FINAL

RECORD OF DECISION
LHAAP-35A(58), SHOPS AREA, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared for

U.S. Army Corps of Engineers
Tulsa District
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Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AT123D	Anaytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System
BERA	baseline ecological risk assessment
bgs	below ground surface
BHHRA	baseline human health risk assessment
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	chemical of concern
COEC	chemical of ecological concern
COPC	chemical of potential concern
CSM	conceptual site model
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
ECOP	environmental condition of property
EPC	exposure point concentration
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FR	Federal Register
FS	feasibility study
ft^2	square feet
GW-Ind	TCEQ groundwater medium-specific concentration for industrial use
GW-Res	TCEQ groundwater medium-specific concentration for residential use
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
Jacobs	Jacobs Engineering Group
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
mg/kg-day	milligrams per kilogram per day
MNA	monitored natural attenuation

Acronyms and Abbreviations (continued)

MOA	memorandum of agreement
MSC	medium-specific concentration
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	slope factor
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
SVOC	semivolatile organic compound
TAC	Texas Administrative Code
TCA	trichloroethane
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	trinitrotoluene
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USC	U.S. Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

LHAAP-35A(58), Shops Area, Group 4

Longhorn Army Ammunition Plant
Karnack, Texas

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

1.2 Statement of Basis and Purpose

This decision document presents the selected remedy for LHAAP-35A(58), Shops Area, located at the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Code of Federal Regulations (CFR) Title 40 §300.

The remedy selection was based on the Administrative Record for the site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2002), baseline human health risk assessment (BHHRA) report (Jacobs, 2003), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007a), feasibility study (FS) (Shaw, 2009), Proposed Plan (U.S. Department of the Army [U.S. Army], 2010), and other related documents contained in the Administrative Record for LHAAP-35A(58).

This document is issued by the U.S. Army, the lead agency for this installation. The USEPA (Region 6) and the Texas Commission on Environmental Quality (TCEQ) are the regulatory agencies providing technical support, project review and comment, and oversight of the U.S. Army cleanup program. The USEPA and TCEQ concur with the selected remedy.

1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

1.4 Description of the Selected Remedy

The final selected remedy for LHAAP-35A(58) protects human health and the environment by preventing human exposure to groundwater contaminated with chlorinated solvents

(tetrachloroethene [PCE], trichloroethene [TCE], cis-1,2-dichloroethene [DCE], trans-1,2-DCE, 1,1-DCE, vinyl chloride [VC], 1,1,2-trichloroethane [TCA], 1,1-dichloroethane [DCA], and chloroethane) and preventing groundwater contaminated with chlorinated solvents from migrating into nearby surface water. No principal threat source material has been identified at LHAAP-35A(58). Two separate plumes were identified at LHAAP-35A(58): the eastern plume and the western plume. The remedy components are summarized below for the two plumes.

Eastern Plume

- In situ bioremediation will be implemented in a target area where the highest concentrations of contaminants were detected. It is anticipated that the treatment will enhance biodegradation in portions of the plume outside the treated area.
- Monitored natural attenuation (MNA) will follow in situ bioremediation treatment and reduce contaminants to cleanup levels. Monitoring will be quarterly in Years 1 and 2, and semiannual in Years 3 through 5. In subsequent years, monitoring will be annual until the next five-year review. Monitoring will continue every 5 years until cleanup levels are achieved.
- Land use control (LUC) in the impacted area will ensure the protection of human health by restricting the use of groundwater to environmental monitoring and testing. The LUC will remain in place until the cleanup levels are met.

Western Plume

- MNA will be implemented to verify that the TCE plume is stable and will not migrate to nearby surface water at levels that may present an unacceptable risk to human health and the environment. MNA will return groundwater to its potential beneficial use, wherever practicable. Performance objectives will be evaluated after 2 years of MNA. During those 2 years, monitoring will be quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented. If MNA is found to be effective, it will be continued, and long-term monitoring (LTM) will be semiannual for 3 years. In subsequent years, LTM will be annual until the next five-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue every 5 years until cleanup levels are achieved.
- LUC in the impacted area will ensure the protection of human health by restricting the use of groundwater to environmental monitoring and testing. The LUC will remain in place until the cleanup levels are met.

Based on a preliminary natural attenuation evaluation and groundwater modeling, cleanup levels are expected to be met through natural attenuation in approximately 200 years in the western plume. The cleanup times for natural attenuation for the eastern plume will be evaluated after in situ bioremediation, but the cleanup times are anticipated to be similar to the western plume. Estimated cleanup times based on first order kinetics are presented in the natural attenuation evaluation in the FS, Appendix A (Shaw, 2009). For the western plume, the estimated cleanup

time is 135 years for 1,1-DCE, and then an additional 70 years for its daughter product VC. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the time to achieve cleanup levels may vary. In the course of the remedy, the additional monitoring results will allow more accurate time estimates.

The groundwater flow rates are within the normal range for the formation material at the site. Based on the groundwater flow rate and the distance to surface water, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels.

The remedial design (RD) will include the specific LUC and implementation details. The MNA performance monitoring plan will also be presented in the RD. Within 90 days of the signing of the ROD, the U.S. Army will prepare and submit the RD to USEPA consistent with the schedule of Section XVI of the Federal Facility Agreement (FFA). The U.S. Army, USEPA, and the Texas Water Commission (currently known as TCEQ) entered into the FFA for the remedial activities at LHAAP on December 30, 1991. The U.S. Army will be responsible for implementation, maintenance, periodic inspection, and enforcement of LUC in accordance with the RD. Although the U.S. Army may transfer these responsibilities to another party through property transfer agreement or other means, the U.S. Army will remain responsible for: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify or terminate LUC and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy.

U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at this site after it has transferred. U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or implementation of a land use change inconsistent with the LUC objectives and use assumptions of the remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

The management strategy at LHAAP is to approach each site separately to address human health issues and to approach the sites by sub-area to address ecological risk. Thus, the implementation of this remedy at LHAAP-35A(58) is independent of any other remedial action at LHAAP to address human health issues. To address ecological risk, LHAAP-35A(58) was grouped with several other sites as part of the Industrial Sub-Area. No chemicals exceeded ecological

thresholds of concern in the Industrial Sub-Area, thus, no action is needed at LHAAP-35A(58) to address ecological risk (Shaw, 2007a).

1.5 Statutory Determinations

For the eastern plume, the selected remedy does satisfy the statutory preference for treatment as a principle element of the remedy. For the western plume, the selected remedy does not satisfy the statutory preference. Although the final selected remedy for the western plume is not intended to address the statutory preference for treatment to the maximum extent practicable, the final selected remedy offers, within a reasonable time frame and at a lower cost, a similar level of protection to human health and the environment than those remedy alternatives which satisfy the preference for treatment. In addition, no source materials constituting principle threats will be addressed within the scope of this action. In addition, the remedy offers long-term effectiveness through the implementation of LUC, which would minimize the potential risk posed by the contaminated groundwater. Further, evaluation of MNA including routine monitoring of the attenuation until cleanup levels are met would document the effectiveness of the selected remedy. The selected remedy is easily and immediately implementable and has a moderate cost compared to the other alternatives considered for LHAAP-35A(58) with the exception of Alternative 1 (No Action).

The selected remedy of MNA for the western plume would reduce the toxicity, mobility, or volume of contaminants in the groundwater through a passive remedial action. The selected remedy of in situ bioremediation and MNA for the eastern plume would reduce the toxicity, mobility, or volume of contaminants in the groundwater through active remediation. There is no known principal threat material or contaminant source in the LHAAP-35A(58) groundwater.

Because hazardous substances, pollutants, or contaminants may remain at the site above levels that allow for unlimited use and unrestricted exposure, a five-year review will be conducted every five years to ensure protection of human health and the environment under CERCLA §121(c), U.S. Code (USC) Title 42 §9621(c). In accordance with Texas Administrative Code (TAC) Title 30 §335.566, a notification will be recorded in Harrison County records stating that the site is suitable for nonresidential use and that a restriction of groundwater usage to environmental monitoring and testing is in place until the cleanup levels are achieved. Although the U.S. Army may later pass these procedural responsibilities to the transferee by property transfer agreement, the U.S. Army shall retain ultimate responsibility for remedy integrity, per the FFA and CERCLA §121.

1.6 ROD Data Certification Checklist

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

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater as identified in the baseline risk assessment and ROD (**Section 2.6**).
- Potential land and groundwater use that will be available at the sites as a result of the selected remedy (**Section 2.6**).
- Chemicals of concern (COCs) and their concentrations (**Section 2.7**).
- Baseline risk represented by the COCs (**Section 2.7**).
- Cleanup levels established for COCs and the basis for these levels (**Sections 2.7.3** and **2.8**).
- Absence of source materials constituting principle threats that need to be addressed at this site (**Section 2.11**).
- Key factor(s) that led to selecting the remedy (**Section 2.12**).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**).

1.7 Authorizing Signatures

As the lead agency, the United States Army issues this ROD for LHAAP-35A(58) which documents the final selected remedy. The undersigned is the appropriate approval authority for this decision.

Thomas E. Lederle 29 Sep 2010
(*Name*) (*Date*)

Thomas E. Lederle
Industrial Branch Chief
Base Realignment and Closure Division
United States Army

The United States Environmental Protection Agency approves the selected remedy as provided in the ROD for LHAAP-35A(58).

9-30-10
(*Name*) (*Date*)

Samuel Coleman, P.E.
Director
Superfund Division
United States Environmental Protection Agency
Region 6

2.0 Decision Summary

2.1 Site Name, Location, and Description

LHAAP-35A(58), Shops Area

Longhorn Army Ammunition Plant
Karnack, Texas

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

Lead Agency: U.S. Army, Department of Defense
Support Agencies: USEPA Region 6, TCEQ

Source of Cleanup Money: U.S. Army, Department of Defense
Site Type: Industrial Facility

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

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

LHAAP-35A(58), also known as the Shops Area, is located in the north-central portion of LHAAP. LHAAP-35A(58) is an industrial area (former maintenance complex which included the Shops Area) that provided a wide range of support services. Early investigations for LHAAP-35A(58) covered a larger area that included additional areas to the south. The current boundary covers approximately 11 acres. Located within the boundaries of LHAAP-35A(58) are other sites including LHAAP-02, vacuum truck overnight parking; LHAAP-03, Paint Shop Building 722 (waste collection); LHAAP-60, pesticide storage buildings; LHAAP-68, mobile

storage tank parking; and LHAAP-69, service station underground storage tanks. **Figure 2-2** shows both the historic and current site boundaries.

2.2 Site History and Enforcement Activities

2.2.1 History of Site Activities

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

In December 1954, a third facility, Plant 3, began production of solid-fuel rocket motors for tactical missiles. Rocket motor production at Plant 3 continued to be the primary operation at LHAAP until 1965 when Plant 2 was again reactivated for the production of pyrotechnic and illuminating ammunition. In the years following the Vietnam conflict, LHAAP continued to produce flares and other basic pyrotechnic or illuminating items for the U.S. Department of Defense inventory. From September 1988 to May 1991, LHAAP was also used for the static firing and elimination of Pershing I and II rocket motors in compliance with the Intermediate-Range Nuclear Force Treaty in effect between the United States and the former Union of Soviet Socialist Republics. 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-35A(58), the Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility. The site was active throughout LHAAP's mission and became inactive in 1996-1997, along with the entire installation.

2.2.2 History of Investigative Activities

As part of the Installation Restoration Program, the U.S. Army began an environmental investigation in 1976 at LHAAP followed by installation wide assessments/investigations that included the following:

- In 1980, U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted a record search to assess the impact of the LHAAP installation activities, including usage, storage, treatment, and disposal of toxic and hazardous materials, on the environment, and defined conditions that may have adversely affected human health and the environment (USATHAMA, 1980).

- Contamination Survey – In 1982 as part of the LHAAP contamination survey, Environmental Protection Systems collected six groundwater samples for laboratory analyses. Subsequently in 1987, as part of the Resource Conservation and Recovery Act (RCRA) permit application process, and as a continuation of the contamination survey, U.S. Army Environmental Hygiene Agency (USAEHA) identified, described, and evaluated all solid waste management units at LHAAP (USAEHA, 1987). Units requiring further sampling, investigation and corrective action were delineated.

- RCRA Facility Assessment (RFA) – In 1988, a preliminary RFA was conducted by the U.S. Army (Maley, 1988). Waste at the various sites was characterized, but no samples were collected.

Several investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments at LHAAP-35A(58) were conducted and are listed below. Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, explosive compounds, perchlorate, pesticides, polychlorinated biphenyls (PCBs), dioxins/furans, total petroleum hydrocarbons, and/or polycyclic aromatic hydrocarbons, depending on the focus of the investigation. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-35A(58) was included in Group 4. The group designation was de-emphasized as the complexities of the individual sites became greater. The following summarizes the investigations at LHAAP-35A(58).

- **Multi-phase investigation of Group 4 sites**: Between 1992 and 2001 numerous investigations were conducted in a phased approach by Jacobs, U.S. Army Corps of Engineers (USACE), and BCM Engineers, Inc. Activities included installation of 24 monitoring wells and analysis of groundwater, surface water, sump contents, soil, and sediment samples. The results are documented in the RI for Group 4 sites (Jacobs, 2002). **Figures 2-3** and **2-4** show the soil and groundwater sample locations, respectively, at LHAAP-35A(58).

- **Plant-wide perchlorate investigation**: The investigation was conducted by Solutions to Environmental Problems, Inc. (STEP) in 2000 through 2002 (STEP, 2005). Groundwater samples were collected from five wells.

- **Baseline Human Health Risk Assessment**: The BHHRA (Jacobs, 2003) used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation results up to that time. The report concluded that the soil at LHAAP-35A(58) required no action because the associated carcinogenic risk and non-carcinogenic hazard were acceptable. Groundwater was found to pose unacceptable carcinogenic risk and non-carcinogenic hazard.

- **Environmental Site Assessment**: Media investigated in 2003 included soil and groundwater (Plexus Scientific Corporation, 2005).

- **Baseline Ecological Risk Assessment**: The BERA (Shaw, 2007a) determined that LHAAP-35A(58), as a part of the Industrial Sub-Area, did not have chemicals of

ecological concern (COECs). The evaluation was based on environmental investigations from 1993 to 2006.

- **Data gaps**: Additional investigations were conducted by Shaw in 2004 after the BHHRA was finalized to further delineate the extent of groundwater contamination identified during previous sampling events. The results of the 2004 investigation were presented in the *Data Gaps Investigation* (Shaw, 2007b).

- **Sumps report**: The 146 sumps/waste rack sumps across LHAAP were grouped together and were designated as LHAAP-35/36. Five of these sumps/waste rack sumps were located on LHAAP-35A(58). All sumps were removed from the site in the mid-1990s, and it was determined that no further action is necessary for sump-related soil (Shaw, 2008).

- **Feasibility Study**: The FS (Shaw, 2009) was based on the available results from previous investigations. In addition, it included the natural attenuation evaluation based on sampling results from 2008 and before.

2.2.3 History of CERCLA Enforcement Activities

Due to the releases of chemicals from facility operations, the USEPA placed LHAAP on the Superfund NPL on August 9, 1990. Activities to remediate contamination associated with the listing of LHAAP as a Superfund site began in 1990. After the listing on the NPL, the U.S. Army, the USEPA, and the Texas Water Commission (currently known as the TCEQ) entered into a CERCLA §120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991.

The FS for LHAAP-35A(58) (Shaw, 2009) was issued in December 2009, and the Proposed Plan (U.S. Army, 2010) was issued in January 2010. This ROD follows that Proposed Plan and precedes the more detailed RD.

2.3 Community Participation

The U.S. Army, USEPA, TCEQ and the LHAAP Restoration Advisory Board (RAB) have provided public outreach to the surrounding community concerning LHAAP-35A(58) and other environmental sites at LHAAP. The outreach program has included fact sheets, media interviews, site visits, invitations to attend quarterly RAB and regulatory review meetings, and public meetings consistent with its public participation responsibilities under Sections 113(k)(2)(B), 117(a), and 121(f)(1)(G) of CERCLA.

The Final Proposed Plan (U.S. Army, 2010) for the selection of the remedy for LHAAP 35A(58) was released to the Administrative Record and made available to the public for review and comment on January 25, 2010. A media release was sent to radio stations KTBS, KSLA and KETK on January 18, 2010. The initial notice of availability of the Proposed Plan and other related documents in the Administrative Record file was published in both *The Shreveport Times*

and the *Marshall News Messenger* on both January 17 and 24, 2010. An extension to the public review period was requested. A notice for the 30-day extension and a second public meeting was published in *The Shreveport Times* on February 22 and 28, 2010, and in the *Marshall News Messenger* on February 21 and 28, 2010. The newspaper and media notices for the meetings are provided in **Appendix A**. The public comment period for the Proposed Plan began on January 25, 2010 and ended March 25, 2010. Public meetings were held on January 26, 2010 in an open forum style with informal comments, questions, and discussions, and on March 9, 2010 with a more formal format and a court reporter. The transcript for the meeting on March 9, 2010 is part of the Administrative Record. The significant comments (oral or written) are addressed in the Responsiveness Summary, which is included in this ROD as **Section 3.0**.

The Administrative Record may be found locally at the information repository maintained at the following location:

Location:	Marshall Public Library 300 S. Alamo Marshall, Texas, 75670
Business Hours:	Monday – Thursday 10:00 a.m. – 8:00 p.m. Friday – Saturday 10:00 a.m. – 5:00 p.m.

2.4 Scope and Role of Response Action

The recommended action at LHAAP-35A(58) will prevent potential risks associated with exposure to contaminated groundwater. Although groundwater at Longhorn is not currently being used as drinking water, nor may it be used in the future based on its reasonably anticipated use as a national wildlife refuge, when establishing the remedial action objectives (RAOs) for this response action, the U.S. Army has considered the NCP's expectation to return usable groundwaters to their potential beneficial uses wherever practicable and has also considered the State of Texas designation of all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). The U.S. Army intends to return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial uses, which for the purposes of this ROD is considered to be attainment of the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). If an MCL is not available for a chemical, the promulgated TCEQ groundwater medium-specific concentration (MSC) for industrial use (GW-Ind) 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 the contaminated groundwater, and evaluate further risk reduction.

The preferred remedial action will also ensure containment of the plume to prevent potential impact to surface water. The potential exists for contaminated shallow groundwater to migrate to surface water, which could ultimately affect Caddo Lake, a source of drinking water.

In addition, the preferred action will include groundwater monitoring to demonstrate that the plume is not migrating at levels that present a potential impact to nearby surface water bodies and to verify that contaminant levels are being reduced to drinking water standards (MCLs or GW-Ind if no MCL is available) when the LUC may be terminated.

2.5 Site Characteristics

This section of the ROD presents a brief comprehensive overview of the LHAAP-35A(58) site characteristics with respect to the conceptual site model (CSM), physical site features, known or suspected sources of contamination, types of contamination, and affected media. Known or potential routes of contaminant migration are also discussed. Detailed information about the site characteristics can be found in the RI (Jacobs, 2002).

2.5.1 Conceptual Site Model

Figure 2-5 illustrates the overall CSM for LHAAP-35A(58) and presents the potential pathways that are being considered for remediation. Pathways that are likely to be incomplete or have negligible impact are not being considered for remediation.

The sources of contamination at LHAAP-35A(58) were most likely spills resulting from the variety of support services that occurred in the area. Sampling of and near the sumps does not indicate them as likely sources of contamination. The spills would result in minor soil contamination that would migrate, depending on the contaminants, through overland flow via surface runoff or through leaching to the groundwater. Overland flow does not currently appear to be contributing to a migration of contaminants, as the ditch surface water did not contain any VOCs, SVOCs, explosives, pesticides, or PCBs. Likewise, the sediment data do not show detections of VOCs, SVOCs, explosives, or pesticides. Some metals were detected in the surface water and sediment at low concentrations that naturally occur.

The other migration pathway, leaching of contaminants to groundwater, is a likely pathway. Although there appears to be no residual soil contamination (no VOCs detected in subsurface soils), VOCs are present in the groundwater. Chlorinated compounds were initially detected in two shallow groundwater wells, LHSMW05 and LHSMW07, separated by approximately 750 feet with differing relative amounts of the contaminants. The shallow well LHSMW06, located between the two contaminated wells, had low concentrations of VOCs with no MCL exceedances; however, TCE, cis-1,2-DCE, and VC were detected in the 2007 sampling round. Two isolated areas of contamination, one centered around LHSMW07, and the other centered around LHSMW05 with its edge approximately at LHSMW04, are present at LHAAP-35A(58).

These two areas are referred to as the eastern and western plumes. An intermediate and a deep well are located immediately adjacent to LHSMW05. An intermediate well is located adjacent to LHSMW07. Contaminants are not found in these wells, suggesting that downward migration has not occurred.

Well LHSMW05, located in the eastern plume, has elevated levels of only TCE and PCE. The maximum concentrations for PCE and TCE in this well are 5,100 and 230 micrograms per liter (µg/L), respectively. Both of these concentrations were above the MCL. In February 2007, PCE at 6.4 µg/L was detected for the first time in LHSMW04, approximately 300 feet east of LHSMW05. In 2008, both PCE and TCE were detected in LHSMW04 at concentrations above their MCLs.

LHSMW07, located in the western plume, is near the sampled drainage ditch which flows to Goose Prairie Creek. Another well, 35AWW04, located downgradient from LHSMW07, is closer to Goose Prairie Creek and historically had low levels of VOCs present. VOCs were not detected in well 35AWW04 during the 2004 sampling round. The maximum contaminant concentration detected in LHSMW07 was 576 µg/L of 1,1-DCE in 2008, which is greater than the drinking water MCL. Other VOCs were detected in this well with concentrations of TCE and VC also exceeding their MCLs. A new well, 35AWW06, was installed downgradient of LHSMW07 in 2008. The 1,1-DCE concentration was 57.6 µg/L in this well and the TCE and VC are below their MCLs, but PCE is above its MCL at 7.29 µg/L. The nearest downgradient surface water sampling location in Goose Prairie Creek is GPSCW08 (approximately 1,750 feet to the south). No contaminants were detected at this location during the 2004 or earlier sampling events (Jacobs, 2002).

There is little potential for the COCs present in shallow groundwater at LHAAP-35A(58) to adversely impact Goose Prairie Creek. This is based on modeling calculations of the fate and transport of the contaminants, and on the groundwater elevation and the topography. The modeling calculations are further discussed in **Section 2.5.5**. Based on the groundwater elevation and the topography, it is unlikely that the groundwater near LHSMW07 will migrate up to the surface water tributary to Goose Prairie Creek. The nearest creek staff location is approximately 1,000 feet downstream from LHAAP-35A(58) in Goose Prairie Creek. At this location, the creek bottom is approximately 203 feet above mean sea level (MSL). It is expected that the creek bottom elevations near LHAAP-35A(58) would be higher than the 203 feet MSL since the tributary near LHAAP-35A(58) is not deep and the surface elevation is approximately 219 feet MSL. The groundwater elevation on the western side of LHAAP-35A(58) near the creek tributaries is approximately 200 feet MSL. Thus, the groundwater from LHAAP-35A(58) is below the creek bottom and would not flow into the surface water at this location.

2.5.2 Overview of the Site

The current site boundary of LHAAP-35A(58) comprises approximately 11 acres in the north-central portion of LHAAP. In November 2006, USACE evaluated different boundaries for LHAAP-35A(58) that were found in various documents to include the Shops Area and the grounds of a power plant known as the 200 Area. It was recommended that LHAAP-35A(58) should include only the Shops Area and should not include the 200 Area (USACE, 2006). The historic and current site boundaries are shown on **Figure 2-2**.

The surface features are a mixture of asphalt-paved roads, parking area, and wooded and grassy vegetation-covered areas. The topography in this area is relatively flat with the surface drainage flowing into tributaries of Goose Prairie Creek. Runoff from the site enters Caddo Lake via Goose Prairie Creek. LHAAP-35A(58) has no known areas of archaeological or historical importance.

