LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

ADMINISTRATIVE RECORD

Volume 14 of 16

2011

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Prepared for

Department of the Army
Longhorn Army Ammunition Plant

1976 – 2011

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD – CHRONOLOGICAL INDEX

VOLUME 14 of 16

2011

A. Title: Report – Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): U.S. Army
Recipient: All Stakeholders
Date: August 24, 2011
Bate Stamp: 00110920 – 00111367

B. Title: Meeting Minutes – Longhorn AAP Monthly Managers' Meeting
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: August 24, 2011
Bate Stamp: 00111368 – 00111375

C. Title: Meeting Minutes – LHAAP Restoration Advisory Board (RAB) Meeting
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: September 15, 2011
Bate Stamp: 00111376 – 00111393

D. Title: Meeting Minutes – Longhorn AAP Monthly Managers' Meeting
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: September 15, 2011
Bate Stamp: 00111394 – 00111403

E. Title: Report – Final Remedial Design LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: September 30, 2011
Bate Stamp: 00111404 – 00111532

F. Title: Report – Final Remedial Design LHAAP-35A(58), Shops Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: September 30, 2011
Bate Stamp: 00111533 – 00111686

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD – CHRONOLOGICAL INDEX

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2011

G. Title: Report – Final Remedial Design LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas
Author(s): Shaw Environmental, Inc., Houston, Texas
Recipient: All Stakeholders
Date: September 30, 2011
Bate Stamp: 00111687 – 00111793

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

August 24, 2011

DAIM-ODB-LO

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

Re: Final Remedial Design LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas, August 2011

Dear Mr. Tzhone,

The above-referenced document is enclosed for your file.

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

Sincerely,

Rose M. Zeiler

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

Copies furnished:
F. Duke, TCEQ, Austin, TX (2)
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
M. Plitinik, USAEC, TX
P. Srivastav, Shaw – Houston, TX (Administrative Record)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

August 24, 2011

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 Remedial Design LHAAP-35B (37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas, August 2011

SUP 126

Dear Ms. Duke,

The above-referenced document is enclosed for your file.

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

Sincerely,

Rose M. Zeiler

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

Copies furnished:
S. Tzhone, USEPA Region 6, Dallas, TX (2)
D. Vodak, TCEQ, Tyler, TX
P. Bruckwicki, Caddo Lake NWR, TX
J. Lambert, USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
M. Plitnik, USAEC, TX
P. Srivastav, Shaw, Houston, TX (Administrative Record)

FINAL
REMEDIAL DESIGN
LHAAP-35B (37), CHEMICAL LABORATORY AND LHAAP-67, ABOVEGROUND STORAGE TANK FARM
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared by

U.S. Army Corps of Engineers
Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma

August 1, 2011

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Acronyms and Abbreviations

µg/kg	micrograms per kilogram
Army	U.S. Army
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemicals of concern
DCA	dichloroethane
DCE	dichloroethene
ECP	environmental condition of property
LHAAP	Longhorn Army Ammunition Plant
LHAAP-35B(37)	Chemical Laboratory
LHAAP-67	Aboveground Storage Tank Farm
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
PCE	tetrachloroethene
RAO	remedial action objective
RD	remedial design
ROD	record of decision
TCA	Trichloroethane
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride

1.0 Purpose

This remedial design (RD) document addresses the Chemical Laboratory [LHAAP-35B(37)] and the Aboveground Storage Tank Farm (LHAAP-67) at Longhorn Army Ammunition Plant (LHAAP). The purpose of this RD is to provide information on how the remedy of monitored natural attenuation (MNA) and the land use control (LUC) components remedy selected in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision (ROD) for LHAAP-35B(37) and LHAAP-67 will be implemented and maintained to ensure that remedial action objectives are met.

In June 2010, the final ROD for LHAAP-35B(37) and LHAAP-67 was signed (U.S. Army, 2010). The remedy consists of LUCs in conjunction with MNA. The LUC is the restriction of groundwater use for the protection of human health.

The final remedies specified in the ROD, MNA and LUCs, were chosen in accordance with the CERCLA, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). They are intended to be protective of human health and the environment under the current and anticipated future land use of the site.

The LUC implementation and maintenance actions described herein will be effective immediately upon approval of this RD as the primary document by the USEPA Region VI with the concurrence of the Texas Commission on Environmental Quality (TCEQ), and shall be subject to the enforcement provisions of the September 11, 1991 Federal Facility Agreement. Once in effect, the requirements set forth in this RD will remain applicable to LHAAP-35B(37) and LHAAP-67 during the Army's administrative control and that of subsequent transferees.

2.0 Description of the Site

LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, are located on the former Longhorn Army Ammunition Plant (LHAAP). The former LHAAP is an inactive, government-owned, formerly contractor-operated and maintained Department of Defense facility located in central east Texas in the northeast corner of Harrison County. As shown on **Figure 2-1,** LHAAP is approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The former U.S. Army installation occupied over 8,400 acres between State Highway 43 at Karnack, Texas, and the southwestern shore of Caddo Lake and is accessed by State Highways 43 and 134.

LHAAP was placed on the 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.

LHAAP-35B(37), the Chemical Laboratory, encompasses approximately 12.2 acres and is located in the north-central portion of LHAAP near the southwestern corner of LHAAP-47 and south of the intersection of Avenue P and 59th Street (**Figure 2-2**). The surface features at LHAAP-35B(37) include a mixture of asphalt-paved roads and parking area, several administration buildings, the former Chemical Laboratory (Building 29-A), and a mixture of wooded and grassy vegetation-covered areas. The topography in this area is relatively flat with the surface drainage flowing into Goose Prairie Creek. The creek runs perpendicular to the western border of the site and then turns south through the east-central portion of the site and eventually drains into Caddo Lake.

LHAAP-67, a former aboveground storage tank farm, covers an area of approximately 1.9 acres and is located in the central portion of LHAAP on the southeast corner of 48th Street and Ignatius Avenue (**Figure 2-2**). The site is relatively flat. The nearest significant surface water body to LHAAP-67 is Central Creek located approximately 870 feet southeast of the site.

These sites are surrounded by an area (nearly 7,000 acres) that was transferred by the U.S. Department of the Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge. The U.S. Army, the lead agency for environmental response actions at LHAAP, is acting in partnership with USEPA Region 6 and TCEQ in planning and implementing remedial actions at LHAAP-35B(37) and LHAAP-67.

The LUC area associated with the groundwater use restriction at LHAAP-35B(37) is expected to extend beyond the site boundary at the northwestern boundary of the site, and encompass approximately 13.35 acres. The preliminary LUC boundary and the groundwater monitoring network at LHAAP 35B(37) are depicted in **Figure 2-3**. The LUC area associated with the groundwater use restriction at LHAAP-67 is expected to extend beyond the site boundaries along the eastern and southern boundaries of the site, and encompass a total of 2.60 acres. The preliminary LUC boundary and the groundwater monitoring network at LHAAP-67 are depicted in **Figure 2-4.** The remedies of MNA and LUCs will be reviewed by the Army and the USEPA every five years to determine if they are still necessary or if a modification is appropriate in accordance with the terms of **Section 6.2.7** of this RD**.** To satisfy the requirements under 42 U.S.C. § 9621(c) [CERCLA § 121(c)], the remedies of MNA and LUCs will remain in place until the concentrations of the chemicals of concern (COCs) have met cleanup levels. The selected remedy finalized in the Record of Decision (ROD) (U.S. Army, 2010) was developed based on the assumption that future land use will be industrial/recreational (e.g., national wildlife refuge). The remedial action assumes that land use notification will be recorded at the Harrison County courthouse to indicate that the property is suitable for nonresidential use. It is also assumed that this remedial action will be the final action at the site.

2.1 Hydrogeological Setting

LHAAP-35B(37)

Topsoil at LHAAP-35B(37) ranges in thickness from 0 to 4 feet and consists of the Quaternary silty clay underlain by alternating layers of clayey sand, silty sand, and poorly sorted sand of the Wilcox Group. The sand layers are laterally discontinuous and separated by silty clay. Groundwater at the site was encountered at 12 to 33 feet below ground surface (bgs) in the upper shallow zone, to 47 feet in the lower shallow zone, and at about 70 feet in the intermediate zone. December 2007 shallow and intermediate groundwater data indicated that flow at the site was to the south-southeast, although the shallow groundwater flow direction may vary locally during high water table conditions due to the influence of Goose Prairie Creek. For the shallow groundwater zone, hydraulic conductivity values in the sand units ranged from a minimum value of 4.3×10^{-4} centimeters per second (cm/sec) in the northwest portion of the site to a maximum value of 7.7×10^{-4} cm/sec east of the site. The average groundwater flow rate is 0.0496 feet/day for LHAAP-35B(37), based on the average hydraulic conductivity, hydraulic gradient, and effective porosity (Shaw, 2007e).

LHAAP-67

Across the site, below the surficial fill, lies a silty clay of the Wilcox Group ranging in thickness from about 2 to 15 feet. The clay grades into a fine-grained silty sand thickening toward the east-southeast. Groundwater at the site, encountered at depths of 17 to 20 feet bgs, has an easterly and southeasterly flow. There is likely limited interconnectivity between the shallow and intermediate zones because of the laterally and vertically discontinuous nature of the channel sands, flow is predominantly horizontal through these units. For the shallow groundwater zone, hydraulic conductivity values of the sand units ranged from a minimum value of 1.2×10^{-5} cm/sec to a maximum value of 1.0×10^{-2} cm/sec. The average groundwater flow rate is 0.0172 feet/day for LHAAP-67, based on the average hydraulic conductivity (U.S. Army, 2008b), hydraulic gradient and effective porosity (Shaw, 2007e).

2.1.1 Groundwater and Surface Water Interaction

LHAAP-35B(37)

Groundwater at the LHAAP-35B(37) was encountered at 12 to 33 feet below ground surface (bgs) in the upper shallow zone, to 47 feet in the lower shallow zone, and at about 70 feet in the intermediate zone. Groundwater elevation contours based on shallow groundwater elevations measured in December 1998, September 2000, and December 2007 indicate that flow at the site is generally to the south-southeast **(Figure 2-3**), although the shallow groundwater flow direction may vary locally during high water table conditions due to the influence of Goose Prairie Creek. Although not indicated by the elevation data (discussed below), monitoring of the COCs present in shallow groundwater beneath LHAAP-35B(37) for potential discharge to surface water in Goose Prairie Creek which flows to Caddo Lake, a drinking water source, is planned. The surveyed elevation of the Goose Prairie Creek bed at location GPS shown in **Figures 2-3** and **2-5** is 186.86 feet above mean sea level (msl), and the water level elevation in the shallow groundwater zone is 186.31 feet msl (measured in September 2004). These data indicate that the shallow zone water table is below the creek and was not discharging to Goose Prairie Creek in September 2004. Additional creek and groundwater elevation data is provided in Table 2, Appendix M of the Shaw Final Modeling Report Derivation of Soil and Groundwater Concentrations Protective of Surface Water and Sediment LHAAP Revision I (Shaw, 2007e). However, due to uncertainties regarding the seasonal variations in the water table elevation it is assumed that the shallow groundwater may discharge into the creek when the water table is higher.

LHAAP-67

Groundwater at LHAAP-67, encountered at depths of 17 to 20 feet bgs, has an easterly and southeasterly flow based on shallow groundwater elevations measured in December 1998, September 2000, September 2004, and December 2007 (**Figure 2-4**). Although not indicated by the elevation data (discussed below), there is a concern that the COCs (1,1-DCE, 1,2-DCA, 1,1,1-TCA, 1,1,2-TCA, and TCE) present in groundwater beneath LHAAP-67 could potentially discharge to surface water in Central Creek located to the southeast of the site, which flows to Caddo Lake, a drinking water source. The shallow groundwater potentiometric surface indicates that the groundwater from LHAAP-67 has an easterly and southeasterly flow and may discharge into Central Creek as shown in **Figure 3** in **Appendix A**. The surveyed elevation of the Central Creek bed at location CC3 shown in **Figure 2-5** is 168.54 feet msl, and the water level elevation in the shallow groundwater zone is 168.05 feet msl (measured in September 2004). These data indicate that the shallow zone water table is below the creek and was not discharge to the Central Creek in September 2004. Additional creek and groundwater elevation data is provided in Table 3, Appendix M of the Shaw Final Modeling Report Derivation of Soil and Groundwater Concentrations Protective of Surface Water and Sediment LHAAP Revision I (Shaw, 2007e). However, due to uncertainties regarding the seasonal variations in the water table elevation it is assumed that the shallow groundwater may discharge into the creek when the water table is higher.

3.0 Remedy Performance Objectives

Army recognizes USEPA's policy to return all groundwater to beneficial uses, based upon the non-binding programmatic expectation in the NCP. The remedy performance objectives for the selected remedies at LHAAP-35B(37) and LHAAP-67 (U.S. Army, 2010), which address contamination associated with the media at the sites and take into account the reasonably anticipated future use as a national wildlife refuge include:

- Ensure protection of human health by preventing human exposure to the contaminated groundwater
- Ensure protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water
- Ensure return of groundwater to its potential beneficial use as drinking water, wherever practicable

The final remedy for both LHAAP-35B(37) and LHAAP-67 includes utilizing land use controls (LUCs) and MNA. The remedy meets the performance objectives developed for these sites to protect human health and the environment by preventing human exposure to chlorinated solvents-contaminated groundwater [1,1-dichloroethene (DCE), trichloroethene (TCE), and tetrachloroethene (PCE) at LHAAP-35B(37) and 1,1,1-trichloroethane (TCA), 1,1,2-TCA, 1,2-dichloroethane (DCA), TCE, and 1,1-DCE at LHAAP-67], ensuring containment of the chlorinated solvents-contaminated groundwater for the protection of surface water, and returning the groundwater to its potential beneficial use as drinking water wherever practicable.

Due to the potential for chlorinated solvents-contaminated groundwater to migrate, MNA will be implemented to assure that the plumes will not migrate to nearby surface water bodies at levels that may present an unacceptable risk to human health and the environment. The monitoring and reporting associated with this remedy will continue until cleanup levels are achieved for COCs. Monitoring will be used to demonstrate that MNA is effective in meeting remedial action objectives. Due to the unacceptable risk posed by chlorinated solvents in groundwater during the MNA remedy, LUCs are needed in the impacted areas to ensure the protection of human health by preventing human exposure to the contaminated groundwater. The selected LUCs will prevent human exposure to chlorinated solvents-contaminated groundwater through the restriction of groundwater use. The LUCs will remain in place until cleanup levels are achieved.

4.0 Land Use Controls for the Site

The LUCs to be implemented by the Army or its representatives for LHAAP-35B(37) and LHAAP-67 to prevent human exposure to residual groundwater contamination presenting an unacceptable risk to human health include:

- Ensure no withdrawal or use of groundwater beneath the sites for anything other than environmental monitoring and testing until cleanup goals are met

Notification of the groundwater use restriction will accompany all transfer documents and will be recorded at the Harrison County Courthouse in accordance with Texas Administrative Code (TAC) Title 30, §335.566.The LUC addresses the areas of LHAAP-35B(37) and LHAAP-67 that include groundwater plumes at LHAAP-35B(37) and LHAAP-67 with levels of contamination that require implementation of a remedy (see **Section 2.0**). The U.S. Army is responsible for implementing, maintaining, monitoring, reporting on, and enforcing the LUC.

U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an LUC objective at this site after it has transferred. U.S. Army shall obtain USEPA and TCEQ concurrence prior to termination or significant modification of the LUC, or implementation of a change in land use inconsistent with the LUC objectives and use assumptions of the remedy. Although not a remedy, the land use assumption for LHAAP-35B(37) and LHAAP-67 forms the basis for the remedy. The reasonably anticipated future use of the site as part of a national wildlife refuge is consistent with an industrial risk exposure scenario. Notification of the land use assumption of this site will be made in transfer documentation, will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566 and compliance with the use assumption will be documented in the Five-Year Review reports.

5.0 Monitored Natural Attenuation

MNA is a passive remedial action that relies on natural biological, chemical, and physical processes that act to reduce the mass and concentration of the groundwater COCs under favorable conditions. These natural attenuation processes include biodegradation, dispersion, dilution, adsorption, volatilization, and abiotic destruction of contaminants. Based on groundwater modeling, groundwater MCLs are expected to be met through natural attenuation in 39 to 43 years for LHAAP-35B(37) and in 21 to 66 years for LHAAP-67. Monitoring of natural attenuation is required to 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.

At LHAAP-35B(37), attenuation is indicated by the presence of TCE and 1,1-DCE, which indicate dechlorination of PCE and TCE. Historical volatile organic trends indicate the occurrence of complete reductive dechlorination by the presence of 1,1-DCE, cis-1,2-DCE, and ethene. Evaluation of the primary and secondary lines of evidence demonstrates that natural attenuation mechanisms including reductive biodegradation, dilution, dispersion, sorption, and volatilization, may all be contributing to the observed reduction in COC concentrations at LHAAP-35B(37). The presence of 1,1-DCE and 1,2-DCA at LHAAP-67 indicates that some degree of dechlorination has occurred from 1,1,1-TCA and 1,1,2-TCA, respectively. Degradation rates of literature-based half-life values, 10 times these values, and no degradation at all were used to obtain a more conservative estimate. The conservative degradation rate of 10 times the literature-based half-life (e.g. Half-life=45 years for TCE) was used for the natural attenuation modeling results reported below for LHAAP-35B(37) and LHAAP-67.

Natural attenuation of LHAAP-35B(37) and LHAAP-67 COCs in groundwater will be monitored to confirm that contaminant levels are being reduced thereby preventing migration of contaminated groundwater to surface water at levels that may present an unacceptable risk to human health and the environment. Based on groundwater modeling, groundwater MCLs are expected to be met through natural attenuation in 28 to 38 years for PCE, 39 to 43 years for TCE, and 16 to 21 years for 1,1-DCE at LHAAP-35B(37) (Shaw, 2007e; U.S. Army, 2008b). Considering the lithologic variability at LHAAP-35B(37), particularly the lateral and vertical change from sand to clay, the times to MCL may range to an order of magnitude greater. For LHAAP-67, MCLs would be met through natural attenuation in 17 to 66 years for TCE, 20 to 34 years for 1,1-DCE, and 21 to 43 years for 1,2-DCA. Although the times to MCL for 1,1,1-TCA and 1,1,2-TCA were originally modeled to be 22 and 20 years respectively, these two VOCs are no longer detected above MCLs at LHAAP-67 (Shaw, 2007b; U.S. Army, 2008b). The groundwater flow rates are within the normal range for the formation material at these sites, an average groundwater flow rate of 0.0496 feet/day for LHAAP-35B(37) and an average groundwater flow rate of 0.0172 feet/day for LHAAP-67.

Modeling calculations were completed to assess the potential for the COCs present in shallow groundwater at LHAAP-35B (37) and LHAAP-67 to migrate toward and discharge to surface water. Conservative literature half-life values were used (Shaw, 2007e).

The modeling for LHAAP-35B(37) assumes an instantaneous source and conservatively used the maximum historical TCE concentration of 330 ug/L detected at monitoring well LHSMW59. Based on the results of the instantaneous source model for LHAAP-35B(37), the maximum concentration of TCE (3.63 μg/L) appears at the point of entry of the groundwater into Goose Prairie Creek after approximately 11.59 years (Shaw, 2007e), and is below the MCL for TCE of 5 μg/L. TCE would be diluted further after entry into the surface water, most likely to undetectable levels. The modeling for LHAAP-67 used two different scenarios simulating a total period of 100 years, which was long enough to capture the maximum contaminant concentrations where groundwater discharges into Central Creek. The first scenario assumes an instantaneous source in which there is no contaminant leaching from vadose zone soil to groundwater. The second scenario, which is more conservative and less likely, assumes a continuous source of contaminant leaching from the vadose zone soil to groundwater over time. This scenario was considered in order to account for a case where a VOC source may be present in the soil in an area or depth that was not sampled during the RI. Based on the results of the instantaneous source model, the maximum COC concentrations were below their respective MCLs where groundwater discharges into Central Creek. Furthermore, based on the results of the continuous source model, multiple groundwater COCs could eventually exceed their respective MCLs where groundwater discharges into Central Creek in less than 16, but up to 29 years. Therefore, additional modeling was completed with calculated dilution within Central Creek. The resultant concentrations of the COCs in Central Creek after dilution were less than 3 percent of their respective MCLs. Thus, no adverse impact is expected to the surface water during the time it would take natural attenuation to reduce contaminant concentrations to MCLs.

6.0 Remedy Implementation Actions

6.1 Design Criteria

The design criteria for the RD are based on the RAOs of 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, and the return of groundwater to its potential beneficial use as drinking water, wherever practicable.

To prevent human exposure to contaminated groundwater, LUCs will be implemented to prevent access to the contaminated groundwater until all COCs and their by-products (daughter contaminants) in the groundwater attain the Safe Drinking Water Act MCLs. A LUC boundary will be established around the perimeter of each site which contains the contaminated groundwater plume. The LUC boundaries are generally depicted in Figure 2-3 and 2-4, but will be finalized and recorded after installation of new monitoring wells and subsequent to the first quarter of groundwater data. Restrictions will be placed on the property bound by the LUC boundary barring the use of groundwater for any purpose other than environmental monitoring and testing. The effectiveness of the restrictions will be documented with periodic certifications.

Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water, and the return of groundwater to its potential beneficial use as drinking water, wherever practicable will be accomplished by MNA. MNA at the sites will include the installation of additional monitoring wells within and downgradient of the contaminant plumes, and the monitoring of contaminant levels in a subset of the monitoring wells at the site. For LHAAP-35B(37), monitoring wells will be installed only in the shallow groundwater zone, which has been shown to be contaminated by past monitoring. The deeper intermediate groundwater zone will not be monitored, since past monitoring showed no contamination in the intermediate groundwater zone and the ROD concluded contaminants are confined in the shallow groundwater zone and have not migrated into the intermediate zone. For LHAAP-67, the intermediate groundwater zone will be monitored, since past monitoring showed some contamination in the intermediate zone. Although the contamination in the intermediate groundwater zone at LHAAP-67 was below MCL, the detection indicates the potential for vertical migration. Additional sampling of the intermediate groundwater zone, during installation of temporary borings at LHAAP-67, will be conducted to evaluate whether an additional monitoring well should be installed in the intermediate zone. Data from the monitoring wells within the contaminant plumes will be used to evaluate the natural attenuation of the COCs. Data from monitoring wells downgradient of the plumes will be used to verify that the plumes are not migrating to nearby surface water bodies at levels that may present unacceptable risk to human health and the environment. Surface water sampling will be conducted to confirm contaminated groundwater is not migrating to surface water. MNA will continue until MCLs are achieved. Monitoring wells not designated for long-term monitoring will be plugged and abandoned after the first Five-Year Review.

6.1.1 Basis Of Design

The interval of interest for LHAAP-35B(37) is 165 to 180 feet msl and for LHAAP-67 is 176 to 186 feet msl based on the screening interval where contamination was found at the sites (see cross sections and drilling logs [**Attachment 1** in **Appendix A**], plume maps [**Figure 2-3** and **Figure 2-4**], and historical COC concentrations[**Tables 6-1** and **Table 6-2**]). Criteria for well abandonment include the well’s screened interval, location of the well with respect to the path of the plume based on potentiometric surface data, and whether it can be used to confirm the plume is not migrating.

LHAAP-35B(37)

Results of the groundwater sampling shown in **Table 6-1** indicate that the elevated VOC concentrations are located in the upper shallow groundwater zone at LHAAP-35B(37) at 165 to 180 feet msl. **Figure 2-3** shows the locations of the groundwater monitoring wells, estimated contaminant plume boundaries based on December 2006 sampling, and groundwater elevation contours from groundwater elevation measurements made in December 1998, September 2000 and December 2007. The December 2007 groundwater elevation contours are considered most accurate of the three sets of contours in the area around LHAAP-35B(37) because they were developed using measurements from a greater number of monitoring wells in the LHAAP35B(37) site than the other two events, however it should be noted that Longhorn has received low annual rainfall for the past several years with respect to historical rainfall at the site. December 2007 shallow groundwater data indicated that flow at the site was to the south-southeast. The center of mass of the TCE plume is considered to be in proximity to monitoring well 35BWW08 and the center of mass of the PCE plume is considered to be in proximity to monitoring well 35BWW04. Monitoring wells for the Long-Term Monitoring Program are located north-northwest of the plume (upgradient), within the plume and south-southwest of the plume (downgradient) to confirm the plume limits, to confirm natural attenuation is occurring, and to confirm the plume is not migrating.

LHAAP-67

Results of the groundwater sampling shown in **Table 6-2** indicate a relatively small area of contamination in the shallow groundwater at 176 to 186 feet msl. **Figure 2-4** shows the locations of the groundwater monitoring wells, estimated contaminant plume boundaries based on December 2006 sampling, and groundwater elevation contours from groundwater elevation measurements made in December 1998, September 2000, September 2004 and December 2007. The December 2007 groundwater elevation contours are considered the most accurate of the four sets of contours in the area around LHAAP-67 because they were developed using measurements from a greater number of monitoring wells in the LHAAP-67 site than the other three events. Groundwater at the site, encountered at depths of 17 to 20 feet bgs, has an easterly and southeasterly flow. The center of mass of the plume is considered to be in proximity to monitoring well 67WW01. Monitoring wells for the Long-Term Monitoring Program are located north-northwest (upgradient), within the plume, and south-southeast of the plume (downgradient) to confirm the plume limits, to confirm natural attenuation is occurring, and to confirm the plume is not migrating.

6.2 Land Use Control Implementation Actions

The Army or its representatives will be responsible for LUC implementation and certification, reporting and enforcement. The Army shall address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable.

As a condition of property transfer, the Army may require the transferee to assume responsibility for various implementation actions, as indicated below. Although the Army may transfer responsibility for various implementation actions, the Army shall retain its responsibility for remedy integrity. This means that the Army is responsible for addressing substantive violations of performance objectives that would undermine the Army's CERCLA remedy. The Army also will be responsible for: 1) incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation; 2) recording groundwater use restriction and survey plat at the Harrison County Courthouse; and 3) notifying Texas Department of Licensing and Regulation of the groundwater restriction which includes the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the Army, the USEPA, and the TCEQ. The following LUC implementation actions shall be undertaken by the Army in order to ensure that the aforementioned LUC performance objectives for LHAAP-35B(37) and LHAAP-67 are met and maintained:

6.2.1 Comprehensive Land Use Control Management Plan

Within 30 days of receiving USEPA and TCEQ approval of this RD, the Army will incorporate this document into the Comprehensive LUC Management Plan. The Comprehensive LUC Management Plan consists of LHAAP RD documents and a survey plat showing the locations where LUCs being implemented at LHAAP are applied. The purpose of this Comprehensive LUC Management Plan is to ensure all site specific LUCs are compiled into one comprehensive location for both pre-transfer use by the installation and for post-transfer use by the transferee. This document is also accessible to regulators, the local government and the public. The Comprehensive LUC Management Plan is located in the Marshall Public Library to accompany LHAAP's Administrative Record. As LUC RD documents for additional environmental sites are approved by USEPA and TCEQ, the Army shall likewise add those documents and survey plats to the Comprehensive LUC Management Plan as well as update the previous copy of the plan placed in the Marshall Public Library.

6.2.2 Site Certifications and Reporting

Beginning with finalization of this RD, the Army will undertake annual certifications to confirm continued compliance with the LUC objectives. The Army will retain the annual LUC Compliance Certification documents in the project files for incorporation into the Five-Year Review Reports, and these documents will be made available to USEPA and TCEQ upon request. The certification form will be consistent with the form attached as **Appendix B**. In addition, should any violations be found during the annual certification, the Army will provide to USEPA and TCEQ along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations**.** Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental transfer document. The need to continue annual certifications will be revisited at Five-Year Reviews.

6.2.3 Notice of Planned Property Conveyances

The Army shall provide notice to USEPA and TCEQ of plans to convey LHAAP-35B(37) and LHAAP-67 acreage. The notice shall describe the mechanism by which LUCs will continue to be implemented, maintained, inspected, reported, and enforced.

6.2.4 Opportunity to Review Text of Intended Land Use Controls

Army will provide a copy of the groundwater use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. In addition, the Army will produce an ECP or other environmental document for transfer of LHAAP-35B(37) and LHAAP-67, but before executing transfer, the Army will provide USEPA and TCEQ with a draft copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before document execution, to review all LUC-related provisions.

6.2.5 Notification Should Action(s) Which Interfere with Land Use Control Effectiveness Be Discovered Subsequent to Conveyance

Should the Army discover after conveyance of the site any activity on the property inconsistent with the LUC performance objectives, the Army shall notify USEPA and TCEQ within 72 hours of such discovery. Consistent with **Section 6.2.6** below, the Army will then work with USEPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

6.2.6 Land Use Control Enforcement

Should the LUC remedy reflected in this LUC RD fail, the Army will coordinate with USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the owner or violator, to the institution of judicial action under the auspices of Texas property law or CERCLA. Alternatively, should the circumstances warrant such, the Army could choose to exercise its response authorities under CERCLA, and then seek cost recovery after the fact from the person(s) or entity(ies) who violated a given LUC. Should the Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction, the Army will notify these agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUCs.

6.2.7 Modification or Termination of Land Use Controls

The Army shall not, without USEPA and TCEQ concurrence, make a significant modification to, or terminate a LUC, or make a land use change inconsistent with the LUC objectives and use assumptions of the selected remedy. Likewise, the Army shall seek prior USEPA and TCEQ concurrence before commencing actions that may impact remedy integrity. In the case of an emergency action, the Army shall obtain prior USEPA and TCEQ concurrence as appropriate to the exigencies of the situation.

The LUCs shall remain in effect until such time as the Army, TCEQ and USEPA agree that the concentrations of COCs have met cleanup levels. When this occurs, the LUCs will be terminated as needed. The decision to terminate LUCs will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial action completion report. If the property has been transferred and a determination by the Army, TCEQ and USEPA has been made to terminate one or more of the LUCs, the Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also timely advise other local stakeholders of the action.

6.3 Monitored Natural Attenuation Implementation Actions

Implementation actions include installation of additional monitoring wells, plugging and abandonment of monitoring wells not designated for long-term monitoring, implementation of a groundwater monitoring plan, monitoring, and reporting. The project schedule and cost summary for implementation actions are provided in **Appendix H**. Groundwater monitoring will be conducted to monitor the effectiveness of MNA in reducing contaminant concentrations over time. Monitoring will also be conducted to evaluate plume migration and ensure that chlorinated solvents-contaminated groundwater does not impact nearby surface water at unacceptable levels. Surface water sampling will be conducted to confirm contaminated groundwater is not migrating to surface water. The Groundwater Monitoring Plan, attached as **Appendix A**, describes the wells, their locations, analytical parameters, the frequency of the monitoring, surface water sampling, and presents a list of the monitored constituents and their respective MCLs. Groundwater monitoring and surface water sampling conducted at LHAAP-35B(37) and LHAAP-67 will follow the Health and Safety Plan (**Appendix E**), the Contractor Quality Control Plan (**Appendix F**), the Chemical Data Acquisition Plan (**Appendix G**), Field Activities (**Appendix C**) and Field Procedures (**Appendix D**) as contained in the appendices of the Remedial Design LHAAP-35B(37) and LHAAP-67.

Annual reports will be prepared for any year in which sampling occurs to document the monitoring program. The first year’s annual report will include a review of the first four quarters of data, which include natural attenuation parameters and provide an evaluation for the evidence of MNA as a remedial method and a review of the first year’s surface water sample data. The TCEQ provides guidance for MNA as a remedial action in *Monitored Natural Attenuation Demonstrations* (Texas Natural Resource Conservation Commission [TNRCC], RG-366/TRRP-33, October 2001). Although LHAAP is being addressed under the Risk Reduction Standards rather than Texas Risk Reduction Program (TRRP), this guidance is comparable to USEPA guidance and may be used as a guideline for the evaluation of the groundwater data. TRRP guidance specifies recommended lines of evidence to document the occurrence of natural attenuation at a site. For the first annual report, primary and secondary lines of evidence will be evaluated to document that attenuation is occurring at LHAAP-35B(37) and LHAAP-67. The primary line of evidence uses historic groundwater data to demonstrate a trend of stable or decreasing COC concentrations over time and away from the source area. Secondary lines of evidence include geochemical parameters to document that the proper conditions are present for MNA to occur as well as the presence of daughter products. For the subsequent annual reports, the data evaluation presented will focus on trend analysis for the primary COCs. Additional information on the reporting procedures is provided in **Appendix A**.

6.4 CERCLA Five-Year Reviews

The Army shall conduct Five-Year Reviews of the LHAAP-35B(37) and LHAAP-67 remedy, as required by CERCLA and the NCP, because residual contamination in excess of established unrestricted use cleanup criteria will remain on site. As part of the CERCLA Section 121 (c) Five-Year Review, the Army shall prepare a report certifying the continued effectiveness of the remedy including the LUCs implemented at LHAAP-35B(37) and LHAAP-67.

The Five-Year Review Report will present summaries of information from the LUC inspection and certification forms and the annual MNA reports as from the five-year sampling event, evaluate that information, and recommend the future course of action. The Five-Year Review will include:

- A narrative of field activities for the past five years
- Figures of the site and wells locations
- Summary of groundwater sample results
- Site inspection with relevant photographs
- Evaluation of progress toward cleanup levels
- Evaluation of the effectiveness of the LUC
- Recommendations for future actions

The progress toward cleanup levels will be evaluated in the five-year report. The Five-Year Review offers the periodic opportunity to declare the site successfully and completely remediated, progressing satisfactorily toward remediation, or in need of more aggressive remedy. When cleanup levels are reached, monitoring may cease and the LUC may be terminated as recommended in the Five-Year Reviews.

7.0 Points of Contact

- Dr. Rose M. Zeiler, Site Manager
  Longhorn Army Ammunition Plant
  P.O. Box 220
  Ratcliff, Arkansas 72951
  Phone: 479-635-0110

- BRAC Division
  ATTN: DAIM-BD
  600 Army Pentagon
  Washington, DC 20310-0600
  Phone: 703-602-2854

- USEPA Region 6
  ATTN: Mr. Stephen Tzhone
  Superfund Division (6SF-AT)
  1445 Ross Avenue
  Dallas, Texas 75202
  Phone: 214-665-8409

- Texas Commission on Environmental Quality
  ATTN: Ms. Fay Duke
  TCEQ Environmental Cleanup Section II, Team 2(MC-221)
  12100 Park 35 Circle, Bldg. D
  Austin, Texas 78753
  Phone: 512-239-2443

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Jacobs, 2002a, *Final Remedial Investigation Report for the Group 4 Sites, Sites 35A, 35B, 35C,46, 47, 48, 50 60, and Goose Prairie Creek, Longhorn Army Ammunition Plant, Karnack, TX*, January.

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U.S. Army, 2010, *Final Record of Decision, LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant Karnack, Texas*, June.

Figures

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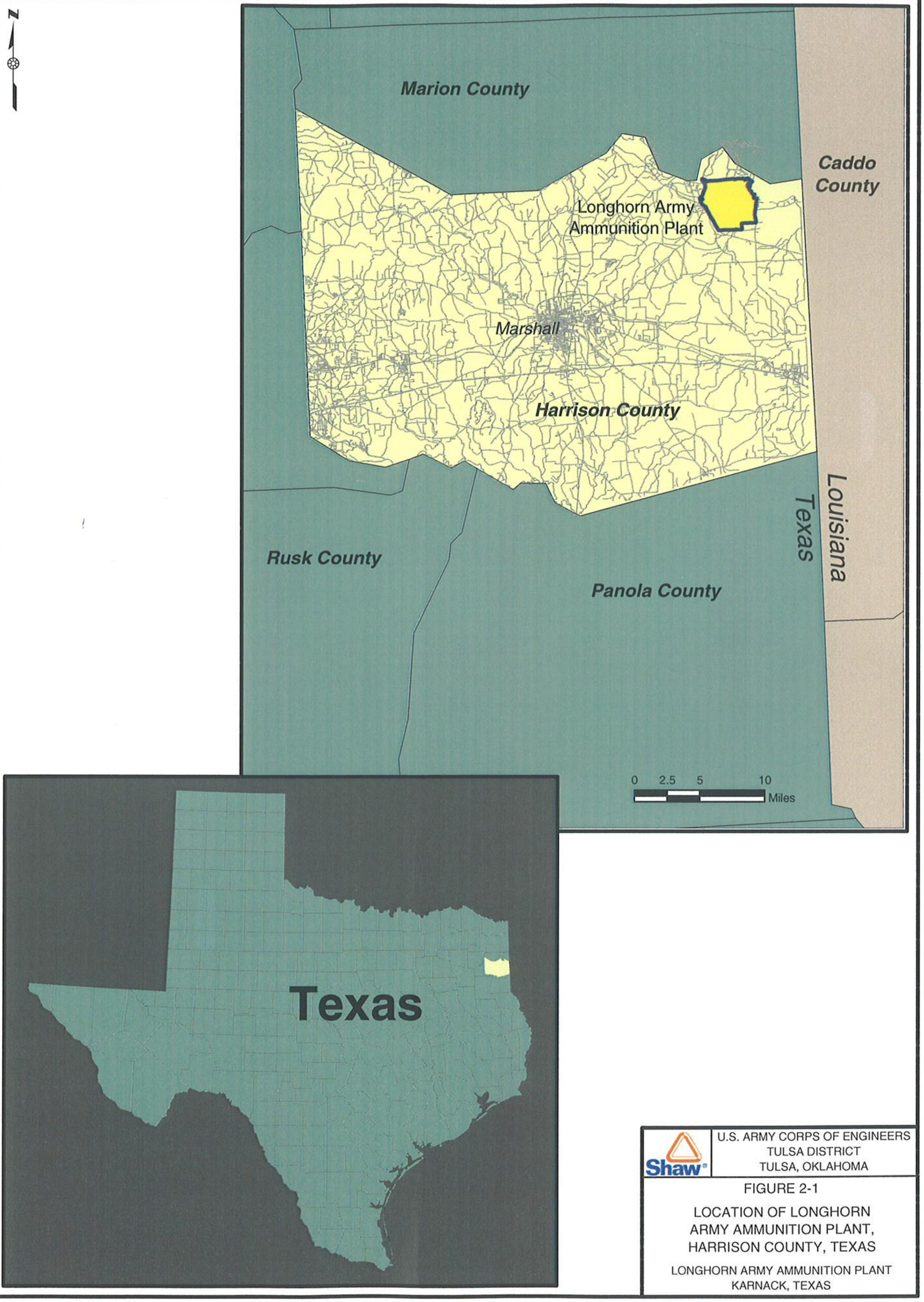

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-1

LOCATION OF LONGHORN
ARMY AMMUNITION PLANT,
HARRISON COUNTY, TEXAS

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
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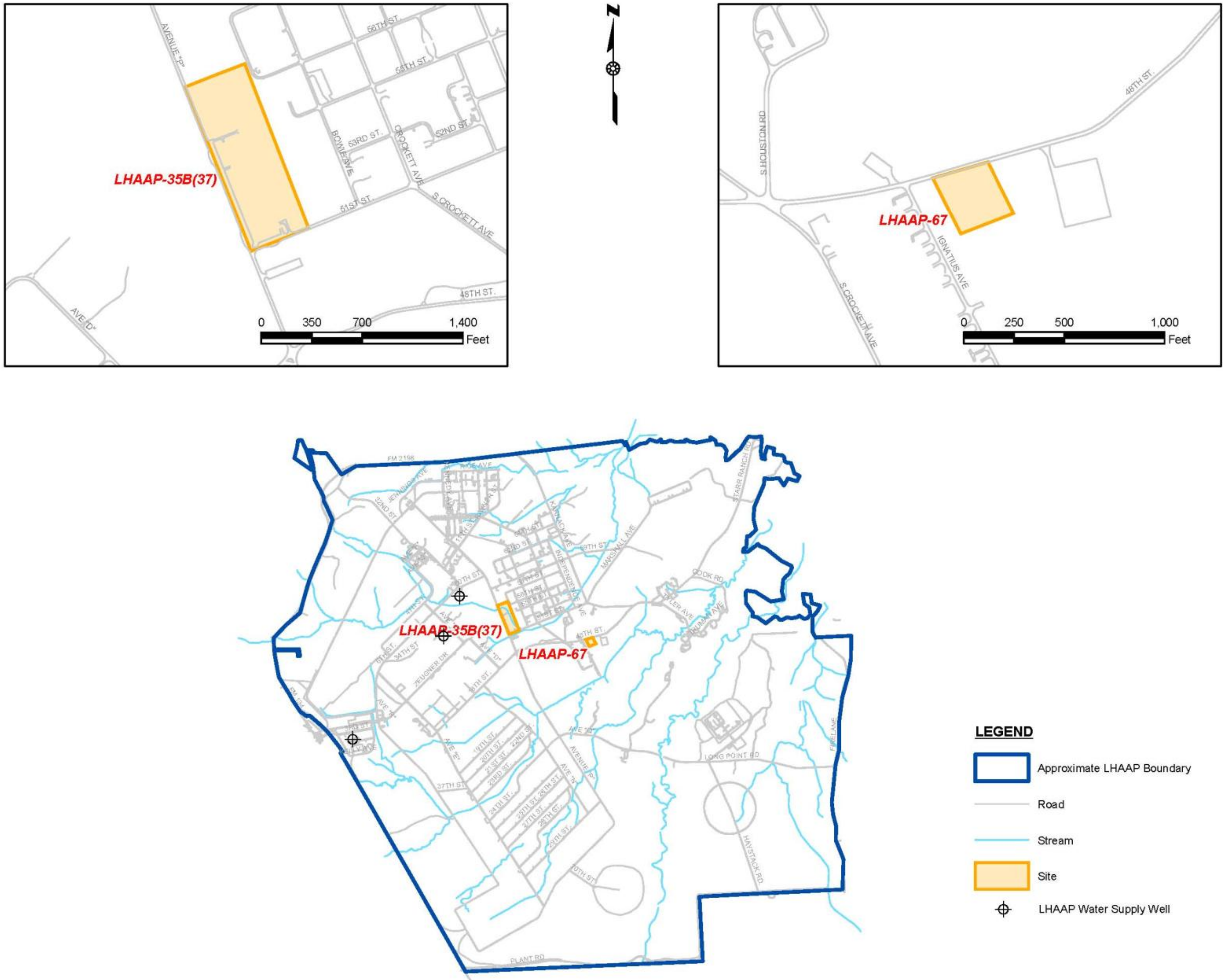
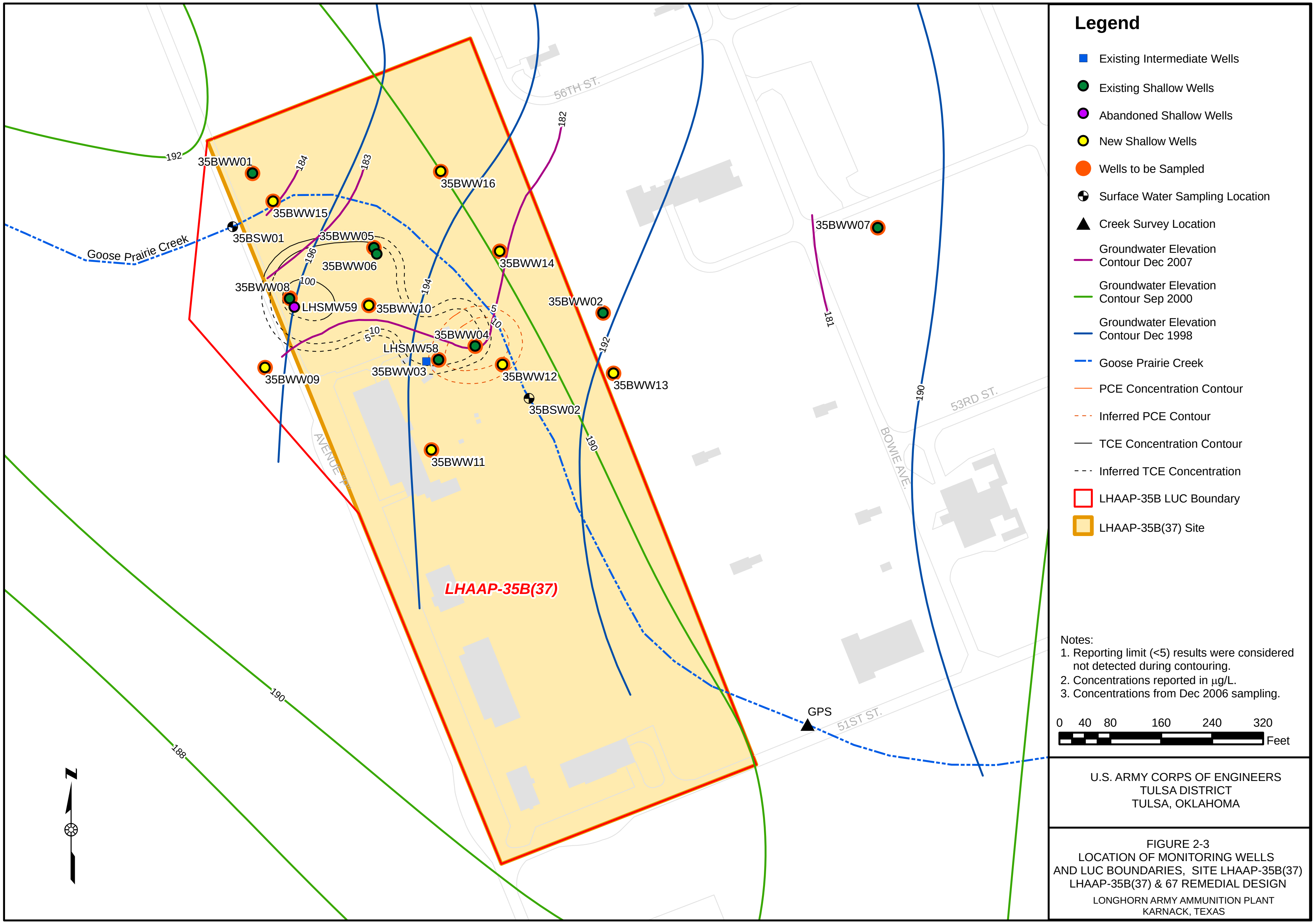


U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 2-2
SITE LOCATION MAP
REMEDIAL DESIGN
LHAAP-35B(37) AND LHAAP-67, GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



Notes:
1. Reporting limit (<5) results were considered not detected during contouring.
2. Concentrations reported in µg/L.
3. Concentrations from Dec 2006 sampling.

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

FIGURE 2-3
LOCATION OF MONITORING WELLS
AND LUC BOUNDARIES, SITE LHAAP-35B(37)
LHAAP-35B(37) & 67 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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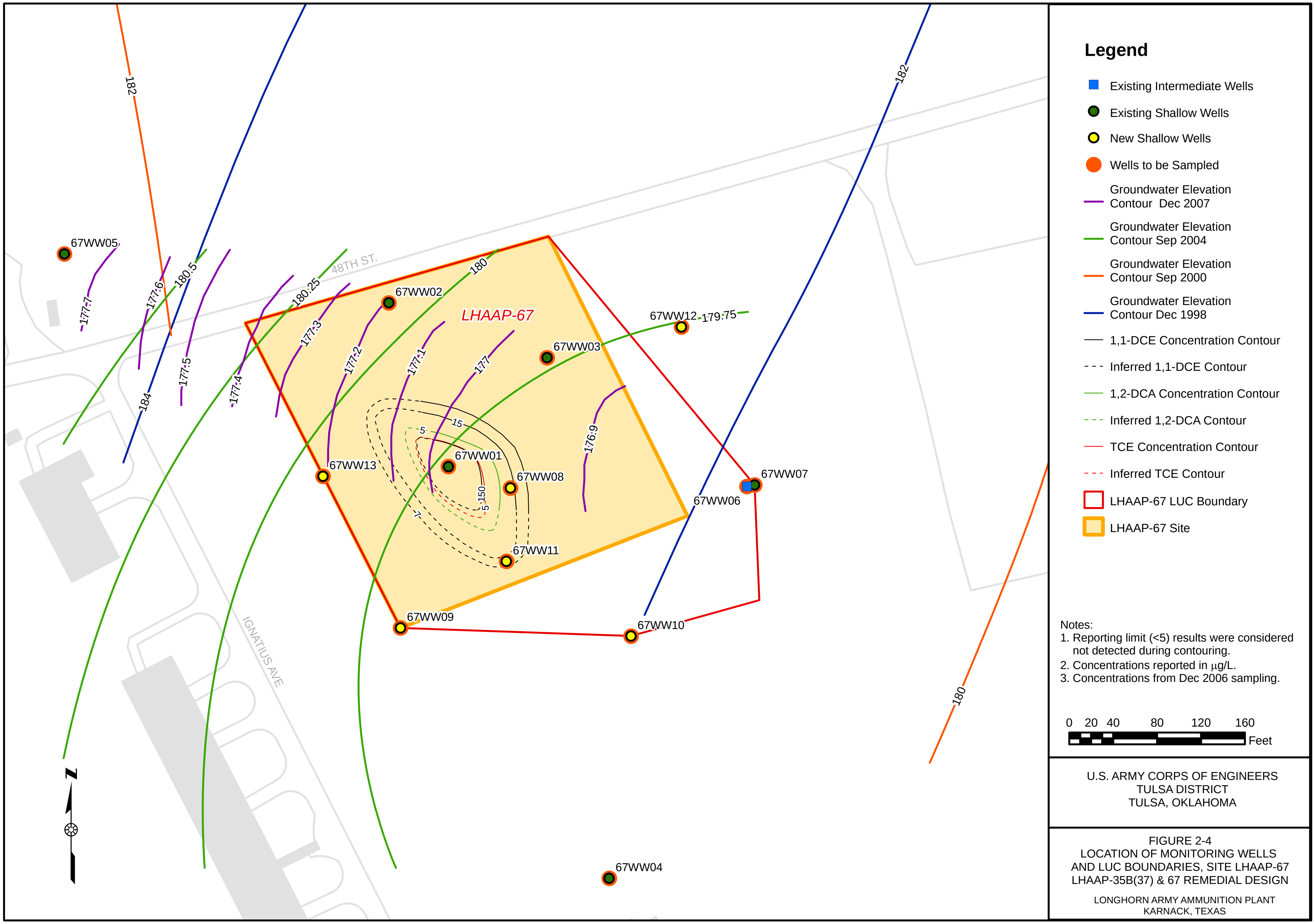

Notes:
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2. Concentrations reported in μg/L.
3. Concentrations from Dec 2006 sampling.

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

FIGURE 2-4
LOCATION OF MONITORING WELLS
AND LUC BOUNDARIES, SITE LHAAP-67
LHAAP-35B(37) & 67 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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FILE LOCATION
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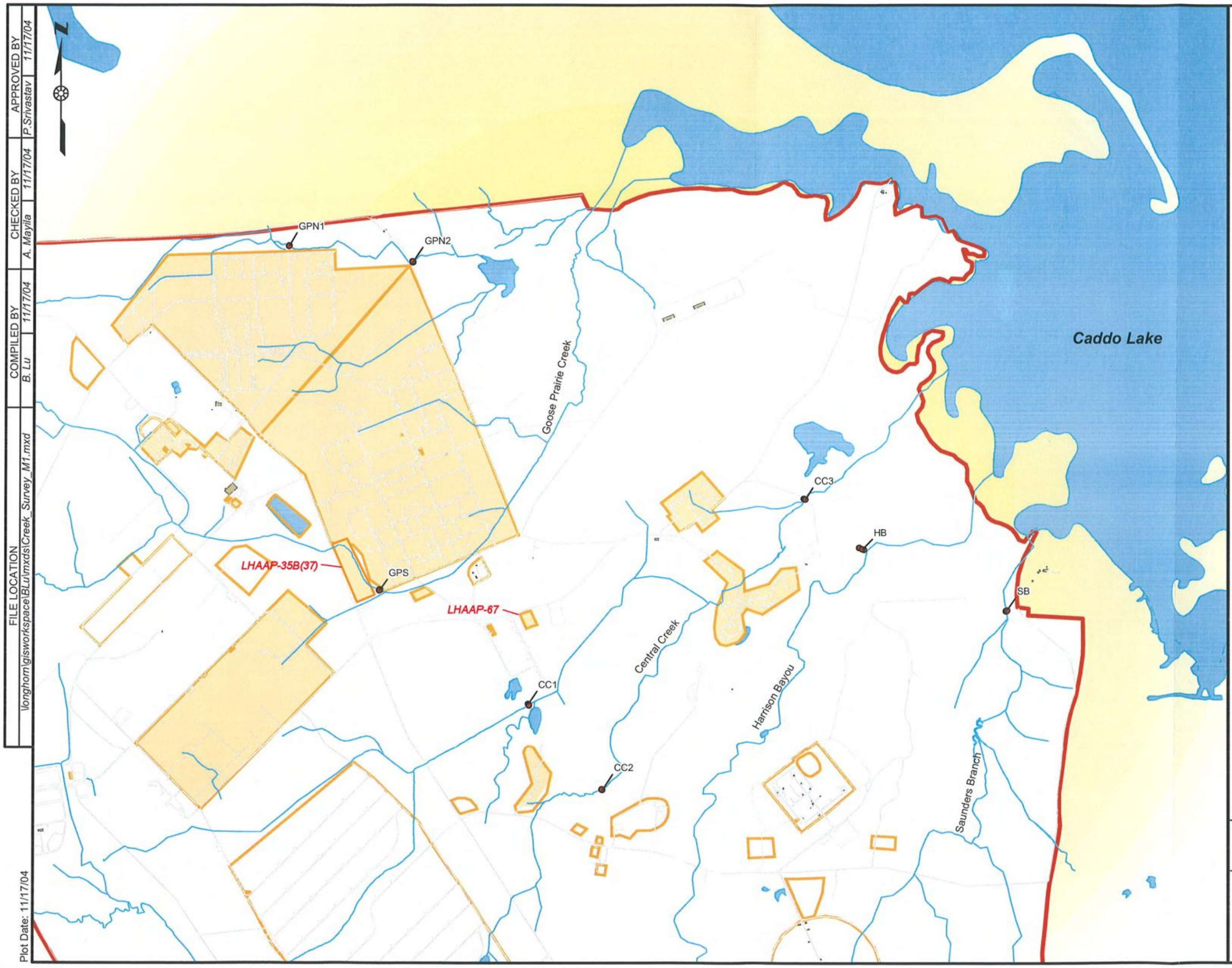
COMPILED BY
B. Lu 11/17/04

CHECKED BY
A. Mayila 11/17/04

APPROVED BY
P.Srivastav 11/17/04

Plot Date: 11/17/04



Legend

●	Creek Survey Location
—	Streams
	Roads
🟨	Modeled Site
▨	Buildings, Known to Exist
🟦	Lakes
☐	Site Boundary
🟥	LHAAP Boundary

0 900 1,800 3,600 Feet

Shaw®

U.S. Army Corps of Engineers
Tulsa District
Tulsa, Oklahoma

FIGURE 2-5
CREEK SURVEY LOCATION MAP
LHAAP-35B(37) & 67 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Tables

Table 6-1
LHAAP-35B(37) Historical COC Concentrations

				COC Concentrations in µg/L								
				PCE MCL=5			TCE MCL=5			1,1-DCE MCL=7		
Well ID	**Zone**	**Screened Interval (ft msl)**	**Date**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**
35BWW01	Shallow	181.2-191.2	8-Nov-98	1	U	U	1	U	U	1	U	U
			10-Sep-04	5	U	U	5	U	U	5	U	U
			10-Aug-06	5	U	U	5	U	U	5	U	U
			17-Dec-06	5	U	U	5	U	U	5	U	U
35BWW02	Shallow	187.1-192.1	8-Nov-98	1	U	U	1	U	U	1	U	U
			10-Sep-04	Dry			Dry			Dry		
			9-Aug-06	Dry			Dry			Dry		
35BWW03	Intermediate	121.3-131.3	10-Sep-04	5	U	U	5	U	U	5	U	U
			9-Aug-06	5	U	U	5	U	U	5	U	U
			16-Dec-06	5	U	U	5	U	U	5	U	U
35BWW04	Shallow	169.3-179.3	16-Dec-06	**30.1**			**10.8**			3.34	J	J
35BWW05	Upper Shallow	164-174	14-Dec-06	1	J	J	**12.9**			5	U	U
35BWW06	Lower Shallow	148-158	14-Dec-06	5	U	U	5	U	U	5	U	U
35BWW07	Shallow	172.9-182.9	14-Sep-07	1	U	-	1	U	-	1	U	-
35BWW08	Shallow	169.4-179.4	14-Sep-07	0.981	J	-	**150**			1	U	-
LHSMW58	Shallow	168.8-178.8	11-Dec-94	**21**			NR			**58**		
			21-Aug-96	**7.9**			**11.5**			**25.4**		
			20-May-98	**9.5**			**9.4**			4.2		
			10-Sep-04	**20**			**33**			4	J	J
			9-Aug-06	**21.8**		J	**21.8**		J	2.11	J	JH
			16-Dec-06	**9.01**			**13.7**			3.17	J	J
LHSMW59	Shallow Composite	153.5-173.5	11-Dec-94	**11**			NR			5	U	U
			21-Aug-96	**16.9**			**327**			2.2		
			20-May-98	**7**			**330**			1	U	U
			10-Sep-04	3	J	J	**180**	D		5	U	U
			10-Aug-06	1.19	J	J	**135**			5	U	U
			13-Dec-06	1.15	J	J	**166**			5	U	U

Notes and Abbreviations:

Shaded and bold values exceeded their MCLs

1,1-DCE	1,1-dichloroethene
COC	Chemical of Concern
D	Dilution
ft msl	feet above mean sea level
J	Estimated result detected above the method detection limit but below the reporting limit.
JH	Sample hold time exceeded. Result shown is estimated.
MCL	Maximum contaminant level
NR	not reported by laboratory
PCE	tetrachloroethene
Qual	laboratory qualifier
TCE	trichloroethene
U	Not detected. The reporting limit is shown.
VQ	Validation Qualifier
µg/L	micrograms per liter

Table 6-2
LHAAP-67 Historical COC Concentrations

				COC Concentrations in µg/L														
				TCE MCL=5			1,1-DCE MCL=7			1,2-DCA MCL=5			1,1,1-TCA MCL=200			1,1,2-TCA MCL=5		
Well ID	**Zone**	**Screened Interval (ft msl)**	**Date**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**	**Result**	**Qual**	**VQ**
67WW01	Shallow	176.3-186.3	8-Dec-98	**6.3**			**380**			**27**			**560**			**33**		
			12-Sep-04	**6**			**280**	D		**13**			5	U	U	1	J	J
			6-Aug-06	**5.38**		JH	**153**			**5.57**	Q	JH	5	U	U	0.305	J	JH
			18-Dec-06	**5.99**			**179**			**6.37**			5	U	U	0.28	J	J
67WW02	Shallow	171.7-181.7	8-Dec-98	1	U	U	2.4			1	U	U	100			**6.4**		
			12-Sep-04	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			6-Aug-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			18-Dec-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
67WW03	Shallow	173.3-183.3	8-Dec-98	20	U	U	**36**			20	U	U	**1800**			**24**		
			12-Sep-04	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			9-Aug-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			17-Dec-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
67WW04	Shallow	179-189	19-Dec-00	0.1	U	U	0.2	U	U	0.1	U	U	0.1	U	U	0.1	U	U
			12-Sep-04	1	J	J	5	U	U	5	U	U	5	U	U	5	U	U
67WW05	Shallow	171.5-181.5	19-Dec-00	0.1	U	U	0.2	U	U	0.1	U	U	0.1	U	U	0.1	U	U
			12-Sep-04	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			8-Aug-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			17-Dec-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
67WW06	Intermediate	149-159	19-Dec-00	0.14		J	0.2	U	U	3.51			0.1	U	U	0.1	U	U
			12-Sep-04	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			8-Aug-06	5	U	U	5	U	U	3.02	J	J	5	U	U	5	U	U
			18-Dec-06	5	U	U	5	U	U	1.62	J	J	5	U	U	5	U	U
67WW07	Shallow	173-183	19-Dec-00	0.1	U	U	0.2	U	U	2.28			0.1	U	U	0.1	U	U
			12-Sep-04	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			8-Aug-06	5	U	U	5	U	U	5	U	U	5	U	U	5	U	U
			18-Dec-06	5	U	U	5	U	U	1.65	J	J	5	U	U	5	U	U

Notes and Abbreviations:

Shaded and bold values exceeded their MCLs		ft msl	feet above mean sea level	Q	One or more quality control fail
1,1-DCE	1,1-dichloroethene	J	Estimated result detected above the method detection limit but below the reporting limit.	Qual	Laboratory qualifier
1,2-DCA	1,2-dichloroethane			TCE	trichloroethene
1,1,1-TCA	1,1,1-trichloroethane	JH	Sample hold time exceeded. Result shown is estimated.	U	Not detected. The reporting limit is shown.
1,1,2-TCA	1,1,2-trichloroethane	MCL	Maximum contaminant level	VQ	Validation Qualifier
COC	Chemical of Concern	NR	not reported by laboratory	µg/L	micrograms per liter
D	Dilution	PCE	tetrachloroethene		

Appendix A

Groundwater Monitoring Plan

Table of Contents

List of Tables

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Acronyms and Abbreviations

COC	chemicals of concern
DCA	Dichloroethane
DCE	Dichloroethene
LHAAP	Longhorn Army Ammunition Plant
LHAAP-35B(37)	Chemical Laboratory
LHAAP-67	Aboveground Storage Tank Farm
LUC	land use control
MCL	maximum contaminant level
MNA	monitored natural attenuation
PCE	Tetrachloroethene
TCA	Trichloroethane
TCE	Trichloroethene
TNRRC	Texas Natural Resource Conservation Commission
TRPP	Texas Risk Reduction Program
VOC	volatile organic chemicals

1.0 Purpose

The Groundwater Monitoring Plan describes the plan for the installation of additional monitoring wells at LHAAP-35(37) and LHAAP-67, and groundwater monitoring and reporting requirements at the sites. Groundwater monitoring will be used to monitor the effectiveness of monitored natural attenuation (MNA) in reducing contaminant concentrations over time, to evaluate plume migration and to ensure that contaminated groundwater does not impact nearby surface water.

2.0 Installation of New Monitoring Wells

Additional monitoring wells will be installed at LHAAP-35B(37) and LHAAP-67 to provide additional data in the evaluation of MNA at the sites, to ensure the contaminated groundwater does not migrate to nearby surface water at levels presenting an unacceptable risk, and to confirm the plume limits. Temporary borings will be installed and the groundwater sampled and analyzed using field instruments to provide additional information on the current extent of the contaminant plumes at the two sites. This additional information, along with sampling and analysis of all existing wells, will be used as guidance in the optimal placement of new monitoring wells. During installation of temporary borings at LHAAP-67 the intermediate groundwater zone will be sampled to determine if an additional intermediate groundwater well should be installed. Eight additional wells will be installed in the shallow groundwater zone at LHAAP-35B(37). **Figure 1** shows the location of the eight wells to be installed at LHAAP-35B(37). Six additional wells will be installed in the shallow groundwater zone at LHAAP-67. **Figure 2** shows the location of the six wells to be installed at LHAAP-67. **Tables 1a and 1b** provide a list of the monitoring wells to be installed at LHAAP-35B(37) and LHAAP-67 respectively, along with the approximate depths of the wells, and the locations of the wells based on the Texas State Plane coordinate system. **Table 5** provides a summary of well construction information. Available boring logs for existing monitoring wells and geologic cross sections at the two sites are included in **Attachment 1**.

3.0 Field and Analytical Program

Groundwater monitoring of monitoring wells at the two sites will be conducted to document the migration of the groundwater contamination and to ensure that the target contaminants do not discharge to nearby surface water bodies at such levels that applicable or relevant and appropriate requirements are exceeded. The location of the monitoring wells designated for long-term monitoring are shown on attached **Figure 1** for LHAAP-35B(37) and **Figure 2** for LHAAP-67 . Monitoring wells to be sampled are listed in **Tables 2a** and **2b** for LHAAP-35B(37) and LHAAP-67 respectively. **Tables 3a** and **3b** present a summary of the constituents of concern monitored at the two sites respectively, along with their respective MCLs. At the Five-Year Review, monitoring wells not in the long-term monitoring network will be considered for plugging and abandonment and are listed in **Table 4** for LHAAP-35B(37).

In addition to monitoring of the chemicals of concern (COCs) at the two sites, monitoring for antimony and thallium will take place at LHAAP-35B(37). Antimony and thallium were detected in groundwater at the site prior to the Remedial Investigation conducted 2002, but were determined not to be COCs due to follow-on groundwater sampling results being non-detect for these metals, their non-detection in soils at the site, and the lack of their historical uses at the site. No subsequent sampling was conducted at LHAAP-35B(37) for antimony and thallium after 2002. Because previous detections of antimony and thallium were qualified results, sampling of the wells at the site for antimony and thallium will take place during the first monitoring event to confirm the previous decision to exclude these constituents as COCs. After the first sampling and analysis event for antimony and thallium at LHAAP-35B(37), the Army will evaluate the need for additional monitoring of these constituents.

At both sites the samples from the monitoring wells will be analyzed for volatile organic chemicals (VOCs) quarterly for the first two years, and analyzed for antimony and thallium during the first monitoring event at LHAAP-35B(37). The wells will be sampled semi-annually for VOCs at both sites for years three through five and annually thereafter until the next Five-Year Review. The results from monitoring will be reviewed during the Five-Year Review and the monitoring frequency evaluated. Unless otherwise indicated by the data, the wells will then be sampled at each Five-Year review.

Groundwater monitoring of the LHAAP-35B(37) onsite monitoring wells 35BWW04, 35BWW05, 35BWW08, 35BWW11, 35BWW15 and LHSMW58 and LHAAP-67 onsite monitoring wells 67WW01 and 67WW08 will be conducted to monitor the effectiveness of natural attenuation in reducing contaminant concentrations over time. For the first year of the sampling program, in addition to VOCs, the wells will be analyzed quarterly for nitrates, nitrites, sulfates, pH, Eh (redox potential), conductivity, temperature, dissolved oxygen, ferrous iron, chloride, methane, ethane, ethene, inorganic and organic carbon, and *Dehalococcoides*.

Surface water sampling for VOCs will take place quarterly for the first year and annually until the next Five-Year Review. to confirm contaminated groundwater is not migrating to surface water. The surface water will then be sampled every five years to support the Five-Year Reviews unless the sampling results indicate more frequent sampling is necessary. The locations of the surface water sampling are shown on attached **Figure 1** for LHAAP-35B(37) and **Figure 3** for LHAAP-67.

Groundwater monitoring and surface water sampling conducted at LHAAP-35B(37) and LHAAP-67 will follow the Health and Safety Plan (**Appendix E**), the Contractor Quality Control Plan (**Appendix F**), the Chemical Data Acquisition Plan (**Appendix G**), Field Activities (**Appendix C**) and Field Procedures (**Appendix D**) as contained in the appendices of the Remedial Design LHAAP-35B(37) and LHAAP-67.

Monitoring well plugging and abandonment conducted at LHAAP-35B(37) and LHAAP-67 will follow the Health and Safety Plan (**Appendix E**), Field Activities (**Appendix C**), Field Procedures (**Appendix D**), and Contractor Quality Control Plan (**Appendix F**) as contained in the appendices of the Remedial Design LHAAP-35B(37) and LHAAP-67.

4.0 Reporting

Annual reports will be prepared for any year in which sampling occurs to document the monitoring program. The first year annual report will include a review of the first four quarters of data which include natural attenuation parameters, and provide an evaluation for the evidence of MNA as a remedial method and a review of the first year's surface water sample data. The Texas Natural Resource Conservation Commission (TNRCC) provides guidance for MNA as a remedial action in *Monitored Natural Attenuation Demonstrations* (TNRCC RG-366/TRRP-33, October, 2001). Although LHAAP is being addressed under the Risk Reduction Standards rather than Texas Risk Reduction Program (TRRP), this guidance is comparable to USEPA guidance and may be used as a guideline for the evaluation of the groundwater data. TRRP guidance specifies recommended lines of evidence to document the occurrence of natural attenuation at a site.

For the first annual report, primary and secondary lines of evidence will be evaluated to document that degradation is occurring at LHAAP-35B(37) and LHAAP-67. The primary line of evidence uses historic groundwater data to demonstrate a trend of stable or decreasing chemicals of concern (COC) concentrations over time and away from the source area. All of the COCs identified at the two sites are chlorinated VOCs, with trichloroethene (TCE), tetrachloroethene (PCE) and 1,1-dichloroethene(1,1-DCE) being the COCs at LHAAP-35B(37) and 1,1,1-trichloroethane (TCA), 1,1,2-TCA, 1,2-dichloroethane (DCA), TCE, and 1,1-DCE being the COCs at LHAAP-67. Results for perimeter monitoring wells will be evaluated for indications of plume migration to ensure that COC-contaminated groundwater does not impact nearby surface water at unacceptable levels.

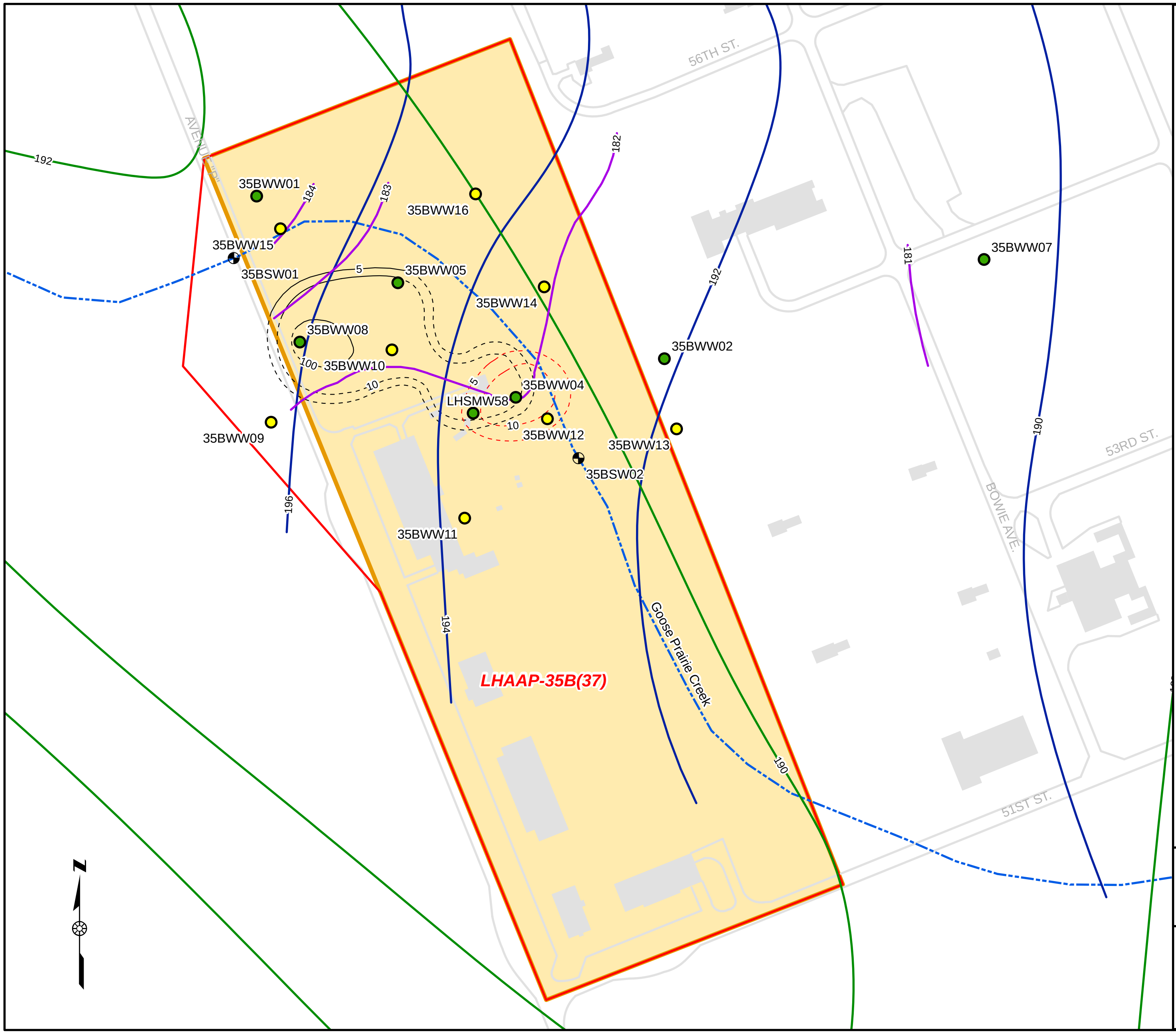
Secondary lines of evidence include geochemical parameters which may be used to document that the proper conditions are present for degradation of chlorinated compounds to occur as well as the presence of the daughter products of PCE, TCE and 1,1-DCE for LHAAP-35B(37) and TCA, DCA, TCE, and 1,1-DCE for LHAAP-67. Degradation of PCE, TCE and 1,1-DCE for LHAAP-35B(37) and TCA, DCA, TCE, and 1,1-DCE for LHAAP-67 are favored under anaerobic conditions. Results of the dissolved oxygen, oxidation-reduction potential, and methane conditions will be used to determine if anaerobic conditions exist at the site. Sulfate, nitrates, and ferrous iron will also be considered in the evaluation. For example, high levels of sulfate and nitrates may compete with the chlorinate reduction pathway, while elevated ferrous iron may indicate favorable conditions for reduction. The first four quarters of results will be reviewed to determine if daughter products such as cis-1,2-dichloroethene, vinyl chloride, ethene and ethane continue to be present.

