively reliable with long-term maintenance and monitoring. To control discharges to Harrison Bayou, Alternatives 2 and 3b extract and treat contaminants in groundwater.

Alternative 2 requires long-term groundwater extraction, which has proven to be moderately effective. The extraction system has had reliability problems as with any mechanical system that must operate over the long term. Alternative 3b extracts groundwater for a shorter amount of time.

The other action alternatives rely on passive treatment options (i.e., in situ permeable reactive barrier, in situ bioremediation, passive biobarriers, MNA) to protect Harrison Bayou. The in situ permeable reactive barriers used in Alternatives 4, 5a, and 5b and in situ bioremediation and passive biobarriers used in Alternative 7, require regular monitoring and replacement of the reactive media to ensure long-term effectiveness. Long-term maintenance of these barriers could prove to be problematic because of potential fouling of the treatment media and changing geochemistry that could reduce their effectiveness. Collection trenches at LHAAP-16 would be difficult to design to effectively intercept the contaminated groundwater and drain passively. Permeable barriers and biobarriers were selected to be the representative process option because of their flexibility in being used to address VOC and perchlorate removal.

If operating effectively, the in situ groundwater treatment process of Alternatives 4 and 5 and in situ enhanced bioremediation and passive biobarriers of Alternative 7 more reliably meet the surface water objective of preventing discharge of contaminants into Harrison Bayou than the natural attenuation option in Alternatives 3 and 6. Results of the MNA evaluation for LHAAP-16 indicated that natural attenuation is a feasible remedy for certain portions of the site but not as a sole remedy due to migration concerns for the shallow groundwater zone. Alternatives 3 and 6 have a planned contingent action of using the enhanced extraction and treatment system of Alternative 2 if natural attenuation is not occurring at a sufficient level to control future discharges to Harrison Bayou.

Alternative 7 utilizes in situ bioremediation and passive biobarriers to further degrade the contaminants in groundwater in conjunction with MNA. Based on the results of the ESTCP semi-passive biobarrier technology demonstration (ESTCP, 2005; ESTCP, 2007) and the preliminary MNA evaluation, the groundwater contaminants at LHAAP-16 have been shown to be amenable to degradation by biological processes prior to discharge to Harrison Bayou.

In summary, all of the action alternatives, including their contingent actions, would effectively meet the RAOs. The reliability of the permeable treatment barrier of Alternatives 4 and 5 is less certain than that of the extraction system of Alternative 2 and 3b, but it may be more effective than the natural attenuation component of Alternatives 3a, 6, and 7. The biological processes utilized in Alternative 7 have been shown to be effective and reliable at LHAAP-16. The current source action, a cap, is limiting releases from the landfill material to the groundwater. However, the removal of the hot spots in Alternative 5a (if they can be found), or treatment of those same hot spots as in Alternative 6, can enhance the reliability of the cap. LUCs to prevent access to the landfill material are considered effective. There is no information to suggest that the hot spots identified as the probable source of migration of contaminants to groundwater would also have the greatest risk if accessed, so these alternatives are not considered more reliable. However, full removal of the waste, Alternative 5b, would be the most reliable.

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

The no further action alternative does not include treatment and would not result in a reduction of toxicity, mobility, or volume of contaminants.

Alternatives 2, 3, 4, and 7 would not address the landfill source other than providing containment through capping. Alternative 3a, through its complete reliance on groundwater natural attenuation, provides the least reduction in contaminant volume and toxicity. The natural biological and chemical processes, over time, would gradually reduce the toxicity of VOCs in groundwater and the overall volume of contaminated groundwater. Alternative 4, with its permeable reactive barrier, would reduce the toxicity and volume of the shallow groundwater that passes through it. Although the groundwater upgradient of the reactive barrier is unaffected by the reactive media (until it passes through it), the reactive barrier provides a greater reduction in toxicity and volume than Alternative 3a. Alternatives 2 and 3b actively remove contaminated groundwater from the heart of the plume and treat it ex situ in the LHAAP treatment plant. The processes in the treatment plant would reduce the toxicity and volume of the extracted groundwater. Much of the contamination in the groundwater plume would be reduced over time, offering greater reductions in toxicity and volume than that in Alternative 3a.