2.5.3 Geology and Hydrogeology

Groundwater is present in shallow, intermediate, and deep zones at LHAAP-35A(58). The shallow, intermediate, and deep zones are encountered at 10 to 25 feet below ground surface (bgs), 60 to 71 feet bgs, and 126 to 140 bgs, respectively. Data gathered from the monitoring wells installed at the site indicated that the groundwater flows radially from near the central southwestern part of the site with an east flow on the eastern side of the site and a south/southeast flow on the western side of the site, as shown in **Figure 2-6**.

For the shallow groundwater zone, hydraulic conductivity values ranged from a minimum value of 3.5×10^{-5} centimeters per second (cm/sec) in the southeast portion of the site to a maximum value of 1.4×10^{-3} cm/sec northwest of the site. The hydraulic conductivity value for the deep groundwater zone is 1.3×10^{-3} cm/sec (Jacobs, 2002).

The soil at LHAAP-35A(58) consists of clays and silty clays with thin lenses of sand. The sand lenses are approximately 3 to 5 feet thick. The depth to the sand lenses varies across the site. A cross-section of the site is shown in **Figure 2-7**.

2.5.4 Sampling Strategy

Several sampling events were conducted at LHAAP-35A(58) from 1992 to 2008, as outlined in **Section 2.2.2** on site investigations. In the early investigations, soil samples were collected from throughout the site to determine the areas of contamination. Subsequent investigations focused on the areas where contamination was found, performing additional soil, groundwater, and sediment sampling and installing monitoring wells to delineate the contamination. Samples were analyzed for various analytes including VOCs, SVOCs, metals, explosives, perchlorate, pesticides, and dioxins/furans. In the area of the contaminant plume, groundwater samples were

also analyzed for indicators of conditions that promote natural attenuation (biodegradation), such as sulfide, methane, and chloride.

2.5.5 Nature and Extent of Contamination

Based on the risk assessment and subsequent evaluations, it was determined that the COCs for the shallow groundwater at this site are PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1.2-DCE, VC, 1,1,2-TCA, 1,1-DCA, and chloroethene. The plume boundaries for PCE, TCE, and 1,1-DCE, as determined by their respective MCLs, are shown in **Figure 2-8**. The COCs are toxic and carcinogenic. No principal threat source material (such as dense non-aqueous phase liquid [DNAPL]) was identified or suspected to exist at LHAAP-35A(58).

The eastern plume has a lateral extent of approximately 270,000 square feet (ft^2), and a vertical extent of approximately 5 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 3.03 million gallons. The highest concentrations detected for PCE and TCE were 9,590 µg/L and 675 µg/L, respectively, from well 35AWW08, sampled in November 2008. The highest concentrations detected for 1,1-DCE and VC were 24 µg/L and 4.1 µg/L, respectively, from well 1004TW001, sampled in December 2003. Five shallow zone wells are within the eastern plume boundaries (35AWW08, 1004TW001, LHSMW04, LHSMW05, 03WW01), as well as one direct push data point (58DPT04).

The western plume has a lateral extent of approximately 180,000 ft^2, and a vertical extent of approximately 5 feet. Assuming a total porosity of 0.3, the calculated volume of contaminated groundwater is 2.02 million gallons. In the sampling results from November 2008, the highest concentrations detected for TCE, 1,1-DCE, and VC were 25 µg/L, 576 µg/L, and 14.4 µg/L, respectively, from well LHSMW07; the highest concentration detected for PCE was 7.19 µg/L from well 35AWW06. Three shallow zone wells are within the western plume boundaries: LHSMW07, 35AWW06, and 1004TW006.

Modeling calculations were completed to assess the potential for the COCs present in shallow groundwater at LHAAP-35A(58) to migrate toward and discharge to Goose Prairie Creek. The modeling concluded that contaminants present in the shallow groundwater at the site will not adversely impact Goose Prairie Creek surface water (Shaw, 2007c). The results were obtained by using the transport model Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System (AT123D). AT123D assumes the aquifer to be homogeneous and isotropic. It accounted for advection, dispersion, adsorption, and chemical degradation. There are uncertainties in the use of modeling to estimate the impact of groundwater on surface water. Specifically, the absence of a downgradient well between the site and Goose Prairie Creek precluded the field verification of the model's results.

2.6 Current and Potential Future Land and Resource Uses

2.6.1 Current and Future Land Uses

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

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

The reasonably anticipated future use of LHAAP-35A(58) is as a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge. Presently the Caddo Lake National Wildlife Refuge occupies approximately 7,000 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (16 USC 668dd), the land will remain as a national wildlife refuge unless there is a change brought about by an act of Congress, or the land is part of an exchange authorized by the Secretary of the Interior.

2.6.2 Current and Future Surface Water Uses

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

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

2.6.3 Current and Future Groundwater Uses

Groundwater in the drinking water aquifer (250-430 feet bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater described at LHAAP-35A(58), which is encountered at 126 to 140 bgs. There are five active water supply wells near LHAAP. One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 feet and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 2 miles southeast of town. This well is approximately 430 feet deep and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3, and all are hydraulically upgradient of LHAAP (Jacobs, 2002). These wells are completed deeper than the deepest zone of contamination at LHAAP. Because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, there are several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 feet.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station; the second well is located approximately 0.35 miles southwest of the Fire Station. The third well is located north of the USFWS administration building for the Caddo Lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these wells to LHAAP-35A(58) are approximately 0.39 mile, 0.57 mile, and 1.41 miles, respectively. All three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-35A(58). Two additional wells previously supplied water to the installation, but these have been plugged and abandoned. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for non-potable uses.

Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-35A(58) as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

2.7 Summary of Site Risks

The BHHRA and BERA estimate the risks posed by the site if no action were taken. These assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action.

The site boundary used for the BHHRA was larger than the current limits of LHAAP-35A(58), and some of the maximum detected concentrations used as exposure point concentrations (EPCs) came from wells currently outside of LHAAP-35A(58) and have been incorporated into other areas that are being evaluated separately. The results of this change are further discussed in **Section 2.7.1.5**.

2.7.1 Summary of Human Health Risk Assessment

This section is based on the conclusions presented in the *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites* (Jacobs, 2003), in the *Data Gaps Investigations* (Shaw, 2007b), and in additional data collected in preparation of the *Final Feasibility Study, LHAAP-35A(58)* (Shaw, 2009). The risk assessment used data from the investigations conducted through 2001 including the plant-wide perchlorate investigation. Results from the later investigations did not change the overall outcome of the risk assessment. During the risk assessment, soil and groundwater data were used to calculate the aggregate risk, which was then compared to the USEPA target risk range of 1×10^{-4} to 1×10^{-6} for the excess lifetime carcinogenic risk and to a hazard index (HI) of 1 for non-carcinogenic hazards. If there is no unacceptable risk associated with a medium, and a cleanup level is not exceeded, then the medium is not identified in this ROD for remediation. The CSM that is associated with the risk assessment was introduced in **Section 2.5.1**, and is presented as **Figure 2-5**.

2.7.1.1 Identification of Chemicals of Potential Concern

The BHHRA identified chemicals of potential concern (COPCs) for LHAAP-35A(58) and evaluated the carcinogenic risk and non-carcinogenic hazard for each. **Table 2-1** summarizes the risk assessment data for the COPCs, including minimum and maximum detected concentrations, frequency of detection, and EPCs. Analytical results for various congeners of dioxins and furans are expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The EPCs for bis(2-ethylhexyl)phthalate, aluminum, perchlorate, and 1,3,5-Trinitroperhydro-1,3,5-triazine (RDX) became invalid for the risk assessment for LHAAP-35A(58) when the site boundary was redefined. For these chemicals, the EPCs had been based on wells (LHSMW01 and LHSMW03) that were associated with other sites outside the current LHAAP-35A(58) boundary. This is further discussed in **Section 2.7.1.5**.

2.7.1.2 Exposure Assessment

The Jacobs risk assessment (Jacobs, 2003) presented the human health risks and hazards to a hypothetical future maintenance worker under an industrial scenario for soil and groundwater.

For soil, reasonable exposure pathways according to the CSM are: incidental ingestion of the surface soil (0 to 2 feet bgs), dermal contact with the surface soil, inhalation of particulates, and inhalation of VOCs from the soil (0 to 7 feet bgs). The BHRRA found VOC levels in the soil at

0 to 7 feet bgs to be non-detect; this exposure pathway did not add to carcinogenic risk or non-carcinogenic hazard. Therefore, it was not added to the summary tables in the ROD.

For groundwater, reasonable exposure pathways are ingestion of groundwater, dermal contact while showering with contaminated groundwater, and inhalation of VOCs while showering with contaminated groundwater.

2.7.1.3 Toxicity Assessment

The carcinogenic and non-carcinogenic toxicity assessments from the BHHRA are summarized in **Tables 2-2** and **2-3**, respectively. The toxicity data assumes that exposure would be chronic to be conservative. Sources for the data include the Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST).

2.7.1.4 Risk Characterization

Characterization of the carcinogenic risk and non-carcinogenic hazard are summarized in **Tables 2-4** and **2-5**, respectively. For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime carcinogenic risk is calculated from the following equation:

$$Risk = CDI \times SF$$

where: risk = unitless probability of an individual developing cancer
CDI = chronic daily intake averaged over 70 years, expressed as milligrams per kilogram per day (mg/kg-day)
SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

These risks are probabilities that usually are expressed in scientific notation. An excess lifetime carcinogenic risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime carcinogenic risk" because it would be in addition to the risks of cancer that individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ).

An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI < 1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-carcinogenic HQ = CDI/RfD

Where: CDI = chronic daily intake
RfD = reference dose

CDI and RfD are expressed in the same units and represent the same exposure period (e.g., chronic, subchronic, or short-term).

The carcinogenic risks for soil and groundwater are 2.1×10^{-5} and 1.6×10^{-2}, respectively (Jacobs, 2003). The hazard indices for soil and groundwater are 0.47 and 38, respectively. The carcinogenic risk and non-carcinogenic hazard are both acceptable for soil, and are both unacceptable for groundwater. Therefore, the remedial action focuses on the groundwater. The major contributors to both the carcinogenic risk and non-carcinogenic hazard of groundwater were PCE and 1,1-DCE.

The BHHRA included an uncertainty analysis which identified factors that would cause values used in the risk assessment to be over- or underestimated. The analysis concluded that the risks and HIs are overestimated, making the BHHRA a conservative evaluation. The analysis listed eight factors that would lead to overestimations, four that would lead to underestimations, and five that could lead to either over- or underestimations.

2.7.1.5 Evaluation of COPCs

To further evaluate the occurrence of COPCs, a data gap investigation was conducted (Shaw, 2007b) and additional investigations were conducted when preparing the FS (Shaw, 2009). While these investigations did not change the overall outcome of the earlier BHHRA, they determined what COCs needed to be targeted by the remedial action, and accounted for the change in the site boundary since the time of the BHHRA. The historical and current site boundaries are shown in **Figure 2-2**. Chemicals that had high detections at a well that is no longer in the current boundary are noted in the discussion below. COPCs with high detections from wells that are no longer part of LHAAP-35A(58) were re-evaluated to determine if they should still be included as a COC for LHAAP-35A(58).

Table 2-6 lists the chemicals that have a HQ greater than 0.1 and **Table 2-7** lists chemicals that have a carcinogenic risk greater than 1×10^{-6} for the hypothetical maintenance worker. These tables also summarize the justifications for which of the COPCs should be classified as COCs. **Table 2-8** presents the outcome of the evaluation, which is the list of COCs that require remediation.

Volatile Organic Compounds

The maximum concentration of 1,1-DCE in groundwater (1,340 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (7 µg/L). The most recent groundwater sample result, 576 µg/L from LHSMW07 in 2008, still exceeds the MCL. Thus, 1,1-DCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of PCE in groundwater (9,590 µg/L) was from 35AWW08 and exceeded the MCL (5 µg/L). PCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of VC in groundwater (10 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (2 µg/L). The most recent groundwater samples from LHSMW07 in 2008 of 14.4 µg/L still exceed the MCL. Thus, VC is considered a COC in the shallow groundwater zone at LHAAP-35A(58). VC concentrations that exceed the MCL consistently occur with the 1,1-DCE concentrations that exceed the MCL, so no separate VC extent is shown on **Figure 2-8**.

The maximum concentration of TCE in groundwater (675 µg/L) was from 53AWW08 in 2008 and exceeded the MCL (5 µg/L). TCE is considered a COC in the shallow groundwater zone at LHAAP-35A(58).

The maximum concentration of 1,2-DCA in groundwater (3 µg/L) was from LHSMW07 in 1996 and is less than the MCL (5 µg/L). Thus, 1,2-DCA is not considered a COC at LHAAP-35A(58).

The maximum concentration of 1,1,2-TCA in groundwater (8 µg/L) was from LHSMW07 in 1996 and exceeded the MCL (5 µg/L). 1,1,2-TCA was detected at LHSMW07 in 2008 at a concentration of 1.92 µg/L. Even though the most recent groundwater sample was less than the MCL, 1,1,2-TCA is included as a COC at LHAAP-35A(58) for LTM.

Semivolatile Organic Compounds

The EPC used in risk assessment for bis(2-ethylhexyl)phthalate in groundwater (88 µg/L) was from LHSMW03 in 1994 and exceeded the MCL (6 µg/L). The well LHSMW03 is outside the LHAAP-35A(58) boundary, so the EPC based on that well is not valid. Bis(2-ethylhexyl)phthalate was detected in 2 of the 19 groundwater samples analyzed between 1994

and 2003. The results were all less than the MCL except for a 1998 estimated concentration of 12 µg/L at 35AWW02. That result was concluded to be anomalous (Jacobs, 2002). Bis(2-ethylhexyl)phthalate is also a common laboratory contaminant. Thus, bis(2-ethylhexyl)phthalate is not considered a COC at LHAAP-35A(58).

Metals

The risk assessment reported that the maximum concentration of manganese, 5,800 µg/L from LHSMW05 in 1994, is a contributor to the groundwater noncancer hazard (1.2) (Jacobs, 2003). This maximum manganese concentration is less than the LHAAP perimeter well groundwater background value (95% upper tolerance limit) of 7,820 µg/L (Shaw, 2007d). The most recent manganese sample from LHSMW05 in 1998 had a maximum concentration of 4,070 µg/L. This suggests that the maximum value from 1994 may have been in part due to suspended solids in the sample. Additionally, manganese from the new well 35AWW06 was 5,320 µg/L in November 2008, which is below the promulgated GW-Ind of 14,000 µg/L. Thus, manganese is not considered a COC for LHAAP-35A(58).

The maximum aluminum concentration in groundwater (98,200 µg/L), used as the EPC, was from LHSMW03 in 1994. The well LHSMW03 is outside the LHAAP-35A(58) boundary, so the EPC based on that well is not valid. The maximum aluminum concentration in groundwater (35,400 µg/L) at LHAAP-35A(58) was from LHSWM05 in 1994. In 1998, the aluminum concentration at LHSMW05 was 2,400 µg/L. This suggests that the fluctuations in maximum values from 1994 may be due to sampling methods used and may have been due to suspended solids in the sample. The maximum concentration of aluminum in the 1998 groundwater samples at LHAAP-35A(58) was 4,800 µg/L from 35AWW03, which was dry in 2008. The maximum aluminum concentration in 2008 was 2,610 µg/L at 35AWW07. This concentration is about 3% of the EPC used in the risk assessment. Thus, the HQ would be well below 1, and aluminum is not considered a COC at LHAAP-35A(58).

The maximum concentration of nickel in groundwater (1,100 µg/L), used as the EPC, was from LHSWM05 in 1996. Nickel was detected in 14 of the 16 groundwater samples analyzed between 1996 and 2003. In 1998, the nickel concentration at LHSMW05 was 240 µg/L. This is about 22% of the EPC concentration. It was noted that the two samples with the highest nickel concentrations (both at LHSMW05) also have the highest chromium concentrations. In 2008, the maximum nickel concentration (1,900 µg/L) was also associated with the highest chromium concentration. LHSMW05 and LHSMW04 were installed at the same time. That suggests that nickel and chromium detection are co-related. The wells are constructed of stainless steel, which contains both chromium and nickel. All steel alloys are susceptible to corrosion when in contact with groundwater. The localized nickel detections suggest that the elevated nickel concentrations may be related to well construction material, rather than from site-related

activities. Additionally, nickel is below the proposed cleanup goal of 2,000 µg/L based on the GW-Ind. Thus nickel is not considered a COC at LHAAP-35A(58).

The maximum concentration of thallium in groundwater (3.6 µg/L), used as the EPC, was from LHSMW07 in May 1998 and exceeded the MCL (2 µg/L). Thallium was detected in 5 of the 20 groundwater samples analyzed between 1994 and 2003. Thallium results from November 1998 have a maximum concentration of 1.8 µg/L (estimated value), and the most recent thallium result from November 2008 had a concentration of 0.000129J µg/L (estimated value). It appears that earlier samples contained more thallium than recent samples, indicating that thallium in the groundwater could be considered an artifact of turbid samples collected during historic sampling rounds. Thus, thallium is not considered a COC for LHAAP-35A(58).

The maximum concentration of strontium in groundwater (23,000 µg/L), used as the EPC, was from LHSMW07 in 1998. The strontium concentration at LHSMW07 from 2008 was almost the same at 23,300 µg/L. The maximum strontium concentration of 23,000 µg/L is well below the GW-Ind value of 61,000 µg/L. Thus, strontium is not considered a COC at LHAAP-35A(58).

Two detections of antimony in 1998 were above the MCL of 6 µg/L. The maximum concentration of antimony in groundwater (13 µg/L), used as the EPC, was from 35AWW03 in 1998. Metals were only analyzed for once at 35AWW03, and the well was dry in 2008. At 35AWW04, antimony was detected at 10 µg/L in September 1998. A second sample was collected and analyzed after the November 1998 sample, and antimony was not detected above 5 µg/L. This suggests that sampling methodology could have affected the result. The most recent detected result of 2.53 µg/L at 35AWW02 in 2008 was less than the MCL. Thus, antimony is not considered a COC for LHAAP-35A(58).

The maximum concentration of selenium in groundwater (65.8 µg/L), used as the EPC, was from LHSMW07 in 1996 and exceeded the MCL (50 µg/L), but had an HQ of only 0.13. The most recent selenium result at LHSMW07, from November 2008, had a detection of selenium at 90 µg/L. The HQ for 2008 selenium concentration using a ratio of HQ to EPC/maximum concentration would yield an HQ of 0.18 which is acceptable, and selenium is not considered a COC for the hypothetical future maintenance worker LHAAP-35A(58).

The maximum concentration of cobalt in groundwater (250 µg/L), used as the EPC, was from LHSMW05 in 1998. The highest concentrations of cobalt were isolated to LHSMW05. The maximum cobalt concentration of 250 µg/L is well below the GW-Ind value of 6,100 µg/L. Thus, cobalt is not considered a COC at LHAAP-35A(58).

Perchlorate and RDX

The maximum concentration of perchlorate in the groundwater (81 µg/L) used as the EPC was from LHSMW01 in 2001. Redefinition of the LHAAP-35A(58) boundary in 2006 put the well outside the current site boundary. Therefore, the EPC from LHSMW01 is not applicable to LHAAP-35A(58), and the well is being addressed under LHAAP-04. Perchlorate was not detected in the most recent 2007 samples collected from wells LHSMW04, LHSMW06, and LHSMW07 located at LHAAP-35A(58). Thus, perchlorate is not considered a COC at LHAAP-35A(58).

The maximum concentration of RDX in the groundwater (88.3 µg/L) from LHSMW03 in 1996 was used as an EPC in the 2003 risk assessment. A subsequent result in May 1998 was 1.3 UJ µg/L. Redefinition of the LHAAP-35A(58) boundary in 2006 resulted in well LHSMW03 lying outside the current site boundary. Because RDX was not detected in any other wells within LHAAP-35A(58), RDX is not considered a COC.

2.7.2 Summary of Ecological Risk Assessment

The ecological risk for LHAAP-35A(58) was addressed in the installation-wide BERA (Shaw, 2007a). The BERA provides a process that evaluates the likelihood that adverse ecological effects may occur, or are occurring, as a result of exposure to one or more stressors. A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response. The BERA for LHAAP focuses only on chemical stressors.

Ecological risk does not exist unless:

- The stressor has the inherent ability to cause adverse effects
- It co-occurs with or contacts an ecological component (i.e., organism, population, community, or ecosystem) long enough and at sufficient intensity to elicit an adverse effect

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. Each of the individual sites at LHAAP was grouped into one of these sub-areas, based on commonalities of historic use, habitat type, and spatial proximity to each other. Conclusions for individual sites and the potential for detected chemicals to adversely affect the environment are made in the context of the overall conclusions of the sub-area in which the site falls.

LHAAP-35A(58) lies within the Industrial Sub-Area, and the BERA concluded that no chemicals exceeded ecological thresholds of concern in the Industrial Sub-Area (Shaw, 2007a). Thus, there are no COECs at LHAAP-35A(58). Therefore, no action is needed at LHAAP-35A(58) for the protection of ecological receptors.

2.7.3 Basis of Action

The remedial action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. The conclusion reached by the FS investigation and subsequent investigations is that the COCs for groundwater at LHAAP-35A(58) are PCE, TCE, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and VC. There are no COCs for soil. **Table 2-8** presents the cleanup levels for the COCs. The table includes cleanup levels for 1,1,2-TCA and its daughter products 1,1-DCA and chloroethane, even though they are not currently classified as COCs due to their low detections during recent sampling. However, 1,1,2-TCA and its daughter products will be included for inclusion as COCs for LTM as described in **Section 2.12.2** because the historical level of 1,1,2-TCA was a concern in the past.

A SDWA MCL has been determined for each of the COCs except for 1,1-DCA and chloroethene. For the chemicals with an MCL that has been determined, the MCL is used as the cleanup level. If no MCL exists, the GW-Ind is used as the cleanup level (TCEQ, 2006).

The human health risk assessment, which was based on the reasonably anticipated future use as a national wildlife refuge, does not address unrestricted use. Although not part of the remedy, limited monitoring in the form of five-year reviews will be conducted to certify proper land use and, in accordance with 30 TAC 335.566, a notification will be recorded in the Harrison County records stating that the site is suitable for nonresidential use.

2.8 Remedial Action Objectives

The RAOs for LHAAP-35A(58), 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 by preventing human exposure to the contaminated groundwater
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water
- Return of groundwater to its potential beneficial uses as drinking water, wherever practicable

The above RAO recognizes USEPA's policy to return all groundwater to beneficial uses, based on the non-binding programmatic expectation in the NCP and is consistent with the NCP regulations requiring the lead agency, the U.S. Army in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

2.9 Description of Alternatives

Four alternatives (including No Action) are proposed. This section introduces the remedy components, identifies the common elements and distinguishing features of each alternative, and describes the expected outcomes of each.

2.9.1 Description of Remedy Components

Alternative 1 – No Action

As required by the NCP, the no action alternative provides a comparative baseline against which the action alternatives can be evaluated. Under this alternative, groundwater would be left "as is" without implementing any additional monitoring, containment, removal, treatment, or other mitigating actions. No actions would be implemented to reduce existing or potential future exposure to human receptors, although natural attenuation would be ongoing.

Estimated Capital Present Worth Cost: $0
Estimated O&M Present Worth Cost: $0
Cost Estimate Duration: --
Estimated Present Worth Cost: $0

Alternative 2 – Monitored Natural Attenuation and Land Use Control

The major components of the MNA remedy with a contingency remedy for the impacted groundwater include the following.