In addition, a site conceptual model will be presented including identification of source areas of contamination, groundwater flow directions, and potential receptors. Natural attenuation processes and evidence for dechlorination of the COCs will also be discussed.

For the subsequent annual reports and Five-Year Reviews, since geochemical conditions at LHAAP-35B(37) and LHAAP-67 will have already been established, the data evaluation presented in the reports will focus on primary lines of evidence or trend analysis for the primary COCs. Results for perimeter monitoring wells will be evaluated for indications of plume migration and to ensure that COC contaminated groundwater does not migrate into nearby surface water. Wells may be removed from the

Long-Term Monitoring Program if deemed to be no longer needed from the annual reports or Five-Year Reviews.

Figures



Legend

- ● Existing Shallow Wells
- ○ New Shallow Wells
- Surface Water Sampling Location
- Groundwater Elevation Contour Dec 2007
- Groundwater Elevation Contour Sep 2000
- Groundwater Elevation Contour Dec 1998
- Goose Prairie Creek
- PCE Concentration Contour
- Inferred PCE Contour
- TCE Concentration Contour
- Inferred TCE Concentration
- 🟥 LHAAP-35B LUC Boundary
- 🟧 LHAAP-35B(37) Site

Notes:
1. Reporting limit (<5) results were considered not detected during contouring.
2. Concentrations reported in µg/L.
3. Concentrations from Dec 2006 sampling.

0 35 70 140 210 280 Feet

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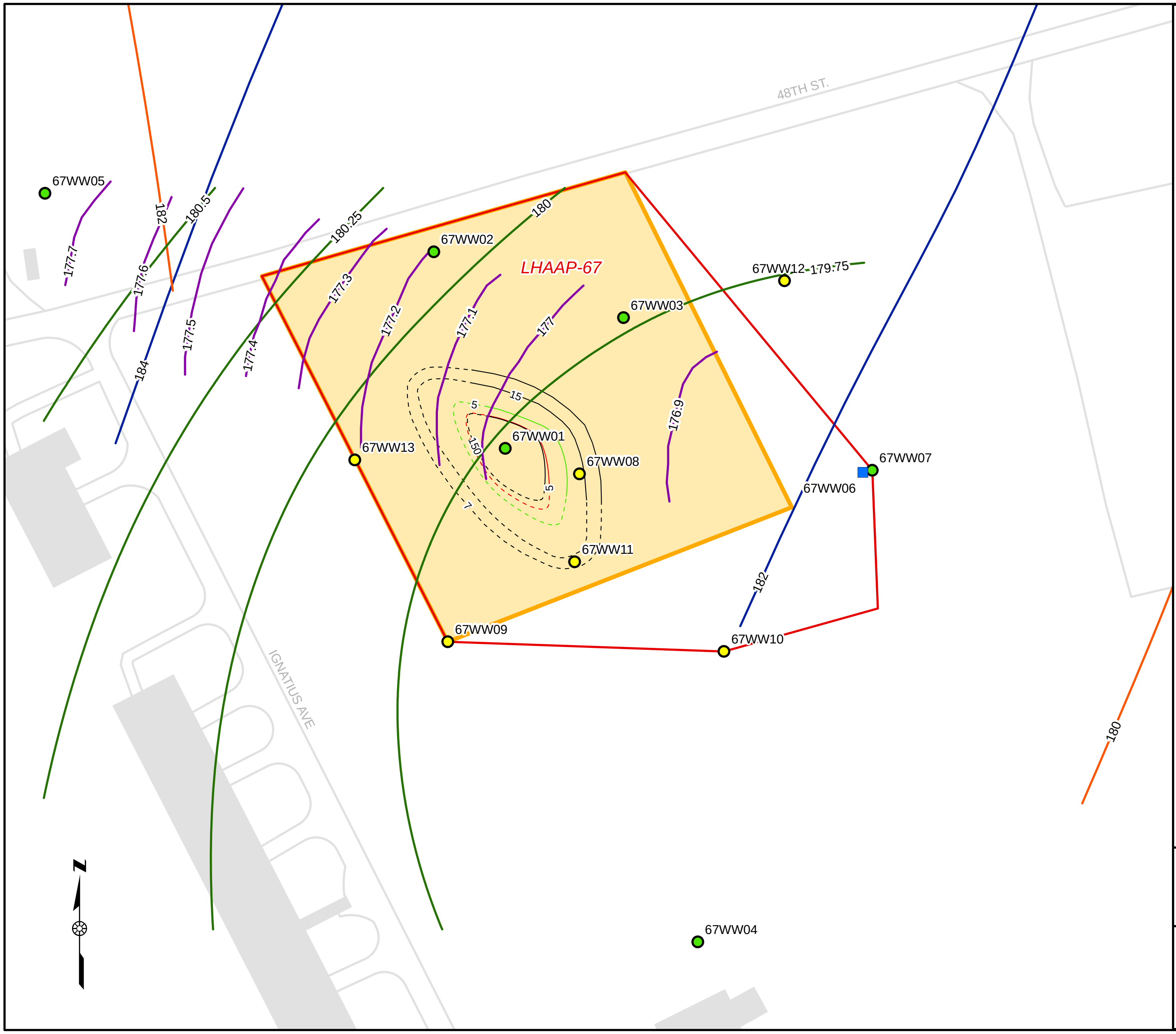
TULSA, OKLAHOMA

FIGURE 1
WELLS DISIGNATED FOR LONG-TERM MONITORING, SITE LHAAP-35B(37)
LHAAP-35B(37) & 67 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

LHAAP35BLTM.mxd 08/04/11



Legend

- 🟦 Existing Intermediate Wells
- ● Existing Shallow Wells
- ○ New Shallow Wells
- Groundwater Elevation Contour Dec 2007
- Groundwater Elevation Contour Sep 2004
- Groundwater Elevation Contour Sep 2000
- Groundwater Elevation Contour Dec 1998
- 1,1-DCE Concentration Contour
- Inferred 1,1-DCE Contour
- 1,2-DCA Concentration Contour
- Inferred 1,2-DCA Contour
- TCE Concentration Contour
- Inferred TCE Contour
- ☐ LHAAP-67 LUC Boundary
- 🟧 LHAAP-67 Site

Notes:
1. Reporting limit (<5) results were considered not detected during contouring.
2. Concentrations reported in µg/L.
3. Concentrations from Dec 2006 sampling.

0 20 40 80 120 160 Feet

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FIGURE 2
WELLS DESIGNATED FOR LONG-TERM MONITORING, SITE LHAAP-67
LHAAP-35B(37) & 67 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

LHAAP67LTM.mxd 08/04/11

Tables

Table 1a

New Monitoring Wells to be Installed at LHAAP-35B(37)

Well	Approximate Depth (feet bgs)	Groundwater Zone	Location East	Location North
35BWW09	29	Shallow	3307835	6958024
35BWW10*	35	Shallow	3307999	6958122
35BWW11	35	Shallow	3308097	6957894
35BWW12*	35	Shallow	3308209*	6958029*
35BWW13	30	Shallow	3308384	6958015
35BWW14	35	Shallow	3308205	6958208
35BWW15	35	Shallow	3307848	6958287
35BWW16	35	Shallow	3308111	6958334

Notes:

Coordinate system is State Plane, Texas North Central, FIPS 4202, Feet, NAD 1983

bgs – below ground surface

**To be installed after collecting samples from temporary borings to ensure installation at optimal location within the plume, locations given are approximate*

Table 1b

New Monitoring Wells to be Installed at LHAAP-67

Well	Approximate Depth (feet bgs)	Groundwater Zone	Location East	Location North
67WW08*	26	Shallow	3311501*	6956892*
67WW09	26	Shallow	3311401	6956765
67WW10	26	Shallow	3311611	6956757
67WW11*	26	Shallow	3311497*	6956825*
67WW12	26	Shallow	3311656	6957039
67WW13	26	Shallow	3311331	6956903

Notes:

Coordinate system is State Plane, Texas North Central, FIPS 4202, Feet, NAD 1983

bgs – below ground surface

** To be installed after collecting samples from temporary borings to ensure installation at optimal location within the plume, locations given are approximate*

Table 2a
Wells Designated for Long-Term Monitoring at LHAAP-35B(37)

Well	Groundwater Zone	Objectives
35BWW01	Shallow	2, 3
35BWW02	Shallow	3
35BWW04	Shallow	1, 2
35BWW05	Shallow	1, 2
35BWW07	Shallow	3
35BWW08	Shallow	1
35BWW09	Shallow	3
35BWW10	Shallow	1, 2
35BWW11	Shallow	2, 3
35BWW12	Shallow	1, 2, 3
35BWW13	Shallow	2, 3
35BWW14	Shallow	2, 3
35BWW15	Shallow	2, 3
35BWW16	shallow	2, 3
LHSMW58	Shallow	1, 2

Notes:

*1- **Provide data in the evaluation of MNA***
*2- **Ensure contaminated groundwater does not migrate to nearby surface water at levels presenting an unacceptable risk***
*3- **Confirm the plume limits***

Table 2b

Wells Designated for Long-Term Monitoring at LHAAP-67

Well	Groundwater Zone	Objectives
67WW01	Shallow	1
67WW02	Shallow	3
67WW03	Shallow	2, 3
67WW04	Shallow	2, 3
67WW05	Shallow	2, 3
67WW06	Intermediate	3
67WW07	Shallow	2, 3
67WW08	Shallow	1, 2, 3
67WW09	Shallow	2, 3
67WW10	Shallow	2, 3
67WW11	Shallow	1, 2, 3
67WW12	Shallow	2, 3
67WW13	Shallow	2, 3

Notes:

1- Provide data in the evaluation of MNA
2- Ensure contaminated groundwater does not migrate to nearby surface water at levels presenting an unacceptable risk
3- Confirm the plume limits

Table 3a

Monitored Constituents at LHAAP-35B(37)

Constituent	MCL (mg/L)
1,1-Dichloroethene	0.007
Tetrachloroethene	0.005
Trichloroethene	0.005
Antimony	0.006
Thallium	0.002
Vinyl Chloride	0.002

Table 3b

Monitored Constituents at LHAAP-67

Constituent	MCL (mg/L)
1,1-Dichloroethene	0.007
1,2-Dichloroethane	0.005
1,1,1-Trichloroethane	0.02
1,1,2-Trichloroethane	0.005
Trichloroethene	0.005
Vinyl Chloride	0.002

Table 4

Wells Considered for Future Plugging and Abandonment at LHAAP-35B(37)

Well	Groundwater Zone	Depth (feet bgs)	Reason for Abandonment
35BWW03	Intermediate	81	Well doesn’t address objectives
35BWW06	Shallow	52	Adjacent well 35BWW05 addresses more objectives

<u>Notes:</u>

bgs – below ground surface

Table 5
Well Construction Information

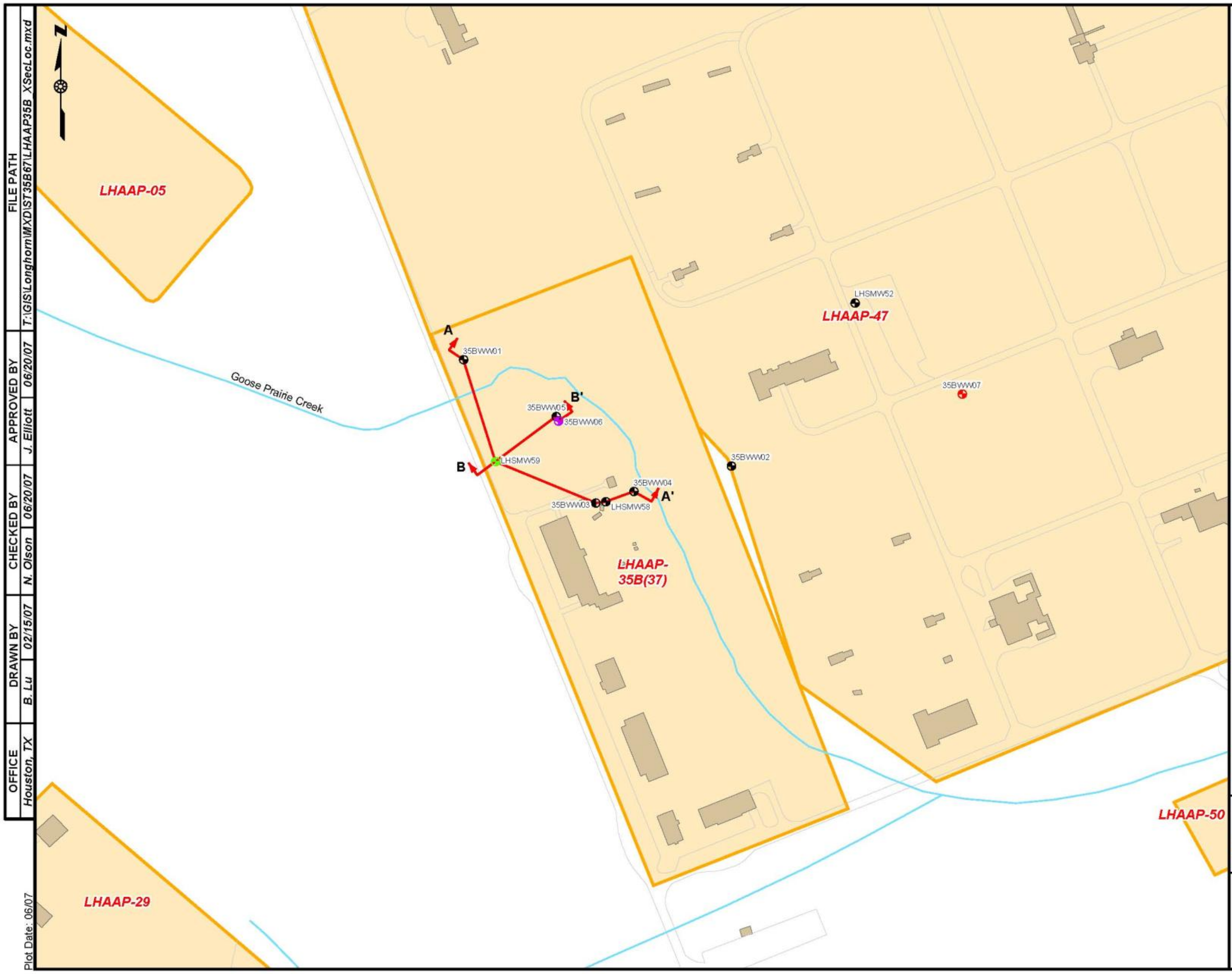
LHAAP-35B(37)	Well Diameter (in.)	Total Depth (ft bgs)	Screen Location (ft bgs)	Screen Length (ft)
35BWW01	4	19	9-19	10
35BWW02	4	43	9-14	5
35BWW03	-	81	70-80	10
35BWW04	4	30	20-30	10
35BWW05	2	36	26-36	10
35BWW06	-	52	42-52	10
35BWW07	2	28	18-28	10
35BWW08	2	32	22-32	10
35BWW09	TBD	TBD	TBD	TBD
35BWW10	TBD	TBD	TBD	TBD
35BWW11	TBD	TBD	TBD	TBD
35BWW12	TBD	TBD	TBD	TBD
35BWW13	TBD	TBD	TBD	TBD
35BWW14	TBD	TBD	TBD	TBD
35BWW15	TBD	TBD	TBD	TBD
35BWW16	TBD	TBD	TBD	TBD
LHSMW58	4	34	21.4-31.2	9.8

LHAAP-67	Well Diameter (in.)	Total Depth (ft bgs)	Screen Location (ft bgs)	Screen Length (ft)
67WW01	4	22	12-22	10
67WW02	4	25	15-25	10
67WW03	4	24	14-24	10
67WW04	4	23	11-21	10
67WW05	4	26	16-26	10
67WW06	4	51	38-48	10
67WW07	4	24	14-24	10
67WW08	TBD	TBD	TBD	TBD
67WW09	TBD	TBD	TBD	TBD
67WW10	TBD	TBD	TBD	TBD
67WW11	TBD	TBD	TBD	TBD
67WW12	TBD	TBD	TBD	TBD
67WW13	TBD	TBD	TBD	TBD

Attachment 1

Existing Monitoring Well Information

LHAAP-35B(37) Drilling Logs and Geologic Cross Sections



Legend

- ● Upper Shallow Zone Monitoring Well
- ● Lower Shallow Zone Monitoring Well
- ● Composite Upper And Lower Shallow Monitoring Well
- ◐ Intermediate Zone Monitoring Well
- ● Proposed Upper Shallow Zone Monitoring Well
- ↔ Geologic Cross Section
- — Stream
- — Road
- ▨ Former Building or Concrete Slab
- ▢ Site

0 100 200 400
Feet

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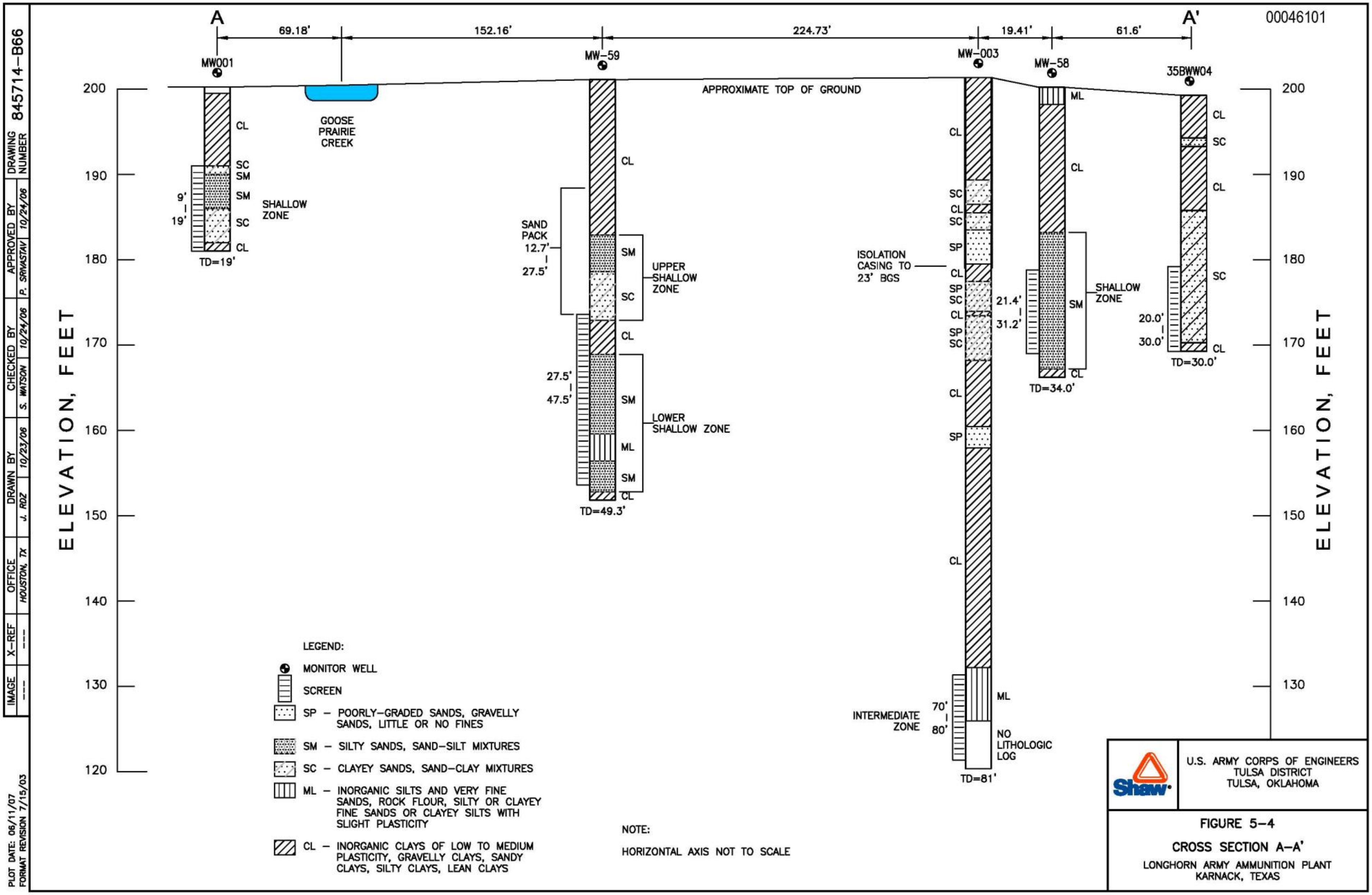
FIGURE 5-3
GEOLOGIC CROSS SECTION AND
LOCATION OF NEW SHALLOW WELLS
LHAAP-35B(37)
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	Houston, TX
DRAWN BY	B. Lu 02/15/07
CHECKED BY	N. Olson 06/20/07
APPROVED BY	J. Elliott 06/20/07
FILE PATH	T:\GIS\Longhorn\MXD\ST35B67\LHAAP35B XSecLoc.mxd

Plot Date: 06/07



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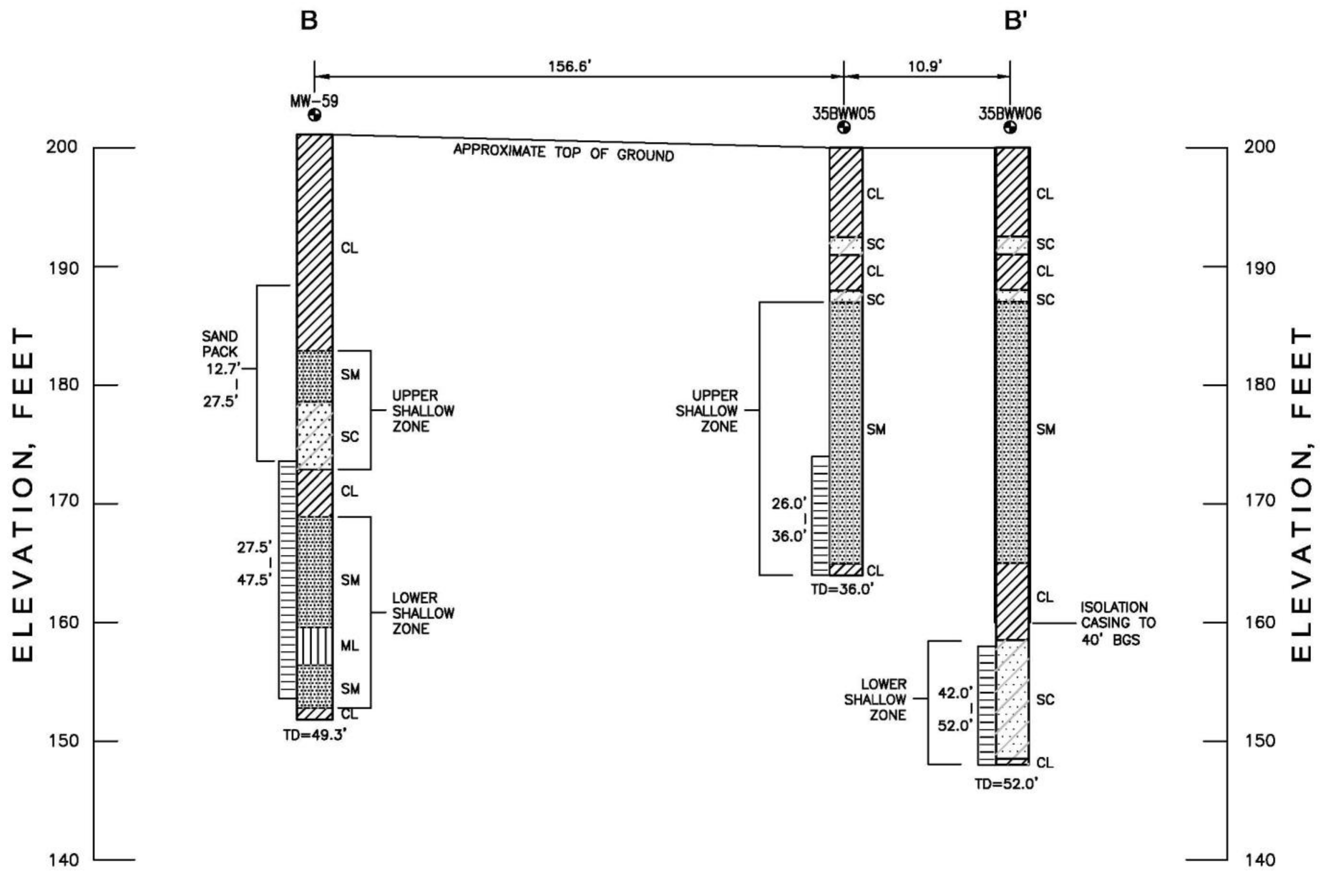
TULSA, OKLAHOMA

FIGURE 5-4

CROSS SECTION A-A'

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00046102



LEGEND:

- ⊕ MONITOR WELL
- ☰ SCREEN
- ⬚ SP – POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
- ▩ SM – SILTY SANDS, SAND-SILT MIXTURES
- ▨ SC – CLAYEY SANDS, SAND-CLAY MIXTURES
- ▥ ML – INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
- ▧ CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

NOTE:

HORIZONTAL AXIS NOT TO SCALE

Shaw

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FIGURE 5–5

CROSS SECTION B–B'

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DRAWING NUMBER	845714–B66
APPROVED BY	P. SRIVASTAV 10/24/06
CHECKED BY	S. WATSON 10/24/06
DRAWN BY	J. RDZ 10/23/06
OFFICE	HOUSTON, TX
X-REF	---
IMAGE	---

PLOT DATE: 06/11/07
FORMAT REVISION 7/15/03

Hole No. 35BWW02(S)

DRILLING LOG

DIVISION: USACE Tulsa

INSTALLATION: LHAAP Karnack, TX

SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP Site 35B
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: GPI, Inc Houston, TX
4. HOLE NO. (As shown on drawing title and file number): 35BWW02
5. NAME OF DRILLER: José Landeros
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT: Hor. Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 3¼" ID 7" OD HSA / 3' Cont Sampler / 11" OD HSA
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12 | UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: NA
15. ELEVATION GROUND WATER: —
16. DATE HOLE: STARTED 8-31-98 | COMPLETED 8-31-98
17. ELEVATION TOP OF HOLE: —
18. TOTAL CORE RECOVERY FOR BORING: NA %
19. SIGNATURE OF INSPECTOR: BB

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1 2	CL	silty clay - red to orange red some lt brown (mottled). stiff to very stiff - (Dry)	3.5' of 4.0'	SS#1 0.0' to 4.0'	Commenced @ 1325 [illegible]
	3 4	CL	silty clay - lt gray to lt brown w/ some orange staining (mottled) (stiff to friable) (Dry)			Sampler = 0ppm
	5 6 7 8 9 10	SM	silty sand - lt gray sand w/ high silt content low plasticity soft and friable throughout (Dry) high fines content from 7' to 8' fines increasing again from 8' downward/ grades into CL at 10.5'	5.0' of 5.0'	SS#2 4.0' to 9.0'	Sampler =
	11 12	CL	silty clay - gray to lt gray w/ orange staining (mottled) moderate plasticity (moist)	5.0' of 5.0'	SS#3 9.0' to 14.0'	Sampler = 4ppm
	13	SM	silty sand/sandy silt - gray to dark gray silty sand/ no plasticity soft to very soft (free water) grades into CL around 14 to 14.1'			
	14	CL	silty sandy clay - med gray to lt gray w/ orange staining (moist) ← thin layer of hard shale like "clay about 2" thick			
	15 16 17 18 19	SP	poorly sorted sand - lt gray to lt gray sand w/ some silt no plasticity very soft some orange staining. (free water)	2.5' of 5.0'	SS#4 14.0' to 19.0'	
				2.0' 2.0'	SS#5 19.0' [illegible]	

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PROJECT

HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. 35Bw002

PROJECT

INSTALLATION

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20	SM	Silty sand - orange-brown to lt gray (mottled) silty sand w/ some gravel around 20.2' (soft to stiff) no plasticity (wet)	2.0' of 2.0'	SS#5 19.0' to 21.0'	
	21 22	SM/SC	silty clayey sand - lt gray to orange brown - sand with lots of fines. (some plasticity) soft to very soft (free water)	2.0' to 2.0'	SS#6 21.0' to 23.0'	
	23 24	SM	silty sand - lt gray to lt brown silty sand no plasticity very soft (free wat)	5.0' of 2.0'	SS#7 23.0 to 25.0	
	25 26	SM	as above	2.0' of 2.0'	SS#8 25.0 to 27.0	
	27 28	SM	As above	2.0' of 2.0'	SS#9 27.0 to 29.0	
	29 30 31 32			5.0' of 5.0'	SS#10 29.0' to 34.0'	
	33 34	SM/SC	silty clayey sand - lt gray to lt brown w/ a purple tint soft + (free water)			Clayey sandy - gravel. w/ appreciable amounts of sandy silt and clayey "shale" Dark brown to lt gray 2 occurrences (wet) stiff but friable SP -68
	35 36 37 38	SM	silty sand lt brown n. sand w/ some fines increase towards bottom (soft freewater)	5.0' of 5.0'	SS#11 34.0' to 35.0'	
	39 40 41	SM	As above freewater	5.0' of 5.0'	SS#12 35.0' 44.0	
	42	CL	thin clay layer - (med stiff to stiff) lt gray clay. (wet)			
	43	SM	lt gray silty sand. - soft + freewater no plasticity			

44
45
46
47

ENG FORM 1836-A (ER 1110-1-1801) GPO 1960 OF-920-603 PROJECT HOLE NO.

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: A. Willmore

DRILLING CONTRACTOR: JEDI

DRILLING TECHNIQUE: HSA
AUGER SIZE AND TYPE: 8" Auger

BOREHOLE IDENTIFICATION: 35B WW07
BOREHOLE DIAMETER: 8"
WELL IDENTIFICATION: 35BWW07

WELL CONSTRUCTION START DATE: 9/8/07
WELL CONSTRUCTION COMPLETE DATE: 9/8/07

SCREEN MATERIAL: SCH 40 PVC
SCREEN DIAMETER: 2"
STRATUM-SCREENED INTERVAL (FT): 10'

CASING MATERIAL: SCH 40 PVC
CASING DIAMETER: 2"

TYPE OF FILTER PACK: 20/40 SILICA SAND
GRADIATION: 20/40
AMOUNT OF FILTER PACK USED: 5-50 lb bags

TYPE OF BENTONITE: pellets
AMOUNT BENTONITE USED: ~12.5 lbs

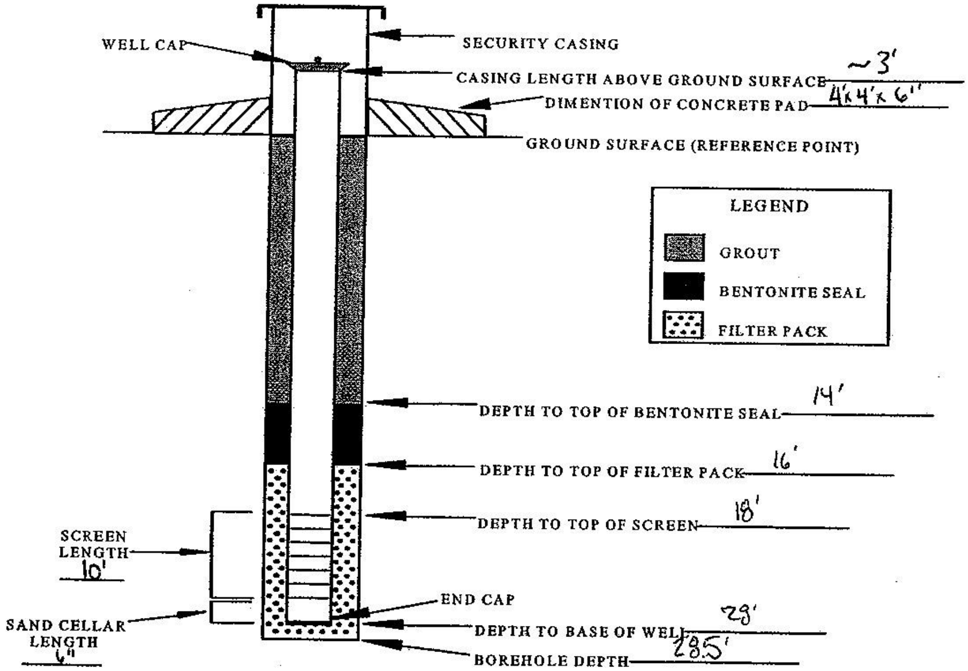
TYPE OF CEMENT: PORTLAND-CEMENT
AMOUNT CEMENT USED: 6-94 lb bags
GROUT MATERIALS USED: slurry

DIMENSIONS OF SECURITY CASING: 6" x 6"

TYPE OF WELL CAP: 2" well plugging cap
TYPE OF END CAP: SCH 40 PVC

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: Oscar Garcia - JEDI INSTALLATION OBSERVED BY: Allen Willmore-Shaw

DISCREPANCIES:

SITE 35B(37)
HOLE NO. 35BWW07

BORING LOG	DIVISION: TERC HOUSTON FEDERAL	INSTALLATION LHAAP	SHEET 1 OF SHEETS
1. PROJECT LHAAP		9. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MSL	
2. LOCATION KARNACK, TEXAS		10. MANUFACTURER'S DESIGNATION OF DRILL CME 75	
3. DRILLING AGENCY VEDI DRILLING		11. OVERBURDEN SAMPLES	DISTURBED YES	UNDISTURBED
4. HOLE NO. *(As shown on drawing title and file number)* 35BWW07		12. TOTAL NUMBER CORE BOXES MR	
		13. ELEVATION GROUND WATER	
5. NAME OF DRILLER OSCAR GARCIA		14. DATE HOLE	STARTED 9/8/07	COMPLETED 9/8/07
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED 0° DEG. FROM VERT.		15. ELEVATION TOP OF HOLE NOT ORIGINALLY RECORDED, SEE SURVEY	
7. TOTAL DEPTH OF HOLE 28'		16. TOTAL CORE RECOVERY FOR BORING ___ %	
8. SIZE AND TYPE OF BIT 8" O.D. HSA, 2" SPLIT SPOON		17. LOGGED BY A. Willmore	QC

PID *(ppm)* a	DEPTH b	USCS c	CLASSIFICATION OF MATERIALS *(Description)* d	% CORE RECOVERY e	SAMPLE f	REMARKS *(Drilling time, water loss, depth of weathering, etc., if significant)* g
0.0		CL	CLAY, SANDY, NO PLASTICITY, STIFF, DRY, BROWN, NO ODOR	100%		
0.0	5			75%		
		SM	SAND, SILTY, ~~LOOSE~~ MAX SLIGHTLY DENSE, MODERATELY TO WELL SORTED, GRAY, MOIST, NO ODOR			
0.0		ML	SILT, CLAYEY, DENSE, NO PLASTICITY, POORLY SORTED, MOIST, GRAY, NO ODOR	100%		
0.0	10	CL	CLAY, SANDY, LOW PLASTICITY, SOFT TO STIFF, MOIST, GRAY, NO ODOR	100%		

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE

Hole No. 35BWW07

PROJECT LHAAP-TERC

INSTALLATION LHAAP

SHEET 2

OF SHEETS

PID ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
a	b	c	d	e	f	g
0.0		CL	SAME AS ABOVE	100%		
			-BECOMES SILTY, STIFF			
	15					
0.0				100%		
0.0		SC	SAND, CLAYEY, LOOSE TO MOD DENSE, POORLY-SORTED SATURATED, NO ODOR	100%		
	20	CL	CLAY, SILTY, LOW PLASTICITY, SOFT, MOIST, NO ODOR, GRAY -BECOMES HARD TO STIFF -BECOMES DRY			
0.0				0.0		
	25					
			END OF BORING @ 28' BGS			

ENG FORM 1836—A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT

HOLE NO.

35BWW08

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: A. Willmore

DRILLING CONTRACTOR: JEDI

DRILLING TECHNIQUE: HSA
AUGER SIZE AND TYPE: 8" Auger

BOREHOLE IDENTIFICATION: 35BWW08
BOREHOLE DIAMETER: 8"
WELL IDENTIFICATION: 35BWW08

WELL CONSTRUCTION START DATE: 9/7/07
WELL CONSTRUCTION COMPLETE DATE: 9/7/07

SCREEN MATERIAL: SCH 40 PVC
SCREEN DIAMETER: 2"
STRATUM-SCREENED INTERVAL (FT): 10'

CASING MATERIAL: SCH 40 PVC
CASING DIAMETER: 2"

TYPE OF FILTER PACK: 20/40 SILICA SAND
GRADIATION: 20/40
AMOUNT OF FILTER PACK USED: 5-50 lb bags

TYPE OF BENTONITE: pellets
AMOUNT BENTONITE USED: ~12.5 lbs

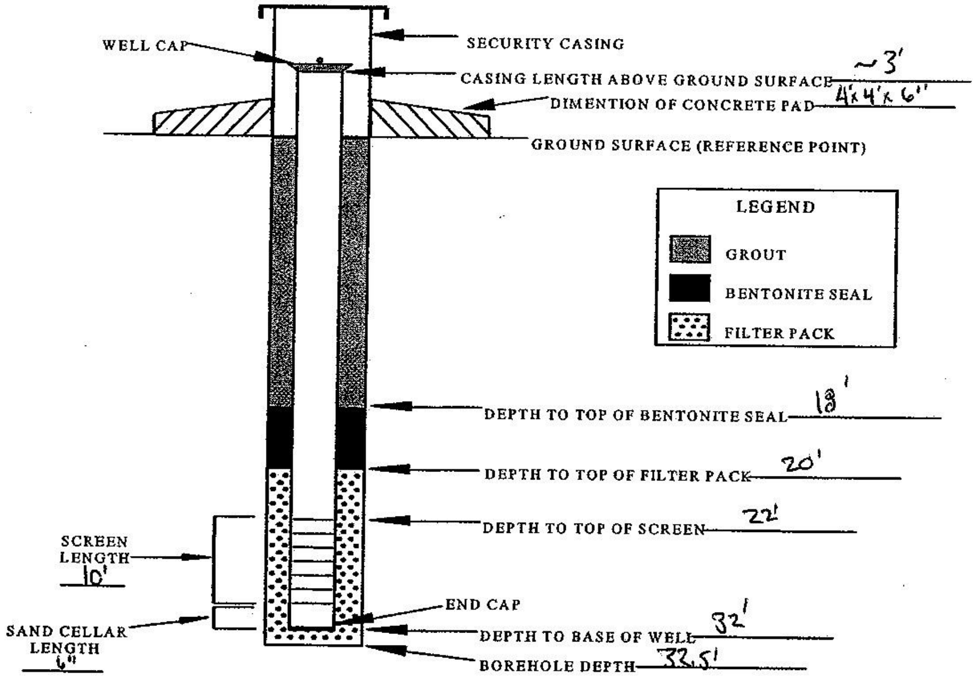
TYPE OF CEMENT: PORTLAND-CEMENT
AMOUNT CEMENT USED: 6-94 lb bag
GROUT MATERIALS USED: slurry

DIMENSIONS OF SECURITY CASING: 6"x6"

TYPE OF WELL CAP: 2" well plugging cap
TYPE OF END CAP: SCH 40 PVC

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



CASING LENGTH ABOVE GROUND SURFACE ~3'
DIMENTION OF CONCRETE PAD 4'x4'x6"
GROUND SURFACE (REFERENCE POINT)
DEPTH TO TOP OF BENTONITE SEAL 18'
DEPTH TO TOP OF FILTER PACK 20'
DEPTH TO TOP OF SCREEN 22'
SCREEN LENGTH 10'
SAND CELLAR LENGTH 6"
DEPTH TO BASE OF WELL 32'
BOREHOLE DEPTH 33.5'

NOT TO SCALE

INSTALLED BY: Oscar Garcia - JEDI INSTALLATION OBSERVED BY: Allen Willmore - SHAW

DISCREPANCIES:

SITE 35B(37)

HOLE NO. 35BWW08

DRILLING LOG

DIVISION FEDERAL - HOUSTON

INSTALLATION LHAAP

SHEET OF SHEETS

1. PROJECT LHAAP

2. LOCATION (Coordinates or Station) KARNACK, TEXAS

3. DRILLING AGENCY JEDI DRILLING

4. HOLE NO. (As shown on drawing title and file number) 35B WW08

5. NAME OF DRILLER OSCAR GARCIA

6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED 0° DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN NA

8. DEPTH DRILLED INTO ROCK NA

9. TOTAL DEPTH OF HOLE 32'

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL

12. MANUFACTURER'S DESIGNATION OF DRILL CME 75

13. OVERBURDEN SAMPLES DISTURBED UNDISTURBED YES

14. TOTAL NUMBER CORE BOXES NR

15. ELEVATION GROUND WATER

16. DATE HOLE STARTED 9/7/07 COMPLETED 9/7/07

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING %

INSPECTOR

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			CLAY, SANDY, BROWN TO GRAY, DRY, LOW PLASTICITY, SOFT			
0.0						
				100%		
		CL	- BECOMES LESS SANDY			
0.0						
	5					
				95%		
0.0						
0.0	AD ~~10~~					
	10			85%		
0.0						

p1 of 3

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE: NR

Hole No. 35BWW08

PROJECT: LHAAP-TCRC

INSTALLATION: ~~Hav~~ LHAAP

SHEET OF SHEETS

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAME AS ABOVE			
0.0				85%		
	15	CL				
		AW				
0.0						
				95%		
0.0						
	20					
			SAND, SILTY, DENSE, POORLY-SORTED, WET, BROWN TO GRAY			
0.0				90%		
		SM				
0.0	25					
				100%		
0.0						
				100%		

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MAR 71

PROJECT | HOLE NO.

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE NR	Hole No. 35BWW08
PROJECT LHAAP- TTMRC	INSTALLATION LHAAP	SHEET OF SHEETS

PID ~~ELEVATION~~ a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
0.0	30	CL	~~CLAY, SANDY, BROWN TO GRAY, MOIST, MEDIUM PLASTICITY, STIFF, NO ODOR~~ AL 9/7/07 SAME AS ABOVE	100%		
0.0	32		CLAY, SANDY, MEDIUM PLASTICITY, STIFF, MOIST, NO ODOR, BROWN TO GRAY	100%		
			END OF BORING @ 32' BGS.			

ENG FORM 1836–A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT | HOLE NO.

LHAAP-67 Drilling Logs

Hole No. G4WW01

DRILLING LOG

DIVISION: USACE - Tulsa

INSTALLATION: LHAAP - Karnack, TX

SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Group IV

2. LOCATION (Coordinates or Station):

DRILLING AGENCY: GPI Inc. - Austin, TX

LE NO. (As shown on drawing title .d file number): G4WW01

5. NAME OF DRILLER: Amadore Hinahosa

6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: Penetrated 23.0'

8. DEPTH DRILLED INTO ROCK: N/A

9. TOTAL DEPTH OF HOLE: 23.0 ft below Grade

10. SIZE AND TYPE OF BIT: Auger Bit

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 / 7 1/8" O.D. HSA / 5' CME cont. Sampler / 11" O.D. HSA

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 2 | UNDISTURBED 0

14. TOTAL NUMBER CORE BOXES: N/A

15. ELEVATION GROUND WATER

16. DATE HOLE: STARTED 12-2-98 | COMPLETED 12-2-98

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING: N/A %

19. SIGNATURE OF INSPECTOR: W. Cika P.G.

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g Time
	1					5' offset Drill hole (HSA) for Drilling/Sampling installing 4" SS monitoring well (G4WW01)
	2					
	3					
	4					
	5					
	6					*NOTE: See Drilling Log for G4SB01 for Lithologic Descrip. of soils from grade to 19.0' below grade
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17		sand - Lt. tan, some Lt. gray + greenish-gray (mottled) fine grained, some sl. silty, poorly sorted - wet/saturated (soft)			
	18					
	19	SP				0930
		CL	silty clay - Lt. tan + med. gray tan + yellowish-orange (mottled) plastic, some fine sand + moist - (stiff)		SS# 1	
	20					

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(TRANSLUCENT)

PROJECT

HOLE NO. G4WW01

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. G4WW01

PROJECT Group II

INSTALLATION LHAAP - Karnack, TX

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20 21 22 23	CL	- Silty clay - Lt. gray (some blue-gray, few red yellowish-orange - mottled, streaked, and stained, some v. thin black 'root-like' structures, plastic, trace to some fine grained sand - moist (stiff)		19.0' to 23.0'	HNU Reading in Sampler = 2 ppm+
			T.D. @ 23.0' below grade in silty clay @ 0940			Overdrilled hole c̄ 11" HSA for G4WW01 (5' offset hole from G4SB01) to 22' below grade for GW monitoring well installation Monitoring well completion for G4WW01 Bent Grout 5' to grade Sugar Sand 6'-5' Bent. Seal 9' to 6' Sugar Sand 10' to 9' Primary Sand (16-30) 22' to 10' 10'-4" SS screen 22' to 12' T.D. @ 22.0' below grade in silty clay

Hole No. G4WW02

DRILLING LOG	DIVISION USACE-Tulsa	INSTALLATION LHAAP-Karnack, TX	SHEET 1 OF 2 SHEETS

1. PROJECT LHAAP - Group IV
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY GPI, Inc. - Austin, TX
4. HOLE NO. (As shown on drawing title and file number) G4WW02
5. NAME OF DRILLER Amadore Hinojosa
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 25.0' ft.
8. DEPTH DRILLED INTO ROCK N/A
9. TOTAL DEPTH OF HOLE Penetrated 25' below grade
10. SIZE AND TYPE OF BIT Auger Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL CME-75/7 7/8" O.D./HSA/11" O.D. HSA/
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2 | UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 12-1-98 | COMPLETED 12-1-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR Dave [illegible] PG

ELEVATION a	DEPTH (ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) Time g
	1					5' Offset Drill hole (HSA) for Drilling/sampling/installing 4" SS monitoring well (G4WW02)
	2					
	3					
	4					*NOTE: See Drilling Log for G4SB02 for Lithologic description of soils from grade to 18' below grade.
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18	SP	- Sand Lt gray and tan (mottled) fine grained sand, some sl. silty, poorly sorted - Wet/Saturated (soft)	4.8'	SS# 1 18.0' to 23.0'	0930
	19					
	20					

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PROJECT LHAAP

HOLE NO. G4WW02

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE

Hole No. G4WW02

PROJECT LHAAP - Group IV

INSTALLATION LHAAP

SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21' 22 23	SP	-Sand- Lt gray/greenish-gray and tan (mottled), fine grained, Dec sl silty			Hnu Reading in Sampler = 3+ ppm
	24 25	CL	-siltyclay- Lt. gray, Lt. blue-gray, brown, yellowish-orange and tan mottled, streaked, and stained, plastic, trace to some fine sand- Moist (med. stiff)	3.0'	SS# 2. 23.0 to 26.0'	Hnu Reading in Sampler = 0ppm
	26		T.D. 5' offset hole for G4WW02 @ 26.0' below grade in silty clay @ 0955			Overdrilled w/ 11" HSA for G4WW02 (5' offset hole from G4SB02) to 25' below grade for GW Mon. Well Install. Monitoring well completion for G4WW02 Bent. grout 8' to grade Sugar Sand 9' to 8' Bent seal (Hyd.) 12' to 9' Sugar Sand 13' to 12' Primary Sand (16-30) 25' to 13' 10' SS 4" Screen 25' to 15' T.D. @ 25' in silty clay

Hole No. G4WW03

DRILLING LOG

DIVISION: USACE-Tulsa

INSTALLATION: LHAAP-Karnack, TX

SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Group IV
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: GPI - Austin, TX
4. HOLE NO. (As shown on drawing title and file number): G4WW03
5. NAME OF DRILLER: Amadoré Londeros
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Penetrated 24.0'
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: 24.0 Below Grade
10. SIZE AND TYPE OF BIT: Auger Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 / 7 7/8" O.D. HSA / 5' CME cont. sampler / 11" O.D. HSA
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 12-1-98 COMPLETED 12-1-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: David W. Cika P.G.

ELEVATION a	DEPTH (ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1					5' offset Drill hole (HSA) for Drilling/Sampling/installing 4" SS monitoring well (G4WW03)
	2					
	3					
	4					
	5					* Note = See Drilling Log for G4SB03 for Lithologic Descrip. of Soils from grade to 14.0' below grade
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14	SP SM	- Sand - Lt. gray and tan (mottled) some brown staining, fine grained sand, trace to some silt - Wet/Saturated (soft)	5.0'	SS# 1 14.0' to 19.0'	1435
	15					
	16	SP	- silty sand Lt. gray and tan (mottled), fine grained sand - wet/saturated (soft)			
	17					
	18		- Sand - Lt. to med. gray and tan (mottled), fine grained, trace to some silt zones - Wet/Saturated (soft)			
	19				SS# 2	
	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

(TRANSLUCENT)

PROJECT: LHAAP

HOLE NO.: G4WW03

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE

Hole No. G4WW03

PROJECT Group III

INSTALLATION LHAAP - Karnack, TX

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21 22	SP	- sand - Lt. to med. gray, some greenish-gray and tan (mottled), fine grained sand, trace to some silt - wet/saturated (soft)	5.0'	19.0' to 24.0'	HNu Reading in sample = 0ppm
	23 24	CL	- silty clay - Lt. to med. gray, some blue gray, tan and yellowish-orange (mottled), plastic, trace to some fine grained sand - moist (v. stiff)			
	25		T.D. @ 24.0' Below grade in silty clay			Overdrilled hole c̄ 11" HSA for G4WW03 (5' offset hole from G4SB03) to 24' below grade for GW monitoring well installation Monitoring well completion for G4WW03 Bent. Grout 7' to grade Sugar Sand 8' to 7' Bent. seal (Hyd.) 11' to 8' Sugar Sand 12' to 11' Primary Sand (16-30) 24' to 12' 10' SS 4" screen 24' to 14' T.D. @ 24.0' in silty clay

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF - 628-603

PROJECT LHAAP

HOLE NO. G4WW03

Hole No.

DRILLING LOG	DIVISION USACE - Tulsa	INSTALLATION LHAAP	SHEET 1 OF 2 SHEETS

1. PROJECT LHAAP

2. LOCATION (Coordinates or Station)

3. DRILLING AGENCY ETTL

4. HOLE NO. (As shown on drawing title and file number) 67WW04

5. NAME OF DRILLER Doug Hents

6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN

8. DEPTH DRILLED INTO ROCK N/A

9. TOTAL DEPTH OF HOLE

10. SIZE AND TYPE OF BIT 8 IN OD HS

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL FOREMOST B-5500

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED 5 UNDISTURBED 0

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE STARTED 12-1-09 COMPLETED

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING N/A %

19. SIGNATURE OF INSPECTOR Keith Hoal

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1 2	OL	BROWN SILTY CLAY, SOME GRAY FINE SAND LENSES, STIFF, DRY, ROOTLETS AND ORGANIC MATTER, TRACE GRAVEL, SMALL ROUNDED	22"/24"	ST1	1330 START WITH SHELBY TUBE, WAITING AUGERS HNU 4 PPM
	3 4	ML	BROWN SILTY CLAY, STIFF DRY, SOME ROOTLETS SOME BLACK NODLES, TRACE FINE TO MED ROUNDED GRAVEL	12"/12"	ST2	HNU 7 PPM Breathing Zone HNU 0 PPM 1450 RECEIVE CLEAN AUGER
	5 6 7 8	SM	LT GRAY SILTY FINE SAND, DRY, VERY HARD, SOME FE STAIN, SOME BLACK NODLES AND BLACK [illegible] STAIN	52"/60"	CS1	HNU 0PPM
	9 10 11 12 13	SM	LT GRAY FINE SAND WITH BROWN MOTTLING, HARD, DRY, DECREASE OF SILT WITH DEPTH, TRACE BLACK NODLES,	60"/60"	CS2	HNU 0PPM
	14 15 16 17 18		LT BROWN WITH GRAY MOTTLING, HARD WET SAME, INCREASE OF CLAY	60"/60"	CS3	HNU 0PPM WET AT [illegible]

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT

HOLE NO.

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE **Hole No.** 67 ww 64

PROJECT LHAAP

INSTALLATION LHAAP

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	18 19		LT GRAY, SILTY FINE SAND, HARD, WET, SOME FE STAIN, TRACE BLACK NODULES	60"/60"	CS4	HNU 0 ppm 1540 Dave C. agrees set well in Clay. Will over Drill Down TO 21 FT. 21 - 11 ft screen 21 - 9 ft SAND 9 - 7 ft Bentonite will over Drill SAT 12-2-00
	20 21		GRAY CLAY, MOIST, HARD, PLASTIC, FE STAIN			
	22		LT GRAY, SILTY FINE SAND, HARD, WET			
	23		EOB 23 FT			12-2-00 0835 10 in OD HS Arrive @ SITE. START Reaming Boring 0905 START SAND Placement 0919 START Bentonite Pellet placement

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF - 628 - 603

PROJECT LHAAP

HOLE NO. 67ww64

Hole No. 67WW05

DRILLING LOG

DIVISION USACE-Tulsa

INSTALLATION LHAAP - Karnack TX

SHEET 1 OF 2 SHEETS

1. PROJECT LHAAP - Supplemental RI Site 67
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY ETTL - Tyler TX
4. HOLE NO. (As shown on drawing title and file number) 67WW05
5. NAME OF DRILLER Tom Cook
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN Penetrated 27'
8. DEPTH DRILLED INTO ROCK N/A
9. TOTAL DEPTH OF HOLE 26' below grade
10. SIZE AND TYPE OF BIT Auger Bits
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-51 / 5' Cont. sampler SS = Soil Sample
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED 6 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES N/A
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 11-30-00 COMPLETED 11-30-00
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING N/A %
19. SIGNATURE OF INSPECTOR PG

ELEVATION a	DEPTH (ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1 2 3	CL	Silty Clay - Med. brown, tan, yellowish-orange and orange-brown - mottled, some roots, plastic, trace to some fine sand throughout - Moist (stiff)	3.8'/4.0'	SS #1 0.0' to 4.0'	0920 Commenced HSA Pilot hole c 4 1/4" I.D. Augers HNu (PID) Calib. to isob. (10.2 eV Lamp) HNu Reading in Sampler = 0ppm HNu Reading @ Augers = 0ppm
	4 5 6 7 8		Silty Clay - Lt. brown, Lt. to med gray, tan, and some orange-brown-mottled streaked, and stained, Lt. gray color inc. with depth, trace to some fine sand throughout - Damp (V. stiff)	4.6'/5.0'	SS #2 4.0' to 9.0'	0927 HNu Read in sampler = 5ppm HNu Reading @ Augers = 0ppm Ambient air = 0ppm
	9 10 11 12 13		Clayey Silt - Lt. to med. gray, tan, and orange-brown-Mottled, some fine sand, becoming less plastic with depth - Moist (Soft to stiff) SP sand @ 13.4' below grade	4.3'/5.0'	SS #3 9.0' to 14.0'	0935 HNu Reading in Sampler = 10 ppm HNu Reading @ Augers = 0ppm No obvious odor back of rig/[illegible] Ambient air = 0ppm
	14 15 16 17 18	SP SP-SM	Sand - Lt. gray, tan, and some yellow-orange streaking and staining, V. fine to fine grained, some silt throughout, Some apparent layering/bedding - Wet/saturated (Loose) Silt content increasing wet/saturated (Gradational transition with depth)	5.0'/5.0'	SS #4 14.0' To 19.0'	HNu Reading in Sampler = 5ppm HNu Reading @ Augers = 0ppm Ambient air = 0ppm
	19	SM			SS #5	1002

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PROJECT LHAAP

HOLE NO. 67WW05

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE

Hole No. 67WW05

PROJECT LHAAP Supplemental RI Site 67

INSTALLATION LHAAP - Karnack, TX

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21 22 23	SM	Silty Sand Lt. gray, tan, and Lt. yellow-orange-mottled, V. fine to fine grained sand, poorly sorted - Wet/Saturated (Loose)	4.2'/5.0'	19.0' to 24.0'	HNu Reading in sampler = 3ppm HNu Read @ Augers = 0ppm No obvious odor back of Rig/near augers
	24 25 26 27	CL	Silty Clay Lt. gray and Lt. to med blue-gray, Very plastic, trace to some fine sand throughout, Damp to Sl. Moist	3.0'/3.0'	SS #6 24.0' to 27.0'	HNu Reading in sampler = 2ppm HNu Reading @ Augers = 0ppm Ambient air = 0ppm
	28 29 30		T.D. @ 27.0' in Lt. gray-blue-gray silty clay - rig torquing up T.D. @ 1023			Commenced overdrilling pilot hole with 11" O.D. "plugged" HSA for 4" SS monitor well installation

- Bent./cement Grout 10' to grade
- Bent. seal 13'-10'
- Filterpack sand (20-40) 26'-13'
- 4" SS (304) #10 slot screen 26' to 16'

T.D. @ 26.0' below grade

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF - 628-603

PROJECT LHAAP

HOLE NO. 67WW05

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. 67WW05

PROJECT LHAAP Supplemental RI Site 67

INSTALLATION LHAAP - Karnack, TX

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21 22 23	SM	Silty Sand Lt. gray, tan, and Lt. yellow-orange-mottled, V. fine to fine grained sand, poorly sorted - Wet/Saturated (Loose)	4.2'/5.0'	19.0' to 24.0'	HNu Reading in sampler = 3ppm HNu Read @ Augers = 0ppm No obvious odor back of Rig/near augers
	24 25 26		Silty Clay Lt. gray and Lt. to med blue-gray, very plastic, trace to some fine sand throughout, Damp to Sl. Moist	3.0'/3.0'	SS #6 24.0' to 27.0'	HNu Reading in sampler = 2ppm HNu Reading @ Augers = 0ppm Ambient air = 0ppm
	27	CL				
	28 29 30		T.D. @ 27.0' in Lt. gray-blue-gray silty clay - rig torquing up T.D. @ 1023			Commenced overdrilling pilot hole with 11" O.D. "plugged" HSA for 4" SS monitor well installation - Bent./cement Grout 10' to grade - Bent. seal 13'-10' - Filterpack sand (20-40) 26'-13' - 4" SS (304) #10 slot screen 26' to 16' T.D. @ 26.0' below grade

DRILLING LOG

DIVISION USACE - Tulsa

INSTALLATION CHAAP

SHEET 1 OF 3 SHEETS

1. PROJECT LHAAP
2. LOCATION (Coordinates or Station) SITE 67
3. DRILLING AGENCY ETTL
4. HOLE NO. (As shown on drawing title and file number) 67WW06(I)
5. NAME OF DRILLER DOUG HENTS
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____________ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK N/A
9. TOTAL DEPTH OF HOLE 51 ft
10. SIZE AND TYPE OF BIT 8 in OD HS / 10 in OD HS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL FOREMOST B-550
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 10 — UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES NA
15. ELEVATION GROUND WATER
16. DATE HOLE — STARTED 11-30-00 — COMPLETED 12-1
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING r/k %
19. SIGNATURE OF INSPECTOR Erik Hockel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	CL	BROWN AND GRAY MOTTLED, CLAY WITH FINE SAND, WET, FIRM, ROOTS. RUST STAINING	24"/24"	ST1	1422 START Boring HNU 0ppm
	2 3	ML	GRAY CLAYEY SILT, HARD DRY, RUST STAIN, SOME BLACK NODULES.	12"/12"	ST2	HNU 0ppm HNU 0ppm
	4 5 6 7 8	SM	LT GRA FINE SANDY SILT, loose, DRY, NON PLASTIC, SOME RUST STAIN	60"/60"	CS1	
			SAME AS ABOVE			HNU 0ppm
	9 10 11	SM	LT GRAY SAND, FINE, loose, MOIST, TRACE CLAY, ORGANIC MATTER, SOME RUST STAIN	60'/60"	CS2	
	12 13	SP	LT GRAY CLAYEY FINE SAND, FIRM, MOIST, ORGANIC MATTER			
	14 15 16 17 18		LT GRAY FINE SAND, loose WET/MOIST, HORIZONTAL BANDS OF RUST STAIN 1 TO 3 mm THICK THROUGHOUT	37"/60"	CS3	HNU 0ppm

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PROJECT LHAAP

HOLE NO. 67WW06

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE

Hole No. 67WW06

PROJECT LHAAP

INSTALLATION

SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	18		LT GRAY FINE SAND, LOOSE, WET, HORIZ. TAL, TRACE IRON STAIN			▽ HNU 0 ppm
	19	SP		60"/60"	CS4	
	20		LT GRAY FINE SAND, LOOSE, WET, TRACE IRON STAIN			
	21	SP				
	22		BROWN AND GRAY MOTTLED CLAYEY FINE SAND, LOOSE WET, IRON STAINS			
	23	SC	LENSE OF VERY WET SAND			HNU 0ppm
	24		BROWN AND GRAY MOTTLED CLAYEY FINE SAND, LOOSE, WET, IRON STAIN			
	25	SC		60"/60"	CS5	
	26					
	27					
	28		BROWN & GRAY FINE SAND, TRACE CLAY, WET FE STAINING			HNU 0ppm
	29	SC		60"/60"		
	30					
	31				CS6	
	32					
	33					HNU 0ppm
	34					
	35		GRAY FINE SAND, TRACE CLAY, WET	60"/60"	CS7	
	36		BROWN WITH SOME GRAY MOTTLING FINE SAND WET			
	37					
	38					

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE **Hole No.** 67WW06

PROJECT LHAAP INSTALLATION SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	38		LIGHT GRAY FINE SAND			
	39	SC	FINE SAND WET, OCCASIONAL IRON STAIN HORIZONTAL BANDS [illegible] WIDE	60"/60"		HNU 0ppm
	40					
	41				CS8	
	42					
	43		SAME DENSER PACK TO SAND			1421 AWAITING MORE AUGERS
	44			36"/36"		1450 START Drilling
	45				CS9	Drilling resistance increases. Thought maybe clay
	46					
	47					
	48			60"/60"	CS10	
	49	ML-CL	GRAY SILTY CLAY, DENSE VERY STIFF, DRY, HORIZ. BEDDING LIGHT GRAY Fine Snd beteen layers			
	50					
	51		EOB 51 ft			1520 COMPLETE BORING. Pull Augers. Cover Boring w/ 10in OD Auger To Secure well. Will over Drill in morning.
						12-1-00 0800 All on Site. Ream Boring w/ 10in OD HS To 48ft. Will install 10 ft Screen (NOT overpack) 48-38 Screen 48-35 SAND, 35-32 Bentonite. 32-0 grout. 0852 install well 15 gal water added Due To Heav. SanD.

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PROJECT LHAAP HOLE NO. 67WW06

DRILLING LOG

DIVISION: USACE

INSTALLATION: LHAAP

SHEET 1 OF 1 SHEETS

1. PROJECT: LHAAP
2. LOCATION (Coordinates or Station): SITE 67
3. DRILLING AGENCY: ETTL
4. HOLE NO. (As shown on drawing title and file number): 67WW07(S)
5. NAME OF DRILLER: Doug Henste
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: —
8. DEPTH DRILLED INTO ROCK: —
9. TOTAL DEPTH OF HOLE: 24 FT
10. SIZE AND TYPE OF BIT: 10 IN OD HS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: FOREMOST B-5500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 12-1-00 COMPLETED 12-1-00
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SHALLOW WELL INSTALLED AFTER COMPLETION OF 67WW06. NO LOGGING CONDUCTED. OFFSET 8 FT NORTH OF 67WW06. SEE log for 67WW06 for SITE Lithology.			

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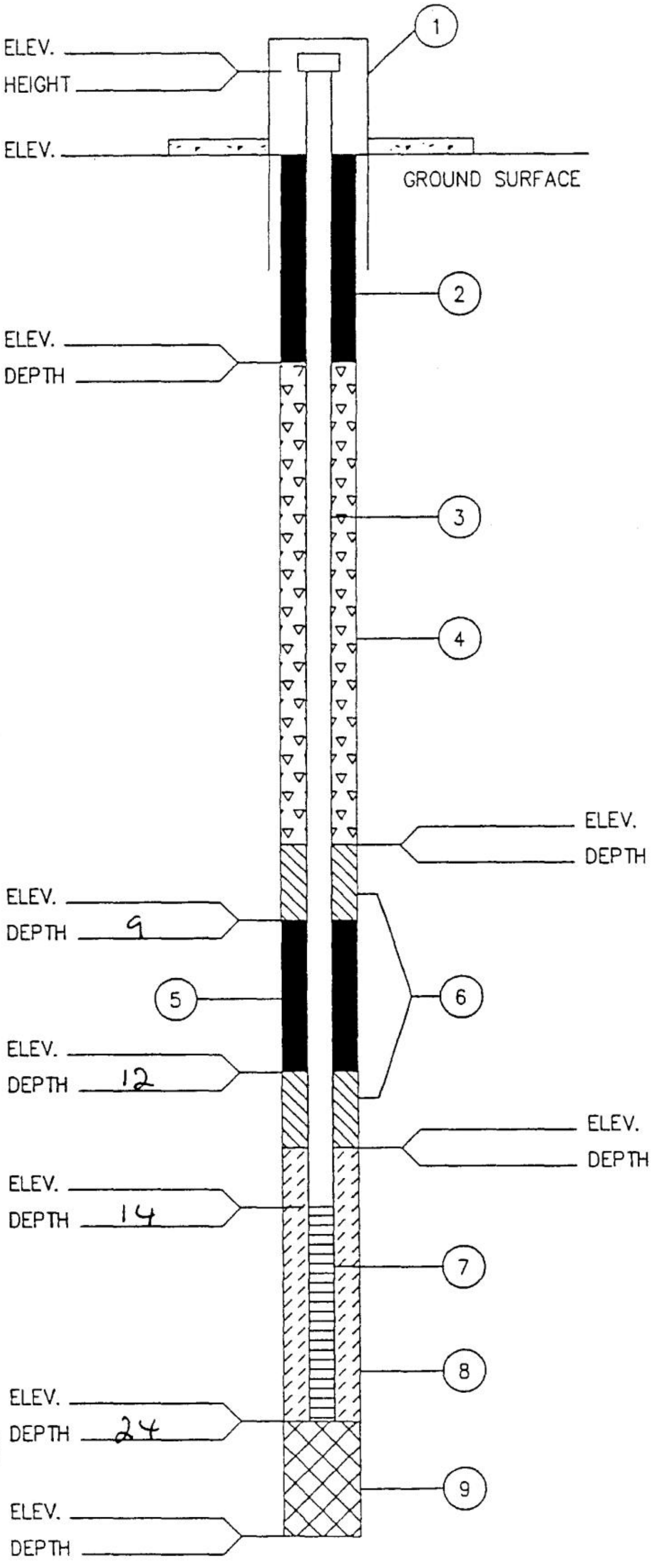
PROJECT: LHAAP

HOLE NO.: 67WW07



ELEV.
DEPTH 9

ELEV.
DEPTH 12

ELEV.
DEPTH 14

ELEV.
DEPTH 24

ELEV.
DEPTH

MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. C5018700

BORING/WELL NO. 67WW07

DATE 12-1-00

CHIEF UNIT Wilcox

1. PROTECTIVE CASING [✓ YES] NO

LOCKING [✓ YES] NO

2. TYPE OF SURFACE SEAL (IF INSTALLED) bentonite

3. SOLID PIPE TYPE 304 S.S.

SOLID PIPE LENGTH 14 ft.

JOINT TYPE SLIP/GLUED/[✓ THREADED]

4. TYPE OF BACKFILL Cement/bentonite

HOW INSTALLED – [✓ TREMIE]

FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED) bentonite Chip

6. TYPE OF SECONDARY FILTER PACK NA

7. SCREEN TYPE 304 SS.

SCREEN LENGTH 10 ft.

SLOT SIZE #10 Wire Wound in.

SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK 20-40 Silica Sand

9. TYPE OF BACKFILL

10. DRILLING METHOD HSA

WATER LEVEL ____ DATE ____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

JE JACOBS ENGINEERING

Appendix B

Sample Annual Land Use Control Compliance Certification Documentation

Sample Annual Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design Addendum dated __________ for LHAAP-35B(37), a certification of site was conducted by _____________________ [indicate transferee] on__________.

A summary of land use control mechanisms is as follows:

- Groundwater restriction – [Indicate whether groundwater restrictions are still required at LHAAP-35B(37)]

A summary of compliance with land use and restriction covenants is as follows:

- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-35B(37)

I, the undersigned, do document that the certification was performed as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: _______________________________

Name/Title: _______________________________

Signature: _______________________________

Completed annual compliance certification forms shall be sent no later than March 1 of each year for the previous calendar year.

U.S. Department of the Army
TCEQ
USEPA Region 6

Sample Annual Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design Addendum dated __________ for LHAAP-67, a certification of site was conducted by _____________________ [indicate transferee] on__________.

A summary of land use control mechanisms is as follows:

- Groundwater restriction – [Indicate whether groundwater restrictions are still required at LHAAP-67]

A summary of compliance with land use and restriction covenants is as follows:

- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-67

I, the undersigned, do document that the certification was performed as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: ______________________________

Name/Title: ______________________________

Signature: ______________________________

Completed annual compliance certification forms shall be sent no later than March 1 of each year for the previous calendar year.

U.S. Department of the Army
TCEQ
USEPA Region 6

Appendix C

Field Activities

Table of Contents

1.0 Common Field Activities

The field activities that may be required at LHAAP-35B(37) and LHAAP-67 are described in the following major tasks. These activities are based on the LHAAP *Final Installation-Wide Work Plan* (Shaw, 2006). Each task is described in the succeeding sections.

Task 1	Mobilization and Site Setup
Task 2	Monitoring Well/Compliance Well Installation
Task 3	Survey of Monitoring Well Locations
Task 4	Groundwater Sampling
Task 5	Soil Sampling
Task 6	Surface Water/Sediment Sampling
Task 7	Investigation-Derived Waste Management

Additional information regarding these activities can be found in **Appendices D-G**. The field procedures described in this document are consistent with those employed previously at the site (Shaw, 2004a,b).

1.1 Task 1 - Mobilization and Site Setup

Prior to the mobilization of subcontractors to the installation, the contractor will inspect drilling locations for overhead and ground level accessibility. In areas that have excessive vegetation and/or tree growth, a backhoe or excavator will be used to clear the areas to allow rig equipment access. After coordinating with underground utility locators for utility clearances, drilling locations and areas that require surface soil removal will be located and staked.