Alternative 7 includes in situ bioremediation in the vicinity of shallow wells and upgradient of the wells with the highest levels of chlorinated ethenes. The process would reduce the toxicity and volume. The passive biobarriers provide further reduction of toxicity, mobility, and volume of the groundwater that passes through them. MNA in conjunction with in situ bioremediation would enhance reduction of toxicity and volume. Alternative 7 includes treatment of groundwater within the plume itself. Alternatives 3a/3b, 6, and 7 include a natural attenuation component together with dilution, dispersion, and other natural processes that have the capability of ultimately reducing the contaminants to satisfy the chemical-specific ARARs.

Alternative 6 includes the in situ treatment of the landfill. The extracted VOCs, the majority of the source term at LHAAP-16, would be destroyed in a thermal oxidation unit. Although the contaminants in groundwater would be treated only through natural degradation processes, the overall reduction in toxicity and volume is greater than other alternatives.

Alternative 5 removes source material from the site, but the base action does not include treatment of that material. The permeable barrier does provide some reduction of toxicity of contaminants through treatment. If the excavated material is RCRA-characteristic, treatment of that material to meet LDRs would satisfy the NCP preference for treatment.

5. Short-Term Effectiveness

The no further action alternative would not involve any action; therefore, there would be no increase in short-term risks and no short-term environmental effects.

Through LUCs and engineered controls (e.g., physical barriers, administrative controls, and dust suppression), the six action alternatives would be protective of the community during implementation. Alternative 3a would be the most protective in the short term because there is no construction or off-site transportation. Alternative 5b and, to a lesser extent, Alternative 5a would pose the greatest potential exposure and transportation risks to the public due to the extensive waste excavation and transportation activities. Local and site traffic would be similar for all other alternatives.

The cap maintenance activities at the landfill would require the same health and safety measures for all alternatives except for Alternative 5b. Alternative 5b and to a lesser extent Alternative 5a require extensive handling of the landfill waste and thus pose the greatest risk to remediation workers. Alternative 6 presents lower risks to remediation workers than Alternative 5a because of the less intrusive waste operations of the vapor extraction operations. Appropriate mitigative measures would be applied during construction and transportation to attain appropriate worker and public health exposure requirements in all action alternatives. By planning the construction, excavation, and transportation activities in accordance with industry and OSHA codes and requirements, risks from contaminant exposure and construction operations would be controlled to acceptable levels. All of the remaining alternatives pose similar risks to the remediation worker with Alternative 3a being the safest alternative to implement.

The short-term disturbance of on-property vegetation and wildlife habitat would be greatest under Alternatives 5a and 5b, primarily because of the waste excavation activities and the installation of the long groundwater collection trench. There would be short-term impacts on the vegetation and wildlife habitats in the vicinity of the permeable reactive barrier under alternative 4 and in situ bioremediation injection points and passive biobarriers under alternative 7, though less than that for the longer barriers in Alternatives 5a and 5b. The vapor extraction operations in Alternative 6 would lightly impact vegetation on the landfill. The remaining alternatives would have little to no short-term impacts above those related to minor maintenance activities. For earthwork and construction activities, sediment deposition into Harrison Bayou would be controlled. Erosion control measures would include surface grading; placement of rip rap and silt fences; covering surfaces with straw, mulch, riprap, or geotextile fabrics; and/or using riprap in areas with high water velocity. Following completion of all construction and excavation, disturbed areas would be regraded with clean backfill and revegetated with native grasses.

The approximate construction time for the action alternatives ranges from 6 months in Alternative 2 to 36 months in Alternative 7. Because the source term is effectively controlled in all of the alternatives (with appropriate cap maintenance), the length of time required before groundwater containment systems are no longer needed are comparable, outside the 30-year present worth period. Additional source actions (Alternatives 5 and 6) are likely to lessen the time required to control the groundwater.

The MNA evaluation for LHAAP-16 demonstrated that natural attenuation is occurring in some areas at the site. The attenuation of contaminants was observed at the source and side-downgradient of the plume. However, the shallow groundwater zone plume is still migrating along the groundwater flow direction toward Harrison Bayou. The intermediate groundwater zone plume is more stable with less migration along the flow direction. Thus, natural attenuation is a feasible remedy for certain portions of the site but not as a sole remedy due to migration concerns for the shallow zone. MNA is proposed for Alternative 7 in conjunction with in situ bioremediation to enhance reductive dechlorination within the plume and a passive biobarrier to prevent the discharge of contaminants into surface water. Natural attenuation would be evaluated after two years of quarterly monitoring and a re-application of bio-amendments (i.e., additional in situ bioremediation) would be implemented if deemed necessary.