- MNA to return groundwater to its potential beneficial use, wherever practicable
- Performance objectives to evaluate the MNA remedy performance after two years
- LTM semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached
- A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective
- LUC to restrict access to the contaminated groundwater until the cleanup levels are reached

Estimated Capital Present Worth Cost: $60,500
Estimated O&M Present Worth Cost: $432,300
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $492,800

Alternative 3 – In Situ Bioremediation, Short Term LUC and LTM

The major components of this alternative include the following:

- In situ bioremediation in a target area that has the highest contaminant concentrations at each of the two plumes
- MNA with LTM to reduce groundwater contamination to cleanup levels
- LUC until the cleanup levels are achieved

Estimated Capital Present Worth Cost: $860,000
Estimated O&M Present Worth Cost: $483,000
Cost Estimate Duration: 10 years
Estimated Present Worth Cost: $1,343,000

Alternative 4 – In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume

In this alternative, the western and eastern plumes have separate treatments. The major components of this alternative include the following:

Eastern plume

- In situ bioremediation in a target area that has the highest contaminant concentrations
- MNA with LTM to reduce groundwater contamination to cleanup levels
- LUC until the cleanup levels are achieved

Western plume

- MNA to return groundwater to its potential beneficial use, wherever practicable
- Performance objectives to evaluate the MNA remedy performance after two years
- LTM semiannually for three years, annually until the next five-year review, then once every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen until cleanup levels are reached
- A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective
- LUC until the cleanup levels are achieved

Estimated Capital Present Worth Cost: $191,000
Estimated O&M Present Worth Cost: $594,000
Cost Estimate Duration: 30 years
Estimated Present Worth Cost: $785,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

Common Elements of Alternatives 2, 3, and 4

Common elements of Alternatives 2, 3, and 4 are described below.

MNA – MNA is a passive remedial action that relies on natural biological, chemical, and physical processes to reduce the mass and concentrations of groundwater COCs under favorable conditions. The natural attenuation evaluation indicates that MNA is a feasible technology for the groundwater in the western plume at LHAAP-35A(58) (Shaw, 2009). Alternative 2 would implement MNA in both the eastern and western plumes. Alternative 4 will implement only MNA in the western plume. In Alternatives 3 and 4, natural attenuation would reduce contaminant concentrations in areas outside of the treated target areas. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

MNA performance monitoring will be performed quarterly for the first two years. After eight quarterly sampling events, MNA will be evaluated. The analytical program will consist of VOCs, including chlorinated compounds and degradation products, methane, ethene, and ethane. Initially, the following geochemical parameters will also be included in the analytical program, dissolved oxygen (field), redox potential (field), sulfate, nitrate, nitrites, alkalinity, total organic carbon, and ferrous iron (field).

LUC – The LUC would be implemented to support the RAOs. The U.S. Army would be responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC. The U.S. Army will provide details of the LUC long-term implementation and long-term maintenance actions in the RD for the site. The LUC would prevent human exposure to residual groundwater contamination presenting an unacceptable risk to human health and ensure that there is no withdrawal or use of groundwater beneath the sites for anything other than environmental monitoring and testing. The groundwater restriction LUC would be maintained until the concentrations of contaminants and by-product (daughter) contaminants in groundwater had been reduced to levels below their respective cleanup levels. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and a notification of LUC with the Harrison County Courthouse would include a map showing the areas of groundwater restriction at the site, in accordance with 30 TAC 335.566.

In order to transfer this property (LHAAP-35A[58]), an Environmental Condition of Property (ECOP) document would be prepared and the Environmental Protection Provisions from the

ECOP would be attached to the letter of transfer. The ECOP would include LUC for groundwater as part of the Environmental Protection Provisions. The property would be transferred subject to the LUC identified in the ECOP. These restrictions would prohibit or restrict property uses that might result in exposure to the contaminated groundwater (e.g., drilling restrictions). The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of a LUC objective at this site after it has been transferred. The U.S. Army shall consult with TCEQ and obtain USEPA concurrence prior to termination or significant modification of a LUC, or land use change inconsistent with the LUC objectives and use assumptions of the remedy. In the event that TCEQ and/or EPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

Inspection/Long-Term Groundwater Monitoring – Alternatives 2, 3, and 4 include inspection and long-term groundwater monitoring activities. Monitoring would be continued as required to demonstrate effectiveness of the remedy, to demonstrate compliance with applicable or relevant and appropriate requirements (ARARs) and RAOs, and to support five-year reviews.

Distinguishing features of Alternatives 3 and 4

The distinguishing feature of Alternative 3 and 4 compared to Alternative 2 is the inclusion of in situ bioremediation action. The components of this action are described below.

Determining effective treatment – Currently shallow monitoring wells 35AWW06, 35AWW08, 03WW01, LHSMW04, LHSMW05, and LHSMW07 are impacted. Contaminated groundwater is present in shallow thin sand lenses which occur in a formation consisting primarily of clays and silty clays. Two separate plumes are evident. Alternative 2 and 3 uses the same process options in both plumes. Alternative 2 would implement MNA in both plumes. Alternative 3 would implement in situ bioremediation in both plumes. Alternative 4 would implement in situ bioremediation in the eastern plume, because the natural attenuation evaluation (Shaw, 2009) indicated that there was sufficient evidence of natural attenuation in the western plume, and less evidence of it in the eastern plume. A bench-scale treatability study may be conducted during the design phase to determine the most effective bioaugmentation additive (i.e., quantities and types of microbial cultures and nutrients to accelerate attenuation in a shorter time and/or disperse to treat a larger area).

Installing temporary wells for injection – Chlorinated solvents often require circulation of nutrients and other growth-stimulating additives/materials specific to the contaminants' metabolic degradation process. The wells would be used to inject these materials to accelerate microbial degradation of the plumes.

Injecting microbial cultures and nutrients into the subsurface – Bacteria present in the groundwater can use chlorinated solvents as electron acceptors. Electron donors may include a wide variety of nutrients: sugars (molasses), alcohols (methanol, ethanol), volatile acids (acetate, lactate), and/or wastes (food processing, manure). The COCs at LHAAP-35A(58) can degrade under anaerobic conditions, but microorganisms, mechanisms, and redox requirements differ. Based on results of the treatability study, bioaugmentation additives, appropriate nutrients and other materials, would be injected into the subsurface. For this ROD, it is assumed that bioaugmentation will be used at the site. This form of bioremediation combines the injection of microbial cultures capable of degrading the contaminants with a carbon source to provide adequate conditions for the proliferation of the dechlorinating organisms. For costing purposes, it is assumed that Alternative 3 will include 70 injection points installed using direct-push technology, and Alternative 4 will include 10 injection points. It is anticipated that the bioaugmentation material would be injected twice and that the injection would occur in the shallow zone, at approximately 20 feet bgs.

Sampling wells to monitor effectiveness – Monitoring for contaminants, bacteria, and geochemical parameters would be performed to assess the effectiveness of the treatment. Anticipated remediation times may be short with appropriate contact. Assuming first order anaerobic degradation rates and reasonable half-lives for the COCs, the COCs within the treated areas could be reduced to their respective cleanup levels in approximately 2 to 3 years. However, it is anticipated that COCs will remain in the plumes outside the treated areas and will attenuate to levels below MCLs over time. The MNA sampling will occur quarterly for the first 2 years. The LTM will then be conducted semiannually for years 3 through 5, then annually until the next five-year review, then once every 5 years. This frequency has been assumed for the estimate. Periodic reports will be prepared to document the monitoring program.

Injecting additional substrate – It is also assumed for the cost estimate that a second bioaugmentation treatment in the area of highest contamination may be required during year 2 of the remediation program to further treat COCs. However, this would only occur if warranted based on the first six quarters of data.

2.9.3 Expected Outcomes of Each Alternative

Alternative 1 would allow the site to remain a hazard to human health, since it simply leaves the site as is. Alternatives 3 and 4 have very similar outcomes, and the main difference is in the time required to reach the cleanup levels, which is anticipated to occur in 10 years for Alternative 3, 200 years for Alternative 4, and longer than 200 years for Alternative 2. The similar outcomes are considered to be attainment of the SDWA MCLs to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C). For the daughter products of TCA (1,1-DCA and chloroethane), no MCL has been promulgated, so the GW-Ind is used in place of the MCL, in accordance with 30 TAC 335. In addition, the monitoring activities associated with MNA would

assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Until that time, LUC will restrict the use of the site's groundwater to environmental monitoring and testing.

2.10 Summary of Comparative Analysis 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. **Table 2-9** summarizes the comparative analysis of the alternatives.

2.10.1 Overall Protection of Human Health and the Environment

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

The four alternatives provide varying levels of human health protection. Alternative 1, no action, does not confirm achievement of the RAO for the return of groundwater to its potential beneficial use as a drinking water since there is no monitoring involved. Alternative 1 also 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 the groundwater contamination.

Alternatives 2, 3, and 4 satisfy the RAOs for LHAAP-35A(58). Alternatives 2, 3 and 4 provide confirmation that human health and the environment will be protected because monitoring will be conducted to ensure that MNA is returning the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial uses as a drinking water, wherever practicable, and to document that the plumes are contained and prevented from impacting surface water at levels that could present a risk to human health and the environment. Furthermore, the LUC would protect human health by preventing access to the contaminated groundwater until contaminants in the groundwater attain the cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) for all contaminants above the cleanup levels and attain the cleanup levels for all contaminant by-products (daughter contaminants) above the cleanup levels.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State

requirements, standards, criteria, and limitations, which are collectively referred to as "ARARs" unless such ARARs are waived under CERCLA Section 121(d)(4). The ARARs that pertain to this ROD are discussed in **Section 2.13.2**.

Because contaminated groundwater has the potential to discharge to surface water features that flow to Caddo Lake, a drinking water supply, chemical-specific ARARs for surface water consumption are appropriate and relevant. Specifically, Texas surface water quality standards are set forth in 30 TAC 307.6(d)(1) for PCE (5 µg/L), TCE (5 µg/L), 1,1,2-TCA (5 µg/L), 1,1-DCE (7 µg/L), and VC (2 µg/L) for LHAAP-35A(58). These standards are equivalent to the MCLs. For contaminants that are not listed in 30 TAC 307.6(d)(1), the TCEQ groundwater MSC for residential use (GW-Res) for cis-1,2-DCE (70 µg/L) (MCL), trans-1,2-DCE (100 µg/L) (MCL), 1,1-DCA(3,700 µg/L) (non-MCL), and chloroethane (15,000 µg/L) (non-MCL) apply.

Alternative 1 does not comply with chemical-specific ARARs because no additional remedial action would be implemented. Alternatives 2, 3, and 4 return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, these alternatives would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Alternative 2 does comply with surface water ARARs because modeling results indicate that MNA will reduce TCE, 1,1-DCE, and PCE concentrations in groundwater to the cleanup levels prior to discharge as base flow into surface water; monitoring would be used to confirm it.. Alternatives 3 and 4 also comply with surface water chemical specific ARARs because active remedial processes will reduce contaminant levels in groundwater to levels below water quality standards prior to discharge as base flow into surface water.

Location-specific and action-specific ARARs would not apply to Alternative 1 since no remedial activities would be conducted. Alternatives 2 and 3 comply with all location-specific and action-specific ARARs.

2.10.3 Long-Term Effectiveness and Permanence

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

For Alternative 1, contaminant removal would occur by natural attenuation processes, but the long-term effectiveness and permanence would be unknown because of the absence of monitoring. Also, no measures would be implemented to control exposure risks posed by contaminated site groundwater.

Alternative 2 offers a moderate degree of long-term effectiveness through the implementation of MNA with LUC, which would minimize the potential risk posed by the contaminated groundwater. Alternative 2 may pose the same risk as Alternative 1 if MNA is not effective, the plume is not stable and migrates. Alternatives 3 and 4 use active in situ bioremediation which will reduce groundwater contaminant concentrations. The long-term effectiveness of the in situ bioremediation may be limited by: 1) the nature of the permeable water-bearing zones; and 2) the distribution and presence of COCs remaining in the groundwater in untreated areas. Alternatives 2, 3 and 4 are remedial actions that would permanently reduce contaminant levels in the groundwater over time and return the groundwater to its potential beneficial use as drinking water wherever practicable, with Alternative 3 requiring the least amount of time. Monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

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

Alternative 1 has the potential to reduce the mass and concentration of contaminants through natural attenuation processes, although the progress would be unmonitored and undocumented. Alternative 2 would use MNA to permanently reduce the mass and concentration of contaminants through natural processes and, therefore, the volume, toxicity and mobility of the contaminants. Alternatives 3 and 4 would use in situ bioremediation to achieve the same reductions in contamination that are expected from Alternative 2. MNA is a passive remedial action, and bioremediation is an active treatment process.

Biological activity would generate daughter products that may temporarily increase toxicity or mobility of the contaminant plume. Alternatives 2, 3, and 4 include monitoring so that daughter products would be quantified, documented, and evaluated. The same biological activities would also consume the daughter products, and it is anticipated that these concentrations would be reduced to levels below their associated cleanup levels to return groundwater to its potential beneficial use as drinking water, wherever practicable.

Achievement of cleanup levels in groundwater would be expedited under Alternative 3 or 4 by implementing in situ bioremediation treatment in areas of highest contaminant concentrations in

the groundwater. It is noted that monitoring for contaminants would be performed to assess the effectiveness of the treatment. Also, it is anticipated that COCs will remain above cleanup levels in the plume outside the treated areas and will continue to attenuate to levels below cleanup levels over time.

2.10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Because Alternative 1 does not involve any remedial measures, no short-term risk to workers, the community or the environment would exist. The activities associated with Alternative 2, 3, and 4 are protective to the surrounding community from short-term risks. Alternatives 2, 3, and 4 involve potential short-term risks to workers associated with exposure to contaminated groundwater and operation of drilling/construction equipment. Alternatives 3 and 4 require more drilling/construction activities than Alternative 2. MNA presents negligible risks to workers associated with the exposure to contaminants during groundwater monitoring activities.

Since Alternatives 2, 3, and 4 contain LUC as an element of their remedies, they would provide almost immediate protection through implementation of LUC that prohibits installation of wells for any purposes other than environmental monitoring and testing. The time period to achieve groundwater cleanup levels is a significant difference between Alternatives 2, 3, and 4. Alternative 3 is expected to take the least time to achieve RAOs.

2.10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Under the no action alternative, no remedial action would be taken. Therefore, no difficulties or uncertainties would be associated with its implementation. Alternative 2 is easily implemented from a technical standpoint because no construction activities would be performed, although the U.S. Army would be responsible for long-term maintenance and enforcement of the LUC, long-term evaluation of MNA, long-term sampling; and long-term maintenance and operation of sampling equipment.

Alternatives 3 and 4 are also technically implementable, although less so than Alternative 2 because of the uncertainties associated with the effective field implementation of in situ bioremediation to lower contaminant levels and to enhance natural attenuation. These alternatives would be somewhat more difficult to implement due to the specialized expertise required for design and construction.

Administratively, all of the alternatives are implementable.

2.10.7 Cost

Cost estimates are used in the CERCLA process to eliminate those remedial alternatives that are significantly more expensive than competing alternatives without offering commensurate increases in performance or overall protection of human health or the environment. The cost estimates developed are preliminary estimates with an intended accuracy range of –30 to +50 percent. 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 2.8 percent. The estimates for Alternatives 2 and 4 utilize a 30-year project life for costing purposes, although the timeframe to achieve RAOs is expected to be longer. Alternative 3 would be expected to be complete approximately 10 years after injection.

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2, Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lowest present worth and capital costs of the remedial action alternatives. The highest capital cost is associated with Alternative 3 primarily due to the activities associated with the injection phase of in situ bioremediation into both plumes.

2.10.8 State/Support Agency Acceptance

The USEPA and TCEQ have reviewed the Proposed Plan, which presented Alternative 4 as the preferred alternative. Comments received from the USEPA and TCEQ during the Proposed Plan development have been incorporated. Both agencies concur with the selected remedial action.

2.10.9 Community Acceptance

Community acceptance is an important consideration in the final evaluation of the selected remedy. Public comments were received during the 60-day public comment period, including written comments sent to the U.S. Army and verbal comments made at the January 26, 2010 and March 9, 2010, public meetings. Two sets of comments were submitted by the public. Questions included: the timeframe to achieve MCLs, potential for contamination of surface water by groundwater, and adequacy of monitoring wells for determining the plume extent. Comment responses were provided and incorporated into the ROD, including clarification of times to restoration, surface water-groundwater interaction, and explanation of why current well locations provide satisfactory data for determining plume extent. Significant comments are

discussed in the Responsiveness Summary (**Section 3.0**). Responses to written comments have been filed in the Administrative Record.

2.11 Principal Threat Wastes

LHAAP-35A(58) has no known principal threat wastes (e.g., source materials such as DNAPLs).

2.12 The Selected Remedy

2.12.1 Summary of Rationale for the Selected Remedy

Alternative 4, in situ bioremediation followed by MNA and LUC for the eastern plume and MNA and LUC for the western plume, is the selected alternative for LHAAP-35A(58) and is consistent with the intended future use of the site as a wildlife refuge. This alternative is selected because it satisfies the RAOs for the site through groundwater use restriction LUC, which will ensure protection of human health by preventing human exposure to contaminated groundwater, and MNA and in situ bioremediation, which will return the contaminated water to its potential beneficial use as a drinking water, wherever practicable. The LUC will remain in place until cleanup levels are met. Furthermore, LTM will assure that human health and the environment are being protected by verifying that contaminated groundwater does not migrate into nearby surface water bodies at levels that exceed MCLs. The LTM and reporting associated with this remedy will continue until primary COC and daughter product cleanup levels are attained. Based on a preliminary natural attenuation evaluation and groundwater modeling, groundwater cleanup levels are expected to be met through natural attenuation in approximately 200 years in the western plume (Shaw, 2009) and within the same timeframe for the eastern plume. Considering the lithologic variability, particularly the lateral and vertical change from sand to clay, the times to the cleanup levels may vary. The groundwater flow rates are within the normal range for the formation material at these sites. Thus, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to cleanup levels. The selected alternative offers a high degree of long-term effectiveness, can be implemented, and costs less than the Alternative 3.

The performance of MNA in the western plume will be evaluated after two years of performance monitoring using data from eight quarterly sampling events and from the historical sampling events of the prior ten years. The performance objectives for groundwater remediation will be included in the RD. If it is found that the performance objectives are not met, a contingency remedy such as in situ bioremediation (see Alternative 3 description for basic elements) will be implemented, after approval of the RD for the contingency remedy. If MNA is found to be effective, the LTM program will be conducted as follows: 3 years of semiannual monitoring, then annual monitoring until the next five-year review, and then every 5 years until the cleanup levels are reached.

Based on the information currently available, the U.S. Army believes that the selected alternative provides the best balance of tradeoffs among the other alternatives with respect to the CERCLA §121(b) criteria used to evaluate remedial alternatives. The selected alternative will: 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize a permanent solution; and 5) utilize treatment as a principal element. No source materials constituting a principle threat will be addressed within the scope of this action.

The U.S. Army will present details of the LUC implementation plan, the groundwater monitoring plan, and the MNA remedy implementation in an RD for LHAAP-35A(58).

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

2.12.2 Description of the Selected Remedy

The selected remedy, Alternative 4, was outlined in **Section 2.9**; that description is expanded in the following discussion. The remedy may change somewhat as a result of the RD and construction processes. Changes to the remedy described in the ROD will be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences (ESD), or ROD amendment.

The major components of the remedy for the impacted groundwater include:

Eastern plume

- *In situ bioremediation in a target area that has the highest contaminant concentrations*. A bench-scale treatability study will be conducted to evaluate the effects of plume-specific conditions on the effectiveness of the bioremediation design, and the RD would be adjusted accordingly. Both nutrients and microbes will be injected. Following the study, bioremediation will be implemented in the target area. The treatment will be evaluated, and a second round of injections will be considered when the results from 6 quarterly sampling events are available.

- *MNA to reduce groundwater contamination to cleanup levels*. MNA will be implemented in the plume area that is outside of the target area. It will be evaluated as described below for the western plume. LTM will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).

- *LUC until the cleanup levels are achieved*. LUC for the eastern plume would be similar as those described below for the western plume.

Western plume

- *MNA to return groundwater to its potential beneficial use, wherever practicable*. Historic data suggests that natural attenuation of COCs is occurring at the site;

however, additional data collection is necessary to fully evaluate natural attenuation. Monitoring wells will be sampled for eight consecutive quarters to evaluate and confirm the occurrence of natural attenuation in conjunction with historical data. Data from the eight quarterly events will be combined with historic data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations.

- *Performance objectives to evaluate the MNA remedy performance after two years.* During the RD prior to implementing the remedy, the specific evaluation criteria will be developed. However, each of the general performance objectives must be met as indicated below. If the criteria are not met to illustrate that MNA is an effective remedy, a contingency action would be initiated. If MNA is effective, a baseline will be established from the data to this point in time. The MNA evaluation will be based on the USEPA lines of evidence (USEPA, 1999) and the anaerobic screening (USEPA, 1998) as follows:
  - MNA potential based on evaluating biodegradation screening scores using USEPA guidance
  - Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells)
  - MNA Process Evaluation demonstrated based on an attenuation rate calculated with empirical performance monitoring data and MNA Process Demonstration based on the presence of daughter products and bacterial culture counts
- *A contingency remedy to enhance MNA to reach the RAOs if MNA is found to be ineffective.* The contingency remedy will use elements from the active remedial alternative included in this ROD to address the ineffective aspects of MNA. The area and the elements of the contingency remedy would be selected based on the entire data set available. If a contingency remedy is implemented, it will be documented in an ESD.
- *Initiate LTM.* If MNA is determined to be effective, monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve or worsen after the baseline is established. Monitoring will continue after the initial eight quarters at a frequency of semiannual for three years, then annually until the next five-year review. The performance monitoring plan will be developed in the RD and will be based on USEPA guidance (USEPA, 2004).
- *Because of the historical levels of 1,1,2-TCA at LHAAP-35A(58), include 1,1,2-TCA and its daughter products (1,1-DCA, and chloroethane) in the LTM program until their cleanup levels are attained*. The cleanup levels are shown in **Table 2-8**.

  - *Continue LTM every five years to evaluate remedy performance and determine if plume conditions remain constant, improve, or worsen.* The baseline of the plume for future five-year reviews will be established as part of the MNA evaluation program. The initial LTM plan will be developed during RD.

- *LUC to restrict access to the contaminated groundwater to environmental monitoring and testing only until cleanup levels are reached.* LUC implementation details will be included in the RD. The recordation notification for the site which will be filed with Harrison County will include a description of the LUC. The boundary of the LUC would enclose the site boundaries and the plume boundaries shown on **Figure 2-8**.

The U.S. Army would be responsible for implementation, maintenance, inspection, reporting, and enforcement of the LUC. 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: (1) CERCLA §121(c) five-year reviews; (2) notification of the appropriate regulators of any known LUC deficiencies or violations; (3) access to the property to conduct any necessary response; (4) reservation of the authority to change, modify or terminate the LUC and any related transfer or lease provisions; and (5) ensuring that the LUC objectives are met to protect the integrity of the selected remedy. In the event that TCEQ and/or USEPA and the U.S. Army agree with respect to any modification of the selected remedy, including the LUC component of the selected remedy, the remedy will be changed consistent with the FFA and 40 CFR 300.435(c)(2) and 40 CFR 300.430(f)(4)(iii).

LUC implementation and maintenance actions would be described in the RD for LHAAP-35A(58). The selected LUC will prevent human exposure to groundwater contaminated with chlorinated solvents and perchlorate through the restriction of groundwater use. The groundwater restriction LUC shall be maintained until the concentrations of contaminants and by-product (daughter) contaminants have been reduced to below their respective cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to allow unlimited use and unrestricted exposure at LHAAP-35A(58). The LUC would be included in the property transfer documents. In addition, the Texas Department of Licensing and Regulation responsible for notifying well drillers of groundwater restrictions would be notified and a recordation of the area of groundwater restriction would be filed in the Harrison County Courthouse.

Monitoring activities associated with the LUC and MNA would be undertaken to ensure that groundwater is not being used, and to demonstrate containment of the plume and the eventual reduction of contaminates to levels below cleanup levels.

Long-term operational requirements under this alternative would include maintenance of the LUC. The need for continued monitoring will be evaluated every five years during the reviews. Sampling frequency and analytical requirements will be presented in the RD for LHAAP-35A(58).

2.12.3 Cost Estimate for the Selected Remedy

Table 2-10 presents the present worth analysis of the cost for the selected remedy, Alternative 4. The information in the table is based on the best available information regarding the anticipated scope of the remedial alternative. The quantities used in the estimate are for estimating purposes only. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within -30 to +50 percent of the actual project cost.

The total project present worth cost of this alternative is approximately $785,000, using a discount rate of 2.8%. The capital cost is estimated at $191,000. The total O&M present value cost is estimated at approximately $594,000. The O&M cost includes evaluation of MNA, maintenance of LUC, and LTM through Year 30. The LTM would support the required CERCLA five-year reviews.