The contractor will mobilize the appropriate personnel, subcontractors, and equipment necessary for the specific task(s). A permanent decontamination station is located at the on-site groundwater treatment plant (GWTP) at LHAAP-18/24 and can accommodate large equipment. Temporary decontamination pads will be constructed at approved on-site locations as needed to decontaminate drilling equipment and prevent cross contamination between sites. The decontamination pad will be approximately 15 feet in length and width, bermed, and covered with high-density polyethylene (HDPE) sheeting. The pad can be constructed in a staging area that can be used between sites. Wash water will be contained and transported to the GWTP for disposal when necessary.

1.2 Task 2 - Monitoring Well/Compliance Well Installation

Monitoring and compliance wells will be drilled and installed using a high-torque-stem auger or mud rotary drill rig depending upon site conditions. Each well will be constructed with flushjoint threaded, schedule 40, polyvinyl chloride (PVC). If necessary, soil samples will be collected continuously using a split barrel core sampler advanced ahead of the drill bit. The soil (or sediment) samples will be described according to American Society for Testing and Materials (ASTM) D2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), and logged on USACE Engineering

Form 1836 (Drilling Log) or equivalent. Additional details for well installation are found in Attachment 13 of **Appendix D**, Field Procedures.

The monitoring wells will be installed in the annulus of hollow-stem augers. The PVC well screen for each well will be 0.01-inch slotted and 10 feet in length. A threaded PVC bottom cap will be secured to the bottom of the screen interval. Solid PVC casing will be installed from the top of the screen interval to approximately 3 feet above surface grade. A filter pack consisting of clean silica sand (20-40 size) will be placed in the auger-well annulus from approximately 0.5 feet below the well bottom to approximately 2 feet above the screen interval. A 3-foot thick bentonite seal (pellets or chips) will be placed above the sand filter pack and hydrated with potable water. The annular space from the top of the bentonite seal to the surface will be filled with a bentonite-cement grout. The screen length and sealing criteria may be adjusted on a site specific basis.

For the wells installed in the intermediate groundwater zone, the shallow groundwater zone will be isolated using a suitable diameter, schedule 40 steel casing. The casing will be installed from near surface grade to the top of the first confining layer. Upon grouting and setting of the isolation casing, drilling will proceed into the intermediate zone. For any wells installed in the deep groundwater zone, both the shallow and intermediate groundwater zones will be isolated using suitable diameter steel casings for each string.

The drilling equipment will be decontaminated prior to the arrival at the site and between wells. Additional information on decontamination procedures can be found in **Attachment 9** of **Appendix D**. Core samplers will be washed between sampling intervals in a detergent/water solution and double rinsed with tap water in clean buckets. The decontamination wastewater and drill cuttings will be placed in 55-gallon drums and handled as described in Task 7.

Aboveground surface completions will be constructed for each monitoring/compliance well installed (**Appendix D**). The surface completion will consist of protective steel casing, with a hinged, lockable lid set in a concrete pad. Concrete-filled steel bollards will be installed at the corners of the concrete pad.

The monitoring wells and surface completions will be installed in general accordance with USACE and State of Texas requirements by a drilling subcontractor licensed in the State of Texas. At the end of the field work, a State of Texas Well Report will be submitted to the Texas Department of Licensing and Regulations for construction of each well.

1.2.1 Well Development

The newly installed monitoring wells will be developed to remove drilling fines and enhance hydraulic communication between the well and the groundwater zone. The wells will be developed no sooner than 48 hours and no later than 7 days after installation of the well. Well development will be performed by pumping and gentle surging of the screened interval using a rubber-lined surge block. A minimum of three well borehole volumes of water will be removed. The volume of groundwater removed from each well will be calculated from the static water level measurement referenced from the top-of-casing. An electronic interface probe will be used to measure the water levels. As an alternative to pumping, a bottom-filling bailer may be used to remove water from low-yielding wells. Water quality parameters (temperature, pH, conductivity, and turbidity) of the development discharge water will be monitored. Development will continue until the water quality parameters have stabilized to within 10 percent and the water is visually clear. Additional guidance on well development is provided in **Attachment 3** of **Appendix D**.

A contractor hydrogeologist will supervise well development, and document the development process and measurements in a Well Development Record specific to each well. Downhole development equipment will either be disposed after each use or will be decontaminated prior to and following use at each well location by cleaning in a detergent/water solution and double rinsing with tap water in clean buckets. The development and decontamination wastewater will be placed in 55-gallon drums and handled as described in **Section 1.7**.

1.3 Task 3 - Surveying

A State of Texas-licensed professional land surveyor will survey the locations and elevations of the newly installed monitoring wells. The horizontal coordinates (northing and easting) of the wells will be surveyed to the nearest foot and will be based on the North American Datum of 1983. The vertical elevations of the top of the wells (top-of-casing) will be surveyed to nearest 0.01 feet. The ground surface elevation at each well location will be surveyed to the nearest 0.1 feet. To ensure compatibility with pre-existing well elevations, the top-of-casing for one of the existing wells at each site will be surveyed. If discrepancies are noted, the USACE will be consulted for resolution.

For identifying locations of soil confirmation samples and limits of excavation, either land surveying or Global Positioning System (GPS) may be used. The contractor will coordinate with the USACE prior to the use of GPS.

1.4 Task 4 - Groundwater Sampling

Monitoring wells will be sampled using the low flow method. The only exceptions would be slow recharging wells that go dry or proceed to drawdown significantly whereby equilibrium cannot be maintained. Procedures for purging and sampling the monitoring wells with the low flow method or alternative means are detailed in **Attachment 2** of **Appendix D**. Detailed information on groundwater sampling can also be found in the Chemical Data Acquisition Plan (CDAP) (**Appendix G**). Analytical parameters and the frequency of sampling are discussed in the Groundwater Monitoring Plan, **Appendix A**.

1.5 Task 5 - Soil Sampling

Surface soil is defined as that which exists from the land surface extending approximately one foot bgs. Surface soil samples may be collected during various investigation or remediation activities. Surface soil sampling equipment and procedures are detailed in **Attachment 6** of **Appendix D**.

Subsurface soil samples may be collected during various activities including drilling of soil borings, test pits, or installation of monitoring wells for investigation activities. Soils samples will be collected during drilling activities and will be described according to the ASTM D2488- 00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Each boring will be logged on USACE drilling forms or equivalent. Soil samples will be screened using an organic vapor monitor (OVA) and headspace readings will be taken and entered on the drilling form. Generally, samples collected for chemical analysis will be from the highest OVA reading, from the first two feet of the boring or well, and at boring terminus unless otherwise specified by the site-specific work plan addendum. More information regarding subsurface soil samples can be found in **Attachment 5** of **Appendix D**.

Test pits may be dug at the facility to fulfill specific objectives relating to site investigations or for confirmation purposes. Generally, test pits will be utilized in order to identify the location of pipelines, the condition of pipelines, and to characterize the surrounding soil to determine if there have been any impacts to the soil during past operations. Additional procedural criteria and sampling protocols will be defined in future addenda to this plan.

1.6 Task 6 - Surface Water/Sediment Sampling

During various phases of work, surface water and sediment samples may be collected to satisfy specific requirements. Using clean disposable gloves, surface water sample bottles should be totally submerged with a slight tilt to effectively fill the bottle without displacing any preservatives, if any. The bottle should be tightly capped immediately after filling. Other sampling equipment may be utilized depending on sample objectives and site conditions (e.g., Kemmerer samplers, etc.). Sampling after a heavy rain is not recommended, since sediments can be stirred up by agitation and the result would not be a representative sample. Sampling should be postponed until better conditions are present. Surface water samples should be collected prior to any sediment sampling at the same location. Additional information regarding surface water sampling can be found in **Attachment 7** of **Appendix D**.

Sediment samples are usually collected in conjunction with a surface water sample, and as close as possible to the location the surface water sample was collected. Sediments should be collected using clean disposable gloves, a decontaminated trowel or shovel to loosen and remove the sediment and placed in a laboratory-supplied soil jar. As with other media, samples should first be collected from the point suspected to be the least contaminated and later from more contaminated points to minimize the risk of cross-contamination (e.g., collection near a pipe outfall should not be the first sample if several samples are planned for the water body).

1.7 Task 7 - Investigation-Derived Waste Management

Wastes generated during installation and sampling of monitoring wells will include drill cuttings; wastewater from equipment decontamination, well development, or purging; and miscellaneous wastes. Management of the waste streams is described below.

1.7.1 Drill Cuttings

Drill cuttings may initially be placed in 55-gallon drums or similar containers, or directly placed in an HDPE-lined roll-off container. Upon completion of each well, drums will be sealed and transported to a staging area. Drill cuttings in drums will be transferred to an HDPE-lined rolloff container if the quantity of drill cuttings is large. Composite samples will be collected from drums or roll-off boxes for characterization before disposal. The procedures for sampling the drill cuttings in drums or roll-offs are detailed in the CDAP (**Appendix G**). A procedure for handling of investigation-derived waste is presented in **Attachment 10** of **Appendix D**.

Following characterization, drill cuttings will be disposed on site if they are determined to be non-hazardous. The cuttings will be transported to a permitted landfill if they are determined to be hazardous.

1.7.2 Wastewater

Wastewater generated from equipment decontamination, well development, sampling, and purging activities will be stored in 55-gallon drums or larger containers. Containers will be transported to the GWTP at LHAAP-18/24 for disposal and will be released in the influent stream of the plant.

1.7.3 Miscellaneous Wastes

Miscellaneous wastes include spent personnel protective equipment, HDPE sheeting, rags, paper towels, etc. These wastes will not be characterized and will be placed in plastic bags for disposal as municipal solid waste.

1.8 Task 8 - Well Abandonment

The abandonment procedures used at a site are dependent upon specific regulatory requirements and generally fall into two different methods – abandonment of the well in place or removal of the well and associated materials from the aquifer. Abandonment in place will be considered when contamination cannot enter from the surface and cross-contamination cannot occur between various zones. In other circumstances, removal of the well materials will be implemented by overdrilling the well casing using a hollow stem auger drill. The auger is centered over the casing with the center plug and pilot bit removed, or a small guide plug is inserted in the casing, guiding the drill string downhole and bringing well completion materials to the surface.

Several goals should be met while conducting well abandonment activities. These include the prevention of vertical migration of fluids in the borehole and prevention of intermixing of waters from different water-bearing zones. In addition, any physical hazards that may be present, such as an open borehole, should be eliminated after conducting well abandonment procedures. Lastly, well abandonment activities should be conducted in such a way to preserve aquifer properties. Additional information is in **Appendix D**, Attachment 11, Monitoring Well and Borehole Abandonment.

2.0 Site Restoration and Demobilization

Following completion of remediation activities, the contractor will restore the site and demobilize. Disturbed areas will be graded, if necessary, for proper drainage and reseeded with native vegetation. Equipment and personnel will be demobilized from the project site immediately following completion of field operations. Equipment will be decontaminated before leaving the site.

3.0 Safety and Health

The Health and Safety Plan (HASP) defines and establishes the policies and procedures that protect workers and the public from potential hazards posed by planned project activities during this installation-wide investigation and remediation effort at LHAAP. The HASP incorporates health and safety policies and safe operating procedures for individual project site activities proposed under this contract. These procedures allow work activities to be carried out in a controlled, effective manner.

Prior to initiating work at the facility for any site, workers will have signed the HASP in the designated area to indicate they have read and understood the document. Also, daily safety meetings will be held with all field crew members prior to starting work each day in order to review the day's scope of work, any site conditions expected, and any hazards that need to be addressed or acknowledged. The HASP is in **Appendix E**.

4.0 Quality Assurance/Quality Control

The Contractor Quality Control Plan in **Appendix F** provides additional information on QA/QC procedures. This plan identifies personnel, procedures, controls, instructions, tests, verifications, documents, and forms to be used and what type of records to be maintained. The USACE Three-Phase QC process will be used to enforce QA/QC requirements and include preparatory inspections, initial inspections, and follow-up inspections. The three phases of inspections will target each definable feature of work during execution of project activities.

The contractor will coordinate with the USACE to meet the requirements of the Quality Assurance Surveillance Plan (QASP). The QASP, developed by the USACE, will incorporate key quality control activities that the USACE will use to assess progress toward milestones as described in the PWS.

5.0 References

ASTM International, 2003, ASTM D2488-00, *Standard Practice for Description and Identification of Soils*, West Conshohocken, PA 19428-2959.

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

Jacobs, 2002, *Final Remedial Investigation Report Volume 1: Report for the Group 4 Sites, Sites 35A, 35B, 35C, 46, 47, 48, 50, 60, and Goose Prairie Creek, Longhorn Army Ammunition Plant, Karnack, Texas*, Oak Ridge, Tennessee, January.

Shaw Environmental, Inc. (Shaw), 2004a, *Final Work Plan, Installation-Wide Background Study, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas.

Shaw, 2004b, *Final Work Plan, Groundwater Data Gaps Investigation, Groups 2 and 4, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas.

Shaw, 2005, *Draft Project Management Plan for Site Closure of Multiple Sites, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas.

Shaw, 2006. *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas.

Appendix D

Field Procedures

List of Attachments

Attachment 1

Collection and Field Screening of Soil Samples

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 1

Subject: COLLECTION AND FIELD SCREENING OF SOIL SAMPLES

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes guidelines and procedures for use by field personnel in collection and field screening of hand-augered, grab, and sleeve-lined split-spoon soil samples from surface or subsurface soils, or sediments.

The use of field screening methods for hand-augered, grab, or sleeve-lined split-spoon samples allows field teams to develop a general understanding of contaminant profiles with the objective of optimizing confirmation sampling activities. Consistent sampling procedures help to ensure uniformity of results and to reduce either false positives or negatives.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring that field activities are completed to meet the project objectives, are conducted in accordance with the project plans and requirements, and all activities are performed according to the respective procedures. This will be accomplished by staff training, by maintaining quality assurance/quality control (QA/QC), and proper documentation.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring all team members also perform work in accordance with this procedure.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The site CQCSM is responsible for ensuring that this procedure is correctly implemented and that data collected meet the requirements of the project work plan.

4.0 DEFINITIONS

En Core® Sampler. A disposable volumetric sampling device used for collecting, storing and delivery of a soil sample.

Hand Auger. A hand-operated device used for collecting shallow subsurface soil samples. Several types of hand augers are available: screw-type augers, barrel augers, tube type augers, and hand-held power augers. The basic operation of a hand auger involves turning the auger repeatedly while applying pressure so that it goes down into the soil. Soil samples are collected either from the cuttings (screw-type) or the barrel (barrel or tube-type) of the auger.

Split Spoon Sampler. The split-spoon sampler consists of two split-barrel halves, a drive shoe, and a sampler head containing a ball 'n check valve, all of which are threaded together. The sampler is commonly 2 to 3 inches in outside diameter and 2-feet in length. The sampler is threaded to a driving rod and either pushed or hammered into the ground to obtain a soil sample.

5.0 TEXT

5.1 Required Records And Forms

1. Field Activity Daily Log (FADL)
2. Sample labels and chain-of-custody forms
3. Sample collection log (SCL)
4. Material safety and data sheets (MSDS).

5.2 Required Materials, Equipment, Or Supplies

1. Indelible black-ink pens and markers
2. Personal protective clothing and gear
3. Gloves, nitrile
4. Keys for locking well caps
5. Paper towels
6. Radio, two-way, hand held or cellular phone
7. Safety glasses with side shields
8. Hard hat
9. Aluminum Foil
10. Portable organic vapor detector (i.e., photoionization detector [PID] or flame ionization detector [FID])
11. Clean stainless steel spoon or spatula

12. Certified clean glass sample container or zip-top type bags
13. End caps, and Teflon® tape
14. Stainless steel, brass, Lexan® or Teflon® inserts (liners) for split-spoons. Liners must be sized appropriately for the diameter of the split spoon used.

5.3 General Requirements

The collection of field-screening samples can be accomplished by several types/sizes of sampling devices (e.g., hand auger, Geoprobe sampler system, or split-spoon samplers). However, the greater the number of analyses to be performed in the field, the greater the volume of soil that will be required for on-site and potential off-site laboratory analyses. The following procedures outline the collection methods from three of the most common sample retrieval devices that allow for both on-site and off-site analyses.

1. Verify that all personnel have read and understood the approved site-specific health and safety plan and have the proper training and certifications required under OSHA.

2. Sample locations are to be marked and proper utility clearances obtained prior to sampling event.

3. Verify the site location by existing maps and surface features. Mark off the boundaries of the work site with flagging or other means to prohibit access to unauthorized personnel.

4. Check to see that all the necessary equipment (including PPE) is available at the site, is in good working condition, and has been properly decontaminated.

5. Check that all monitoring equipment is properly calibrated and operating.

6. The use of biochemical field devices (e.g., immunoassay kits) may be used to augment the field screening for total petroleum hydrocarbons and specific VOCs.

7. Dispose of the soils/sediment and containers as stated in the Work Plan and Attachment 10 of Appendix D, Investigation Derived Waste.

5.4 Specific Requirements for Hand Augering

1. Follow the general procedures for collection of subsurface soil samples as defined Attachment 5 of Appendix D, Subsurface Soil Sampling.

2. Using gloved hands and spatula/spoon, fill either a clean container or zip-top bag approximately one-half to two-thirds full with soil/sediment and tightly seal the zip-top type bag or tightly cap the clean container with a piece of aluminum foil.

3. Properly identify the sample.

4. Allow the sample to set for approximately 15 min in a warm environment (e.g., the sun or a heated car).

5. Pierce the aluminum foil or the zip-tip type bag with the sample probe of the organic vapor detector and record the highest initial reading from the container's headspace on the FADL.

5.5 Specific Requirements for Split-Spoon Sampler (24-inch or 5-foot [CME])

1. Follow the general procedures for collection of subsurface soil samples as defined in Attachment 5. The split-spoon sampler may be used when a large volume of soil is needed for samples or an extra liner is needed for lithologic description.

2. Place the liners in the split spoon as illustrated in the attached diagram (**Figure 1**). Prepare labels, or label the liners, with all pertinent sampling information and liner designations.

3. Collect soil sample following Attachment 5.

4. Take appropriate hand-held meter measurements (PID or FID) from the ends of liners and record on the FADL.

5. If all liners have approximately the same PID/FID readings, seal liners C1 and C2 (see Fig. 1) with Teflon tape and end caps. If a particular liner section has a significantly higher PID/FID reading, this liner should be selected as the off-site VOC sample.

6. Extrude total petroleum hydrocarbons (TPH) sample from liner B for on-site laboratory analysis, if necessary. If there is no TPH analysis, proceed to next step.

7. Collect additional sample volume for other on-site analyses [e.g., metals or semivolatile organic compounds (SVOCs)] from liner D and place in the appropriate container for shipping to the on-site laboratory. Cap liners A, B, and D with Teflon tape and end caps. Liner A, the topmost liner, may contain slough from the previous sample run's drilling activities. Use liner A only if there is insufficient sample volume and collect from the bottom of the liner first. Place liners A, B, and D and C2 in plastic bags and store on ice in coolers.

8. Field-screening analysis must be completed before a decision can be made on whether the stored liners (i.e., A, B, D, and C2) are to be sent to the off-site laboratory for analysis, archived for future use, or discarded. The decision to send samples to the off-site laboratory must be consistent with the decision criteria set forth in the SFSP and the samples must arrive at the laboratory at least 5 working days before the holding times expire.

9. If samples are to be sent to the off-site laboratory, remove the necessary sample volume from liners A, B, and D, composite the samples, and place in appropriate

containers for shipment to laboratory. Ensure each sample is clearly labeled. A liner from which on-site samples were collected will not be shipped.

10. If samples are to be archived or discarded, procedures must be consistent with those set forth in the SFSP or work plan.

5.6 Records

All information will be recorded in the FADL for the subject site. The FADL entries will be recorded chronologically and the time of the entry recorded first. All FADL continuation pages will be sequentially numbered and the last page recorded for the day will be signed and dated by the recording technician.

Records generated as a result of this SOPP will be controlled and maintained in the project record files.

6.0 EXCEPTION PROVISIONS

Headspace analysis is limited by potential loss of volatile organic compounds during method execution.

7.0 CROSS REFERENCE

Attachment 5 - Subsurface Soil Sampling
Attachment 9 - Field Equipment Decontamination

Annual Book of ASTM Standards, *Standard Guide for Soil Gas Monitoring in the Vadose Zone*, D5314.

HAZWRAP, 1996. *Document No. DOE/HWP-100, Standard Operating Procedure 2A and 2B, Collection and Field Screening of Hand-Augered and Grab Samples and Sampling and Field Screening of Sleeved Soil Samples.*

8.0 TABLES

None

9.0 ATTACHMENTS

Figure 1 - Lining the Split-Spoon Sampler
Figure 2 – Field Activity Daily Log

Figure 1

Sampling Procedures

1. Record PID/FID readings.

2. Seal liners C1 and C2 with Teflon tape and caps.

3. Samples for TPH will be extruded from Liner B for analysis at the field laboratory, if required. The remaining soil in the liner will be sealed with Teflon tape and capped.

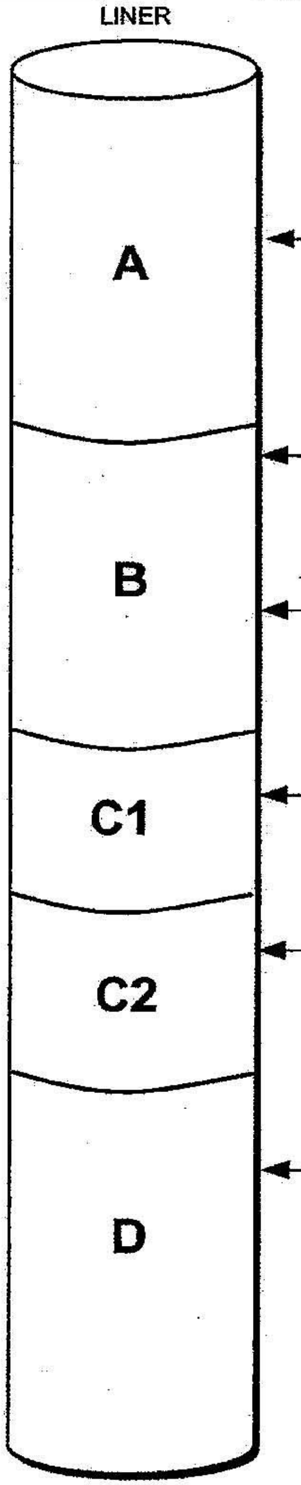
4. Seal liners A and D with Teflon tape and caps.

5. Place labels on end caps.

6. Place liners in plastic bags and place on ice in coolers.

7. Based on field screening results, selected samples will be shipped to the fixed-base lab. liners A, B, and D will be homogenized using stainless steel utensils for CLP SVOCs and pesticides/PCBs and TAL metals and cyanide, and TPH confirmation if required.
(2-8 oz. glass jars)
(1-4 oz. glass jar for TPH)

Acronyms:
CLP - contract laboratory program
PCB - polychlorinated biphenyl
PID - photoionization detector
SVOC - semivolatile organic compounds
TAL - target analyte list
TPH - total petroleum hydrocarbons
VOC - volatile organic compound



Sampling Parameters by Liner

Homogenized (see Note 7)
with B & D

Grab (TPH)
(mobile lab)
(1-4 oz. Glass jar)

Homogenized (See Note 7)
with A & D after grab TPH

Capped (VOCs mobile)

Capped (CLP VOCs fixed-base lab or VOCs confirmation if required)

Homogenized (See Note 7)
with A & B

Figure 2

Shaw™
Shaw Environmental & Infrastructure, Inc.

DAILY LOG
DATE:
NO.
SHEET OF

FIELD ACTIVITY DAILY LOG

PROJECT NAME PROJECT NO.

FIELD ACTIVITY SUBJECT:

DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:

VISITORS ONSITE:

CHANGES FROM PLANS AND SPECIFICATIONS AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.

WEATHER CONDITIONS:

IMPORTANT TELEPHONE CALLS:

IT PERSONNEL ONSITE:

SIGNATURE: DATE:

Attachment 2

Groundwater Sampling

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 2

Subject: GROUNDWATER SAMPLING

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes guidelines and procedures for use by field personnel in sampling monitoring well groundwater.

A consistently implemented groundwater sampling procedure will help ensure data comparability between different sampling events and between sites. One of the following methods shall be used to collect groundwater samples. The method to be used shall depend upon the site conditions or requirements of the work plan. The low-flow method shall be used unless other methods are specified or approved for special circumstances.

(a) ***Low-flow purge and sample using a submersible bladder pump.***
The method involves purging the well at low-flow rates until water quality parameters stabilize or are within acceptable ranges, and collecting the sample at the same low flow rates. This method should be used by default unless the site conditions or the work plan require using a different method. A bladder pump is preferred for low flow sampling; however, other pumps (e.g., peristaltic pump) may be acceptable depending upon the objective of the sampling.

(b) ***Volume purge and sample using a bailer or submersible pump.***
The method involves purging a fixed number of well volumes using a bailer or submersible pump. Purging is continued until at least 3 well volumes are purged and the parameters have stabilized. This method shall be used in lieu of the low-flow method, only if warranted by the site conditions (e.g., exceptionally low recharge rate). A bailer may be used for collecting sample from a well that goes dry even at the slowest pumping rate during low-flow purging. In such a case, the well is pumped dry and sample is collected with a bailer within 24 hours. This method shall be used only if specified in the work plan or approved by a task manager or the technical lead.

The low-flow purge and sample method shall be used as a default method for collecting groundwater samples for chemical analysis. The use of method (b) will be restricted only to special circumstances, either if specified in the work plan or if warranted by site conditions. If site conditions warrant the use of method (b), prior approval from the technical lead is required and the approving person must be identified in the sample collection log.

1.1 Low-Flow Purge and Sample

Introduction. The low-flow (minimum drawdown, micropurging) sampling method is based upon the premise that a pump located within the screened interval of a well and pumping at a rate corresponding to the hydraulic conductivity of the formation, will rapidly establish a horizontal laminar flow of groundwater and withdraw fresh formation water without significant mixing or dewatering of the stagnant casing water in the well (U.S. Army Corps of Engineers, 1995). The low flow method aims to minimize well water turbidity which may be caused by resuspension of well sediments or additional development of the formation during high speed pumping.

Establishment of a low flow regime will be ensured by carefully monitoring the drawdown because excessive drawdown indicates that the pump is withdrawing stagnant casing water. The maximum drawdown allowed will be 0.3 feet (4 inches). During purging, the flow rate will typically be maintained within the range of 0.1-0.5 liter/minute (L/min). The flow rate will be decreased further if the drawdown exceeds 0.3 feet. Flow rates up to 1 L/min may be used in purging some high yielding residuum aquifers, if the drawdown remains within the allowable limit of 0.3 feet. Flow rates greater than 1 L/min may be allowed in bedrock wells where the well may be screened across a cavity, with the limitation of the maximum drawdown. However, the flow rate in all cases must be slowed down to 0.1 to 0.3 L/min during sampling to prevent turbulence and aeration of water.

If excessive drawdown is noted using the lowest possible pump rate, then the low-flow method is not applicable. In such a case, the well will be pumped dry once and sample will be collected with a bailer as soon as adequate quantity of water for samples is available.

2.0 RESPONSIBILITY MATRIX

2.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring that field activities are completed to meet the project objectives, that they are conducted in accordance with the project plans and requirements, and that all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring that all site personnel are trained in the procedures, that the procedures are adhered to, and that all activities are documented.

2.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring that all team members also perform work in accordance with this procedure.

3.0 DEFINITIONS

Bailer. A bailer is an enclosed cylindrical tube containing a floating ball check-valve at the bottom. Lowering the bailer into water causes the ball to float allowing water to enter the cylinder. Raising the bailer through the water causes the ball to settle, creating a seal to trap the water so that it can be brought to the surface.

Bladder Pump. A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. The gas (air or nitrogen) is provided by compressors or compressed gas cylinders.

Peristaltic Pump. A peristaltic pump is a self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement which causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet.

Purging. The process of evacuation of the static water in the monitoring well to allow formation water to flow into the well. The aim of purging a well before sampling is to obtain a sample that is representative of the groundwater in the soil or rock formation. Purging can be accomplished either by utilizing low-flow purge or volume purge methods. In the low-flow purge method, water is pumped at a slow rate to establish a horizontal laminar flow to draw water from the formation without drawing in the stagnant casing water. Volume purge involves evacuating 3-5 well volumes of water to ensure that all stagnant water has been removed from the well.

Water Quality Parameters. Chemical and physical properties of groundwater measured during purging and sampling to ensure that a representative groundwater sample has been collected and to document the ambient subsurface conditions at the time of sampling. The parameters normally measured include pH, Eh, temperature, dissolved oxygen, conductivity, and turbidity. The measurements are made at specified intervals and documented in appropriate sample collection logs completed in the field.

4.0 PROCEDURE

4.1 Required Records And Forms

1. Groundwater Sampling Log (Attachment 1.0)
2. Chain-of-Custody Form
3. Sampling and Analysis Plan
4. Material Safety Data Sheets (MSDS)
5. Field Activity Daily Log (FADL).

4.2 Required Materials, Equipment, Or Supplies

The following supplies are required for low-flow purge and sample method. Other supplies as needed in addition or in-lieu of those listed below are specified in respective sections.

1. Personal protective equipment (PPE) as required by the site-specific health and safety plan
2. Calculator
3. Decontamination solutions; nonphosphate detergent, rinse water, deionized water
4. Compressor, air
5. Container, 1-gal clear glass
6. Controller Box
7. Cooler with ice and packing materials
8. Cylinder, graduated, 2-liter

9. Drum, 55-gallon
10. Filters, high capacity, in-line sample filter, 0.45 micron
11. Filtration units, (disposable) and hand-operated vacuum pump (if needed in-lieu of in-line filtration)
12. Flow-through cell or equivalent
13. Gasoline
14. Gloves, nitrile or latex
15. Keys for locking well caps
16. Labels, sample bottles
17. Litmus paper or pH indicator strips
18. Paper towels
19. Pens, waterproof
20. Pipettes
21. Pump, bladder
22. Radio, two-way, hand-held or cellular phone
23. Safety glasses with side shields
24. Sample containers
25. Sheeting, polyethylene
26. Steel tape, weighted
27. Stop watch
28. Thermometer
29. Photoionization Detector (PID)
30. Trash bags, large plastic
31. Trash can, 32-gallon plastic
32. Tubing, Teflon®-lined polyethylene discharge bundled with polyethylene air tube
33. Water Level Indicator.

4.3 General Requirements

Decontamination:

1. All field sampling equipment (pump, bailer, water discharge tubing, support cables, water level indicator, flow-through cells, etc) likely to come in contact with the sampled groundwater shall be decontaminated before and after each use or between wells. The pump shall be initially dissembled and decontaminated. Refer to the decontamination SOPP for complete procedures.

2. The water discharge tubing shall then be attached and the pump used to twice circulate detergent solution followed by potable water and deionized water rinses. Only Teflon® or Teflon®-lined tubing shall be reused after decontamination. Polyethylene or tygon tubing shall be discarded after each use and shall not be decontaminated for reuse.

Other Requirements

3. Provide shade for the spooled tube when a sampling event occurs during summer months in full sun. Otherwise, the tube may act as an effective heater, warming the groundwater sample and creating a potential for volatilization.

4. The portable generator/compressors shall be placed downwind from the well being sampled.

5. Store field parameter measurement "instruments" in shade during transportation and at the sampling site. The instruments may give inaccurate readings if left under full sun.

6. To the extent possible, groundwater sampling shall be conducted so as to sample upgradient, presumably "clean" wells first.

7. All personnel involved in sampling shall wear appropriate health and safety clothing and gear, including clean nitrile gloves, in accordance with the site-specific health and safety plan.

8. In order to minimize turbidity in the well, pump and tubing assemblages shall be lowered into the well as slowly as possible to minimize turbidity.

4.4 Specific Requirements for Low-Flow Sampling

Follow steps given below:

Pump Installation

1. Measure the static water level and the total well depth with an electric water level indicator.

2. Based on the well design information, subsurface geology, and the measured water level, determine the location of the pump intake using the guidelines given below:

    a. If a zone with a relatively high hydraulic conductivity (K) is present in the screened interval, place the pump intake within this zone. A high K zone may be a sandy or gravel unit within an overall clayey unit or a fracture zone within the bedrock. If the high K zone is near the bottom of the screen, the pump intake should be as much above the well bottom as possible.

    b. If a high K zone is not present and the screen is completely submerged, place the pump intake near the middle or slightly above the middle of the screen.

    c. If a high K zone is not present and if the water level is below the top of the screen, place the pump near the middle of the water column. The pump intake should be as much above the well bottom as possible.

3. Connect the safety cable, discharge tube, and air tube to the bladder pump. The discharge tube will be Teflon®-lined polyethylene and its length will be appropriate for the well being sampled. For example, a 100-foot long tube may not be used in sampling a 30-foot deep well; instead a 50-foot length will be used.

   Using an appropriate length of tube will minimize the amount of decontamination fluids generated and lessen the opportunity for chemical and physical changes in the water due to contact with the spooled tube.

4. Gently lower the pump to the appropriate sampling depth so as to minimize mixing of stagnant casing water with the screen water and resuspension of bottom sediments. Secure the pump at the desired depth by clamping the support cable to the 4-inch non-locking well cap.

5. Lower an electric water level indicator (with an audio and visual alarm) again into the well, measure and record the water level. The water level may be temporarily elevated because of the insertion of the pump into the well. Wait for a few minutes until the water level returns to the static level.

6. Make proper connections for the pump. Attach the air supply line to the pump controller. Connect the pump discharge tube to a "T" insert with a valve. Connect two sections of Teflon® -lined tube to the two remaining ends of the "T". Connect one tube to the flow through cell of the water quality meter and place the discharge from the flow cell into the purge water container. The third tube from the "T" will be used for sample collection.

7. Calibrate water quality meters and place probes into the flow through cell.

8. Measure the water level in the well. Secure the water level probe 0.3 foot (4 inches) below the water level and keep the instrument on.

9. Start the pump at the lowest setting. Gradually increase the flow rate.

10. Constantly monitor the drawdown as the flow rate is increased. If the drawdown exceeds 0.3 foot, indicated by visual or audio alarms on the water level indicator, decrease the flow rate appropriately.

11. Monitor the pump flow rate in mL/min using a stop watch and a graduated measuring cylinder. The targe flow rate is 100 to 500 mL/min (0.1 to 0.5 L/min), which may be increased in the case of a rapid recharging well to 1 L/min (residuum well) or greater (bedrock well), with the maximum drawdown limitation of 0.3 foot.

12. Measure water quality indicator parameters every 3 to 5 minutes. The parameters and their tolerance limits are provided in **Table 1** and discussed further in a subsequent section. The measurements shall be recorded on the groundwater

sampling form. All measurements shall be recorded in units shown on the form. If measurements are made in different units, these units must be clearly shown on the form.

13. Once water quality indicator parameters stabilize (four consecutive readings within acceptable variability), turn the valve at the "T" junction so that the water is diverted from the flow cell to the tube designated for sample collection. Collect samples at 100 to 500 mL/min purging rate.

    A bailer should be used for sampling in the case where a well is extremely slow to recharge (i.e., the recovery rate is below the minimum possible pump rate) and has to be pumped dry. Follow the procedures given below under these circumstances.

14. If the recharge rate of a well fails to sustain the lowest possible flow rate of the pump, causing an excessive drawdown, purge the well dry once. Remove the pump from the well and allow the well to recover until adequate water for samples is available.

15. Use a bailer to collect samples within 24 hours. Collect samples for different parameters as the water becomes available, in the order specified in section 4.8. This is especially important for wells that have historically yielded turbid samples. Up to 24 hours may elapse between purge dry and sample collection to allow silt to settle out.

4.5 Specific Requirements for Volume Purge and Sampling Using a Bailer or Submersible Pump

The following procedures shall be applicable to the volume purge and sampling of a well. The volume purge method shall be used only under special circumstances. However, prior approval from the technical lead or the remediation manager shall be obtained and documented on the sample collection form before using this method.

1. Prepare and decontaminate equipment as per general procedures.

2. Measure the static water level and the total well depth with an electric water level indicator.

<u>Bailer</u>

3. Use Teflon® bailers, if the bailers are to be decontaminated between wells and reused, or disposable bailers.

4. Use disposable twine with the bailer. Do not decontaminate and reuse plastic twine. Only Teflon®-covered steel cable may be decontaminated and reused at another well.

5. To start purging, gently lower and raise the bailer in the water column.

Submersible Pump

6. Lower the pump gently to the bottom of the well.

7. Complete power connections and begin purging.

8. Record water quality parameters at least twice for each well volume evacuated.

9. Purge until at least 3 well volumes have been evacuated and the well parameters have stabilized or the well is bailed dry. Proceed with sample collection once parameter stabilization and low turbidity values (**Table 1**) have been achieved. If the well is bailed dry, wait until adequate water is available in the well and proceed with sample collection.

10. Collect the samples in the analyte order provided in a subsequent section.

11. If collecting a filtered sample, use a disposable filtration unit with a hand-operated vacuum pump. Alternatively, send an unpreserved (no nitric acid added) sample to the laboratory. The sample will be filtered in the laboratory before analysis.

12. Record all pertinent information on the groundwater sampling form, identifying the sampling method used (i.e., volume purge and sample with a bailer) in the "Comments" field. Any fields in the form not applicable to the method used shall be marked "NA."

4.6 Disposal of Purge Water

The water purged from the well is considered investigation-derived waste (IDW). All purge water shall be containerized and handled according to the work plan.

4.7 Specific Requirements for Water Quality Parameter Measurements

Water quality parameters to be monitored during the purge process shall include pH, temperature, conductivity, redox potential (Eh), dissolved oxygen (DO), and turbidity. Measurements shall be made at intervals required by the specific method used. If using a pump, a flow-through cell will be used to measure field parameters at the discharge from the pump at a frequency specified in the sample collection log. If using a bailer for purging, field parameters shall be measured at least twice per well volume evacuated.

The goal of the purging process is to obtain a groundwater sample that is representative of the surrounding aquifer. Field parameters are the simplest indicators for determining when the formation water is being removed. The normal ranges of field parameters are indicated in **Table 1**. Stabilization of parameters is required for before analytical samples may be collected, irrespective of the method used. Field parameter stabilization is defined as four consecutive readings within the criteria presented in **Table 1**.

Professional judgment should be used in evaluating field measurements. For example, if DO readings are in the 5 to 7 milligrams per liter (mg/L0 range, then 10 percent is a reasonable fluctuation. But if DO is in the o.5 to 1 mg/L range, then fluctuations within 10 percent are perhaps overly stringent and 20-50 percent variations may be allowed. The same is true for conductivity and the 10 mV goal for redox. If after 3 well volumes have been purged, all but one or two parameters have stabilized, but are relatively close to their respective target bounds, then this may be an adequate indication that formation water is being removed and sample may be collected. Rationale for samples collected when field parameters are outside of the target fluctuations will be documented on the sample collection logs.

Under low-flow sampling conditions, no minimum volume of water is required to be removed from a well prior to sampling. Under volume purge techniques (pump or bailer), at least 3 well volumes of water should be purged before sampling. Up to 5 well volumes may be purged if parameters do not stabilize after purging 3 volumes and there is an indication that the parameters may stabilize with further purging. However, if field measurements have not stabilized after 5 well volumes have been removed, then the task manager or technical lead shall be contacted to determine whether collecting a sample is appropriate.

Turbidity measurements should be treated differently for different situations. When the analytical program specifies metals (total or unfiltered) for laboratory analysis, then the target turbidity shall be less than 10 NTU, and consecutive turbidity readings less than 10 NTU will be considered equivalent. When metals are not an analytical parameter, then turbidity is not as great a concern, and the target shall be less than 20 NTU. However, in both cases, these goals may not be attainable due to silty or clayey sections of the aquifer matrix. If each parameter has stabilized, but turbidity is still above the target NTU value, then purging shall continue in an effort to attain the target NTU. Decisions to continue purging will be based on how far out of compliance the values are (e.g., 15 versus 100 NTU), and will be made by the technical lead on a case-by-case basis.

During purging, the field parameter values shall be periodically compared to the normal parameter ranges **(Table 1)**. Parameters outside the normal range may indicate a problem with instrument calibration or a faulty well construction. The accuracy of certain instruments tends to drift with time and such instruments may require frequent calibration. An example of a faulty well construction is the presence of cement grout in the screen interval due to a poor bentonite seal. The cement grout causes the pH of the groundwater to be abnormally high (11-13 range). If the parameters are observed to be outside the normal range, the instruments shall be recalibrated and the measurement repeated. If the parameters are still outside the normal range for 4 consecutive readings during purging, the well construction may be faulty and the task manager or technical lead must be contacted for further direction. No samples shall be collected from a well with questionable construction until further direction.

4.8 Sample Collection

Regardless of the purging technique used, samples shall be collected at flow rates in the range 0.1-0.5 L/min or poured gently to avoid aeration, bubble formation, or turbulent filling of sample bottles.

Samples shall be collected in the following order of target analytes, if adequate amount of water is available in the well:

- Volatile organic compounds (VOC)
- Semivolatile organic compounds (SVOC)
- Turbidity
- Major water quality cations and anions
- Carbonate/bicarbonate
- Total suspended solids
- Total dissolved solids
- Kjeldahl nitrogen
- Total metals
- Dissolved metals
- Total petroleum hydrocarbons
- Cyanide
- Ammonia, nitrogen.

Samples for any target analytes not listed above shall be collected in the order of decreasing volatility within the framework of this list. If the amount of water available in the well is low, minimum volume requirements provided in **Table 2** should be implemented or certain target analytes may be omitted, upon approval from the task manager and project chemist.

Filtered Samples. Filtered groundwater samples are normally not needed if a successful low-flow sampling program is implemented. However, if specified in the work plan, filtered groundwater samples will be collected according to the following procedures:

1. If using a flow cell, connect an inline, disposable 0.45 μm filter to the discharge flow tube attached to the "T" junction upstream from the flow cell. If a flow cell is not being used, connect the filter to the discharge tube of the pump. Collect the water discharging from the filter in the sample container.

2. If the low rate is too slow to allow filtration through an in-line filter or if samples are collected by a bailer, an alternative filtration method may be required. A disposable filtration unit and a hand-operated vacuum pump will be used to filter the sample in the field.

3. If filtration can not be accomplished in the field, an unpreserved sample (no nitric acid added) cooled to 4°C shall be shipped to the laboratory along with the preserved sample for unfiltered analysis. The unpreserved sample shall be filtered

upon receipt and the filtrate preserved with nitric acid. The data from the laboratory filtered sample will be reported as "dissolved metals."

4.9 Records

For each monitoring well purged, the technician shall complete a groundwater sampling form (Attachment A). This form prompts the technician to identify and record information such as: site ID, well ID, sample number, depth of well, depth to water, and well diameter. The technician can then use the information on the form to perform a well casing volume calculation. The form also includes spaces to record the field parameters that are measured during purging and any comments and observations. This form also prompts the technician to record the sample number, collection date, and time, sample containers, and associated QC sample information.

All well purging and sampling data and information shall be recorded in the Field Activity Data Log (FADL) for the site sampled. The FADL entries shall be recorded chronologically and the time of the entry recorded first. All FADL continuation pages shall be sequentially numbered and the last page recorded for the day shall be signed and dated by the recording technician.

5.0 CROSS REFERENCE

U.S. Environmental Protection Agency (USEPA), 1986, *Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Technical Enforcement Guidance Document,* OSWER-9950.1, September.

U.S. Army Corps of Engineers (USACE), 1994, *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3, September.

U.S. Environmental Protection Agency (USEPA), 1996, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region 4, May.

U.S. Environmental Protection Agency (USEPA), 1995, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, Groundwater Issue*, EPA/540/S-95/504, December.

6.0 TABLES

Table 1 - Water Quality Indicator Parameters
Table 2 - Water Sample Volume Requirements

7.0 FIGURES

Figure 1 - Groundwater Sampling Form
Figure 2 – Water Sample Field Collection Report

Table 1
Water Quality Indicator Parameters

Measurement	Normal Range	**Acceptable Variability**[a]
PH	4.6 to 8.5	± 0.1
Temperature (°C)	10 to 18	± 10%
Specific Conductivity (µS/cm)	10 to 8,000	± 3%
Redox (mV)	+400 to -300	± 10
Dissolved oxygen (mg/L)	<10	± 10%
Turbidity (NTU)	variable	± 10%[b]

Notes and Abbreviations:

[a] acceptable variability for four consecutive readings

[b] values of less than 10 NTU are considered to be equivalent

°C	degrees celsius
µS/cm	micro siemens per centimeter
mV	millivolt
mg/L	milligrams per liter
NTU	nephelometric turbidity unit

Table 2
Water Sample Volume Requirements

Analysis	Standard Volume (mL)	Minimum Volume (mL)*	Minimum Volume Option*
Volatile organics	120	40	X
Semivolatile organics	1000	1000	
Pesticides/PCBs	1000	1000	
Herbicides	1000	1000	
Metals – Total	500	125	X
Metals – Dissolved	500	125	X
Mercury – Total Mercury – Dissolved	Included with metals (100)	Included with metals (100)	
Cyanide	500	125	X
Anions	250	100	X
Nitrate-nitrite	100	50	X
Total suspended solids and total dissolved solids (TSS and TDS)	500	200	X
Total organic carbon (TOC) RCRA 4/well	4 x 25	4 x 25	
Total organic halides (TOX) RCRA 4/well	4 x 100	4 x 100	
Total petroleum hydrocarbon (TPH)	1000	1000	X
Gasoline range organics (GRO)	80	40	X
Diesel range organics (DRO)	1000	1000	

Notes:

* Quantitation limits (detection levels) may be affected when operating with minimum sample volumes. If volumes are lowered below the minimum sample volumes, quantitation limits will be raised.

Figure 1

Water Level Measurement/Groundwater Sampling Log Form

Well No. ____________________ Date ____________________
Sample ID No. ____________________
Project ID ____________________ Measured/Sampled By: ____________________
Time: Start ____________________ End: ____________________

Measuring Point Elevation: ____________ Ft. Well Construction Material: ____________
Well Depth Ft: 1) ________ 2) ________ 3) ________ 4) ________
Avg. ____________________ (of valid measurements*)

Water Depth Ft: 1) ________ 2) ________ 3) ________ 4) ________
Avg. ____________________ (of valid measurements*)
(*Minimum of three measurements, last two within 0.01 feet.)

Well Internal Diameter: ____________ Ft.
Riser Above/Below Pad Elevation Marker: ____________________ Ft.

Pad Elevation: ____________ Ft.
Sampling Equipment Used:
____
____

Equipment Numbers:
pH Meter ________ EC Meter ________ Turbidity Meter ________ Thermometer ________

Casing Volume Information:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

Purging Information:
Measured Well Depth (B): ____________ Ft.

Measured Water Level Depth (C): ____________ Ft.

Length of Static Water Column (D): ____ (B) - ____ (C) = ____ ft.

Casing Water Volume (E): ____ (A) x ____ (D) = ____ gal.

Total Purge Volume = (gal) (minimum of three casing volumes)

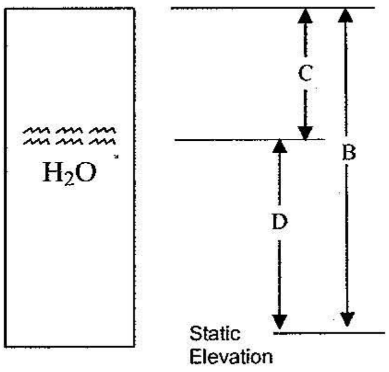


Figure 1 (*continued*)

Water Level Measurement/Groundwater Sampling Log Form (Continued)

Field Indicator Parameter Measurements During Purging:

pH ____ ____ ____ ____

Temp.°C ____ ____ ____ ____

Specific Conductance: µmhos/cm ____ ____ ____ ____

Turbidity: NTU ____ ____ ____ ____

Visual Appearance of Water: ____ ____ ____ ____

Comments:

Field Indicator Parameter Measurements After Sampling:

pH ____ ____ ____ ____

Temp.°C ____ ____ ____ ____

Specific Conductance: µmhos/cm ____ ____ ____ ____

Turbidity: NTU ____ ____ ____ ____

Visual Appearance of Water:

Comments:

Laboratory Analysis Requested:

Sample ID No.	Parameter	Method	Preservation	Duplicate	No. of Containers

Figure 2

Shaw Shaw Environmental & Infrastructure, Inc.	WATER SAMPLE FIELD COLLECTION REPORT	Project Number: ____________ Project Name: ____________ Site Location: ____________

Sample ID Number	____________	Date Collected	____________
Sample Location[7]	____________	Time Collected	____________
Diameter of Well	________ (in.)	Sampler	I.D. #__________
Depth to Bottom of Well	________ (ft.)	Casing Stick Up	____________
Static Water Level	________ (ft.)	Measured From[1]	________ (ft.)
Well Volumes Purged	____________	Purging Method[2]	____________
Type of Sample[3]	____________	Sampling Method[4]	____________
Depth of Sample	________ (ft.)	Measured From[1]	____________
Sample Collection Order			

FIELD SCREENING AND TEST RESULTS

Water Temperature ____________ °C pH ____________ Units

Specific Conductance ____________ umho/cm at ____________ °C

OVA ☐ HNU PID ☐ Reading ____________ PPM

Photovac GC (P/GC) Probable Compound ____________ Reading____________PPM

METER CALIBRATION

pH STD	METER READING	SP. COND. STD	METER READING	________/STD (8)	METER READING

SAMPLE TYPES COLLECTED

CONTAINER #	TYPE (5)	CONTAINER TYPE		VOLUME	FILTERED			
		P ☐	G ☐		Y ☐	N ☐	Y	N ☐
		P ☐	G ☐		Y ☐	N ☐	Y	N ☐
		P ☐	G ☐		Y ☐	N ☐	Y	N ☐
		P ☐	G ☐		Y ☐	N ☐	Y	N ☐
		P ☐	G ☐		Y ☐	N ☐	Y	N ☐

WEATHER CONDITIONS: TEMP.________ °F CLEAR ☐ CLOUDY ☐ RAIN ☐ SNOW ☐ WINDY ☐

(1)	T.O.C. = Top of Protective Casing; T.O.W. = Top of Well Casing; G.S. = Ground Surface	(5)	General Chem., Metal, VOA, Organics, Etc.
(2)	Bailed, Pumped, Air Lift, Etc.	(6)	HNO^3, NaOH, H^2SO^4, $Na^2O^3S^2$, Etc.
(3)	Stream, Pond, Spring, Well, Seep, Supply, Etc.	(7)	If Well, give Well I.D. Number.
(4)	Bailer, Kemmerer, Grab, Pump, Etc.	(8)	OVA, PID, P/GC or Other.

Attachment 3

Well Development

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 3

Subject: WELL DEVELOPMENT

1.0 PURPOSE AND SUMMARY

The objective of this Standard Operating Project Procedure (SOPP) is to define the procedural requirements for developing monitoring wells.

Monitoring wells are developed to create an effective filter pack around the well screen; to repair damage to the formation caused by drilling; to remove the "skin" from the borehole wall; to claim liquids introduced during drilling; and to remove fine-grained particles from the filter pack and the adjacent formation. When a cement-bentonite grout is used to seal the annular space, wells shall not be developed for a minimum of 48 hours (hr) after grouting. Further, the development shall be initiated within 7 days after the final grouting of the well. Timely development of a well is essential to remove fine-grained silt and clay particles that may become permanently lodged in the filter pack with time. Further, the borehole wall "skin" may also become more difficult to remove with time.

Depending upon the amount of water in a monitoring well, well development may be accomplished during an initial attempt or may have to be completed in multiple stages over several months. Specific cases and required procedures are addressed in subsequent sections. A successful well development requires an active participation of the task manager or designate in following the well development process. As addressed in the following sections, wells with an inadequate amount of water to accomplish full development during the initial attempt would have to be redeveloped if the water level rises in the well during the next wet season. The task manager or designate shall schedule water level measurements in the *wet season* in wells that are candidates for redevelopment, so that a decision regarding a redevelopment effort may be made.

There are many well development methods currently in use within the industry:

- Pumping
- Overpumping
- Surging and pumping
- Bailing
- Mechanical surging using a surge block
- Backwashing
- Airlifting (not recommended when the well will be sampled for volatile organic compounds within 7 days of development).

The well development method to be used for this project is a modified surging and pumping method. Water quality indicator parameters of the produced water should be monitored to assist in the proper development of monitoring wells. The indicator parameters monitored should include pH, specific conductance, temperature, and turbidity.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring that field activities are completed to meet the project objectives, that they are conducted in accordance with the project plans and requirements, and that all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring that all site personnel are trained in the procedures, that the procedures are adhered to, and that all activities are documented.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring that all team members perform work in accordance with this procedure. The team members are responsible for communication with the task manager and technical lead to address issues or key decision points.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The Site CQCSM is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of well development activities meet the requirements of the project.

4.0 DEFINITIONS

Bailer. A long, narrow tubular device with an open top and a check valve at the bottom that is used to remove water and sediment from a borehole or well.

Drilling Fluid. A fluid introduced into the borehole in the well drilling operation to remove cuttings from the borehole, to clean and cool the bit, to reduce friction between the drill string and the sides of the borehole and to hold the borehole open during the drilling operation.

Formation Damage. Reduction of formation hydraulic conductivity at the borehole wall caused by the drilling process. May consist of compaction, clay smearing, clogging of pores with drilling mud filtrate, or other drilling-related damage.

Indicator Parameters. Chemical parameters, including pH, specific conductance, temperature and dissolved oxygen content, which are used to determine when formation water is entering a monitoring well.

Monitoring Well. A well that is constructed by one of a variety of techniques that may serve a variety of purposes: (1) extracting ground water for physical, chemical, or biological testing; (2) measuring water levels; (3) measuring formation fluid chemical or physical parameters.

Surge Block. A plunger-like tool consisting of disks of flexible material (for example, neoprene) sandwiched between rigid (for example, metal) disks that may be solid or valved, and that is used in well development. The surge block should have a vent hole to let the air escape as the block is lowered. See surging.

Surging. A well-development technique in which a surge block is alternately raised and lowered within the well casing or screen, or both, to create a strong inward and outward movement of water through the well screen.

Turbidity. Cloudiness in water due to suspended and colloidal material; measured in nephelometric turbidity units (NTU).

Well Development. The act of repairing damage to the borehole caused by the drilling process and removing fine-grained materials or drilling fluids, or both, from formation materials so that natural hydraulic conditions are restored and well yields are enhanced.

5.0 TEXT

5.1 Required Records And Forms

1. Well development Log (**Figure 1**)
2. Field Activity Daily Log (FADL)

5.2 Required Materials, Equipment, Or Supplies

The following equipment is needed to develop a monitoring well:

1. bailer
2. surge block

3. pump, bottom filling (bladder) or peristaltic (Note: All pumps used should have check valves to prevent backflow.)
4. controller
5. pump tubing
6. Teflon®-coated stainless-steel wire
7. power source (e.g., generator), if required
8. water-level meter
9. temperature, specific conductivity, Eh, DO, and pH meters
10. turbidity meter
11. container or flow-through cell to measure field parameters
12. personal protective equipment (PPE) as specified in the site-specific health and safety plan
13. decontamination supplies, if required on-site
14. disposal drums to contain produced water.

5.3 General Requirements

Well development procedures will vary depending upon the amount of water available in the monitoring well. Scenarios likely to be encountered and required procedures are as follows:

1. The screen is 80-100 percent submerged. Proceed with well development in accordance with procedures provided in Sections 5.4 and 5.5.

2. The height of the water column in the well is between 2 feet and 80 percent of screen length (8 feet for a 10-foot screen, and 4 feet for a 5-foot screen). Proceed with well development in accordance with procedures provided in Sections 5.4 and 5.5. Measure the water level in the well again during the wet season. Redevelop the well if the water level is significantly higher than the level at the time of the initial development. The task manager or the technical lead will evaluate the benefit of a redevelopment effort and instruct the field staff accordingly.

3. The height of the water column in the well is less than 2 feet. The well shall not be surged. A minimum 2 feet of water is necessary for the surge operation to be effective. Sections 5.4 and 5.6 provide the procedure to be followed when less than 2 feet of water is present in the well. Measure the water level in the well again during the wet season. Redevelop the well if the water level is significantly higher than the level at the time of the initial development. The task manager or the technical lead will evaluate the benefit of redevelopment and instruct the field staff accordingly.

5.4 General Requirements for Developing Wells

The following steps shall be followed when developing wells:

1. Don PPE as specified in the site-specific health and safety plan.

2. Calibrate all meters in accordance with standard operating procedures and manufacturer's guidelines.

3. Open, check, and note the condition of the wellhead, including the condition of the surveyed reference mark.

4. Decontaminate and prepare the necessary equipment for developing the well.

5. Using a decontaminated electric water level indicator, determine the static water level and depth to the bottom of the well (from the surveyed reference mark). Record on the appropriate field forms. Compare measured total depth to reported total depth and document the accumulation of silt at the well bottom, if any.

6. Compare the depth to water with depths to the top and bottom of the screen. Determine the applicable scenario from those listed above based on the height of the water column in the well. Follow the steps given in Section 5.5 if Scenarios 1 or 2 are applicable. For Scenario 3 (water column less than 2 feet), follow procedures given in Section 5.6.

5.5 Specific Requirements for Well Development by Surge and Pump

The intent of this procedure is to effectively develop the well through mechanical surging and removal of settleable fines while minimizing overall volume of water removed from the well.

1. Slowly lower a bottom-check valve bailer into the well and remove a bailer full of water from mid-screen. Empty the contents into a vessel large enough to contain the well probes. Measure and record water quality parameters (T, SC, pH, turbidity, DO, Eh).

2. Evacuate any sediment present at the well bottom using a bottom intake pump or bailer. If the well is shallow, a peristaltic pump may be used to evacuate sediments. Minimize the water volume removed.

3. Measure static water level after removing sediment; allow equalization if water level drops within screened interval.

4. Insert the surge block so that it is within the screen interval of the well. Surge the water column gently with 2 feet strokes working towards the bottom of the screen. Remove the surge block and rods from the well slowly.

5. Using a bailer or submersible pump, evaluate the turbid water. Periodically measure and record water quality parameters.

6. Repeat steps 1 through 5 until water quality parameters stabilize and are within the normal range of values observed for the site. The criteria for parameter stabilization are the normal ranges of values provided in **Table 1.** If the well

dewaters before desired parameter values are reached, allow time to recharge and continue.

7. Water quality parameters are considered stabilized if they are within the ranges provided in **Table 1** for 4 consecutive measurements.

8. Periodically, compare the parameter readings with the normal range of values (**Table 1**). If the parameters are significantly outside the normal range, the field crew shall recalibrate the instruments and repeat the measurement. If the readings are consistently outside the range for 4 consecutive measurements, a faulty well construction may be the cause (e.g., grout in the filter pack). Contact the technical lead for further instructions.

9. Following a minimum of 3 surge and pump cycles, a minimum of one well volume should be removed. At least 3 well volumes should be removed and (depending upon depth and static water level) upon direction of the task manager or technical lead.

10. Collect 0.5 liters of the last batch of water evacuated from the well and place it into a clean jar. The jar should be labeled with development date and well number. Each sample should be individually agitated and immediately photographed with a 35-mm camera in a backlit setting so that the clarity of the water is visible. The photographs will be a minimum 5 inch x 7 inch in size, and will be individually identified with the project name, well number, and photo date. The photograph will become a part of the well development documentation and will be included in the report along with the development log.

11. Record pertinent data in the FADL and well development log form (Well Development, **Figure 1**).

12. Remove the development equipment from the well, decontaminate (as required), and clean up the site. Lock the well cover before leaving. Dispose of produced water as required by the project work plan.

5.6 Specific Requirements for Minimal Well Development

This procedure is applicable to situations where the height of the water column in the well is less than 2 feet. The surging operation is not considered effective under these conditions and the development process would essentially involve using a pump to evacuate sediments and extremely turbid water near the well bottom. Follow the steps given below:

1. Using a bailer remove a small quantity of water from the well. Empty contents into a container and measure water quality parameters.

2. Lower a bottom-filling pump into the well and evacuate the sediments and turbid water. If possible, maintain the pumping at a rate that would not cause the well to run dry. If the well goes dry even at the lowest possible pumping rate, allow it to

recharge and repeat pumping. A bailer may also be used for sediment evacuation.

3. Measure water quality parameters every 3 to 5 minutes during pumping, preferably using a flow-through cell if a pump is used.

4. Record pertinent data in a well development form (**Figure 1**) and a FADL.

5. Collect the 0.5-liter of the last batch of water evacuated from the well and place it into a clear jar. The jar should be labeled with development date and well number. Each sample should be individually agitated and immediately photographed with a 35-mm in a backlit setting so that the clarity of the water is visible. The photographs will be a minimum 5-inch x 7-inch in size and will be individually identified with project name, well number and photo date. The photograph will be become a part of the well development documentation and will be included in the report along with the development log.

6. Remove the development equipment from the well, decontaminate (as required), and clean up the site. Lock the well cover before leaving. Dispose of produced water as required by the project work plan.

7. Water level shall be measured in the well during the following wet season. The well shall be redeveloped if the water level appears to have risen significantly. The task manager or technical lead will evaluate the benefit of redevelopment and instruct the field staff accordingly.

5.7 Well Volume Calculation

The well's volume must be calculated to estimate how many drums or other containers may be required and how many well volumes were removed.

$$Well\ Volume\ = A + B$$

Where:

$$A\ (Riser\ \ Volume\ ) = \left(H \times r^2 \times \pi\right) \times 7.4805$$

Where:

H = static water column (total depth - depth to water) (in feet)
R = radius of riser or screen (in feet)
π = 3.1416

and

$$B\ (Sand\ Pack\ Volume) = 0.25 \times \left(\left(\left(R^2 \times \pi \times L\right) - \left(r^2 \times \pi \times L\right)\right) \times 7.4805\right)$$

Where:

R = Borehole radius (in feet)
π = 3.1416
L = Filter pack length (in feet)
R = radius of riser or screen (in feet)

Porosity is assumed to be 25 percent. Record these data and calculations in the FADL or well development form (Well Development Attachment 1).

5.8 Development and Sampling Break

A period of at least 14 days will be allowed between well development and sampling. The intent of this hiatus is to allow the newly installed and developed well to equilibrate to the ambient conditions, thus enabling the collection of a representative sample.

5.9 Restrictions/Limitations

Where flammable light, nonaqueous phase liquid (LNAPL) or emulsified LNAPL is expected or known to exist on or in groundwater, use only intrinsically safe electrical devices and place portable power sources (e.g., generators) 50 feet (or more) from the wellhead and disposal drums. Effort should be made to remove LNAPL (bailer) prior to surging to prevent spreading/dispensing of product into sand pack/screen interval.

6.0 EXCEPTION PROVISIONS

This SOPP implements a modified surge-and-pump method that emphasizes the removal of sediments from the well in an efficient manner and is not driven by evacuation of a specified volume of water that may or may not remove all the sediments from the well.

7.0 CROSS REFERENCE

American Society for Testing of Materials (ASTM), 1994. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*, ASTM D5521-94.

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8.0 TABLES

Table 1 - Water Quality Indicator Parameters

9.0 FIGURES

Figure 1 - Well Development Log Form

Table 1
Water Quality Indicator Parameters

Measurement	Normal Range	Acceptable Variability[a]
PH	4.6 to 8.5	± 0.1
Temperature (°C)	10 to 18	± 10%
Specific Conductivity (µS/cm)	10 to 8,000	± 3%
Redox (mV)	+400 to -300	± 10
Dissolved oxygen (mg/L)	<10	± 10%
Turbidity (NTU)	Variable	±10%[b]

[a] Acceptable variability for four consecutive readings.
[b] Values of less than 10 NTU are considered to be equivalent.

°C	- Degrees Celsius.
µS/cm	- MicroSiemens per centimeter
mV	- Millivolt
mg/L	- Milligrams per liter.
NTU	- Nephelometric turbidity unit

Figure 1

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID______
SHEET _______ OF _______

PROJECT NAME: ____________ PROJECT NO.: ________________ DATE: ________________

LOCATION: ________________ DATE INSTALLED: ______________________________

TOTAL DEPTH (FTOC) __________ CASING DIAMETER ______________________________

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐

Describe______________________________

Equipment decontaminated prior to development ☐ Yes ☐ No

Describe____

EQUIPMENT NUMBERS

pH Meter ____________ EC Meter ________ Turbidity Meter ________ Thermometer __________

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

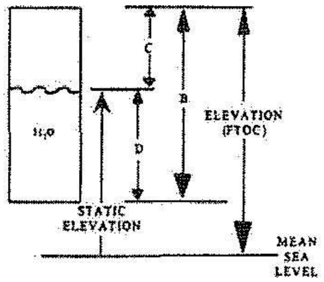
Measured Well Depth B ______________________ ft.

Measured Water Level Depth (C) ______________________ ft.

Length of Static Water Column (D) ________ - ________ = ______
B C

Casing Water Volume (E) ________ x ________ = ______
(A) (D)

Total Purge Volume = __________ gal



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments

Attachment 4

Groundwater Level Measurements

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 4

Subject: GROUNDWATER LEVEL MEASUREMENTS

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes guidelines and procedures for use by field personnel in determining the groundwater level in monitoring wells.

Proper recording procedures are necessary to assure the quality and integrity of all groundwater level measurements. Prior to collecting groundwater levels, a strategy should be developed based on the objectives of the investigation.

The measurement of the ground water level in a well is frequently conducted in conjunction with ground water sampling to determine the "free" water surface. This potentiometric surface measurement can be used to establish ground water flow direction and gradients. Total well depth and ground water level measurements are needed to determine the volume of water in the well casing prior to purging the well for sampling purposes.

All ground water level and total depth measurements should be made relative to an established reference point on the well casing and should be documented in the field records. To be useful for establishing ground water gradient, the reference point should be tied in with the NGVD (National Geodetic Vertical Datum) or a local datum.

When measuring wells for water table or potentiometric surface analysis, and if the contaminant history is known for each of the wells, it is advisable to monitor water levels beginning with the least contaminated wells first and progressing to the most contaminated wells last, where practical.

Documents other than those required by the contract and consulted in the preparation of this SOPP are listed under “Cross Reference.”

The details within this SOPP should be used in conjunction with the Work Plan which will generally provide the following information:

- Data collection objectives;
- Locations for data collection;
- Types of data to be collected; and
- Specific quality control (QC) procedures required.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring field activities are completed to meet the project objectives, are conducted in accordance with the project plans and requirements, and all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring all site personnel are trained in the procedures, the procedures are adhered to, and all activities are documented.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring all team members also perform work in accordance with this procedure.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The Site CQCSM is responsible for ensuring that this procedure is correctly implemented and that data collected meet the requirements of the Project Work Plan.

4.0 DEFINITIONS

Electronic Water Level Indicator. This instrument consists of a spool of dual wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Penlight or 9-volt batteries are normally used as a power source. Measurements should be made and recorded to the nearest 0.01 foot.

5.0 TEXT

5.1 Required Records And Forms

1. Field Activity Daily Log (FADL)
2. Instrument operation manual.

5.2 Required Materials, Equipment, Or Supplies

1. Indelible black-ink pens and markers
2. Personal protective clothing and gear
3. Gloves, nitrile
4. Keys for locking well caps
5. Paper towels
6. Radio, two-way, hand held or cellular phone
7. Safety glasses
8. Appropriate equipment and meters for obtaining field measurements as specified in the Work Plan (i.e., water quality)
9. Linear measuring device (e.g., tape measure)
10. Electronic water indicator (appropriate length)
11. Organic vapor analyzer (FID/PID).

The equipment must be capable of recording a measurement to the accuracy required by the Work Plan. Project data quality objectives and site characteristics must be taken into account when determining the groundwater level measurement equipment to use. The total number of wells to be measured, weather, tidal influences, pumping, and construction can all affect water level measurements.

5.3 General Requirements

Operation manuals provide operation and calibration procedures to be followed. Several standard steps should be taken before beginning any depth measurement of groundwater level measurement activity is performed.

1. Verify that all personnel have read and understood the approved site-specific health and safety plan and have the proper training and certifications required under OSHA.

2. Verify the site location by existing maps and surface features. Mark off the boundaries of the work site with flagging or other means to prohibit access to unauthorized personnel.

3. Check to see that all the necessary equipment (including PPE) is available at the site, is in good working condition, and has been properly decontaminated.

4. Check that all monitoring equipment is properly calibrated and operating. Measuring tapes should be checked a minimum of every six months against a surveyor's tape to determine if shrinking or stretching has occurred.

5. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the well head should be noted on the FADL and the site manager notified for repair or replacement of the equipment.

6. Uncap the well and monitor the air space for organic vapors immediately above the open casing with an FID/PID. (Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the

FADL. If air is observed to be entering or flowing out of the casing, the sounder should not be placed inside the well until the air flow stops and pressure equalizes.

5.4 Specific Requirements

The specific procedure for determining groundwater level using an electronic water level indicator is described below.

1. Lower the electronic water level indicator into the well until the water surface is encountered as indicated by an audible (beep) or visual (light) signal.

2. When the water surface is reached, give the tape a short, sharp jerk to ensure that the probe is not responding to condensation along the well casing.

3. Measure the distance from the water surface to the permanent reference point. For aboveground "stickup" completions, the reference point is usually a groove cut into the north side of the casing. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the FADL and the appropriate form on which the water level is recorded. For flush mount completions, such as street boxes, the groundwater level measurement should be referenced to a steel grate placed across the rim of the street box and over the casing. Any aboveground completions without permanent reference points or marks should be brought to the attention of the appropriate supervisory personnel.

4. Collect measurements until two consecutive measurements are identical or within the specified tolerance (usually 0.01 ft). Record all appropriate information on the FADL. At a minimum, the following information must be recorded:

    - project name and number;
    - unique well identification number;
    - date and time of measurement collection;
    - depth to water to the specified tolerance;
    - weather conditions; and any problems encountered.

5. Once the water level measurement is completed, turn the device in the off position and slowly lower the probe to the bottom of the well to sound the depth. Record the depth to the bottom of the well to the nearest 0.01 feet and document the bottom condition (i.e., soft, silty, hard).

6. Cap and relock the well.

7. Perform all equipment decontamination procedures as specified in the field procedures in Attachment 9 of Appendix D. Measuring **equipment must be decontaminated** prior to utilizing for well measurements.

5.5 Records

All information will be recorded on a FADL for the subject site. The FADL entries will be recorded chronologically and the time of the entry recorded first. All FADL continuation pages will be sequentially numbered and the last page recorded for the day will be signed and dated by the recording technician. Records generated as a result of this SOPP will be controlled and maintained in the project record files.

6.0 EXCEPTION PROVISIONS

None.

7.0 CROSS REFERENCE

Annual Book of ASTM Standards, 1987 *Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)*, D4750.

EPA, 1996, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region 4, Athens, GA.

EPA, 1986, *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Government Printing Office, Washington, D.C.

U.S. Army Corp of Engineers, 1998, *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites,* EM 1110-1-4000.

8.0 TABLES

None

9.0 ATTACHMENTS

None.

Attachment 7

Surface Water Sampling

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 7

Subject: SURFACE-WATER SAMPLING

1.0 PURPOSE AND SUMMARY

The objective of this Standard Operating Project Procedure (SOPP) is to define requirements and methodologies for collecting surface-water samples. The sampler should refer to the work plan and work plan addenda when appropriate for project specific requirements and objectives. Documents other than those required by contract and used in the preparation of this SOPP are listed in the "Cross Reference" section.

Surface water sampling techniques and equipment are designed to minimize effects on the physical and chemical integrity of the sample.

Because data quality objectives (DQO), contaminant types, and surface-water body configurations vary from site to site, a variety of sampling equipment and techniques will be necessary. The procedures described herein define the methods and equipment required to collect surface-water samples in a variety of environments.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITIES

3.1 Site Manager

The Site Manager, or Field Team Leader, is responsible for ensuring field activities are completed to meet the project objectives, are conducted in accordance with the project plans and requirements, and all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring all site personnel are trained in the procedures, the procedures are adhered to, and all activities are documented.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring all team members also perform work in accordance with this procedure.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The Site CQCSM is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of field measurable physical characteristic samples collected meet the requirements of the project.