Detailed evaluation of natural attenuation processes would be required to determine whether the Harrison Bayou remediation levels can be met in the near future or whether a contingent action is needed under Alternatives 3 and 6.

6. Implementability

Under the no further action alternative, no new remedial action would be taken. Therefore, there would be no difficulties or uncertainties with implementation.

Overall, all of the action alternatives are technically feasible to implement. Although Alternatives 5a, 5b, and 6 would require more time, equipment, and activity than the other alternatives, the components of most alternatives use technologies that have been straightforward to implement at other sites with contaminants and conditions similar to those found at LHAAP-16. These technologies would be implemented using conventional equipment and construction methods. The excavation of the landfill wastes under Alternatives 5a and 5b would be moderately difficult because of the inherent difficulties associated with excavating debris from a landfill with an uncertain disposal history. Given the uncertain nature of the wastes in the landfill, the potential for delays in excavation exist should anomalous items or debris be encountered. Likewise, coordination issues between excavation, waste characterization sampling, and disposal could slow the process. Although the media in the reactive barrier in Alternatives 4, 5a, and 5b is expected to treat VOCs and perchlorate, the specific conditions at LHAAP-16 (low gradient, high VOCs, low perchlorate levels) have not been tested. There are negative interactions with other site contaminants that could reduce the media's performance. Based on the ESTCP semi-passive biobarriers technology demonstrations, groundwater contaminants at LHAAP-16 are amenable to degradation by biological processes under Alternative 7. All components of Alternative 7 are readily implementable. Alternative 5b, and to a lesser extent Alternative 5a, would be the most technically difficult to implement.

Alternative 6 would be more technically implementable than Alternatives 5a and 5b, though there may be some challenges associated with the installation of the vapor extraction 'system in the landfill wastes. Also, the uncertainties associated with the flow of soil gas through the variable and heterogeneous buried waste would also contribute to difficulties in implementability and performance. The robustness of the process, however, would ensure that adequate volumes of soil vapor would be removed. Alternative 6 also has uncertainty associated with the implementation and operation of a permeable barrier.

There are few technical challenges to the implementation of Alternative 4 other than those associated with the installation of the permeable reactive barrier. Although Alternative 3a does not require the installation of any engineered components, the uncertainty in the long-term effectiveness of natural attenuation with the source term still in place may cause future delays should a contingent action need to be implemented. The groundwater extraction system and water treatment plant used in Alternatives 2 and 3b are currently operating and proven in their operation and effectiveness and make these alternatives the most technically implementable.

Administratively, all alternatives are implementable. Virtually all services and materials required for the implementation of the action alternatives would be standard for the construction industry and would be readily available. However, considerable testing and development may be needed to produce an effective design for in situ treatment of VOCs and perchlorate in groundwater. Alternative 5 is the least administratively implementable because of the off-site waste transportation and disposal activities. Various Department of Transportation regulations (e.g., 49 CFR 172, 173, and 177) apply to the transportation of wastes such as those expected from the landfill, and the waste acceptance criteria of the off-site disposal facility must be complied with. In the event that a portion of the wastes must be treated before disposal (Alternative 5 contingent action), the waste acceptance criteria of the treatment facility must also be met. Alternatives 4 and 5 would also require personnel with specialized experience in reactive barrier treatability testing, installation, and operation. The vapor extraction activities in Alternative 6 would require personnel with specialized experience in vapor extraction installation and operation. Alternative 7 would require expertise in engineering design and implementation of the in situ bioremediation and the passive biobarrier component of the alternative.
Alternative 2 and Alternative 3 are the most administratively implementable.