2.12.4 Expected Outcomes of Selected Remedy

The purpose of this response action is to attain the RAOs stated in **Section 2.8** of this document. **Table 2-8** presents the cleanup levels. The cleanup levels for the COCs in the groundwater are the Federal SDWA MCLs or if no MCL exists for that chemical, the cleanup level is the GW-Ind (TCEQ, 2006).

The expected outcome of the selected remedy is that the VOC plumes in the groundwater would be reduced to the cleanup levels. Achievement of the cleanup levels is anticipated to be completed in 200 years. When the contaminants in the groundwater reach cleanup levels, the LUC will be removed. In the short-term (prior to the groundwater achieving cleanup levels), the site will be made part of a national wildlife refuge operated by USFWS, and will continue as such in the long-term (after the groundwater achieves cleanup levels).

In addition, the monitoring activities associated with MNA would assure the protection of human health and the environment by documenting the return of the groundwater to its potential beneficial use as a drinking water supply, by documenting reduction of the contaminant mass and protection of surface water through containment of the plume. Until that time, the LUC will restrict the use of the site's groundwater to environmental monitoring and testing.

2.13 Statutory Determinations

Under CERCLA §121 and the NCP, the U.S. Army must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA

includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets the statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy, Alternative 4, will achieve the RAOs for LHAAP-35A(58). For the western plume, this alternative does not provide for human intervention to remediate groundwater; the alternative is a passive subsurface remedial action conducted natural processes and mechanisms. For the eastern plume, the alternative does utilize active treatment. This alternative would eventually achieve the destruction of the COCs present in the groundwater plumes at LHAAP-35A(58) to protective ARAR levels. Continued maintenance of the LUC would prevent human access and exposure to groundwater that poses an unacceptable risk to human health, until COCs have sufficiently degraded to below the action levels. Therefore, the residual risk upon completion of the remedial actions will be within the risk range for the hypothetical future maintenance worker. At LHAAP-35A(58) the evaluation of historical groundwater contaminant trends indicates that natural attenuation processes are occurring at the site and have stabilized the western plume and slowed the migration of the eastern plume. The monitoring activities associated with MNA will ensure that COCs and by-product (daughter) contaminants in groundwater do not discharge to nearby surface water bodies at such levels that ARARs are exceeded.

Additionally, the results of plume migration modeling for LHAAP-35A(58), which assumes that discharge could occur into Goose Prairie Creek, indicated that the maximum concentrations of the COCs at the point of entry of the groundwater into Goose Prairie Creek, after plume impact, would not be detected, or if detected would be below groundwater and surface water ARARs, which would also be protective of Caddo Lake (see **Section 2.5.5**).

Hazardous substances detected in soil at the site were considered to represent no threat to the environment, and it was determined that no remediation for the protection of ecological receptors was necessary at LHAAP-35A(58) (Shaw, 2007a).

2.13.2 Compliance with ARARs

The selected remedy complies with all ARARs. The ARARs are presented below and in **Table 2-11**.

Chemical-Specific ARARs

The chemical-specific ARAR is to reduce the contaminants in groundwater to Federal SDWA MCLs or GW-Ind when no MCL is available, as presented in **Table 2-8**. This alternative will return the contaminated shallow groundwater zone at LHAAP-35A(58) to its potential beneficial

use as drinking water, wherever practicable, which for the purposes of this ROD is considered to be attainment of the relevant and appropriate cleanup levels (SDWA MCLs or GW-Ind if no MCL is available) to the extent practicable, and consistent with 40 CFR 300.430(e)(2)(i)(B&C) and 30 TAC 335. If a return to potential beneficial uses is not practicable, this alternative would still meet the NCP expectation to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Because modeling results indicate that maximum concentrations of COCs would be below their respective cleanup levels in the nearby surface water bodies where groundwater discharges, nearby surface water bodies will be protected from ARAR exceedances. In the event of remedy failure resulting in or potentially resulting in a release to surface water, 40 CFR 122, 125, 129, 130, and 131 and 30 TAC 307.1, 307.2, 307.3, 307.4, 307.5(a) and (b), 307.6, 307.7, 307.8 and 307.9 are considered potential future ARARs.

Location-Specific ARARs

There are no location-specific ARARs associated with this alternative.

Action-Specific ARARs

The selected remedy has potential action-specific ARARs related to the following activities: waste generation, characterization, management, storage, and disposal activities; and well construction.

- **Waste and disposal activities**: The processes of monitoring, intercepting, or treating contaminated groundwater may generate a variety of primary and secondary waste streams (e.g., soil, personal protective equipment, and dewatering and decontamination fluids). These waste streams are expected to be non-hazardous waste. All solid waste (defined as any solid, liquid, semisolid, or contained gaseous material intended for discard [40 CFR 261.2]) generated during remedial activities must be appropriately characterized to determine whether it contains RCRA hazardous waste (40 CFR 262.11; 30 TAC 335.62; 30 TAC 335.503[a][4]; 30 TAC 335.504). All wastes must be managed, stored, treated (if necessary), and disposed of in accordance with the ARARs for waste management listed in **Table 2-11** for the particular type of waste stream or contaminants in the waste.

- **Well construction**: The remedial action may involve the placement, use, or eventual plugging and abandonment of some type of groundwater monitoring, injection, and/or extraction wells, either for in situ treatment of the contaminated groundwater or for LTM of the groundwater. Available standards for well construction and plugging/abandonment would provide ARARs for such actions and include 30 TAC 331, Subchapters A, C, and H. Texas has promulgated technical requirements in Chapter 76 of Title 16 of the TAC applicable to construction, operation, and plugging/abandonment of water wells. In particular, 16 TAC 76.1000 (*Locations and Standards of Completion for Wells*), 16 TAC 76.1002 (*Standards for Wells Producing Undesirable Water or Constituents*) (LHAAP-35A[58] contaminated groundwater could be considered "undesirable water" defined pursuant to Section 76.10[36] as

"water that is injurious to human health and the environment or water that can cause pollution to land or other waters"), 16 TAC 76.1004 (*Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones*), and 16 TAC 76.1008 (*Pump Installation*) may provide ARARs for the placement, construction, and eventual plugging/abandonment of groundwater injection or extraction wells or the placement and long-term operation of groundwater monitoring wells for proposed groundwater remedial strategies.

- **Water Treatment**: Contaminated groundwater and wastewaters collected during well drilling or decontamination activities could be transported to the groundwater treatment plant at LHAAP-18/24 for processing, and would subsequently be discharged in compliance with the effluent limits for that plant. Such waters would be characterized, as required, before transport and managed accordingly in compliance with requirements for the type of waste contaminating the water. To assure compliance with the groundwater treatment plant's discharge limits, the incoming water must meet the waste acceptance criteria for the facility. On-site wastewater treatment units (as defined in 40 CFR 260.10) that are part of a wastewater treatment facility that is subject to regulation under Section 402 or Section 307(b) of the Clean Water Act of 1972 are not subject to RCRA Subtitle C hazardous waste management standards (40 CFR 270.1[c][2][v]; 40 CFR 264.1[g][6]; 30 TAC 335.42[d][1]). The USEPA has clarified that this exemption applies to all tanks, conveyance systems, and ancillary equipment, including piping and transfer trucks, associated with the wastewater treatment unit (Federal Register [FR] Title 53, 34079, September 2, 1988).

2.13.3 Cost-Effectiveness

The progression of present worth costs from the least expensive alternative to the most expensive alternative is as follows: Alternative 1, Alternative 2 (with no contingency implemented), Alternative 4, and Alternative 3. No costs are associated with Alternative 1 because no remedial activities would be conducted. Alternative 2 has the lowest present worth and capital costs of the remediation alternatives (Alternatives 2 through 4). The present worth costs for Alternative 2 is lower than that of Alternatives 3 and 4, primarily due to the costs and activities associated with the installation of the bioremediation system and the two injection phases of in situ bioremediation for the eastern plume. Alternative 3 is approximately 71% more than the cost of Alternative 4.

Table 2-10 is the cost estimate summary table for the selected remedy. **Table 2-9** compares the cost and effectiveness of each alternative.

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

For the eastern plume, the selected remedy addresses the issue of permanent solution through treatment with in situ bioremediation. For the western plume, the selected remedy does not

address the issue of a permanent solution through disposal, treatment, or recovery of contaminants. The selected remedy provides the best balance of trade offs in terms of five balancing criteria and considering State and community acceptance. Alternative 4 would document effectiveness through the confirmation of MNA and the routine monitoring of the attenuation and migration of the contaminants in groundwater. Natural attenuation effectively controls plume migration and has stabilized the size of the western plume area exhibiting COC and by-product (daughter) contaminant concentrations exceeding cleanup levels. Natural biodegradation is an irreversible treatment process that would reduce the mass and concentration of contaminants. Alternative 4 would provide almost immediate protection because the LUC would be implemented relatively quickly. Maintenance of these controls would be required until natural attenuation processes reduce COC and by-product (daughter) contaminant concentrations to below cleanup levels. Alternative 4 is easily implemented from a technical standpoint; it requires in situ bioremediation in the eastern plume, routine maintenance of the LUC, evaluation of MNA, and sampling. Alternative 4 has a moderate present worth and capital cost compared to the other remedial alternatives.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy would reduce the toxicity, mobility, or volume of contaminants in the groundwater through an active remedial process. By utilizing in situ bioremediation as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied. In addition, there is no known principal threat material in the groundwater and there is no known source of groundwater contamination in soils remaining at LHAAP-35A(58).

2.13.6 Five-Year Review Requirements

Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C) provide the statutory and legal basis for conducting five-year reviews. Because the final remedy will result in contaminants that remain on site above levels that allow unlimited use and unrestricted exposure, a review will be conducted at least every five years to ensure that the remedy continues to provide adequate protection of human health and the environment.

2.14 Significant Changes from the Proposed Plan

The Proposed Plan for LHAAP-35A(58) was released for public comments on January 25, 2010. The Proposed Plan identified Alternative 4 as the Preferred Alternative for groundwater remediation. The U.S. Army reviewed all written and verbal comments submitted during the public comment period. After careful consideration of the comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

Table 2-1
Summary of Chemicals of Concern and Medium Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Concentration Detected[1] (mg/L)		Frequency of Detection	Exposure Point Concentration (mg/L)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	*Volatile Organic Compounds*					
	1,1,2-Trichloroethane	1.60E-03	8.00E-03	4/35	8.00E-03	maximum
	1,1-Dichloroethene	1.30E-03	1.34E+00	7/35	1.34E+00	maximum
	1,2-Dichloroethane	5.10E-04	3.00E-03	4/35	3.00E-03	maximum
	Benzene	2.20E-04	8.00E-04	2/35	8.00E-04	maximum
	Methylene Chloride	9.70E-04	9.70E-04	1/35	9.70E-04	maximum
	Tetrachloroethene	2.70E-04	5.40E+00	9/35	5.40E+00	maximum
	Trichloroethene	4.30E-04	1.60E-01	12/35	1.60E-01	maximum
	Vinyl Chloride	6.20E-04	1.00E-02	4/35	1.00E-02	maximum
	Semi-Volatile Organic Compounds					
	bis(2-Ethylhexyl)phthalate	1.00E-03	8.80E-02	4/30	8.80E-02	maximum
	Metals					
	Aluminum	2.56E-01	9.82E+01	29/33	9.82E+01	maximum
	Antimony	1.00E-02	1.30E-02	2/35	1.30E-02	maximum
	Beryllium	5.00E-04	3.70E-03	9/27	3.70E-03	maximum
	Cadmium	9.00E-04	2.00E-03	2/35	2.00E-03	maximum
	Chromium	1.00E-02	2.80E+00	33/35	2.80E+00	maximum
	Cobalt	3.10E-03	2.50E-01	10/35	2.50E-01	maximum
	Lead	7.00E-03	9.00E-02	10/35	9.00E-02	maximum
	Manganese	4.90E-02	5.80E+00	34/35	5.80E+00	maximum
	Nickel	4.00E-02	1.10E+00	22/27	1.10E+00	maximum
	Selenium	2.80E-03	6.58E-02	10/35	6.58E-02	maximum
	Strontium	1.50E-01	2.30E+01	35/35	2.30E+01	maximum
	Thallium	1.10E-03	3.60E-03	7/35	3.60E-03	maximum
	Vanadium	3.00E-02	5.60E-02	4/27	5.60E-02	maximum
	Pesticides					
	Aldrin	6.30E-06	6.30E-06	1/4	6.30E-06	maximum
	alpha-BHC	7.60E-06	7.60E-06	1/4	7.60E-06	maximum
	beta-BHC	5.40E-06	5.40E-06	1/4	5.40E-06	maximum
	delta-BHC	4.60E-06	4.60E-06	1/4	4.60E-06	maximum
	Explosive					
	RDX	1.80E-03	8.83E-02	3/30	8.83E-02	maximum
	Anion					
	Perchlorate	1.00E-02	3.69E-02	2/3	8.10E-02	---

Table 2-1 *(continued)*
Summary of Chemicals of Concern and Medium Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil (0 to 2 feet below ground surface)

Exposure Point	Chemical	Concentration Detected[1] (mg/kg)		Frequency of Detection	Exposure Point Concentration (mg/kg)	Statistical Measure
		Minimum	Maximum			
Ingestion, inhalation, dermal contact	*Semi-Volatile Organic*					
	Benzo(a)anthracene	5.10E-02	1.60E+00	4/30	1.60E+00	maximum
	Benzo(a)pyrene	1.50E-01	2.00E+00	3/30	2.00E+00	maximum
	Benzo(b)fluoranthene	8.80E-02	3.10E+00	5/30	3.10E+00	maximum
	Bis(2-Ethylhexyl)phthalate	7.00E-02	2.00E+02	7/30	2.00E+02	maximum
	Dibenzo(a,h)anthracene	3.70E-02	3.00E-01	2/30	3.00E-01	maximum
	Indeno(1,2,3-cd)pyrene	1.20E-01	2.10E+00	2/30	2.10E+00	maximum
	Metals					
	Aluminum	1.80E+03	1.63E+04	30/30	9.23E+03	95% UCL
	Antimony	3.40E+00	8.50E+00	2/30	8.50E+00	maximum
	Cadmium	1.10E+00	1.85E+01	5/30	1.85E+01	maximum
	Mercury	8.80E-02	4.37E+01	4/28	4.37E+01	maximum
	Silver	7.66E-01	1.09E+02	4/30	1.09E+02	maximum
	Vanadium	7.00E+00	6.60E+01	13/13	5.12E+01	95% UCL
	Dioxin/Furan					
	2,3,7,8-TCDD	---	---	---	2.53E-05	maximum

Notes

[1] Minimum/maximum detected concentration above the reporting limit
---: No information available
95% UCL: 95% upper confidence level of the mean
µg/L: micrograms per liter
mg/kg: milligrams per kilogram
TCDD: tetrachlorodibenzo-p-dioxin

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Summary of Chemicals of Potential Concern and Medium-Specific Exposure Point Concentrations

The table presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each (i.e. the concentration used to estimate the exposure and risk from each COPC). The table includes the range of concentrations detected for each COPC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and the statistical measure upon which the EPC was based. The COPCs listed are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).
The EPCs for bis(2-ethylhexyl)phthalate, aluminum, perchlorate, and RDX became invalid for the risk assessment for LHAAP-35A(58) when the site boundary was redefined. This is further discussed in Section 2.7.1.5.

Table 2-2
Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact				
Chemical of Concern	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Volatile Organic Compounds				
1,1,2-Trichloroethane	5.70E-02	7.04E-02	C	USEPA-IRIS, 2001
1,1-Dichloroethene	6.00E-01	6.00E-01	C	USEPA-IRIS, 2001
1,2-Dichloroethane	9.10E-02	9.10E-02	B2	USEPA-IRIS, 2001
Benzene	5.50E-02	5.67E-02	A	USEPA-IRIS, 2001
Methylene Chloride	7.50E-03	7.89E-03	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.20E-02	5.20E-02	B2	USEPA-IRIS, 2001
Trichloroethene	1.10E-02	1.10E-02	B2	USEPA-IRIS, 2001
Vinyl Chloride	1.50E+00	1.50E+00	A	USEPA-IRIS, 2001
Semivolatile Organics				
bis(2-Ethylhexyl)phthalate	1.40E-02	7.37E-02	B2	USEPA-IRIS, 2001
Metals				
Aluminum	NTV	NTV	not classified	---
Antimony	NTV	NTV	not classified	---
Beryllium	NTV	NTV	B1	USEPA-IRIS, 2001
Cadmium(Water)	NTV	NTV	B1	TCEQ, 2001
Chromium	NC	NC	not classified	---
Cobalt	NTV	NTV	not classified	---
Lead	NTV	NTV	not classified	---
Manganese	NC	NC	D	USEPA-IRIS, 2001
Nickel	NTV	NTV	A	USEPA-IRIS, 2001
Selenium	NC	NC	D	USEPA-IRIS, 2001
Strontium	NTV	NTV	not classified	---
Thallium	NC	NC	not classified	---
Vanadium	NTV	NTV	not classified	---
Pesticides				
Aldrin	1.70E+01	3.40E+01	B2	USEPA-IRIS, 2001
alpha-BHC	6.30E+00	6.49E+00	B2	USEPA-IRIS, 2001
beta-BHC	1.80E+00	1.98E+00	C	USEPA-IRIS, 2001
delta-BHC	1.80E+00	3.60E+00	B2	TCEQ, 2001
Explosive				
RDX	1.10E-01	1.10E-01	C	USEPA-IRIS, 2001
Anion				
Perchlorate	NTV	NTV	not classified	---

Table 2-2 *(continued)*
Carcinogenic Toxicity Data Summary

Pathway: Inhalation			
Chemical of Concern	Unit Risk Factor $(mg/m^3)^{-1}$	Weight of Evidence/ Carcinogen Guideline Description	Source/Date
Volatile Organic Compounds			
1,1,2-Trichloroethane	1.60E-05	C	USEPA-IRIS, 2001
1,1-Dichloroethene	5.00E-02	C	USEPA-IRIS, 2001
1,2-Dichloroethane	2.60E-02	B2	USEPA-IRIS, 2001
Benzene	7.80E-06	A	USEPA-IRIS, 2001
Methylene Chloride	4.70E-04	B2	USEPA-IRIS, 2001
Tetrachloroethene	5.80E-07	B2	USEPA-IRIS, 2001
Trichloroethene	1.70E-03	B2	USEPA-IRIS, 2001
Vinyl Chloride	8.80E-03	A	USEPA-IRIS, 2001
Semivolatile Organic Compounds			
bis(2-Ethylhexyl)phthalate	4.00E-03	B2	USEPA-IRIS, 2001
Metals			
Aluminum	NTV	not classified	---
Antimony	NTV	not classified	---
Beryllium	2.40E+00	B1	USEPA-IRIS, 2001
Cadmium(Water)	1.80E+00	B1	TCEQ, 2001
Chromium	NC	not classified	---
Cobalt	NTV	not classified	---
Lead	NTV	not classified	---
Manganese(Non-Diet)	NC	D	USEPA-IRIS, 2001
Manganese(Food)	NC	D	TCEQ, 2001
Nickel	4.80E-01	A	USEPA-IRIS, 2001
Selenium	NC	D	USEPA-IRIS, 2001
Strontium	NTV	not classified	---
Thallium	NC	not classified	---
Vanadium	NTV	not classified	---
Pesticides			
Aldrin	4.90E-03	B2	USEPA-IRIS, 2001
alpha-BHC	1.80E-03	B2	USEPA-IRIS, 2001
beta-BHC	5.30E-04	C	USEPA-IRIS, 2001
delta-BHC	5.10E-04	B2	TCEQ, 2001
Explosive			
RDX	NTV	C	USEPA-IRIS, 2001
Anion			
Perchlorate	NTV	not classified	---

Table 2-2 *(continued)*
Carcinogenic Toxicity Data Summary

Notes

--- : No information available
BHC: benzenehexachloride (hexachlorocyclehexane)
mg/kg-day: milligrams per kilogram per day
mg/m^3: milligrams per cubic meter
NC: Chemical not classified as a carcinogen
NTV: no toxicity value available
RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine

Weight of Evidence/Carcinogen Guideline Description:

A - Human carcinogen
B1- Probable human carcinogen – Indicates that limited human data are available
B2- Probable human carcinogen – Indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March 2001.

U.S. Environmental Protection Agency (USEPA)-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001.

Summary of Toxicity Assessment

The table provides carcinogenic risk information which is relevant to the contaminants of potential concern in soil and ground water. The list of chemicals of concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003).

Table 2-3
Non-Carcinogenic Toxicity Data Summary

Pathway: Ingestion, Dermal Contact						
Chemical of Concern	Chronic/ Subchronic	Oral RfD Value mg/kg-day	Dermal RfD mg/kg-day	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Volatile Organics						
1,1,2-Trichloroethane	Chronic	4.00E-03	3.24E-03	Blood alterations	1000/1	USEPA-IRIS, 2001
1,1-Dichloroethene	Chronic	9.00E-03	9.00E-03	Hepatic lesions	1000/1	USEPA-IRIS, 2001
1,2-Dichloroethane	NA	3.00E-02	3.00E-02	NA	NA	USEPA-NCEA, 2001
Benzene	NA	3.00E-03	2.91E-03	NA	NA	USEPA-NCEA, 2001
Methylene Chloride	Chronic	6.00E-02	5.70E-02	Liver toxicity	100/1	USEPA-IRIS, 2001
Tetrachloroethene	Chronic	1.00E-02	1.00E-02	Hepatotoxicity, weight gain	1000/1	USEPA-IRIS, 2001
Trichloroethene	NA	6.00E-03	6.00E-03	NA	NA	---
Vinyl Chloride	Chronic	3.00E-03	3.00E-03	Liver cell polymorphism	30/1	USEPA-IRIS, 2001
Semivolatile Organics						
bis(2-Ethylhexyl)phthalate	Chronic	2.00E-02	3.80E-03	Liver effects	1000/1	USEPA-IRIS, 2001
Metals						
Aluminum	NA	1.00E+00	1.00E-01	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	4.00E-04	6.00E-05	blood	1000/1	USEPA-IRIS, 2001
Beryllium	Chronic	2.00E-03	1.40E-05	Small Intestine	300/1	USEPA-IRIS, 2001
Cadmium(Water)	Chronic	5.00E-04	1.25E-05	Proteinuria	10/1	USEPA-IRIS, 2001
Chromium	Chronic	1.50E+00	1.95E-02	No effects observed	100/10	USEPA-IRIS, 2001
Cobalt	NA	2.00E-02	1.60E-02	NA	NA	---
Lead	NA	NTV	NTV	NA	NA	---
Manganese (Non-diet)	Chronic	4.70E-02	2.82E-03	CNS	1/1	USEPA-IRIS, 2001
Nickel	Chronic	2.00E-02	8.00E-04	Decreased body weight	300/1	USEPA-IRIS, 2001
Selenium	Chronic	5.00E-03	2.50E-03	Skin	3/1	USEPA-IRIS, 2001
Strontium	Chronic	6.00E-01	1.20E-01	Rachitic bone	300/1	USEPA-IRIS, 2001
Thallium	Chronic	8.00E-05	8.00E-05	Blood	3000/1	USEPA-IRIS, 2001
Vanadium	NA	7.00E-03	1.82E-04	NA	NA	---
Pesticides						
Aldrin	Chronic	3.00E-05	1.50E-05	Liver	1000/1	USEPA-IRIS, 2001
alpha-BHC	NA	8.00E-03	7.76E-03	NA	NA	ATSDR, 1997
beta-BHC	NA	NTV	NTV	NA	NA	---
delta-BHC	NA	3.00E-04	1.50E-04	NA	NA	TCEQ-derived
Explosive						
RDX	Chronic	3.00E-03	3.00E-03	Inflammation of the prostate	100/1	USEPA-IRIS, 2001
Anion						
Perchlorate	Chronic	9.00E-04	9.00E-04	NA	NA	USEPA, 1998

Table 2-3 *(continued)*
Non-Carcinogenic Toxicity Data Summary

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC mg/m^3	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source/Date
Volatile Organics					
1,1,2-Trichloroethane	---	NTV	---	---	---
1,1-Dichloroethene	---	NTV	---	---	---
1,2-Dichloroethane	NA	0.005	NA	NA	USEPA-NCEA, 2001
Benzene	NA	0.006	NA	NA	USEPA-NCEA, 2001
Methylene Chloride	Chronic	3	Liver toxicity	100/1	USEPA-HEAST, 1997
Tetrachloroethene	NA	0.49	NA	NA	USEPA-NCEA, 2001
Trichloroethene	---	NTV	---	---	---
Vinyl Chloride	Chronic	0.1	Liver	30/1	USEPA-IRIS, 2001
Semivolatile Organics					
bis(2-Ethylhexyl)phthalate	---	NTV	---	---	---
Metals					
Aluminum	NA	0.0035	NA	NA	USEPA-NCEA, 2001
Antimony	Chronic	0.0005	Pulmonary toxicity, chronic interstitial inflammation	300/1	USEPA- IRIS, 2001
Beryllium	Chronic	0.00002	Lungs	10/1	USEPA-IRIS, 2001
Cadmium(Water)	NA	0.0002	NA	NA	USEPA-NCEA, 2001
Chromium	NA	0.0001	NA	NA	TCEQ, 2001
Cobalt	NA	0.0000175	NA	NA	USEPA-NCEA, 2001
Lead	---	NTV	---	---	---
Manganese(Non-diet)	Chronic	0.00005	Impairment of neurobehavioral function	1000/1	USEPA-IRIS, 2001
Nickel	Chronic	0.0002	Respiratory effects	NA	ATSDR, 1997
Selenium	NA	0.0002	NA	NA	TCEQ, 2001
Strontium	---	NTV	---	---	---
Thallium	NA	0.0001	NA	NA	TCEQ, 2001
Vanadium	NA	0.00005	NA	NA	TCEQ, 2001
Pesticides					
Aldrin	---	NTV	---	---	---
alpha-BHC	---	NTV	---	---	---
beta-BHC	---	NTV	---	---	---
delta-BHC	---	NTV	---	---	---
Explosive					
RDX	NA	0.0005	NA	NA	TCEQ, 2001
Anion					
Perchlorate	---	NTV	---	---	---

Table 2-3 *(continued)*
Non-Carcinogenic Toxicity Data Summary

Notes

---: No information for a compound with no toxicity value (NTV)
BHC: benzenehexachloride (hexachlorocyclehexane)
CNS: Central nervous system
IRIS: Integrated Risk Information System, USEPA
mg/kg-day: milligrams per kilogram per day
mg/m^3: milligrams per cubic meter
NA: Information not available
NTV: No toxicity value available
RDX: 1,3,5-Trinitroperhydro-1,3,5-triazine
RfC: Reference concentration
RfD: Reference dose

References

Agency for Toxic Substances and Disease Registry (ATSDR), 1997, Minimal Risk Levels (MRLs) for Hazardous Substances.