4.0 DEFINITIONS

Surface water: Water that flows over or rests on the land and is open to the atmosphere; it includes ditches, streams, rivers, lakes, pools, ponds, basins, or any other that fits the definition of surface water.

Grab samples: Discrete aliquots representing a specific location at a given point in time. The sample is collected all at once and at only one particular point in the sample medium. Grab samples are not mixed or composited with other samples.

Composite samples: Nondiscrete samples composed of more than one specific aliquot collected at various locations or at different points in time. Analytical results from this type sample represent an average value for the locations or time periods incorporated into the sample. Composite samples can be collected where investigative goals indicate that is appropriate; otherwise, grab samples should be collected.

5.0 TEXT

5.1 Required Records and Forms

1. Field activity daily log (FADL)
2. Sample collection log (SCL)
3. Sample tags/label and the appropriate forms/documentation for sample shipment
4. Material safety data sheets (MSDS)

5.2 Required Materials, Equipment, and Supplies

The list of potential sampling equipment and supplies needed for collection of surface water samples includes but is not limited to the items listed below. The specific requirements for each sampling project should be identified from the results of the pre-sampling field reconnaissance.

1. Life preservers
2. Polyethylene safety line (floatable)
3. Cellular phone or radio
4. Site maps
5. Pond sampler or extended dipper with 1-liter (L) beaker, clamp, and telescoping heavy duty pole, sample collection vessels- bucket, bailer, beakers- composed of Teflon, glass, stainless steel, or other inert material
5. Weighted bottle sampler, Wheaton bottle, or Kemmerer sampler
6. Peristaltic pump (or equivalent) with tubing and power supply
7. Syringe sampler device
8. Horiba U-10 Water Quality Checker (for measurement of pH, specific conductivity, temperature, and dissolved oxygen), redox meter (for measurement of oxygen reduction potential), or a Horiba U-22 Water Quality Checker (for measurement of pH, specific conductivity, temperature, dissolved oxygen and oxygen reduction potential) and DRT meter (for measurement of turbidity).
9. Sample bottles with preservative
10. Sample coolers with ice or blue ice
11. Sample labels and tape
12. Black pens
13. Permanent marker pens
14. Sample collection logs
15. pH paper
16. Paper towels
17. Plastic trash bags
18. Folding ruler or yardstick
19. 100 m measuring tape
20. Stopwatch
21. Camera and film
22. Wooden stakes

23. Flagging tape
24. Sledge hammer
25. Boat or canoe if needed
26. Waders
27. Mudders

5.3 Procedures

5.3.1 General Considerations

Regardless of the sampling methods or equipment selected, several general procedures are applicable to the collection of all surface-water samples.

1. If surface water is extremely silty or muddy, sampling should be postponed until better conditions prevail.

2 Plan to collect samples first from those areas suspected of being the least contaminated so areas of suspected contamination are collected last, thus minimizing the risk of cross-contamination.

3. If sediment samples are to be collected at the same location as surface water samples, the surface water samples must be collected first. In general, surface water samples should be collected from near the base of the water column, as near to the sediment/surface water interface as possible. The exception would be when sampling to assess a floating layer or sheen.

4. Surface water sampling from flowing bodies should be coordinated so as to reflect base flow conditions, and not during or immediately after a rainfall event.

5. The flow rate in a flowing water body should be measured or estimated.

6. When sampling in flowing water, the sample locations will depend upon the flow conditions and channel geometry relative to location of the suspected release. Stagnant pools should be avoided unless they are adjacent to a suspected discharge point. Samples are to be collected from the active flow tube within the stream. If the channel is linear, the sample should be collected from the same side of the stream as the source or suspected discharge point. When sampling for VOCs, avoid sampling below waterfalls or riffles or in shallow water in direct sunlight, where volatility effects could impact sample integrity.

7. Where possible, take field measurements (pH, temperature, conductivity, etc.) directly from the surface water body (not the sample) in the location from which the sample was collected.

8. Whenever possible, surface-water samples should be collected directly into the sample container. Samples for oil and grease, total petroleum hydrocarbons (TPH), etc., must be collected directly into the sample container. This procedure reduces any loss of volatiles, cross-contamination, or other alteration that could occur during transfer from a collection vessel into the sample container.

9. Samples collected for analysis of volatile organic compounds (VOCs) and some semivolatile organic compounds (SVOCs) must not be composited.

10. For any given stream, sampling should begin with the sampling point located farthest downstream and proceed upstream to prevent cross-contamination of downstream samples by upstream activities. For lakes and ponds, sampling should begin with the sampling point located closest to the discharge point and proceed around the lake or pond in an orderly fashion.

11. If wading is required, one should approach the sample site from downstream, being careful not to disturb any bottom sediment. The mouth of the sample container should be positioned so it faces upstream while the sampling personnel are standing downstream. In water bodies with little or no current, the sampling personnel should not enter the actual sample area. A pond sampler with an extendable handle should be used to reach the sample site.

12. Unless required otherwise, samples should be collected from below the water surface. The sample container should be submerged and then opened underwater to expel air.

13. Sample packaging, handling, and shipping shall be conducted in accordance with Sampling Handling Procedures in Attachment 8.

14. The collection of surface-water samples should be documented on the appropriate FADL and/or a sample collection form.

5.3.2 Preparation

The following steps should be taken when preparing for sampling surface water.

1. Conduct a presampling field reconnaissance to verify the presence of surface water and to assess field conditions. The

field reconnaissance will assist in the selection of appropriate equipment for health and safety and sampling requirements. The sampling locations should be assessed to 1) verify the surface water body is not excessively silty or muddy, and 2) for flowing water bodies, to verify that baseflow conditions prevail.

2. Calibrate field equipment and instruments as required and ensure they are in proper working order.

3. Record on the FADL a description of the site and sampling location. Include description of the water body (size, depth, flow, bottom materials).

4. Put on required protective clothing and gear as specified in the SAP and/or the Health and Safety Plan.

5. Prepare sampling site by laying out plastic sheeting on the ground and on any tables used. Segregate sampling equipment and supplies from the decontamination area.

6. Sampling equipment must be decontaminated prior to, between, and after sample locations in accordance with Attachment 9, Decontamination Procedures.

5.3.3 Shallow Surface-Water Sample Collection

5.3.3.1 Method of Collecting Samples of Near-Shore Surface Water for Volatile Organic Analysis

The following steps must be taken when collecting samples of near-shore surface water for volatile organic analysis (VOA).

1. Slowly dip VOA vial completely beneath the water and fill. Do not disturb bottom sediments. The open end of the vial should be pointed upstream in undisturbed, gently flowing water. The vial should be inverted so that only water from the desired sample point enters when turning the vial upright, expelling air (Otherwise, the sample contains the water that first enters the vial as it enters the water.

2. Be sure to dislodge any air bubbles from the vial before sealing with the cap.

3. If the VOA vial contains a preservative, carefully submerge a portion of the lip of the vial. Slowly fill the container while being careful not to overfill the vial Use

the vial cap to finish filling the vial. Ensure a meniscus is raised above the lip of the vial before capping.

4. Place cap with Teflon septum on each vial as it is filled.

5. Turn the vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. If bubbles are present, remove the cap and refill the vial. If the vial contains a preservative, a new vial will be used.

6. Wipe dry the sample vials and label.

7. Place sample container(s) in zip-top or other plastic bags and immediately place into a sample cooler with ice and cool to 4 ± 2 ° Celsius (°C).

5.3.3.2 Method for Shallow Surface-Water Sample Collection for Nonvolatile Organic and Inorganic Compounds

The following steps must be followed when collecting shallow, surface-water samples for nonvolatile organic and inorganic compounds.

1. Use the appropriate flask, dipper, pail, or pond sampler (if required) to collect samples.

2. Immerse sample container into the water and fill. Do not disturb underlying sediments.

3. When collecting grab samples, the sample containers should be filled directly underwater.

4. If the Work Plan requires the collection of composite samples, collect a sufficient volume of water to fill all sample containers and place pooled samples into a stainless steel or glass mixing bowl. Homogenize the sample by stirring and pour into the appropriate sample containers.

5. Seal sample containers, wipe dry, and label.

6. Place sample container(s) in zip-top plastic bags and immediately place into a sample cooler with ice and cool to 4 ± 2 °C.

5.4 Collection of Samples for Oil and Grease, Total Petroleum Hydrocarbons, etc.

Samples collected for oil and grease, TPH, etc., must be collected directly into the sample containers from the water surface. Never composite samples collected for oil and grease, TPH, etc. These analytes will coat out on automatic samplers.

5.5 Deep Surface-Water Sample Collection

Numerous methods and devices have been used to collect discrete, at-depth samples from surface waters. The most practical methods incorporate the use of either a weighted bottle, Wheaton bottle, Kemmerer bottle, or a peristaltic pump.

The weighted bottle and the Wheaton bottle are very similar. The device is lowered to the desired depth, at which time a mechanism is activated to open the sampler. When the sampler is full, the device is raised to the surface and the contents are transferred to the appropriate sample containers.

The Kemmerer bottle is a messenger-activated water-sampling device. In the open position, water or other sample fluid flows through the device. Once lowered to the desired depth, a weighted messenger is dropped down the sample line, thus tripping the release mechanism and closing the bottle. In the closed position the bottle is sealed, allowing retrieval of the sample.

The peristaltic pump sampling system can be used to obtain surface-water samples at depths up to approximately 26 feet (ft). The peristaltic pump is suitable for most physical, chemical, or radiological parameters. If the flow rate of the pump is reduced to minimize sample agitation, this method may permit VOC sampling for definitive confirmation (if permitted by the appropriate regulatory agencies).

Note: All sampling equipment should be constructed of material that will not compromise the integrity of the sample (e.g., Teflon, stainless steel, or glass).

5.5.1 Method for Specified Depth Collection of Surface-Water Samples Using a Weighted Bottle Sampler

The basic operation of the weighted bottle sampler, the Wheaton bottle, and the Kemmerer bottle are similar; therefore, to avoid repetition, only the procedure for use of the weighted bottle is detailed here. The following steps must be followed when collecting (specified depth) surface water samples using a weighted bottle sampler.

1. Lower the weighted sampler to the specified depth.

2. Remove the stopper by pulling on the sampler line; this will fill the sampler.

3. Release the sampler line to reseat the stopper and retrieve to the surface.

4. Fill the appropriate sample containers. Samples may be composited in stainless steel or Teflon containers if required.

5. Seal each container as it is filled. Check for air bubbles in VOC samples. If bubbles are present, remove the cap and refill the container. If the vial contains a preservative, a new vial will be used.

6. Wipe dry the sample containers and label.

7. Place sample container(s) in zip-top plastic bags and immediately place in a sample cooler with ice and cool to 4 ± 2 °C.

5.5.2 Method for Deep Surface Water Sample Collection by Peristaltic Pump

The following steps must be followed when collecting deep, surface-water samples by peristaltic pump.

1. Install clean, medical-grade silicon or Tygon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.

2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling depth. Attach the intake sampling tube to the intake pump tube.

3. Lower the intake tube to the specified depth.

4. Start the pump and allow at least three volumes of liquid to flow through and rinse the system before actual sampling. Collect the purged liquid and then return it to the source after sample collection is complete.

5. If VOC samples are to be collected, reduce the flow rate of the pump to minimize sample agitation. Disconnect the Teflon tubing from the intake side of the pump. Seal the end of the tubing with the thumb and remove the Teflon tubing from the surface body of water. Slowly fill the VOA bottles from the end of the tubing. For VOC samples, allow a meniscus to form at the top before capping.

6. Fill the appropriate sample containers-for all analyses except VOCs-directly from the discharge line. Allow the liquid to flow

gently down the side of the sample bottle to minimize entry turbulence.

7. Cap and seal sample containers. Wipe dry the sample containers and label

8. Place sample container(s) in zip-top plastic bags and immediately place in a sample cooler with ice and cool to 4° ± 2°C.

9. Drain pump system and properly decontaminate and/or dispose of used materials.

5.5.3 Method for Deep Surface Water Sample Collection by Syringe Sampler (VOC Only)

1. Install clean, medical-grade silicon tubing on the 60 milliliter (ml) sterile medical catheter syringe. Leave sufficient tubing on to allow for sample collection depth with respect to the sample collection personnel (i.e., if a sample is being collected at the bottom of a sink hole that is 6 feet in depth and the sides of the sink hole are 4 feet from the center, then you will need approximately 11 feet of silicon tubing). A pole and cable ties will be needed to attach the syringe sampler in order to collect the sample at the desired location.

2. Attach a disposable polyethylene tubing connector to the silicon tubing. Attach a three foot section of clean disposable teflon tubing. The volume of the tubing will be approximately 90 ml. Attach the other disposable polyethylene tubing connector to the end of the Teflon® tubing in order to retain the sample volume.

3. Lower the syringe sampler intake tube to the specified depth.

4. Draw a vacuum by pulling back the syringe plunger. Collect the surface water drawn into the Teflon tubing and fill the appropriate VOC sample containers from the intake line. Allow the liquid to flow gently down the side of the sample bottle to minimize entry turbulence. Slowly push in the plunger which will slowly fill the VOA bottle from the end of the tubing. Allow a meniscus to form at the top before capping.

5. Return any excess volume to the surface water body after the sample collection is complete.

6. Cap and seal sample containers. Wipe dry the sample containers and label.

7. Place sample container(s) in zip-lock bags and immediately place in a sample cooler with ice and cool to 4 ± 2 °C.

8. If the dedicated materials come in contact with the sampling medium, decontamination or disposal is required to prevent cross-contamination.

5.6 Surface-Water Sample Compositing

Surface water samples can be composited on a spatial or temporal basis.

5.6.1 Surface Water Spatial Compositing

The following steps are to be followed when collecting spatially composited surface-water samples.

1. Determine where composite sample(s) will be obtained as detailed in the Work Plan.

2. Note: VOC and, in some cases, SVOC samples must be collected and contained immediately as discrete samples and, therefore, cannot be composited.

3. Collect a minimum of three equal-volume samples from the specified sample location. The volume of each sample must be at least the amount required for a single sample.

4. Place the samples in a stainless steel bowl and homogenize the pooled samples with a stainless steel spoon or dipper.

5. Transfer aliquots of the composited sample into the appropriate sample containers. Seal, rinse, label sample containers, and immediately place in a cooler with ice and cool to 4 ± 2 °C.

5.6.2 Time Averaged Compositing

Time averaged composite sampling is used to determine mass-per-unit time concentrations and to identify sporadically discharged contaminants from outfalls or streams. The system can be used for basins, ponds, pools, lakes, or streams. Time averaged composite samples can be collected with an automated sampler (i.e. ISCO sampler) or manually. Factor influencing the selection of the time averaged sampling method (automated sampler or manual sample collection) include, but are not limited to considerations such as sampling frequency, location accessibility, security, and budget constraints.

The following steps are to be followed when collecting time-averaged composite surface water samples with an automated sampler:

1. Place the automated sampler with the refrigerated sample-collection jar near the specified sample point. Appropriate

cleanliness applies here as it does for other surface-water sample collection.

2. Set mechanisms on the sampler to collect a selected volume at the desired time frequency (e.g., 250 milliliters of the total discharge at the same time each hour).

3. At the end of the period of sampling specified in the Work Plan, decant the samples, (including VOCs) into the appropriate sample containers.

4. Seal, rinse, label sample containers, and place in a cooler with ice and cool to 4 ± 2 °C. Handle with the same care as other samples from the site.

For each surface water sample collected, the technician will complete a SCL. This form prompts the technician to identify and record information such as: site ID, sample location ID, sample number, collection date and time, sample containers, and associated QC sample information. Other pertinent information to be recorded includes an estimate of flow rate (if applicable), diagram of sampling site, channel configuration, and height of water column. All sampling data and information will be recorded on the FADL for the site sampled. The FADL entries will be recorded chronologically and the time of the entry recorded first. All FADL continuation pages will be sequentially numbered and the last page recorded for the day will be signed and dated by the recording technician.

Records generated as a result of this SOPP will be controlled and maintained in the project record files.

5.7 Marking of Surface-Water Sample Locations

Sampling locations will be marked by a spray painted and labeled wooden stake that will be pounded into the bank deep enough to ensure it will remain during periods of high water or high flow. If the sampling location cannot be staked, the stake should be placed at the bank of the water body and the distance from the sampling location to the stake noted on the FADL or sample collection form.

If the staked location is not easily seen, flagging tape will be used to clearly mark the path to the sampling location. Prior to leaving the site, a sketch of the sampling location will be drawn, depicting all relevant landmarks. Photographs depicting the labeled stake may also be required to document the sample location.

6.0 EXCEPTION PROVISION

1. Surface water samples should not be collected if the area has received a significant amount of rainfall, and surface water bodies do not reflect baseflow conditions.

2. Surface water samples should not be collected if the surface water body is excessively muddy or silty.

3. Peristaltic pumps generally are not capable of collecting samples from depths exceeding 20-25 ft.

7.0 CROSS REFERENCE

Department of Energy, Environmental Survey Manual, DOE/EH-0053,19. Lockheed Martin Energy Systems, Inc., Quality Control Requirements for Field Methods, DOE/HWP-69/R2. , Hazardous Waste Remedial Actions Program, Oak Ridge, Tennessee, 1996.

Martin Marietta Energy Systems, Inc., *Grab Sampling with Kemmerer Bottles,* Environmental Surveillance Procedures, Method No. ESP 3014, 1988.

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U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods,* EPA/540K/P-87/001, 1987/

U.S. Environmental Protection Agency, *Data Quality Objectives Process for Superfund,* EPA/540/G-93/071, 1993.

U.S. Environmental Protection Agency, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, 1996.

8.0 TABLES

None.

9.0 ATTACHMENTS

None.

Attachment 8

Non-Hazardous Sampling Handling, Packaging and Shipping

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 8

Subject: NON-HAZARDOUS SAMPLE HANDLING, PACKAGING AND SHIPPING

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes guidelines and procedures for field personnel to use in the packaging and shipping of environmental samples for chemical and physical analysis.

This SOPP only applies to the packaging and shipping of low concentration environmental samples. This procedure does not apply to those samples considered hazardous materials, hazardous waste, mixed waste, radioactive waste, or dangerous goods. Those requirements are specified in the Department of Transportation (DOT) 49 CFR 171-178 and the most current edition of the International Air Transport Association (IATA) Dangerous Goods Regulations. The details within this SOPP are only applicable to the general requirements for sample packaging and shipping and should only be used as a guide for developing more job-specific work plans.

The details within this SOPP should be used in conjunction with the Work Plan, which will generally provide the following information:

- Sample collection objectives
- Locations and depths of soil samples to be collected
- Numbers and volumes of soil samples to be collected
- Types of analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required

2.0 TABLE OF CONTENTS

7.0 Cross Reference
8.0 Tables
9.0 Attachments

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager: The Site Manager or Field Team Leader, is responsible for ensuring field activities are completed to meet the project objectives, are conducted in accordance with the project plans and requirements, and all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring all site personnel are trained in the procedures, the procedures are adhered to, and all activities are documented.

3.2 Field Team: All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring all team members also perform work in accordance with this procedure.

3.3 Site Contractor Quality Control Systems Manger (CQCSM): The Site CQCSM is responsible for the periodic review of documentation generated during sample handling, packaging, and shipping and the periodic review and audit of field personnel as they perform the work. If problems arise, the site CQCSM is also responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and procedures, variances to requirements, issuing nonconformances).

4.0 DEFINITIONS

Environmental Sample - A low concentration sample that does not meet DOT or IATA definitions for a regulated shipment.

Hazardous Materials/Dangerous Goods Sample - Medium or high concentration sample regulated by either DOT or IATA.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) that would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous waste is defined and regulated by the U.S. Environmental Protection Agency (USEPA).

Hazardous Material/Dangerous Good - A material in a quantity or form which may pose an unreasonable risk to health, safety, and/or property as defined by DOT when transported in commerce. Hazardous materials are defined by DOT (49 CFR 171.8), and dangerous goods are defined by IATA (Section 3).

Sample - Physical evidence collected from a facility or the environment which is representative of conditions at the point and time at which the sample is collected.

U. S. DOT Regulations – Requirements for shipping hazardous materials by highway domestically found at 49 CFR 171-178.

IATA Regulations, current edition – Requirements for shipping dangerous goods by air both domestically and internationally.

5.0 TEXT

5.1 Supplies and Equipment

The following is a list of the supplies and equipment needed to implement this SOPP in the field.

5.1.1 Required Records and Forms

1. Sample Collection Log (SCL)
2. Field Activity Daily Log (FADL)
3. Sample tags/labels and the appropriate forms/documentation for sample shipment
4. Material Safety Data Sheets (MSDS)
5. Site-Specific Field Sampling Plan.
6. CFR 171-178 for ground shipping or the IATA regulations for air shipping.

5.1.2 Materials, Equipment, or Supplies

1. Indelible black-ink pens and markers
2. Plastic or metal coolers (typically provided by the laboratory)
3. Waterproof sealing tape
4. Ice (double bagged)
5. Fiberglass packing tape
6. Nitrile or Latex gloves
7. Plastic Zip-Loc® bags
8. Bubble wrap, styrofoam packing material, vermiculite (or other absorbent)

5.2 Procedures

The following steps must be followed when packaging and shipping <u>non-regulated</u> environmental samples:

1. Properly label (with indelible ink) sample container with the site, unique sample identifier, matrix type, time and date of collection, analytical method, preservatives, and sampling personnel at the time of sample collection. Clear tape should be placed over the label to minimize damage to sample label caused by moisture.

2. As soon as possible after sample collection, tightly seal the container, and place a piece of custody tape over or around the cap. The custody tape should be placed over the cap so that any attempt to remove the cap will cause the tape to be

broken. Do not place custody tape over a volatile organic analysis (VOA) vial septum.

3. Prepare chain-of-custody and request for analyses forms as required by the Quality Control Plan.

4. Place all containers in separate, appropriately sized, airtight, seam sealing polyethylene bags (e.g., Ziploc®). Seal the bag, removing any excess air and wrap with bubble wrap or similar material.

5. Place the bagged container inside an insulating shipping container, such as a common plastic picnic cooler (not styrofoam).

6. Surround the bagged container with absorbent material (e.g., vermiculite).

7. Samples must be packed so they are surrounded and covered by a sufficient volume of ice to maintain a 4 ± 2 degrees Celsius (°C) temperature immediately following collection of the samples in the field and during the entire shipping period. Ice used in the cooler must be contained in two sealed, leak-proof plastic bags to prevent contact of the sample containers with melted ice.

8. Samples labels must be compared to the COC forms to ensure proper documentation. Sample labels must be attached so they will not come loose from sample containers during shipment or if they become wet (the use of clear tape wrapped around the label will prevent this).

9. Place additional packing material (e.g. bubble wrap, vermiculite, or styrofoam) on top of the samples to eliminate the potential for samples to shift during shipment. Cushioning materials may be used to inhibit breakage of sample containers; however, cushioning material must not interfere with maintaining sample cooling.

10. Record the air bill number or other shipping information on the COC.

11. Place the original COC in a resealable bag and tape to inside of top of cooler. A copy of the COC must be retained for the field file.

12. Place custody seals on shipping container. Use custody seals on individual bottles if coolers might be opened during transport (customs, etc.).

13. Seal cooler with strapping tape over the custody seals. Place address label on cooler. Mark the container "THIS END UP," or apply arrow labels that indicate the proper position to be maintained during shipping.

14. If samples are shipped via commercial overnight delivery service, a copy of the shipping bill must be retained in the appropriate files. All pertinent information

must also be recorded on the FADL. If sampling personnel are delivering samples to the laboratory, this should be noted on the COC. In this case, the cooler need not have custody seals during transport.

15. The laboratory should be contacted to confirm safe arrival of all samples. If delivery of samples will occur at the laboratory on weekends or holidays, the laboratory will be notified to have someone available to receive them. Any problems occurring after sample shipment should be recorded on the FADL along with the names of personnel at the laboratory who explained the problem.

16. For packages containing preserved samples or sample containers with preservative inside, shipping details are provided in Section 7.0, "Restrictions/Limitations".

6.0 EXCEPTION PROVISIONS

1. Blue ice or similar products are not allowed for shipping because it/they do not maintain the 4°C standard required for sample shipping, it should only be used while in the field collecting samples.

2. Samples must be packed so they are surrounded and covered by a sufficient volume of ice to maintain a 4 ± 2 °C temperature immediately following collection of the samples in the field and during the entire shipping period. Ice used in the cooler must be contained in sealed, leak-proof plastic bags to prevent contact of the sample containers with melted ice.

3. When shipping packages containing samples preserved with corrosives such as hydrochloric acid, sulfuric acid, and sodium hydroxide, the samples will not meet DOT's definition of Class 8 – Corrosives <u>because of the preservative</u> as long as these limitations are met:

    - hydrochloric acid in water solution at a concentration of 0.04% or less by weight ($pH \geq 1.96$),
    - nitric acid in water solution at a concentration of 0.15% or less by weight ($pH \geq 1.62$),
    - sulfuric acid in water solution at a concentration of 0.35% or less by weight ($pH \geq 1.15$), and
    - sodium hydroxide in water solution at a concentration of 0.08% or less weight ($pH \geq 12.30$).

4. After it has been established that the samples do not meet DOT's definition of Class 8 – Corrosive <u>because of the preservative</u>, it must still be determined if the contaminant of concern causes the sample to meet any of DOT's hazard class definitions. If it does, appropriate identification, classification, packaging, marking, labeling, and documentation must be performed accordingly.

5. When shipping bottles that contain only preservatives, the trained shipper will attempt to meet the small quantity/excepted quantity or limited quantity requirements detailed in the DOT or IATA regulations in order to reduce preparation time, materials costs, handling hazards, and shipping costs. Complete instructions and found in the appropriate sections of the applicable regulations.

6. Per 49 CFR 172 Subpart H, an employee who performs hazardous materials (or dangerous goods) shipping is required to complete General Awareness and Function-Specific Training covering his or her particular shipping responsibilities to be updated at least every three years for domestic shipping or every two years for international shipping.

7.0 RECORDS

All sample packaging and shipment data will be recorded on the book or FADL for the samples shipped. The FADL entries will be recorded chronologically and the time of the entry recorded first. All FADL continuation pages will be sequentially numbered and the last page recorded for the day will be signed and dated by the recording technician.

Records generated as a result of this SOPP will be controlled and maintained in the project record files.

8.0 CROSS REFERENCE

Department of Transportation, *Hazardous Materials Regulations*, 49 CFR Parts 171-180.

EPA, 1996, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region 4, Athens, GA.

HAZWRAP, 1996. *Document No. DOE/HWP-100, Standard Operating Procedure 5C, Packing and Shipping Environmental Samples.*

International Air Transport Association, *Dangerous Goods Regulations*, current edition.

9.0 TABLES

None.

10.0 ATTACHMENTS

None.

Attachment 9

Field Equipment Decontamination

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 9

Subject: FIELD EQUIPMENT DECONTAMINATION

1.0 PURPOSE AND SUMMARY

The objective of this procedure is to describe the proper methods for decontaminating downhole and sampling equipment used to perform field investigations.

Decontamination of field equipment is necessary to ensure that chemical analyses reflect actual concentrations at sampling locations by maintaining the quality of samples and preventing cross-contamination. Furthermore, decontamination reduces the health hazards to field personnel and prevents the spread of contaminants off-site.

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3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring that field activities are completed to meet the project objectives, that they are conducted in accordance with the project plans and requirements, and that all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring that all site personnel are trained in the procedures, that the procedures are adhered to, and that all activities are documented.

3.2 Field Team

All members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring that all team members perform work in accordance with this procedure. The field team members are also responsible for communication of issues with task managers and technical leads, and for documenting change orders and directions.

3.3 Site Contractor Quality Control System Manager

The site CQCSM is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of field equipment decontamination activities meet the requirements of the project Work Plan.

4.0 DEFINITIONS

Decontamination. The process of removing or reducing undesirable physical and chemical constituents, from equipment or materials that come into direct contact with the sample media. Decontamination minimizes the potential for cross-contamination and ensures the representativeness of physical or chemical analyses proposed for a given sample.

Sampling Equipment. Sampling equipment includes split spoons, hand augers, bailers, submersible pumps, bowls, knives, scoops, water samplers, non-disposable filtration equipment, or any equipment that directly contacts samples.

Sample Contacting Equipment. Equipment that comes in direct contact with the sample or portion of the sample that will undergo chemical analyses or physical testing (for example, bailer, split-spoon sampler).

Potable water. Tap water used for drinking purposes by general population.

Deionized water. Deionized, solvent-free water (ASTM Type II or equivalent). Deionized water can be provided by the laboratory.

Detergent. Laboratory grade detergent for washing equipment is recommended such as Liquinox® or Alconox®.

5.0 TEXT

5.1 Required Forms and Documentation

- Field Activity Daily Log (FADL)
- Material safety data sheets (MSDS).

5.2 Required Materials, Equipment, or Supplies

Decontamination procedures for small equipment; downhole and heavy equipment; pumps; and downhole probes are described below separately. Each section also includes the required materials, equipment, and supplies.

5.3 Specific Requirement for Small Sampling Equipment

Before samples are collected, small sample-contacting equipment will be decontaminated appropriately. Small sampling equipment includes split spoons, bailers, knives, mixing bowls, etc. Equipment necessary to complete decontamination procedures includes:

- 5-gallon (gal) or larger plastic buckets or troughs
- Laboratory-grade detergent; Liquinox® recommended
- Three stiff-bristle brushes capable of cleaning the inside and outside of equipment
- Teflon® sprayers or wash bottles, or 2 - to 5 - gallon manual pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes
- Aluminum foil
- Potable water
- Deionized water
- 10 % Nitric acid solution made from reagent grade nitric acid and deionized water (use only on glass, Teflon®, or stainless steel)
- Gloves, goggles, and other protective clothing as specified in the site-specific health and safety plan.

The following decontamination procedures will be followed:

1. Set up a decontamination line on plastic sheeting covering the ground or on a table covered by plastic sheeting or aluminum foil (shiny side away from equipment). At a minimum, clean plastic sheeting must be used to cover the ground beneath decontamination equipment and plastic sheeting or aluminum foil must cover tables or other surfaces where decontaminated equipment is to be placed. The decontamination area should be located away from potential contaminant sources (e.g., construction areas) to reduce or eliminate potential cross-contamination during decontamination. The decontamination area should progress from "dirty" to "clean" and end with an area for drying equipment.

2. The decontamination line should consist of several buckets or troughs in one line. The first bucket will contain a detergent solution. The next two buckets will contain potable water for rinses. A final liberal rinse of deionized laboratory grade water with a bottle sprayer completes the line.

3. Dislodge as much loose dirt as possible from equipment before beginning the decontamination process. Wash the item thoroughly in the bucket or trough of

detergent solution. Use a stiff-bristle brush to dislodge any clinging dirt. Before washing, disassemble any items that might trap contaminants internally.

4. Rinse in second bucket or trough containing potable water. Rinse water shall be replaced as necessary (generally when water is cloudy).

5. Repeat step 3 in the third bucket or trough for a second rinse. A rinse with nitric acid in a spray bottle may be added before this step if sampling for metals.

6. Using a hand sprayer, rinse the item with deionized water over the fourth bucket.

7. If the equipment will have time to fully air dry before its next use, allow to air dry. If the equipment will not be allowed to fully air dry, rinse with deionized water over the last rinse bucket before reassembling or using any equipment.

8. If equipment will not be used immediately after drying, wrap in aluminum foil (shiny side out) for storage and transport.

9. Record decontamination protocol, equipment types, and date on the FADL at each occurrence.

10. After the decontamination activities are complete, collect all contaminated waters, plastic sheeting, aluminum foil, disposable gloves, boots, and clothing. Place contaminated items in properly labeled containers for disposal. Liquids and solids must be drummed separately. Decontamination water can be taken to the on site groundwater treatment system for disposal.

5.4 Specific Requirement for Downhole and Heavy Equipment

Downhole equipment consists of nonsampling tools such as hollow-stem augers, drill pipe, bits, casing, and screen. Drill rigs, backhoes, and other heavy machinery are also included. Equipment necessary to complete decontamination procedures includes:

- Plastic sheeting or steel, prefabricated decontamination pad. See below for decontamination pad construction requirements.
- Metal, wooden, or plastic sawhorses or other stands
- Laboratory-grade detergent, Liquinox® recommended
- Steam cleaner or high pressure hot water washer capable of generating 2,500 pounds per square inch of pressure and producing steam or hot water (200 °F), with soap compartment
- Stiff-bristle brushes
- 2- to 5-gal manual pump sprayer (pump sprayer must be compatible with the solution used)

- Potable water
- Gloves, goggles, boots, and other protective clothing as specified in the site-specific health and safety plan.

Before drilling, sampling, excavating, leaving the site, and in between each location, all drilling equipment used in field sampling activities must be decontaminated. All downhole augering, drilling, and sampling equipment shall be sandblasted (off-site) if it is new, painted, (such as split spoons or auger flights) or exhibits build-up of rust or caked material. Heavy equipment not directly used for sampling will be decontaminated at a designated area designed to contain decontamination wastes and waters. The area designated is located at the on site wastewater treatment plant decontamination pad. If a decontamination pad is needed for site-specific requirements, a temporary pad can be constructed. The following steps must be taken when decontaminating this equipment.

1. Set up a decontamination pad that is large enough (up to the size of the drill rig) to fully contain the equipment to be cleaned. If practical, a centralized decontamination area should be established. This area should be set up to contain contaminated rinse waters and may be constructed using one or more layers of heavy plastic sheeting, 6mm or heavier, with bermed sides, a lined excavated pit, or a bermed concrete or asphalt pad. If possible, the area should be constructed to eliminate or minimize any overspray or wind-blown spray from decontamination activities (e.g., plastic sheeting secured to a wood frame surrounding the area). The decontamination area must be constructed so that fluids can be easily pumped from the area to holding containers.

2. Set up a "clean" area upwind of the decontamination pad to receive cleaned equipment for air drying. At a minimum, clean plastic sheeting must be used to cover surfaces on which decontaminated equipment is to be placed.

3. Don personal protective equipment as specified in the site-specific health and safety plan before beginning cleaning activities.

4. For heavy equipment, areas exposed to contaminated soil should be sprayed using a steam spray unit. Be sure to spray down all surfaces, including the undercarriage. It is also good practice to clean the motor, hydraulic lift, oil fill, and fuel tank area to avoid introducing contamination at the work site.

5. For smaller equipment such as augers, place the objects to be cleaned on metal or plastic-covered wooden sawhorses, supports, or decontamination trays. Using the steam-spray unit, spray the contaminated equipment. Be sure to spray inside corners and gaps especially well; use a brush, if necessary, to dislodge dirt.

6. For steps 4 and 5, aim the sprayer downward as much as possible to avoid spraying outside the decontamination area.

7. If the condition of downhole or heavy equipment warrants using hot soapy water in the steam-spray unit, rinse the equipment with clean, clear potable water following the steam spray. If using steam spray without a detergent the potable water rinse is not necessary.

8. Remove the equipment from the decontamination area to the "clean" area to dry.

9. Record decontamination protocol, equipment types, and date on the FADL.

10. After decontamination procedures are complete, or any time the decontamination fluids fill the bermed or contained area, decontamination fluids will be collected and transferred to appropriate containers. Place all plastic and personal protective equipment into appropriate containers. All containers must be labeled properly for disposal. Liquids and solids must be drummed separately.

5.5 Specific Requirement for Pump and Pump Assemblies

Any pump in which potentially contaminated fluids come into contact with any part of the pump equipment requires decontamination. This requirement does not apply to peristaltic pumps because water does not contact any part of the pump. Only Teflon® or Teflon®-lined tubing should be reused for sampling after decontamination. If using PVC or polyethylene tubing, discard the tubing after each use unless the tubing is used for well development, where properly-decontaminated tubing may be reused. Polyethylene or PVC tubing can not be properly decontaminated and potential for cross-contamination during sampling remains high. This requirement also applies to the tygon tubing attached to the rollers of a peristaltic pump. The tygon tubing shall be discarded after use at a well.

The procedure provided below applies primarily to the decontamination of bladder pumps. A field setup may be implemented while decontaminating pumps other than bladder pumps or if frequent trips to the field office are not practical or cost effective. Equipment needed to complete decontamination procedures include:

- Deionized water
- Plastic sheeting
- Source of electricity (generator or direct line)
- Compressor and controller for bladder pumps
- Three to five decontamination cells (4-inch diameter PVC) for pumps and tubing
- Laboratory-grade detergent, Liquinox® recommended
- Gloves, goggles, boots, and other protective clothing as specified in the site-specific work plan.

Following the use of a pump for development, purging, or sampling, the pump should be decontaminated by the following method.

1. Set up decontamination cells in a line on the plastic. Only three cells are required for normal decontamination.

2. Add potable water with a small amount of detergent to the first container; add potable water alone to the second container. Add deionized water to the third container. There should be sufficient water in each container to accomplish the decontamination procedure.

3. Place one drum close enough to the decontamination area to collect the spent decontamination fluids.

4. Place the pump in the first container and pump enough water through it to equal at least three pump-and-tube-volumes. Pump the water into the waste drum. Move the pump to the second container and repeat. Repeat again with deionized water in the third cell. However, one volume of deionized water is the minimum amount required for this rinse.

5. If necessary, the pump can be disassembled and each part can be decontaminated using several buckets as described in the equipment decontamination method above.

6. Record decontamination protocol, equipment types, and date on the FADL.

7. After decontamination activities are complete, collect all contaminated water; solvents; plastic sheeting; aluminum foil; and disposable gloves, boots, and clothing. Place contaminated items in properly labeled drums for disposal. Liquids and solid wastes must be drummed separately and handled in accordance with the investigation-derived waste procedure. (Liquids will be disposed at the on site wastewater treatment plant.)

5.6 Specific Requirement for Downhole Probes

Decontamination of downhole probes, such as water level indicators, pressure transducers, Trolls®, etc. shall be based on the contamination expected in a well and on professional judgment.

5.6.1 Water Level Indicator

For decontaminating water level indicators during snapshot water level sweeps, follow the steps given below:

1. Carry a detergent solution and deionized water in two separate spray bottles.

2. Spray detergent solution in a piece of paper towel and deionized water in another piece of paper towel.

3. This method involves wiping the water level indicator cable as it is pulled out of a well.

4. Grab the water level indicator cable with the two paper towels in your hands such that the detergent paper towel is below the deionized water paper towel.

5. The cable should be pulled out slowly by a second person and rolled onto the carrying wheel.

6. Once the probe is out of the well, spray it first with the detergent solution and then with deionized water. Wipe with a clean paper towel and store in the carrying case.

Records generated as a result of this written procedure will be controlled and maintained in the project record files.

5.7 Restrictions and Limitations

- Fluids decontamination rinses must be stored separately until disposal is made at the on site wastewater treatment plant.

- All deionized or distilled water must have field-blank samples collected and analyzed at the proper frequency to ensure the purity of the water.

6.0 EXCEPTION PROVISIONS

None.

7.0 REFERENCES

American Society for Testing of Materials (ASTM), 1990, *Standard Practice for Decontamination of Field Equipment Used at Radioactive Waste Sites,* D 5088-90, September.

U.S. Environmental Protection Agency (EPA), 1991, *Handbook of Suggested Practices for the Design and Installation of Around-Water Monitoring Wells*, EPA/600/4-89/034, PB 92-216886, March.

U.S. Environmental Protection Agency (EPA), 1996, *Standard Field Cleaning Procedures, Appendix B, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, USEOA Region 4, May.

8.0 TABLES

None

9.0 ATTACHMENTS

None.

Attachment 10

Investigation Derived Waste

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 10

Subject: INVESTIGATION DERIVED WASTE

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes specific management practices for the handling and subsequent disposition of environmental media generated as a result of investigation actions.

Longhorn Army Ammunition Plant (LHAAP) is conducting investigation activities that generate waste materials. The waste materials typically consist of environmental media (drill cuttings, monitor well purge and development water), and project-related trash (spent PPE and other inert materials such as plastic, rope, tape, paper, etc. that are generated during well installation and sampling activities and associated site activities. When accumulated, the waste materials must be managed appropriately to minimize the exposure to human health and the environment while adhering to applicable regulatory requirements.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITIES

3.1 Site Manager

The Site Manager or Field Team Leader, is responsible for ensuring that field activities are completed to meet the project objectives, that they are conducted in accordance with the project plans and requirements, and that all activities are performed according to the respective procedures. The Site Manager is responsible for ensuring that all site personnel are trained in the procedures, that the procedures are adhered to, and that all activities are documented.

3.2 Field Team

Members of the field team (samplers, technicians, field geologists, engineers, etc.) are responsible for understanding and implementing this field procedure as well as ensuring that all team members also perform work in accordance with this procedure.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The Site CQCSM is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of field measurable physical characteristic samples collected meet the requirements of the project.

4.0 DEFINITIONS

None.

5.0 TEXT

5.1 Required Records and Forms

- Sample Collection Log (SCL)
- Field Activity Daily Log (FADL)
- Sample tags/labels and the appropriate forms/documentation for sample shipment
- Material Safety Data Sheets (MSDS)
- Field Sampling Plan/Work Plan.

5.2 Required Materials, Equipment, or Supplies

- Indelible black ink pens and markers
- Appropriate sample containers
- Insulated cooler and water proof sealing tape
- Nitrile or latex gloves
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Personal protective clothing and gear
- Appropriate equipment and meters for obtaining field measurements (i.e., PID/FID).

5.3 Procedures

5.3.1 Preparation

The following steps must be followed when preparing for management of IDW:

- Verify that all personnel have read and understand the approved site-specific health and safety plan and have the proper training and certifications required under OSHA.
- Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
- Document the sampling events, recording the information on the SCL or equivalent form as specified. Document any and all deviations from standard operating procedures on the FADL and include rationale for changes.

5.3.2 Specific Preparation

The following paragraphs detail the planned methodologies for dealing environmental media once generated during site activities

Initial Handling Requirements

All environmental media will be managed in an effort to minimize exposure to human health and the environment. Typically, the media will be generated as a result of two major activities, drilling soil-test borings and constructing and sampling ground-water monitoring wells. In instances where soil test borings are advanced, either for the sole purpose of retrieving soil samples or to allow for the retrieval of a ground-water sample via a hydropunch or similar sampling device, including obtaining a sample from an open borehole, the following handling protocols for investigation-derived waste (IDW) soil will be used:

- All soil cuttings will be placed adjacent to the borehole on plastic or other suitable material capable of precluding contact with the ground surface.
- All cuttings will be covered daily or during rainfall events to prevent contact with moisture.
- Upon completion of the downhole activity (i.e., drilling, groundwater sampling, etc.), the soil cuttings will be placed back into the borehole from which they were generated.
- Replaced cuttings will be compacted to the extent practical and a 1- by 1-foot by three inches thick grout cap will be placed over the top of the borehole to prevent vertical migration of surface water.

In cases where a soil-test boring is advanced for the purposes of installing a groundwater monitoring well, all environmental media accumulated will be containerized to allow for characterization upon generation and situated at a designated staging area or near the point of generation. As solids are generated, they will first be placed into 55-gallon drums, or other approved containers including roll-off boxes, until they are characterized as hazardous or nonhazardous. Pending further characterization, solids may be bulked into larger approved containers situated within the work area. Liquids may be bulked upon generation unless directed otherwise. All solids and liquids will be separated prior to disposal.

After each container (i.e., drum, roll-off box, etc.) has been filled, the container and lid, if appropriate, will be labeled indicating a description of the media (i.e., soil, purge water, decon water, PPE), origin of media (i.e., sample identification such as boring or well), date the media was placed in the container, site identification (i.e., LHAAP-##), date container was sealed and sampled, and any other pertinent information (i.e., hazardous versus nonhazardous). The containers may be labeled using a paint pen or other indelible marker that will not fade when exposed to weather. A record of the number of containers and their contents will be completed at each generation site and will be included in the logbook before leaving each site.

At the end of each day and/or field activity, all containers will be sealed or covered in such a way to prevent the introduction of rain water or surface run-off.

A centralized staging area will be assigned for each site prior to initiation of any site work. Unless directed otherwise, the staging area will be located within the boundaries of the site where field work will take place. All filled containers generated for a given site will be placed in the central location. The containers will be moved from their original filling location to the staging area within 5 days of filling. In the event that conditions indicate the potential for reactive wastes, special handling and storage precautions will be utilized. The integrity of containers moved to the staging area will be monitored routinely, as required.

Waste may be transported between sites when required or in preparation for disposal activities without specific regulatory concurrence.

5.4 Characterization of Environmental Media

The characterization of environmental media will be determined by a two-step process. First, the materials will be characterized using analytical data obtained during the activity from which the materials were generated previously. As stated, it is anticipated that specific generation activities will include soil-test borings, monitoring well installations, and monitoring well purge and development actions. Water obtained from specific monitor well sampling points (i.e., purge and development water) will be characterized using groundwater sampling data taken from the specific well site from which the water was obtained. Analytical data obtained from a particular borehole reflecting soil contaminant levels will be used to characterize solids generated from that borehole. Other solids such as rock and other environmental media generated during field activities will be characterized for disposal based on the analytical results of the soil and water sampled at the specific location where the solids were generated. Analytical results from both soils and water will be used to characterize decon water. When appropriate, analytical data will be extrapolated to reflect toxicity characteristic leaching procedure (TCLP) values (i.e., 20x divisor rule for soils). Generator's knowledge may be used to evaluate the media potential for corrosivity, ignitability, and reactivity.

If analytical results indicate contaminant levels below 75 percent of TCLP values, no additional analytical testing will be performed and the media will be considered nonhazardous. When analytical results indicate that elevated contaminant levels (i.e., more than 75 percent of TCLP) are present, additional analyses will be performed. In these cases, composite samples will be taken for each type of media generated (i.e., soil, water) and for each specific generation location (i.e., monitoring well, soil boring, etc.). Samples will be taken directly from the containers. Where multiple numbers of containers are generated for a particular media and generation site, the samples will be taken to ensure that the volume of soil from which one composite sample is prepared is equivalent to no more than the volume contained by ten 55-gallon drums. The suite of analyses to be run will be determined based on suspected contaminants and any prior available analytical data. Generator knowledge may be used to minimize the volume of analytical test required to adequately characterize the media. Hazardous versus nonhazardous determinations will be made utilizing those parameters outlined in the Texas Administrative Code. All sampling and analytical testing protocols will be consistent with TCEQ/EPA requirements and methodologies.

5.5 Management and Disposition

Once adequately characterized, the containers will be labeled as described. U.S. Department of Transportation (DOT) approved labels will be used if transportation outside of LHAAP boundaries is required or anticipated. Waste materials may also be bulked on site (within the staging area), with like waste streams possessing compatible nonreacting characteristics. Hazardous and nonhazardous materials will be segregated and all liquids and solids will be separated. Other specific management requirements are as follows:

5.6 Waste Water

In general, all waste water (including decontamination water) generated during the described site activities will be disposed within the confines of LHAAP at the onsite groundwater treatment plant (GWTP). Other specifics are as follows:

5.6.1 Nonhazardous Wastewater

Wastewater determined to be nonhazardous (Section 40 Code of Federal Regulations [CFR] Part 261), but possessing some level of contaminants, will be disposed directly into LHAAP's GWTP.

5.6.2 Hazardous Wastewater

Hazardous wastewater will be transported, when required, and treated at an appropriate treatment facility when the following conditions are met:

1. The treatment facility meets the definition of a waste water treatment unit as defined in the Texas Administrative Code.

2. The treatment facility is capable of (a) rendering characteristically hazardous wastes nonhazardous or (b) removing listed wastes from the contaminated media so that the media no longer contains the listed waste for which the media was originally considered hazardous. If after treatment, analytical tests show the listed waste is not present above laboratory detection limits, then the contaminated media will be considered to no longer contain the listed waste and will no longer be considered hazardous.

Wastewater determined to be hazardous may be transported between sites and within LHAAP boundaries for treatment/disposition in accordance with the previously outlined provisions without specific regulatory concurrence.

In the event that LHAAP does not have a facility on-line capable of treating the hazardous wastewater, the water will be taken to a fully permitted, off-site treatment/disposal facility in accordance with state and federal regulations.

Unless specifically mandated by TCEQ and the EPA, the treatment and disposal of hazardous and nonhazardous wastewater will be performed as previously described. The wastes will be treated and disposed in a timely manner so as to expedite site activities and to ensure the protection of human health and the environment. Except where noted, specific written concurrence from TCEQ and EPA prior to those actions previously described is not required.

5.7 Solids

Solids may include soil cuttings, rock, grout, and other environmental media generated during field activities. All solids will be containerized at or near the point of generation and staged as described in Section 5.3.2. Other specific management practices are as follows:

5.7.1 Nonhazardous Solids

Soil cuttings and rock determined to be nonhazardous will be staged within the confines of the site from which they were generated. After characterizations (hazardous versus nonhazardous) are finalized and depending upon site conditions, nonhazardous cuttings will be removed from containers and replaced "at or near" the location from which they were derived. "At or near" infers a media will be placed as near to its point of origin as is practical. Examples would be placing monitoring well cuttings around the monitoring well from which they originated as opposed to within it. However, when not practical, the media may be centrally located within the confines of the originating site in an area of minimal traffic and where the media could be managed in a manner protective of human health and the environment.

In the event that site conditions are not conducive to the replacement of the materials, soils exhibiting contaminant levels below analytical detection limits are considered non-regulated and will be disposed at the discretion of LHAAP representatives.

5.7.2 Hazardous Solids

For management and disposition purposes, the solids will be broken into two major categories: those exhibiting hazardous characteristics and those containing listed hazardous waste.

Solids exhibiting hazardous characteristics or that contain a listed hazardous waste will be stored upon generation "at or near" the point of generation within the site of origin or bulked in anticipation of disposal activities at a centralized location at LHAAP. Secondary containment will not be required for the storage of hazardous solids as long as the containers are secure and monitored routinely for releases. Unless otherwise directed, the solids will not be subject to 90-day storage requirements.

Whenever practical and depending upon actual site conditions, containerized solids that do not possess hazardous characteristics but do contain listed wastes, will be removed from their storage containers and replaced "at or near" the location from which they were derived. The solids may be replaced anytime after characterization is complete, but most likely at the end of the project phase. Once replaced, the materials will be managed in a manner as to minimize surface erosion. Because of the known presence of contaminants, the solids will be managed in a manner protective of human health and the environment.

The disposition of solids possessing hazardous characteristics will be determined on a case-by-case basis depending on specific contaminants, concentrations, and site conditions. The solids will be returned (i.e., from storage containers) to the site from which they were generated and the remediation of the media, if required, will be addressed, at which time a remedial plan is prepared for other contaminated soil at the site. Prior to this replacement, a request detailing the planned placement procedures with a site sketch indicating the planned placement location will be provided.

In the event that hazardous solids are not allowed to be returned to the site and on site treatment is not available, the media will be disposed off-site in accordance with state and federal requirements in a permitted disposal facility, as required.

5.8 Trash

Trash includes nonhazardous solids such as spent PPE, plastic sheeting, rope and unused monitor well construction materials generated during field activities. These materials will be placed into dumpsters or roll-offs for disposal at a permitted solid waste disposal facility.

6.0 EXCEPTION PROVISION

None.

7.0 CROSS REFERENCES

U.S. Environmental Protection Agency (EPA), 1992a, ***Guide to Management of Investigative-Derived Wastes***, Office Of Solid Waste and Emergency Response, Publication 9345.3-03FS, April 1992.

U.S. Environmental Protection Agency (EPA), 1992b, ***Management of Contaminated Media***, Region IV EPA, Guidance Number TSC-92-02, December 28, 1992.

U.S. Environmental Protection Agency (EPA), 1991, ***Management of Investigative-Derived Wastes During Site Inspections***, Office Of Research and Development, Publication, EPA/540/G-91/009, May 1991.

8.0 TABLES

None.

9.0 ATTACHMENTS

None

Attachment 11

Monitoring Well and Borehole Abandonment

SHAW STANDARD OPERATING PROJECT PROCEDURE

LONGHORN ARMY AMMUNITION PLANT

ATTACHMENT 11

Subject: MONITORING WELL AND BOREHOLE ABANDONMENT

1.0 PURPOSE AND SUMMARY

This Standard Operating Project Procedure (SOPP) establishes guidelines and procedures for field personnel to use in the supervision of borehole or soil boring abandonment and groundwater monitoring well abandonment (destruction) activities. Any exceptions to the requirements are addressed in the section entitled "Exception Provision." Documents other than those required by the contract and consulted in the preparation of this SOPP are listed under "Cross Reference."

The goals of borehole and monitoring well abandonment are to:

- Prevent vertical migration of fluids in the borehole or monitoring well being abandoned;
- Prevent intermixing of waters from different water-bearing zones;
- Eliminate physical hazards (e.g. open boreholes); and
- Preserve aquifer properties.

The exact type of methodology that is used at a site is dependent upon specific regulatory requirements, and may actually be negotiated with the applicable regulatory agencies. Two general types of abandonment are applicable to address the goals and objectives stated above.

- Abandonment of a well in place
- Removing the well and associated materials from the aquifer

Abandoning the well in place basically consists of filling and isolating the screened interval and cementing the casing in place, usually with a cement bentonite grout. The grout is commonly pumped through a tremie pipe inside the well. Abandonment in place can be considered when no cross-contamination can occur between various zones and contamination can not enter from the surface.

Certain conditions may require perforating prior to grouting the well in place. Such conditions include excess sand pack interval (i.e., behind blank casing), and/or intervals of poor cement seal (as determined from a cement bond log run inside the casing). The grouting is then conducted in successive stages across the perforated intervals. Microfine grout facilitates the passage of grout from the well into the surrounding borehole to provide a good seal. In other instances, the regulatory agencies may require in-place abandonment be conducted using pressure grouting techniques.

Removal of the well materials is most commonly performed by overdrilling. Hollow stem auger drilling is most commonly used, but air rotary drilling with a washover casing, and drilling with a tricone bit are other options. The drill string size is selected so that the inside diameter of the drill string is slightly greater than the well casing and screen. Using hollow stem augers as an example, the auger is centered over the casing with the center plug and pilot bit removed, or a small guide plug inserted in the casing. The cement seal, bentonite seal, and sand pack is then drilled out with the augers as they are advanced or washed over the well casing and screen. Once the cement seal, bentonite seal, and sand have been drilled out and circulated to the surface, the well casing and screen are then pulled from the hole. The remaining boring is then usually sealed with a tremied cement grout.

The above methodologies also commonly incorporate the removal of the well head and surface completion materials down to a pre-specified depth. The surface is then sealed and a permanent marker or monument may also be emplaced at the surface.

Any of the above methodologies are effective in rendering the wells inoperable and preventing them from becoming conduits for enhanced vertical transport.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager is responsible for ensuring that all abandonment activities are conducted and documented in accordance with this SOPP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 Field Team

All field team members assigned to borehole and well abandonment activities are responsible for completing their tasks according to specifications outlined in this SOPP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Site Manager or Task Manager.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The CQCSM is responsible for periodic review of field generated documentation associated with this SOPP. The CQCSM is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPPs, variances to the abandonment requirements, issuing nonconformances, etc.) if problems occur.

4.0 DEFINITIONS

Borehole Abandonment - The process whereby boreholes or soil borings are grouted or sealed following completion of drilling, sampling and/or logging.

Bridging - The process where material poured or dropped from the ground surface down a borehole or tremie pipe jams and causes a blockage. This impedes the material from reaching the bottom of the borehole.

Casing splitter - A device attached to the drill string that breaches the well casing allowing communication between the inside of the well and the annular space.

Grout - sealing material that is composed of cement, bentonite, or a cement-bentonite mixture.

Native material - Naturally occurring geologic materials found at the site.

Overdrilling - Drilling where the existing well passes up the inside diameter of the drill string and the material in the annular space is removed from the boring.

Perforation - a breach (slot or hole) created in the well casing to allow communication between the inside of the well and the annular space.

Plugging - The process of placing a material in the well or borehole that has a lower hydraulic conductivity than the surrounding geologic formation.

PVC - Polyvinyl chloride is the material of which monitoring wells are constructed.

Tremie Pipe - a pipe that is inserted into a well or borehole to transport grout or other well materials from the ground surface to a specified depth. The specification of a side-exiting tremie pipe is often made. A side exiting tremie pipe has a fitting on the end that causes the material being pumped through the tremie pipe to exit in a lateral direction.

Well Abandonment - For the purposes of this SOPP "well abandonment" will refer to the abandonment of groundwater monitoring wells only. Well abandonment is the process of formally destroying the well such that it may never be used again.

5.0 TEXT

5.1 Required Records And Forms

1. Field Activity Daily Log (FADL)
2. Site-Specific Field Sampling Plan
3. Well Abandonment Forms (Well Abandonment Procedures Attachment 1)
4. Site Specific Health and Safety Plan
5. Installation-Wide Safety and Health Plan
6. Appropriate Standard Operating Procedures

5.2 Required Materials, Equipment, Or Supplies

1. Indelible black-ink pens and markers
2. Copies of the Well Construction form and/or boring log.
3. Latex or Nitrile gloves
4. Decontamination equipment and supplies
5. Personal protective clothing and gear
6. Drill Rig with appropriate drill rods, bits, and tools
7. Grout Mixing Equipment
8. Grout Pumping Equipment
9. Tremie Pipe equipped with a side-discharging tip
10. Bentonite
11. Portland Cement (ASTM Type I or Type II)

5.3 General Requirements

This section contains responsibilities, procedures and requirements for borehole and well abandonment. Abandonment procedures to be used at a particular site must incorporate project-specific regulatory requirements. Consequently, the Work Plan will identify the following:

- Abandonment objectives
- Boreholes to be abandoned
- Monitoring wells to be abandoned
- Specific procedures for borehole and well abandonment beyond those covered in this SOPP.

- Applicable site-specific regulatory requirements for monitoring well abandonment

5.4 Specific Requirements for Abandonment of Boreholes

Methods of borehole abandonment differ based on the diameter of the boring and the material into which the boring is completed. Soil borings that are of small diameter (e.g., hydropunch) will be backfilled with bentonite pellets; larger diameter soil borings (e.g. auger holes) will be backfilled with the cuttings from that location; and boreholes that extend into rock and are not completed as wells will be grouted to the surface.

5.4.1 Hydropunch Boreholes

1. Upon removal of the direct push rods from the soil, the open borehole will be filled with bentonite pellets. These pellets will be dropped from the surface and allowed to fall by gravity; therefore, care should be taken to assure that the feed rate of the bentonite pellets is sufficiently slow to avoid bridging.

2. The bentonite pellets will be inserted into the borehole until they reach the surface.

3. If the boring is completed into asphalt or cement (e.g. parking lots or sidewalks, or runways) The upper 1 foot of the boring will be completed with a like material. For example, if the boring was advanced through an asphalt parking lot, the upper 1 foot will be completed with asphalt patching material.

5.4.2 Auger Boreholes

1. Upon removal of the augers from the open borehole, the soil cuttings will be used to backfill the borehole. Because the soil is dropped from the surface and allowed to fall by gravity, care should be taken to assure that the feed rate of the soil is slow to avoid bridging.

2. The soil will be shoveled into the borehole until the tamped soil is at the ground surface.

3. If the boring is completed into asphalt or cement (e.g. parking lots or sidewalks, or runways). The upper 1 foot of the boring will be completed with a like material. For example, if the boring was advanced through an asphalt parking lot, the upper 1 foot will be completed with asphalt patching material.

5.4.3 Bedrock Boreholes

1. Using a decontaminated weighted tape, measure the total depth of the borehole.

2. Calculate the volume of the borehole using the formula found in MW and Borehole Abandonment Procedures Attachment 1. This calculation should

be performed on the FADL. This volume will be useful to determine the volume of neat cement needed and should be compared to the volume of cement actually used to document that bridging did not occur.

3. Mix the neat grout to be used for sealing the well. Neat grout is a mixture of Portland American Society for Testing and Materials (ASTM) Type I or II cement, water, and bentonite. Type II cement should be used in applications where the groundwater contains high concentrations of dissolved sulfates. The organic-free bentonite (granular) will be added at a rate of 2 to 5 pounds of bentonite per 94 pound sack of cement to produce a grout that is 2 to 5 % bentonite by weight. This will be mixed with 5 to 7.5 gallons of water to create a pumpable slurry. Refer to the table in Attachment 2 to determine exact grout volumes for differing bentonite/water/cement ratios.

4. Measure the grout weight using a mud balance if available. The weight will be recorded on the FADL.

5. Assemble and insert a decontaminated tremie pipe with a side-discharging tip into the borehole.

6. When the grout is thoroughly mixed begin pumping the grout down the tremie pipe. The tremie pipe should be raised as the borehole fills with grout; however, the tip of the tremie pipe should remain submerged in the top of the grout column.

7. Raise the drill casing as the boring fills with grout. The casing should be slowly extracted during grouting such that the bottom of the casing does not come above the top of the grout column.

8. The rise of the grout column should also be visually monitored or sounded with a weighted tape.

9. In the event that highly cavernous bedrock conditions are encountered and there is significant grout loss, additional measures may be taken. These may include, but are not limited too: addition of bentonite pellets to plug the borehole, use of additives such as calcium chloride to speed up the grout setting time, use of grout baskets or the addition of lost-circulation materials to plug the borehole. All of these procedures may be used to plug the borehole so that it can be grouted according to the procedures listed in steps 1-8.

10. During the grouting process, the drilling hands performing the task should be supervised to assure that potentially contaminating material (oil, grease, or fuels from gloves, pumps, hoses, et. al) does not enter the grout mix and that personnel are properly wearing personal protective equipment as specified in the project Health and Safety Plan.

11. After grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole. Repeat visits as necessary.

12. The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project work plans.

5.5 Specific Requirements for Abandonment (destruction) of Wells

The aquifer properties well materials, well construction type, and status and type of contamination at the site should be considered when selecting a method of well abandonment. In general, two methods of monitoring well abandonment are presented here. The first involves leaving the well materials in the ground and either grouting the casing intact or splitting the casing and grouting with microfine grout under pressure. The second method involves the removal of the casing, and well materials (sandpack, bentonite seal, and annular seal) and grouting the remaining boring to the surface.

5.6 Specific Requirements for Pre-Abandonment Activities

Plans for abandonment presented should be reviewed by the field crew. The procedures for the abandonment within the plan should be consistent with applicable regulatory requirements

Certain information may be required prior to the abandonment activities. This information may include the following:

- The subsurface lithology/soil types in the immediate vicinity of the well, as derived from the boring, soil core and/or borehole geophysical logs compiled from the particular well.

- Knowledge of depth to bedrock, cavities/fractures in bedrock or prior well construction problems.

- The well condition information based upon historical or operations records (including sample collection forms) and previous inspection activities (e.g., tape soundings, video camera logging, borehole geophysical logging, etc.).

- The well construction information, including type and diameter of casing and well screen, and depths, composition and thicknesses of sand packs, bentonite seals and cement seals.

- Past analytical results of groundwater samples collected from the well.

5.7 Specific Requirements for In-Place Well Abandonment

Two general methods of in-place well abandonment (cementing) are discussed in this section. One method leaves the well intact and can be used when the construction details of the well are known and the well is known to have a competent annular seal. The second method of in-place abandonment involves breaching the well casing and pumping microfine grout into the well and into the surrounding formation around the well.

5.7.1 In-Place Abandonment with the Casing Intact

1. Upon initiation of abandonment activities, all downhole sampling (e.g., dedicated purge pumps, sample pumps, etc.) and monitoring equipment must be removed from the well.

2. Obtain a measurement of the total depth of the well and compare to the existing well construction information. Record this information on the well abandonment log and the FADL.

3. If granular material (e.g., sand pack, formation sediment, etc.) is believed present inside the well based upon the sounding, a bailer may be run to bottom to attempt to ascertain the type of debris.

4. The granular well debris should then be removed from the well by bailing, pumping or other appropriate techniques.

5. If the condition of the well casing is suspect or of concern it may be advisable to run a video log of the well, if it has not already been done. However, judgment and caution will need to be exercised to prevent sticking the camera inside the well during the video logging.

6. If significant scaling or encrustation of the well is observed the well should then be brushed, cleaned, and the free material removed by pumping or bailing

7. Calculate the volume of the screened interval, as determined from the construction log, using the formula provided in MW and Borehole Abandonment Procedures **Figure 1** of this SOPP. This calculation should be documented on the FADL.

8. Fill the screened interval with clean silica sand so that sand is two feet above the top of the screen. The sand should be poured slowly to ensure that bridging does not occur.

9. Sound the top of the clean silica sand with a decontaminated weighted tape. Record this measurement on the abandonment form and on the FADL. Sufficient time should be allowed to ensure that all of the sand has settled prior to this final measurement.

10. Add a two-foot-thick bentonite seal above the silica sand. Bentonite pellets are recommended and shall be poured slowly to avoid bridging.

11. Sound the top of the bentonite seal with a decontaminated tape and record this measurement on the abandonment form and the FADL.

12. Allow the bentonite seal to hydrate per the manufacturer's instructions.

13. Mix the neat grout to be used for sealing the well. Neat grout is a mixture of Portland American Society for Testing and Materials (ASTM) Type I or II cement, water, and bentonite. Type II cement should be used in applications where the groundwater contains high concentrations of dissolved sulfates. The organic-free bentonite (granular) will be added at a rate of 2 to 5 pounds of bentonite per 94 pound sack of cement to produce a grout that is 2 to 5 % bentonite by weight. This will be mixed with 5 to 7.5 gallons of water to create a pumpable slurry. Refer to the table in Attachment 2 to determine exact grout volumes for differing bentonite/water/cement ratios.

14. Measure the grout weight using a mud balance. The weight will be recorded on the FADL.

15. Assemble and insert a decontaminated tremie pipe with a side-discharging tip into the borehole.

16. When the grout is thoroughly mixed begin pumping the grout down the tremie pipe. The tremie pipe should be raised as the borehole fills with grout; however, the tip of the tremie pipe should remain submerged in the top of the grout column.

17. The rise of the grout column should also be visually monitored or sounded with a weighted tape.

18. Remove pads, posts and cut off casings to one foot below grade and seal with bentonite or cement grout.

19. After grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole. Repeat visits as necessary

20. The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project work plans.

5.7.2 In-Place Abandonment with Breached Casing

1. Upon initiation of abandonment activities, all downhole sampling (e.g., dedicated purge pumps, sample pumps, etc.) and monitoring equipment must be removed from the well.

2. Obtain a measurement of the total depth of the well and compare to the existing well construction information. Record this information on the well abandonment log and the FADL.

3. If granular material (e.g., sand pack, formation sediment, etc.) is believed present inside the well based upon the sounding, a bailer may be run to bottom to attempt to ascertain the type of debris.

4. The granular well debris should then be removed from the well by bailing, pumping or other appropriate techniques.

5. If the condition of the well casing is suspect or of concern it may be advisable to run a video log of the well, if it has not already been done. However, judgment and caution will need to be exercised to prevent sticking the camera inside the well during the video logging.

6. If significant scaling or encrustation of the well is observed the well should then be brushed, cleaned, and the free material removed by pumping or bailing

7. Calculate the volume of the screened interval, as determined from the construction log, using the formula provided in MW and Borehole Procedure Attachment 1 of this SOPP. This calculation should be performed on the FADL.

8. Fill the screened interval with clean silica sand so that sand is two feet above the top of the screen. The sand should be poured slowly to ensure that bridging does not occur.

9. Sound the top of the clean silica sand with a decontaminated weighted tape. Record this measurement on the abandonment form and on the FADL. Sufficient time should be allowed to ensure that all of the sand has settled prior to this final measurement.

10. Install a two-foot-thick bentonite seal above the silica sand. Bentonite pellets are recommended and shall be poured slowly to avoid bridging.

11. Sound the top of the bentonite seal with a decontaminated tape and record this measurement on the abandonment form and on the FADL.

12. Allow the bentonite seal to hydrate per the manufacturer's instructions.

13. Install the casing splitter into the well riser and advance it to a depth 3 to 5 feet above the top of the bentonite seal. This should result in a well casing that is breached on multiple sides at a point near the bentonite seal.

14. Mix microfine grout composed of Portland Cement and bentonite to create a pumpable slurry.

15. Measure the grout weight using a mud balance. The weight will be recorded on the FADL.

16. Pressure grout the casing until grout is returned at the surface.

17. After grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole. Repeat visits as necessary.

18. The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project work plans.

5.8 Specific Requirements for Abandonment with Well Removal

This section describes basic requirements for monitoring well abandonment by drilling the well out. The drilling technique used depends on the well material. For PVC wells, hollow-stem auger drilling techniques are most commonly employed. For stainless and mild steel casings a washover casing and air-rotary drill rig will be used.

5.8.1 PVC, Teflon, And Other Plastic-Type Casings

1. Upon initiation of abandonment activities, all downhole sampling (e.g., dedicated purge pumps, sample pumps, etc.) and monitoring equipment must be removed from the well.

2. Obtain a measurement of the total depth of the well and compare to the existing well construction information. Record this information on the well abandonment form and on the FADL.

3. If granular material (e.g., sand pack, formation sediment, etc.) is believed present inside the well based upon the sounding, a bailer may be run to bottom to attempt to ascertain the type of debris.

4. The granular well debris should then be removed from the well by bailing, pumping or other appropriate techniques.

5. If significant scaling or encrustation of the well is observed the well should then be brushed, cleaned, and the free material removed by pumping or bailing

6. If the condition of the well casing or screen is suspect (e.g. parting is suspected) a video log may be run inside the well. If parting of the casing or screen is evident, drilling the well out may not be feasible and abandoning the well in-place may need to be considered as a more viable option.

7. Prepare the site for drill rig access so that the rig can be centered over the well. The lead auger is positioned such that it will wash over the well casing during drilling. A small guide plug may then be positioned through the inside of the auger and into the casing.

8. The cement seal and sand pack are then drilled out by advancing the augers and adding auger joints to the drill string. Drilling should be conducted following procedures specified in applicable drilling method SOPPs and regulatory guidance.

9. Advance the borehole to at least the depth equal to the total depth of the boring containing the well. If possible the overdrilling should continue to 0.5 ft beyond the well. The boring should be cleaned by circulating the augers. This will remove the cement, sand pack and cuttings.

10. The well casing is then removed using casing jacks, drill line or other appropriate methods. If the casing is disconnected during removal it is advisable to suspend and hold the casing with slips. Care should be taken to prevent the remaining casing from falling back into the hole.

11. Using a decontaminated weighted tape, measure the total depth of the borehole.

12. Calculate the volume of the borehole using the formula in Attachment 1. This calculation should be performed on the FADL. This volume will be useful to determine the volume of neat cement needed and should be compared to the volume of cement actually used to assure that bridging did not occur. For rough calculation assume that one 94 Lb. sack of cement (when mixed with 5 gallons of water) will fill approximately one cubic foot of space. The addition of 2 to 5 pounds of granular bentonite (2-5% bentonite by weight) and additional water will change the volumes. A table containing water, cement, and bentonite rations and associated volumes is located in Attachment 2.

13. Measure the grout weight using a mud balance. The weight will be recorded on the FADL.

14. Assemble and insert a decontaminated tremie pipe with a side-discharging tip into the borehole.

15. When the grout is thoroughly mixed begin pumping the grout down the tremie pipe. The tremie pipe should be raised as the borehole fills with grout; however, the tip of the tremie pipe should remain submerged in the top of the grout column.

16. The rise of the grout column should also be visually monitored or sounded with a weighted tape until undiluted grout is at the surface

17. After grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole. Repeat visits as necessary.

18. The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project work plans.

19. The final well surface disposition should be completed as stated in the abandonment and/or project work plans.

20. Any problems or unusual conditions observed during the entire abandonment process should be recorded on the FADL. A well abandonment form (Attachment 1) should also be completed for the well during and upon completion of abandonment activities to provide appropriate documentation.

5.8.2 Stainless Steel and Mild Steel Casings

1. Upon initiation of abandonment activities, all downhole sampling (e.g., dedicated purge pumps, sample pumps, etc.) and monitoring equipment must be removed from the well.