7. Cost

Cost estimates are used in the CERCLA FS 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 +50 to –30 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). Present worth costs were developed for each alternative assuming a discount rate of 2.7 percent. The estimates for all alternatives utilize a 30-year project life for costing purposes, although the timeframe to achieve RAOs is expected to be longer. The costs of Alternatives 1 through 6 have been updated from the costs presented in the Final FS (Jacobs, 2002) to January 2008 using the Engineering News Record construction cost index, and the costs of 5-year reviews have been added to all alternatives. Also, the cost of Alternative 1 has been updated to reflect the ongoing cap maintenance/inspection activities and the implementation of LUCs under the Interim ROD for LHAAP-16.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 7, Alternative 3a, Alternative 3b, Alternative 4, Alternative 6, Alternative 2, Alternative 5a, and Alternative 5b. Lowest costs are associated with Alternative 1 because no further remedial activities would be conducted. Alternative 7 has the lowest present worth and capital costs of the action alternatives. Alternatives 3a, 3b, and 4 are next in costs (all $5,000,000 or below). While Alternatives 3a and 3b rely heavily on a passive treatment component (MNA), Alternative 7 utilizes active technologies (in situ bioremediation and biobarriers) prior to MNA; those active technologies lead to much lower monitoring costs in the future, thus giving Alternative 7 a lower total present value cost. The large O&M cost for groundwater treatment (Alternative 2) and the higher capital and O&M cost of in situ vapor extraction (Alternative 6) make these alternatives roughly twice as expensive as Alternatives 3a, 3b, and 4. However, if other sites require use of the LHAAP groundwater treatment plant, the cost of Alternative 2 will be comparable to Alternative 3.

Alternatives 5a (present worth of $13 million) and 5b (present worth of $116 million) are considerably more expensive because of the combination of high capital costs and high O&M costs. The contingent action costs do not change the order of costs.

8. State/Support Agency Acceptance

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

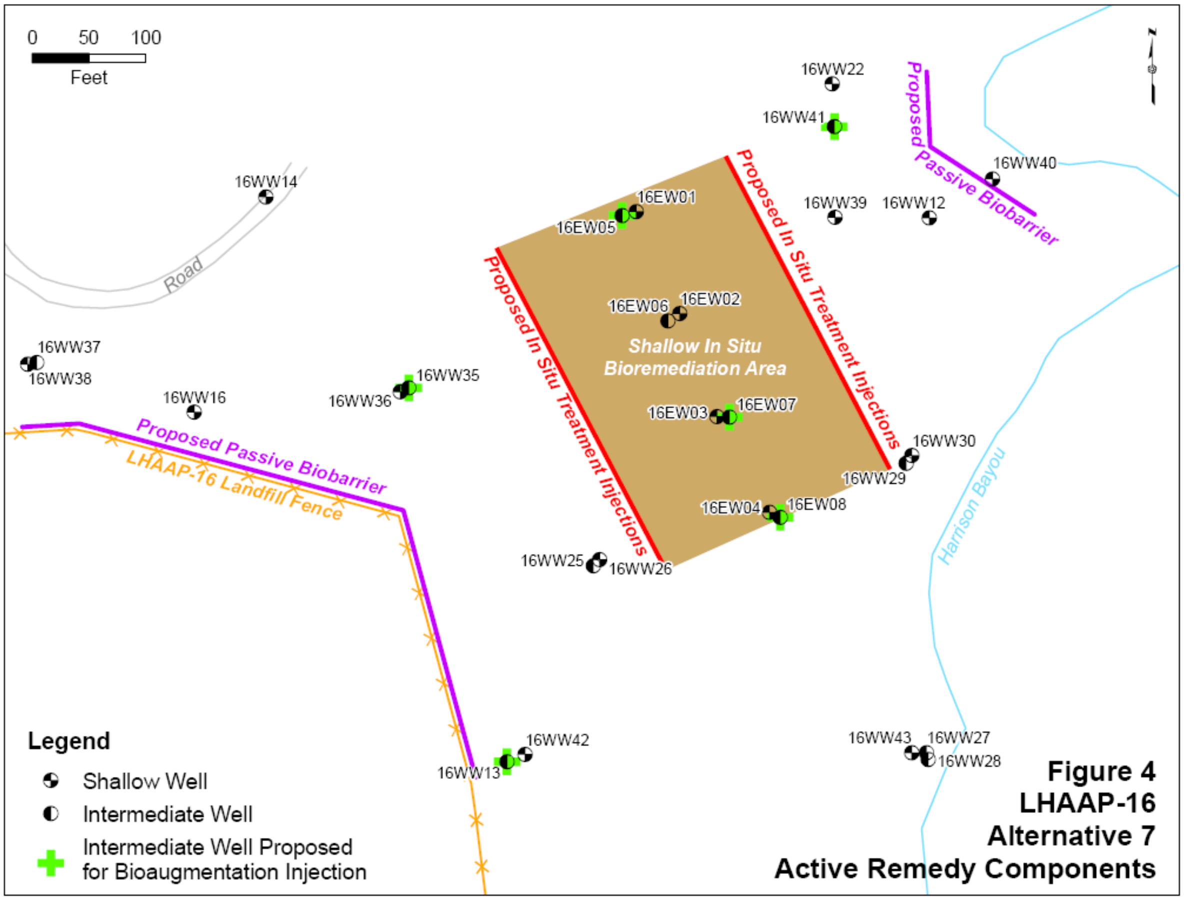
9. Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends. Public comments will be described and addressed in the ROD for the site.