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Texas Commission on Environmental Quality (TCEQ), 2001. Update to 1998 Consistency Memorandum. Toxicity Factors Table, 15 March, 2001.

U.S. Environmental Protection Agency (USEPA), 1998. *Perchlorate Environmental Contamination Toxicological Review and Risk Characterization based on Emergency Information*, Review Draft, Office of Research and Development. NCEA-1-0503, 31 December, 1998.

USEPA-HEAST, 1997. Health Effects Summary Table (HEAST). FY 1995, Annual Office of Emergency and Remedial Response. Washington, D.C. EPA/340/R-95-036.

USEPA-IRIS, 2001. Integrated Risk Information System (IRIS). United States Environmental Protection Agency Online Database for Toxicity Information on Hazardous Chemicals, 2001.

USEPA-NCEA, 2001. USEPA Region 3 Risk-Based Concentration Tables (5/8/2001). Referenced values from National Center for Environmental Assessment (NCEA).

Summary of Toxicity Assessment

This table provides non-carcinogenic risk information relevant to the contaminants of concern in both soil and ground water. The list of chemicals of potential concern presented here are the ones that were quantitatively evaluated for carcinogenic risk and non-carcinogenic hazard in the Baseline Human Health Risk Assessment (Jacobs, 2003). The uncertainty factor and modifying factor are used in the development of a references dose. The uncertainty factor adjusts results from dose-response studies in animals to make them applicable to humans. The modifying factor is used to account for uncertainties in the available toxicity data from which the reference dose is derived. In the risk assessment, the reference doses and concentrations were for the chronic case, to be conservative.

Table 2-4
Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Ingestion or exposure through showering	*Anion*				
			Perchlorate	NTV	NE	NE (Kp<=0.01)	N/A
			Explosives				
			RDX	3.4E-05	NE	NE (Kp<=0.01)	3.4E-05
			Pesticides				
			Aldrin	3.7E-07	NE	NE (Kp<=0.01)	3.7E-07
			alpha-BHC	1.7E-07	NE	2.1E-08	1.9E-07
			beta-BHC	3.4E-08	NE	4.6E-09	3.9E-08
			delta-BHC	2.9E-08	NE	4.7E-09	3.4E-08
			Metals				
			Aluminum	NTV	NE	NE (Kp<=0.01)	N/A
			Antimony	NTV	NE	NE (Kp<=0.01)	N/A
			Beryllium	NTV	NE	NE (Kp<=0.01)	N/A
			Cadmium	NTV	NE	NE (Kp<=0.01)	N/A
			Chromium	NC	NE	NE (Kp<=0.01)	N/A
			Cobalt	NTV	NE	NE (Kp<=0.01)	N/A
			Lead	NTV	NE	NE (Kp<=0.01)	N/A
			Manganese	NC	NE	NE (Kp<=0.01)	N/A
			Nickel	NTV	NE	NE (Kp<=0.01)	N/A
			Selenium	NC	NE	NE (Kp<=0.01)	N/A
			Strontium	NTV	NE	NE (Kp<=0.01)	N/A
			Thallium	NC	NE	NE (Kp<=0.01)	N/A
			Vanadium	NTV	NE	NE (Kp<=0.01)	N/A
			Semivolatile Organics				
			Bis(2-ethylhexyl)phthalate	4.3E-06	NE	2.8E-06	7.1E-06
			Volatile Organics				
			1,1,2-Trichloroethane	1.6E-06	7.8E-09	1.4E-06	3.0E-06
			1,1-Dichloroethene	2.8E-03	4.1E-03	3.8E-03	1.1E-02
			1,2-Dichloroethane	9.5E-07	4.8E-06	4.4E-07	6.2E-06
			Benzene	1.5E-07	3.8E-10	1.1E-08	1.7E-07
			Methylene chloride	2.5E-08	2.8E-08	NE (Kp<=0.01)	5.3E-08
			Tetrachloroethene	9.8E-04	1.9E-07	3.9E-03	4.9E-03
			Trichloroethene	6.2E-06	1.7E-05	8.2E-06	3.1E-05
			Vinyl Chloride	5.2E-05	5.4E-06	NE (Kp<=0.01)	5.8E-05
						Groundwater risk total =	1.6E-02

Table 2-4 *(continued)*
Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, and dermal contact	*Dioxin/Furan*				
			2,3,7,8-TCDD	1.3E-06	4.4E-11	5.1E-07	1.8E-06
			Metals				
			Aluminum	NTV	NTV	NTV	NA
			Antimony	NTV	NTV	NTV	NA
			Cadmium	NTV	1.8E-09	NTV	1.8E-09
			Mercury	NC	NC	NC	NA
			Silver	NC	NC	NC	NA
			Vanadium	NTV	NTV	NTV	NA
			Semivolatile Organics				
			Benzo(a)anthracene	4.1E-07	7.4E-15	3.8E-07	7.9E-07
			Benzo(a)pyrene	5.1E-06	9.3E-14	4.8E-06	9.9E-06
			Benzo(b)fluoranthene	7.9E-07	1.4E-11	7.4E-07	1.5E-06
			Bis(2-ethylhexyl)phthalate	9.8E-07	4.2E-11	3.3E-06	4.3E-06
			Dibenzo(a,h)anthracene	7.7E-07	1.4E-14	7.2E-07	1.5E-06
			Indeno(1,2,3-cd)pyrene	5.4E-07	9.8E-15	5.0E-07	1.0E-06
						Soil risk total =	2.1E-05
						Total risk (soil and groundwater) =	1.6E-02

Notes

BHC	benzenehexachloride (hexachlorocyclehexane)
Kp	Dermal permeability coefficient
N/A	Not applicable
NC	Not classified as a carcinogen
NE	Not evaluated through this exposure pathway. Chemical is not identified as volatile.
NE(Kp<=0.01)	Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
NTV	No toxicity value available to quantitatively address this exposure
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
TCDD	Tetrachlorodibenzo-p-dioxin

References

USEPA, *Supplemental Region VI Risk Assessment Guidance, May 5, 1995*.

Summary of Risk Characterization

The table provides risk estimates for the significant routes of exposure at LHAAP-35A(58). These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a hypothetical future maintenance worker's exposure to soil and groundwater, as well as the toxicity of the chemicals of concern. The total risk from exposure to contaminated soil and groundwater at this site is estimated to be 1.6×10^{-2}. A risk below 1×10^{-4} is generally considered to be acceptable. The soil risk is acceptable, while the groundwater risk is unacceptable.

Table 2-5
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Ingestion or exposure through showering	*Explosives*					
			RDX	Prostate	2.9E-01	NE	NE (Kp<=0.01)	2.9E-01
			Metals					
			Aluminum	N/A	9.6E-01	NE	NE (Kp<=0.01)	9.6E-01
			Antimony	Blood	3.2E-01	NE	NE (Kp<=0.01)	3.2E-01
			Beryllium	Small intestine	1.8E-02	NE	NE (Kp<=0.01)	1.8E-02
			Cadmium	Proteinuria	3.9E-02	NE	NE (Kp<=0.01)	3.9E-02
			Chromium	No effects observed	1.8E-02	NE	NE (Kp<=0.01)	1.8E-02
			Cobalt	N/A	1.2E-01	NE	NE (Kp<=0.01)	1.2E-01
			Lead	N/A	NTV	NE	NE (Kp<=0.01)	N/A
			Manganese	CNS	1.2E+00	NE	NE (Kp<=0.01)	1.2E+00
			Nickel	Body weight	5.4E-01	NE	NE (Kp<=0.01)	5.4E-01
			Selenium	Skin	1.3E-01	NE	NE (Kp<=0.01)	1.3E-01
			Strontium	Bone	3.8E-01	NE	NE (Kp<=0.01)	3.8E-01
			Thallium	Blood	4.4E-01	NE	NE (Kp<=0.01)	4.4E-01
			Vanadium	N/A	7.8E-02	NE	NE (Kp<=0.01)	7.8E-02
			Anion					
			Perchlorate	N/A	8.8E-01	NE	NE (Kp<=0.01)	8.8E-01
			Pesticides					
			Aldrin	Liver	2.1E-03	NE	NE (Kp<=0.01)	2.1E-03
			alpha-BHC	N/A	9.3E-06	NE	1.2E-06	1.0E-05
			beta-BHC	N/A	NTV	NE	NTV	N/A
			delta-BHC	N/A	1.5E-04	NE	2.5E-05	1.7E-04
			Semivolatile Organics					
			Bis(2-ethylhexyl)phthalate	Liver	4.3E-02	NE	2.8E-02	7.1E-02
			Volatile Organics					
			1,1,2-Trichloroethane	N/A	2.0E-02	NTV	1.8E-02	3.7E-02
			1,1-Dichloroethene	Liver	1.5E+00	NTV	1.9E+00	3.4E+00
			1,2-Dichloroethane	N/A	9.8E-04	1.0E-01	4.5E-04	1.0E-01
			Benzene	N/A	2.6E-03	2.3E-02	1.9E-04	2.6E-02
			Methylene chloride	Liver	1.6E-04	5.5E-05	NE (Kp<=0.01)	2.1E-04
			Tetrachloroethene	Liver	5.3E+00	1.9E+00	2.1E+01	2.8E+01
			Trichloroethene	N/A	2.6E-01	NTV	3.5E-01	6.1E-01
			Vinyl Chloride	Liver	3.3E-02	1.7E-02	NE (Kp<=0.01)	5.0E-02
							Groundwater Hazard Index Total =	3.8E+01

Table 2-5 *(continued)*
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 to 2 feet)	Soil and particulates	Incidental ingestion, inhalation of particulates, dermal contact	*Dioxin/Furan*					
			2,3,7,8-TCDD	NA	NTV	NTV	NTV	NA
			Metals					
			Aluminum	NA	9.0E-03	3.9E-04	5.8E-03	1.5E-02
			Antimony	Blood	2.1E-02	2.5E-06	8.9E-03	3.0E-02
			Cadmium	Proteinuria	1.8E-02	1.4E-05	4.6E-03	2.3E-02
			Mercury	Immune system	1.4E-01	2.2E-05	1.3E-01	2.7E-01
			Silver	Argyria	2.1E-02	1.6E-03	3.4E-02	5.7E-02
			Vanadium	Decrease in erythrocyte superoxide dismutase	7.2E-03	1.5E-04	1.8E-02	2.5E-02
			Semivolatile Organics					
			Benzo(a)anthracene	NA	NTV	NTV	NTV	NA
			Benzo(a)pyrene	NA	NTV	NTV	NTV	NA
			Benzo(b)fluoranthene	NA	NTV	NTV	NTV	NA
			Bis(2-ethylhexyl)phthalate	Liver effects	9.8E-03	NTV	3.3E-02	4.3E-02
			Dibenzo(a,h)anthracene	NA	NTV	NTV	NTV	NA
			Indeno(1,2,3-cd)pyrene	NA	NTV	NTV	NTV	NA
							Soil Hazard Index Total =	4.7E-01
							Receptor Hazard Total (soil and groundwater) =	3.8E+01
							Liver Hazard Total =	8.8E-02

Notes

BHC	benzenehexachloride (hexachlorocyclehexane)
CNS	Central nervous system
Kp	Dermal permeability coefficient
NA	Information was not available
NE	Not evaluated through this exposure pathway
NE (Kp<=0.01)	Based on USEPA Region 6 guidance, chemicals of potential concern with a Kp<=0.01 were not evaluated for dermal contact while showering (USEPA, 1995)
NTV	No toxicity value
RDX	1,3,5-Trinitroperhydro-1,3,5-triazine
TCDD	Tetrachlorodibenzo-p-dioxin

References

U.S. Environmental Protection Agency (USEPA), 1989, *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, (Part A)*, EPA/540/1-89/002, December.

USEPA, *Supplemental Region 6 Risk Assessment Guidance*, May 5, 1995.

Summary of Risk Characterization

The table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure for LHAAP-35A(58). The Risk Assessment Guidance for Superfund (USEPA, 1989) states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse non-carcinogenic effects. The estimated HI of 38 for groundwater indicates that the potential for adverse non-carcinogenic effects could occur from exposure to contaminants in that medium; the components having HQs greater than 1 are tetrachloroethene, 1,1-dichloroethene, and manganese. The estimated HI of 0.47 for soil is acceptable.

Table 2-6
Chemicals with Hazard Quotient Greater than 0.1 in Groundwater

Chemical	Hazard Quotient[a]	Exposure Point Concentration[b] (µg/L)	MCL (µg/L)	GW-Ind (µg/L)	Retained as Chemical of Concern?
Tetrachloroethene (PCE)	28	5,400	5	5	Yes, 1
1,1-Dichloroethene (1,1-DCE)	3.4	1,340	7	7	Yes, 1
Manganese	1.2	5,800	-	14,000	No, 2,3
Aluminum	0.96	98,200	-	100,000	No, 4
Perchlorate	0.88	81	-	72	No, 4
Trichloroethene (TCE)	0.61	160	5	5	Yes, 1
Nickel	0.54	1,100	-	2,000	No, 3
Thallium	0.44	3.6	2	2	No, 5
Strontium	0.38	23,000	-	61,000	No, 3
Antimony	0.32	13	6	6	No, 4
RDX	0.29	88.3	-	--	No, 4
Selenium	0.13	65.8	50	50	No, 4
Cobalt	0.12	250	-	6,100	No, 3

Notes and Abbreviations:

All chemicals with hazard indexes exceeding 0.1 are listed.

1. *Identified as COC since noncancer hazard quotient is greater than 0.1 and the Exposure Point Concentration is above the Safe Drinking Water Act MCL or Texas Commission on Environmental Quality (TCEQ) GW-Ind.*
2. *Excluded as COC since Exposure Point Concentration is less than LHAAP perimeter well background.*
3. *Excluded as COC based on since Exposure Point Concentration is less than a proposed cleanup level based on GW-Ind.*
4. *Excluded as COC based on more recent data showing much lower concentrations that are below TCEQ GW-Ind or MCL.*
5. *Excluded as COC based on difference in sampling methods.*

[a] *From Baseline Risk Assessment Table 3-74 and Table C-44 (Jacobs, 2003).*

[b] *From Baseline Risk Assessment Table 3-49 (Jacobs, 2003).*

COC *chemical of concern*
GW-Ind *TCEQ Risk Reduction Standard 2, groundwater medium-specific concentration for industrial use*
MCL *Safe Drinking Water Act maximum contaminant level*
µg/L *micrograms per liter*

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Table 2-7
Chemicals with Carcinogenic Risk Greater than 1×10^{-6} in Groundwater

Chemical	Cancer Risk Groundwater[a]	Exposure Point Concentration[b] (µg/L)	MCL/ GW-Ind (µg/L)	Retained as Chemical of Concern?
1,1-Dichloroethene (1,1-DCE)	1.1×10^{-2}	1,340	7	Yes, 1
Tetrachloroethene (PCE)	4.9×10^{-3}	5,400	5	Yes, 1
Vinyl Chloride	5.8×10^{-5}	10	2	Yes, 1
RDX	3.4×10^{-5}	88.3	-	No, 3
Trichloroethene (TCE)	3.1×10^{-5}	160	5	Yes, 1
bis(2-Ethylhexyl)phthalate	7.1×10^{-6}	88	6	No, 3, 4
1,2-Dichloroethane (1,2-DCA)	6.2×10^{-6}	3	5	No, 2
1,1,2-Trichloroethane (1,1,2-TCA)	3.0×10^{-6}	8	5	No, 3

Notes and Abbreviations:

All Chemicals with cancer risks exceeding 1.0×10^{-6} are listed.

1. *Identified as COC since Exposure Point Concentration is above the Safe Drinking Water Act MCL.*
2. *Excluded because since Exposure Point Concentration is below the Safe Drinking Water Act MCL.*
3. *Excluded based on more recent data showing much lower concentrations.*
4. *Excluded as COC based on bis(2-ethylhexyl)phthalate being a common laboratory contaminant.*

[a] *From Baseline Risk Assessment Table 3-73 (Jacobs, 2003).*

[b] *From Baseline Risk Assessment Table 3-49 (Jacobs, 2003).*

COC *chemical of concern*

GW-Ind *Texas Commission on Environmental Quality, Risk Reduction Standard 2, groundwater medium-specific concentration for industrial use*

MCL *Safe Drinking Water Act maximum contaminant level*

RDX *1,3,5-Trinitroperhydro-1,3,5-triazine*

µg/L *micrograms per liter*

References

Jacobs Engineering Group, Inc. (Jacobs), 2003, *Final Baseline Human Health and Screening Ecological Risk Assessment for the Group 4 Sites (Sites 04, 08, 35A, 35B, 35C, 46, 47, 48, 50, 60, 67, Goose Prairie Creek, Saunders Branch, Central Creek, and Caddo Lake), Longhorn Army Ammunition Plant, Karnack, Texas*, Final, Oak Ridge, TN, June.

Table 2-8
Cleanup Levels

COC	ARAR
	MCL (µg/L)
1,1,2-Trichloroethane (TCA) [a]	5
1,1-Dichloroethene (DCE)	7
cis-1,2-Dichloroethene	70
trans-1,2-Dichloroethene	100
Tetrachloroethene (PCE)	5
Trichloroethene (TCE)	5
Vinyl Chloride (VC)	2
	GW-Ind (µg/L) [b]
1,1-Dichloroethane (TCA daughter product) [a]	10,000
Chloroethane (TCA daughter product) [a]	41,000

Notes and Abbreviations

[a] *Not currently classified as a COC, but will be included in the list of COCs for long-term monitoring (see Section 2.12.2)*

[b] *Groundwater medium-specific concentration for industrial use since no MCL exists*

µg/L micrograms per liter
ARAR applicable or relevant and appropriate requirement
COC chemical of concern
GW-Ind Texas Commission on Environmental Quality groundwater medium-specific concentration for industrial use
MCL maximum contaminant level as established in the Safe Drinking Water Act

Table 2-9
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation with LUC	Alternative 3 In Situ Bioremediation with Short Term LUC and Long-Term Monitoring	Alternative 4 In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume
Overall protection of human health and the environment	Does not confirm achievement of the RAO for the return of groundwater to its potential beneficial use as a drinking water since there is no monitoring involved.	Achieves RAOs. Protection of human health and environment provided by maintenance of LUC. Monitored natural attenuation activities would demonstrate that degradation of plume is occurring.	Achieves RAOs. Protection of human health and environment provided by bioremediation of groundwater COCs. Groundwater monitoring and LUC will remain in place until remainder of plume degrades to MCLs.	Achieves RAOs. Protection of human health and environment provided by remediation of groundwater COCs in the area of highest contamination in the eastern plume and monitored natural attenuation in the western plume. Groundwater monitoring and LUC would remain in place until MCLs are met
Compliance with ARARs	Possible that it would meet cleanup levels by (unmonitored) natural attenuation, but this would be unverifiable without monitoring.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Long-term effectiveness and permanence	Natural attenuation would occur, but is progress would be unverified by monitoring. No evaluation of natural attenuation's long-term effectiveness and permanence.	Decrease in contaminant concentrations and presence of degradation products suggests that contaminants are degrading naturally. LUC would be effective and reliable so long as it is maintained until RAOs are met.	Should be effective and permanent; however, uncertainty exists concerning the effectiveness and time needed for in situ biological treatment and degradation to reduce contaminant concentrations to preliminary remediation goals. A treatability study may be required. Long-term groundwater monitoring will be conducted after treatment. LUC would be effective and reliable so long as it is maintained until remainder of plume reaches MCLs.	Should be effective and permanent; however, uncertainty exists concerning the effectiveness and time needed for in situ biological treatment and degradation to reduce contaminant concentrations to preliminary remediation goals. A treatability study may be required. Long-term groundwater monitoring will be conducted after treatment. LUC would be effective and reliable so long as it is maintained until remainder of plume reaches MCLs.

Table 2-9 *(continued)*
Comparative Analysis of Alternatives

Comparative Analysis of Alternatives Criteria	Alternative 1 No Action	Alternative 2 Monitored Natural Attenuation with LUC	Alternative 3 In Situ Bioremediation with Short Term LUC and Long-Term Monitoring	Alternative 4 In Situ Bioremediation for Eastern Plume followed by MNA and LUC; MNA and LUC for Western Plume
Reduction of toxicity, mobility, or volume through treatment	No active reduction.	No active reduction.	Provides permanent reduction through in situ bioremediation in the areas of highest contamination provided conditions are favorable.	For western plume, no active reduction. For eastern plume, provides permanent reduction through in situ bioremediation in the areas of highest contamination provided conditions are favorable.
Short-term effectiveness	Continued risk to community through no action. No risk to workers. To impact to the environment.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.	Minimal impacts to the community, workers, or the environment from short-term activities. Provides almost immediate protection.
Implementability	Inherently implementable.	Readily implemented.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to preliminary remediation goals. Specialized knowledge required for implementation.	Implementable, but uncertainty exists in the effectiveness and time required to reduce contaminants to preliminary remediation goals. Specialized knowledge required for implementation.
Cost • Capital present worth • O&M present worth • Total present worth	 $0 $0 $0	 $60,500 $432,300 $492,800	 $860,000 $483,000 $1,343,000	 $191,000 $594,000 $785,000
State acceptance	Not acceptable	Not acceptable	Acceptable	Acceptable
Community acceptance	Responded to comments			

Notes and Abbreviations:

ARAR applicable or relevant and appropriate requirement
COC chemical of concern
LUC land use control
MCL maximum contaminant level
MNA monitored natural attenuation
O&M operation and maintenance
RAO remedial action objective

Table 2-10
Remediation Cost Table
Selected Remedy (Alternative 4)
Present Worth Analysis

Year	Fiscal Year	Capital Costs	Operation & Maintenance Costs			Present Value (NPV)		
			Long-Term Monitoring	Bioremediation	Total	Discount Rate	Capital	O&M
						2.8%		
1	2010	$190,712	$118,108		$118,108	NPV	$190,712	$593,996
2	2011		50,353	101,397	151,750			
3	2012		24,558		24,558		NPV Total	$784,708
4	2013		24,558		24,558			
5	2014		67,083		67,083			
6	2015		17,135		17,135			
7	2016		17,135		17,135			
8	2017		17,135		17,135			
9	2018		17,135		17,135			
10	2019		58,074		58,074			
11	2020				0			
12	2021				0			
13	2022				0			
14	2023				0			
15	2024		53,572		53,572			
16	2025				0			
17	2026				0			
18	2027				0			
19	2028				0			
20	2029		53,572		53,572			
21	2030				0			
22	2031				0			
23	2032				0			
24	2033				0			
25	2034		53,572		53,572			
26	2035				0			
27	2036				0			
28	2037				0			
29	2038				0			
30	2039		53,572		53,572			
		$190,712	$625,564	$101,397	$726,961			

Table 2-10 *(continued)*
Remediation Cost Table
Selected Remedy (Alternative 4)

Notes

O&M	operation & maintenance
UIC	underground injection control
VOC	volatile organic compounds

Major assumptions are as described below. Quantities and assumptions are for cost estimating purposes only.