2. Obtain a measurement of the total depth of the well and compare to the existing well construction information. Record this information on the well abandonment form and on the FADL.

3. If granular material (e.g., sand pack, formation sediment, etc.) is believed present inside the well based upon the sounding, a bailer may be run to bottom to attempt to ascertain the type of debris.

4. The granular well debris should then be removed from the well by bailing, pumping or other appropriate techniques.

5. If significant scaling or encrustation of the well is observed the well should then be brushed, cleaned, and the free material removed by pumping or bailing

6. If the condition of the well casing or screen is suspect (e.g. parting is suspected) a video log may be run inside the well. If parting of the casing or screen is evident, drilling the well out may not be feasible and abandoning the well in-place may need to be considered as a more viable option.

7. Prepare the site for drill rig access so that the rig can be centered over the well. Center the well casing inside the washover casing.

8. Advance the washover casing over the well casing using an air-rotary drill rig. The washover casing should be advanced to at least the depth equal to the total depth of the boring containing the well.

9. Remove the washover casing from the borehole.

10. The well casing is then removed using casing jacks, drill line, crane or other appropriate methods. If the casing is disconnected during removal it is advisable to suspend and hold the casing with slips. Care should be taken to prevent the remaining casing from falling back into the hole.

11. Using a decontaminated weighted tape, measure the total depth of the borehole.

12. Calculate the volume of the borehole using the formula in MW and Borehole Procedures Attachment 1. This calculation should be performed on the FADL. This volume will be useful to determine the volume of neat cement needed and should be compared to the volume of cement actually used to that bridging did not occur. Assume that one 94 Lb. sack of cement (when mixed with 5 gallons of water) will fill approximately one cubic foot of space. The addition of 2 to 5 pounds of <u>granular</u> bentonite (2-5% bentonite by weight) and additional water will change the volumes. A table containing water, cement, and bentonite rations and associated volumes is located in MW and Borehole Procedures Attachment 2.

13. Measure the grout weight using a mud balance. The weight will be recorded on the FADL.

14. Assemble and insert a decontaminated tremie pipe with a side-discharging tip into the borehole.

15. When the grout is thoroughly mixed begin pumping the grout down the tremie pipe. The tremie pipe should be raised as the borehole fills with grout; however, the tip of the tremie pipe should remain submerged in the top of the grout column.

16. The rise of the grout column should also be visually monitored or sounded with a weighted tape.

17. After grouting, barriers should be placed over grouted boreholes as the grout is likely to settle in time, creating a physical hazard. Grouted boreholes will typically require at least a second visit to "top off" the hole. Repeat visits as necessary.

18. The surface hole condition should match the pre-drilling condition (asphalt, concrete, or smoothed flush with native surface), unless otherwise specified in the project work plans.

19. Any problems or unusual conditions observed during the entire abandonment process should be recorded on the FADL. A well abandonment form (Attachment 1) should also be completed for the well during and upon completion of abandonment activities to provide appropriate documentation.

For each well abandoned, the activities, calculations, locations, and materials used should be recorded on the FADL. A well abandonment form will also be completed. Portions of this form are taken directly from existing boring and construction logs and may be completed prior to arriving at the site. The remaining information is to be competed while on site during the abandonment process. Entries to the FADL, or well abandonment form are should be completed in a timely manner. The general guidelines of documentation will be followed. Records generated as a result of this SOPP will be controlled and maintained in the project record files.

5.9 Records

All information pertinent to the collection of sediment samples should be recorded on the FADLs and/or the Sample Collection Forms. At a minimum, the following information shall be recorded in the FADL and abandonment logs.

- Project name (include site name and Longhorn identification number)
- Date and times of activities
- Well locations
- Level of PPE required
- Weather or other environmental conditions
- Equipment used (include serial numbers of field instruments)
- Any deviation to the approved work plan
- Notation of any visitors to the site

6.0 EXCEPTION PROVISIONS

None.

7.0 CROSS REFERENCE

Texas Administrative Code, Title 16, Part 4, Chapter 76, Rule §76.1004, Technical Requirements – Standards for Capping and Plugging Wells that Penetrate Undesirable Water

or Constituent Zones <http://info.sos.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p...>

American Standard of Testing and Materials (ASTM), *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, ASTM Designation D 5092 - 90, published October 1990, reapproved 1995).

ASTM, (1996) Standard Guide pp. Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, D 5299 - 92.

Driscoll, F. G., 1986, Groundwater and Wells, (second edition, Johnson Division, St. Paul , Minnesota, 1089 pp.

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

U.S. Environmental Protection Agency (EPA), *Manual of Water Well Construction Practices*,
EPA/570/9-754)()1, 1975.

Hazardous Waste Remedial Action Program, 1996, *Standard Operating Procedures For Site Characterization,* DOE/HWP-1OO, September 1996.

U.S. Army Corps of Engineers, Engineering and Design *Monitoring Well Design, Installation, and Documentation, at Hazardous, Toxic, and Radioactive Waste Sites*, EM 1110-1-4000, November,1998.

8.0 TABLES

None

9.0 FIGURES

Figure 1 - Formulas and other Useful Information
Figure 2 - Well Abandonment Forms (1 coversheet plus 2 pages of forms)

Monitoring Well and Borehole Abandonment Procedures
Figure 1

Formulas and Other Useful Information

Formulas and Other Useful Information

Grout Slurry Densities (HAZWRAP, 1996)

Percentage (by weight) Bentonite	Water to Cement Ratio	Minimum Density in Pounds per Gallon	Volume in Ft^3 per Sack of Cement
2	6.0 gal / Sack of Cement	14.7	1.36
3	6.5 gal / Sack of Cement	14.4	1.45
4	7.2 gal / Sack of Cement	14.1	1.55
5	7.8 gal / Sack of Cement	13.8	1.64

Conversions

7.481 Gallons of water in 1 cubic foot (Gallons/7.481) = cubic feet of water
8.345 Pounds per Gallon (Gallons * 8.345) = pounds of *water*

1 SACK OF CEMENT DRY = 0.48 FT^3
1 94 LB SACK OF CEMENT MIXED WITH 5 GALLONS OF WATER = ABOUT 1 FT^3

The formula for calculating the borehole volume is

$$\mathbf{V = [(D^2(()/4](L}$$

Where:
V = Well volume in cubic feet (ft^3)
D = Well diameter in feet (ft)
L = Length of borehole in feet (ft)

Monitoring Well and Borehole Abandonment Procedures
Figure 2

Well Abandonment Forms

Well Abandonment Form

Project:

Well No.

Client:

Project No.

Coordinates:

N E

Date Begun:

Date Completed

Prepared By

Reference Point for Measurements

Well Type: (circle one) Overburden

Bedrock Extraction Temporary

Other__________________

NOTES:

BEFORE ABANDONMENT

WELL CONSTRUCTION SUMMARY (SEE DIAGRAM ON BACK OF FORM)

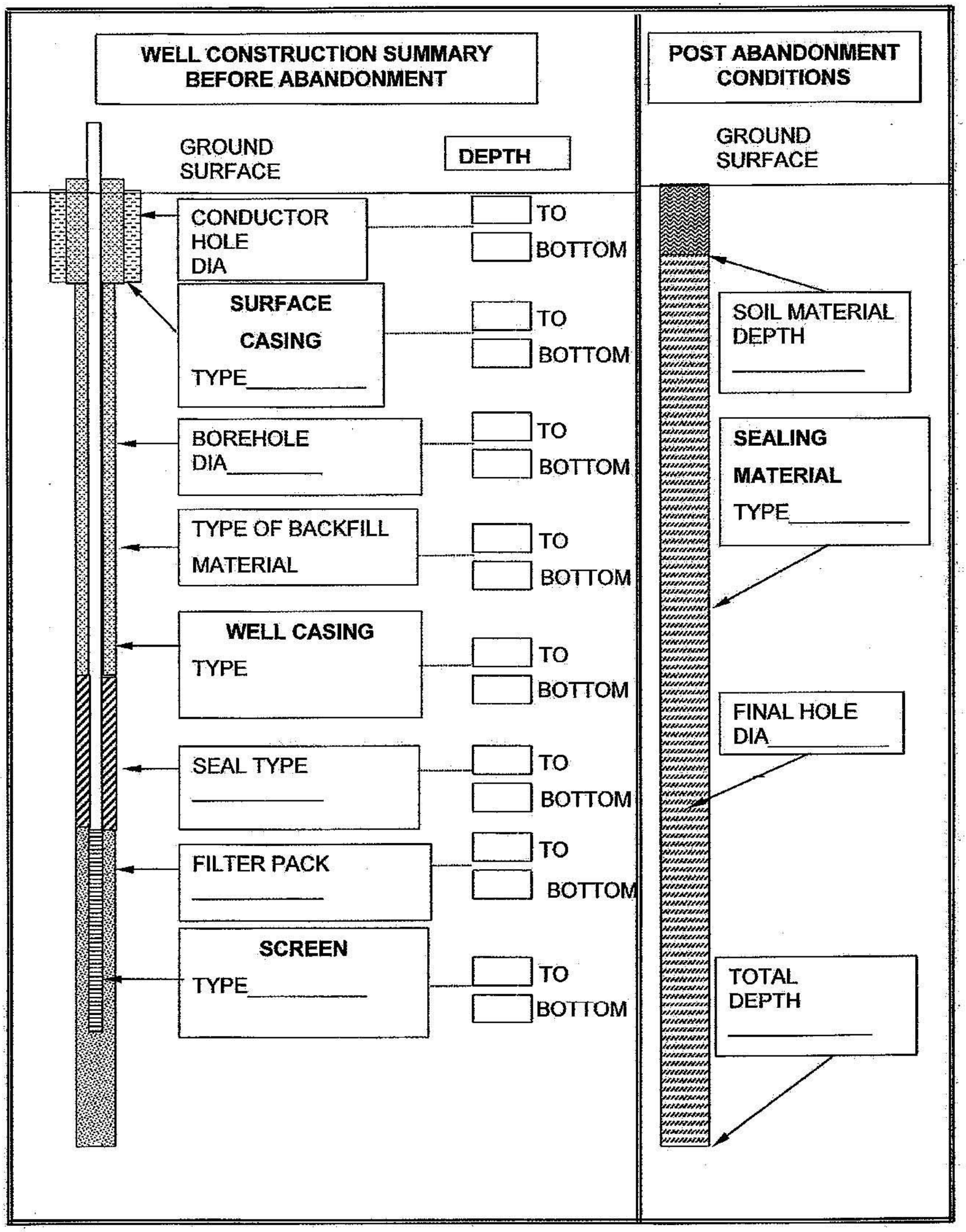
Well No.	Location
TD	Drilled By
Date Completed	Ground EL.
	TOC EL.

AFTER ABANDONMENT

	NO	YES	N/A
Concrete Pad Removed			
Protective Posts Removed			
Surface Casing Removed			
Flush Mount Removed			

(SEE DIAGRAM ON BACK OF FORM)

SITE SKETCH



WELL CONSTRUCTION SUMMARY BEFORE ABANDONMENT

GROUND SURFACE

DEPTH

CONDUCTOR HOLE DIA — ☐ TO ☐ BOTTOM

SURFACE CASING TYPE__________ — ☐ TO ☐ BOTTOM

BOREHOLE DIA________ — ☐ TO ☐ BOTTOM

TYPE OF BACKFILL MATERIAL — ☐ TO ☐ BOTTOM

WELL CASING TYPE — ☐ TO ☐ BOTTOM

SEAL TYPE __________ — ☐ TO ☐ BOTTOM

FILTER PACK __________ — ☐ TO ☐ BOTTOM

SCREEN TYPE__________ — ☐ TO ☐ BOTTOM

POST ABANDONMENT CONDITIONS

GROUND SURFACE

SOIL MATERIAL DEPTH __________

SEALING MATERIAL TYPE__________

FINAL HOLE DIA__________

TOTAL DEPTH __________

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TITLE 16 ECONOMIC REGULATION
PART 4 TEXAS DEPARTMENT OF LICENSING AND REGULATION
CHAPTER 76 WATER WELL DRILLERS AND WATER WELL PUMP INSTALLERS
RULE §76.1004 **Technical Requirements--Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones**

(a) All wells which are required to be plugged or capped under Texas Occupations Code Chapters 1901 and 1902 or this Chapter shall be plugged and capped in accordance with the following specifications:

(1) all removable casing shall be removed from the well;

(2) any existing surface completion shall be removed;

(3) the entire well pressure filled via a tremie pipe with cement from bottom up to the land surface ;

(4) In lieu of the procedure in paragraph (3) of this section, the well shall be pressure filled via a tremie tube with clean bentonite grout of a minimum 9.1 pounds per gallon weight followed by a cement plug extending from land surface to a depth of not less than two (2) feet, or if the well to be plugged has one hundred 100 feet or less of standing water the entire well may be filled with a solid column of 3/8 inch or larger granular sodium bentonite hydrated at frequent intervals while strictly adhering to the manufacturers' recommended rate and method of application. If a bentonite grout is used, the entire well from not less than two (2) feet below land surface may be filled with the bentonite grout. The top two (2) feet above any bentonite grout or granular sodium bentonite shall be filled with cement as an atmospheric barrier.

(5) Undesirable water or constituents shall be isolated from the fresh water zone(s) with cement plugs and the remainder of the wellbore filled with neat cement or clean bentonite grout of a minimum 9.1 weight followed by a cement plug extending from land surface to a depth of not less than two (2) feet.

(b) Large hand dug and bored wells 36-inches or greater in diameter to one hundred (100) feet in depth may be plugged by back filling with compacted clay or caliche to surface. All removable debris shall be removed from the well. If the well contains standing water, it shall be chlorinated by adding chlorine bleach at a rate of one (1) gallon of bleach for every five hundred (500) gallons of standing water. Leave mounded to compensate for settling.

(c) Wells which do not encounter groundwater (dry holes) may be plugged by backfilling with drill cuttings from total depth to within two (2) feet of the surface; where a two (2) feet cement plug shall be poured.

(d) Drillers may petition the Department, in writing, for a variance from the methods stated in subsection (a) of this section. The variance should state in detail, an alternative method proposed and all conditions applicable to the well that would make the alternative method preferable to those methods stated in subsection (a) of this section.

(e) A non-deteriorated well which contains casing in good condition and is beneficial to the landowner can be capped with a covering capable of preventing surface pollutants from entering the well and sustaining weight of at least four hundred (400) pounds and constructed in such a way that the covering cannot be easily removed by hand.

Source Note: The provisions of this §76.1004 adopted to be effective November 8, 2001, 26 TexReg 8814; amended to be effective December 1, 2003, 28 TexReg 10468

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Attachment 13

Monitoring Well Installation Procedures

STANDARD OPERATING PROJECT PROCEDURE
LONGHORN ARMY AMMUNITION PLANT
ATTACHMENT 13
Subject: MONITORING WELL INSTALLATION PROCEDURES

1.0 PURPOSE AND SUMMARY

The purpose of this Standard Operating Project Procedure (SOPP) is to define the requirements for the installation of monitoring wells at Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. The procedures and equipment requirements contained in this SOPP are subject to modification, based upon project specific requirements and site conditions. Drilling conditions at LHAAP can vary significantly from location to location. The procedures in this SOPP have been modified from multiple guidance documents listed in the reference section to reflect the typical field conditions encountered at LHAAP. The procedures are subject to change if unusual or unanticipated field conditions are encountered; however, all deviations must be approved by one of the following: the LHAAP technical lead or the LHAAP project manager before implementation.

The purpose of monitoring well installation is to provide access to groundwater for collecting samples, as well as for obtaining water levels and other data. Monitoring wells are potential contaminant migration routes between aquifers or from the surface to the subsurface. Construction procedures and standards must ensure that neither passive nor active introduction of contaminants can occur. Properly installed hydraulic seals and locking well covers reduce the potential for cross-contamination of monitoring wells.

2.0 TABLE OF CONTENTS

3.0 RESPONSIBILITY MATRIX

3.1 Site Manager

The Site Manager is responsible for ensuring that field personnel are properly trained in monitoring well installation and for verifying that monitoring wells are installed in accordance with this SOPP. Some projects may have site-specific sampling plan attachments (work plan) or a drilling subcontractor Statement of Work (SOW). In general, these documents will take precedence over the SOPP.

3.2 Field (or rig) Geologist

The field geologist is responsible for documenting that the drilling subcontractor complies with the procedures and equipment requirements contained in this SOPP. The field geologist is responsible for recording all information relevant to the construction and materials used in monitoring well installation. All phases of well construction and installation, with the exception of surface completions, require oversight by the field geologist. If a field geologist or other authorized contractor representative is not present for the surface completion activities, the surface completions shall be inspected after installation to document that criteria set forth in this SOPP or other project specific documents such as a SFSP or SOW are met. Any deviations from this SOPP, or the site specific work plan, or the subcontractor's SOW require approval from either the technical lead or project manager. All deviations shall be documented in writing.

3.3 Site Contractor Quality Control Systems Manager (CQCSM)

The Site CQCSM is responsible for ensuring that this procedure is correctly implemented and that data collected meet the requirements of the contract.

4.0 DEFINITIONS

Bentonite. Swelling clay minerals, commonly sodium montmorillinite, that are used as a sealing material and are added to cement to create neat grout. Bentonite is typically found in granular, powdered or pellet forms.

Filter Pack. Sand and gravel that is smooth, uniform, clean well rounded, and siliceous. It is placed in annulus of the wall between the borehole wall and the well screen to prevent formation material from entering the well screen.

PID. Photoionization detector

FID. Flame ionization detector

Tag. Tag is a measurement below ground surface to the top of the item being measured (e.g. tag the top of the sandpack).

Shallow monitoring well. A monitoring wel1 with a monitoring interval (top of filter pack to base of filter pack) instal1ed completely in the shallow zone at LHAAP (base approximately 15-25 feet bgs).

Intermediate monitoring well. A monitoring wel1 with the monitoring interval straddling the intermediate zone at LHAAP (base approximately 30-40 feet bgs).

Deep monitoring well. A monitoring well with the monitoring interval (top of filter pack to base of filter pack) in the deep zone at LHAAP (base approximately 70-90 feet bgs).

5.0 TEXT

5.1 Required Records and Forms

1. HASP
2. Field Activity Daily Logs (FADL)
3. Boring log
4. Well construction form.

5.2 Required Materials, Equipment, or Supplies

5.2.1 Drilling Subcontractor Equipment

Potential equipment for monitoring well installation includes but is not limited to the following:

1. Drilling or augering equipment appropriate to site conditions, drilling depth, and other project requirements.
2. Drill bits appropriate for the expected rock type(s) to be encountered.
3. Sufficient threaded flush-joint riser pipe. Currently, Schedule 40 PVC is the accepted riser material. (Note: No glues are permitted.)
4. Sufficient threaded flush-joint continuous slot Schedule 40 PVC well screen. (Note: No glues are permitted). Prepack screens may be required at some locations. Well screens are typically of the slot size 0.010 (10 slot). The typical length is 10 feet, however, some wells may contain a longer screened interval, depending upon the purpose and location of the monitoring well.
5. Properly sized and washed filter pack material (# 1 quartz sand) in sufficient volume to meet the required well design criteria)
6. Bentonite or polymer-bentonite pellets, chips, or granules.
7. Powdered bentonite.
8. Portland cement [American Society for Testing and Materials (ASTM) Types I or II].
9. Black carbon steel surface casing (if required).
10. Steel protective casing with locking cap or flush mount junction boxes with manhole covers.
11. Tremie pump/box and pipe.
12. Steel or aluminum protective casing with locking cap or flush mounted junction boxes with manhole covers.
13. Grout baskets.
14. Centralizers.
15. Mud balance.
16. Grout mixer and pump (may be combined with tremie equipment).
17. Assorted tools (wrenches, shovels, etc.).
18. Personal protective clothing, as required by the site-specific health and safety plan.
19. Stainless steel weighted tape.
20. Decontamination supplies.

5.2.2 Field Geologist Equipment

- Straight edge or engineering ruler
- Calculator
- Munsell soil color charts
- Water level indicator
- Surveyor's measuring tape with weight for tagging depths of installed well materials

- Required Health and Safety Equipment- PPE, monitoring equipment cell phone or radio

5.3 General Materials Requirement

Monitoring wells that are installed are typically constructed of the materials listed below. This list of materials is subject to modification, based upon project specific requirements and objectives.

Casing (riser) and sump: 4-inch diameter Schedule 40 Polyvinyl Chloride (PVC) with threaded ends Casing length is dependent upon the completion depth of the borehole.

Well screen: 4-inch diameter Schedule 40 PVC continuous wrap screen, with threaded ends. Typical screen length is 10 feet, however the length may vary depending on the specific project objectives.

Surface casing: (For bedrock well installation) 6-inch inside diameter steel casing. The length of surface casing will depend upon depth to bedrock and project specific objectives.

Filter pack: - # 1 sand or equivalent.

Bentonite: 1/8 inch or ¼ inch diameter pellets. Bentonite chips are not acceptable for annular seal material.

Grout: - the grout mixture should consist of Portland cement, powdered bentonite, and potable water in the following proportions: for each 94-pound sack of Portland cement, add 2-5% (approximately 2 to 5 pounds) powdered bentonite, and 6 ½ to 7 gallons of potable water. Certain field conditions, such as highly solutioned or fractured bedrock, may require that accelerants, such as calcium chloride be added to reduce the grout curing time.

Well caps: - expanding well caps.

Locks: - well locks will be installed.

Surface Completion: - either stickup completion with protective steel casing or flush mounted.

5.4 Specific Requirements for Monitoring Well Installation

The typical drilling method for overburden monitoring wells is hollow stem augering. The inside diameter of the augers should be at least 4 inches greater than the outside diameter of the well materials.

5.4.1 Installation of Shallow Monitoring Wells

The typical drilling method for shallow monitoring wells at LHAAP is hollow stem augering. The inside diameter of the augers should be at least 4 inches greater than the outside diameter of the well materials.

1. When the total depth (TD) of the borehole is reached, the borehole should be cleaned out to remove excess drill cuttings. Because the overburden materials are primarily fine-grained silts and clays, care should be taken to prevent sealing of the borehole by excessive raising and lowering of the augers. Installation of the well should begin within 12 hours of reaching TD, except when it is necessary to pull up the augers slightly to determine the static water level prior to setting a well. Record the borehole TD and the depth to water prior to installation of well materials. Verify that the measured TD is desired completion depth. If the hole has partially collapsed or heaved, options for

cleaning, redrilling, or installation in the open section of the borehole should be discussed with the task manager or technical lead.

2. In the event that the well completion depth is desired across an interval depth less than the total depth, the well should be plugged to the base of the desired interval, grout, bentonite pellets, or bentonite chips as specified by the work plan may be added to the bottom of the boring to raise the bottom of the hole to the desired depth. The grout should be pumped through a tremie pipe and fill from the bottom of the boring upward. During grouting, the tremie pipe should be submerged below the top of the grout column in the borehole to prevent free-fall and bridging. Well installation will not commence until the grout has cured, approximately 24 hours. Curing of the grout will be verified by a "hard tag". Generally, an overnight curing period will be sufficient for an adequate cure. If bentonite is used, it should be added gradually to prevent bridging. Grout or bentonite addition will stop when its level has reached approximately one foot below the bottom of the desired string depth. A fine sand layer should be placed immediately above the bentonite/grout plug prior to filter pack placement. The bentonite plug will be hydrated for at least one hour before installation of a filter pack.

3. Verity the cleanliness of the well materials to be installed. If the materials are precleaned, wrapped in polyethylene bags, and documentation of precleaning is confirmed, then decontamination is not necessary. If the wrappings are not intact, and/or precleaning cannot be documented, then the well materials shall be decontaminated in accordance with SOPP 3.0.

4. Determine if the surface completion of the well will be above ground or flush mount to calculate the quantity of well riser required. Assemble the well string (sump, screen, and riser) by screwing together the various sections according to the manufacturer's instructions. No solvents or glues are to be used to assemble the sump, screen, and casing. All well materials shall be handled with clean latex or nitrile gloves or comparable substitutes. The well materials will be installed inside the augers. There should be a minimum of 6 inches and a maximum of 3 feet below the bottom of the well sump and the bottom of the borehole. Centralizers are required for wells with depths exceeding 50 feet bgs. At a minimum, centralizers shall be placed below the well screen, above the top of the bentonite seal, and every 30 to 50 feet thereafter. The field geologist shall record the location of all centralizers on the well construction diagram and the field notes.

5. Carefully lower the well string through the inside of the augers until the well string is at the desired depth. The well string should be suspended by the drill rig and should not rest on the bottom of the boring. In the event that the well string was dropped, lowered abruptly, or for any other reason is suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sand. If this occurs, the driller must not place any drilling equipment, (drill pipe, hammers, etc.) to prevent the well string from rising. The amount of rise should be noted by the rig geologist who should then consult the task manager, technical lead, or project manager for an appropriate course of action. The field geologist shall document the start and finish time for installation of the well string and depths of sump, well screen, and riser.

6. Filter pack may be placed in the well annulus through the augers by gravity if the borehole is less than 50 feet deep. The filter pack should be poured from both sides of the augers to ensure an even distribution of filter pack material in the annulus. In wells

greater than 50 feet or the water in the borehole has abundant silt and clay sized particles, the filter pack will be by the tremie method. The augers will be pulled up as the filter pack is installed for settling below the well and against the borehole walls. The filter pack will extend from the bottom of the borehole to 3 to 5 feet above the top of the screen unless otherwise specified in the drilling plan. The filter pack location shall not cross any confining layers. Periodic tagging of the filter pack during installation is recommended to prevent overfilling of the annulus. The field geologist shall document the quantity of filter pack used and compare the actual volume and calculated volume. Significant discrepancies between actual and calculated filter pack volumes should be explained as well as possible (loss of formation, borehole sloughing, etc.). Surging with a surge block may be used to compact the filter pack around the well screen. A minimum of 15 minutes between completion of the filter pack installation and initiation of the bentonite placement shall be observed to allow for settling of any filter pack through the water column. When installation of the filter pack is complete, both the drilling subcontractor and the field geologist shall tag and record the depth to the top of filter pack. Additional filter pack will be added as necessary until the necessary volume is emplaced. The rig geologist shall document base of filter pack, top of filter pack, and start and finish times for filter pack installation.

7. Bentonite pellets will be placed in the well annulus above the filter pack through the augers by gravity if the borehole is less than 50 feet deep. If the borehole is greater than 50 feet deep, the bentonite pellets should be installed by the tremie method. The bentonite should be added slowly and tamped to prevent bridging. If the augers have been removed completely from the borehole, the bentonite will be emplaced by the tremie method. A bentonite seal placed above the water table will be installed in 6-inch lifts, with each lift being hydrated and allowed to sit 15 minutes before the next lift is installed. A minimum of 3 feet to a maximum of 5 feet of bentonite will be placed in the annular space between the borehole and the well casing. The field geologist shall document the quality of bentonite used, the manufacturer, lot number, and compare the actual volume versus the calculated volume. Potable water shall be added to the borehole to hydrate bentonite emplaced above the water table. If approved by the task manager, technical lead, or project manager, a bentonite slurry, such as Volclay grout, may be used for seals above the water table. The manufacturer's instruction should be consulted to determine the optimal hydration time required. At a minimum, hydration time for the bentonite seal will be 8 hours. The top of the bentonite seal shall be tagged and recorded by the drilling subcontractor and the field geologist after installation and after hydration. Six-inches of fine filter sand maybe placed above the bentonite seal to prevent grout infiltration. The field geologist shall document the base of the bentonite seal, top of the bentonite seal, and start and finish times for bentonite placement.

8. After the bentonite seal has hydrated, the top of the seal should be tagged again to document the amount of swelling after hydration. The post-hydration measurement will be recorded on the well construction diagram as the top of the bentonite seal. The grout mixture will be mixed as specified in Section 5.0 of this SOPP, and pumped through a tremie pipe with a side discharge port from the top of the bentonite seal upward. The side discharge is required to prevent damage to the bentonite seal and/or the filter pack. The bottom of the tremie pipe should be maintained below the top of the grout to prevent free fall and bridging. Grout the well annulus to within 2 to 3 feet of the surface. The field geologist shall document the quantity of grout added to the borehole and compare the actual volume versus the theoretical calculated volume. Significant discrepancies between actual and theoretical volumes should be explained as well as possible. The base of the grout seal, the top of the grout seal, and start and finish times for grouting shall be

documented by the field geologist. After the grout is cured, the top of grout should be measured and recorded again to estimate slumping or loss to the formation.

9. Grout may be required to be placed in lifts (approximately 25 foot/lift) for deeper wells (>75 feet deep) to minimize the head of the grout and prevent compacting of the bentonite seal and filter pack or grout loss in the aquifer.

10. The grout should cure a minimum of 24 hours before starting surface completions. Requirements for above ground and flush mount surface completions are contained in Section 5.4.3.1 and 5.4.3.2 of this SOPP, respectively.

5.4.2 Installation of Intermediate and Deep Monitoring Wells

Drilling the well boreholes for intermediate or deep wells is done in two phases. The boreholes are advanced through the unconsolidated materials by hollow stem augering or by the mud rotary method. A surface casing is grouted in the aquitard or clay zone below the first shallow water boring zone. Surface casing should extend at least 3 feet into the aquitard. To complete the bedrock borehole, the drill string is advanced inside the surface casing by air or mud rotary method or by coring.

1. When the TD of the borehole is reached, the borehole should be cleaned out to remove excess drill cuttings and to condition the hole. Installation of the well should begin within 12 hours of reaching TD. However, it is recommended that well installation begins immediately, or as soon as reasonably possible after the borehole is cleaned out to avoid collapse of unconsolidated materials in the overburden. Record the borehole TD and the depth to water prior to installation of well materials. Verify that the measured TD is the desired completion depth. If the hole has partially collapsed, options for cleaning, redrilling, or installation in the open section of the borehole should be discussed with the technical lead or project manager.

2. In the event that the well completion depth is desired across an interval depth less than the total depth, the well should be plugged to the base of desired interval, grout, bentonite pellets, or bentonite chips may be added to the bottom of the boring to raise the bottom of the hole to the desired depth.

   Well installation will not commence until the grout has cured, approximately 24 hours.

   Grout or bentonite addition will stop when its level has reached approximately one foot below the bottom of the desired well string depth. A fine sand layer should be placed immediately above the bentonite/grout plug prior to filter pack placement.

3. Verify the cleanliness of the well materials. If the materials are precleaned, wrapped in intact polyethylene bags, and documentation of precleaning is confirmed, then decontamination is not necessary. If the wrappings are not intact, and/or precleaning cannot be documented, then the well materials shall be decontaminated in accordance with Attachment 9.

4. Determine if the surface completion of the well will be above ground or flush mount to calculate the quantity of well riser required. Assemble the well string (sump, screen, and riser) by screwing together the sections and tightening according the manufacturer's instructions. No solvents or glues are to be used to assemble the sump, screen, and casing. All well materials shall be handled with clean latex or nitrile gloves or comparable substitutes. There should be a minimum of 6 inches and a maximum of 3 feet

below the bottom of the borehole and the bottom of the well sump. Centralizers for wells with depths exceeding 50 feet bgs. Centralizers shall be placed below the well screen, above the top of the bentonite seal, and every 30 to 50 feet thereafter. The field geologist shall record the location of all centralizers on the well construction diagram and the field notes.

5. Carefully lower the well string until it is at the desired depth. The well string should be suspended by the drill rig and should not rest on the bottom of the boring. In the event that the well string was dropped, lowered abruptly, or for any other reason is suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sand. If this occurs, the driller must not place any drilling equipment, (drill pipe, hammers, etc.) to prevent the wellstring from rising. The amount of rise should be noted by the rig geologist who should then consult the task manager, technical lead, or project manager for an appropriate course of action. The field geologist shall document the start and finish time for installation of the well string, and depths of sump, well screen, and riser.

6. The filter pack will be installed by the tremie method, except where cavities or highly fractured intervals are encountered that preclude the placement of a filter pack. At highly fractured intervals and cavities prepack screens should be used.

   The tremie pipe should be moved around the borehole annulus to ensure an even distribution of the filter pack material in the annulus. The filter pack will extend from the bottom of the borehole to 3 to 5 feet above the top of the screen unless otherwise specified in the drilling plan. The filter pack location shall not cross any confining layers. Periodic tagging of the filter pack during installation is recommended to prevent overfilling of the annulus. The field geologist shall document the quantity of filter pack used and compare the actual volume and calculated volume. Significant discrepancies between actual and calculated filter pack volumes should be explained as well as possible (loss of formation, borehole sloughing, etc.). Surging with a surge block may be used to compact the filter pack around the well screen. A minimum of 15 minutes between completion of the filter pack installation and initiation of the bentonite placement shall be observed to allow for settling of any filter pack through the water column. When installation of the filter pack is complete, both the drilling subcontractor and the field geologist shall tag and record the depth to the top of filter pack. Additional filter pack will be added as necessary until the necessary volume is emplaced. The rig geologist shall document base of filter pack, top of filter pack, and the start and finish times for filter pack installation.

7. Bentonite pellets will be placed in the well annulus above the filter pack by the tremie method. The bentonite should be added slowly and tamped to prevent bridging. A minimum of 3 feet and a maximum of 5 feet of bentonite will be placed in the annular space above the filter pack. If a prepack screen was utilized during well construction, a grout basket will then be used to support the bentonite above the cavernous interval. The field geologist shall document the quantity of bentonite used and compare the actual volume versus the calculated volume. Significant discrepancies between actual and calculated volumes should be explained as well as possible. Potable water shall be added to the borehole to hydrate bentonite emplaced above the water table. If approved by the task manager or technical lead, a bentonite slurry, such as Volclay grout, maybe used for seals above the water table. The manufacturer's instruction should be consulted to determine the optimal hydration time required. At a minimum, hydration time for the

bentonite seal will be 8 hours. The top of the bentonite seal shall be tagged and recorded by the drilling subcontractor and the field geologist after installation and after hydration. The field geologist shall document the base of the bentonite, top of bentonite, and start and finish times for bentonite placement.

8. After the bentonite seal has hydrated, the top of the seal should be tagged again to document the amount of swelling after hydration. The post-hydration measurement will be recorded on the well construction diagram as the top of the bentonite seal.

9. The grout will be mixed as specified in Attachment 11, and pumped through a tremie pipe with a side discharge port and filled from the top of the bentonite seal upward. The side discharge is required to prevent damage to the bentonite seal and/or the filter pack. The bottom of the tremie pipe should be maintained below the top of the grout to prevent free fall and bridging. Other alternative grouting methods may be necessary if karst or highly permeable conditions are encountered (i.e., grout baskets above a cavernous interval). The grout may be required to be placed in lifts of approximately 25 feet for deeper wells (>75 feet deep) and the wells that require a grout basket. The lifts of grout are to prevent compacting of the bentonite seal and filter pack and to lessen the loss of grout into the formation. Grout the well to within 2 to 3 feet of the ground surface. The field geologist shall document the quantity of grout added to the borehole and compare the actual volume versus the calculated volume. Significant discrepancies between the actual and calculated should be explained as well as possible. The base of the grout seal, the top of the grout seal, and start and finish times for grouting shall be documented by the field geologist. After the grout is cured, the top of grout should be measured and recorded again to estimate slumping or loss to the formation.

10. A minimum grout cure time of 24 hours is required prior to above ground and flush mounted surface completion activities.

5.4.3 Surface Completions

The majority of the surface completions for monitoring wells installed are above ground completions, however some monitoring wells are located in high traffic areas and will require flush mount completions. The purpose of the surface completions is to prevent downward migration of surface water or rainfall through the monitoring well annulus.

Any cutting of the PVC riser during surface completion or any other phase of monitoring well installation will be done with a pipe cutter to ensure an even cut and to prevent PVC shavings from entering the well. Hacksaws are not an acceptable alternative to pipe cutters.

5.4.3.1 Above Ground Surface Completions

Above ground surface completions consist of an expanding well cap, concrete pad, protective casing with locking cap and 4 guard posts.

<u>Concrete pad:</u> The concrete pad will be a minimum of a 3-foot square and 4 inches thick. Approximately half of the pad thickness will be below land surface. The pad will be constructed so that it slopes away from the wellhead. If applicable, the freshly poured concrete should be protected from rain by covering with plastic until the concrete is cured. If forms are used, they are to be removed after the concrete has cured.

<u>Protective Casing:</u> The PVC well riser will be surrounded by aluminum (preferred) or steel protective casing with a locking cap. The protective casing will be five feet in length with a diameter a minimum of 4-inches larger than the riser pipe. An internal mortar collar will be

placed within the protective casing and outside the PVC well casing to a height of approximately 6-inches above the ground surface inside the protective casing. The protective casing will be installed to a depth of approximately 2 ½, feet bgs. Two weep holes shall be drilled in the protective casing above the mortar collar for drainage approximately 6 to 8-inches above ground surface. The monitoring well will be stenciled in black on the protective casing. Additionally, a brass plate containing the well number and horizontal and vertical coordinates will be attached to the protective casing with screws. The PVC riser may have to be cut to accommodate the expansion well cap and locked inside the protective casing.

Guard posts: Four 3-inch diameter, 6-foot long steel guard posts will be installed on each corner of the concrete pad. The posts will be installed approximately 4 feet from the well head to approximately 3 feet bgs, and cemented in. The posts will be filled with concrete and painted fluorescent orange with a paintbrush.

5.4.3.2 Flush Mount Well Completion

Flush mount well completions will be necessary at locations where an aboveground well completion would interfere with facility operation. Flush mount completions consist of a an expanding well cap, concrete pad, below ground traffic box or equivalent and an 8 or 12-inch steel, flush mount, bolt down traffic bearing cover.

Concrete pad: The concrete pad will be a minimum of 3-foot square and 4 inches thick. Approximately half of the pad thickness will be below land surface. If the pad is located in a roadway or parking lot, the edge of the pad shall be even with the existing concrete or asphalt surface to prevent vehicle damage. The pad will be constructed so that it slopes away from the wellhead. If applicable, the freshly poured concrete should be protected from rain by covering with plastic until the concrete is cured. If forms are used, they are to be removed after the concrete has cured.

Traffic box and manhole cover: The traffic box should be installed slightly above grade. The concrete pad will be flush with the top of the traffic box and slope to grade to promote surface drainage away from the well. The manhole cover shall be equipped with a gasket to prevent leakage of rainwater or surface water into the traffic box. The PVC riser may have to be cut to accommodate the expansion well cap and lock.

5.5 Special Considerations

- Perched Water. Where present, screen lengths and well construction should be adjusted to insure the monitored interval (including the filter pack) does not span or include both the perched water and water table in the overburden. Conversely, if a perched interval is the desired monitoring objective, wells should be drilled and installed with a short 5-foot screen across the perched zone only, with the base of the well and screen set no deeper than the underlying perched horizon (i.e. does not allow for migration below perched aquifer).

- Light Nonaqueous Phase Liquid (free product) considerations. There LNAPL is expected, screen interval lengths should be adjusted or constructed so as to straddle the water table (free product will not be detectable in a well screened below the water table horizon).

5.6 Records

At a minimum, the field geologist for well installation shall document the following information: The information is to be recorded in the FADL, field form, and well construction diagrams. The start and finish times for each phase of the well installation process shall be recorded. Additional relevant information may be recorded at the field geologist's discretion.

- Total depth of borehole [feet below ground surface (ft bgs)]
- Diameter of borehole (inches)
- Length, diameter, and material of surface casing
- Depth surface casing installed to (ft bgs)
- Location, diameter, and depth of any centralizers.
- Quantity of grout used to cement surface casing (type of grout, number of sacks, sack weight, type and quantity of any additives used- (i.e. used 12 - 50 pound sacks of Lonestar Type I Portland Cement mixed with approximately 25 pounds of Wyo-Ben powdered bentonite)
- Material, length, diameter, and slot size of the well screen
- Installation depth of well screen (ft bgs)
- Length, diameter, and material of casing
- Installation depth of casing (ft bgs)
- Casing stickup (if applicable)
- Quantity of filter pack (include manufacturer's name, sand size, number of sacks used, and sack weight)
- Tagged depth of filter pack (ft bgs)
- Quantity of bentonite used (include manufacturer name, diameter if pellets used, number of buckets, and weight of bucket)
- Tagged depth of bentonite (ft bgs) (Before and after hydration)
- Quantity of grout used to cement well casing (include manufacturer name, # of sack, sack weight, type and quantity of any additives used)
- Tagged depth of grout after installation and after curing (if multiple lifts are performed, record data for each lift)
- Surface completion information.

Any deviations from this SOPP, or the site-specific work plan will require approval from one of the following personnel: the technical lead or the project manager. All deviations shall be documented in writing.

6.0 EXCEPTION PROVISIONS

None.

7.0 CROSS REFERENCE

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Hazardous Waste Remedial Action Program, *Standard Operating Procedures for Site Characterization, DOE/HWP-100,* July 1990.

U.S. Environmental Protection Agency (EPA) (Region 4) *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996.

U.S. Environmental Protection Agency (EPA), *A Compendium of Superfund Field Operations Methods, EPN5401P-87/001, 1987.*

U.S. Environmental Protection Agency (EPA), *Manual of Water Well Construction Practices,* EPA/570/9-75-001, 1975.

American Standard of Testing and Materials, *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers,* ASTM Designation D 5092 - 90, published October 1990, reapproved 1995).

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U.S. Army Corps of Engineers, *Monitoring Well Design, Installation, and Documentation, at Hazardous Toxic, and Radioactive Waste Sites,* EM 1110-1-4000, November 1998.

U.S. Environmental Protection Agency (EPA), *Procedure Manual for Ground Water Monitoring at Solid Waste Disposal Facilities,* SW-611, December 1980.

U.S. Environmental Protection Agency (EPA), *Resource Conservation and Recovery Act (RCRA) Ground-Water Monitoring Technical Enforcement Guidance Document*, EPA/PB87-107751,1986.

8.0 TABLES

None

9.0 ATTACHMENTS

A- Field Facts
B - Well Completion Form
C – Drilling Log

ATTACHMENT A
Field Facts

Volume of Schedule 40 PVC Pipe				
Diameter (inches)	O.D. (inches)	I.D. (inches)	Volume (gal/linear ft.)	Weight of Water (lbs/linear ft.)
1¼	1.660	1.380	0.08	0.64
2	2.375	2.067	0.17	1.45
3	3.500	3.068	0.38	3.20
4	4.500	4.026	0.56	5.51
6	6.625	6.065	1.5	12.5
8	8.625	7.981	2.6	21.65
12	12.750	11.938	5.81	48.44

Hole Diameter	Volume/Linear Ft. of Hole		Nominal Casing Diameter	Volume/Linear Ft. of Annulus		Pounds Sand/ Linear Ft. of Annulus	Pounds ½" Pellets per Linear Ft. of Annulus
	Gal.	Cu. Ft.		Gal.	Cu. Ft.		
7¼"	2.14	0.29	1¼"	2.03	0.27	27	21
7¼"	2.14	0.29	2"	1.91	0.26	26	20
7¾"	2.45	0.33	2"	2.22	0.30	30	23
8¼"	2.78	0.37	2"	2.55	0.34	34	26
10¼"	4.29	0.57	2"	4.05	0.54	54	41
8¼"	2.78	0.37	3"	2.28	0.30	30	23
10¼"	4.29	0.57	3"	3.79	0.51	51	38
12¼"	6.13	0.82	3"	5.62	0.75	75	57
8¼"	2.78	0.37	4"	1.95	0.26	26	20
10¼"	4.29	0.57	4"	3.46	0.46	46	35
12¼"	5.13	0.82	4"	5.30	0.71	71	54
12¼"	6.13	0.82	6"	4.33	0.58	58	44

Miscellaneous Data:

1 Cu. Ft. = 7.5 gal. (approx.)
1 Gallon = 0.134 Cu. Ft. (approx.)
1 Cu. Yd. = 202 gal. (approx.)
1 Gallon = 0.005 Cu. Yd. (approx.)
1 Gallon of Water = 8.34 lbs. (approx.)
1 Cu. Ft. of Fresh Water – 62.4 lbs. (approx.)
PSI = 0.434 x the height of the water column in feet
Feet of Head = PSI x 2.304
1 Barrel = 42 gallons (approx.)
1 Sack of Sand = 1 Cu Ft. and approx. 100 lbs.
1 Sack of Cement = 1 Cu. Ft. and approx. 96 lbs.
1 Pail of Bentonite Pellets = 50 lbs. (approx.)

Shaw

ATTACHMENT B

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: ____________

DRILLING CONTRACTOR: ____________

DRILLING TECHNIQUE: ____________
AUGER SIZE AND TYPE: ____________

BOREHOLE IDENTIFICATION: ____________
BOREHOLE DIAMETER: ____________
WELL IDENTIFICATION: ____________

WELL CONSTRUCTION START DATE: ____________
WELL CONSTRUCTION COMPLETE DATE: ____________

SCREEN MATERIAL: ____________
SCREEN DIAMETER: ____________
STRATUM-SCREENED INTERVAL (FT): ____________

CASING MATERIAL: ____________
CASING DIAMETER: ____________

TYPE OF FILTER PACK: ____________
GRADIATION: ____________
AMOUNT OF FILTER PACK USED: ____________

TYPE OF BENTONITE: ____________
AMOUNT BENTONITE USED: ____________

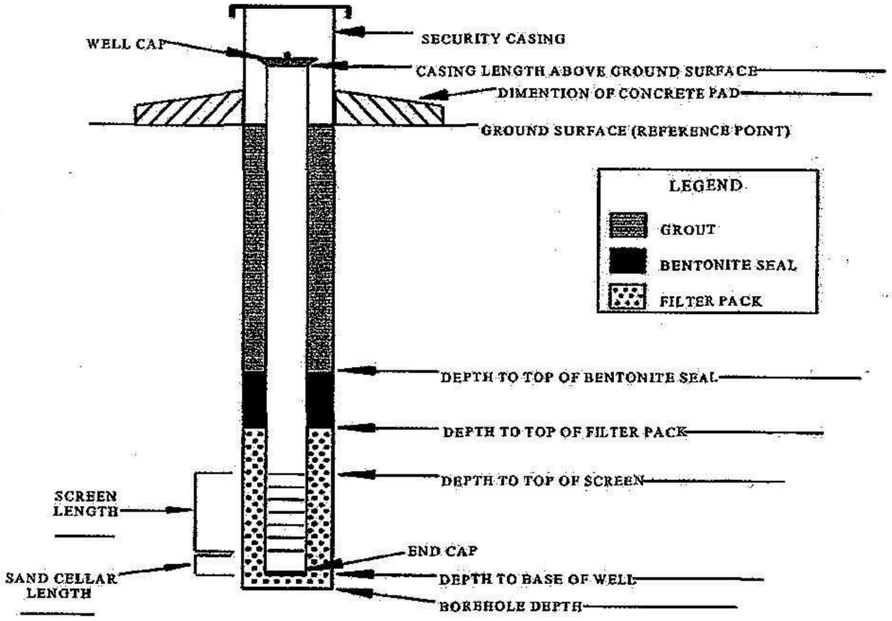
TYPE OF CEMENT: ____________
AMOUNT CEMENT USED: ____________
GROUT MATERIALS USED: ____________

DIMENSIONS OF SECURITY CASING: ____________

TYPE OF WELL CAP: ____________
TYPE OF END CAP: ____________

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: ____________ INSTALLATION OBSERVED BY: ____________

DISCREPANCIES: ____________

Hole No.

DRILLING LOG

DIVISION

INSTALLATION

SHEET OF SHEETS

1. PROJECT

2. LOCATION *(Coordinates or Station)*

3. DRILLING AGENCY

4. HOLE NO. *(As shown on drawing title and title number)*

5. NAME OF DRILLER

6. DIRECTION OF HOLE

☐ VERTICAL ☐ INCLINED ________ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN

8. DEPTH DRILLED INTO ROCK

9. TOTAL DEPTH OF HOLE

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*

12. MANUFACTURERS DESIGNATION OF DRILL

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE | STARTED | COMPLETED

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING

19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS *(Description)* d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth of weathering, etc., if significant)* g

ENG FORM 1836
MAR 71

PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)

PROJECT

HOLE NO.

Appendix E

Health and Safety Plan

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

List of Tables

List of Figures

List of Attachments

Acronyms and Abbreviations

AHA	activity hazard analysis
CFR	Code of Federal Regulations
CGI	combustible gas indicator
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
EMS	emergency medical services
EO	equipment operator
ERCP	Emergency Response and Contingency Plan
eV	electron volts
EZ	exclusion zone
F/B	flash/bang
FM	Factory Mutual
GFCI g	round fault circuit interrupter
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
IP	ionization potential
kV	kilovolt
LEL	lower explosive limit
LEPC	Local Emergency Planning Committee
LHAAP	Longhorn Army Ammunition Plant
LSP	lightning safety position
mm	millimeters
mph	miles per hour
MSDS	material safety data sheets
NIOSH	National Institute for Occupational Safety and Health
NLSI	National Lightning Safety Institute
O_2	oxygen
OSHA	Occupational Safety and Health Administration
PM	Project Manager
PPE	personal protective equipment

Acronyms and Abbreviations (continued)

ppm	parts per million
PSO	Project Safety Officer
PVC	polyvinyl chloride
SZ	support zone
TBD	to be determined
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	trinitrotoluene
TO	task order
UL	Underwriters Laboratories
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
XRF	X-ray fluorescence

1.0 Introduction

This Health and Safety Plan (HASP) defines and establishes the policies and procedures that protect workers and the public from potential hazards posed by planned project activities at the former Longhorn Army Ammunition Plant (LHAAP) Karnack, Texas. The plan incorporates health and safety policies and safe operating procedures for individual project activities. These project activities will comply, at a minimum, with the *Safety and Health Requirements Manual* (EM-385-1-1) (USACE, 2008), which define the minimum health and safety requirements for project site activities under this TO.

Note: This HASP has been designed for the methods presently anticipated for the execution of the proposed work. Each company or contractor is responsible for the safety and health of their personnel, for their actions, and for the work they perform. It is highly recommended that each company or contractor working at LHAAP perform their work under the supervision of their internal health and safety professionals. In addition, as the work is performed, conditions different from those anticipated may be encountered and the HASP may have to be modified.

2.0 Site-Specific Environmental Safety and Health Plan

Project activities will be conducted in a manner that minimizes the probability of injury, accident, or incident occurrence. The contractor employees, subcontractors, and visitors are required to be familiar with the HASP prior to site entry and to sign the Health and Safety Plan Worker Acknowledgment (**Attachment 1**).

The HASP and site activities will be in compliance with the following regulations, contract requirements, and guidelines:

- *Safety and Health Requirements Manual* (EM 385-1-1) (USACE, 2008)
- U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) standards, specifically:

    √ Title 29 Code of Federal Regulations (CFR) 1910 – Safety and Health Regulations for General Industry

    √ Title 29 CFR 1910.1200 – Hazard Communication

    √ Title 29 CFR 1926.59 – Hazard Communication

    √ Title 29 CFR 1926 – Safety and Health Regulations for Construction

- U.S. Environmental Protection Agency (USEPA), 1988, Standard Operating Safety Guidelines
- State-specific safety and health regulations

Although the HASP focuses on the specific work activities planned for this project site, it must remain flexible because of the nature of the work. Conditions may change and unforeseen situations may arise that require deviations from the original plan. This flexibility allows modification by the Project Safety Officer (PSO) who take into account changing site conditions, such as new data on chemical hazards, weather, and changes in scope of work. Changes to the HASP must be approved by the Health and Safety Manager (HSM).

This HASP is based on the scope of work, project work plan, and site-specific information provided in the TO that includes the following:

- Background information on previous site operations
- Location and approximate size of the site

- Site description and site map
- Anticipated contaminants and characteristics
- Applicable federal, state, and local regulations and codes

2.1 Scope of Work

The contractor will perform the following site work tasks to complete the project scope of work. The activity hazard analysis (AHA) for the tasks listed are included as **Attachment 4** to this HASP.

- Mobilization and Site Setup
- Monitoring Well Installation/Development/Abandonment
- Surveying
- Groundwater / Soil Sampling
- Surface Water/Sediment Sampling
- Investigation Derived Waste Management
- Soil Excavation and Disposal
- Field Screening (e.g., X-Ray Fluorescence [XRF])
- Site Restoration and Demobilization

2.2 Site Description

LHAAP is located in central-east Texas, in Harrison County, between State Highway 43 at Karnack, Texas, and Caddo Lake. **Figure 2-1** in the Remedial Design shows the location of LHAAP and surrounding communities. The former installation occupied nearly 8,500 acres. The nearest cities are Marshall, Texas, approximately 14 miles to the southwest, and Shreveport, Louisiana, approximately 40 miles to the east.

The LHAAP was established in 1941 when the Army issued a contract to build a six-line production facility for manufacturing trinitrotoluene (TNT). From 1942 to 1945, the facility produced 414 million pounds of TNT. From 1952 to 1956, the facility produced 3.4 million pyrotechnic devices, photoflash bombs, simulators, hand signals, and 40-millimeter (mm) tracers. During the Vietnam conflict, pyrotechnic and illuminating ammunition was produced. From 1954 to 1980, solid-fuel rocket motors for tactical missiles were produced. During this period, the LHAAP manufactured approximately 50 million pounds of propellant and 200,000 rocket motors. From 1988 to 1991, LHAAP was also used for the static firing and elimination of Pershing I and II rocket motors.

Various media have been contaminated by past industrial operations and waste management practices at LHAAP. LHAAP was placed on the National Priorities List on August 9, 1990. A Federal Facility Agreement among USEPA, the Army, and the Texas Commission on Environmental Quality (TCEQ) (formerly Texas Natural Resource Conservation Commission), became effective December 30, 1991.

3.0 Key Personnel and Management

The HSM and the PSO are responsible for formulating and enforcing health and safety requirements, and for implementing this HASP. The following summarizes the health and safety responsibilities of the site management.

3.1 Project Safety Management Responsibilities

The PM has the overall responsibility for the project and assures that the requirements of the contract are attained in a manner consistent with the HASP requirements. The PM will coordinate with the PSO to assure that the work is completed in a manner consistent with the HASP. The PSO is responsible for field implementation of the HASP. The PSO will be the main contact in any on-site emergency situation. The PSO is authorized to administer this HASP. The PSO is authorized to stop work when an imminent health or safety risk exists. The HSM is responsible for reviewing the HASP and determining that the HASP is complete and accurate.

3.2 Equipment Operators

Equipment operators (EOs) will be responsible for the maintenance, inspection, and safe operation of their equipment. EOs are responsible for daily inspection of the equipment and verifying that it is in safe operating condition.

3.3 Employee Safety Responsibility

Each employee is responsible for his own safety as well as the safety of those around him. The employee shall use the equipment provided in a safe and responsible manner as directed by his supervisor.

3.4 Responsible Contractor Health and Safety Personnel

The following contractor personnel will be responsible for health and safety on site.

- Project Manager
- Project Health and Safety Manager
- Project Safety Officer

4.0 Project Hazard Analysis

This section outlines the potential chemical and physical hazards that workers may be exposed to during work on this project. **Table 4-1** lists primary contaminants known to be present at the LHAAP. A list and material safety data sheets (MSDSs) for chemicals anticipated to be found at LHAAP-35B(37) and LHAAP-67 are included in **Attachment 3** of this HASP.

Table 4-1
Potential Chemical Hazards

Chemical	Exposure Routes	PEL/TLV	Health Hazards/Physical Hazards
Lead	Inhalation, ingestion	0.050 mg/m^3	Weakness, insomnia; loss of appetite, loss of weight, abdominal pain; anemia; tremors; weakness of wrists/ankles; kidney damage; low blood pressure. Incompatible with strong oxidizers, hydrogen peroxide and acids
Mercury	Inhalation, skin contact	0.025 mg/m^3 SKIN alkyl compounds 0.01 mg/m^3	Cough, chest pain, shortness of breath; tremor, insomnia, irritability, headache, weakness, stomach pain, loss of appetite; kidney damage. Reacts with acetylene, ammonia, chlorine dioxide, copper and other metals
Trichloroethene	Skin, eye, inhalation, ingestion	50 ppm	A skin and eye irritant; dermatitis, headache, vertigo, visual distortion, fatigue, nausea, vomiting, irregular heart rhythm. A dangerous fire hazard, reacts with strong caustics and chemically reactive metals, will emit toxic phosgene gas when heated.
Trinitrotoluene	Skin, eye, inhalation, ingestion	0.5 mg/m^3	A skin and eye irritant; headache, weakness, anemia, liver injury, hallucinations, visual distortions, cyanosis. A severe explosion hazard, will explode on heating or strong shock; thermal decomposition will emit NO_X gases and/or detonation.
Methylene Chloride	Skin, eye, inhalation, ingestion	50 ppm	A suspected human carcinogen; headache, narcosis, fatigue, tingling in the limbs, stupor; a strong skin, eye irritant. Can react violently with strong oxidizers, light metals, potassium hydroxide; low combustability, flammable at elevated (>100 C) temperatures; emits toxic gases when burned

Chemical	Exposure Routes	PEL/TLV	Health Hazards/Physical Hazards
Ammonium Perchlorate	Skin, eye, inhalation, ingestion		Can irritate the nose causing coughing and wheezing and can interfere with the ability of the blood to carry oxygen causing headache, fatigue, dizziness, and a blue color to the skin and lips. Is a powerful oxidizer. Stable in pure form, but decomposes at a temperature 150 degrees C or above. It becomes explosive when mixed with finely divided organic materials and can exhibit explosive sensitivity to shock and friction when contaminated with small amounts of some impurities such as sulfur, powdered metals and carbonaceous materials. May explode in fire.

Abbreviations:

CNS	*central nervous system*	*STEL*	*short-term exposure limit*
PEL/TLV	*permissible exposure limit/threshold limit value*	*mg/m^3*	*milligrams per cubic meter*
ppm	*parts per million*	*NO_x*	*nitrogen oxides*

4.1 Chemical Hazards

Chlorinated Solvents

Chlorinated solvents include trichloroethene (TCE), methylene chloride, and other similar compounds. TCE is irritating and toxic to the central nervous system. Inhalation of high concentrations have led to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty. Methylene chloride can cause irritation to the respiratory and gastrointestinal tract. Skin contact can result in irritation, redness, and pain. Chronic exposure can cause headache, mental confusion, depression, liver effects, among other effects. Methylene chloride may cause cancer in humans. Avoid exposure to methylene chloride through engineering controls and wearing personal protective equipment (PPE).

Lead

Exposure to lead can be from inhalation of dusts or from skin exposure. Symptoms are nonspecific and can be hard to distinguish from minor seasonal illnesses. The symptoms are decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, digestive disorders (particularly constipation), abdominal pains, and decreased appetite.

Mercury

Mercury is a naturally occurring element that is found in air, water and soil. It exists in several forms that include elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. Pure mercury is a liquid metal that volatizes readily to become an invisible, odorless toxic vapor.

Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that bioaccumulates in fish, shellfish and animals that eat these fish. At high levels of exposure, methylmercury's harmful effects on these animals include death, reduced reproduction, slower growth and development, and abnormal behavior.

Symptoms of methylmercury poisoning may include:

- impairment of the peripheral vision;
- “pins and needles” feelings, usually in the hands, feet, and around the mouth;
- lack of coordination of movements;
- impairment of speech, hearing, walking; and muscle weakness.

Perchlorate

Perchlorate is both a naturally occurring and man-made chemical. Most of the perchlorate manufactured in the United States is used as the primary ingredient of solid rocket propellant. Wastes from the manufacture and improper disposal of perchlorate-containing chemicals are increasingly being discovered in soil and water. Perchlorate is associated with the disruption of thyroid function, which can potentially lead to thyroid tumor formation. The USEPA, federal, state, and water suppliers are already actively addressing perchlorate in drinking water and surface water.

Residual amounts of these chemicals may be present during soil excavation, well installation and groundwater sampling activities; however, potential for worker exposure to these substances is remote. Airborne dust and particulate at well installation sites will be closely controlled. Real-time air monitoring will be conducted during these activities to monitor potential exposure and action levels established to initiate PPE upgrades. Workers will undergo initial personal monitoring to determine actual exposure levels, and confirm PPE levels.

The following general symptoms may indicate exposure to a hazardous chemical. Personnel will be removed from the work site and provided immediate medical attention if the following symptoms occur:

- Dizziness or stupor
- Nausea, headaches, or cramps
- Irritation of the eyes, nose, or throat
- Euphoria
- Chest pains and coughing
- Rashes or burns

4.2 Hazard Communication

The purpose of hazard communication (employee right-to-know) is to verify that the chemical hazards located at this field project site are communicated according to 29 CFR 1926.59 to all contractor personnel and subcontractors. Hazard communication will include the following elements.

4.2.1 Container Labeling

Contractor personnel will ensure that all drums and containers are labeled according to contents. These drums and containers will include those from manufacturers and those produced on site by operations. All incoming and outgoing labels shall be checked for identity, hazard warning, and name and address of responsible party.

4.2.2 Material Safety Data Sheets

There will be MSDSs located on site for each chemical used on site. Hazardous chemical MSDSs are located in **Attachment 3** of the HASP.

4.2.3 Employee Information and Training

Training employees on chemical hazards should be accomplished through ongoing contractor training programs. Additionally, chemical hazards will communicated to employees through daily safety meetings held at the field project site and by an initial site orientation program.

At a minimum, the contractor and subcontractor employees will be instructed about the following:

- Chemicals and their hazards in the work area
- How to prevent exposure to these hazardous chemicals
- What the company has done to prevent workers' exposure to these chemicals
- Procedures to follow if they are exposed to these chemicals
- How to read and interpret labels and MSDSs for hazardous substances
- Emergency spill procedures
- Proper storage and labeling

Before a new chemical is introduced on-site, each contractor and related subcontractor employee will be given information in the same manner as during the initial site orientation program. The PSO will be responsible for seeing that the MSDS for the new chemical is available for review by on-site personnel. The information pertinent to the chemical hazards will be communicated to project personnel.

Morning safety meetings will be held and the hazardous materials used on site will be discussed. Attendance is mandatory for all on-site employees.

Refer to **Attachment 3** of this HASP for a list of hazardous chemicals anticipated to be found at the site and their MSDS.

4.3 Physical Hazards

To minimize physical hazards, standard safety protocols should be followed. Failure to follow safety protocols will result in removal of an employee from the site and appropriate disciplinary actions.

The PSO will observe the general work practices of each crew member and EO, and enforce safe procedures. Work areas will be inspected by the crew leaders and PSO. Hazards will be corrected in a timely manner. A variety of physical hazards may be encountered during work activities at this site. An AHA Table, **Attachment 4**, has been developed for each principal activity, and will identify the major hazards to which employees may be exposed. Hard hats, safety glasses, and steel toe safety boots are required in all areas of the site. Site-specific hazards and the necessary precautions will be discussed at the daily safety meetings.

Physical hazards include safety and environmental hazards. The following physical hazards may be present during project activities:

- Heat stress
- Cold stress
- Biological hazards (poison ivy, ticks, Lyme disease)
- Manual lifting/back strain
- Noise
- Fire/explosion
- Vehicle traffic

Heat and cold stress prevention procedures will be implemented according to EM 385-1-1 (USACE, 2008). Personal noise exposures will be controlled by a Hearing Conservation Program established by the contractor.

4.3.1 Safety Hazards

Site personnel shall become familiar with the field activities that shall be conducted at the site and trained to work safely under various field conditions. In addition, the PSO shall observe the general work practices of each crew member and EO and enforce safe procedures to minimize safety hazards. The following sections shall be typical safety hazards and the relevant hazard control procedures.

4.3.1.1 Heavy and Bulky Loads

Load size and weight shall be considered before heavy and bulky loads are lifted or handled manually by personnel. Mechanical equipment such as forklifts, wheelbarrows, hand-trucks, loaders, and cranes shall be utilized when possible and needed.

Employees shall make certain the load can be safely handled by considering the size, weight, and shape of the load. No loads over 60 pounds shall be lifted by a single person. Proper lifting techniques shall be utilized: feet shall be shoulder width apart, one foot shall be placed alongside the load, bend at knees, maintain arch in back, keep the load close to the body, lift with the legs not the back.

4.3.1.2 Heavy Equipment Operation and Inspection

Heavy construction EOs present construction safety hazards to operating and ground personnel. Only trained and qualified operators shall be authorized to operate heavy construction equipment.

The operators shall be responsible for performing and documenting daily equipment inspections to identify, take out of service, and correct equipment defects of non-functioning safety devices that would render the equipment unsafe to operate. Standard safety devices and equipment required to be inspected and functional during use includes the following:

- Seat belts
- Safety glass in enclosed cab
- Braking system
- Back-up alarms
- Portable fire extinguisher
- Horn
- Tires
- Steering and hydraulic systems

Operators shall be required to wear seat belts when operating equipment and shall be responsible for the location of ground personnel (i.e., spotters) in their work area.

4.3.1.3 Bulk Fuel Storage

At least one dry chemical, ABC-type fire extinguisher will be positioned in this area.

4.3.1.4 Flame, Heat, or Spark-Producing Operations

Because of the possibility of flammable materials being present at this site, flame, heat, or spark-producing operations shall be limited. If a case arises where hot work is necessary, it shall be performed in accordance with an contractor established hot work procedure.

This procedure requires a hot work permit and shall be inspected by the PSO prior to commencing hot work. Combustible materials shall be removed from the area before the start of hot work. A fire watch shall be posted and the atmosphere shall be tested for combustible gases. A hot work permit shall be completed by the PSO. The permit shall indicate the area, the employees involved, air monitoring results, fire protection systems, and fire department phone number. All flammable materials/fuels shall be stored in safety containers and backflow preventers shall be required for welding/cutting torches.

4.3.1.5 Small Quantity Flammable Liquids

Small quantities of flammable liquids shall be stored in safety cans and properly labeled as to their contents.

4.3.1.6 Electrical Hazards

Overhead power lines, downed electrical wires, and buried cables pose a danger of shock or electrocution if workers contact or sever them during site operations

To help minimize the hazard posed to workers by electrical equipment, low-voltage equipment with ground-fault interrupters and water-tight, corrosion-resistant connecting cables shall be used on site. In addition, lightning is a hazard during outdoor operations, particularly for workers handling metal containers or equipment. To eliminate this hazard, weather conditions shall be monitored and work shall be suspended during electrical storms. An additional electrical hazard involves capacitors that may retain a charge. Such items shall be properly grounded before handling. OSHA’s standard in Title 29, CFR 1910.137 describes clothing and equipment for protection against electrical hazards.

Electrical work shall be performed only by approved electricians. No electrical work should be performed on an energized circuit. Single-phase electrical hand tools must be approved by a recognized testing agency, and all exposed non-current carrying metal parts must be grounded or double insulated. Electrical equipment cannot be used if there are deficiencies in the appliance, cord, or plug.

4.3.1.7 Underground/Overhead Utilities

Intrusive activities are defined as any activity that produces a man-made cut, cavity, trench, or depression into the earth’s surface formed by earth removal or any activity that results in an object placed into the earth below the surface. These activities include excavating, drilling, augering, boring, shoveling, fence post driving, driving stakes, etc. Intrusive activities can be dangerous and can result in severe personal injury or death. Intrusive activities can also cause significant property damage to both utilities/structures and operational equipment. Breaching underground utilities can result in electrocution from damaged electric lines, fires from broken fuel/gas lines, and disruption of telephone service.

Before any intrusive activity at the site begins, positive steps shall be taken to determine if the area contains underground utilities or overhead hazards. It is important to understand that underground utilities have been found in areas that have been properly investigated and thought not to have utilities present. Personnel shall always be alert for marking tape, wires, pipes, previously disturbed soils, crushed stone or sand bedding/backfill, containers, discolored soil, or anything else unusual.

4.3.1.8 Slip/Trip/Fall Hazards

Some areas may have wet surfaces that greatly increase the possibility of inadvertent slips. Caution must be exercised when using steps and stairs.

Use of handrails when climbing stairs shall be enforced, and handrails shall remain secure until the support itself is removed and lowered to ground level. Good housekeeping practices are essential to minimize trip hazards. Full body harnesses shall be used by personnel working 4 feet or more above surfaces, including man lifts.

The work area shall be kept clean and orderly. Tools and debris must be picked up and placed in the proper place to prevent a tripping hazard. Walkways and grating shall be kept in good condition. Spills shall be cleaned up immediately. Personnel shall not walk or climb on piping, valves, fittings, or any other equipment not designed as walking surfaces

4.3.1.9 Ground Personnel

All ground personnel should be constantly aware of the possibility of slips, trips, and falls due to poor and possibly slippery footing in the work areas. Before crossing either in front of or behind a piece of heavy equipment, ground personnel shall signal the EO and receive confirmation before moving.

4.3.1.10 Head and Back Injuries

As minimum requirements, hard hats and safety glasses shall be donned prior to performing site activities. At the daily safety meeting, personnel shall be instructed in proper lifting techniques and reminded not to lift heavy items without assistance.

4.3.1.11 Heavy Equipment and Vehicle Traffic

The use of heavy equipment for excavation presents the greatest potential for injury to personnel. In order to minimize these hazards, designated routes shall be established for mobilization through the facility, and specific traffic patterns shall be established. Trucks and other heavy equipment shall have spotters for backing maneuvers. Those crew members directly involved with spotting for the operator shall be the only personnel allowed in the vicinity of the heavy equipment. Other personnel shall remain a safe distance away from these operations. Personnel who need to approach heavy equipment while in operation shall observe the following protocols:

- Make eye contact with the operator (and spotter)
- Signal the operator to cease heavy equipment activity
- Approach the equipment and inform the operator of intentions

The contractor and subcontractor personnel shall follow traffic rules. Company vehicles shall yield to bikes, pedestrians, and railroad crossings. Vehicles must come to a complete stop at railroad crossings. Vehicles must be operated in a safe and legal manner. Motor vehicles that are defective or not operating properly must be reported immediately. Seat belts must be worn while driving. Personnel shall drive at posted speed limits or at speeds consistent with prevailing road, traffic, or weather conditions.

4.3.2 Heat Stress

With the possible combination of ambient factors such as high air temperature, high relative humidity, low air movement, high radiant heat, and protective clothing, the potential for heat stress is a concern. The potential exists for the following:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

Heat stroke, heat cramps, and heat exhaustion shall be discussed during safety tailgate meetings, which shall be conducted before each workday. Workers shall be encouraged to increase consumption of water and electrolyte-containing beverages such as Gatorade™ during warm weather. Water and electrolyte-containing beverages shall be provided on site and shall be available for consumption during work breaks. Site personnel shall follow the contractor established procedures for heat stress prevention.

4.3.3 Cold Stress

With outdoor work in the winter months, the potential exists for hypothermia and frostbite. Protective clothing greatly reduces the possibility of hypothermia in workers. Personnel shall be instructed to wear warm clothing and to stop work to obtain more clothing if they become too cold. Employees shall also be advised to change into dry clothes if their clothing becomes wet from perspiration or from exposure to precipitation. In cold weather, the potential for frostbite exists, especially in body extremities. Personnel shall be instructed to pay particular attention to hands, feet, and exposed skin when dressing. Personnel shall obtain more clothing if they begin to experience loss of sensation due to cold exposure.

Employees shall be encouraged to use heated shelters on site at regular intervals depending upon the severity of exposure. Symptoms of cold stress, including heavy shivering, excessive fatigue, drowsiness, irritability, or euphoria should be treated with an immediate return to the shelter.

4.3.4 Hearing Conservation Program

On projects where noise levels may exceed a time-weighted average of 85 dBA (decibels, A-scale), hearing protection shall be made available to all exposed employees. Additionally, sound level monitoring shall be conducted on-site. Contractor personnel shall be restricted from high noise exposure without appropriate hearing protection. The contractor Hearing Conservation Program should be in compliance with OSHA regulations found in Title 29 CFR 1910.95.

4.3.5 Excavation Procedures

Any excavation 5 feet deep or greater into which persons will enter and perform work must be shored, sloped, or otherwise made safe for entry. Excavations less than 5 feet in depth and which a competent person examines and determines there to be no potential for cave-in do not require protective systems. Excavations will be done in compliance with OSHA regulation 29 CFR 1926.650.