SUMMARY OF THE PREFERRED ALTERNATIVE

Alternative 7, capping, LUCs, in situ enhanced bioremediation in a target area, passive biobarriers, and MNA, is the preferred alternative for LHAAP-16 and is consistent with the intended future use of the site as a national wildlife refuge. The approximate locations of the active components of the remedy are presented on **Figure 4**; MNA will be implemented for areas outside the influence of the active remedies. This alternative is recommended because it will be protective of human health due to the implementation of LUCs prohibiting unauthorized use of the cap and groundwater, thereby eliminating the potential contaminant exposure pathway for human receptors. Further, this alternative will satisfy the RAOs for LHAAP-16 and will reduce the COC concentrations in groundwater and control discharge of contamination to Harrison Bayou. Groundwater and surface water monitoring will be conducted to confirm that COC concentrations in the groundwater plume are declining through natural processes and that Harrison Bayou is protected from exceedances of the cleanup levels. The passive biobarriers component of this alternative will provide additional protection of Harrison Bayou. Monitoring will continue until it is demonstrated that there is no further threat of releases of contaminated groundwater into the surface water and the groundwater can be used without restriction.

Based on a preliminary natural attenuation evaluation, groundwater cleanup levels are expected to be met through natural attenuation in approximately 280 years or longer (Shaw 2010). The time frame will be reevaluated after additional sampling is conducted following shut down of the extraction system and implementation of in situ bioremediation and the passive



biobarriers. Natural attenuation will be evaluated after two years of quarterly monitoring. If proper conditions of natural attenuation are established, monitoring will continue at a reduced frequency. Otherwise, re-application of bio-amendments (i.e., additional in situ bioremediation) will be implemented.

Maintenance of the LUCs and continued environmental monitoring will be required while the landfill waste materials remain on site and the groundwater COC concentrations exceed their respective cleanup levels. The effectiveness of LUCs, cap maintenance, and long-term monitoring will be evaluated during five-year CERCLA reviews and inspections of any physical mechanisms in place at LHAAP-16. The Five-Year Reviews may indicate the need for components of this alternative to be modified based on existing and expected future surface water and groundwater conditions.

Alternative 7 is readily implementable and no significant short-term risks to worker health and safety or to the community would be expected. The present worth cost of Alternative 7 is lower than the other remedial alternatives except for Alternative 1, the No Further Action alternative.

Based on the information currently available, the U.S. Army believes that 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) criteria 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 permanent solution; and 5) utilizes treatment as a principal element.

The Army intends to present details of the groundwater and surface water monitoring plan, and the MNA remedy implementation in a remedial design for LHAAP-16.

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

Notification of nonresidential use will accompany all transfer documents and will be recorded in the County Courthouse. Five-Year Reviews will be performed to document that the remedy remains protective of human health and the environment.

COMMUNITY PARTICIPATION

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-16 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, and 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-16

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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.

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

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 at LHAAP.

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

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.

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.

Maximum Contaminant Level (MCL) — The maximum contaminant level is the maximum permissible level of a contaminant in a public water system. MCLs are defined in the Code of Federal Regulation (40 CFR 141, National Primary Drinking Water Regulations, which implement portions of the Safe Drinking Water Act). The TCEQ has adopted MCLs as the regulatory cleanup levels for both industrial and residential uses. Any detected compound in the groundwater samples with a MCL was evaluated by comparing it to its associated MCL.

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.

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.

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.

ACRONYMS

µg/L	micrograms per liter
ARARs	applicable or relevant and appropriate requirements
BERA	Baseline Ecological Risk Assessment
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
DCE	dichloroethene
DNT	dinitrotoluene
ECOP	environmental condition of property
FFA	Federal Facility Agreement
FS	feasibility study
HI	hazard index
IRA	interim remedial action
LHAAP	Longhorn Army Ammunition Plant
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
RAO	remedial action objective
RI	remedial investigation
ROD	record of decision
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for LHAAP-16 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 November 8, 2010. If you have questions about the comment period, please contact Dr. Rose M. Zeiler 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.zeiler@us.army.mil