Capital costs related to bioremediation include: 1) Work plans/safety plans, 2) UIC permit and design, 3) Treatability study and related costs (including sample collection, driller, per diem and travel costs, mobilization/demobilization), 4) Field Health & Safety, 5) Field supervisor and geologist, 6) Vehicles, 7) Per diem, 8) Driller mobilization/demobilization, 9) Installation of injection wells, 10) Well survey, 11) Well drill waste disposal, 12) Collection and preparation of well waste drum samples, 13) Sample analysis for waste characterization, 14) Bioaugmentation materials, 15) Collection and preparation of samples, 16) Samples analysis for VOCs.

Long-term monitoring activities in Year 1 include: 1) Establishment of a database, licenses, and development of work plans, etc; 2) Geoprobe installation of two additional monitoring wells.

Monitoring costs are based on the assumption that 8 wells are sampled in sampling events from Years 1 through 10, and that sampling is reduced to 4 wells for subsequent years. The frequency of sampling events is in accordance with the frequency described in the Record of Decision. In Years 1 and 2, the samples are analyzed for VOCs and MNA parameters. Subsequent years are analyzed for VOCs only. Five-year reviews are conducted in Years 5, 10, 15, 20, 25, and 30.

The discount rate of 2.8% is based on the Office of Management and Budget Circular No. A-94, January 2008.

Table 2-11
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Groundwater		
State of Texas Primary Drinking Water Standards 30 TAC 290, Subchapter F	Applicable to drinking water for a public water system—**relevant and appropriate** for water that could potentially be used for human consumption	Must not exceed drinking water standard for water designated as a current or potential source of drinking water. See Table 3-2 for specific numeric criteria.
State of Texas Risk Reduction Standards 30 TAC 335.558 and 335.559(d)(2) as updated in the Texas Commission on Environmental Quality memorandum July 23, 1998	Applicable to industrial groundwater—**relevant and appropriate** for potential hypothetical future maintenance worker exposure to groundwater	If no maximum contaminant level has been promulgated, groundwater must not exceed the industrial medium-specific concentration.
Waste Generation, Management, and Storage		
Characterization of Solid Waste 40 CFR 262.11 30 TAC 335.62 30 TAC 335.504 30 TAC 335.503(a)(4)	Generation of solid waste, as defined in 30 TAC 335.1—**applicable**.	Must determine whether the generated solid waste is RCRA hazardous waste by using prescribed testing methods or applying generator knowledge based on information regarding material or process used. If the waste is determined to be hazardous, it must be managed in accordance with 40 CFR 262–268. After making the hazardous waste determination as required, if the waste is determined to be nonhazardous, the generator shall then classify the waste as Class 1, Class 2, or Class 3 (as defined in Section 335.505 through Section 335.507) using one or more of the methods listed in Section 335.503(a)(4) and Section 335.508 and manage the waste in accordance with the requirements of Chapter 335 of the TAC for industrial solid waste.
Characterization of Hazardous Waste 40 CFR 264.13(a)(1); 40 CFR 268.7 30 TAC 335.504(3) 30 TAC 335.509 30 TAC 335.511	Generation of a RCRA hazardous waste for treatment, storage, or disposal—**applicable** if hazardous waste is generated (e.g., PPE).	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) that at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268. Must also determine whether the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.
Management of RCRA Hazardous Waters—Wastewater Treatment Unit Exclusion 40 CFR 264.1(g)(6) 40 CFR 270.1(c)(2) 30 TAC 335.41(d)(1)	Treatment/disposal of wastewater containing RCRA hazardous waste—**applicable** to management of contaminated groundwater if it is determined to contain RCRA characteristically hazardous waste.	On-site wastewater treatment units, as defined in 40 CFR 260.10, that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are excluded from the requirements of RCRA Subtitle C (Note: USEPA has clarified that this exemption applies to all tank systems, conveyance systems, and ancillary equipment, including transfer trucks, associated with the wastewater treatment unit [53 FR 34079, September 2, 1988]).

Table 2-11 *(continued)*
Description of ARARs for Selected Remedy

Citation	Activity or Prerequisite/Status	Requirement
Requirements for Temporary Storage of Hazardous Waste in Accumulation Areas 40 CFR 262.34(a) and (c)(1) 30 TAC 335.69(a) and (d)	On-site accumulation of 55 gallons or less of RCRA hazardous waste for 90 days or less at or near the point of generation—applicable if hazardous waste is generated (e.g., PPE) and stored in an accumulation area.	A generator may accumulate hazardous waste at the facility provided that • Waste is placed in containers that comply with 40 CFR 264.171 to 264.173 (Subpart I); and • Container is marked with the words "hazardous waste"; or • Container may be marked with other words that identify the contents.
Requirements for the Use and Management of Containers 40 CFR 264.171–264.173 30 TAC 335.69(e) 30 TAC 335.152(a)(7)	On-site storage/treatment of RCRA hazardous waste in containers for greater than 90 days—applicable if hazardous waste is generated (e.g., PPE) and is stored in containers.	Design and operating standards of 40 CFR 264.175(c) and 40 CFR 264.171, 264.172, and 264.173(a) and (b) must be met for the use and management of hazardous waste in containers.
Wells		
Well Construction Standards—Monitoring or Injection Wells 16 TAC 76.1000	Construction of water wells—applicable to construction of new monitoring or injection wells, if needed.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate.
Class V Injection Wells 30 TAC 331, Subchapters A, C, and H	Installation, operation, and closure of injection wells for in situ bioremediation fall in the category of Class V Injection Wells—relevant and appropriate	Injection wells shall be constructed to the required specifications for isolation casing, surface completion, prevention of commingling, and confinement of undesirable groundwater to its zone of origin. Closure shall be accomplished by removing all of the removable casing and the entire well shall be pressure filled via a tremie pipe with cement from bottom to the land surface, or closure shall be performed by the alternative method for Class V Wells completed in zones of undesirable groundwater. Groundwater concentrations at time of well closure will determine the appropriate method of abandonment.

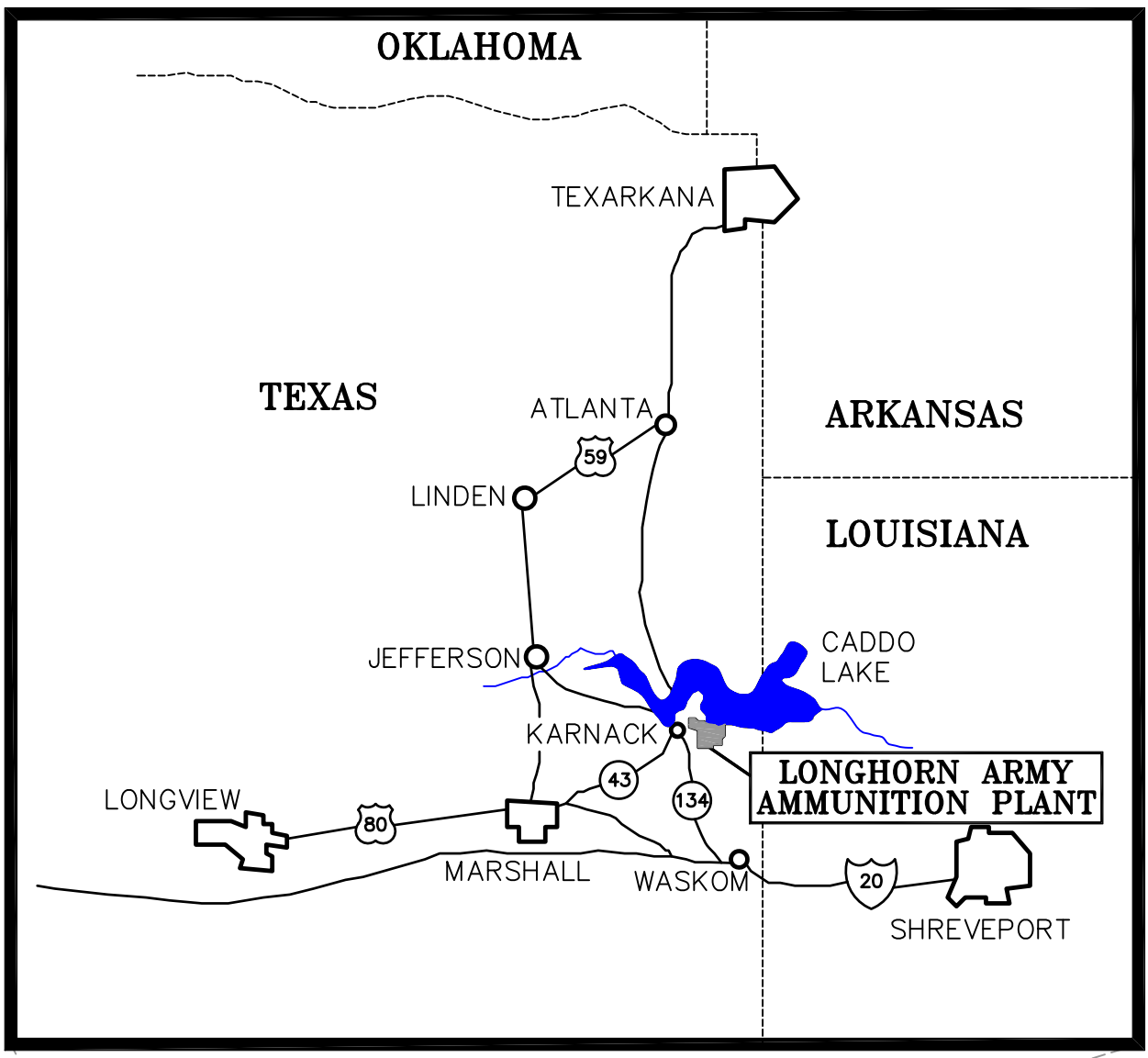
Table 2-11 *(continued)*
Description of ARARs for Selected Remedy

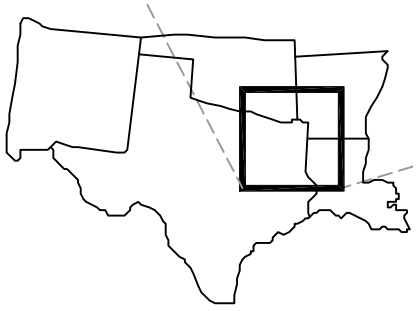
Citation	Activity or Prerequisite/Status	Requirement
Well Construction Standards—Extraction Wells 16 TAC 76.1000(a) and (c) through (h) 16 TAC 76.1002(a) through (c) 16 TAC 76.1008(a) through (c)	Construction of water wells—applicable to construction of extraction (recovery) wells.	Wells shall be completed in accordance with the technical requirements of Section 76.1000, as appropriate. Water wells completed to produce undesirable water shall be cased to prevent the mixing of water or constituent zones. The annular space between the casing and the wall of the borehole shall be pressure grouted with cement or bentonite grout to the land surface. Bentonite grout may not be used if a water zone contains chloride water above 1500 ppm or if hydrocarbons are present. Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface. During installation of a water well pump, installer shall make a reasonable effort to maintain integrity of groundwater and to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances. Pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.
Treatment/Disposal		
Disposal of Wastewater (e.g., contaminated groundwater, dewatering fluids, decontamination liquids) 40 CFR 268.1(c)(4)(i) 30 TAC 335.431(c)	RCRA-restricted characteristically hazardous waste intended for disposal—applicable if extracted groundwater is determined to be RCRA characteristically hazardous .	Disposal is not prohibited if such wastes are managed in a treatment system subject to regulation under Section 402 of the CWA that subsequently discharges to waters of the United States.
Closure		
Standards for Plugging Wells that Penetrate Undesirable Water or Constituent Zones 16 TAC 76.1004(a) through (c)	Plugging and abandonment of wells—applicable to plugging and closure of monitoring and/or extraction wells.	If a well is abandoned, all removable casing shall be removed and the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface. In lieu of this procedure, the well shall be pressure-filled via a tremie tube with bentonite grout of a minimum 9.1 lb/gal weight followed by a cement plug extending from land surface to a depth of not less than 2 feet. Undesirable water or constituents or the freshwater zone(s) shall be isolated with cement plugs.

Abbreviations:

%	*percent*	*lb/gal*	*pound per gallon*
µg/L	*micrograms per liter*	*LHAAP*	*Longhorn Army Ammunition Plant*
ARAR	*applicable or relevant and appropriate requirement*	*PPE*	*personal protective equipment*
CFR	*Code of Federal Regulations*	*ppm*	*part per million*
CWA	*Clean Water Act of 1972*	*RCRA*	*Resource Conservation and Recovery Act of 1976*
DCE	*dichloroethene*	*TAC*	*Texas Administrative Code*
USEPA	*U.S. Environmental Protection Agency*	*TCE*	*trichloroethene*
FR	*Federal Register*	*VC*	*vinyl chloride*
FS	*feasibility study*		

00098776





"DRAWING NOT TO SCALE"

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FIGURE 2–1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

IMAGE	---	X–REF	---	OFFICE	Houston, Texas	DRAWN BY	L. JONES	12/17/03	CHECKED BY	G. JONES	10/07/09	APPROVED BY	P. SRIVASTAV	10/07/09	DRAWING NUMBER	117591–A55

PLOT DATE: 10/07/09
FORMAT REVISION 3/25/99

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Houston, TX	B. Lu 04/30/07	S. Watson 09/16/07

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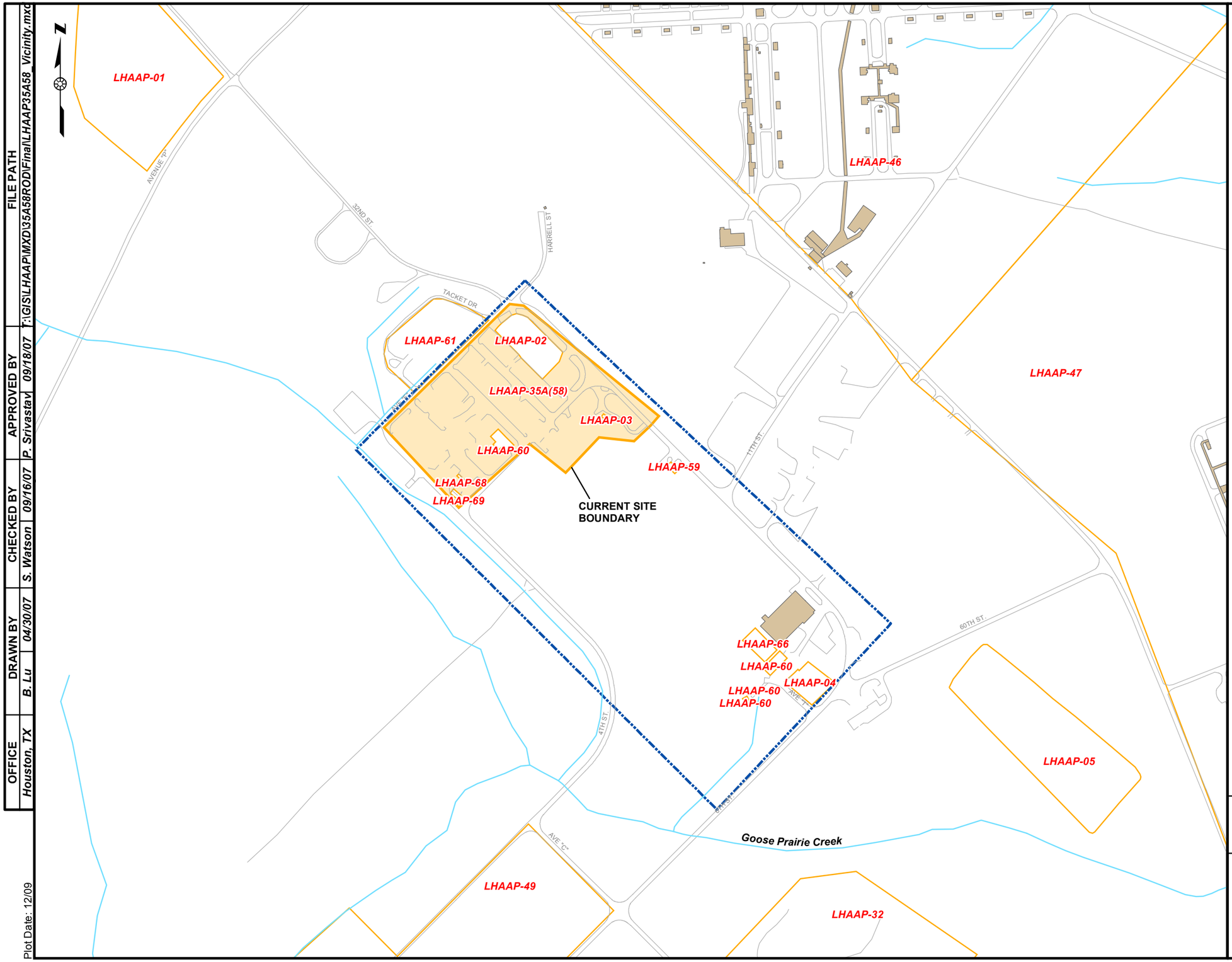

LEGEND

- Stream
- Road
- Existing Building
- Historic LHAAP-35A(58) Site Boundary
- Other LHAAP Site
- LHAAP-35A(58) Site
- Lake/Pond

0 200 400 800 Feet

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FIGURE 2-2

SITE VICINITY MAP
LHAAP-35A(58) , GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098778

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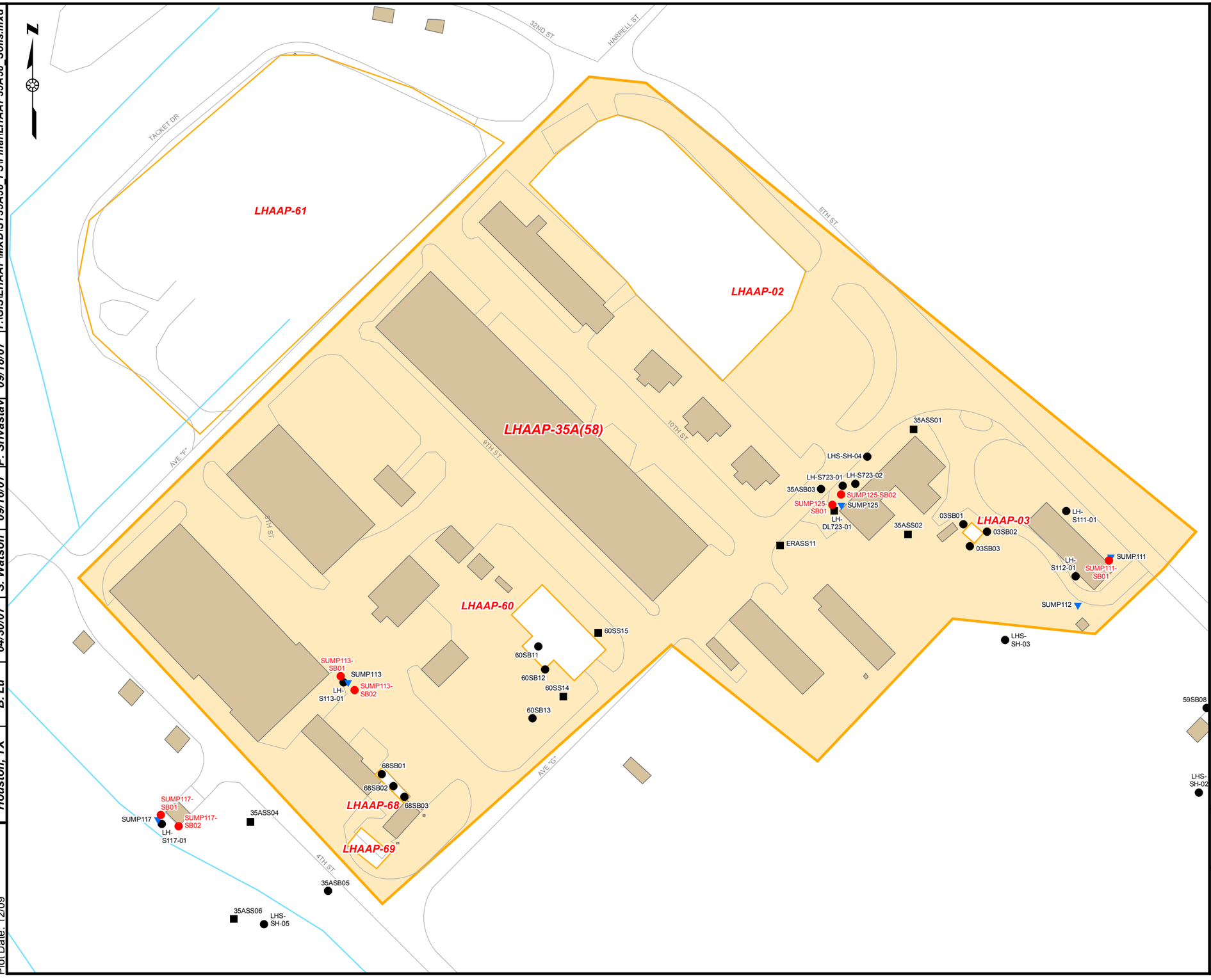

LEGEND

- Soil Boring (2006 Sump Investigation)
- Soil Boring (Phase I, II)
- Surface Soil Sample (Phase II)
- Sump
- Stream
- Road
- Former Building or Tank
- LHAAP-35A(58) Site
- Other LHAAP Site

0 50 100 200 Feet

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FIGURE 2-3

SOIL SAMPLE LOCATION MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098779