All excavations shall be performed from a stable ground position. Daily inspections of the excavation shall be made by a competent person, one who has received training in excavation safety. The inspector shall determine the likelihood of a cave-in, and remedial action such as sloping or shoring shall be taken if the walls appear to be unstable. The inspector shall verify that adequate means of egress are in place.

All spoil shall be located at least 2 feet from the edge of the excavation to prevent it from falling back into the excavation and surcharging the excavation face. Perimeter protection will be used for all excavation activities at the site, consisting of warning barricades or fencing placed at a distance not closer than 6 feet from the edge of the excavation, and displays adequate warning at an elevation of 3 feet to 4 feet above ground.

All project personnel shall participate in the site-specific training session and be instructed on the following requirements. Before excavating, the existence and location of underground pipe, electrical equipment, and gas lines will be determined and documented. If the locations of any lines are in question, a cable-avoiding tool will be used to positively locate them.

No ignition sources are permitted if the ambient airborne concentration of flammable vapors exceeds 10 percent of the lower explosive limit (LEL) during the excavation. A combustible gas indicator (CGI) will be used to make this determination.

Operations must be suspended and the area vented if the airborne flammable concentration reaches 10 percent of the LEL in the area of an ignition source (i.e., sparks from bucket of excavator).

Combustible gas readings of the general work area will be made regularly.

If excavating equipment is located in the vicinity of overhead power lines, maintain at least 10 feet from overhead power lines, up to 50 kilovolt (kV). For voltages over 50 kV, add 0.4 inches per kV to obtain the safe distance between equipment and power lines.

Ladders will be provided and placed at an angle not more than 30 degrees from vertical, and secured as necessary. Ladder side rails shall extend at least 3 feet above the ground surface.

Excavations greater than four feet in depth that require personnel to enter shall have sufficient means of entry and egress (stairs, ladders, ramps). Means of entry/egress shall not require personnel to travel laterally more than 25 feet.

Excavations occurring within 3 feet of communication cables will be performed by hand digging until the cable is exposed.

4.3.6 Drilling and Well Installation

All drillers performing work must possess required state or local licenses to perform such work. All members of the drill crew must receive site-specific safety training prior to beginning work. The lead driller is responsible for the safe operation of the drill rig as well as the drill crew's adherence to the requirements of this HASP.

The lead driller must ensure that all safety equipment is in proper condition and is properly used. The members of the crew must follow all instructions for the lead driller, wear all required PPE, and be aware of all hazards and control procedures. The drill crews must participate in the daily tailgate safety meeting and be aware of all emergency procedures.

Rig Inspection. Each day, prior to the start of work, the drill rig and associated equipment must be inspected by the driller and/or drill crew. The following items must be inspected:

- Vehicle/equipment condition
- Proper storage of equipment
- Condition of all wire rope and pulleys
- Location of fire extinguisher and first aid kit.

Rig Set Up. The drill rig must be properly blocked and leveled prior to raising the derrick. The wheels which remain on the ground must be chocked. The rig can only be moved after the derrick has been lowered. The leveling jacks must not be raised until the derrick is lowered.

Site drilling will comply with the following rules:

- Before drilling, the existence and location of underground pipe, electrical equipment, and gas lines will be determined. The Utility Line Protection Law requires that anyone planning borings call the state’s ONE-CALL number at least three, but not more than ten business days prior to conducting drilling activities.
- If drilling is conducted in the vicinity of overhead power lines, maintain at least 10 feet from overhead power lines, up to 50 kV. For voltages over 50 kV, add 0.4 inches per kV to obtain the safe distance between equipment and power lines.
- Restricting work area access from vehicular/pedestrian traffic by utilizing temporary fencing or warning tape will be required.

- If lubrication fittings are not accessible with guards in place, machinery must be stopped before oiling and greasing. Fuel, hydraulic fluid, or oil will not be refilled in the drill rig unless the engine has been turned off.
- All drilling will occur a minimum of 3 feet from any known or suspected location of an underground structure or utility. A hand auger or posthole digger must be utilized to advance through the first 5 feet of the subsurface.
- Rigging equipment for material handling must be checked prior to use on each shift and as often as necessary to ensure it is safe. Defective rigging must be removed from service immediately.
- Drillers will not add or remove pipe from the drill stem without the assistance of the driller's helper.
- Lifting and transporting of drums should be completed using the appropriate equipment and following safe loading and unloading procedures.

Hoisting Operations

- Drillers must never engage the rotary clutch without watching the rotary table and ensuring it is clear of personnel and equipment.
- Unless the drawworks is equipped with an automatic feed control, the brake must not be left unattended without first being tied down.
- Casing or pipe must not be picked up suddenly.
- Drill pipe must not be hoisted until the driller is sure that the pipe is latched and the drilling assistant has signaled that he/she may safely hoist the load.
- During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller will be on the rig floor and no one will be on the rig or derrick.
- The brakes on the drawworks of every drilling rig must be tested by each driller at the beginning of each shift to determine whether they are in good order. The brakes must be thoroughly inspected by a competent individual each week.
- A hoisting line with a load imposed will not be permitted to be in direct contact with any derrick member or stationary equipment unless it has been specifically designed for line contact.
- Hoisting control stations must be kept clean and controls labeled as to their functions.

Riding Hoisting Equipment. Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will be the cat line be used as a personnel carrier.

Cat Line Operations

- Only experienced workers will be allowed to operate the cathead controls. The kill switch must be clearly labeled and operational prior to operation of the cat line.
- The cathead area must be kept free of obstruction and entanglements.
- The operator will not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.

- Personnel must not stand near, step over, or go under a cable or cat line which is under tension.
- Employees rigging loads on cat lines must:
- Keep out from under the load
- Keep fingers and feet where they will not be crushed
- Be sure to signal clearly when the load is being picked
- Make sure that the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

Pipe Handling

- Pipe must be loaded and unloaded, layer by layer, with the bottom layer pinned or blocked securely on all four corners. Each successive layer must be effectively blocked or chocked.
- Workers will not be permitted to top off the load during loading, unloading, or transferring or pipe or rolling stock.
- Employees must be instructed never to try to stop rolling pipe or casing; they must be instructed to stand clear of rolling pipe.
- When pipe is being hoisted, personnel will not stand where the bottom end of the pipe could whip and strike them

4.3.7 Confined Space Entry

A confined space is defined as a space large enough and so configured that an employee can bodily enter and perform assigned work, has limited means for entry or exit, and is not designed for continuous employee occupancy. Contaminated soil excavations, storage vessel entries, and other confined space work may pose additional hazards such as air contamination, flammable or explosive atmosphere, and oxygen deficiency. Excavation entry may pose the possibility of engulfment.

Only personnel properly trained shall supervise and participate in confined space entry procedures or serve as standby attendants. All confined spaces are initially considered permit required. Under certain conditions, a space may be reclassified as a non-permit confined space provided the HSM approves the reclassification.

4.3.8 Fire Prevention and Protection

Clothes, cotton waste, and other combustible materials that might constitute a fire hazard will be placed in closed metal containers and placed outside or destroyed at the end of each day. The contractor will provide and maintain portable fire extinguishers in the following manner:

Portable fire extinguishers will be provided, where needed, and inspected on a monthly basis. A visual inspection will be made to ensure that extinguishers are fully charged and in an operable condition.

Hoses, nozzles, brackets, and supports will be inspected for deficiencies and corrected. Gauge pressure will be checked on pressurized units on a monthly basis to ensure units are fully charged and non-pressurized units will have their cartridges weighed on an annual basis. The chemical within dry chemical extinguishers will be inspected on an annual basis to ensure that it is powdery and in a free-running condition. An inspection tag will be attached to all extinguishers to designate that they have received an annual inspection. Fire extinguishers will be suitably placed, distinctly marked, and readily accessible.

A fire extinguisher with a rating of not less than 10-B will be located within 50 feet or wherever more than 5 gallons of flammable gas are being used on the work site (this does not apply to integral fuel tanks of motor vehicles).

A fire extinguisher with a rating of not less than 20-B will be located outside of and within 10 feet of the door opening into any room, building, or trailer used for storage of more than 60 gallons of flammable or combustible liquids.

If flammable liquids are being stored in an outside location, at least one portable fire extinguisher with a rating of not less than 20-B will be located at least 25 feet from the storage area, but not more than 75 feet away.

All tank trucks or vehicles used for transporting and/or dispensing flammable or combustible liquids will have a portable fire extinguisher with not less than a 20-BC rating.

A portable fire extinguisher with a rating of not less than 20-BC will be placed within 50 feet of each service or fueling area.

Fire extinguishers will be placed in storage areas so they are capable of extinguishing materials being stored.

All fire extinguishers will be approved by a nationally recognized testing laboratory.

A fire extinguisher with a rating of not less than 2-A will be provided where torches or open flames are in use.

At least one dry chemical or carbon dioxide fire extinguisher, with a 5-BC rating minimum, will be available for placement on each unit of heavy equipment, and each site vehicle (excluding rental cars).

Fuel handling is another hazard which will be present during this task. Refueling of the mechanical equipment poses burn hazards. All refueling and fuel handling equipment must be Underwriters Laboratories (UL) listed and Factory Mutual (FM) approved. The refueling must be done in a designated area to prevent contamination from minor spills and to reduce the risk of fires. The following guidelines must be followed whenever personnel are dispensing flammable and combustible liquids:

Flammable liquid dispensing systems will be electrically bonded and grounded. All tanks, hoses, and containers of 5 gallons or less will be kept in metallic contact while flammable liquids are being transferred; transfer of flammable liquids in containers in excess of 5 gallons will be done only when the containers are electrically bonded.

Flammable or combustible liquids will be drawn from, or transferred into, vessels, containers, or tanks within a building or outside only through a closed piping system, from safety cans, by means of a device drawing through the top, or from a container, or portable tanks, by gravity or pump, through an approved self closing valve. Transferring by means of air pressure on the container or portable tanks is prohibited.

Areas in which flammable or combustible liquids are transferred in quantities greater than 5 gallons from one tank or container to another will be separated from other operations by at least 25 feet or a barrier having a fire resistance of at least 1 hour. Drainage or other means will be provided to control spills.

Natural or mechanical ventilation will be provided to maintain the concentration of flammable vapor at or below 10% of the lower explosive level.

Dispensing units will be protected against collision damage.

Dispensing nozzles and devices for flammable liquids will be of an approved type.

Lamps, lanterns, heating devices, and similar equipment will not be filled while hot: these devices will be filled only in well-ventilated rooms free of open flames or in open air and shall not be filled in storage buildings.

4.3.9 Electrical Power

All electrical equipment must have a ground fault circuit interrupter (GFCI) as part of the circuit. All equipment must be suitable and approved for the class of hazard. Temporary wiring conductors installed for operation of construction tools and equipment will be either Type TW or THW contained in metal raceways, or will be hard usage or extra hard usage multiconductor cord. Temporary wiring will be secured above the ground or floor in a workmanlike manner and will not present an obstacle to persons or equipment. Applicable OSHA standards for electrical power, 29 CFR 1926 Subpart K, shall apply.

4.3.10 Ladder Safety

The following safe work practices will be adhered to during use of ladders:

- Assess work areas for fall hazards. A fall protection system is required if work is conducted 6 feet or over.
- Use Type 1A rated ladders.
- Make sure ladder rungs are sturdy and free of cracks.

- Use ladders with secure safety feet.
- Pitch ladders at a 4:1 ratio.
- Secure ladders at the top or have another person at the bottom to help stabilize it.
- Ladders used to access an upper landing surface shall extend at least three (3) feet above the upper landing surface.
- Use non-conductive ladders near electrical wires.
- The top step of a stepladder should not be used as a step.
- Do not carry any object or load that could cause a loss of balance or a fall.

4.3.11 Manual Material Lifting

Many different types of objects may be handled manually during site operations. Care should be taken when lifting and handling heavy or bulky items because they are the cause of many back injuries. The following fundamentals address the proper lifting techniques that are essential in preventing back injuries:

The size, shape, and weight of the object to be lifted must first be considered. No individual employee is permitted to lift any object that weights over 60 pounds. Multiple employees or the use of mechanical lifting devices are required for objects over the 60-pound limit. The anticipated path to be taken by the lifter should be inspected for the presence of slip, trip, and fall hazards.

The feet shall be placed far enough apart for good balance and stability (typically shoulder width). THE FOOTING SHALL BE SOLID. The worker shall get as close to the load as possible. The legs shall be bent at the knees. The back shall be kept as straight as possible and abdominal muscles should be tightened.

To lift the object, the legs are straightened from their bending position.

A worker shall never carry a load that cannot be seen over or around.

When placing an object down, the stance and position are identical to that for lifting. The legs are bent at the knees and the object lowered.

When two or more workers are required to handle the same object, coordination is essential to ensure that the load is lifted uniformly and that the weight is equally divided between the individuals carrying the load. When carrying the object, each worker, if possible, shall face the direction in which the object is being carried. In handling bulky or heavy items, the following guidelines shall be followed to avoid injury to the hands and fingers:

A firm grip on the object is essential; leather gloves shall be used if necessary.

The hands and object shall be free of oil, grease, and water which might prevent a firm grip, and the fingers shall be kept away from any points that could cause them to be pinched or crushed, especially when setting the object down.

The item shall be inspected for metal slivers, jagged edges, burrs, and rough or slippery surfaces prior to being lifted.

4.3.12 Clearing - General Practices

If personnel are clearing brush using machetes, the following rules apply:

When employees are using a machete to clear the area, no one is permitted within 30 feet of the person swinging the machete. Personnel will be instructed to not stand with their backs toward the active machete work area. All personnel must wear leg chaps and wrist thongs and be familiar with the use of a machete. When trees are being felled, the following rules must be adhered to: Before beginning the operation, alert all personnel in the area that the operation is about to commence. Then check that the area around the landing point of the tree is clear. Use a spotter to make sure that area remains clear. Check that there are no overhead power lines or obstructions that may catch or deflect the tree as it falls.

Never turn your back on the tree while it is being felled. Watch for kickback from the saw and do not force the saw if it becomes stuck in the tree. Make use of wedges to insure fall direction and prevent saw binding on larger diameter trees.

4.3.13 Lockout/Tagout of Hazardous Energy Sources

Lockout/tagout procedures will be implemented to assure the safety of personnel during servicing or maintenance of machines and equipment where the unexpected release of stored energy or the energization of these machines or equipment could cause employee injury. These procedures shall comply with the requirements established in 29 CFR 1926.417. All portable electrical equipment and extension cords shall be protected with a GFCI as part of the circuit. The applicable requirements found in 29 CFR 1926, Subpart K, *Electrical* shall be implemented.

Subcontractors may implement their own lockout/tagout procedure if the HSM has approved its use and verifies that it is no less protective than the primary contractor's procedure.

4.3.14 Vehicle Safety Management

Motor vehicle incidents are the number one cause of occupational fatalities, accounting for one in three deaths. Fifty percent or more of vehicle safety incidents occur while backing up. The contractor will require employees to use seat belts at all times when traveling in contractor owned or leased/rented vehicles. The PSO will develop a parking area plan, including backing vehicles into parking spaces, using spotters for backing vehicles and policy mandated vehicle inspections.

All contractor personnel and subcontractors shall obey all vehicle traffic safety requirements imposed by local and state agencies. Designated routes for parking and truck traffic relating to construction activities must be established before doing the work. An emergency contact person must be established before work to ensure proper notifications in the event of an incident.

Contractor employees are expected to incorporate safe actions and preparations to avoid vehicle accidents and personal injury during work and off-hours. Breaks should be planned into lengthy job mobilizations and demobilizations, including rotation of drivers at regular intervals. If parking areas are busy or crowded and more than one worker is traveling in the same vehicle, one worker should remain outside the vehicle as it leaves the parking space to assist the driver with traffic observation. Vehicles traveling before dawn and at dusk in rural or wooded areas should be prepared to brake for wildlife, e.g. deer crossing roadways.

Contractor employees arriving at work areas should park vehicles away from delivery, heavy equipment and vehicle loading/unloading locations to prevent parked vehicles from damage by various deliveries. Heavy EOs should inspect areas and request vehicles to be moved or spotters used if necessary, to maneuver equipment in tight areas. Employees who observe near misses or potential risks to parked or moving vehicles must report these to the PSO or HSM immediately.

Contractor employees are expected to use the vehicle inspection form and check/test the safety systems on the vehicle on a daily basis. Check the following: brakes, mirrors, seat belts, tires, leakage from the undercarriage, lights and turn signals. Vehicles with safety deficiencies must be reported immediately and not driven until properly repaired. Vehicles running errands from different project sites should have telephone numbers of the job site in the vehicle in case calls for assistance are required.

Because of the different ways alcohol can affect behavior, even in very small amounts, the best and safest course is not to drink before driving. Personnel involved in motor vehicle incidents are subject to drug and alcohol testing.

Weather conditions can have a profound effect on driving. On slippery roads, drive more slowly. Stop and turn with care. Keep several car lengths from other vehicles. At speeds in excess of 35 miles per hour (mph), the chances of hydroplaning increase with speed. In general, keep back 1 car length for every 10 mph to prevent striking the car ahead.

Vehicles will be operated in accordance with the requirements listed below:

- Seatbelt use is mandatory for all passengers;
- Personnel may not ride in the back of cargo vehicles;
- The driver must make a 360 degree walk around the assigned vehicle prior to vehicle movement;
- A ground guide is used to back up any vehicle;
- Vehicle speed is limited to the posted speed limits for developed roadways, 25 mph maximum on dirt roads and 10 mph maximum off-road (based on conditions);

- Vehicle driven in four wheel low and low gear when on dirt roads or off road driving where steep grades dictate;
- All operators must possess a valid driver's license;
- Fuel or gasoline are not transported inside the passenger compartment;
- No vehicle is left running when unattended; and
- Parking brakes are used when vehicles are parked.

In the event of a vehicle incident, the PSO will be notified ***immediately*** and all required reports completed.

4.3.15 Heavy Equipment Safety

There may be various types of heavy construction equipment that the contractor may be using during the execution of this project. All operators of this equipment will be familiar with the requirements for inspection and operation of the equipment they will be using. Before equipment is placed into use, it will be inspected by the operator to ensure that it is in safe operating condition. The following guidelines will be adhered to while operating heavy construction equipment:

- Equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.
- Getting off or on any equipment while it is in motion is prohibited.
- Use the three-point contact rule when getting on and off of equipment.
- Always clear the tracks with debris to ensure good footing and to prevent slippage, especially in wet conditions.
- Spotters will be used to back-up equipment and direct traffic in all "blind" areas.
- Equipment will be operated in accordance with the manufacturer's instructions and recommendations.
- Determinations of road conditions and structures will be made in advance to assure that clearances and load capacities are safe for the passage of equipment.
- All machinery or equipment will be shut down and positive means taken to assure that clearances and load capacities are safe for the passage of equipment.
- Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment will be either fully lowered or blocked when being serviced. Equipment designed to be serviced while running are exempt from this requirement.
- Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment will be either fully lowered or blocked when being repaired or when not in use. All controls shall be in a neutral position, with the engines stopped and brakes set, unless work being performed on the machine requires otherwise.
- No guard, safety appliance, or device will be removed from machinery or equipment, or made ineffective except for making immediate repairs, lubrications, or adjustments, and them only after

the power has been shut off. All guards and devices will be replaced immediately after completion of repairs and adjustments and before power is turned on.

- Mechanized equipment will be shut down prior to and during fueling operations. Closed systems, with automatic shut-off which will prevent spillage if connections are broken, may be used to fuel diesel powered equipment left running.
- Each bulldozer, scraper, dragline, crane, motor grader, front-end loader, mechanical shovel, backhoe, and other similar equipment will be equipped with at least one dry chemical or carbon dioxide fire extinguisher with a minimum rating of 5-B:C.
- Personnel will not work or pass under or ride in the buckets or booms of loaders in operations.
- All self-propelled construction equipment, whether moving alone or in combination, be equipped with a reverse signal alarm.
- Standard hand signals will be used to communicate between operators and ground crew.
- All heavy equipment will be equipped with operable seat belts; belts will be used by all operators.

4.3.16 Knife Safety

The following requirements will be adhered to for protection of employee cut injuries during sampling activities or other activities where knives are used:

- Ensure that hand knives are actually the most practical tool for the task. Where possible use the safest cutting tool for the job (e.g. scissors, snips or wire strippers).
- Cutting tools, such as scissors, snips, side cutters, etc., are also to be used in lieu of box cutters.
- If box cutters are determined to be the appropriate tool for the job, the only type that should be used are the designs that have a self retracting blade capability and employees must utilize appropriate PPE to allow for further protection
- If the knife happens to be the correct tool, keep the knife sharp and clean. A dull blade can cause accidents because more force is needed to cut an object. However, a knife or any other unprotected blade tool must be the last resort when choosing a cutting tool.
- Have a supply of either replacement knives and/or blades and make them readily available.
- Cut away from yourself, ending the knife stroke away from your body. Hold the item you’re cutting firmly, and don’t cut downwards and towards your body. Cut into the air or onto something hard.
- Confirm that appropriate PPE (e.g. gloves) specific to the task is available to employees and mandate the use of gloves when the possibility of injury exists.
- Personal knives (e.g. pocket knives) shall not be considered as a tool for any type of work-related cutting. This must be communicated to employees such that they are required to ask for a cutting tool from site / project / office supervision, thereby resulting in an additional review of using the right cutting tool for the job.
- The PSO should inspect all material handling activities to assure that leather gloves are being used to protect hands.

There are many cutting tool manufacturers and they offer a variety of safety knives that are available for all types of cutting.

4.4 Biological Hazards

4.4.1 Ticks

Ticks are vectors of many different diseases, including Rocky Mountain spotted fever, Q fever, tularemia, Colorado tick fever, and Lyme disease. They attach to their host's skin and intravenously feed on blood, creating an opportunity for disease transmission. Covering exposed areas of the body and the use of tick repellent are two ways to prevent tick bites. Periodically during the workday, employees will inspect themselves for the presence of ticks. If a tick is discovered, the following procedure should be used to remove it:

- Do not try to detach a tick with bare fingers; bacteria from a crushed tick may be able to penetrate even unbroken skin. Fine-tipped tweezers should be used.
- Grip the tick as close to the skin as possible and gently pull it straight away from the skin until it releases its hold.
- Do not twist the tick while pulling, and do not squeeze its bloated body. That may actually inject bacteria into the skin.
- Thoroughly wash hands and the bite area with soap and water, and apply an antiseptic to the bite area.
- Save the tick in a small container and note the date, the body location of the bite, and where the tick came from.
- Notify the PSO of tick bites as soon as possible.

Recently, Lyme disease has been the most prevalent type of disease transmitted by ticks in the United States.

4.4.2 Poisonous Plants

Toxic plants are found among trees, shrubs, vegetables, and vines. The largest number of plant poisonings occurs from ingestion. However, the largest concern for field workers comes from contact poisons that are most irritating to the skin: poison ivy, poison oak, and poison sumac; all plants native to Texas.

Poison Ivy

Physical Description. Poison ivy is a woody shrub or vine that climbs high in trees or along the ground, having alternate leaves with three leaflets. Small greenish flowers hang in clusters and form globe-shaped, yellowish, berry-like fruits. The leaf margins may be smooth or finely-toothed, or may be variously lobed.

Habitat. Poison ivy is found growing in rocky fields, pastures, thickets, woods, and waste places, often climbing trees, fences, and dwellings.

Symptoms. Contact results in a burning, itching rash that develops into broken blisters; the rash and blisters spread rapidly when scratched.

Treatment. Blisters may be drained, but tops should not be removed. Topical medication may be applied to the infected area.

Poison Oak

Physical Description. Poison oak is a perennial shrub with slender stems that are erect and woody, with one or a few erect branches. It does not climb nor does it have aerial roots. The leaves are three-parted on long erect stems, and found mostly near the top. The leaflets are found to be elliptic, rhombic, or obviate, and are hairy on the top surface and velvety beneath, with three to seven deep teeth, suggesting oak leaves. The fruit is greenish to buff and approximately 5 mm in diameter.

Habitat. Poison oak grows in dry barrens, sandy wastes, pine woods, and sandy woods.

Symptoms. Contact results in a burning, itching rash that develops into broken blisters; the rash and blisters spread rapidly when scratched.

Treatment. Blisters may be drained, but tops should not be removed. Topical medication may be applied to the infected area.

Poison Sumac

Physical Description. Poison sumac is a shrub or tree growing to 25 feet. It has compound leaves with 7 to 11 pointed leaflets without marginal teeth, and the leaf and leaflet stalks are reddish with clustered whitish fruits that resemble poison ivy.

Habitat. Poison sumac is found growing in the swamps of eastern North America.

Symptoms. Contact results in a burning, itching rash that develops into broken blisters; the rash and blisters spread rapidly when scratched. In severe cases, the infection covers the entire body, producing swelling and fever.

Treatment. Blisters may be drained, but tops should not be removed. Topical medication may be applied to the infected area.

If the work sites are located in areas where poisonous plants may be encountered, personnel should wear long pants, long sleeves, and gloves to minimize the possibility of exposure. In some areas, the use of a Tyvek® or other protective suit may be advisable.

4.4.3 Venomous Arthropods

Many of the organisms in the phylum Arthropoda can produce venomous bites. The black widow and brown recluse spiders are included in the phylum.

Black Widow Spider

Physical Description. The adult female is glossy black with short, almost microscopic hairs. Most female black widow spiders have a crimson hourglass marking on the underside of the abdomen. The spider reaches an overall length equal to 40 mm or 1.5 inches.

Habitat. The female spider is found with her web and egg sacs in protected places such as vacant rodent burrows and under stones, logs, long grass, hollow stumps, and brush piles. They are also found in dark corners of barns, stables, garages, and piles of boxes and crates.

Symptoms. After the bite, a dull, numbing pain in the affected extremity occurs. Also, pain and some muscular rigidity in the abdomen, back, and chest occur. The bite may also produce pain on inspiration (inhalation), headache, dizziness, skin rash, nausea, vomiting, anxiety, and weakness. Increased skin temperature over the affected area may be observed.

Treatment. Ice may be placed over the bite to reduce the pain. Seek immediate medical attention.

Brown Recluse Spider

Physical Description. The brown recluse is a spider of medium size (body 10 to 15 mm in length). It is brown in color, and the legs are long and lack unpaired claws.

Habitat. This spider is found outdoors under rocks and rubble.

Symptoms. After the bite, some localized pain develops within an hour. The bite area becomes swollen and skin temperature increases. The lesion has the appearance of a bull's eye and often becomes larger, ruptures, and leaves an ulcer that may involve underlying tissues, including muscle. Systemic symptoms and signs may develop, including nausea and vomiting.

Treatment. Ice may be placed over the bite to reduce the pain. Seek immediate medical attention.

4.4.4 Snakes

The degree of toxicity resulting from snakebites depends on the potency of the venom, the amount of venom injected, and the size of the person bitten. Poisoning may occur from injection or absorption of venom through cuts or scratches. The most effective way to prevent snakebites is to avoid snakes. Personnel should avoid walking at night or in high grass and underbrush. Visual inspection of work areas should be performed prior to activities. The use of leather boots and long pants will be required, since more than half of all bites are on the lower part of the leg. No attempts at killing snakes should be made; many people are bitten in these attempts.

If someone is bitten by a potentially poisonous snake, the following treatment should be initiated:

- Keep patient calm
- Notify emergency medical services (EMS)
- Wash the wound and keep the affected body part still
- Apply direct pressure to site of bite if bleeding is extreme
- Keep the affected area lower than the heart
- Carry a victim who must be transported, or have him/her walk slowly
- Transport to closest medical facility

If work sites at LHAAP are such that the possibility of encountering snakes exists, all personnel shall be cautioned to be alert. Should a snake bite occur, attempts should be made to kill the snake for positive identification. The victim should be transported to the nearest hospital within 30 minutes. Snake venoms are complex and include proteins, some of which have enzymatic activity. The effects produced by venoms include neurotoxic effects with sensory, motor, cardiac, and respiratory difficulties; cytotoxic effects on red blood cells, blood vessels, heart muscle, kidneys, and lungs; defects in coagulation; and effects from local release of substances with enzymatic actions. Other noticeable effects of snake bites include swelling, edema, and pain around the bite, and the development of ecchymosis (the escape of blood into tissues from ruptured blood vessels).

4.4.5 Rodents

Rodents, such as rats and deer mice, can potentially carry hantavirus. Rats differ from related mice by their larger size and teeth. Deer mice, such as mesas, usually live at higher elevations, and can be distinguished from other rodents by their small size (2 $^{4}/_{5}$ inches to 4 inches long) and by their bicolored tail. However, the Centers for Disease Control believes that other rodents also have the potential to carry the virus, so precautions must be taken when dealing with any species of rodent. It is not possible to distinguish whether a rodent carries the hantavirus by observation.

Hantavirus affects the respiratory system in humans. The first symptoms of infection can occur at any time up to 45 days after exposure, and includes one or more of the following: fever, muscle aches, headache, or coughing. These symptoms progress rapidly into a severe lung disease that often requires intensive care treatment. Hantavirus can be transferred to humans, primarily from breathing infected rodent excreta particles that have become airborne or ingesting excreta particles that cling to hands or clothing. It can also be contracted from rodent bites or transferred through broken skin. Though the illness caused by hantavirus is severe, it is relatively rare and can be prevented by simple precautions and common sense.

The best way to avoid contact with the hantavirus is to avoid contact with rodents and their excreta. Do not leave food or garbage where rodents have access to them; this includes leaving food items and wrappers in vehicles. When possible, seal any opening greater than ¼ inch diameter with steel wool to prevent rodent access in vehicles or structures.

Minor amounts of rodent excreta and rodents caught in mouse traps may be disposed of by personnel, provided precautions are taken. A suggested procedure is:

- When excreta or dead rodents are discovered in an enclosed area, ventilate the area for 30 minutes; the more air flow the better.
- Wear the proper PPE.
- Implement dust suppression techniques (such as use of a "bug" sprayer filled with water and a small amount of detergent to lightly spray the floor prior to entry).
- To dispose of wastes, place the rodent excreta or dead rodents in a plastic bag. Rinse gloved hands with bleach solution of 1 part bleach or 10 parts water, then doff any PPE in proper order, placing disposable items such as boot covers and respirator cartridges, in with the wastes. Place the respirator, if any, into a plastic bag, and mark the bag as "POTENTIALLY INFECTIOUS." Wet the wastes with the bleach solution, seal the plastic bag, place it into a second bag, and seal this bag also. Spray the outside of the plastic bag with commercial spray disinfectant. The waste may be disposed of as regular garbage.
- After the wastes are properly bagged, spray the surfaces where the wastes originally were found with disinfectant.
- Thoroughly wash hands, face, and forearms with soap and water.

4.4.6 Scorpions

Several species of scorpions are found in the south. Only one species, the Bark Scorpion, is regarded as life threatening. The Bark Scorpion may be distinguished from other less toxic species by its more slender tail segments and pincers. Reaching only 1.5 inches at maturity, it is a relatively small scorpion. Scorpions are relatively inactive during the daylight hours. The majority of scorpion bites occur at night during warm summer months. The most effective way to prevent scorpion bites is to avoid conducting work at night, visually inspect work areas prior to activities, and protect hands and legs by wearing the proper PPE.

Symptoms. Scorpion stings can cause immediate local pain with minimal swelling. Numbness and tingling are frequently reported. The injured area may be hypersensitive to touch, pressure, heat, and cold. Small children are at highest risk, as demonstrated by "roving eye" symptoms and hyperactivity.

Treatment. Most scorpion stings can be treated in the field. Clean the bitten area with soap and press a cool compress on the sting. Elevate the stricken limb to the approximate heart level. Take an analgesic to relieve minor pain, as needed. If symptoms are severe, seek immediate medical assistance at an emergency room or urgent care facility.

4.5 Explosive Hazard

Explosive materials produced and handled at LHAAP included cyclonite, TNT, and black powder, rocket propellants, and pyrotechnics. Rocket propellants contained a rubber binder, an oxidizer (ammonium perchlorate), and a powdered aluminum fuel. Pyrotechnics were generally composed of sodium nitrate, magnesium powder, and a binder. The sites of explosive concern include Sites 29, 46, and 47.

Avoidance will be practiced if explosive materials or objects are suspected or encountered. All work will be immediately halted, personnel will move upwind away from the suspected material, and the contractor PM will be immediately notified for further instructions. Work shall not be resumed until clearance has been obtained for the specific sampling location or a different sampling location is selected with no visible explosive concern.

4.6 Task-Specific Activity Hazard Analyses

The AHA for primary tasks provides a breakdown of the hazards and control measures for each principal task. Pre-mobilization AHA are located in **Attachment 4** of this HASP and are general in nature. They must be made project specific prior to each task by the PSO who must list specific equipment and any changes to principle steps. The AHA will be field-checked by the PSO on an ongoing basis and will be revised as necessary. Revisions will be communicated to the work crew and posted to **Attachment 4** of this plan.

5.0 Site Control and Work Zones

To prevent migration of contamination caused through tracking by personnel or equipment, work zones and PPE are clearly specified prior to beginning field operations. The contractor will designate work zones as suggested by *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (National Institute for Occupational Safety and Health [NIOSH], 1985). Each work site will be divided into three zones as follows:

- Exclusion (or "hot") zone
- Contamination reduction zone
- Support zone

A site map will be on site identifying the following:

- Exclusion zone
- Work staging areas
- Contamination reduction zone
- Location of alarms
- Location of emergency response equipment
- Site access control points (entrances and exits)
- Evacuation routes
- Location of telephones

5.1 Exclusion Zone

The exclusion zone (EZ) is the area suspected of contamination and presents the greatest potential for worker exposure. Personnel entering the area must wear the mandated level of protection for that area. In certain instances, different levels of protection will be required depending on the tasks performed and air monitoring results obtained within that zone. The EZ will be demarcated using barrier tape and/or high-visibility fencing. The PSO will establish the EZ for each task/operation. The EZ boundary will be posted with signs to warn on-site personnel of the construction, safety, and health hazards, and to keep unauthorized personnel out of the EZ.

5.2 Contamination Reduction Zone

The contamination reduction zone (CRZ) or transition zone will be established between the EZ and Support Zone (SZ). In this area, personnel will begin the sequential decontamination process required to exit the EZ. To prevent off-site migration of contamination and for personnel accountability, site personnel will enter and exit the EZ through the CRZ.

5.3 Support Zone

The SZ serves as a clean control area. Operational support facilities are located within the SZ. Normal work clothing and support equipment is appropriate in this zone. Contaminated equipment or clothing will not be allowed in the SZ. The support facilities should be located upwind of site activities. There will be a clearly marked controlled access point from the SZ into the CRZ and EZ that is monitored closely by the PSO to verify that proper safety protocols are followed.

5.4 Site Control Log

A log of personnel visiting, entering, or working on the site will be maintained at the site by the PSO. The log will list the time, date, company or agency, and name of persons entering or exiting the site.

5.5 Safe Work Practices

The following items are requirements to protect the health and safety of workers and will be discussed in the safety briefing prior to initiating work on the site.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of contaminants is prohibited in the site area.
- Hands and face must be washed upon leaving the site and before eating, drinking, chewing gum or tobacco, smoking, or other activities that may result in ingestion of contaminants.
- During site operations, each worker will consider himself as a safety backup to his partner. Off-site personnel provide emergency assistance. Site personnel will be aware of dangerous situations that may develop.
- Visual contact will be maintained between buddies on site when performing hazardous duties.
- No one will be admitted to the site without the proper safety equipment, training, and medical certification.
- Personnel must comply with established safety procedures. Any staff member who does not comply with safety policy as established by the PSO may be immediately dismissed from the site.
- Proper decontamination procedures must be followed before leaving the site.

- Employees and visitors must sign in and out of the site.

5.6 Visitor Access

Visitors should check in immediately upon arrival. Only authorized visitors will be allowed access to the contaminated areas. Visitors and subcontractors with access to contaminated areas must submit proof of current 40-Hour OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Training and current medical certification to the contractor PSO. Each visitor will be required to provide and wear the necessary protective equipment during the visits and shall be escorted by contractor personnel. Visitors, subcontractors, and personnel entering the site area will be required to sign a safety plan acknowledgement form to certify that they have read, understand, and will comply with the HASP.

Failure to comply with this site entry procedure will result in expulsion from the site. A visitor's log will be kept by the PSO or his designee.

5.7 Buddy System

A "buddy system" will be implemented when conditions represent a risk to personnel that can be either physical or chemical. A buddy system requires that two or three people work as a team, each looking out for the other. "Buddies" must always be in each other's line of sight and should maintain verbal or visual communication. No one must enter into the site area alone because hazards are likely to exist, which could render the employee helpless and prevent self-rescue.

5.8 Site Communications

On-site communications will be established between site work zones and will consist of verbal communications or line-of-sight observations. Off-site communications will be established in the site area to summon off-site emergency services and will consist of either on-site cellular telephones or identification of the nearest telephone to the site. (Air horns will be available for emergency conditions in the site area.)

5.9 Health and Safety Inspections

The PSO or designee will perform regular health and safety inspections. A report including results of the inspection and any corrective actions taken will be placed in the project files, with a copy sent to both the USACE project manager and the HSM.

5.10 Accident Investigation

All injuries including cases that require only minor first aid will be reported to the PSO. All first aid cases, near miss incidents, occupational injuries or illnesses, and vehicle and equipment damage must be investigated.

6.0 Protective Equipment

This section specifies the levels of PPE, which are or may be required for each principal activity performed at this site. Site personnel must be trained in the use of PPE.

6.1 Anticipated Protection Levels

The protection levels shown in **Table 6-1** have been established for the site work activities based on the level of site contaminants and the scope of work. Results of site air monitoring and visual inspection of the work activities may indicate the need for changes in PPE level(s).

Table 6-1
Personal Protection Equipment

Task	Initial PPE Level	Upgrade PPE Level	Skin Protection	Level C Respiratory Protection	Other PPE
Mobilization/ site preparation	D	—	Coveralls, work gloves	None	Hard-hat, steel-toe work boots, safety glasses, and hearing protection > 85 dBA
Monitoring well installation	D+	C	Tyvek® suit, surgical gloves (minimum of two pairs)	APR with acid gases/organic vapors/P100 filter cartridge	Hard-hat, steel-toe work boots, and hearing protection >85 dBA
Survey wells	D	D+	Tyvek® suit, nitrile gloves, surgical inner gloves	None	Hard-hat, steel-toe work boots, safety glasses, hearing protection >85 dBA
Soil excavation	D+	C	Tyvek® suit, nitrile gloves, surgical inner gloves	APR with acid gases/organic vapors/P100 filter cartridge	Hard-hat, steel-toe work boots, safety glasses
Groundwater/soil/ surface water/ sediment sampling and analysis	D+	C	Tyvek® suit, nitrile gloves, surgical inner gloves	APR with acid gases/organic vapors/P100 filter cartridge	Hard-hat, steel-toe work boots, safety glasses
XRF Survey	D	D+	Tyvek® suit, nitrile gloves, surgical inner gloves	None	Hard-hat, steel-toe work boots, safety glasses, hearing protection >85 dBA
Equipment decontamination	D+		PVC rain suit or Tyvek® coveralls	None	Hard-hat, steel-toe work boots, goggles/face shield, latex gloves, latex boots, and hearing protection >85 dBA
General site activities	D	—	None	None	Hard-hat, steel-toe work boots, safety glasses, and hearing protection > 85 dBA

Abbreviations:

APR	*air-purifying respirator*	*PPE*	*personal protective equipment*	*XRF*	*x-ray fluorescence*
dBA	*decibels, A-scale*	*PVC*	*polyvinyl chloride*		

6.2 Protection Level Descriptions

This section lists the minimum requirements for each protection level. Modification to these requirements may have been noted above.

6.2.1 Level D

Level D consists of the following:

- Safety glasses with side shields
- Hard hat
- Safety-toe work boots
- Work clothing as prescribed by weather

6.2.2 Modified Level D

Modified Level D (D+) consists of the following:

- Safety glasses with side shields
- Hard hat
- Safety-toe work boots
- Nitrile, neoprene, or polyvinyl chloride (PVC) gloves over latex sample gloves
- Tyvek® coverall

6.2.3 Level C

Level C consists of the following:

- Full-face, air-purifying respirator with organic vapors/acid gases cartridge P100 filter cartridges
- Tyvek® coveralls (polyethylene-coated Tyveks® required when workers have a potential to be exposed to contaminated liquids or sludges)
- Hard hat
- Steel-toe work boots (use PVC overboots when the potential for exposure to contaminated liquids/sludges exist)
- Nitrile, neoprene, or PVC gloves over latex sample gloves

6.3 Respiratory Protection Program

Respiratory protection is an integral part of employee health and safety at hazardous waste sites where contamination is present or suspected. The site respiratory protection program will consist of the following:

- All site personnel who may use respiratory protection will have an assigned respirator.
- All site personnel who may use respiratory protection will have been fit-tested and qualified in the use of an air-purifying/air-supplied respirator within the past 12 months.
- All site personnel who may use respiratory protection must within the past year have been medically certified as being capable of wearing a respirator. Documentation of the medical certification must be provided to the PSO or HSM prior to commencement of site work.

- Only cleaned, maintained, NIOSH/Mine Safety and Health Administration-approved respirators are to be used on this site.
- If full-face air purifying respirators are used, the respirator cartridge is to be properly disposed of at the end of each work shift, or when load-up or breakthrough occurs.
- All site personnel who may use respiratory protection will be clean-shaven. Mustaches and side burns are permitted, but they must not touch the sealing surface of the respirator.
- Respirators will be inspected, and a positive negative pressure test performed prior to each use.

After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag.

6.4 Air-Purifying Respirators

A NIOSH-approved full-face respirator with appropriate air purifying cartridges will be used for Level C work. The crew members working in Level C will wear respirators equipped with organic vapors/acid gases cartridge/P100 filter air-purifying cartridges approved for organic vapors, chlorine, hydrogen chloride, chlorine dioxide or sulfur dioxide, hydrogen fluoride or hydrogen sulfide (escape only), and at least 99.97% efficiency against all types of particulate aerosols.

6.5 Respirator Cartridges

The crew members working in Level C will wear respirators equipped with air-purifying cartridges approved for the following contaminants:

- Organic vapors <1,000 parts per million (ppm)
- Chlorine gas <10 ppm
- Hydrogen chloride <50 ppm
- Sulfur dioxide <50 ppm
- Dusts, fumes, and mists with a threshold limit value <0.05 mg/m^3
- Asbestos-containing dusts and mists
- Radionuclides

6.6 Cartridge Changes

All cartridges will be changed a minimum of once weekly or more frequently if personnel begin to experience increased inhalation resistance. The HSM will establish a cartridge changeout schedule if air monitoring indicates action levels requiring respirator protection are achieved (see **Section 8.0**).

6.7 Inspection and Cleaning

Respirators are checked periodically by the PSO and inspected before each use by the wearer. Respirators and associated equipment will be decontaminated and hygienically cleaned after use.

6.8 Fit Testing

Annual respirator fit tests are required of personnel wearing negative pressure respirators. The test will utilize isoamyl acetate or irritant smoke. The fit test must be for the style and size of the respirator to be used. Additionally, a positive and negative fit test shall be conducted each time a respirator is donned.

6.9 Facial Hair

No personnel who have facial hair that interferes with the respirator's sealing surface will be permitted to wear a respirator.

6.10 Corrective Lenses

Normal eyeglasses cannot be worn under full-face respirators because the temple bars interfere with the respirator's sealing surfaces. For workers requiring corrective lenses, special spectacles designed for use with respirators will be provided.

6.11 Medical Certification

Only workers who have been certified by a physician as being physically capable of respirator usage will be issued a respirator. Personnel unable to pass a respiratory fit test or without medical clearance for respirator use will not be permitted to enter or work in areas on-site that require respiratory protection. Employees receive a written physician's opinion that they are fit for general hazardous waste operations as per 29 CFR 1910.120(f)(7).

7.0 Decontamination Procedures

This section describes the procedures necessary to ensure that both personnel and equipment are free from contamination when they leave the work site. A step-by-step description of decontamination procedures for Level D Modified and C has been delineated below.

Air monitoring instruments may be wrapped while using them in the EZ to avoid contamination in very messy conditions. Where conditions are relatively clean, instruments may be wiped down with a damp cloth in the CRZ.

7.1 Personnel Decontamination

Decontamination of personnel shall be performed to ensure that any material that personnel may have contacted in the EZ is removed in the CRZ. All personnel will use the CRZ decontamination sequence listed below during egress from the CRZ.

PPE removed from the decontamination corridor will either be decontaminated or properly bagged to contain any contamination. All used disposable clothing will be placed in polyethylene bags, identified, dated, and stored at the property site pending disposal. Waterproof, non-disposable PPE will be properly decontaminated. Decontamination of personnel exiting the EZ will utilize the following steps as appropriate to the specific work area:

Modified Level D

Step 1: Remove gross contamination from outer boots. Remove and stack boots.
Step 2: Remove outer gloves.
Step 3: Remove hard hat.
Step 4: Remove and discard outer suit.
Step 5: Remove and discard one pair of inner gloves in 55-gallon trash drum (when multiple pairs of inner gloves are used).
Step 6: Remove and discard inner suit (when used).
Step 7: Discard final pair of inner gloves into 55-gallon trash drum.
Step 8: Depart transition zone in work clothes and boots.
Step 9: Wash hands, face, and neck before breaks and lunch.

Level C

Step 1: Remove gross contamination from outer boots. Remove and stack boots.
Step 2: Scrub and remove outer gloves.

Step 3: Remove the hard hat.
Step 4: Remove and discard outer suit.
Step 5: Remove and discard one pair of inner gloves into 55-gallon trash drum (when multiple pairs of gloves used).
Step 6: Remove and discard inner suit (when used).
Step 7: Remove respirators and suitably store while on breaks and during lunch. At the end of shift, discard the cartridges and then clean, disinfect, rinse, and air dry the respirator.
Step 8: Discard final pair of inner gloves into 55-gallon trash drum.
Step 9: Depart transition zone in work clothes and boots.
Step 10: Wash hands, face, and neck before breaks and lunch

7.2 Personal Hygiene

Before eating, smoking, or drinking, personnel will wash hands, arms, neck, and face. Washing facilities with soap will be available in the SZ and in the CRZ.

7.3 Equipment Decontamination

Heavy equipment will be cleaned prior to leaving.

8.0 Air Monitoring

Air monitoring will be conducted in order to characterize personnel exposures and fugitive emissions from site contaminants. The principal contaminants of concern are listed in **Section 4.0** of this HASP. Results of air monitoring will be used to ensure the proper selection of protective clothing and equipment, including respiratory protection, to protect on-site personnel and off-site receptors from exposure to unacceptable levels of site contaminants. Descriptions of air monitoring strategies, procedures, and equipment are provided below. Modification of this plan, including additional monitoring, may be judged necessary by the HSM, in conjunction with the PSO.

8.1 Work Area Air Monitoring

Work area air monitoring during site investigations at LHAAP will include direct reading methods as well as integrated sampling strategies. Air monitoring will be conducted during well installation and groundwater sampling activities.

During well installation, and groundwater sampling activities, direct reading air monitoring will be performed to determine exposure to workers. A summary of air monitoring information is provided in **Table 8-1**.

Table 8-1
Direct Reading Air Monitoring Summary

Monitoring Device	Monitoring Location/ Personnel	Monitoring Frequency	Action Level[a]	Action
PID/OVA (breathing zone)	Soil excavation and sampling, well installation, and groundwater sampling	At start-up, minimum four times daily in work area and breathing zone	>1 ppm for 5 minutes >5 ppm for 5 minutes	Test for benzene (colorometric detector tubes) Upgrade to Level C
LEL/O_2 meters	Soil excavation and sampling, well installation, and groundwater sampling	At start-up, minimum four times daily in work area.	>10% LEL <20.8% O_2	Stop operations; allow vapors to vent <10% before continuing Upgrade to Level B
Colorometric detector tube (benzene)	Soil excavation and sampling, well installation, and groundwater sampling	Periodic when PID/OVA readings exceed action level	> 0.5 ppm benzene > 25 ppm benzene	Upgrade to Level C Upgrade to Level B

Notes and Abbreviations:

[a] *Sustain levels above background for 5 minutes in breathing zone*

ppm	*parts per million*
PID/OVA	*photo ionization detector/organic vapor analyzer*
LEL/O_2	*lower explosive limit/oxygen*

8.2 Instrumentation

The following is a description of the air monitoring equipment to be used at this site.

8.2.1 Lower Explosive Limit/Oxygen Meter

8.2.1.1 Types and Operational Aspects

- MSA Watchman LEL/Oxygen (O_2) Meter or equivalent
    - Principle of Operation
- Oxygen detector uses an electrochemical sensor and produces a minute electric current proportional to the oxygen content.
- CGIs use a combustion chamber containing a filament that ignites flammable vapors. The filament is heated or coated with a catalyst (platinum) to facilitate combustion.

- Filament is part of a balanced resistor circuit. Combustion in the chamber causes the filament temperature to increase which results in increased filament resistance.
- Change in the filament's resistance causes an imbalance in the circuit proportional to the percent of the LEL.
- At concentrations lower than the LEL, the meter will read the approximate percent of combustible atmosphere present.
- Concentrations greater than the LEL will have a meter response greater than 100% LEL. This type of response indicates the gas mixture is then in the flammable range, or is too rich to burn and is not combustible. The danger is that the addition of air to the gas mixture could bring it into the flammable range (less than the upper explosive limit) and an explosion will result.
- Oxygen meter set at the factory to alarm at 19.5% (oxygen deficient atmosphere). Combustible gas meter set by the user to alarm at 10% LEL.

8.2.1.2 Calibration Methods/Frequencies

Before the calibration of the CGI can be checked, the unit must be in operating condition. The CGI LEL is normally calibrated on pentane as representative of the flammability characteristics of most commonly encountered combustible gases. The meter scale is calibrated from zero to 100% LEL, which corresponds in actual volume concentrations of 0 to approximately 14% pentane in air. A booklet of response curves is supplied with the Watchman Meter. These curves may be used to interpret meter readings when sampling combustible gases other than pentane. It is recommended that calibration be checked before and after using each time. The PSO will record and log such calibration information into an air monitoring notebook. The O_2 meter is calibrated by adjusting the O_2 control knob to 20.8% while the meter is operated in a fresh air atmosphere.

8.2.1.3 Preventive Maintenance

The primary maintenance of the unit is the rechargeable 2.4-volt nickel cadmium battery. Recommended charging time is 16 hours. It may be left on charge for longer periods without damaging the battery. The battery sometimes will not supply full power capacity after repeated partial use between charging. Therefore, it is recommended that the battery be exercised at least once a month by running for eight to 10 hours before recharge. If the instrument has not been used for 30 days, the battery should be charged prior to use.

8.2.2 Photoionization Detector

8.2.2.1 Type and Operational Aspects

Photovac Model 20/20 or equivalent

- Principle of Operation
  - Ionization potential (IP) – The energy required to remove the outermost electron from a molecule; measured in electron volts (eV); characteristic property of a specific chemical.

- Photoionization – Using ultraviolet (UV) light to remove the outermost electron from a molecule.
  - Energy of UV light (10.6, 9.5, 11.7 eV) must be equal to or greater than the IP to photoionize the molecule.
  - Fan or pump is used to draw air into the detector where the contaminants are exposed to a UV light source (lamp).
  - Ions are collected on a charged plate and produce a current directly proportional to the number of ionized molecules; current is amplified and displayed on the meter.

8.2.2.2 Calibration Method/Frequencies

The Photovac Model 20/20 is designed for trace gas analysis in ambient air and is calibrated at the manufacturer (HNU) with certified standards of benzene, vinyl chloride, and isobutylene. Other optional calibrations are available (e.g., ammonia, ethylene oxide, H_2S, etc.).

The contractor will use a photoionization detector with a 10.6 eV lamp. This lamp has been determined to be responsive to monitor the contaminants on site. Optional probes containing lamps of 9.5 and 11.7 eV are interchangeable in use within individual read-out assemblies for different applications.

It is recommended that calibration be checked twice each day (beginning and end of shift). The PSO will record and log such calibration information into an air monitoring notebook.

8.2.2.3 Preventive Maintenance

Maintenance of the Photovac Model 20/20 consists of cleaning the lamp and ion chamber, and replacement of the lamp or other component parts or sub-assemblies.

9.0 Emergency Response

9.1 Pre-Emergency Planning

Prior to engaging in investigation activities at the site, the contractor will plan for possible emergency situations and have available adequate supplies and manpower to respond. In addition, site personnel will receive training during the site orientation concerning proper emergency response procedures. The Marshall Fire Department will be contacted when the magnitude of the anticipated emergency conditions warrant.

The situations shown in **Table 9-1** would warrant implementation of the Emergency Response and Contingency Plan (ERCP).

Table 9-1
Situations Warranting Implementation of the Emergency Response and Contingency Plan

Type Hazard	Hazard
Fire/explosion	• The potential for human injury exists • Toxic fumes or vapors are released • The fire could spread on-site or off-site and possibly ignite other flammable materials or cause heat-induced explosions • The use of water and/or chemical fire suppressants could result in contaminated run-off • An imminent danger of explosion exists
Spill or release of hazardous materials	• The spill could result in the release of flammable liquids or vapors, thus causing a fire or gas explosion hazard • The spill could cause the release of toxic liquids or fumes in sufficient quantities or in a manner that is hazardous to or could endanger human health
Natural disaster	• A rain storm exceeds the flash flood level • The facility is in a projected tornado path or a tornado has damaged facility property • Lightning • Severe wind gusts are forecasted or have occurred and have caused damage to the facility
Medical emergency	• Overexposure to hazardous materials • Trauma injuries (broken bones, severe lacerations/ bleeding, burns) • Eye/skin contact with hazardous materials • Loss of consciousness • Heat stress (heat stroke) • Cold stress (hypothermia) • Heart attack • Respiratory failure • Allergic reaction

The following measures will be taken to assure the availability of adequate equipment and manpower resources:

- Sufficient equipment and materials will be kept on site and dedicated for emergencies only. The inventory will be replenished after each use.
- On-site emergency responders will be current in regards to training and medical surveillance programs. Copies of all applicable certificates will be kept on file for on-site personnel required to respond.

- It will be the responsibility of the PSO to brief the on-site response team on anticipated hazards at the site. The PSO shall also be responsible for anticipating and requesting equipment that will be needed for response activities.
- Emergency response activities will be coordinated with the Local Emergency Planning Committee (LEPC) in compliance with Superfund Amendments and Reauthorization Act Title III requirements.

Communications will be established with LEPC prior to commencement of any activities at the remediation site. Communication will be established so that responders on-site have access to pertinent information to allow them to conduct their activities in a safe and healthful manner. Air horns may be used to alert personnel of emergency conditions. A telephone will be located at the command post to summon assistance in an emergency.

Primary communication with local responders in the event of an emergency will be accomplished using commercial telephone lines.

9.2 Emergency Recognition and Prevention

Because unrecognized hazards may result in emergency incidents, it will be the responsibility of the PSO, through daily site inspections and employee feedback (Safety Observation Program, daily safety meetings, and activity hazard analyses), to recognize and identify the hazards that may be found at the site. Potential hazards are shown in **Table 9-2**.

Table 9-2
Potential Hazards

Type Hazard	Hazard
Chemical	Materials at the site Materials brought to the site IDLH atmospheres
Physical	Fire/explosion Slip/trip/fall Electrocution Confined space Excessive noise
Mechanical	Heavy equipment Stored energy system Pinch points Electrical equipment Vehicle traffic
Environmental	Electrical storms High winds Heavy rain/snow Temperature extremes (heat/cold stress) Poisonous plants/animals

Abbreviations:

IDLH immediately dangerous to life or health

Once a hazard has been recognized, the PSO will take immediate action to prevent the hazard from becoming an emergency. This may be accomplished by the following:

- Daily safety meeting
- Task-specific training prior to commencement of activity
- Lockout/tag-out
- PPE selection/use
- Written and approved permits for hot work, confined space
- Trenching/shoring procedure
- Air monitoring
- Following applicable contractor standard operating procedures
- Practice drills for fire, medical emergency, and hazardous substance spills

9.3 Personnel Roles, Lines of Authority, and Communications

This section describes the various roles, responsibilities, and communication procedures that will be followed by personnel involved in emergency responses.

In the event an emergency occurs and the PSO is not on site, the highest-ranking employee on site will serve as the PSO until the PSO arrives. The PSO will determine the nature of the emergency and take appropriate action as defined by the ERCP in **Section 9.7**. The PSO will implement the ERCP immediately as required. The decision to implement the plan will depend upon whether the actual incident threatens human health or the environment. Immediately after being notified of an emergency incident, the PSO or his designee, will evaluate the situation to determine the appropriate action.

9.3.1 Responsibilities and Duties

This section describes the responsibilities and duties assigned to the PSO.

It is recognized that the structure of the "Incident Command System" will change as additional response organizations are added. The contractor will follow procedures as directed by the fire department, LEPC, state, and federal agencies as required. The contractor will defer to the local Fire Department Chief to assume the role of Incident Commander upon arriving on-site. Additional on-site personnel may be added to the Site Emergency Response Team as required to respond effectively.

9.3.2 On-Site Emergency Coordinator Duties

The on-site PSO is responsible for implementing and directing the emergency procedures. Emergency personnel and their communications will be coordinated through the PSO. Specific duties are as follows:

- Identify the source and character of the incident, type, and quantity of any release. Assess possible hazards to human health or the environment that may result directly from the problem or its control.
- Discontinue operations in the vicinity of the incident, if necessary, to ensure that fires, explosions, or spills do not recur or spread to other parts of the site. While operations are dormant, monitor for leaks, pressure build-up, gas generation, or ruptures in valves, pipes, or other equipment, where appropriate.
- Notify local emergency response teams if their help is necessary to control the incident. **Table 9-3** provides telephone numbers for emergency assistance.
- Direct on-site personnel to control the incident until, if necessary, outside help arrives.
- Verify that the building, or area where the incident occurred, and the surrounding area are evacuated, and shut off possible ignition sources, if appropriate. The emergency response team is responsible for directing site personnel such that they avoid the area of the incident and leave emergency control procedures unobstructed.
- If fire or explosion is involved, notify the Marshall Fire Department.

- Notify contractor PM
- Have protected personnel, in appropriate PPE, on standby for rescue

If the incident may threaten human health or the environment outside of the site, the PSO should immediately determine whether evacuation of the area outside of the site may be necessary and, if so, notify the Marshall Fire Department and the Office of Emergency Management.

When required, notify the National Response Center. The emergency telephone number for the National Response Center is 800-424-8802. The following information should be provided to the National Response Center:

- Name and telephone number
- Name and address of facility
- Time and type of incident
- Name and quantity of materials involved, if known
- Extent of injuries
- Possible hazards to human health or the environment outside of the facility

Table 9-3 provides emergency telephone numbers.

Table 9-3
Emergency Telephone Numbers

Emergency Contacts	Phone Numbers
Marshall Fire Department	911 or (903) 935-4580
Police Department	(903) 935-4525
Hospital – Marshall Regional Medical Center	(903) 927-6000
Regional Poison Control Center	(800) 552-4611
State Agencies (TCEQ)	(210) 490-3096
USEPA Region 6 (EPA Regional Branch Response Center)	(214) 665-2222
Agency for Toxic Substances and Disease Registry	(404) 639-0515 (24-hour)
Designated USACE Site Rep (John Lambert)	(918) 669-4992
Longhorn AAP Site Manager – Rose M. Zeiler	(479) 635-0110
U.S. Coast Guard	(804) 484-8192
National Response Center	(800) 424-8802
Chem-TEL	(800) 255-3924 (24-hour)
Project Manager – TBD	
Project HSM – TBD	
Project PSO – TBD	

If hazardous waste has been released or produced through control of the incident, ensure the following:

- Waste is collected and contained.
- Containers of waste are removed or isolated from the immediate site of the emergency.
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided.
- Ensure that no waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed.
- Ensure that emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed.
- Notify the USEPA Regional Administrator that cleanup procedures have been completed and that emergency equipment is fit for its intended use before resuming operations in the affected area of the facility. The USEPA Regional Administrator's telephone number is included in the emergency contacts above.
- Record time, date, and details of the incident, and submit a written report to the USEPA Regional Administrator. Report is due to USEPA within 15 days of the incident.

9.4 Safe Distances and Places of Refuge

No single recommendation can be made for evacuation or safe distances because of the wide variety of emergencies that could occur. Safe distances can be determined only at the time of an emergency based on a combination of site and incident-specific criteria. However, the following measures are established to serve as general guidelines.

In the event of minor hazardous material releases (small spills of low toxicity), workers in the affected area will report initially to the site. Small spills or leaks (generally less than 55 gallons) will require initial evacuation of at least 50 feet in all directions to allow for cleanup and to prevent exposure. After initial assessment of the extent of the release and potential hazards, the PSO or his designee will determine the specific boundaries for evacuation. Appropriate steps such as caution tape, rope, traffic cones, barricades, or personal monitors will be used to secure the boundaries. In the event of a major hazardous material release (large spills of high toxicity/greater than 55 gallons), workers will be evacuated from the building/site. Workers will assemble at the entrance to the site for a head count by their foremen and await further instruction.

If an incident may threaten the health or safety of the surrounding community, the public will be informed and, if necessary, evacuated from the area. The PSO or his designee will inform the proper agencies, if necessary. Emergency contact telephone numbers are listed in **Table 9-3**.

Places of refuge will be established prior to the commencement of activities. These areas must be identified for the following incidents:

- Chemical release
- Fire/explosion
- Power loss
- Medical emergency
- Hazardous weather

In general, evacuation will be made to the crew trailers unless the PSO determines otherwise. It is the responsibility of the PSO to determine when it is necessary to evacuate personnel to off-site locations. In the event of an emergency evacuation, employees will gather at the entrance to the site until a head count establishes that all are present and accounted for. No one is to leave the site without notifying the PSO.

9.5 Evacuation Routes and Procedures

Emergencies require prompt and deliberate action. In the event of an emergency, it will be necessary to follow an established set of procedures. Such established procedures will be followed as closely as possible. However, in specific emergency situations the PSO may deviate from the procedures to provide a more effective plan for bringing the situation under control. The PSO is responsible for determining which situations require site evacuation.

9.5.1 Evacuation Signals and Routes

An air horn will be used to notify employees of the necessity to evacuate an area or building involved in a release/spill of a hazardous material. Total site evacuation will be initiated only by the PSO; however, in his absence, decision to preserve the health and safety of employees will take precedence and may be initiated by the next highest ranking employee. Evacuation routes will be posted in each outside work area. Signs inside buildings will be posted on walls or other structural elements of a building. Periodic drills will be conducted to familiarize each employee with the proper routes and procedures.

9.5.2 Evacuation Procedures

In the event evacuation is necessary, the following actions will be taken:

- The emergency signal will be activated.
- No further entry of visitors, contractors, or trucks will be permitted. Vehicle traffic within the site will cease in order to allow safe exit of personnel and movement of emergency equipment.
- Shut off all machinery if safe to do so.
- On-site personnel, visitors, and contractors in the site area will assemble at the entrance to the site for a head count and await further instruction from the PSO.
- Persons in the site area will be accounted for by their immediate crew leaders (e.g., foreman). Leaders will determine the safest exits for employees and will also choose an alternate exit if the first choice is inaccessible.

- During exit, the crew leader should try to keep the group together. Immediately upon exit, the crew leader will account for the employees in his crew.
- Upon completion of the head count, the crew leader will provide the information to the PSO.
- Contract personnel and visitors will also be accounted for.
- The names of emergency response team members involved will be reported to the emergency spill control coordinator.
- A final tally of persons will be made by the PSO or designee. No attempt to find persons not accounted for will involve endangering lives of the contractor or other employees by re-entry to emergency areas.
- In all questions of accountability, immediate crew leaders will be held responsible for those persons reporting to them. Visitors will be the responsibility of those employees they are visiting. Contractors and truck drivers are the responsibility of the PSO. The security guard will aid in accounting for visitors, contractors, and truckers by reference to sign-in sheets available field office trailer.
- Personnel will be assigned by the PSO to be available at the main gate to direct and brief emergency responders.
- Re-entry into the site will be made only after clearance is given by the PSO. At his direction, a signal or other notification will be given for re-entry into the facility.
- Drills will be held periodically to practice all of these procedures and will be treated with the same seriousness as an actual emergency.

9.6 Emergency Spill Response Procedures and Equipment

In the event of an emergency involving a hazardous material spill or release, the following general procedures will be used for rapid and safe response and control of the situation. Emergency contacts found in **Table 9-3** provide a quick reference guide in the event of a major spill.

9.6.1 Notification Procedures

If an employee discovers a chemical spill or process upset resulting in a vapor or material release, he or she will immediately notify the PSO and the Marshall Fire Department. Report details of a release upon discovery to the Marshall Fire Department at phone number (903) 935-4580.

The PSO will obtain the following information:

- The material spilled or released
- Location of the release or spillage of hazardous material
- An estimate of quantity released and the rate at which it is being released
- The direction in which the spill, vapor, or smoke release is heading
- Injuries involved

- Fire and/or explosion or possibility of these events
- The area and materials involved and the intensity of the fire or explosion

This information will help the PSO to assess the magnitude and potential seriousness of the spill or release.

9.6.2 Procedure for Containing/Collecting Spills

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If a chemical spill is not contained within a dike or sump area, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or pipeline rupture, an initial isolation of at least 100 feet in all directions will be used. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe will require evacuation of at least 50 feet in all directions to allow cleanup and repair, and to prevent exposure. When spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area. If possible, the area will be roped or otherwise blocked off. If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire) and its release (due to high vapor pressures under ambient conditions), further evacuation will be enforced. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled. (Consult the North American Emergency Response Guide for isolation distances for listed hazardous materials.)

If an incident may threaten the health or safety of the surrounding community, the public will be informed and possibly evacuated from the area. The PSO will inform the local Fire Department who will, in turn, inform the proper agencies in the event this is necessary (refer to **Table 9-3**).

As called for in regulations developed under the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), the contractor shall report a spill of a pound or more of any hazardous material for which a reportable quantity has not been established and which is listed under the Solid Waste Disposal Act, Clean Air Act, Clean Water Act, or Toxic Substances Control Act. The contractor shall also follow the same practice for any substances not listed in the Acts noted above but which can be classified as a hazardous waste under the Resource Conservation and Recovery Act.

Cleanup personnel will take the following measures:

- Verify all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources and use spark and explosion-proof equipment for recovery of material.

- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- If wastes reach a storm sewer, try to dam the outfall by using sand, earth, sandbags, etc. If this is done, pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g., clay, sand, lime, etc.) to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, sand, clay or other appropriate material. If possible, use a diagram pump to transfer discharged liquid to drum or holding tank.

9.6.3 Emergency Response Equipment

The following equipment will be staged in the site area and throughout the site, as needed, to provide for safety and first aid during emergency responses:

- ABC-type fire extinguisher
- First aid kit, industrial size
- Eyewash/safety shower
- Emergency signal horn

9.6.4 Personal Protective Equipment

Emergency response personnel will have respirators available for use with cartridge selection determined by the PSO, based on the results of direct reading instruments. Emergency response personnel will also be provided with protective clothing as warranted by the nature of the hazardous material and as directed by the PSO.

9.6.5 Emergency Spill Response Cleanup Materials and Equipment

A sufficient supply of appropriate emergency response cleanup and PPE will be inventoried and inspected visually on a weekly basis. The materials will be kept on-site for spill control depending on the types of hazardous materials present on-site. The majority of this material will be located in the supply trailer, or storage area.

Contaminated soils, absorbent materials, solvents, and other materials resulting from the cleanup of spilled or discharged substances shall be properly stored, labeled, and disposed off site.

9.7 Emergency Response Contingency Plan

This section details the contingency measures the contractor will take to prepare for and respond to fires, explosions, spills, and releases of hazardous materials, hazardous weather, and medical emergencies.

The procedures listed below will be used to respond to medical emergencies. The PSO will contact the local hospital and inform them of the site hazards and potential emergency situations. A minimum of two First Aid/cardiopulmonary resuscitation (CPR)-trained personnel will be retained on site.

<u>Response</u>

The nearest workers will immediately assist a person who shows signs of medical distress or who is involved in an accident. The crew foreman will be summoned. The crew foreman will immediately make radio contact with the PSO to alert him of a medical emergency situation. The foreman will relay the following information:

- Location of the victim at the work site
- Nature of the emergency
- Whether the victim is conscious
- Specific conditions contributing to the emergency, if known

The following actions will then be taken depending on the severity of the incident:

- <u>Life-Threatening Incident</u> – If an apparent life-threatening condition exists, the crew foreman will call (903) 935-4580 and the Marshall Fire Department will send a rescue truck with EMS personnel. Additionally, the crew foreman will inform the PSO. An on-site person will be appointed to meet the rescue truck and direct the truck to the victim. Contractor personnel will evacuate any injured person within the site to a clean area for treatment by EMS personnel arriving with the rescue truck.
- <u>Non Life-Threatening Incident</u> – If it is determined that no threat to life is present, the PSO will direct the injured person through decontamination procedures (see below) appropriate to the nature of the illness or accident. Appropriate first aid or medical attention will then be administered. Injuries will be reported to the USACE Inspector or, in his absence, the Technical Manager.

Note: The area surrounding an accident site must not be disturbed until the scene has been cleared by the PSO.

Any personnel requiring emergency medical attention will be evacuated from the site if doing so would not endanger the life of the injured person or otherwise aggravate the injury. Personnel will not enter the area to attempt a rescue if their own lives would be threatened.

The decision whether or not to decontaminate a victim prior to evacuation is based on the type and severity of the illness or injury and the nature of the contaminant. For some emergency victims, immediate decontamination may be an essential part of life-saving first aid. For others, decontamination may aggravate the injury or delay life-saving first aid. Decontamination will be performed if it does not interfere with essential treatment. If decontamination can be performed, observe the following procedures:

- Wash external clothing and cut it away.

If decontamination cannot be performed, observe the following procedures:

- Wrap the victim in blankets or plastic to reduce contamination of other personnel.
- Alert emergency and off-site medical personnel to potential contamination, and instruct them about specific decontamination procedures.
- Send site personnel familiar with the incident and chemical safety information such as MSDSs, with the affected person.

Any injuries, no matter how small, will be reported to the PSO. An accident/injury/illness report will be completely and properly filled out and submitted to the HSM. A list of emergency telephone numbers is given in **Table 9-3**.