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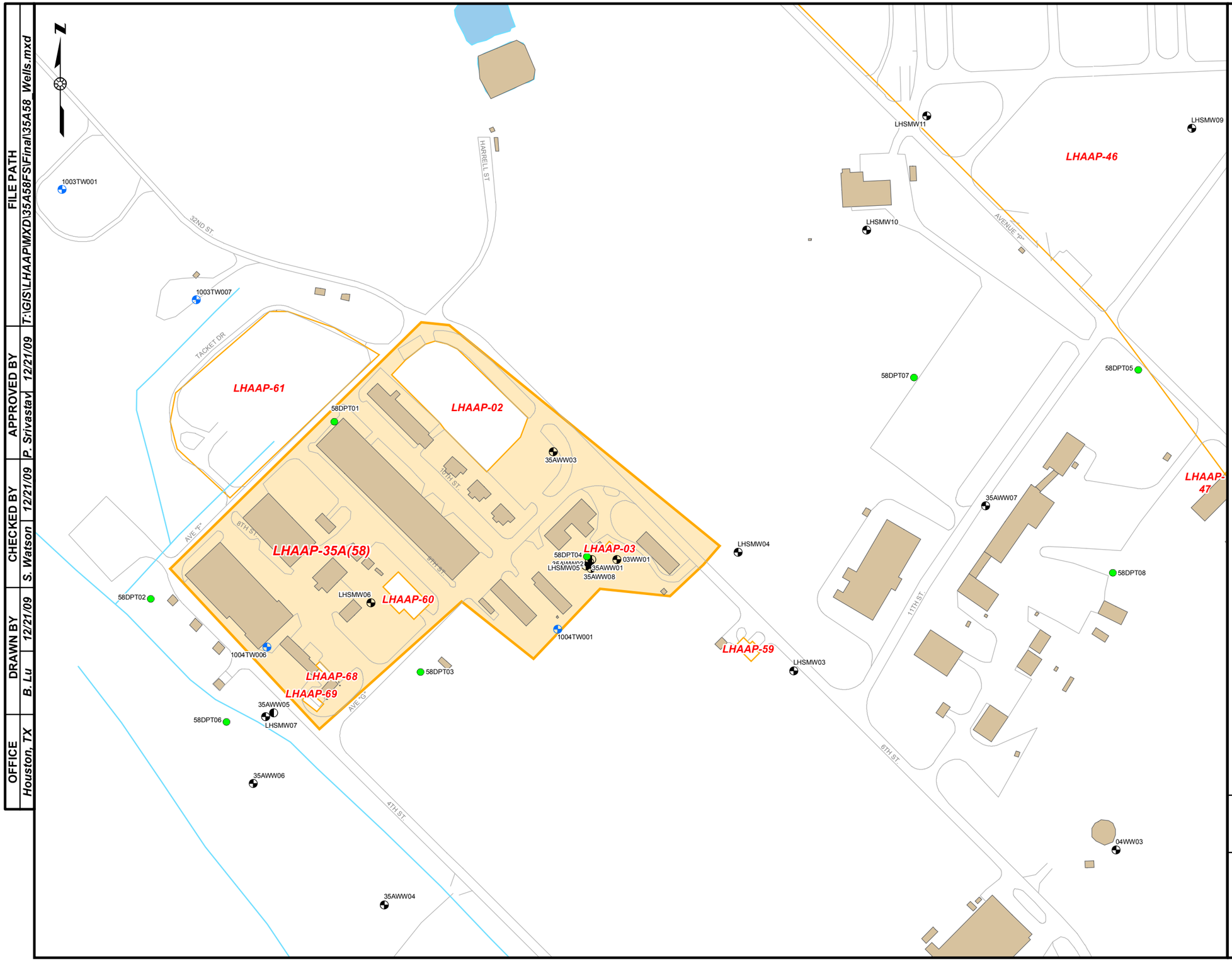
CHECKED BY	
S. Watson	12/21/09

DRAWN BY	
B. Lu	12/21/09

OFFICE
Houston, TX



LEGEND

- DPT Location
- Plexus Temporary Monitoring Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Stream
- Road
- LHAAP-35A(58) Site
- Other LHAAP Site
- Former Building or Tank

0 100 200 400 Feet

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FIGURE 2-4

WELL LOCATION MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098780

PLOT DATE: 05/12/10
FORMAT REVISION 5/13/02

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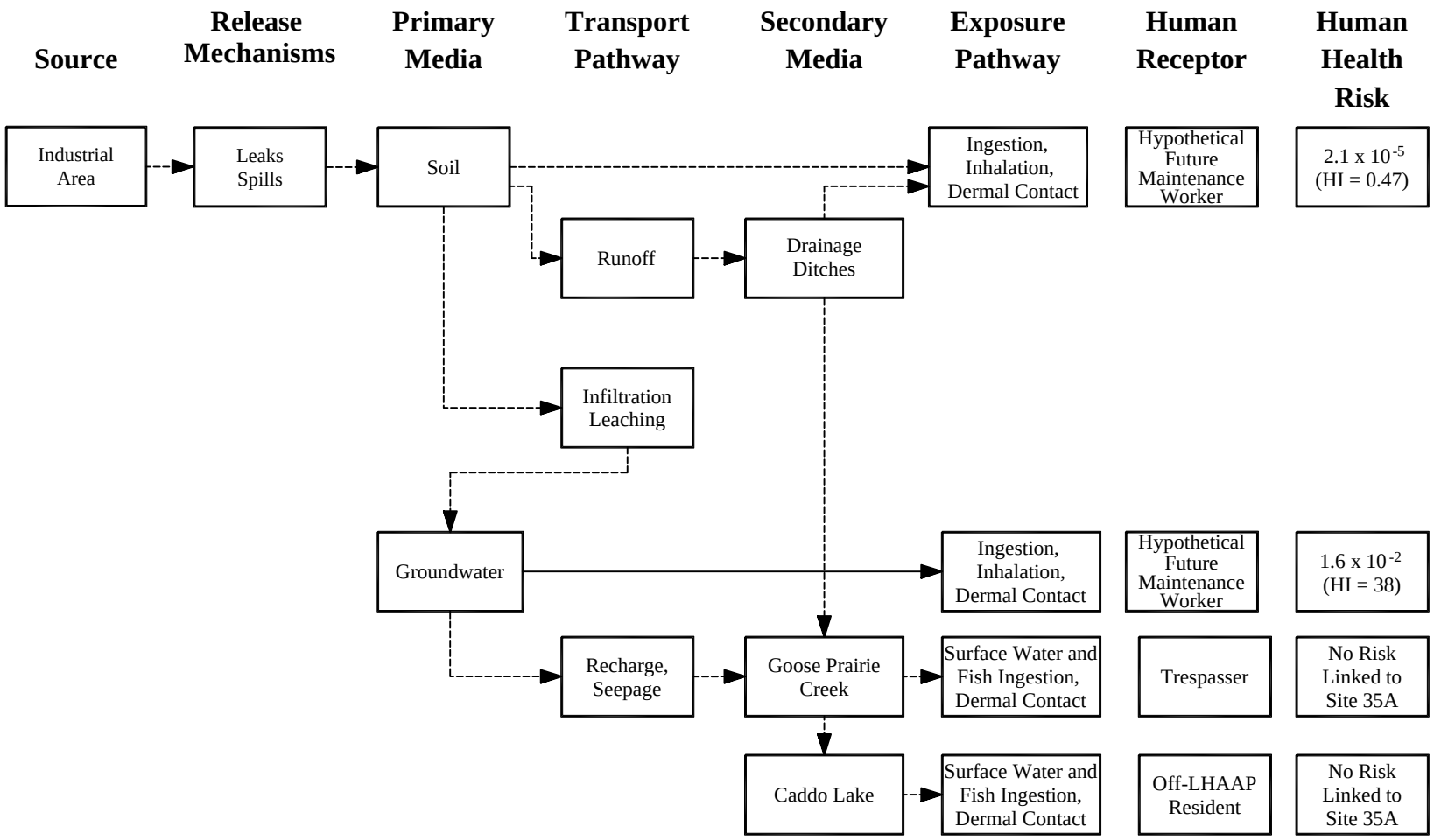

Pathway considered for remediation

Pathway *not* considered for remediation

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FIGURE 2-5
CONCEPTUAL SITE MODEL
LHAAP-35A(58) GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098781

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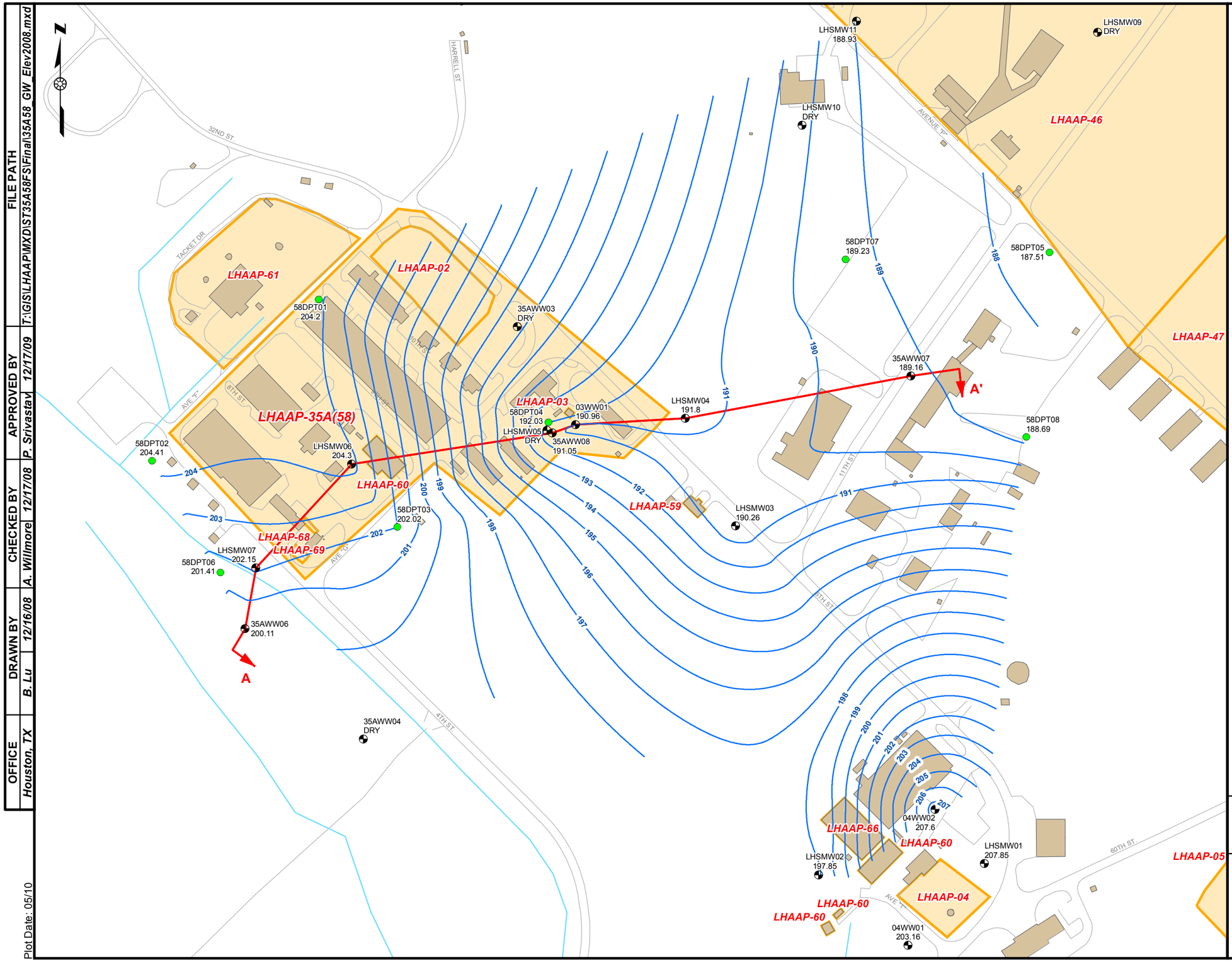

LEGEND

- Shallow Monitoring Well
- DPT Location
- Groundwater Elevation Contour
- Cross-Section Line
- Stream
- Road
- Former Building or Tank
- Site

NOTE:

Contours generated using 3D Analyst Extension in ArcGIS 9.3.

0 110 220 440 Feet

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TULSA, OKLAHOMA

FIGURE 2-6

GROUNDWATER ELEVATION MAP
SHALLOW ZONE, 2008
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098782

PLOT DATE: 05/12/10
FORMAT REVISION

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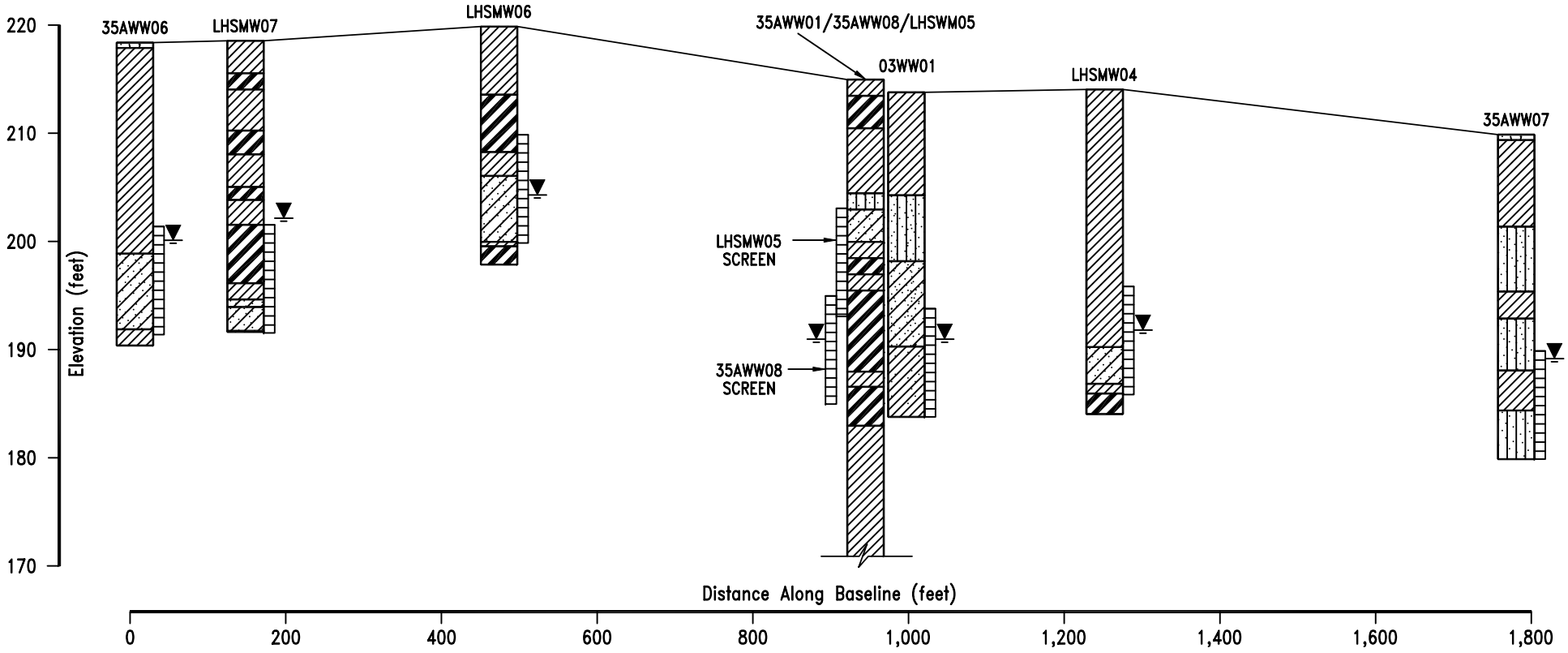

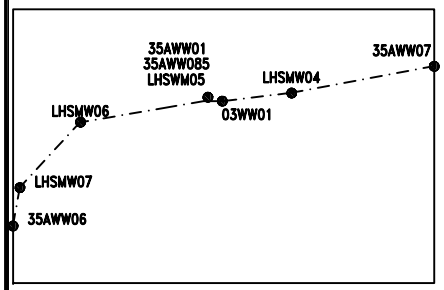

LEGEND:

- (CH) FAT CLAY
- (CL) LEAN CLAY
- (SC) CLAYEY SAND
- (MLS) SANDY SILT
- STATIC WATER LEVEL (11/08)
- SCREEN

HORIZONTAL SCALE
0 200 400
VERTICAL SCALE: AS SHOWN

U.S. ARMY CORPS OF ENGINEERS
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FIGURE 2-7

CROSS SECTION A-A'
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00098783

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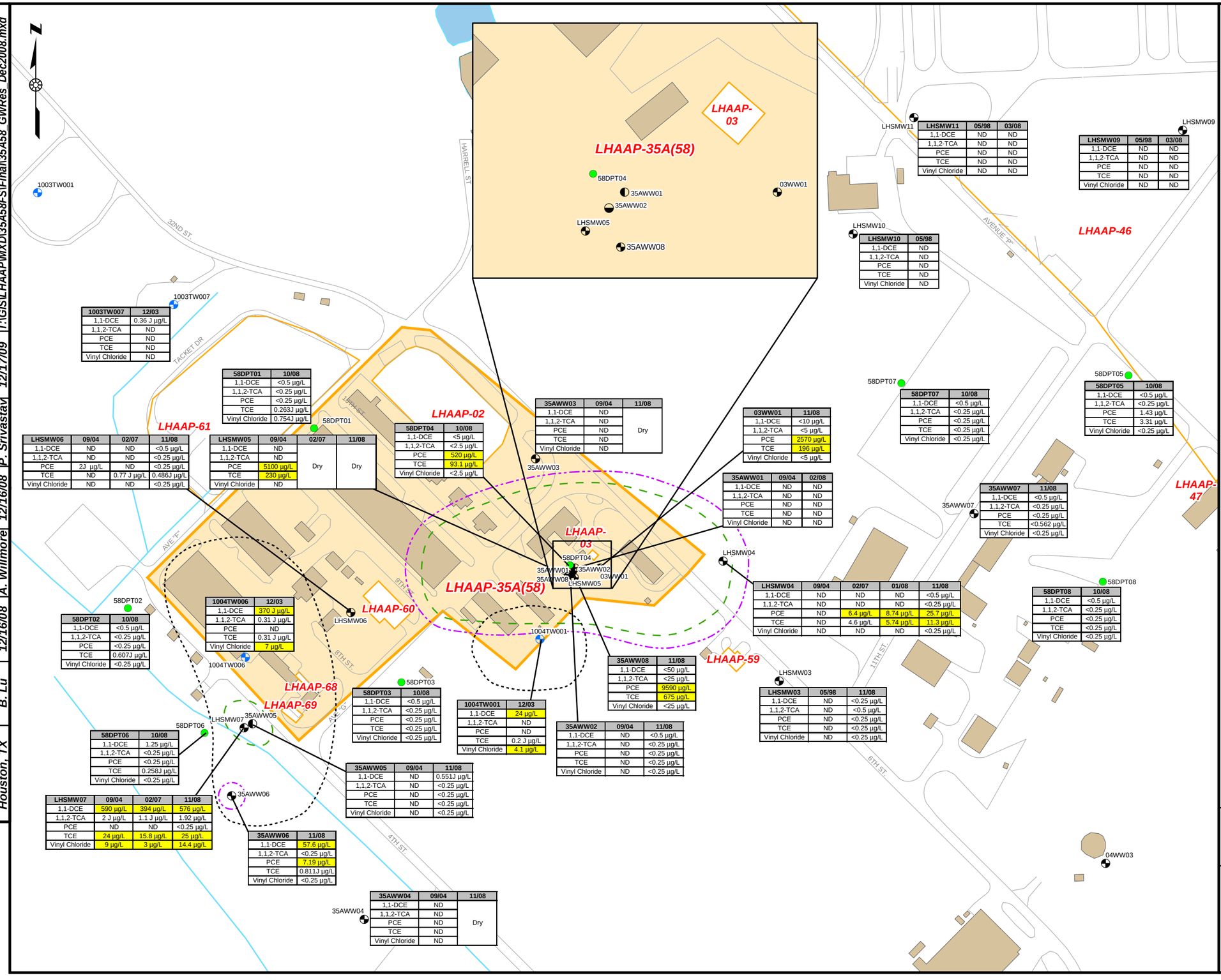

1003TW007	12/03
1,1-DCE	0.36 J µg/L
1,1,2-TCA	ND
PCE	ND
TCE	ND
Vinyl Chloride	ND

58DPT01	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	0.263J µg/L
Vinyl Chloride	0.754J µg/L

LHSMW06	09/04	02/07	11/08
1,1-DCE	ND	ND	<0.5 µg/L
1,1,2-TCA	ND	ND	<0.25 µg/L
PCE	2J µg/L	ND	<0.25 µg/L
TCE	ND	0.77 J µg/L	0.486J µg/L
Vinyl Chloride	ND	ND	<0.25 µg/L

LHSMW05	09/04	02/07	11/08
1,1-DCE	ND		
1,1,2-TCA	ND		
PCE	5100 µg/L	Dry	Dry
TCE	230 µg/L		
Vinyl Chloride	ND		

58DPT04	10/08
1,1-DCE	<5 µg/L
1,1,2-TCA	<2.5 µg/L
PCE	520 µg/L
TCE	93.1 µg/L
Vinyl Chloride	<2.5 µg/L

35AWW03	09/04	11/08
1,1-DCE	ND	
1,1,2-TCA	ND	
PCE	ND	Dry
TCE	ND	
Vinyl Chloride	ND	

03WW01	11/08
1,1-DCE	<10 µg/L
1,1,2-TCA	<5 µg/L
PCE	2570 µg/L
TCE	196 µg/L
Vinyl Chloride	<5 µg/L

35AWW01	09/04	02/08
1,1-DCE	ND	ND
1,1,2-TCA	ND	ND
PCE	ND	ND
TCE	ND	ND
Vinyl Chloride	ND	ND

LHSMW11	05/98	03/08
1,1-DCE	ND	ND
1,1,2-TCA	ND	ND
PCE	ND	ND
TCE	ND	ND
Vinyl Chloride	ND	ND

LHSMW09	05/98	03/08
1,1-DCE	ND	ND
1,1,2-TCA	ND	ND
PCE	ND	ND
TCE	ND	ND
Vinyl Chloride	ND	ND

LHSMW10	05/98
1,1-DCE	ND
1,1,2-TCA	ND
PCE	ND
TCE	ND
Vinyl Chloride	ND

58DPT07	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	<0.25 µg/L
Vinyl Chloride	<0.25 µg/L

58DPT05	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	1.43 µg/L
TCE	3.31 µg/L
Vinyl Chloride	<0.25 µg/L

35AWW07	11/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	<0.562 µg/L
Vinyl Chloride	<0.25 µg/L

1004TW006	12/03
1,1-DCE	370 J µg/L
1,1,2-TCA	0.31 J µg/L
PCE	ND
TCE	0.31 J µg/L
Vinyl Chloride	7 µg/L

58DPT02	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	0.607J µg/L
Vinyl Chloride	<0.25 µg/L

58DPT03	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	<0.25 µg/L
Vinyl Chloride	<0.25 µg/L

1004TW001	12/03
1,1-DCE	24 µg/L
1,1,2-TCA	ND
PCE	ND
TCE	0.2 J µg/L
Vinyl Chloride	4.1 µg/L

35AWW08	11/08
1,1-DCE	<50 µg/L
1,1,2-TCA	<25 µg/L
PCE	9590 µg/L
TCE	675 µg/L
Vinyl Chloride	<25 µg/L

LHSMW04	09/04	02/07	01/08	11/08
1,1-DCE	ND	ND	ND	<0.5 µg/L
1,1,2-TCA	ND	ND	ND	<0.25 µg/L
PCE	ND	6.4 µg/L	8.74 µg/L	25.7 µg/L
TCE	ND	4.6 µg/L	5.74 µg/L	11.3 µg/L
Vinyl Chloride	ND	ND	ND	<0.25 µg/L

58DPT08	10/08
1,1-DCE	<0.5 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	<0.25 µg/L
Vinyl Chloride	<0.25 µg/L

LHSMW03	05/98	11/08
1,1-DCE	ND	<0.25 µg/L
1,1,2-TCA	ND	<0.5 µg/L
PCE	ND	<0.25 µg/L
TCE	ND	<0.25 µg/L
Vinyl Chloride	ND	<0.25 µg/L

58DPT06	10/08
1,1-DCE	1.25 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	<0.25 µg/L
TCE	0.258J µg/L
Vinyl Chloride	<0.25 µg/L

35AWW05	09/04	11/08
1,1-DCE	ND	0.551J µg/L
1,1,2-TCA	ND	<0.25 µg/L
PCE	ND	<0.25 µg/L
TCE	ND	<0.25 µg/L
Vinyl Chloride	ND	<0.25 µg/L

35AWW02	09/04	11/08
1,1-DCE	ND	<0.5 µg/L
1,1,2-TCA	ND	<0.25 µg/L
PCE	ND	<0.25 µg/L
TCE	ND	<0.25 µg/L
Vinyl Chloride	ND	<0.25 µg/L

LHSMW07	09/04	02/07	11/08
1,1-DCE	590 µg/L	394 µg/L	576 µg/L
1,1,2-TCA	2 J µg/L	1.1 J µg/L	1.92 µg/L
PCE	ND	ND	<0.25 µg/L
TCE	24 µg/L	15.8 µg/L	25 µg/L
Vinyl Chloride	9 µg/L	3 µg/L	14.4 µg/L

35AWW06	11/08
1,1-DCE	57.6 µg/L
1,1,2-TCA	<0.25 µg/L
PCE	7.19 µg/L
TCE	0.811J µg/L
Vinyl Chloride	<0.25 µg/L

35AWW04	09/04	11/08
1,1-DCE	ND	
1,1,2-TCA	ND	
PCE	ND	Dry
TCE	ND	
Vinyl Chloride	ND	

LEGEND

- DPT Location
- Plexus Temporary Monitoring Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Stream
- Road
- Other LHAAP Site
- Former Building or Tank
- LHAAP-35A(58) Site
- Estimated TCE Contamination Extent at Concentration = 5 µg/L
- Estimated PCE Contamination Extent at Concentration = 5 µg/L
- Estimated 1,1-DCE Contamination Extent at Concentration = 7 µg/L
- COC Concentration Exceeds MCL

Safe Drinking Water Act Maximum Contaminant Levels (MCL)	
1,1-DCE	7 µg/L
1,1,2-TCA	5 µg/L
PCE	5 µg/L
TCE	5 µg/L
Vinyl Chloride	2 µg/L

1,1-DCE: 1,1-dichloroethene
1,1,2-TCA: 1,1,2-trichloroethane
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter
ND: not detected
COC: chemical of concern

0 100 200 400 Feet

Shaw®

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

FIGURE 2-8

GROUNDWATER RESULTS FOR VOCs
2003 THROUGH 2008
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

3.0 Responsiveness Summary

The Responsiveness Summary serves three purposes. First, it provides the U .S. Army, USEPA, and TCEQ with information about community concerns with the preferred alternative at LHAAP-35A/58 as presented in the Proposed Plan. Second, it shows how the public's comments were considered in the decision-making process for selection of the remedy. Third, it provides a formal mechanism for the U.S. Army to respond to public comments.

The U.S. Army, USEPA, and TCEQ provide information regarding LHAAP-35A/58 through public meetings, the Administrative Record for the facility, and announcements published in the Shreveport Times and Marshall News Messenger newspapers. **Section 2.3** discusses community participation on LHAAP-35A/58, including the dates for the public comment period, the date, location, and time of the public meetings, and the location of the Administrative Record. The following documents related to community involvement were added to the Administrative Record:

- Transcript of the public meeting on March 9, 2010
- Presentation slides from the March 9, 2010 public meeting
- Written questions and comments from the public during the public comment period, and the U.S. Army response to those comments dated June 4, 2010.

The public questions/comments are summarized in **Section 3.1** below, and a response is provided. No written or verbal comments were received from the regulatory agencies during the public comment period or at the public meeting. **Appendix A** contains the public announcement for the public comment period as well as its extension to March 25, 2010. These announcements also provided notification of the open house on January 26, 2010, and the public meeting on March 9, 2010.

3.1 Stakeholder Issues and Lead Agency Responses

This section summarizes and responds to significant issues raised by stakeholders including the public and community groups that were received in written or verbal form. These concerns were addressed by the U.S. Army in the public meetings and with the response to comments available in the Administrative Record.

Question/comment: The proposed plan states that contaminant levels will be reduced to MCLs in approximately 200 years. The uncertainty associated with this estimate is an order of magnitude. That is, the time to achieve MCLs could range from 20 years to 2000 years. It is not reasonable to propose a plan that could require the maintenance of LUCs for many decades or centuries.

Response: The reasonably anticipated future use of the site is as a wildlife refuge (i.e., Caddo Lake National Wildlife Refuge). Once the property is transferred into the refuge system, 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. This proposed transfer as a national wildlife refuge, which by its very nature includes physical access and use restrictions, is subject to control and continual inspection by Refuge personnel. Also, the property is intended to remain under ownership and management of a federal government agency. The LUC will restrict access to the groundwater for purposes other than environmental monitoring and testing until cleanup levels are met. Maintenance of the LUC for groundwater use restrictions would require minimal effort and would be reasonable for extended lengths of time. Effectiveness of the LUC will be evaluated as part of the statutory five-year reviews and does not pose additional burden. Additionally, access of groundwater through well installations requires a permit from the Texas Department of Licensing and Regulation or Texas Water District authority. The department will be provided a copy of the county recordation that indicates the location of contaminated groundwater at the site and associated restriction.

Question/comment: In order to rely on MNA as a remedy, the U.S. Army should show that natural attenuation is occurring at the site. However, the evidence for natural attenuation at LHAAP-35A(58) is limited. Concentrations of COCs appear to be decreasing in only one monitor well at the site (PCE and 1,1-DCE in well LHSMMW007). In most cases, COC concentrations are either remaining fairly constant or are increasing (PCE and TCE at well LHSMMW004, PCE and TCE at well LHSMMW005, and TCE at well LHSMMW007). The U.S. Army should explain why it expects contaminant concentrations to decrease in the future when they are not decreasing in the present.

Response: The use of MNA at LHAAP-35A(58) at LHSMW07 in the western plume is supported by decreasing concentration of contaminants. A more aggressive remedy is proposed for the eastern plume where the other mentioned wells (LHSMW05 and LHSMW04) are located. The statutory five-year reviews will evaluate the effectiveness of the remedy and estimated durations to reach MCLs, and other measures would be recommended for implementation if needed.

Question/comment: The half-life calculation for 1,1-DCE is not in accord with the USEPA's recommendation for performing such calculations. The USEPA states that a decrease in contaminant concentration of at least one order of magnitude is necessary in order to reliably calculate a half-life (rate law).

The half-life calculation for 1,1-DCE is the basis for the U.S. Army's estimate that contaminant levels will be reduced to MCLs in approximately 200 years. The Army should either explain

why the calculation is appropriate, or it should re-do its estimates for the time required for MNA to reduce contaminant concentrations to acceptable levels at LHAAP-50.

Response – The comment correctly quotes the USEPA directive in the footnotes. One difficulty is that the estimated half-life of 21 years would not be expected to generate an order of magnitude reduction within the sampling period (14 years). The estimated attenuation rate does not have a 95% confidence level at this time. As further stated in the USEPA directive (the paragraph following the one quoted in the footnotes), a number of factors should be considered in evaluating reasonable time frames. As more data becomes available during the 2 year MNA evaluation period, the half-lives and estimates of restoration time will be revised. The statutory five-year reviews will evaluate the effectiveness of the remedy and estimated durations to reach MCLs. If unreasonable time frames are estimated, other measures would be recommended for implementation if needed.

Question/comment – The proposed plan states that the progress of MNA will be evaluated for the western plume after two years. If performance objectives for MNA are not being met, a contingency remedy (e.g., bioremediation) will be implemented. The performance objectives will be included in the RD. However, the RD has not been written. Thus, it is not possible to evaluate suitability of the performance objectives.

Response – The performance objectives will follow USEPA Performance Monitoring of MNA Remedies for VOCs in Ground Water, EPA/600/R-04/027, April, 2005.

Question/comment – The proposed plan does not mention a contingency remedy for the eastern plume. Given the uncertainty associated with bioremediation and MNA, a contingency remedy should also be developed for the eastern plume.

Response – The continued performance of the in situ bioremediation will be evaluated during the statutory five-year reviews. If the USEPA determines that it is not effective, additional measures will be evaluated during the five-year review process.

Question/comment – Groundwater flow directions at LHAAP-35A(58) vary with time. Groundwater at the site may flow to the east, southeast, south, or southwest. However, the U.S. Army did not assess the potential effects of contaminated groundwater on the tributary to Goose Prairie Creek that flows about 120 feet from the site's western boundary. Instead, The U.S. Army assessed effects of contaminated groundwater on a segment of Goose Prairie Creek that is approximately 6300 feet east of the site.

The Army claims that groundwater will not enter the nearby tributary because the base of the creek channel is above the elevation of the groundwater. However, the elevation of the groundwater will change, both seasonally and over the longer term. Unless the U.S. Army can produce the data to show that groundwater levels will not reach the base of the channel, the

Army should assess the potential effects of contaminated groundwater on the tributary to Goose Prairie Creek.

The model used to simulate contaminant transport, including the transport of groundwater contaminants to Goose Prairie Creek, used some non-conservative assumptions. These assumptions have the effect of reducing the predicted contaminant concentrations in the creek.

Response – The modeling report (Shaw, 2007c) did not evaluate any potential effect on the tributary to Goose Prairie Creek that runs along the western side of the site since groundwater elevations at that time did not indicate any flow to the south. Additional wells were installed and the recent groundwater elevations indicate flow to the south (Shaw, 2009). As noted in Appendix A of the FS (and expanded upon here), the likelihood of groundwater seeping to surface water in the Goose Prairie Creek tributary is small. With a creek bed elevation of 213 feet MSL, and the measured groundwater elevations at nearby well LHSMW07 ranging from 202.4 feet MSL (2008) to 205 feet MSL (1998), there are 8 feet between the highest measured groundwater level and the creek bed. At another area of LHAAP, there is a series of wells where water levels have been checked monthly for more than 6 years. The largest groundwater elevation difference, from minimum to maximum, measured over that time in any well was 5.68 feet. From this information, it is inferred that flow from groundwater to surface water in the Goose Prairie Creek tributary at LHAAP-35A(58) is unlikely. Infiltration from the surface water to groundwater is more likely (when there is water in the creek).

Question/comment – The full extent of groundwater contamination at LHAAP-38A(58) has not been determined. Data gaps exist in the following areas: to the south of the western plume between 35AWW06 and 35AWW04; to the southeast of the western plume between 58DPT03 and 35AWW04; to the north of the western plume between 1004TW006 and 58DPT01; to the east of the eastern plume between LHSMW04 and 35AWW07, and to the southeast of the eastern plume between 35AWW01 and LHSMW03. The U.S. Army should install at least one monitor well in each of these areas.

Response – The extent of groundwater contamination has been determined, and plume delineation work for the purpose of identifying the nature and extent of contamination is generally complete. There are wells with results less than the cleanup level up, down and cross gradient to the wells with contamination. However, additional data from existing wells will be gathered during the design phase to implement the remedy.

3.2 Technical and Legal Issues

This section is used to expand on technical and legal issues. However, there are no issues of that nature beyond the technical issues already discussed in **Section 3.1**.

4.0 References

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U.S. Army Corps of Engineers (USACE), 2006, Correspondence from Cliff Murray (USACE) to Longhorn Team Members regarding LHAAP-58 Boundary, November 24.

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USEPA, 1999, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, Directive 9200.4-17P, April.

USEPA, 2004, *Performance Monitoring of MNA Remedies for VOCs in Ground Water*, EPA/600/R-04/027, April.

Glossary of Terms

Glossary of Terms

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

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

Chemicals of Concern (COC) – Those chemicals that significantly contribute to a pathway in an exposure model of a hypothetical receptor (e.g., a child that resides on a site). They exceed either the calculated numerical limit for cumulative site carcinogenic risk (1 in 10,000 exposed individuals) or the calculated numerical limit of 1 for non-carcinogenic effects, a value proposed by the USEPA.

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

Contaminant Plume – A column of contamination with measurable horizontal and vertical dimensions that is suspended and moves with groundwater.

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

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

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

Glossary of Terms (continued)

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

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.

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

Organic Compounds – Carbon compounds such as solvents, oils, and pesticides. Most are not readily dissolved in water.

Record of Decision – A legal document presenting the remedial action selected for a site or operable unit. It is based on information and technical analyses generated during the remedial investigation/feasibility study process and consideration of public comments on the proposed plan and community concerns.

Remedial Investigation – A study designed to gather data needed to determine the nature and extent of contamination at a Superfund site.

Resource Conservation and Recovery Act (RCRA) – Gives USEPA the authority to control the generation, transport, treatment, storage, and disposal of hazardous waste. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

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

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

Glossary of Terms (continued)

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

Surface Media – The soil (surface or subsurface), surface water, and sediment present at a site as applicable.

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

Appendix A

Public Meeting Newspaper and Media Notices

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLANS FOR ENVIRONMENTAL SITES LHAAP-46, -49, -50, -35A(58), AND THE PISTOL RANGE, LONGHORN ARMY AMMUNITION PLANT, TEXAS

The U.S. Army is the lead agency for environmental response actions at Longhorn Army Ammunition Plant (LHAAP). In partnership with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency Region 6, the U.S. Army has developed Proposed Plans for the following NPL sites: LHAAP-46, LHAAP-49, LHAAP-50, LHAAP-35A(58), and the Pistol Range. Although the Proposed Plans identify preferred remedies for each of the sites, the U.S. Army welcomes the public's review and comments. The public comment period begins January 25, 2010, and concludes February 23, 2010. **On Tuesday, January 26, 2010, from 6:00 to 8:00 p.m., the U.S. Army is inviting all interested parties to attend an open house forum to view the Proposed Plans and ask questions. The open house forum will be held at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas.** Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. Summaries of each of the sites, including discussion of various alternatives that were evaluated, are provided below.

LHAAP-46, the former Plant 2 production area, is located in the north-central portion of LHAAP and covers an area of approximately 190 acres. Plant 2 was used to produce pyrotechnic devices from February 1952 to 1956 and was reactivated to produce pyrotechnic and illumination devices from 1964 until approximately 1997. Three alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) monitored natural attenuation (MNA) and land use controls (LUCs); and 3) in situ bioremediation, short-term LUCs, and long-term monitoring (LTM). Based on available information, the preferred remedy is MNA and LUCs. The preferred remedy would utilize groundwater use restriction LUCs to protect human health by preventing human exposure to contaminated groundwater and MNA to return the contaminated water to its potential beneficial use as drinking water, wherever practicable.

LHAAP-49, a former Acid Storage Area, is located in the west-central portion of LHAAP and covers an area of approximately 30 acres. The site was used from 1942 to 1945 for formulation and storage of acids and acid mixtures in support of trinitrotoluene production. Based on available information, the preferred remedy at this time is no action. The recommendation is based on the existing data and determination of no unacceptable risk to human health or to ecological receptors at LHAAP-49.

LHAAP-50, a former sump water tank, is located in the north-central portion of LHAAP and covers an area of approximately 1 acre. Historically, LHAAP-50 contained a 47,000-gallon capacity aboveground storage tank which received wastewater from various industrial waste sumps from 1955 to 1988. Three alternatives were evaluated for addressing the contaminated groundwater and soil at the site: 1) no action; 2) soil - excavation, groundwater - MNA and LUCs; and 3) soil - excavation, groundwater - in situ bioremediation, MNA, and LUCs. Based on available information, the preferred remedy at this time is the second alternative: excavation and off-site disposal of perchlorate-contaminated soils, and MNA and LUCs for groundwater. The preferred remedy would ensure protection of human health by eliminating the soil-to-groundwater and soil-to-surface water pathways, implementing groundwater use restriction LUCs to prevent exposure to contaminated groundwater, and implementing MNA until groundwater cleanup levels are achieved.

LHAAP-35A(58), known as the Shops Area, is located in the north-central portion of LHAAP and covers approximately 11 acres. The Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility and became inactive in 1996 and 1997. Four alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) MNA with LUCs; 3) in situ bioremediation with short-term LUCs and LTM; and 4) in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. Based on available information, the preferred remedy at this time is the fourth alternative: in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. The preferred remedy would ensure protection of human health by 1) implementing groundwater use restriction LUCs which prevent human exposure to contaminated groundwater and 2) returning the contaminated water to its potential beneficial use as a drinking water, wherever practicable, through MNA and in situ bioremediation.

The former **Pistol Range** is located in the southeastern portion of LHAAP and covers an area of approximately 0.4 acres. The area was used by base security personnel as early as the 1950s and intermittently through 2004 as a small arms firing range. The target area was a natural, wooded slope at the eastern side of the site. Soil with contamination above industrial cleanup levels was excavated and disposed off site during a 2009 removal action. Based on available information, the preferred remedy at this time is no action. The recommendation is based on existing data and determination of no unacceptable risk to human health or to ecological receptors.

For further information or to submit written comments, contact: Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas 72951; phone number 479-635-0110 or e-mail rose.zeiler@us.army.mil.

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLANS FOR ENVIRONMENTAL SITES LHAAP-46, -49, -50, -35A(58), AND THE PISTOL RANGE, LONGHORN ARMY AMMUNITION PLANT, TEXAS
PUBLIC MEETING AT KARNACK COMMUNITY CENTER MARCH 9, 2010

The U.S. Army is the lead agency for environmental response actions at Longhorn Army Ammunition Plant (LHAAP). In partnership with Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency Region 6, the U.S. Army has developed Proposed Plans for the following NPL sites: LHAAP-46, LHAAP-49, LHAAP-50, LHAAP-35A(58), and the Pistol Range. Although the Proposed Plans identify preferred remedies for each of the sites, the U.S. Army welcomes the public's review and comments. The public comment period began January 25, 2010, and has been extended to March 25, 2010. **On Tuesday, March 9, 2010, from 7:00 to 9:00 p.m., the U.S. Army is inviting all interested parties to attend a public presentation of the proposed remedies for these sites and to ask questions and provide comments on the Proposed Plans. Questions, comments, and responses on the Proposed Plans will be recorded by a court reporter. This public meeting will be held at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas.** Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas, 75670. Summaries of each of the sites, including discussion of various alternatives that were evaluated, are provided below.

LHAAP-46, the former Plant 2 production area, is located in the north-central portion of LHAAP and covers an area of approximately 190 acres. Plant 2 was used to produce pyrotechnic devices from February 1952 to 1956 and was reactivated to produce pyrotechnic and illumination devices from 1964 until approximately 1997. Three alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) monitored natural attenuation (MNA) and land use controls (LUCs); and 3) in situ bioremediation, short-term LUCs, and long-term monitoring (LTM). Based on available information, the preferred remedy is MNA and LUCs. The preferred remedy would utilize groundwater use restriction LUCs to protect human health by preventing human exposure to contaminated groundwater and MNA to return the contaminated water to its potential beneficial use as drinking water, wherever practicable.

LHAAP-49, a former Acid Storage Area, is located in the west-central portion of LHAAP and covers an area of approximately 30 acres. The site was used from 1942 to 1945 for formulation and storage of acids and acid mixtures in support of trinitrotoluene production. Based on available information, the preferred remedy at this time is no action. The recommendation is based on the existing data and determination of no unacceptable risk to human health or to ecological receptors at LHAAP-49.

LHAAP-50, a former sump water tank, is located in the north-central portion of LHAAP and covers an area of approximately 1 acre. Historically, LHAAP-50 contained a 47,000-gallon capacity aboveground storage tank which received wastewater from various industrial waste sumps from 1955 to 1988. Three alternatives were evaluated for addressing the contaminated groundwater and soil at the site: 1) no action; 2) soil - excavation, groundwater - MNA and LUCs; and 3) soil - excavation, groundwater - in situ bioremediation, MNA, and LUCs. Based on available information, the preferred remedy at this time is the second alternative: excavation and off-site disposal of perchlorate-contaminated soils, and MNA and LUCs for groundwater. The preferred remedy would ensure protection of human health by eliminating the soil-to-groundwater and soil-to-surface water pathways, implementing groundwater use restriction LUCs to prevent exposure to contaminated groundwater, and implementing MNA until groundwater cleanup levels are achieved.

LHAAP-35A(58), known as the Shops Area, is located in the north-central portion of LHAAP and covers approximately 11 acres. The Shops Area was established in 1942 as part of the installation's initial construction. Plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical shops served the needs of the overall facility and became inactive in 1996 and 1997. Four alternatives were evaluated for addressing the contaminated groundwater at the site: 1) no action; 2) MNA with LUCs; 3) in situ bioremediation with short-term LUCs and LTM; and 4) in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. Based on available information, the preferred remedy at this time is the fourth alternative: in situ bioremediation followed by MNA and LUCs for the eastern plume, and MNA and LUCs for the western plume. The preferred remedy would ensure protection of human health by 1) implementing groundwater use restriction LUCs which prevent human exposure to contaminated groundwater and 2) returning the contaminated water to its potential beneficial use as a drinking water, wherever practicable, through MNA and in situ bioremediation.

The former **Pistol Range** is located in the southeastern portion of LHAAP and covers an area of approximately 0.4 acres. The area was used by base security personnel as early as the 1950s and intermittently through 2004 as a small arms firing range. The target area was a natural, wooded slope at the eastern side of the site. Soil with contamination above industrial cleanup levels was excavated and disposed off site during a 2009 removal action. Based on available information, the preferred remedy at this time is no action. The recommendation is based on existing data and determination of no unacceptable risk to human health or to ecological receptors.

For further information or to submit written comments, contact: Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas 72951; phone number 479-635-0110 or e-mail rose.zeiler@us.army.mil.

MEDIA RELEASE

The United States Army has prepared Proposed Plans for five environmental sites at the Longhorn Army Ammunition Plant: LHAAP-46, -49, -50, -35A(58) and the former Pistol Range. The Proposed Plans are documents that describe the sites and their proposed remedies. The Proposed Plans were developed to facilitate public involvement in the remedy selection process.

Copies of the Proposed Plans and supporting documentation are available for public review at the Marshall Public Library, 300 S. Alamo, Marshall, Texas 75670 beginning January 25, 2010. The public comment period has been extended to March 25, 2010.

An informal open forum was held on January 26, 2010. A second public meeting, with a formal question and answer session, will be held on March 9, 2010, from 7:00 to 9:00 p.m. at the Karnack Community Center, Highway 134 and Spur 449, Karnack, Texas 75661.

All written public comments on the Proposed Plans must be postmarked on or before March 25, 2010. Written comments may be provided to Dr. Rose M. Zeiler, Longhorn Army Ammunition Plant, P.O. Box 220, Ratcliff, Arkansas 72951 or e-mailed to rose.zeiler@us.army.mil. E-mailed comments must be submitted by close of business on March 25, 2010.

Shaw® Shaw Environmental, Inc.

Date: ***October 25, 2010***

Project No.:117591

TRANSMITTAL LETTER:

To: Mr. Aaron Williams

Address: US Army Corps of Engineers - Tulsa
CESWT-PP-M
1645 South 101st East Ave
Tulsa, Oklahoma 74128

Re: *Final* Record of Decision, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant
Contract No. W912QR-04-D-0027/DS02

For: Review ____ As Requested ____ Approval ____ Corrections ____ Submittal ____ Other X ____

Item No:	***No. of Copies***	***Date:***	***Document Title***
1	2	September 2010	**Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas**

Aaron,
Enclosed are two copies of the above-named document. Copies have been distributed as indicated at the end of this message. Please call with any questions or comments.

Sincerely:

Praveen Srivastav
Project Manager

CC: **Distribution List:**
Mr. J. Lambert – USACE, Tulsa (sent to A. Williams for distribution)
Mr. A. Maly – USAEC (electronic only)
Ms. Rose Zeiler – BRAC-LHAAP
Mr. S. Tzhone – EPA Region 6 (2)
Ms. F. Duke– TCEQ, Austin (2)
Mr. D. Vodak– TCEQ, Tyler
Mr. P. Bruckwicki– U.S. Fish and Wildlife Service

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

October 25, 2010

DAIM-ODB-LO

Mr. Stephen Tzhone
US Environmental Protection Agency
Superfund Division (6SF-AT)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, Shaw's Project Manager, be copied on any communications related to the project. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

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

Copies furnished:
F. Duke, TCEQ, Austin, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maley, USAEC, TX
P. Srivastav, Shaw – Houston, TX (for project files)

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

October 25, 2010

DAIM-ODB-LO

Ms. Fay Duke (MC-136)
SSDAT/Superfund Section
Remediation Division
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Re: Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2010
SUP 126

Dear Ms. Duke,

The above-referenced document is being transmitted to you for your records. The document has been prepared by Shaw Environmental, Inc. (Shaw) on behalf of the Army as part of Shaw's performance based contract for the facility.

The point of contact for this action is the undersigned. I ask that Praveen Srivastav, Shaw's Project Manager be copied on any communications related to the project. I may be contacted at 479-635-0110, or by email at rose.zeiler@us.army.mil.

Sincerely,

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

Copies furnished:
S. Tzhone, USEPA Region 6, Dallas, TX
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
A. Maly, USAEC, TX
P. Srivastav, Shaw, Houston, TX (for project files)