Notification The following personnel/agencies will be notified in the event of a medical emergency:

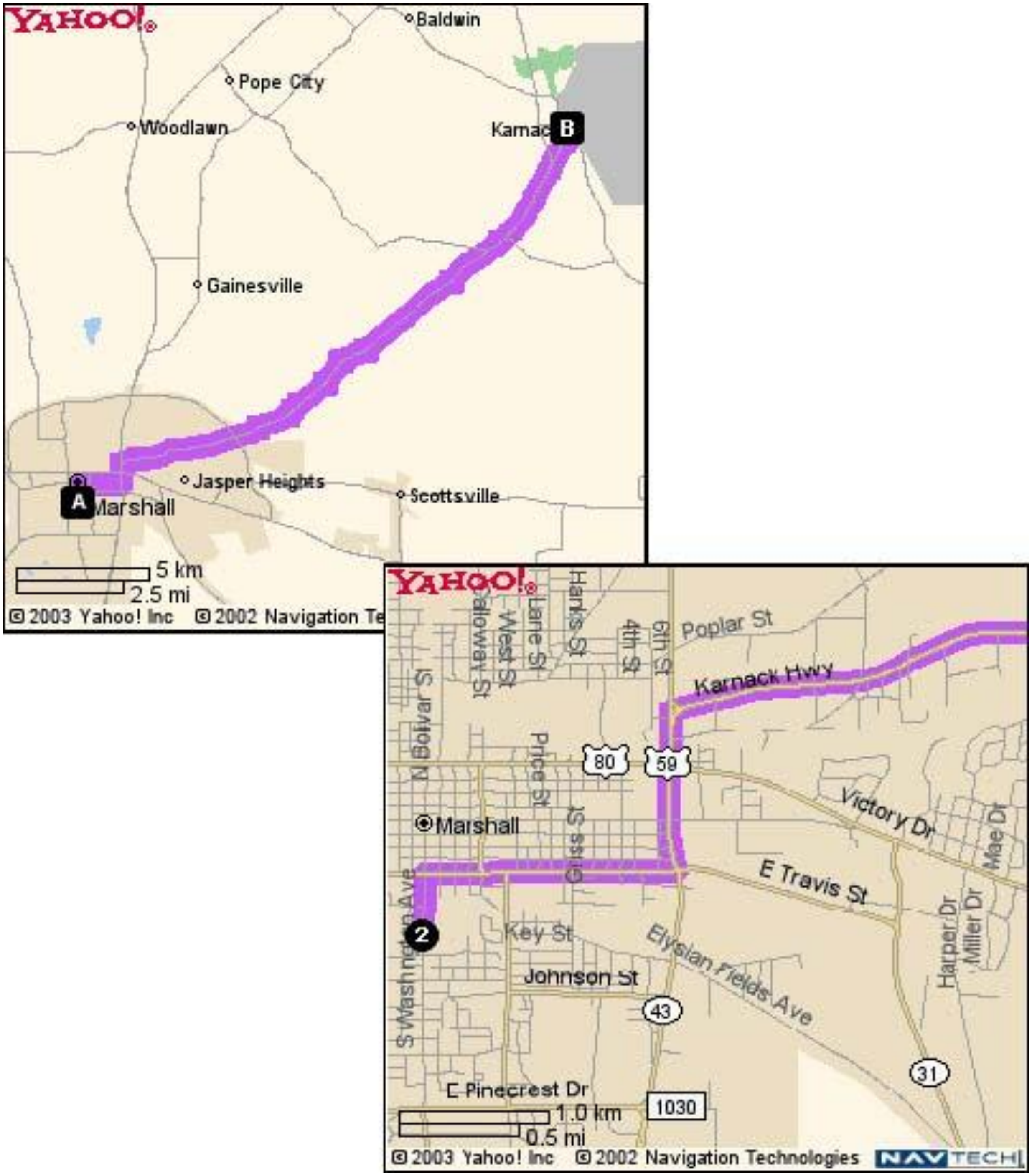
- Local Fire Department or EMS
- PSO
- Workers in the affected areas
- USACE Representative

Directions to Hospital

Written directions (see **Figure 9-1**) to the hospital are as follows: exit base, head southwest on Hwy 449. Hwy 449 will turn into Hwy 43 (Karnack Hwy). Turn left on Hwy 59. Turn right on E. Travis Street. Turn left on S. Washington Avenue. Marshall Regional Medical Center is located at 811 S. Washington Avenue.

For non emergencies:
Longview Occupational Medicine
950 N 4th Street
Longview, Texas 75601
903-757-0577

Figure 9-1
Route to Hospital – Marshall Regional Medical Center, 811 S. Washington Avenue



9.8 Fire Contingency Measures

Contractor personnel and subcontractors are not trained professional firefighters. Therefore, if there is any doubt that a fire cannot be quickly contained and extinguished, personnel will notify the PSO and vacate the structure or area. The PSO will immediately notify the local fire department.

The following procedures will be used to prevent the possibility of fires and resulting injuries:

- Sources of ignition will be distant from areas where flammable materials are handled or stored.
- The air will be monitored for explosivity before and during hot work and periodically where flammable materials are present. Hot work permits will be required for all such work.
- “No Smoking” signs will be conspicuously posted in areas where flammable materials are present.
- Fire extinguishers will be placed in areas where a fire hazard may exist.
- Before workers begin operations in an area, the foreman will give instructions on egress procedures and assembly points. Egress routes will be posted in work areas and exit points clearly marked.

The following procedures will be used in the event of a fire:

- Anyone who sees a fire will notify his supervisor, who will then contact the PSO by radio. The PSO will activate the emergency air horns and contact the local Fire Department.
- When the emergency siren sounds, workers will disconnect electrical equipment in use (if possible) and proceed to the nearest fire exit.
- Work crews will be comprised of pairs of workers (buddy system) who join each other immediately after hearing the fire alarm and remain together throughout the emergency. Workers will assemble at a predetermined rally point for a head count.
- When a small fire has been extinguished by a worker, the PSO will be notified.

9.9 Hazardous Weather Contingency Measures

Operations will not be started or continued when the following hazardous weather conditions are present:

- Lightning
- Heavy rains/snow
- High winds

9.9.1 Response

In the event contingency measures are put into effect, the following response(s) will be implemented:

- Excavation/soil stockpiles will be covered with a plastic liner.
- Equipment will be shut down and secured to prevent damage.
- Personnel will be moved to safe refuge. The PSO will determine when it is necessary to evacuate personnel to off-site locations and will coordinate efforts with fire, police, and other agencies.

9.9.2 Notification

The PSO will be responsible for assessing hazardous weather conditions and notifying personnel of specific contingency measures. Notifications will include the following:

- Contractor employees and subcontractors
- Client representative
- Local civil defense organization

9.9.3 Lightning Safety

As per recommendations of the National Lightning Safety Institute (NLSI), lightning safety should be practiced during thunderstorms. Measuring lightning's distance is useful. Using the flash/bang (F/B) technique, for every five seconds (from the time of seeing the lightning flash to hearing the associated thunder), lightning is 1 mile away. A F/B of 10 seconds equals 2 miles; a F/B of 20 seconds equals 4 miles, etc. The span of a lightning strike can be as much as 6 to 8 miles from the same point of origin. The NLSI recommends the 30/30 rule: suspend activities at the F/B of 30 (6 miles) or when first hearing thunder. Outdoor activities should not be resumed until 30 minutes have passed from the last observable thunder or lightning. If you are suddenly exposed to nearby lightning, adopt the so-called Lightning Safety Position (LSP). LSP means stay away from other people, take off all metal objects, crouch with feet together and head bowed, and place hands on ears to reduce acoustic shock from nearby thunder. When lightning threatens, standard safety measures should include: avoid water and all metal objects; get off the high ground including rooftop, platforms, and heavy equipment; avoid solitary trees; stay off the telephone**.**

9.10 Spill/Release Contingency Measures

In the event of release or spill of a hazardous material, the following measures will be taken.

- A person observing a spill or release will act to remove and/or protect injured/contaminated persons from any life-threatening situation. First aid and/or decontamination procedures will be implemented as appropriate

- First aid will be administered to injured/contaminated personnel. Unsuspecting persons/vehicles will be warned of the hazard. Personnel will act to prevent any unsuspecting persons from coming in contact with spilled materials by alerting other nearby persons of the spill hazard. Without taking unnecessary risks, personnel will attempt to stop the spill at the source. This may involve activities such as uprighting a drum, closing a valve, or temporarily sealing a hole with a plug

- The PSO will be notified of the spill/release, including information on material spilled, quantity, personnel injuries, and immediate life-threatening hazards. Air monitoring will be implemented by the PSO to determine the potential impact on the surrounding community. Notification procedures will be followed to inform on-site personnel and off-site agencies. The PSO will make a rapid assessment of the spill/release and direct confinement, containment, and control measures

Depending upon the nature of the spill, measures may include the following:

- Construction of a temporary containment berm utilizing on-site clay absorbent earth
- Digging a sump, installing a polyethylene liner, and diverting the spill material into the sump
- Placing drums under the leak to collect the spilling material before it flows over the ground
- Transferring the material from its original container to another container

The PSO will notify the designated Emergency Response Coordinator of the spill and of the steps taken to institute cleanup. Emergency response personnel will clean up all spills in accordance with the spill cleanup plan developed by the PSO. Supplies necessary to clean up a spill will be immediately available on site. Such items may include, but are not limited to, the following:

- Shovel, rake
- Clay absorbent
- Polyethylene liner
- PPE
- Steel drums
- Pumps and miscellaneous hand tools

The major supply of material and equipment will be located in the site area. Smaller supplies will be kept at active work locations. The PSO will inspect the spill site to determine if the spill has been cleaned up to the satisfaction of the designated Emergency Response Coordinator. If necessary, soil, water, or air samples may be taken and analyzed to demonstrate the effectiveness of the spill cleanup effort. The PSO will determine the cause of the spill and determine remedial steps to ensure that recurrence is prevented. The PSO will review the cause with the designated Emergency Response Coordinator and obtain his concurrence with the interim remedial action plan.

10.0 Training Requirements

As a requirement for work at this site, in a hazardous waste work area all field personnel will have completed a 40-hour HAZWOPER training class prior to job assignment. This training must cover the requirements in 29 CFR 1910.120, entitled Hazardous Waste Operations and Emergency Response, which includes PPE, toxicological effects of various chemicals, hazard communication, blood borne pathogens, handling of unknown tanks and drums, confined-space entry procedures, electrical safety, etc. In addition, all personnel must receive annual 8-hour refresher training and 3-day on-site training under a trained, experienced supervisor. Supervisory personnel shall have received an additional 8-hour training in handling hazardous waste operations.

All personnel entering the EZ will be trained in the provisions of this site safety plan and be required to sign the Site Safety Plan Acknowledgment in **Attachment 1** of this HASP.

Site-specific safety and health training for this project will be held at the site location by the PSO before any site work activities begin, and will include potential site contaminants, site physical and environmental hazards, emergency response and evacuation procedures, and emergency telephone numbers.

10.1 Daily and Periodic Safety Training

Daily “Tailgate” safety meetings will be held prior to each shift where health and safety problems and issues are discussed. “Phase Safety” briefings will be held prior to the commencement of a new task where task-specific risks and precautions are discussed. Attendance is mandatory and will be documented.

11.0 Medical Surveillance Program

Contractor personnel shall participate in a medical and health monitoring program meeting the requirements of OSHA Standard 29 CFR 1910.120/1926.65(f). The contractor HSM will be immediately notified of any suspected exposures to hazardous materials/wastes.

12.0 References

National Institute for Occupational Safety and Health (NIOSH)/U.S. Coast Guard/U.S. Environmental Protection Agency/U.S. Occupational Safety and Health Administration, 1985, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, DHAS/NIOSH Publication Number 85-115, Washington, D.C.

U.S. Army Corps of Engineers, 2008, *Safety and Health Requirements Manual*, EM-385-1-1, Washington, D.C.

U.S. Environmental Protection Agency, 1998, *Standard Operating Safety Guidelines*, Washington, D.C.

Attachment 1

Site Safety and Health Plan Worker Acknowledgement

WORKER ACKNOWLEDGMENT TO HEALTH AND SAFETY PLAN

I HAVE BEEN TRAINED ON THE SAFETY PLAN FOR THIS SITE AND FULLY UNDERSTAND ITS CONTENTS

NAME	SIGNATURE	EMP. No.	DATE

Attachment 2

Health and Safety Forms

(For Safety Staff only)	REPORT NO.	EROC CODE	**UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT** *(For Use of this Form See Help Menu and USACE Suppl to AR 385-40)*	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1\. **ACCIDENT CLASSIFICATION**

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2\. **PERSONAL DATA**

a. Name *(Last, First, MI)*

b. AGE

c. SEX ☐ MALE ☐ FEMALE

d. SOCIAL SECURITY NUMBER

e. GRADE

f. JOB SERIES/TITLE

g. DUTY STATUS AT TIME OF ACCIDENT
☐ ON DUTY ☐ TDY
☐ OFF DUTY

h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER
☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL
☐ TEMPORARY ☐ STUDENT
☐ OTHER *(Specify)* ____________

3\. **GENERAL INFORMATION**

a. DATE OF ACCIDENT *(month/day/year)*

b. TIME OF ACCIDENT *(Military time)* hrs

c. EXACT LOCATION OF ACCIDENT

d. CONTRACTOR'S NAME
(1) PRIME:
(2) SUBCONTRACTOR:

e. CONTRACT NUMBER ____________
☐ CIVIL WORKS ☐ MILITARY
☐ OTHER *(Specify)* ____________

f. TYPE OF CONTRACT
☐ CONSTRUCTION ☐ SERVICE
☐ A/E ☐ DREDGE
☐ OTHER *(Specify)* ____________

g. HAZARDOUS/TOXIC WASTE ACTIVITY
☐ SUPERFUND ☐ DERP
☐ IRP ☐ OTHER *(Specify)*
____

4\. **CONSTRUCTION ACTIVITIES ONLY** *(Fill in line and corresponding code number in box from list - see help menu)*

a. CONSTRUCTION ACTIVITY ____________ (CODE) #

b. TYPE OF CONSTRUCTION EQUIPMENT ____________ (CODE) #

5\. INJURY/ILLNESS INFORMATION *(Include name on line and corresponding code number in box for items e, f & g - see help menu)*

a. SEVERITY OF ILLNESS/INJURY ____________ (CODE) #

b. ESTIMATED DAYS LOST

c. ESTIMATED DAYS HOSPITALIZED

d. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED
PRIMARY ____________ (CODE) #
SECONDARY ____________ (CODE) #

f. NATURE OF ILLNESS/INJURY ____________ (CODE) #

g. TYPE AND SOURCE OF INJURY/ILLNESS
TYPE ____________ (CODE) #
SOURCE ____________ (CODE) #

6\. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see help menu)*

a. ACTIVITY AT TIME OF ACCIDENT ____________ (CODE) #

b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7\. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE
☐☐ PICKUP/VAN ☐☐ AUTOMOBILE
☐☐ TRUCK ☐☐ OTHER *(Specify)*
____

b. TYPE OF COLLISION
☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END
☐ BROADSIDE ☐ ROLL OVER ☐ BACKING
☐ OTHER *(Specify)* ____________

c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
(1) FRONT SEAT			
(2) REAR SEAT			

8\. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	b. OWNERSHIP	c. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9\. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and correspondence code number in box from list - see help menu)*

a. TYPE OF VESSEL/FLOATING PLANT ____________ (CODE) #

b. TYPE OF COLLISION/MISHAP ____________ (CODE) #

10\. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

11. **CAUSAL FACTOR(S)** *(Read Instruction Before Completing)*

a. (Explain YES answers in item 13)	YES	NO
DESIGN: Was design of facility, workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐

a. *(CONTINUED)*	YES	NO
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?	☐	☐
OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?	☐	☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident	☐	☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. **TRAINING**

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING.	c. DATE OF MOST RECENT FORMAL TRAINING.
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	(Month) (Day) (Year)

13. **FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES** *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE

b. INDIRECT CAUSE(S)

14. **ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).**

DESCRIBE FULLY:

15. **DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.**

a. BEGINNING (Month/Day/Year)

b. ANTICIPATED COMPLETION (Month/Day/Year)

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT

CORPS ____________________

CONTRACTOR ____________________

d. DATE *(Mo/Da/Yr)*

e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*

f. OFFICE SYMBOL

16. **MANAGEMENT REVIEW** *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. **MANAGEMENT REVIEW** *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. **SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW**

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. **COMMAND APPROVAL**

COMMENTS

COMMANDER SIGNATURE	DATE

*U.S. GOVERNMENT PRINTING OFFICE: 1993-0-791-757

10. ACCIDENT DESCRIPTION *(Continuation)*

13a. DIRECT CAUSE *(Continuation)*

13b. **INDIRECT CAUSES** *(Continuation)*

14. **ACTION(S) TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE(S)** *(Continuation)*

OPERATORS DAILY MEMO
AND
SAFETY INSPECTION

Equipment Type: ____ **No.** ___________________

Shift: ____ **Date:** __________________

Adjustment or repairs needed: ____

REVERSE SIDE MUST BE COMPLETED

SAFETY INSPECTION

ITEM INSPECTED	CHECK ONE ONLY		
Service, Parking & Emergency Brakes	**OK**	**N/A**	**REPAIR**
Steering Mechanism			
Tires, Wheel Nuts			
Lights, Reflectors			
Coupling Device			
Operating Controls			
Windshield Wiper			
Horn			
Back Up Alarm			
Seat Belts			
Fire Extinguisher			
Roadside Reflectors or Flares			

Operator

Date

AUTOMOTIVE: AUTOMOBILE AND PICKUP
Safety and Preventive Maintenance Inspection

Number:	**Hours/Miles:**	**Contract Number:**	**Date:**

Item	**Check One Only**			**Explain Deficiencies**
	OK	**N/A**	**Repair**	
Hom & Mirrors				
Lights/Tum Signals				
Cab/Glass/Wipers				
Emergency Brake				
Service Brakes				
Clutch Operation				
Seat ConditionlBelts				
Gauges				
Radiator & Hoses				
Fluid Levels/Condition				
Belts - Wear & Tension				
Smog System & Hoses				
Intake System				
Battery & Wiring				
Line Operation				
Engine Leaks				
Front Suspension				
Exhaust System				
Rear Suspension				
Transmission Leaks				
Transfer Case Leaks				
Differential Seal(s)				
U-Joints				
Body Condition/Paint				
Wheels & Tires				
Jack and Lug Wrench				
Road Test				
CONDITION: Average percent of wear remaining %				

Additional items or information:

____

____

____

____

____

____

____

This is a visual inspection of machines to check for obvious safety and mechanical deficiencies. Minor adjustments, loose bolts or brackets, light bulb changes, etc., should be taken care of at time of inspection. Defects observed but not on checklist should be noted at bottom of inspection form.

Horn/Mirror	Check condition and operation
Lights/Turn Signals	Check condition and operation
Cab/Glass/Wipers	Check condition, operation and cleanliness
Emergency Brake	Check operation
Service Brakes	Check operation
Clutch Operation	Check operation, automatic or manual
Seat Condition/Belts	Check seat belts and seat
Gauges	Check for operation and normal readings
Radiator and Hoses	Check condition and for leaks
Fluid Levels	Check all fluid levels and condition of fluids
Belts/Wear/Tension	Check adjustment and condition of belts
Smog System and Hoses	Look for cracked or uncoupled vacuum hoses
Air Intake System	Check filter lamps and for leaks
Battery and Wiring	Check electrolyte for clean terminals and cuffed or mislocated wiring
Engine Operation	Check at idle and during road test
Engine Leaks	Check for oil, water and vacuum leaks
Front Suspension	Look for abnormal tire wear, shock, tie rod and steering component wear
Exhaust System	Check for exhaust leaks, muffler and exhaust pipe brackets and clamps
Rear Suspension	Check shocks, springs and shackles
Transmission	Check for leaks an mounts
Transfer Case	Check for leaks and mounting bolts
Differential Seal	Check clamp bolts and bearings
U-Joints	Check clamp bolts and bearings
Body Condition/Paint	Check for dents, loose body parts and paint condition
Wheels & Tires	Check wheel condition and for sufficient tread for driving conditions
Jack and Lug Wrench	Are they in vehicle?
Road Test	Check operation of vehicle systems including steering, suspension, brake and drive train operation

Additional items or information not included:

Note any unsafe condition or mechanical deficiencies on items not covered above.

Inspected By:____ Date:________________________

DRILL RIG INSPECTION CHECK LIST

Inspection Item	Adequate	Requires Attention	Not Applicable	Action Taken to Effect Repair
RIG SET-UP				
Emergency				
Communication				
Layout Provides Safe Access				
Fire Breaks				
Flood/Storm Protection				
Combustible Materials Cleared				
Pipe Rack Stability				
Steps and Ladders Secure				
Platforms and Decks Clean				
COLLAR STABILITY				
Collar Installation				
Seal Around Collar				
Flow Line and Trough Condition				
WARNING EQUIPMENT				
Gas Detectors				
Pressure Gauges				
Pit Level Float Indicators				
Mast Power Line Warning Device				
SAFETY				
Regular Safety Meetings				
Safety and First Aid Training				
First Aid Kit				
Regular Fire Drill				
Fire Extinguisher				
Personnel Issued Safety Equipment				
Safety Belts and Lifelines				
General Housekeeping				
General Servicing				
MAST				
Pivots and Locks				
Conditions of Structures				
Condition of Guy Ropes and Anchors				
Fingers and Racking Platform				
Alignment with Hole				
Emergency Escape Device				
HOISTING EQUIPMENT				
Cable Condition and Fixing				
Sheaves and Blocks				
Wireline Equipment				

DRILL RIG INSPECTION CHECK LIST

Inspection Item	Adequate	Requires Attention	Not Applicable	Action Taken to Effect Repair
Hoist Drums and Brakes				
Hook Latch and Clevis				
Hoist Mountings				
Guards and Mountings				
HANDLING EQUIPMENT				
Hoist Plugs and Elevators				
Slips and Clamps				
Slings and Shackles				
Safety Clamps				
Rig Tongs and Wrenches				
Casing Handling Equipment				
DRIVE AND POWER SYSTEMS				
Fuel Lines and Filters, Oil Filters				
Guards on Moving Parts				
Engine Starting				
Clutches and Clutch Adjustment				
Chain and Belt Condition				
Chain and Belt Drive Adjustment				
Universal Joints				
Control Linkage and Lines				
Hydraulic Controls and Lines				
Emergency Engine Shut Down				
ROTATING AND DRILLING SYSTEM				
Rotary Head and Pitman Bearings				
Table Bushings and Chuck Jaws				
Alignment with Hole				
Bushes				
Kelly Drive Pins and Bushings				
Kelly Sub Treads				
Drill Pipe				
Thread Adaptors				
Stabilizers and Reamers				
Drill Bits				
CIRCULATING SYSTEM				
Pressure Rating of Fittings				
Guards on Pump and Relief Valve				
Condition of Mixing Equipment				
Hoses and Safety Chains				

DRILL RIG INSPECTION CHECK LIST

Inspection Item	Adequate	Requires Attention	Not Applicable	Action Taken to Effect Repair
Compressor Unloading Valve				
Air Tank Drains				
Swivel Packings and Bearings				
Pump Gland Packings				
Mud Test Equipment				
Mud Tank and Water Tank Condition				
HAND AND POWER TOOLS				
Wrench Handles and Jaws				
Condition of Spanners, Hammers, etc.				
Inventory and Storage				
Guards on Power Tools				
Cables and Hoses to Power Tools				
Earth Leakage Circuit Breakers				

DAILY SAFETY TRAINING MEETINGS

Date of Training:	
Crew:	**Craft(s):**

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1.

2.

3.

REMARKS

Total Employees on Crew(s):	**Total in Attendance:**

SIGNATURE OF EMPLOYEES ATTENDING

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor:	**Job Title:**

WEEKLY SAFETY TRAINING MEETINGS

Date of Training:

Crew:	**Craft(s):**

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1.

2.

3.

REMARKS

Total Employees on Crew(s):	**Total in Attendance:**

SIGNATURE OF EMPLOYEES ATTENDING

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor:	**Job Title:**

MONTHLY SAFETY TRAINING MEETINGS

Date of Training:

Crew:

Craft(s):

BRIEFLY DESCRIBE SPECIFIC TRAINING TOPICS COVERED

1.

2.

3.

REMARKS

Total Employees on Crew(s):

Total in Attendance:

SIGNATURE OF EMPLOYEES ATTENDING

Complete all sections fully and submit to the Project Supervisor or Safety Representative

Supervisor:

Job Title:

Project Name:__________________________________
Project Location:__________________________________

AIR SAMPLING DATA FORM

SAMPLING INFORMATION

Date Started:__________________________________
Date Completed:__________________________________

Type of Meter:__________________________________
Date Calibrated:__________________________________
Other Notes:__________________________________

	STATION NO. 1	STATION NO. 2	STATION NO. 3	STATION NO. 4	STATION NO. 5	STATION NO. 6	STATION NO. 7	STATION NO. 8
TIME								
READING								
TIME								
READING								
TIME								
READING								
TIME								
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TIME								
READING								
TIME								
READING								
TIME								
READING								
TIME								
READING								

Comments:

NR= Not Recorded

Attachment 3

Material Safety Data Sheets

Tetrachloroethene
Trichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
Antimony
Thallium

International Chemical Safety Cards

TETRACHLOROETHYLENE

ICSC: 0076

TETRACHLOROETHYLENE
1,1,2,2-Tetrachloroethylene
Perchloroethylene
Tetrachloroethene
$C_2Cl_4/Cl_2C=CCl_2$
Molecular mass: 165.8

CAS # 127-18-4
RTECS # KX3850000
ICSC # 0076
UN # 1897
EC # 602-028-00-4

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE		STRICT HYGIENE!	
• **INHALATION**	Incoordination. Exhilaration. Dizziness. Drowsiness. Headache. Nausea. Weakness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness. Skin burns. Blisters.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety goggles, face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled	Separated from metals (see Chemical	Do not transport with food and feedstuffs.

liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place.	Dangers), food and feedstuffs. Keep in the dark. Ventilation along the floor.	IMO: Marine Pollutant Xn symbol R: 40 S: 23-36/37 UN Hazard Class: 6.1 UN Packing Group: III
SEE IMPORTANT INFORMATION ON BACK		
ICSC: 0076	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993	

TETRACHLOROETHYLENE

ICSC: 0076

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air. **CHEMICAL DANGERS:** On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes (hydrogen chloride, phosgene, chlorine). The substance decomposes slowly on contact with moisture producing trichloroacetic acid and hydrochloric acid. Reacts with metals such as aluminium, lithium, barium, berrylium. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 50 ppm; 339 mg/m^3 (STEL): 200 ppm; 1357 mg/m^3 (ACGIH 1992-1993).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidney. Tumours have been detected in experimental animals but may not be relevant to humans (see Notes).
PHYSICAL PROPERTIES	Boiling point: 121°C Melting point: -22°C Relative density (water = 1): 1.6 Solubility in water, g/100 ml at 20°C: 0.015	Vapour pressure, kPa at 20°C: 1.9 Relative vapour density (air = 1): 5.8 Relative density of the vapour/air-mixture at 20°C (air = 1): 1.09 Octanol/water partition coefficient as log Pow: 2.6
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to indoor air and water.	
NOTES		
Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Technical grades may contain small amounts of carcinogenic stabilizers.		

Transport Emergency Card: TEC (R)-722
NFPA Code: H2; F0; R0;

ADDITIONAL INFORMATION

ICSC: 0076 **TETRACHLOROETHYLENE**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

International Chemical Safety Cards

TRICHLOROETHYLENE

ICSC: 0081

TRICHLOROETHYLENE
1,1,2-Trichloroethylene
Trichloroethene
Ethylene trichloride
C_2HCl_3/$ClCH=CCl_2$
Molecular mass: 131.4

CAS # 79-01-6
RTECS # KX4550000
ICSC # 0081
UN # 1710
EC # 602-027-00-9

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. See Notes.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION	Risk of fire and explosion (see Chemical Dangers).		In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE			
• **INHALATION**	Dizziness. Drowsiness. Headache. Weakness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING

Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place (extra personal protection: self-contained breathing apparatus).	Separated from metals (see Chemical Dangers), strong bases, food and feedstuffs. Dry. Keep in the dark. Ventilation along the floor.	Do not transport with food and feedstuffs. IMO: Marine Pollutant Xn symbol R: 40 S: 23-36/37 UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0081	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993

TRICHLOROETHYLENE

ICSC: 0081

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air. As a result of flow, agitation, etc., electrostatic charges can be generated. **CHEMICAL DANGERS:** On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes (phosgene, hydrogen chloride, chlorine). The substance decomposes on contact with strong alkali producing dichloroacetylene , which increases fire hazard. Reacts violently with metals such as lithium, magnesium aluminium, titanium, barium and sodium. Slowly decomposed by light in presence of moisture, with formulation of corrosive hydrochloric acid. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 50 ppm; 269 mg/m^3 (STEL): 200 ppm; 1070 mg/m^3 (ACGIH 1992-1993).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes and the skin. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. Exposure could cause lowering of consciousness. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidney (see notes).
PHYSICAL PROPERTIES	Boiling point: 87°C Melting point: -73°C Relative density (water = 1): 1.5 Solubility in water, g/100 ml at 20°C: 0.1 Vapour pressure, kPa at 20°C: 7.8	Relative vapour density (air = 1): 4.5 Relative density of the vapour/air-mixture at 20°C (air = 1): 1.3 Auto-ignition temperature: 410°C Explosive limits, vol% in air: 8-10.5 Octanol/water partition coefficient as log Pow: 2.42
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to water organisms.	

NOTES

Combustible vapour/air mixtures difficult to ignite, may be developed under certain conditions. Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Technical grades may contain small amounts of carcinogenic stabilizers.

Transport Emergency Card: TEC (R)-723
NFPA Code: H2; F1; R0;

ADDITIONAL INFORMATION

ICSC: 0081 **TRICHLOROETHYLENE**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

International Chemical Safety Cards

1,1,1-TRICHLOROETHANE

ICSC: 0079

1,1,1-TRICHLOROETHANE
Methyl chloroform
Methyltrichloromethane
alpha-Trichloroethane
$C_2H_3Cl_3$ / CCl_3CH_3
Molecular mass: 133.4

CAS # 71-55-6
RTECS # KJ2975000
ICSC # 0079
UN # 2831
EC # 602-013-00-2

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. Heating will cause rise in pressure with risk of bursting. See Notes. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS!	
• **INHALATION**	Ataxia. Dizziness. Drowsiness. Headache. Nausea. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Diarrhoea. Nausea. Vomiting (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for

			medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable, suitable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT let this chemical enter the environment (extra personal protection: self-contained breathing apparatus).	Provision to contain effluent from fire extinguishing. Separated from food and feedstuffs and incompatible materials (see Chemical Dangers). Cool. Dry. Ventilation along the floor.	Do not transport with food and feedstuffs. Xn symbol N symbol R: 20-59 S: (2-)24/25-59-61 Note: F UN Hazard Class: 6.1 UN Packing Group: III Marine pollutant.

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0079

1,1,1-TRICHLOROETHANE

ICSC: 0079

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air. **CHEMICAL DANGERS:** The substance decomposes on heating or on burning producing toxic and corrosive fumes including phosgene and hydrogen chloride. Reacts violently with aluminium, manganese and their alloys, alkalis, strong oxidants, acetone and zinc. Attacks natural rubber. Mixtures of 1,1,1-trichloroethane with potassium or its alloys are shock sensitive. Reacts slowly with water releasing corrosive hydrochloric acid. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 350 ppm; 1910 mg/m^3 (as TWA); 450 ppm; 2460 mg/m^3 (as STEL) (ACGIH 1994-1995).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its vapour and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin and the respiratory tract. The substance may cause effects on the heart and central nervous system, kidneys and liver , resulting in cardiac disorders and respiratory failure. Exposure at high level may result in death. Medical observation is indicated. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin. The substance may have effects on the liver.
PHYSICAL PROPERTIES	Boiling point: 74°C Melting point: -30°C	Relative vapour density (air = 1): 4.6 Flash point: see Notes°C

	Relative density (water = 1): 1.34 Solubility in water: none Vapour pressure, kPa at 20°C: 13.3	Auto-ignition temperature: 537°C Explosive limits, vol% in air: 8-16 Octanol/water partition coefficient as log Pow: 2.49
ENVIRONMENTAL DATA	The substance is harmful to aquatic organisms. This substance may be hazardous to the environment; special attention should be given to air and ground water.	

NOTES

Combustible vapour/air mixtures difficult to ignite, may be developed under certain conditions. The substance burns only in excess oxygen or if a strong source of ignition is present. Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Aerothene, Algylen, Trichloran, Chlorylen, Genklene, Chlorothene NU, Chlorothene VG, and Solvent 111 are trade names.

Transport Emergency Card: TEC (R)-721
NFPA Code: H2; F1; R0

ADDITIONAL INFORMATION

ICSC: 0079 **1,1,1-TRICHLOROETHANE**

International Chemical Safety Cards

1,1,2-TRICHLOROETHANE

ICSC: 0080

1,1,2-TRICHLOROETHANE
Vinyl trichloride
Beta-trichloroethane
$C_2H_3Cl_3$ / $CHCl_2CH_2Cl$
Molecular mass: 133.4

CAS # 79-00-5
RTECS # KJ3150000
ICSC # 0080
UN # 3082
EC # 602-014-00-8

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. Heating will cause rise in pressure with risk of bursting. See Notes.	NO open flames. NO contact with hot surfaces.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	See Notes.		In case of fire: cool drums, etc., by spraying with water but avoid contact of the substance with water.
EXPOSURE		PREVENT GENERATION OF MISTS!	
• **INHALATION**	Dizziness. Drowsiness. Headache. Nausea. Shortness of breath. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
• **SKIN**	MAY BE ABSORBED! Dry skin.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
• **EYES**		Safety spectacles, or face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	(Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Refer for medical

			attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT let this chemical enter the environment (extra personal protection: self-contained breathing apparatus).	Provision to contain effluent from fire extinguishing. Separated from strong oxidants, strong bases, many metals. Well closed. Ventilation along the floor.	Xn symbol R: 20/21/22 S: (2-)9 UN Hazard Class: 9 UN Packing Group: III Marine pollutant.
SEE IMPORTANT INFORMATION ON BACK		
ICSC: 0080	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993	

1,1,2-TRICHLOROETHANE

ICSC: 0080

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air. **CHEMICAL DANGERS:** On contact with hot surfaces or flames this substance decomposes forming hydrogen chloride (see ICSC # 0163), phosgene (see ICSC # 0007), and other toxic gases. Reacts with strong oxidizers, strong bases and metals such as sodium, potassium, magnesium and powdered aluminium. Attacks many plastics, rubber, steel and zinc. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 10 ppm; 55 mg/m^3 (as TWA) (skin) (ACGIH 1993-1994).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its vapour, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C . **EFFECTS OF SHORT-TERM EXPOSURE:** The substance may cause effects on the central nervous system, kidneys, liver , resulting in central nervous depression, liver impairment and kidney impairment. Exposure at high levels may result in unconsciousness. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin.
PHYSICAL PROPERTIES	Boiling point: 114°C Melting point: -36°C Relative density (water = 1): 1.44 Solubility in water: none	Relative vapour density (air = 1): 4.6 Relative density of the vapour/air-mixture at 20°C (air = 1): 4.6 Explosive limits, vol% in air: 6-15.5

	Vapour pressure, kPa at 20°C: 2.5	Octanol/water partition coefficient as log Pow: 2.35
ENVIRONMENTAL DATA	The substance is harmful to aquatic organisms.	

NOTES

Flash point unknown in literature. Combustible vapour/air mixtures difficult to ignite, may be developed under certain conditions. Use of alcoholic beverages enhances the harmful effect. The relation between odour and the occupational exposure limit cannot be indicated. Do NOT use in the vicinity of a fire or a hot surface, or during welding.

NFPA Code: H 3; F 1; R 0;

ADDITIONAL INFORMATION

ICSC: 0080 **1,1,2-TRICHLOROETHANE**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

International Chemical Safety Cards

VINYLIDENE CHLORIDE

ICSC: 0083

VINYLIDENE CHLORIDE
1,1-Dichloroethene
1,1-Dichloroethylene
VDC
$C_2H_2Cl_2/H_2C=CCl_2$
Molecular mass: 97

CAS # 75-35-4
RTECS # KV9275000
ICSC # 0083
UN # 1303 (inhibited)
EC # 602-025-00-8

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Extremely flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive. Vinyl chloride monomer vapours are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in blockage of vents.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep drums, etc., cool by spraying with water. Combat fire from a sheltered position.
EXPOSURE		STRICT HYGIENE!	
• **INHALATION**	Dizziness. Drowsiness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Redness. Skin burns.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain. Sore throat (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place (extra personal protection: complete protective clothing including self-contained breathing apparatus).	Fireproof. Separated from incompatible materials (see Chemical Dangers). Cool. Keep in the dark. Store only if stabilized.	Airtight. Unbreakable packaging; put breakable packaging into closed unbreakable container. IMO: Marine Pollutant F+ symbol Xn symbol R: 12-20-40 S: 7-16-29 Note: D UN Hazard Class: 3 UN Packing Group: I

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0083

VINYLIDENE CHLORIDE

ICSC: 0083

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** VOLATILE COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air and may travel along the ground; distant ignition possible. **CHEMICAL DANGERS:** The substance can readily form explosive peroxides. The substance will polymerize readily due to heating or under the influence of oxygen, sunlight, copper or aluminium, with fire or explosion hazard. May explode on heating or on contact with flames. The substance decomposes on burning producing toxic and corrosive fumes (hydrogen chloride, phosgene and chlorine). Reacts violently with oxidants. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 5 ppm; 20 mg/m^3 (STEL): 20 ppm; 79 mg/m^3 (ACGIH 1992-1993).	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidneys.
PHYSICAL PROPERTIES	Boiling point: 32°C Melting point: -122°C Relative density (water = 1): 1.2 Solubility in water, g/100 ml at 25°C: 0.25 Vapour pressure, kPa at 20°C: 66.5 Relative vapour density (air = 1): 3.3	Relative density of the vapour/air-mixture at 20°C (air = 1): 2.5 Flash point: 5.6°C Auto-ignition temperature: 570°C Explosive limits, vol% in air: 5.6-16 Octanol/water partition coefficient as log Pow: 1.32
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to water organisms. In the food chain important to humans, bioaccumulation takes place, specifically in plants.	

NOTES

Contains inhibitors (e.g. methoxyphenol). Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding.

Transport Emergency Card: TEC (R)-641
NFPA Code: H2; F4; R2;

ADDITIONAL INFORMATION

ICSC: 0083 **VINYLIDENE CHLORIDE**

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International Chemical Safety Cards

1,2-DICHLOROETHANE

ICSC: 0250

1,2-DICHLOROETHANE
Ethylene dichloride
1,2-Ethylene dichloride
Ethane dichloride
$ClCH_2CH_2Cl$ / $C_2H_4Cl_2$
Molecular mass: 98.96

CAS # 107-06-2
RTECS # KI0525000
ICSC # 0250
UN # 1184
EC # 602-012-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Prevent build-up of electrostatic charges (e.g., by grounding). Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
• **INHALATION**	Abdominal pain. Cough. Dizziness. Drowsiness. Headache. Nausea. Sore throat. Unconsciousness. Vomiting. Symptoms may be delayed (see Notes).	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
• **EYES**	Redness. Pain. Blurred vision.	Safety goggles, face shield, or eye protection in combination with	First rinse with plenty of water for several minutes (remove contact

		breathing protection.	lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal cramps. Diarrhoea (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Give nothing to drink. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer (extra personal protection: self-contained breathing apparatus).	Fireproof. Separated from strong oxidants, food and feedstuffs and other incompatible substances (see Chemical Dangers). Cool. Dry.	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs. F symbol T symbol R: 45-11-22-36/37/38 S: 53-45 Note: E UN Hazard Class: 3 UN Subsidiary Risks: 6.1 UN Packing Group: II Marine pollutant.
SEE IMPORTANT INFORMATION ON BACK		
ICSC: 0250	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993	

1,2-DICHLOROETHANE

ICSC: 0250

IMPORTANT DA

PHYSICAL STATE; APPEARANCE:
COLOURLESS, VISCOUS LIQUID , WITH CHARACTERISTIC ODOUR. TURNS DARK ON EXPOSURE TO AIR, MOISTURE AND LIGHT.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible. As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
The substance decomposes on heating and on burning producing toxic and corrosive fumes including hydrogen chloride (ICSC # 0163) and phosgene (ICSC # 0007). Reacts violently with aluminium, alkali metals, alkali amides, ammonia, bases, strong oxidants. Attacks many metals in presence of water. Attacks plastic.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: 10 ppm; 40 mg/m^3 (as TWA) (ACGIH 1994-1995).

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its vapour, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20°C.

EFFECTS OF SHORT-TERM EXPOSURE:
The vapour irritates the eyes, the skin and the respiratory tract. Inhalation of the vapour may cause lung oedema (see Notes). The substance may cause effects on the central nervous system, kidneys, liver , resulting in impaired functions.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. This substance is probably carcinogenic to humans.

T **A**		
PHYSICAL PROPERTIES	Boiling point: 83.5°C Melting point: -35.7°C Relative density (water = 1): 1.235 Solubility in water, g/100 ml: 0.87 Vapour pressure, kPa at 20°C: 8.7 Relative vapour density (air = 1): 3.42	Relative density of the vapour/air-mixture at 20°C (air = 1): 1.2 Flash point: 13°C c.c. Auto-ignition temperature: 413°C Explosive limits, vol% in air: 6.2-16 Octanol/water partition coefficient as log Pow: 1.48
ENVIRONMENTAL DATA		

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorized by him/her, should be considered.

Transport Emergency Card: TEC (R)-605
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION

ICSC: 0250 **1,2-DICHLOROETHANE**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

MSDS Number: **A7152** * * * * * *Effective Date:* ***08/02/00*** * * * * * *Supercedes:* ***09/08/97***

MSDS *Material Safety Data Sheet*

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Antimony

1. Product Identification

Synonyms: Stibium, C.I. 77050
CAS No.: 7440-36-0
Molecular Weight: 121.75
Chemical Formula: Sb
Product Codes: 0848

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Antimony	7440-36-0	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF INHALED. CAUSES IRRITATION. TARGET ORGAN(S): Respiratory system, cardiovascular system, eyes, skin.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 1 - Slight
Reactivity Rating: 2 - Moderate
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Is harmful may be fatal.
Ingestion:
None identified.
Skin Contact:
Prolonged contact may cause dermatitis.
Eye Contact:
None identified.
Chronic Exposure:
Kidney damage, liver damage.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Prompt action is essential.
Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
In case of contact, flush skin with water.
Eye Contact:
In case of eye contact, immediately flush with plenty of water for at least 15 minutes.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
Can be an explosion hazard, especially when heated.
Fire Extinguishing Media:
Use extinguishing media appropriate for surrounding fire.
Special Information:
No information found.

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6. Accidental Release Measures

Wear self-contained breathing apparatus and full protective clothing. With clean shovel, carefully place material into clean, dry container and cover; remove from area. Flush spill area with water.

---

7. Handling and Storage

Keep container tightly closed. Store in secure poison area. Keep product out of light. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
0.5 mg/m3 (TWA)

-ACGIH Threshold Limit Value (TLV):
0.5 mg/m3 (TWA)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to the substance is apparent, consult an industrial hygienist. For emergencies, or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:

Silvery-white metal.

Odor:

No information found.

Solubility:

Negligible (< 0.1%)

Specific Gravity:

6.68

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

1635C (2975F)

Melting Point:

630C (1166F)

Vapor Density (Air=1):

4.2

Vapor Pressure (mm Hg):

Not applicable.

Evaporation Rate (BuAc=1):

No information found.

---

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

No information found.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizing agents, strong acids, halogen acids, chlorine, fluorine.

Conditions to Avoid:

Heat, Light.

11. Toxicological Information

--------\Cancer Lists\--

	---NTP Carcinogen---		
Ingredient	Known	Anticipated	IARC Category
Antimony (7440-36-0)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Antimony (7440-36-0)	Yes	Yes	No	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Antimony (7440-36-0)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.

```
  -----------------------------------------  ---   -----   ----   --------------
  Antimony (7440-36-0)                        No    No      Yes    Antimony com

  --------\Federal, State & International Regulations - Part 2\----------------
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Antimony (7440-36-0)                        5000       No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF INHALED. CAUSES IRRITATION. TARGET ORGAN(S): Respiratory system, cardiovascular system, eyes, skin.
Label Precautions:
Avoid contact with eyes, skin, clothing.
Do not breathe dust. Keep in tightly closed container. Use with adequate ventilation. Wash thoroughly after handling.
Label First Aid:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Prompt action is essential. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse.
Product Use:
Laboratory Reagent.
Revision Information:
No changes.
Disclaimer:
****
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

International Chemical Safety Cards

THALLIUM

ICSC: 0077

THALLIUM
Ramor
Thallium (metal)
Tl
Atomic mass: 204.4

CAS # 7440-28-0
RTECS # XG3425000
ICSC # 0077

EC # 081-001-00-3

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE		PREVENT DISPERSION OF DUST! AVOID ALL CONTACT! AVOID EXPOSURE OF (PREGNANT) WOMEN!	IN ALL CASES CONSULT A DOCTOR!
• **INHALATION**	Abdominal pain. Diarrhoea. Nausea. Vomiting. Loss of hair, pain in legs and chest, and dry skin. Symptoms may be delayed (see Notes).	Local exhaust or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	(Further see Inhalation).	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
• **EYES**		Safety goggles, or eye protection in combination with breathing protection if powder.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Loss of vision, polyneuritis, psychic disturbances, delirium, convulsions, respiratory paralysis, coma, cardiac disturbances (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Sweep spilled substance into sealable containers. Carefully collect remainder, then remove to safe place.	Separated from strong acids, fluorine, other halogens, food and feedstuffs.	Do not transport with food and feedstuffs. T+ symbol R: 26/28-33 S: (1/2-)13-28-45

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0077

THALLIUM

ICSC: 0077

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
BLUISH-WHITE, VERY SOFT METAL. TURNS GREY ON EXPOSURE TO AIR.

PHYSICAL DANGERS:

CHEMICAL DANGERS:
Reacts violently with fluorine. Reacts with other halogens at room temperature.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV (as Tl (soluble compounds)): ppm; 0.1 mg/m^3 (as TWA) (skin) (ACGIH 1994-1995).
MAK not established.

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its aerosol, through the skin and by ingestion.

INHALATION RISK:
Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly especially if powdered.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance may cause effects on the peripheral and the central nervous system, liver and kidneys, the gastrointestinal tract, skin (hair) and the cardiovascular system , resulting in polyneuritis, optic nerve atrophy, encephalopathy, cardiac disturbances, liver and kidney damage, alopecia. Exposure may result in death. The effects may be delayed. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The substance may have effects on the vision, nervous system, skin (hair), heart, gastrointestinal tract. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

PHYSICAL PROPERTIES

Boiling point: 1457°C
Melting point: 304°C

Relative density (water = 1): 11.9
Solubility in water: none

ENVIRONMENTAL DATA

The substance is toxic to aquatic organisms. This substance may be hazardous to the environment; special attention should be given to plants. It is strongly advised not to let the chemical enter into the environment because it persists in the environment.

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of acute thallium poisoning (except for gastrointestinal symptoms) do not become manifest until 12 hours to 4 days after exposure. Do NOT take working clothes home. Refer to cards for specific thallium compounds (e.g., thallous sulfate - see ICSC # 0336).

ADDITIONAL INFORMATION

ICSC: 0077 **THALLIUM**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

Attachment 4

Activity Hazard Analysis Table

ACTIVITY HAZARD ANALYSIS FOR MOBILIZATION/SITE PREPARATION

Principle Steps	Potential Safety/Health Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Mobilization/site setup and survey/ layout	Slips, trips, falls	• Clear walkways, work areas of equipment, tools, vegetation, excavated material and debris • Mark, identify, or barricade other obstructions • Ensure footing. Look before you step	—	—
	Electrical shock	• De-energize or shut off utility lines at their source before work begins • Use double insulated or properly grounded electric power-operated tools • Maintain tools in a safe condition • Provide an equipment-grounding conductor program or employ ground-fault circuit interrupters • Use qualified electricians to hook up electrical circuits • Inspect extension cords daily for structural integrity, ground continuity, and damaged insulation • Cover or elevate electric wire or flexible cord passing through work areas to protect from damage • Keep all plugs and receptacles out of water • Use approved waterproof, weather-proof equipment if exposure to moisture is likely • Inspect electrical power circuits prior to commencing work • Follow appropriate lockout-tagout procedures	—	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut-resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain hand and power tools in a safe condition • Keep guards in place during use	Leather gloves with reinforced palm	—

ACTIVITY HAZARD ANALYSIS FOR MOBILIZATION/SITE PREPARATION				
Principle Steps	**Potential Safety/Health Hazards**	**Hazard Control Measures**	**Personal Protective Equipment**	**Monitoring Devices**
Mobilization/site setup and survey/ layout (*cont.*)	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 decibels, A-scale (dBA) over an 8-hour work period)	Ear plugs	—
	High/low ambient temperature	• Monitor for heat/cold stress • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hand tools	• Daily heavy equipment inspections • Small equipment as specified by operations manual	• Review Site Safety and Health Plan (HASP) Review site-specific Activity Hazard Analysis (AHA) with all task personnel. • Review equipment safety operations manual • Safe driver's training

ACTIVITY HAZARD ANALYSIS FOR WELL INSTALLATION, DEVELOPMENT, AND GROUNDWATER/SOIL SAMPLING				
Task Breakdown	**Potential Hazards**	**Hazard Control Measures**	**Personal Protective Equipment**	**Monitoring Devices**
Well installation, development, and abandonment	Struck by/against flying particles, protruding objects	• Wear hard hats, safety glasses with side shields and steel-toe safety boots at all times • Wear splash shields and safety goggles when cleaning, decontaminating drilling equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Caught in/between moving parts	• Identify and understand parts of equipment which may cause crushing, pinching, rotating or similar injuries • Assure guards are in place to protect from these parts of equipment during operation • Provide and use proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects • Maintain all equipment in a safe condition • Keep all guards in place during use • De-energize and lock-out machinery before maintenance or service	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Leather gloves, with reinforced palm	—
	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants before starting work	Tyvek® coveralls, nitrile gloves	LEL/O_2, photoionization detector (PID)
	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) • Assess noise level with sound level meter if possibility exists that level may exceed 85 dBA time-weighted average (TWA)	Ear plugs	Sound level meter

ACTIVITY HAZARD ANALYSIS FOR WELL INSTALLATION, DEVELOPMENT, AND GROUNDWATER/SOIL SAMPLING

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Well installation, development, and abandonment *(cont.)*	Fire/explosion	• Test atmosphere with combustible gas meter • Eliminate sources of ignition from the work area • Prohibit smoking in well drilling area • Provide ABC (or equivalent) fire extinguishers for all work and flammable storage areas, fuel powered generators and compressors • Store flammable liquids in well ventilated areas • Prohibit storage, transfer of flammable liquids in plastic containers • Post "NO SMOKING" signs • Store combustible materials away from flammables • Store all compressed gas cylinders upright, caps in place when not in use • Separate flammables and oxidizers by 20 feet minimum	—	LEL/O_2
Groundwater/soil sampling	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before sampling operations begin	Latex inner gloves, Tyvek® coveralls, nitrile gloves	LEL/O_2, PID
	Flammable, explosive atmospheres	• Test well head atmosphere for flammable/toxic vapors • Wear proper level of PPE for the type of atmospheric contaminants • Eliminate sources of ignition from the work area • Prohibit smoking in development area	Tyvek® coveralls, nitrile gloves	LEL/O_2, PID
	Struck by/against flying particles, protruding objects, liquid splash	• Wear Hard hats, safety glasses with side shields and steel-toe safety boots at all times • Wear splash shields and safety goggles when sampling, cleaning, decontaminating test equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Cut resistant gloves	—

ACTIVITY HAZARD ANALYSIS FOR WELL INSTALLATION, DEVELOPMENT, AND GROUNDWATER/SOIL SAMPLING

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Groundwater sampling *(cont.)*	High/low ambient temperature	• Monitor for heat/cold stress • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Drill rig • Hand tools	• Daily heavy equipment inspections • Daily drill rig Inspections • Small equipment as specified by operations manual	• 40 hour Hazardous Waste Training • Review HASP • Review site-specific AHA with all task personnel. • Review equipment safety operations manual • Safe driver’s training

ACTIVITY HAZARD ANALYSIS FOR SAMPLING

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Surface water and sediment sampling	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before sampling operations begin	Latex inner gloves, Tyvek® coveralls, nitrile gloves	LEL/O_2, PID
	Flammable, explosive atmospheres	• Test atmosphere for flammable/toxic vapors • Wear proper level of personal protective equipment for the type of atmospheric contaminants • Eliminate sources of ignition from the work area • Prohibit smoking in development area	Tyvek® coveralls, nitrile gloves	LEL/O_2, PID
	Struck by/against flying particles, protruding objects, liquid splash	• Wear hard hats, safety glasses with side shields, and steel-toe safety boots at all times • Wear splash shields and safety goggles when sampling, cleaning, decontaminating test equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut-resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Leather gloves, with reinforced palms	—
	High/low ambient temperature	• Monitor for heat/cold stress • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment
	Underground hazards	• Before beginning intrusive activities, the field supervisor shall ensure that underground utilities are located • Look at underground drawings if available • When underground utilities are exposed, they shall be protected to avoid damage • Personnel on the ground will assist in probing the soils to find the exact location of the lines and will use hand shovels to carefully remove the soil adjacent to the lines • Identify the work area to be sampled	—	—

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hand tools • Monitoring equipment	• Daily heavy equipment inspections • Daily drill rig Inspections • Small equipment as specified by operations manual	• 40-hour Hazardous Waste Training • Review HASP • Review site-specific AHA with all task personnel. • Review equipment safety operations manual • Safe driver training

ACTIVITY HAZARD ANALYSIS FOR SITE RESTORATION				
Principal Steps	**Potential Safety/Health Hazards**	**Hazard Control Measures**	**Personal Protective Equipment**	**Monitoring Devices**
Site restoration and demobilization	Struck by/against heavy equipment, protruding objects	• Use reflective warning vests when exposed to vehicular traffic • Avoid equipment swing areas • Make eye contact with operators before approaching equipment • Wear hard hats, safety glasses with side shields, or splash/face shields and goggles, and steel-toe safety boots at all times • Understand and review hand signals	Warning vests, hard hat, safety glasses	—
	Slips, trips, falls	• Clear, walkways of equipment, tools, debris, other materials • Mark, identify, or barricade other obstructions • Look before you step, ensure safe and secure footing	—	—
	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)	Ear plugs	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb per person for manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Contact dermatitis	• Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants • Identify and review poisonous plants with workers	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	High/low ambient temperature	• Monitor for heat/cold stress • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	—

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hand tools	• Daily equipment documented inspections	• Review AHA with task personnel • Review equipment safe operating manual • Safe driver’s training

Appendix F

Contractor Quality Control Plan

Table of Contents

List of Figures

List of Attachments

Acronyms and Abbreviations

CDAP	Chemical Data Acquisition Plan
CQC	contractor quality control
CQCP	Contractor Quality Control Plan
CQCSM	Contractor Quality Control System Manager
GPS	Global Positioning System
LHAAP	Longhorn Army Ammunition Plant
OSHA	Occupational Safety and Health Administration
PPE	personal protection equipment
QAR	quality assurance representative
QC	quality control
HASP	Health and Safety Plan
PSO	Project Safety Officer
TO	task order
USACE	U.S. Army Corps of Engineers

1.0 Introduction

This Contractor Quality Control Plan (CQCP) documents quality control (QC) requirements that will be implemented during investigation and remediation of the multiple sites. This CQCP will be supplemented as needed to address site-specific issues and specialized technologies.

2.0 Contractor Quality Control Plan Purpose and Scope

2.1 Contractor Quality Control Plan Purpose

This CQCP establishes procedures that enable common project field activities to be completed successfully and documents QC requirements for services provided by the contractor and its subcontractors during various project activities at multiple sites at Longhorn. This plan describes requirements for organizing, planning, performing, reviewing, documenting, and reporting activities that may affect the quality of the work. This CQCP applies the specific requirements of the contractor's Contractor Quality Control (CQC) System to this project by establishing controls for:

- QC staff organization and authority
- Workmanship
- Construction activities for major definable features of work
- Records
- Inspections and tests
- Documentation
- Audits
- Subcontractor performance

This plan references standard field procedures, policies, regulations, and practices required to implement the work. A controlled copy of applicable Field Procedures (**Appendix D**) will be available as a reference document.

2.2 Contractor Quality Control Plan Scope

This CQCP is applicable to work that may be required by the contract including the major definable features of site work (or major project tasks) identified below:

Task 1 – Mobilization and Site Setup

Task 2 – Monitoring Well/Compliance Well Installation

Task 3 – Survey of Monitoring Well Locations

Task 4 – Groundwater Sampling

Task 5 – Soil Sampling

Task 6 – Surface Water/Sediment Sampling

Task 7 – Investigation-Derived Waste Management

2.3 *Acceptance of Contractor Quality Control Plan*

Work within the scope of this plan will not be started prior to providing this CQCP to USACE, unless otherwise permitted by USACE. Any proposed changes to this CQCP will require notification to USACE in writing. Proposed changes are subject to the approval of USACE.

3.0 Organization and Responsibilities

3.1 Personnel and Structure

The Contractor Quality Control System Manager (CQCSM) coordinates implementation of this CQCP with the Site Superintendent, Remediation Manager, and the Project Manager.

3.2 Duties and Responsibilities

The duties and responsibilities of personnel with regard to the CQC program are briefly outlined below. Duties and responsibilities of health and safety personnel are presented in **Appendix E**, Health and Safety Plan (HASP).

Project Manager: The Project Manager is responsible for all activities on the project, and directs and monitors the Site Superintendent in planning, coordinating, and controlling the work. The Project Manager has overall responsibility for establishing the CQCP and for its implementation, and he has the authority to access the available resources required to ensure compliance with the contract requirements.

Remediation Manager: The Remediation Manager will direct investigation and remediation activities and will be responsible for the overall preparation of submittals related to investigation and remediation activities. This individual will direct the technical staff during daily operations. He/she will coordinate and supervise human health/ecological risk assessment activities, feasibility studies, and decision documents and will ensure that regulatory requirements are met and will support the Project Manager with regulatory interaction. Other responsibilities include overseeing drilling, geologic interpretation, and required modeling.

Project Hydrogeologist: The Project Hydrogeologist reports to the Remediation Manager and is responsible for site investigation technical assurance. This individual will oversee the site investigation activities. The project hydrogeologist has the following duties and authorities:

- Plan and oversee site drilling and monitoring well installation
- Select the well screening intervals
- Perform and/or oversee the purging and sampling of newly installed monitoring wells and existing monitoring wells
- Perform and/or oversee the preservation, packaging, and shipping of samples to an off-site, fixed laboratory for environmental analyses
- Ensure documentation accuracy, completeness, and consistency among field team members
- Stop work that deviates from the contract documents or is otherwise nonconforming or unsafe.

CQCSM: The CQCSM is responsible for the overall management of the project CQC program during field activities. Depending on the extent of on-going field work, the CQCSM may perform dual roles of CQC management and site safety management. When serving as CQCSM/Project Safety Officer (PSO), this individual receives administrative and day-to-day direction from the Remediation Manager. This individual is responsible to the contractor Program QC Manager for direction on matters that may affect the QC requirements for the project and to the contractor Program Health and Safety Manager for safety-related matters. The CQCSM/PSO is assigned the following duties:

- Monitor and verify that the work is performed in accordance with the contract requirements
- Review and verify the disposition of discrepancy and corrective action reports
- Perform QC inspections and surveillance, and report daily on project QC
- Monitor project submittals in accordance with submittal register requirements
- Submit QC reports to the USACE Field Representative/Quality Assurance Representative on a daily basis, unless other arrangements are agreed to by the USACE

The CQCSM has the authority to reject materials and workmanship that do not comply with project requirements, and to stop nonconforming work activities (see **Figure 3-1**). This individual will also verify conformance with the HASP.

Site Superintendent: The Site Superintendent is responsible to the Remediation Manager and the Project Manager for day-to-day supervision of the on-site remedial activities. The Site Superintendent’s involvement in QC includes communicating the necessity of quality workmanship in all remedial activities to the on-site project staff.

Program QC Manager: The Program QC Manager is responsible to review, monitor, and report the conformance to QC requirements set forth in the CQCP. He may also advise the CQCSM on QC methods and practices. He will maintain a record of his quality monitoring activities and will inform the CQCSM of his monitoring activities. He shall also be responsible for performing periodic internal audits, and reporting his findings to the CQCSM.

Subcontractors: The contractor assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services. Subcontractors are responsible to the Project Manager and Remediation Manager for completing the portion of work assigned to them, and to the CQCSM for CQCP activities. They shall verify that their construction and materials comply with the requirements of the contract plans and specifications. Subcontractors include organizations supplying quality-related items or services to the project.

3.3 Qualification of Personnel

Contractor personnel assigned to the project are qualified to perform the tasks to which they are assigned. The Project Manager and the Remediation Manager will appraise the qualification of professional and/or technical personnel assigned to the project. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee.

To: To Be Determined

From: Contractor QC Manager

Date: November 15, 2005

Subject: Contractor Quality Control System Manager, Letter of Authority

U.S. Army Corps of Engineers, Tulsa District

LHAAP 35B(37) and LHAAP 67

This letter describes the responsibilities and authority delegated to you in your capacity as the Contractor Quality Control System Manager for Sites LHAAP 35B(37) and LHAAP 67 at Longhorn Army Ammunition Plant, Karnack, Texas.

In this position, you are responsible for the implementation and enforcement of the CQCP and site specific addenda. You will use the plan to verify that the quality of materials, workmanship, operations, and safety monitoring conforms to the Work Plan, its appendices, and addenda.

Your responsibilities include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and requesting solutions for nonconforming activities. You have the authority to control or stop project activities until satisfactory disposition and implementation of corrective actions are achieved. Detailed responsibilities and guidelines are given in the Work Plan, its appendices, and addenda.

Figure 3-1

Letter of Authority

4.0 Contractor Quality Control Systems

4.1 Control Measures

The CQCP provides measures to verify and document that the work performed complies with the requirements specified in the contract documents. These measures include:

- CQC inspections
- Document control
- Submittals
- Completion inspection
- Records

Procedures for implementing the above measures are included throughout the CQCP. The CQCP may be supplemented by additional guidelines or instructions for implementing the work and/or verifying compliance with the contract requirements.

4.2 Quality Control Monitoring

The project CQC program is monitored to verify that the program is in compliance with the CQCP. Monitoring activities are performed by the contractor Program QC Manager, or his representative, and include the review of daily QC reporting and instructions, or directions given to the CQCSM on QC matters. If required, an assessment of the project's CQC system is performed. If performed, the assessment includes the following items:

- Subcontractor performance
- Field operation and records
- CQC and health and safety inspections, testing, and records
- Document control
- Training records

4.3 Quality Control Testing

As applicable, the CQCSM monitors the equipment/materials testing firm and/or analytical laboratory activities to verify the following:

- Execution of required tests
- Location of tests
- Timely and accurate reporting of test results
- Correct frequency of tests
- Completeness of documentation

5.0 Inspection Plan

QC inspections include inspection of equipment, materials, testing procedures, documentation/submittals, and workmanship before, during, and after each definable feature of work. QC inspections are performed by the CQCSM in accordance with the Three-Phase Contractor Quality Control System. The CQCSM gives the USACE Quality Assurance Representative advance notification (at least 24 hours) of formal inspections.

Definable features of site work (or major work tasks) for which QC inspections will be performed are addressed below.

Definable Features of Site Work:

Task 1 – Mobilization and Site Setup
Task 2 – Monitoring Well/Compliance Well Installation
Task 3 – Surveying of Monitoring Well Locations
Task 4 – Groundwater Sampling
Task 5 – Soil Sampling
Task 6 – Surface Water/Sediment Sampling
Task 7 – Investigation-Derived Waste Management

Other site remediation activities that constitute definable features of site work will be defined within site-specific addenda to the work plan. Those addenda will also identify related QC inspection requirements.

5.1 Task 1 – Mobilization and Site Setup

Following approval of the Work Plan, the contractor will mobilize the necessary personnel and equipment to prepare the site for investigation activities. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Site personnel have the necessary Occupational Safety and Health Administration (OSHA) training and medical surveillance statements/certifications
- Heavy equipment (e.g., drilling rig) has undergone safety and preventive maintenance checks, and is suitable for the task for which it will be used.
- Measuring and test equipment has undergone calibration and/or calibration checks to assure accuracy and precision.
- The project team understands the investigation/remediation requirements.
- Site personnel have received a HASP by the PSO and have acknowledged this review by signing the HASP acknowledgment form.

- Installed government property plan (when applicable) is reviewed and implemented for the equipment to be installed on site.
- Work zones and decontamination facilities are established in accordance with the HASP.
- Material storage areas are kept orderly.
- Site security measures are adequately maintained to prevent unauthorized access.
- Work zones are clearly demarcated using temporary barricading or fencing as required.
- Once the site is mobilized and set up, field activities will commence.

5.2 Task 2 – Monitoring Well/Compliance Well Installation

Groundwater monitoring well construction materials and specifications are provided in **Appendix D**. The specifications conform to the following:

- Engineering and Design – *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*, EM 1110-1-4000 (USACE, 1998)
- Technical Requirements – *Locations and Standards of Completion for Wells*, Texas Administrative Code Title 16, Part 4, Chapter 76, Section 76.1000 (State of Texas, 2001)
- Monitor-Well Construction Specifications, Texas Administrative Code Title 30,
- Part 1, Chapter 330, Subchapter I, Section 330.242 (State of Texas, 1993)

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Drilling locations are marked/staked in the field and verified against those in the approved drawings prior to well drilling.
- Underground utilities that transect the sites are located and marked, and their depths are known, so as to avoid damaging them during drilling activities.
- Digging permits (when applicable) are obtained prior to the start of work.
- Qualified drilling firms are procured to perform this task.
- The driller is licensed by the Texas Department of Licensing and Regulation and maintains a current license, in good standing.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.

- The CQCSM/PSO has briefed personnel on task-specific hazards and the appropriate personal protection equipment (PPE) to be worn and performed a job safety analysis for well drilling and installation.
- Drilling personnel have reviewed the HASP and signed the acknowledgement form.
- Task crews undergo preparatory briefing to verify their understanding of the scope of work and health and safety issues.
- Drilling team leader (i.e., the contractor Hydrogeologist) instructs the drilling crew of the depth of the well and its construction, and documents those instructions in the field notes.
- Drilling team leader documents the suitability of the construction materials.
- Construction materials meet specifications, are contaminant-free, and shipped/received in good order.
- Well construction details are properly logged on forms and in the site logbook.
- Incomplete construction is protected from surface-water infiltration.
- Completed construction conforms to work plan requirements, specifications and drawings for well installation and surface completion.
- Generated soil cuttings, decontamination fluids, and contaminated PPE are handled and disposed of in accordance with the waste disposal requirements described in **Section 1.7** of **Appendix C** and **Attachment 10** of **Appendix D**, and state and federal regulations.
- Adjacent ground surfaces are protected from spillage during drilling operations.
- Well filter pack, bentonite, and grout volumes are calculated and documented in the field log book.
- Bentonite seal and grout is allowed to hydrate/cure sufficiently prior to beginning well development.
- Monitoring well development equipment, methods, and stabilization measurements are performed in accordance with the Work Plan and Chemical Data Acquisition Plan (CDAP).
- Well development fluids are handled, characterized, and disposed of in accordance with the requirements addressed in Task 7 of the Work Plan, and state and federal regulations. Field screening requirements are listed in **Section 5.8.1** of this CQCP. Additional information on field screening procedures is found in **Appendix D**, **Attachment 1**.
- Disturbance of property surrounding drilling site is minimized. Ground water sampling will commence following monitoring well installation and development.

5.3 Task 3 – Surveying

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- A qualified land surveyor licensed by the State of Texas is employed to perform well surveying.
- Survey datum (vertical and horizontal) used is consistent with the work plan requirements and/or historical datum.
- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled (e.g., notch in the top of casing and/or brass surveying marker embedded in surface pad).
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards. For identifying locations of soil samples and limits of excavation, a Global Positioning System (GPS) may be used in lieu of land surveying. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:
- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

5.4 Task 4 – Groundwater Sampling

Following the installation of groundwater monitoring wells, the contractor will collect groundwater samples for laboratory analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP and Work Plan and understand the scope of work.
- The CQCSM/PSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling begins.

- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- Well depth and depth-to-water measurements are performed consistently from a common location at top-of-well casing (e.g., notch in top of casing or northern lip of casing).
- Well water volume is calculated accurately using well measurements.
- Well is purged of the required quantity of well water and water quality is stabilized as defined by the CDAP prior to sample collection.
- Purged water is contained in drums and managed in accordance with Work Plan waste handling requirements. Field screening procedures is found in **Appendix D**, **Attachment 1**.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., the contractor Hydrogeologist) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.5 Task 5 – Soil Sampling

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP, Work Plan, and any related documents regarding the scope of work.
- The CQCSM/PSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- The specified sampling equipment and materials are used for sample collection.

- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.6 Task 6 – Surface Water/Sediment Sampling

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP, Work Plan, and any related documents regarding the scope of work.
- The CQCSM/PSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., the contractor Hydrogeologist or Sample Technologist) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- Field instruments are calibrated at the start of the testing day.

5.7 Task 7 – Investigation-Derived Waste Management

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Waste generated during the project activities will be segregated by type (e.g., soil cuttings, PPE, well development and purging liquids, trash/debris) and stored in approved 55-gallon drums or other containers.
- Waste containers are labeled with a waterproof marker according to the Work Plan, indicating the content, accumulation date, waste code(s) (if known) and pertinent analytical information.
- Waste handling activities are documented in the field logbook and a tracking log is prepared that indicates waste type, point of waste generation (i.e., well number) container size and type, accumulation date, storage location, disposal destination, transporter name, shipping paper/manifest number, and transportation and disposal dates.
- Waste containers are leak proof and stored in a secure storage area.
- Waste storage area is clearly demarcated using barricade tape and/or temporary barricade fencing, as required.
- Waste container and storage area inspections are performed on a weekly basis (at a minimum) and documented in the field logbook and/or in a standard inspection form.

5.7.1 Field Screening

The soil and groundwater samples will be screened in the field for confirmation and will be sent to a laboratory for confirmation analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP and understand the scope of work.
- The CQCSM/PSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling screening begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- Field screening instrumentation is calibrated before the start of the work and at the end of the sampling day.
- Calibrated equipment will be uniquely identified by using either the manufacturer’s serial number or other means.

Calibration records traceable to the equipment will be readily available for reference. In addition, the results of calibrations and records of repairs will be recorded in a logbook.

5.8 Task 8 – Monitoring Well Abandonment

The contractor will abandon monitoring wells that were installed during any investigation and remediation activities as needed. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well abandonment.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Abandonment activities will employ a well driller licensed in the state of Texas.
- Well abandonment materials and equipment are suitable and approved for use prior to starting the work.
- Well locations and top of casing elevations are verified and recorded in a logbook prior to abandonment.
- Required agency permits and/or notifications are completed prior to starting abandonment activities.
- Waste generated during abandonment activities is handled and disposed according to the waste management plan.
- Quantity and depth measurements are made and recorded accurately the amount of grout used, depth below ground surface of the top of the grout once the grout has settled and hardened, and the amount of cover soil placed and compacted above the top of the grout to re-establish a level ground surface.
- A multi-purpose completion report and/or well abandonment log is accurately completed for each abandoned well and submitted to the State of Texas. Copies are maintained in the project file until submitted to the USACE with the final report.

6.0 Document Control

6.1 Documentation

The CQCSM maintains current records of QC activities and tests performed, including those of suppliers and subcontractors. The records will be maintained as evidence that required control measures and tests have been performed, and indicate the results of the activities. Photographic documentation is also maintained for this project in accordance with **Section 6.4** of this plan.

6.2 Daily CQC Report

A Daily CQC Report is completed and maintained by the CQCSM using a standard form. The form is provided in **Attachment 1**. As applicable, standard forms used to document safety, technical, and operations aspects of daily field activities will be attached to the Daily CQC Report.

6.3 Daily Weather Conditions/Lost Time Report

A Daily Weather Conditions/Lost Time Report is prepared daily by the CQCSM. A report form is provided at the end of this section. Lost time will be logged into the report in increments of 25% (in other words, 0%, 25%, 50%, 75% or 100%). The amount of lost time incurred will be agreed upon and initialed by the CQCSM and the Corps of Engineers' quality assurance representative (QAR) or Technical Manager overseeing the project work. Upon completion of the report for the specified period of time, one copy of the report should be submitted to the QAR/Technical Manager once each month during fieldwork and an extra copy should be maintained by the CQCSM for future reference.

6.4 Photographs

The CQCSM will photograph the project activities. Photographs will be taken on a regular basis during the course of the project to document the work, events, and equipment used. The frequency and number of pictures taken will depend upon the activities occurring and the amount of documentation needed. The Project Manager or Remediation manager will use judgment to determine the frequency and number of pictures taken; however, a sufficient quantity of pictures will be taken to effectively document the TO.

Pictures will be taken using 35mm film or digital medium (using a digital camera or video camera). Photos will be documented on a project log (see standard form in **Attachment 1**), which includes the photo number, date, time, description of the task depicted, and the view direction (e.g., facing northwest). A copy of the photo log, pictures, slides/videos, and digital media will be maintained in Project Files.

6.5 Review of Vendor Submittals

Vendors and subcontractors are required to expeditiously submit items such as drawings, test data, and specifications to the contractor for review to enable timely submittals to USACE. The contractor technical and CQC personnel review each submittal for compliance with contract documents. If acceptable, the item is stamped or indicated as such, and forwarded to USACE for review and acceptance.

If unacceptable, errors or deficiencies are identified and returned to the vendor or subcontractor for correction. The corrected document is resubmitted to the contractor for review until it meets contract requirements.

6.6 Government Property Accounting and Control

If applicable, the contractor will acquire, manage, and dispose of government property. At the completion of the project, all real property (removed and/or installed) will be listed on a Property Inventory Sheet.

6.7 Submittals

The Project Manager, Remediation Manager, the Program Controls Engineer, and the CQCSM are responsible for project submittals. A submittal register prepared for this project is given in **Figure 6-1**.

SUBMITTAL REGISTER

TITLE AND LOCATION: **Longhorn Army Ammunition Plant –**

CONTRACTOR:

				TYPE OF SUBMITTAL									CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVT. ACTION		
TRANSMITTAL NO a.	ITEM NO b.	SPEC PARA NO c.	DESCRIPTION OF ITEM SUBMITTED d.	DATA e.	DRAWINGS f.	INSTRUCTIONS g.	SCHEDULES h.	STATEMENTS i.	REPORTS j.	CERTIFICATES k.	SAMPLES l.	RECORDS m.	INFO ONLY n.	GOVT. APPROVED o.	REVIEWER p.	SUBMIT q.	APPROVAL NEEDED BY r.	MAT'L NEEDED BY s.	CODE t.	DATE u.	SUBMIT TO GOVT v.	CODE w.	DATE x.	REMARKS
			Project Work Plan (and Appendices)		X	X	X							X		Per Project Schedule								
			Cost/Schedule Reports										X			Monthly								
			Site Personnel OSHA Medical & Training Certificates							X		X	X			Prior to start of work								
			CQC and Safety Reports						X				X			Daily								
			Well Construction Methods/Specifications	X	X								X			Per Work Plan								
			Transporter ID, Insurance Cert							X			X			Prior to subcontract award								
			Manifests/Shipping Papers									X	X			Prior to shipment								
			Disposal Facility ID	X									X			Prior to subcontract award								
			Environmental Inspection Sheets									X	X			Per Work Plan								
			Groundwater Sampling Results	X					X				X			Upon data evaluation and with Background Groundwater Report								
			Survey Drawings (As-built)		X									X		Upon completion								
			Well Construction Completion Forms									X		X		To State of Texas within 30 days of construction completion and with Background Groundwater Report								
			Well Abandonment Forms									X		X		To the State of Texas within 30 days of construction completion								
			Drilling Logs & Groundwater Sampling Forms									X				With Daily QC Reports and Background Groundwater Report								
			Background Groundwater Report	X	X				X			X		X		Per Project Schedule								

Figure 6-1
Submittal Register

7.0 Subcontractor Quality Control

Subcontractors for this project are responsible for compliance with the QC requirements of their respective subcontract. Subcontractors include organizations supplying quality related items or services to the project. The contractor assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services.

Subcontract documents should include the requirements for personnel qualifications, technical performance levels, QC procedures, acceptability criteria, and documentation. The CQCSM, or his designee, reviews the subcontract procurement documents to verify that the QC requirements are communicated to the subcontractor.

Each subcontractor is required to identify an adequately qualified individual within the organization to perform QC duties. The qualifications of this individual are submitted to the CQCSM for review and approval. The CQCSM coordinates the QC functions with the designated subcontractor QC representative. The Project Manager, or his authorized designee, assists the CQCSM in managing subcontractor QC.

The CQCSM is responsible for the performance of inspections, surveillance, document reviews, audits, and other QC functions to verify compliance with the subcontract requirements. These activities are documented on inspection reports, checklists, audit reports, field logs, or other forms appropriate to the function performed.

For field operations, the CQCSM performs QC inspections before, during, and after the subcontractor activities, to the extent required, to verify that the subcontractor is in compliance with the QC requirements of the contract and the applicable subcontract documents.

Audits of subcontractor activities are conducted by the CQCSM as necessary to verify compliance with the CQCP. Objective evidence of conformance to the subcontract documents is reviewed during the audits.

8.0 References

Shaw Environmental and Infrastructure, Inc. (Shaw), 2005, *Standard Operating Procedures* (Intranet), (Headquarters) Baton Rouge, Louisiana, November 9.

Shaw Environmental and Infrastructure, Inc. (Shaw), 2006, *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant, Karnack*, Texas, Houston, Texas.

State of Texas, 2001, Administrative Code Title 16, Part 4, Chapter 76, Section 76.1000, *Technical Requirements – Locations and Standards of Completion for Wells,* Austin, Texas.

State of Texas, 1993, Texas Administrative Code Title 30, Part 1, Chapter 330, Subchapter I, Section 330.242, *Monitor-Well Construction Specifications*, Austin, Texas.

U.S. Army Corps of Engineers, 1998, *Engineering and Design - Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*, EM 1110-1-4000.

Attachment 1

Field Forms

- Preparatory Inspection Check List
- Initial/Follow-Up Inspection
- Final Inspection Form(s)
- Daily Contractor Quality Control Report
- Daily Weather Conditions/Lost Time Report
- Photo Log Form
- Corrective Action Report

PREPARATORY INSPECTION CHECKLIST

Project Name:__________________
Project Location________________
Project No.:_______________

Plan or Specification Title/Section:___________________ Drawing Nos.:______________________

A. Personnel present *(use back of form to list additional personnel)*

Name	Position	Company

B. Submittals involved: *(use back of form to list additional submittals)*

Number and Type	Description	Indicate Contractor of Government Approval

C. Are all materials on hand and in accordance with approvals: ☐ Yes ☐ No
List all deficiencies:

D. Test required: (list/reference all quality control tests with their required frequencies):

E. Accident prevention preplanning (list all health and safety items discussed):

CQCSM: ____________________________

INITIAL/FOLLOW-UP INSPECTION FORM

Project Name:__________________
Project Location_________________
Project No.:_______________

(check one)
INITIAL PHASE CHECK LIST ☐ OR
FOLLOW-UP PHASE CHECK LIST ☐

Plan or Specification Section:____________________________ **Drawing Nos.:**______________________

A. Personnel present:

Name	Position	Company

B. Materials are in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

C. Work being performed is in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

D. Workmanship is acceptable: ☐ Yes ☐ No
If improvement is needed, explain:

CQCSM: ______________________________

FINAL INSPECTION FORM

Project Name:__________________
Project Location_________________
Project No.:_______________

FINAL INSPECTION FORM

Plan or Specification Title/Section:____________________________Drawing Nos.:______________________

Inspected Work (list feature(s) of work inspected):

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

Performance Specification by Contract Delivery Order Reference	Status of Inspection

I certify that the work inspected is complete and meets the performance specifications cited above and that all material and equipment used and work performed was completed in accordance with approved plans and work instructions and meets contract delivery order requirements.

CQCSM ___________________________________ **Date**______/______/______

Site Manager________________________________ **Date**______/______/______

FINAL INSPECTION FORM

Project Name:__________________
Project Location_________________
Project No.:______________

FINAL INSPECTION FORM

Plan or Specification Title/Section:____________________________Drawing Nos.:_______________________

Inspected Work (list feature(s) of work inspected):

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

Performance Specification by Contract Delivery Order Reference	Status of Inspection

I certify that the work inspected is complete and meets the performance specifications cited above and that all material and equipment used and work performed was completed in accordance with approved plans and work instructions and meets contract delivery order requirements.

CQCSM ___________________________________ **Date**_____/_____/_____

Site Manager_______________________________ **Date**_____/_____/_____

DAILY CONTRACTOR QUALITY CONTROL REPORT

Project Name:____________________
Project Location:______________________
Report No.:_________________

WEATHER: ( ) Clear ( ) P. Cloudy ( ) Cloudy
Wind________________________
Temperature: High _______ Low_______
Precipitation: Today_____________________ Previous Period (i.e., weekend)________________________
Site Conditions:____
Lost Time Due to Inclement Weather: ________________%

PRIME CONTRACTOR/SUBCONTRACTORS AND AREAS OF RESPONSIBILITY/LABOR COUNT:
(Include number, trade, hours, employer, location, and description of work.)

a.

b.

c.

d.

e.

f.

WORK PERFORMED: (Include location and description of work performed including equipment used. Refer to work performed by prime and/or subcontractors as previously designated by letter above. Attached subcontractor daily activity reports when applicable):

MATERIALS AND/OR EQUIPMENT DELIVERED: (Include a description of materials and/or equipment, quantity, date/hours used, date of safety check, and supplier)

Page 1 of 3

RESULTS OF SURVEILLANCE: (Include satisfactory work completed or deficiencies with action to be taken.)

a. Preparatory Inspection: (Attach Minutes)

b. Initial Inspection: (Attach Minutes)

c. Follow-up Inspection: (List results of inspection compared to specification requirements.)

d. Safety Inspection: (Include safety violations and corrective actions taken.)

OFF-SITE SURVEILLANCE ACTIVITIES: (Include action taken.)

QC TESTS PERFORMED AND RESULTS: (As required by plans and/or specifications.)

VERBAL INSTRUCTIONS RECEIVED OR GIVEN: (List any instructions received from government personnel or given by Shaw on construction deficiencies identified, required retesting, etc., and the corresponding action to be taken.)

CHANGED CONDITIONS/DELAYS/CONFLICTS ENCOUNTERED: (List any conflicts with the delivery order [i.e., Scope of Work and/or drawings], delays to the project attributable to site, and weather conditions, etc.)

Page 2 of 3

SUBMITTALS REVIEWED: (Include submittal number, specification reference, and name of submitter.)

MEETINGS: (List the meetings, i.e., Health and Safety, Site Operations, Cost/Schedule, etc.)

VISITORS:

REMARKS: (Any additional information pertinent to the project not defined by the previous entries.)

CONTRACTOR'S VERIFICATION: The above report is complete and correct. All material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

____
CQCSM (or designee)

_____/_____/_____
Date

Page 3 of 3

DAILY WEATHER CONDITIONS/LOST TIME REPORT

DAILY WEATHER CONDITIONS/LOST TIME REPORT FOR WEEK/MONTH OF_____________

Contract No.:__________________________ Delivery Order No.:____________ Project:_____________________

Contractor:____________________________

DAY	DATE	W/C. L/T	% LOST	ACTIVITY DELAYED	REMARKS	CONCUR	
						CQCR	QAR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
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30							
31							

Weather Conditions (W/C): R - Precipitation, C - Extreme Temperature, M - Muddy Site Conditions W - Extreme Winds
Other Lost Time Conditions (L/T): D - Demobilized, S - Standby

Representative of the Contractor____________________________

Representative of the Government___________________________

PHOTO LOG FORM

PROJECT PHOTO LOG

Project Name:_______________ **Project Location:**__________________ **Project No.:**______________

Photo No.	Date	Time	Task and Description	View Direction

CORRECTIVE ACTION REPORT

Project Name:____________________
Project Location:______________________
Report No.:__________________

DESCRIPTION OF PROBLEM:

PERSONNEL RESPONSIBLE FOR INVESTIGATIVE PROCESS:

RECOMMENDED CORRECTIVE ACTIONS:

PERSONNEL RESPONSIBLE FOR IMPLEMENTATION OF CORRECTIVE ACTIONS:

RESULTING ACTIONS AND EFFECTIVENESS OF THOSE ACTIONS:

PERSONNEL RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CORRECTIVE ACTIONS:

FINAL DISPOSITION APPROVED BY:

Name:__________________________ Title:______________________

Date:__________________

Name:__________________________ Title:______________________

Date:__________________

COPIES TO:

Appendix G

Chemical Data Acquisition Plan

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Acronyms and Abbreviations

°C	degrees centigrade
CAR	Corrective Action Report
CDAP	Chemical Data Acquisition Plan
COC	chain-of-custody
CQCSM	Contractor Quality Control System Manager
EDT	Electronic Data Transfer
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometer
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LHAAP	Longhorn Army Ammunition Plant
LQMP	Laboratory Quality Management Plan
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
PARCC	precision, accuracy, representativeness, comparability & completeness
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PWS	Project Work Statement
QA	quality assurance
QC	quality control
RPD	relative percent difference
SQCR	Sample Quality Control Report
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1.0 Introduction

This Chemical Data Acquisition Plan (CDAP) describes the analytical and field activities, as well as the quality assurance (QA)/quality control (QC) protocols associated with the site investigations, remediation, and site restoration activities at Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. The figures referenced in this CDAP are included at the end of each respective section.

The ultimate accuracy of any data generation begins with a sampling and measurement procedure that is fully conceived and implemented. This CDAP is designed to delineate the methods that will be used to accomplish the chemical data quality objectives. Data quality objectives include the data quality indicators of precision, accuracy, and completeness addressed in **Section 7.1**. A conscious effort has been made to provide relevant information with minimal duplication of information that is discussed in detail in other project planning documents.

Sampling and analytical activities will be documented in accordance with this plan. Analytical methods and constituents of potential concern and their detection limits are provided in **Attachment 1**. A database will be utilized for data management and to produce data summary tables.

2.0 Project Description

2.1 Site Description

LHAAP is located in central-east Texas, in Harrison County, between State Highway 43 at Karnack, Texas, and Caddo Lake. **Figures 2-1 and 2-2** of the LHAAP-35B(37) and LHAAP-67 Remedial Design show the location of LHAAP and the location of the two sites within the larger LHAAP site.

2.2 Project Objective

The objective of this installation-wide project is to focus on an expedited path toward site closure and bring as many sites to closure or, where needed, into a long term monitoring or long term operation stage as early as possible. In order to accomplish these objectives, more investigations are needed to delineate the nature and extent of contamination and initiate the appropriate remediation at designated sites.

3.0 Project Organization and Responsibility

The project management organization is based on specific project requirements. The key project team members and their responsibilities are listed in **Section 3.1** below.

The Project Manager is the primary focal point for control of project activities. The Project Manager will be supported by the program management support team, which will provide reviews, guidance, and technical advice on project execution issues. The Project Manager is to be supported by a supervisory, safety and health, and QA/QC staff to ensure that the project is executed in compliance with all applicable laws, regulations, statutes, and industry codes.

3.1 Responsibilities of Key Personnel

3.1.1 Project Manager

The Project Manager is responsible for the overall direction of this project, which is executed under his supervision. The Project Manager is ultimately accountable for all work activities undertaken on this project and provides the managerial and administrative skills to ensure resource allocations, planning, execution, and reporting to meet contract requirements. The individual responsibilities of the Project Manager include, but are not limited to, the following:

- Participation in project QA reviews
- General supervision of the project
- Approval, as required, of project specific QA documents
- Approval of procurement documents
- Stopping work on a project, if necessary, because the project cannot be completed to the required quality levels, safety specifications, the schedule, or budget to permit successful completion
- Communication to the project staff of project-specific client and regulatory requirements
- Identification and documentation (and notification to the contracting officer and project staff) of changes in scope of work, regulatory requirements, or QA practices

3.1.2 Remediation Manager

The Remediation Manager will direct investigation and remediation activities and will be responsible for the overall preparation of submittals related to investigation and remediation activities. This individual will direct the technical staff during daily operations. He/she will coordinate and supervise human health/ecological risk assessment activities, feasibility studies, and decision documents and will ensure that regulatory requirements are met and will support the Project Manager with regulatory interaction. Other responsibilities include overseeing drilling, geologic interpretation, and required modeling.

3.1.3 Site Superintendent

The Site Superintendent will be the on-site operational manager of the project and is responsible for its day-to-day operation. He is in charge of the on-site operational and technical staff. He is responsible for maintaining clear, effective, up-to-date communications with the Contracting Officer concerning project scoping and planning. Responsibilities include coordination of subcontractors, including their compliance with contractor policies and procedures and contractual requirements, implementing and maintaining all site-specific plans, health and safety, and controlling cost and schedule aspects of all site activities. Some of the quality-related responsibilities for the Site Superintendent include:

- Notifying the Remediation Manager and Project Manager if the project cannot be completed with regard to quality, schedule, health and safety, or cost.
- Determining that changes, revisions, and reworks are required of the CDAP, and documenting changes.
- Serving as a reviewer prior to release of project information to the client.

3.1.4 Project Contractor Quality Control System Manager

The Project Contractor Quality Control System Manager (CQCSM) will serve as the on-site QC officer. This individual will monitor field personnel engaged in chemical data acquisition. Some of the quality related responsibilities include:

- Determining that changes, revisions, and reworks are required of the Work Plan and CDAP.
- Serving as the final reviewer prior to release of project information to the client.
- Monitor the field investigation activities for compliance with contract documents.
- Stopping work that is nonconforming or deficient.

3.1.5 Project Safety Officer

The Project Safety Officer will be primarily responsible for:

- Assessing the potential health and safety hazards at the site
- Developing/implementing site-specific safety and health plans
- Performing daily safety checks

3.1.6 *Project Chemist*

A Project Chemist will be assigned to this project. He/she, or his/her designee, will be responsible for the following:

- Manage production and quality of data generated from sampling and analytical activities
- Verify that the CDAP quality objectives are met
- Review data prior to release to site
- Provide for contact between site and the subcontract analytical laboratory

3.1.7 *Field Sampling Personnel*

The Field Chemist and Sample Technicians report to the Site Superintendent and are responsible for the following:

- Obtain samples and document sampling tasks
- Package and ship samples to the off-site laboratory

3.2 *Qualifications of Personnel*

Contractor team personnel assigned to this project will be qualified to perform the task to which they are assigned. All members of the team are qualified to perform work on this task order. The Project Manager will make appraisal of the qualifications of additional personnel assigned to the project.

3.3 *Analytical Laboratory*

The contractor will select an analytical laboratory to provide subcontract analytical services for this task order. The laboratory will be USACE validated to perform project analyses. USACE Chemistry and Industrial Hygiene Section, Louisville District, will be notified upon the procurement of the analytical services laboratory. A copy of the Laboratory Quality Management Plan (LQMP) from the lab will be supplied to USACE as a submittal prior to execution of task order. The selected laboratory will be provided a copy of the final CDAP for their reference.

4.0 Sampling and Analysis

Samples expected to be collected for this project include groundwater, soil, surface water, sediment, and waste characterization samples. Sampling procedures are addressed in **Appendix D**, Field Procedures.

4.1 Types of Sampling

In general, two basic types of sampling techniques are recognized for solid media (soil and sediments): composite samples and grab samples.

4.1.1 Composite Sampling

Composite samples are a combination of more than one subsample collected at various sampling locations and/or different points in time. Area composite samples are composited from individual grab samples that are collected on an area or cross-sectional basis. Area composites will be made up of equal volumes of grab samples; each grab sample will be collected in an identical manner. Analysis of composites yields an average value. In certain instances, a composite can be used as an alternative to analyzing a number of individual grab samples and calculating an average value. However, compositing of samples can mask problems by diluting isolated concentrations of some hazardous compounds to below detection limits. Also, a small sample size may be removed for analysis, and if the composite is not homogeneous, an error in reporting results may occur. When compositing for trace organics and/or metals, only stainless steel, glass, or Teflon bowls and spatulas will be used for sampling. Samples for volatile analysis will not be composited in the field, due to potential for analyte loss during the compositing process.

4.1.2 Grab Samples

A grab sample is defined as a single sample that is collected all at once and is representative of the specific location in the sample medium at a given point in time. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples decreases.

4.2 Soil/Sediment Sampling

Soil sampling may involve collection of surface soil and subsurface soil samples. Sediment samples may be collected from the creeks within the installation. Procedures for surface and subsurface soil and sediment sampling are provided in **Appendix D**. Soil and sediment samples will be collected from locations related to sites covered under the Project Work Statement (PWS).

4.3 Surface Water Sampling

Surface water samples may be collected from the creeks within the installation as it relates to sites under the PWS. Procedures for surface water sampling are provided in **Appendix D**.

4.4 Groundwater Monitoring Well Sampling

Groundwater samples will be collected from newly installed monitoring wells and existing monitoring wells of various depths and construction as it relates to sites under the PWS.

4.4.1 Water Level Measurement

Before samples are collected, the static water level will be measured to the nearest 0.01 foot using a battery operated electronic water level probe. Static water level measurements will be recorded on the Field Sampling Report **(Figure 4-1)** or equivalent. Immiscible layers are not anticipated but, if present, an interface probe will be used to measure the level of the immiscible surface and apparent thickness. A sample will also be collected using a transparent, disposable bailer to visually confirm the immiscible layer.

4.4.2 Monitoring Well Purging

Well sampling will be accomplished using the low flow sampling method. In the event the low flow sampling method is not used due to insufficient well recharge, wells will be purged before groundwater samples are collected. **Appendix D** provides the groundwater sampling procedure for this project.

4.4.3 Groundwater Sample Collection

Wells will be sampled using a submersible bladder pump as discussed in the previous section. Only in extreme cases will a bailer be used where a slow recharging well had to be purged dry. In such a case, after a bailer will be lowered gently into the well and sample collected, as soon as sufficient recovery has occurred. Pre-cleaned sample containers will be filled directly from the pump outflow port or bailer. Preservatives will be added to the sample bottle by the laboratory before the containers are shipped to the site. Groundwater sampling analytical parameters and methods are given in **Table 4-1**. Individual analytical constituents and associated detection limits are given in **Attachment 1**. The appropriate sample containers, preservation methods, and holding times for all project aqueous samples are given in **Table 4-2**. QC sample types and minimum sampling frequencies are as follows:

- 10 percent QC replicates
- One trip blank set for each cooler containing volatile organic compounds (VOC) samples

QA sampling and analysis will be performed when requested by the USACE. Additional information on groundwater sampling and handling is found in **Appendix D**, Field Procedures.

4.5 Contaminated Soil in Drums or Roll-off Boxes for Disposal Sampling

Drill cuttings will be staged in drums or roll-off boxes for subsequent disposal analysis. At the completion of the drilling, the drill cuttings will be sampled and sent to the subcontract analytical laboratory for analysis of disposal parameters as listed in **Table 4-1**. The sample technician shall note the drum or roll-off number in the sample logbook. The procedure for collecting a sample from a drum or roll-off box is summarized below:

- Decontaminate equipment:
  - Stainless steel spatula
  - Trowel or trier
  - Stainless steel bowl
- Don a clean pair of sample gloves.
- Remove drum lid.
- Insert trowel into material and remove sample. For roll-off box use a trier and position the trier at the corner of the roll-off and at an angle (i.e., 30 degrees) and push the trier into the soil as far as possible.
- Begin sampling with the acquisition of grab samples for VOCs, conducting sampling with as little disturbance as possible to the media. The sample container shall be filled with no headspace.
- Collect a five point composite sample for all parameters other than VOCs.
- Thoroughly mix the soil in a stainless steel bowl and fill the remaining containers.
- Label the sample container with the appropriate sample label.
- Place the sample containers in a cooler containing ice.
- Complete all chain-of-custody (COC) documents and record in field logbook.

4.6 Sampling and Analytical Requirements

Table 4-1 summarizes the sampling and analytical requirements for the site. **Table 4-2** summarizes the preservation methods, holding times, and sample size/containers for the required analysis. A complete list of the parameters and methods is provided in **Attachment 1**. Ten percent of the field samples collected at the site will be QC Samples.

4.7 Equipment Decontamination

Sampling equipment (core samplers, trowels, triers, and stainless-steel bowls) will be decontaminated prior to the collection of each sample. The electronic interface probe, used to measure depth to groundwater in monitoring wells and pump(s) used for well development and purging, will be decontaminated prior to use at each well. The equipment will be decontaminated using a non-phosphate detergent (such as Alconox, Liquinox, or equivalent), followed by two potable water rinses, one deionized water rinse, and air dried. Decontamination fluids will be containerized for subsequent disposal. Further information and instructions on decontamination procedures are given in **Appendix D**, Field Procedures. Drilling rigs will be brought onto the installation in a clean condition with no mud on the undercarriage or vehicle. The drilling rig and equipment, including augers, bits, and drilling and sampling rods, will be steam-cleaned or hot water pressure-cleaned prior to use at each borehole or monitoring well construction site. Well construction materials will be brought to the site in their original packaging and will remain in the factory-sealed containers until use. If these materials contact the ground during assembly, they will be cleaned with low-sudsing soap and potable water prior to use. A decontamination pad will be established for the washing of drilling equipment. Wash waters from decontamination activities will be contained in the decontamination pad and transferred to containers for proper disposal.

4.8 Sample Handling

4.8.1 Field Documentation

The field geologist (and/or sample technologist) will maintain daily field notes on sampling activities. Items that must be included are sampling protocol, any changes to the procedures, meetings, instructions, safety precautions, level of personnel protection, and other activities pertaining to the samples. The person taking notes must be knowledgeable enough about these activities to know which details are important. Repetition of information recorded in other pertinent logs should be avoided, but enough information should be recorded to present a clear and accurate picture of technical activities. Should a question arise later concerning a specific event or procedure used, it will be answered from these notes. Some items that would be considered noteworthy are as follows:

- Termination of a sample point or parameter and reasons (i.e., terminating a well drilling due to encountering water)
- Unusual appearance or odor of a sample
- Lithologic description of soil samples
- Measurements, volumes of flow, temperature, and weather conditions
- Additional samples and reasons for obtaining them
- Levels of protection (with justification)
- Details concerning any samples split with another party (i.e., USACE)
- Details of QA/QC samples obtained

These notes must be dated and signed (each page) for validity in a court of law. All logbook entries will be made with blue or black waterproof ink and legibly written. Field notes will be entered into a hardbound logbook and the pages will be consecutively numbered. All entries will be in chronological order. The language will be factual and objective. In addition, field sketches may be made in the field logbooks when appropriate, with reference points tied to existing permanent structures in the area (i.e., trees, fence posts, benchmarks, facilities). No erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike-mark and the change initialed and dated by the team member initiating the change. Each page in the field logbook will be signed and dated at the bottom by all persons making entries on that page. Field logbooks will be identified by a project-specific number (i.e., Logbook Number 1 for Project Number 117591, etc.) and stored in the field project files when not in use. At the completion of the field activities, the logbooks will be maintained in the permanent project file. Information on all samples will be entered in the logbook and associated field data collection sheets. The following information items are standard for all projects, recorded on the Field Sampling Report **(Figure 4-1)** or equivalent and entered in a column format where possible:

1. DATE – date sample was obtained
2. SAMPLE NUMBER – consecutive series of numbers assigned to every sample
3. LOCATION – description of area sampled
4. TIME – (military) time sampled (i.e., 24-hour format)
5. SAMPLERS – full name and initials of persons obtaining sample (usually two persons with at least one witnessing, if not involved in the actual sampling task)
6. TYPE OF SAMPLE – water, sediment, sludge, etc.
7. DESCRIPTION OF SAMPLE – physical description of sample (e.g., clear, cloudy, etc.)
8. ANALYSIS – the name of the analytical test or series of analytical tests to be performed on the collected environmental sample
9. WEIGHT OR VOLUME – size of sample (500 milliliters [mL], 32 oz)
10. PRESERVATIVES – preservatives used or included by lab, including cooling to 4 degrees centigrade (°C)
11. LABORATORY – off-site laboratory who performed analytical work
12. FIELD RESULTS – on-site or field analysis will vary according to project requirements; should be in consistent units (i.e., parts per million [ppm], parts per billion [ppb], etc.)
13. CHAIN-OF-CUSTODY NUMBER – for samples sent to the subcontract laboratory
14. ADDITIONAL COMMENTS – space reserved for any other information concerning a particular sample or special procedure or analysis
15. DATE SAMPLES SENT – date samples were sent to subcontract laboratory
16. OVERNIGHT CARRIER AIRBILL NUMBER

4.8.2 Sample Identification and Labeling

A coding system will be used to identify each sample collected during the sampling program. The contractor Sample Technologist will maintain a listing of the project and sample identification numbers. Pre-printed sample labels will include the monitoring well location and a sample number. The sample name will use the following format:

Sample Name: Database ID number-well identification - cc
Where:
Database ID number = L0001

L0001 = Longhorn Army Ammunition Plant and sequential number
Well identification, for example
35BWW03 = site 35B, water well number 03
Disposal samples will be identified as AAAxxx
Where AAA = source of sample:
RO = Roll-off box
DML = Drummed Liquid Sample
DMS = Drummed Soil Sample
TK = Tank
xxx = identification number of the drum or roll-off.
cc = QC sample indicator:
QC = QC (Quality Control) Replicate
QA = QA (Quality Assurance) Replicate
Trip blanks will be coded separately in sequence as follows:
Sample Name: TB – mmyy - xx
Where:
TB = Trip Blank
mmyy = month/year
xx = sequential number

The following are examples of the sample identification scheme for various samples:

L0002-04WW01-QC	A QC replicate of a monitoring well sample collected from LHAAP-04 monitoring well WW01.
DMS005	A soil sample taken from drum number 5.

Environmental samples are identified by a sample label attached to the sample container. Included on the label are the following items:

1. PROJECT # 117591
2. PROJECT NAME (Longhorn Multiple Site)
3. LOCATION (Site identification)
4. SAMPLER (Sampler initials, cross referenced to full names in the field logbook).
5. WITNESS (Witness initials, cross referenced to full names in the field logbook).
6. PRESERVATIVE (Whenever applicable)
7. Database identification code
8. SAMPLE location
9. DATE (DD-MM-YYYY)
10. TIME (24-hour format)
11. ANALYSES (Analytical parameters and methods; i.e., VOC-8260B)

The information described above will be printed neatly using a waterproof marker. After the sample is taken and the label is securely attached, the sample will be logged into the sample logbook. An example of a completed label for VOC analysis is included as **Figure 4-2**.

4.8.3 Custody Seals

Custody seals are narrow strips of adhesive paper or glass fiber used to demonstrate that no tampering of the sample container, equipment and sample cooler has occurred. The custody seal will be signed and dated by the Sample Technician and placed across the opening of the lid and body of the sample transport container (e.g., cooler) on one side and the front (cover the custody seal with wide, clear tape). A custody seal should also be placed from one side, across the top (lid), and to the other side of the sample container. A sample Custody Seal is shown on **Figure 4-3**.

4.9 Chain-of-Custody Procedures

Because of the evidentiary nature of samples collected, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence in legal proceedings, if necessary. To maintain and document sample possession, COC procedures are followed as described below.

The contractor COC is printed with a unique control number in the upper right-hand corner. The COC form will be signed by each individual who has the samples in his or her possession. The COC forms will be completed in the field by the person collecting the samples. Each sample number, time of sampling, description, requested analysis name and method number, and turn-around-time shall be entered on the COC form. When samples are shipped to the subcontract analytical laboratory, the courier name, and waybill (or airbill) number should be noted on the COC form prior to sealing the cooler. Upon arrival at the subcontract analytical laboratory, the person accepting delivery will sign the COC form(s) with a date, time, and initials. Next, the samples in the cooler will be checked against the COC forms for sample number, description, time and date of sampling, and analysis. Any samples in question will be segregated and the field personnel will be notified immediately. The person responsible for checking the samples in the cooler against the COC form shall also complete and sign a cooler receipt form. The COC and cooler receipt forms will be provided in the final data package. If a fast turn-around-time is required for some samples, these samples will be submitted to the subcontract analytical laboratory with a separate COC. In the lower right-hand section of the COC form labeled “remarks”, write the word “**RUSH**” using large letters and underline. The next day, contact the subcontract analytical laboratory and confirm that the samples were received and are processed for the rapid turn-around-time. A sample is under your custody if any of the following conditions is met:

1. It is in your actual possession.
2. It is in your view, after being in your physical possession.
3. It was in your physical possession and they/you lock it up to prevent tampering.
4. It is in a designated secure area.

It is very important that the information on the COC record form match the information on the sample container label; especially sample number, time taken, description and analysis requested. A COC is shown in **Figure 4-4**.

4.10 Shipment of Samples

Samples will be shipped via an overnight carrier to the subcontract laboratory. COCs will be prepared accordingly and are organized by sampling events and matrix; soil samples separate from water samples. All field samples will be placed in appropriately labeled, pre-cleaned sample containers, and enclosed within a plastic sealable bag. The bottom of the shipping cooler will be lined with absorbent material. A sufficient quantity of ice will then be placed on the absorbent material to cover the bottom of the cooler. All ice utilized inside the cooler will be containerized within two plastic freezer bags of 1 quart or larger size. All four sides of the cooler will then be lined with ice packs. Each sample container will be wrapped with bubble pack material to prevent breakage. The wrapped sample container will then be placed in a plastic, sealable bag and sealed. The bagged sample containers will then be placed in the space created by placement of the ice. Any remaining void space will then be filled with bubble pack, styrofoam peanuts, or absorbent material to prevent movement of the sample containers during transport. Once the samples are secured, ice will be placed on top of the sample containers, thereby completely surrounding the sample containers with ice packs. The remaining headspace in the cooler, if any, will be filled with bubble pack, Styrofoam peanuts, or absorbent material.

THE SHIPPING INSTRUCTIONS ARE AS FOLLOWS.

1. Samples must be shipped in strong outer packaging (a plastic cooler is acceptable).
2. Both contractor and the subcontract Laboratory's addresses must appear on the container.
3. The following information must be printed on the container: “FRAGILE” (if glass containers are shipped) with “This Side Up” arrows on two sides of the cooler.
4. A typical contractor shipping label, which also includes contractor and the subcontract analytical laboratory’s addresses, must be attached to top of cooler.
5. Inner packages cannot exceed 1 gallon each, and the entire shipment (cooler, samples, absorbent) cannot exceed 66 pounds.
6. Coolers must be packed with absorbent.
7. 40-mL vials with reagent water will be used as temperature blanks. Temperature conditions will be checked and reported in the Cooler Receipt Form upon arrival at the laboratory.
8. Inner containers should have their lids secured with tape or wire.
9. Prior to sealing the cooler with Custody Seal and Tape, a contractor Shipment Checklist will be completed and reviewed. A sample Shipment Checklist is shown in **Figure 4-5**.
10. A standard airbill is completed to the satisfaction of the selected shipping company.

The completed COC forms shall be enclosed in plastic, sealable bags and taped to the underside of the lid of the cooler. The drain of the cooler will be taped shut. On the day of shipment, fresh ice will be added to the coolers to ensure the preservation criteria are met, the lid will be taped shut using strapping tape (filament type), and a minimum of two custody seals or evidence tape will be fixed to the coolers. The coolers will then be sent to the subcontract laboratory. For liquid samples, a “**THIS SIDE UP**” placard is required.

Table 4-1
Sampling and Analytical Requirements

Matrix	Parameter	Method	Turnaround Time
Groundwater	VOCs	SW-846 8260B	14 Days
Groundwater	Perchlorate	EPA 314	14 Days
Groundwater	Explosives	SW-846 8330	14 Days
Groundwater	Antimony	SW-846 6020	14 Days
Groundwater	Thallium	SW-846 6020	14 Days
Groundwater	Metals	SW-846 6020	14 Days
Groundwater	Dioxin/Furans	SW-846 8290	14 Days
Soil	VOCs	SW-846 8260B	14 Days
Soil	Perchlorate	EPA 314	14 Days
Soil	Explosives	SW-846 8330	14 Days
Soil	Metals	EPA 6010B/7470A	14 Days

Type	Matrix	Parameter	Method	Turnaround Time
Disposal	Soil	TCLP VOCs TCLP SVOC TCLP metals Reactivity Corrosivity Ignitability	SW-846 8260B EPA 314 SW-846 8330 SW-846 7.3 SW-846 9045C 1010	14 Days
Disposal	Water	TCLP VOCs TCLP SVOC TCLP metals Reactivity Corrosivity Ignitability	SW-846 8260B EPA 314 SW-846 8330 SW-846 7.3 SW-846 9040B 1010	14 Days

Notes and Abbreviations:

[1] *United States Environmental Protection Agency (USEPA), 1997.* **Test Methods for Evaluating Solid Waste, Physical Chemical Methods (SW-846)***, Update III. Office of Solid Waste and Emergency Response, Washington, D.C.*

[2] *USEPA, 1983.* ***Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020****. Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio.*

SVOC	*semivolatile organic compound*
TBD	*to be determined based on volume of material collected in the field*
TCLP	*toxicity characteristic leaching procedure*
VOC	*volatile organic compound*

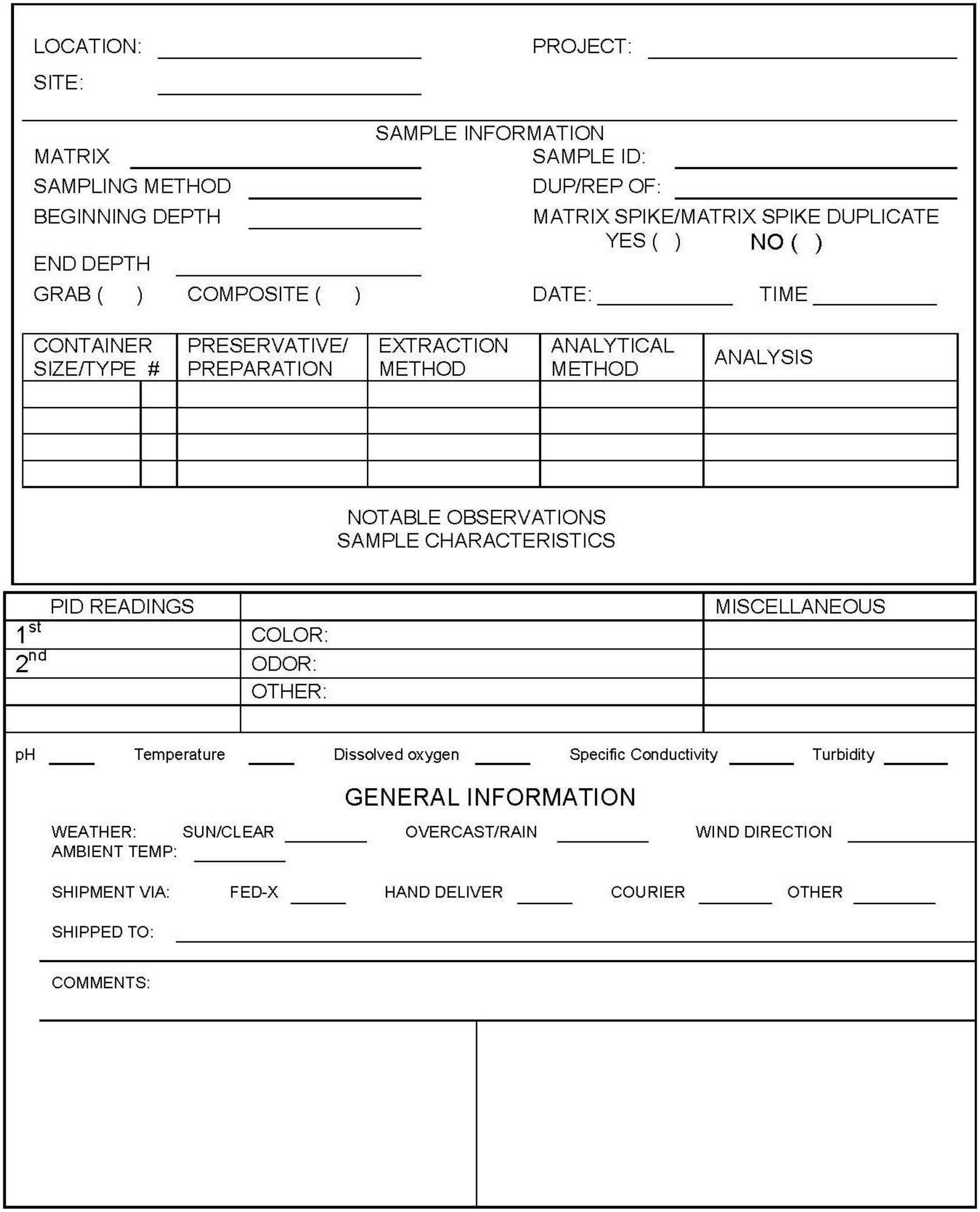
Table 4-2
Sample Volume, Preservation, Holding Times

Parameter	Minimum Sample Volume	Holding Time	Preservation
Water (Groundwater, Surface Water Rinse Blanks)			
Volatiles	3 X 40 mL vial with PTFE septa cap	14 days	HCl to pH < 2 4 °C no headspace
Explosives	2 X 1L AG	7 days to extraction 40 days to analysis	4 °C
Metals	1 X 500 mL HDPE bottle	6 months except mercury, 28 days	HNO_3 to pH < 2 4 ºC
Perchlorate	250 mL HPDE bottle	28 days	4 °C
Dioxin/Furans	2 X 1L AG	30 days to extraction 45 days to analysis	4 °C
TCLP Semivolatiles	1L AG	7 days to extraction 40 days to analysis	4 °C
TCLP Volatiles	2 X 40 mL vial with PTFE septa cap	14 days	4 °C
TCLP Metals	1 L HDPE bottle	6 months except mercury, 28 days	4 °C
Reactivity, Corrosivity, (pH), Ignitability	1 L HDPE bottle	28 days except pH, immediate	4 °C
Soil/Sediments			
Volatiles	2- or 4-ounce CWM (or 5g – Encore)	2 days to extraction 14 days to analysis	4 °C
Perchlorate	1 X 8-ounce CWM with Teflon-lined cap	180 days to analysis	4 °C
Explosives	1 X 4-ounce CWM with Teflon-lined cap	14 days to extraction 40 days to analysis	4 °C
Metals	1 X 4-ounce CWM with Teflon-lined cap	180 days to analysis (EPA Method 6010B) 28 days to analysis (EPA Method 7471A)	4 °C
TCLP Volatiles	4-ounce CWM with PTFE septa cap	14 days to analysis	4 °C no headspace
TCLP Semivolatiles	8-ounce CWM jar	14 days to extraction 40 days to analysis	4 °C
TCLP Metals	4-ounce CWM jar	6 months to analysis except mercury, 28 days	4 °C
Reactivity, Corrosivity, (pH), Ignitability	4-ounce CWM jar	28 days except pH, immediate	4 °C

<u>Notes and Abbreviations:</u>

The above listed volumes provide an adequate quantity of sample to analyze a matrix spike (MS) and matrix spike duplicate (MSD).Multiple analytes, except volatiles may be combined into one 8-ounce jar for soils.

AG	*amber glass jug*	*HNO_3*	*nitric acid*
°C	*degrees centigrade*	*L*	*liter*
CWM	*clear wide mouth jar*	*mL*	*milliliter*
EPA	*U.S. Environmental Protection Agency*	*pH*	*potential hydrogen*
HCl	*hydrochloric acid*	*PTFE*	*polytetrafluoroethylene*
HDPE	*high-density polyethylene*	*TCLP*	*toxicity characteristic leaching procedure*



LOCATION: ____________________ PROJECT: ____________________

SITE: ____________________

SAMPLE INFORMATION

MATRIX ____________________ SAMPLE ID: ____________________

SAMPLING METHOD ____________ DUP/REP OF: ____________________

BEGINNING DEPTH ____________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE

YES ( ) NO ( )

END DEPTH ____________

GRAB ( ) COMPOSITE ( ) DATE: __________ TIME __________

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS
SAMPLE CHARACTERISTICS

PID READINGS		MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH _____ Temperature _____ Dissolved oxygen _____ Specific Conductivity _____ Turbidity _____

GENERAL INFORMATION

WEATHER: SUN/CLEAR ________ OVERCAST/RAIN ________ WIND DIRECTION ________

AMBIENT TEMP: ________

SHIPMENT VIA: FED-X _____ HAND DELIVER _____ COURIER _____ OTHER _____

SHIPPED TO: ____________________

COMMENTS:

Figure 4-1
Field Sampling Report

PROJECT #: 117591

PROJECT NAME: LONGHORN AAP

LOCATION: LHAAP-04 WW01

SAMPLER: RBW

WITNESS: JTR

PRESERVATIVE: ICE

SAMPLE NO: L0002-04WW01

DATE: 16-FEB-2004

TIME: 1415

ANALYSIS: SW8260B

Figure 4-2
Sample Label

CUSTODY SEAL

PERSON COLLECTING SAMPLE BW

DATE COLLECTED 16-FEB-2004

SAMPLE # L002-04WW01

TIME COLLECTED 1415

NOTE: The "Sample #" and "Time Collected" blocks would not be filled in when placing Custody Seals on the outside of the shipping container.

Figure 4-3
Custody Seal

CHAIN-OF-CUSTODY RECORD

PROJ. NO.

PROJECT NAME

SAMPLERS: (Signature)

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

Figure 4-4
Chain of Custody

SHIPMENT CHECKLIST

Project Name ______________________________ Project No. ________________
Street Address ______________________________ Date:________ Time:________
City/State/Zip ____
Phone Number (xxx) ______________________________ Fax Number (xxx)____________

SAMPLE CHECKLIST

	Yes	No	Comments
Sample lids are tight and custody seals in place?	☐	☐	____________
Are sample numbers, dates, times and other label information legible and complete?	☐	☐	____________
Have all sample numbers, dates, times and other sample data been logged into sample logbook?	☐	☐	____________
Do sample numbers and sample description on the labels match with those on the Chain-of-Custody (COC)?	☐	☐	____________
Have the samples been properly preserved?	☐	☐	____________
Have the COCs been filled out completely and correctly?	☐	☐	____________
Are the labels filled out in the indelible ink and/or label taped over with clear tape?	☐	☐	____________
Have the COCs been properly signed in the transfer section?	☐	☐	____________

PACKAGING CHECKLIST

Has each sample been placed into an individual plastic bag?	☐	☐	____________
Has the drain plug of the cooler been taped closed with waterproof tape from the inside?	☐	☐	____________
Has the cooler been adequately lined with cushioning absorbent pads?	☐	☐	____________
Have all the samples been placed into the cooler in an upright position?	☐	☐	____________
Is there adequate spacing of samples so that they will not touch during shipment?	☐	☐	____________
Have an adequate number of blue ice packs been placed around and on top of samples?	☐	☐	____________
Has the COC been placed in a plastic sealable bag and taped to the inside of the lid of the cooler?	☐	☐	____________
Is an analytical request form needed and is it in a plastic sealable bag under the lid of the cooler?	☐	☐	____________
Have custody seals been placed over the lid?	☐	☐	____________
Has the cooler been properly labeled with correct address and proper certification?	☐	☐	____________
Has the laboratory performing the analysis been notified of the shipment of samples?	☐	☐	____________

PROBLEMS/RESOLUTIONS

Prepared by:____________________________ Signature:________________________________

Figure 4-5
Shipment Checklist

5.0 Field Screening Methods

Several field screening methods will be utilized based on site-specific objectives and soil collection methods. During the collection of soil samples from surface soils and subsurface (drilling) soils, basic field screening methods using an organic vapor analyzer (OVA) or photoionization detector (PID) will be employed. The samples will be collected using a clean trowel, trier, or shovel and scooping the appropriate quantity of soil or sediment into a stainless steel bowl. A sufficient quantity of soil will be collected for both the field and laboratory sample requirements. Each sample will be composited and the sample for field analysis will be removed. If the field results indicate that a sample should be submitted to the laboratory for confirmatory analysis, the remaining composited soil will be used for the analyses. For samples requiring VOC analysis, a discrete grab sample will be collected from each of the sample locations. The remaining composited soil will be disposed with the excavated soil.

Excavation sampling, while using the same or similar screening equipment and basic procedures as described above, may require the use of other screening tools or field sampling kits. By guiding the excavation limits at certain sites with the use of these screening tools, soil excavation limits can be delineated horizontally and vertically. If the field analysis results indicate that concentrations of chemicals of interest exceed the cleanup criteria, excavation will continue in the direction from where the sample was collected until exceedances are not detected. When the four sidewall samples and the center “floor” sample(s) do not exceed the cleanup criteria, the excavation will be considered temporarily complete pending the results of the laboratory confirmation results.

Should subsequent laboratory analysis indicate that the concentrations of chemicals of interest in a sample are less than the cleanup criteria, then the excavation from which that sample was collected will be back-filled. Should the sample indicate a concentration greater than or equal to the cleanup criteria, then excavation in the area will recommence and the sample program for that area will proceed from there. If applicable, multi-incremental sampling will be used to delineate compliance with closure criteria.

Sampling devices will be inspected prior to use to ensure that there is no corrosion or wear that would increase the likelihood of contaminant sorption to the sampling equipment. Reusable sample equipment will be thoroughly decontaminated between uses. See **Appendix D**, **Attachment 9**, Decontamination Procedures. **Table 5-1** summarizes the field screening method for this sampling project. Health and safety screening methods are described in the Site Safety and Health Plan.

Table 5-1
Field Screening Procedures

Parameter	Techniques	Field Method
Volatile Organic Compounds	Photoionization Detector	Portable, real-time meter. Operate according to manufacturer instructions.
Groundwater Quality Parameters: pH, temperature, conductivity, and turbidity	Electronic sensors	Portable, real-time meters. Operate according to manufacturer instructions.
Soil Screening and Delineation Parameters: Metals	X-Ray Fluorescence Instrument	Portable, real-time meters. Operate according to manufacturer instructions.

6.0 Off-Site Laboratory

The contractor will notify USACE of the selected laboratory prior to starting the sampling program. The analytical tables in **Attachment 1** summarize the analytical methods, analytes, and detection limits for off-site analysis.

6.1 Data Quality Objectives

The following sections summarize the data quality objectives for the analytical laboratory procedures that can be found in **Attachment 1**. Detection limits for these analytes shall be as stated in either the subcontract analytical laboratory's LQMP or **Attachment 1**, whichever are/is more stringent as compared to the listed groundwater standards.

6.1.1 Method Blanks

The method blank is used to document contamination resulting from the analytical process. As stated in SW-846, Chapter One, Section 5.0, 1994 Edition of *Methods for Chemical Analysis of Water and Wastes*, and U.S. Environmental Protection Agency (USEPA) 600 Methods, for a method blank to be acceptable for use with this site's samples, the concentration in the blank of any analyte of concern should not be higher than the highest of either:

- The method detection limit, or
- 5 percent of the regulatory limit for that analyte, or
- 5 percent of the measured concentration in the sample

A method blank shall be analyzed with each batch of samples that are analyzed from this site by matrix.

6.1.2 Matrix Spikes

A matrix spike (MS) is defined as an aliquot of sample spike with a known concentration of target analytes. The spiking occurs prior to sample preparation and analysis. MSs are used to document the precision and bias of a method in a given sample matrix.

The acceptable criteria (control limits) for use with this site's samples shall be provided in the subcontract analytical laboratory's LQMP, and shall be provided with each set of data and final report. A MS and matrix spike duplicate (MSD) shall be analyzed with each batch of samples analyzed from this site. Site samples must be utilized for an MS/MSD analysis at a minimum of once each 20 samples received by the laboratory, by matrix.

The laboratory is directed by appropriate sections of SW-846 and other USEPA methodologies on the procedure to establish QC limits for each target analyte of interest. These QC control limits shall be provided with all laboratory data, regardless of the turn-around-time requested, for each target analyte requested.

6.1.3 Laboratory Control Sample

A Laboratory Control Sample (LCS) is a volume of reagent water or inert solid spiked with known concentrations of analytes and carried through the preparation and analysis procedure as a sample. The purpose of the LCS is to monitor method loss and recovery data on a sample with no matrix effects. An LCS shall be analyzed with each batch of samples by matrix. NOTE: If there is not a sufficient quantity of sample to perform an MS/MSD, an LCS/Laboratory Control Sample Duplicate (LCSD) analysis shall be analyzed to provide QC data.

The laboratory is directed by appropriate sections of SW-846 and other USEPA methodologies on the procedure to establish QC limits for the LCS for each target analyte of interest in reagent water. These QC control limits shall be provided with all laboratory data, regardless of the turnaround-time requested, for each target analyte requested.

6.1.4 Surrogate Compounds (Organic Methods)

A surrogate compound is an organic compound which is similar to the target analytes in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples. Surrogate compounds are added to monitor the extraction process and method efficiency. Surrogates are to be added to gas chromatography/mass spectrometer (GC/MS) methods and those GC methods that specifically require surrogate compound(s).

In the case of SW-846 GC/MS methods, surrogate QC acceptance recoveries for each compound are established and provided in the method. The subcontract analytical laboratory must meet these surrogate QC acceptance criteria. If the GC/MS and/or GC surrogate QC acceptance criteria is not provided in the method, the laboratory shall establish surrogate QC acceptance criteria as described in the MS section above **(Section 6.1.2)**.

6.1.5 Laboratory Duplicates

Laboratory duplicates are two aliquots of the same sample taken through the whole sample preparation and analysis process in the same manner. The purpose is to monitor system performance and sample homogeneity. Laboratory duplicates are normally specified for metals and water quality parameters. The QC acceptance criteria shall be within 20 percent relative percent difference (RPD).

6.2 Method Quality Control

All calibration and instrument tuning will follow SW-846, EPA 600, or manufacturer's specifications when this is not available. Laboratory blanks, spikes (LCS, LCSD, MS, MSD), duplicates and standard reference materials analyses that are required by the method will be reported.

6.3 *Sample Quality Control*

Subcontract analytical laboratory’s LQMP will be provided to USACE upon request. The LQMP covers QC functions, including, but not limited to:

- Tuning
- Internal Standards
- Surrogate spikes
- Detection limit study
- Analyte identification and tentatively identified compounds
- Serial dilutions
- Duplicate injections
- Post digestion spikes
- Sample dilution
- Method blank
- LCS

The above-mentioned items are also covered in the pertinent methods manual.

7.0 Quality Control Parameters

The quality of analytical data will be assessed in terms of its precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. Because accuracy and precision information may be expressed in several ways, data obtained from this project will be carefully reviewed and evaluated by either an analytical chemist or a statistician. The application of PARCC parameters is described in the following sections.

7.1 PARCC Parameters

7.1.1 Precision

Precision will be assessed by comparing the analytical results between MS and MSD. The RPD between the MS and MSD (or LCS and LCSD) will be calculated using **Equation 7-1**. This information will be used to determine whether the analytical results received provide equal or greater precision data generated by the applicable method validation on similar matrices.

$$\text{RPD} = \frac{\text{MS Result} - \text{MSD Result}}{(\text{MS Result} + \text{MSD Result})} \times 100 \qquad \textbf{Equation (7-1)}$$

The precision of the field sample and the QC field sample will be considered to be outside QC limits under the following circumstances: (1) if at least one of the results exceed the analysis detection limit by a factor of five or greater, and (2) if the ratio of the results (field sample/QC sample or QC sample/field sample) exceed a factor of 2.0 for water samples or 5.0 for soil samples. A major disagreement is apparent when concentration ratios exceed 5.0 for water and 10 for soil. The ratios do not apply when both the QC sample and field sample results are less than 5 times the analytical detection limit. If there is not a sufficient quantity of sample available to conduct an MS and MSD spike analyses, LCS and LCSD analyses must be completed to provide required QC data.

7.1.2 Accuracy

The accuracy of the measured data is evaluated by the comparison of the percent recovery of QC reference materials of known or established concentrations, independent of the routine calibration. Statistically based control limits are established for each method of analysis and sample matrix. Accuracy is determined by the analysis of method spikes (blank spike, LCS) and MS/MSD samples. A blank spike is prepared in the laboratory using an inert matrix such as deionized water or certified clean, inert sand which is spiked with target analytes. When one of the samples in the batch has two additional aliquots prepared and spiked with target analytes, these two aliquots are referred to as the MS and MSD. Spiked samples are routinely analyzed on each batch of up to 20 samples. Note that a batch may also contain less than 20 samples. Recoveries are assessed to determine method efficiency and any matrix interference effects.

Analytical accuracy is expressed as the percent recovery of the spike added. **Equation 7-2** is used to calculate the percent recovery.

$$\text{Percent} = \frac{\text{Spike Sample Results} - \text{Sample Results}}{\text{Amount of Spike Added}} \times 100 \qquad \textbf{Equation (7-2)}$$

7.1.3 Completeness

Completeness is defined as the percentage of measurement taken for analysis in order to make site decisions compared to the total valid results available. **Equation 7-3** defines completeness. The highest percentage possible (minimum of 90 percent) will be achieved between the number of samples in control compared to the total number of samples received by the subcontract analytical laboratory. The results will be calculated following data reduction, review, and assessment.

$$\text{Completeness} = \frac{\text{Valid Data Obtained}}{\text{Total Data Planned}} \times 100 \qquad \textbf{Equation (7-3)}$$

A value of 90 percent or higher is the goal. For values less than 90 percent, problems in the sampling or analytical procedures should be examined and explained.

7.1.4 Representativeness

Unlike accuracy, precision, and completeness that can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is address throughout this CDAP and the Design/Work Plan by describing the rational for sample locations, collection methods, frequency of sampling, and QA/QC procedures. **Table 4-1** summarizes analytical methods and turnaround times. **Table 4-2** summarizes analytical sample volume, holding times, and preservation method. **Table 7-1** presents field QA/QC requirements.

QC considerations including method blank results, sample holding times, sample preservation and sample conditions (i.e., during shipment and upon arrival at the lab) play an important role in sample representativeness. Sample results are not to be corrected for blank contamination. Samples may be rejected before analyzing if preservation requirements are not met, causing undue resampling in the field. If sample holding times are exceeded and samples are received in poor condition at the laboratory, the USACE must be notified immediately for problem resolution.

7.2 Sensitivity / Detection Limits

The detection limits for each test listed in **Table 4-1** are outlined in **Attachment 1** and are covered in subcontract analytical laboratory's LQMP. The more stringent detection limits shall apply.

7.3 Field Quality Control

Field QC samples will be collected and analyzed throughout the field phases of this Task Order. The number and type of field QA/QC samples, as a minimum, are shown in **Table 7-1**.

7.3.1 Trip Blanks

Blanks, which are collected in the field, are an important link in the QC data chain for each set of samples. The analytical data derived from these blanks are necessary to assess quality of field sampling operations. Blanks are used to verify that sample containers, preserving reagents, and equipment are contaminant-free prior to and between different sampling points. Blanks are also used as a check for potential on-site environmental contamination, to evaluate personnel expertise in sample collection, and to reveal problems that may occur in sample storage and transport.

Therefore, the field QC blanks will not be isolated from actual samples. They must be considered as samples and treated identically (preserved with the same reagents, stored and transported in the same containers as the samples, etc.).

PURPOSE: The trip blank will be used when water samples, and soils in Septa jars, are being requested for volatile contaminants. Trip blanks will be analyzed for VOCs to ensure the integrity of the collection and shipping process.

PROCEDURE: Trip blanks will be prepared prior to the sampling event by the subcontract analytical laboratory, which is responsible for the initial preparation of sample containers. The water will be free of volatile organic contaminants. Any appropriate preservatives will be added at the time that the blanks are prepared. The sample containers (vials) will be sealed (custody seal), labeled appropriately, and transported to the site in the same sampling kits as the sample vials. These blanks will not be opened in the field. The trip blank remains with the corresponding field samples at all times during the collection, handling, and shipping of field samples.

FREQUENCY: A set of trip blanks will accompany the storage and transport of all field water samples, and soils collected in Septa jars being requested to be analyzed for volatile contaminants. One set of trip blanks will be placed into every cooler that contains water samples and soils in Septa jars for volatile analysis.

7.3.2 QC Replicate Samples

PURPOSE: QC samples are collected by the Sample Technologist and are used to verify the reproducibility of the subcontract laboratory data. The purpose of the samples is to provide site specific field originated checks that the data generated by the subcontract laboratory are of suitable quality.

Groundwater QC samples will be collected as a single sample using an acceptable sampling device and poured/pumped into separate but identical containers. Volatile samples will be collected first. One sample will be labeled as the field sample and the other sample will be labeled as the QC sample. The QC samples will be contained, preserved, and transported in the same manner as the samples of interest. QC samples will be analyzed for the same parameter groups as the associated field samples of interest.

FREQUENCY: One QC sample will be collected for every 10 or less field samples (for each sample matrix) collected at the site.

The precision of the field sample and the QC field sample will be considered to be outside QC limits under the following circumstances: (1) if at least one of the results exceed the analysis detection limit by a factor of five or greater, and (2) if the ratio of the results (field sample/QC sample or QC sample/field sample) exceed a factor of 2 for water samples or 5 for soil samples. A major disagreement is apparent when concentration ratios exceed 5 for water and 10 for soil. The ratios do not apply when both the QC sample and field sample results are less than 5 times the analytical detection limit.

7.3.3 QA Replicate Samples

PURPOSE: QA samples are used by the USACE to evaluate the performance of the subcontract laboratory.

Groundwater QC samples will be collected as a single sample using an acceptable sampling device and poured/pumped into separate but identical containers. Volatile samples will be collected first. One sample will be labeled as the field sample, one sample will be labeled as the QC sample, and the other sample will be labeled as the QA sample. The QA samples will be contained, preserved, and transported in the same manner as the samples of interest. QA samples will be analyzed for the same parameter groups as the associated field samples of interest.

FREQUENCY: One QA sample will be collected for every 10 or less field samples (for each sample matrix) collected at the site.

7.3.4 Field Measurement Duplicates

PURPOSE: Field measurement duplicate samples (photoionization detector [PID] readings) are used to verify reproducibility of data on field instruments.

PROCEDURE: Field measurement duplicate readings will be collected every ten samples.

FREQUENCY: One QA sample will be collected for every 10 or less field samples (for each sample matrix) collected at the site.

7.4 Sample Quality Control Report

To supplement the information recorded in the field logbook, Sample Quality Control Reports (SQCRs) will also be maintained for every sampling location. An example of the SQCR to be used at the site is shown in **Figure 7-1**. SQCRs will be maintained by the Sample Technologist and cross-checked for completeness at the end of each day by the CQCSM. Each form will be signed and dated by individuals making entries and initialed by the CQCSM upon completion. Copies of the SQCR will be attached to the Daily Quality Control Report and forwarded to USACE.

Table 7-1
Field QA/QC Samples

Quality Control	Frequency of Occurrence	Percent Objective	Minimum Number
Trip Blank	1 per cooler containing waters and soils (in jars with PTFE septa caps) for volatile analysis	100	1
QA Replicate Samples	As requested by the USACE	100	1
QC Replicate Samples	1 per 10 or fewer field samples	100	1

Abbreviations:

PTFE	*polytetrafluoroethylene*
QA	*quality assurance*
QC	*quality control*

USACE Project Manager
Project
Project #
Contract #

Date							
Day	S	M	T	W	TH	F	S
Weather	Bright Sun	Clear		Overcast	Rain		Snow
Temp	<32	32-50		50-70	70-85		>85
Wind	Still	Moderate		High	Report #		
Humidity	Dry	Moderate		Humid			

Subcontractors on Site:

Equipment on Site:

Visitors on Site:

Contractor Personnel on Site:

Work Performed (including sampling):

Quality Control Activities (including field calibrations):

Health and Safety Levels and Activities:

Problems Encountered/Corrective Actions Taken:

Downtime/Standby:

Special Notes:

By: Title:

Figure 7-1
Sampling Quality Control Report Form

8.0 Data Analysis Reporting

8.1 Field Instrument Data Reduction

The Sample Technician will be responsible for the proper use and calibration of the PID instruments used in the field to collect chemical data. All raw data collected for the field survey instruments will be entered into the logbook for the site.

8.2 Field Data Reduction

8.2.1 Responsibilities of the Analyst-Sample Technician

Each analyst will be responsible for converting raw data into reportable values. These specific duties include:

- Proper identification of the analyte
- Checking calibrations to ensure support of data
- Ensuring QA/QC checks are supportive of data
- Ensuring documentation is complete and accurate in respective logbooks

8.2.2 Analytical Records from On-Site Field Analytical

The Sample Technician will maintain a bound, numbered logbook for all PID samples analyzed. The following column headings will be entered, as applicable, for each item of sample information:

- Date – Date sample was collected
- Sample Number
- Location – Description of area sampled (abbreviated form if sampled twice or more - log explaining locations and abbreviations should be attached to or written in front of the logbook).
- Time – Time sample was collected
- Samplers – Persons collecting sample (always two-one at least witnessing even if not involved in the actual act)
- Type of Sample – Water, Soil, Air, etc.
- Analysis by – Person who performed analytical work

- Additional Comments – Space reserved for any other information concerning a particular sample or special procedure or analysis and COC of samples that leave the site

8.3 Field Data Verification

All field equipment will be checked and calibrated prior to use. Each instrument calibration is recorded in the field instrument calibration notebook. Field personnel using the equipment (sample technician, safety and health personnel, project hydrogeologist) are responsible for the following information:

- Internal calibration, complete and accurate
- Field data integrity
- All documentation is complete and accurate in a logbook
- Acknowledging historical data

8.4 Project Data Review

All data produced for the project will be given to the CQCSM and the Remediation Manager for final data review. All logbooks, COC, laboratory reports, etc. are reviewed to ensure all QC protocols have been met. All information will be archived for data storage.

8.5 Data Reporting by Contract Laboratory

8.5.1 Original Laboratory Report

Once the data have been reviewed, it is ready for report production. The report will typically contain the following information:

- Narrative discussing QC problems encountered by analytical method and matrix
- Project Number
- Original COC forms
- Cooler Receipt Form
- Description of sample types
- Tests performed and method number
- Date sampled
- Date received
- Date extracted
- Date analyzed
- Analytical results
- Dilution factor

- Percent solids (if applicable)
- Moisture content (soils)
- Field identification number and corresponding lab identification number
- Actual laboratory detection limit
- QC information
  - – Blanks analyzed
  - – Matrix spikes (MS/MSD)
  - – Method spike (LCS, blank spike)
  - – Surrogates, when applicable
  - – Percent recovery
  - – Control limits
  - – RPD
  - – any other special QC information
- Methodology
- Table cross-referencing field sample numbers and lab identification numbers, when these numbers are not included on each individual lab report form
- Table cross-referencing field samples to the associated method blanks, blank spike, MS, and MSD when more than one batch is included in the lab report package

The hard copy report will be checked by the off-site Project Chemist/Laboratory Coordinator, Remediation Manager and QC Manager before it is released. The original copy of the laboratory report, including the COC and cooler receipt form, will be provided to USACE as an integral part of the final submittal after all review comments have been resolved. A copy of each final laboratory report will be placed in the project file for future reference.

8.5.2 Diskette Deliverable

The analytical laboratory will also provide all project analytical data in an electronic data format. The contractor will specify an appropriate file structure compatible with the contractor’s database. The laboratory will complete the files by downloading the appropriate analytical results and data. The laboratory data files will be added to a database that can be used to produce analytical results tables.

8.6 Contractor Review of Diskette Deliverable

Upon receipt of the laboratory diskette deliverable listed in **Section 8.5.2**, the diskette will be reviewed by contractor technical personnel. The review will consist of reviewing the format and files to ensure that they also comply with the contractor database format. The review will also consist of a review of the diskette contents for completeness; all analytical data has been entered correctly. If problems are encountered in the analytical data, the diskette will be returned to the analytical lab for a correction.

8.7 Data Storage and Deliverables

All documentation used and generated will be given to the Project Manager at the completion of the project. All logbooks, laboratory reports, and support documentation will be submitted to USACE. When available, the data will also be uploaded on the project specific portal provided by the contractor. This information will be accessible to both the Army and regulators for their use. Deliverables to the Army will be in a format compatible with the ERIS and AEDB-R databases in accordance with the terms of the PWS (USACE, 2005).

9.0 Assessments and Response Actions

9.1 Site Audits

Under this task, the CQCSM, or his designee, will conduct a field audit to check the implementation of this CDAP. Site audits will assess the following:

- Personnel performance
- Sampling methods and techniques
- Decontamination methods and techniques
- QC program
- Data review program
- Recordkeeping procedures
- Document control system
- Data storage
- Corrective action responses

Upon completion of the site audit, the CQCSM will generate a report citing the deficiencies found as well as the progress achieved since the last site audit. Any deficiencies will be promptly corrected. Copies of the audit report will be given to the Project Chemist, Remediation Manager, and Project Manager. One copy will also be placed in the project files for reference.

9.2 Data Review System

9.2.1 Laboratory Analyst's Data Review Responsibilities

The laboratory analyst at the subcontract analytical laboratory is responsible for the initial review of the project data. Any errors, or deficiencies, will be addressed at this time.

9.2.2 Laboratory QA Officer Data Review Responsibilities

The QA Officer at subcontract analytical laboratory will be responsible for the final data review prior to sending the initial and final report to the contractor. Any errors, or deficiencies, will be addressed at this time.

9.2.3 Project Chemist Data Review Responsibilities

The Project Chemist is responsible for the initial contractor review of the data from the subcontract analytical laboratory. This review shall include the following:

- Verify that all requested data are reported (indicate any data gaps)

- Verify that samples are analyzed according to the contract specified methods
- Verify that the holding times have not been exceeded
- Verify that MS, MSD, method spike (LCS or blank spike), and surrogate recoveries fall within the laboratory's, or method, acceptable criteria
- Review blank data for gross, or unacceptable, contamination
- Review laboratory corrective actions discussed in narrative
- Provide a comparison of the field and QC sample results
- Provide an evaluation of data acceptability and usability for each sampling episode
- Verify receipt of QC validated database data diskette

The Project Chemist will be responsible for informing the Project Manager and CQCSM of any laboratory and/or sampling deficiencies or issues. The Project Chemist will immediately inform the Project Manager, and/or CQCSM, of any data that do not fall within clean-up or closure criteria. The USACE will make the final decision regarding data acceptability and usability based on review of the data.

9.3 Corrective Action Reports

The Corrective Action Report (CAR) should include, but not limited to, the following:

- A description of the problem, deficiency, or issue
- Proposed resolution
- Resulting action

Depending on the issues, this report may be generated by the laboratory, Project Chemist, or Sample Technician. Copies of the CAR will be given to the Project Chemist, Remediation Manager, Project Manager, CQCSM, and USACE point-of-contact. A copy will also be placed in the project file for future reference. A sample CAR is shown in **Figure 9-1**.

CORRECTIVE ACTION REPORT

TO:
FROM:
PC:
DATE:
PROJECT: **PROJECT NUMBER:**

NATURE OF EVENT:

RECOMMENDED CORRECTIVE ACTION:

CORRECTIVE ACTION TAKEN:

DATE:__________**TIME:**__________ **CORRECTIVE ACTION TAKEN:**_______________

SIGNATURE of person implementing corrective action:______________________________

Figure 9-1
Corrective Action Report Form

10.0 References

U. S. Army Corps of Engineers (USACE), 2001, *Engineering and Design - Requirements for the Preparation of Sampling and Analysis Plans*, Document EM-200-1-3.

USACE, 2005, *Performance Work Statement (PWS), Longhorn Army Ammunition Plant*, July 22.

Attachment 1

Analytical Methods and Constituent/Detection Limits

Comparison of Typical Laboratory Detection Limits to Screening Levels of Aqueous Samples
Volatile Organic Compounds - Method 8260B
Longhorn Army Ammunition Plant, Karnack, Texas

Analyte	Units	Reporting Limit[1]	Groundwater Standard (MCL)[2]
1,1,1,2-Tetrachloroethane	mg/L	0.0005	0.00328
1,1,1-Trichloroethane	mg/L	0.0008	0.2
1,1,2,2-Tetrachloroethane	mg/L	0.0004	0.000426
1,1,2-Trichloroethane	mg/L	0.001	0.005
1,1-Dichloroethane	mg/L	0.0004	0.365
1,1-Dichloroethylene	mg/L	0.0012	0.007
1,1-Dichloropropene	mg/L	0.001	0.000852
1,2,3-Trichlorobenzene	mg/L	0.0003	0.011
1,2,3-Trichloropropane	mg/L	0.0032	1.22E-05
1,2,4-Trichlorobenzene	mg/L	0.0004	0.07
1,2-Dibromoethane	mg/L	0.0006	0.00005
1,2-Dichlorobenzene	mg/L	0.0003	0.6
1,2-Dichloroethane	mg/L	0.0006	0.005
1,2-Dichloropropane	mg/L	0.0004	0.005
1,3-Dichlorobenzene	mg/L	0.0012	0.11
1,3-Dichloropropane	mg/L	0.0004	0.000852
1,4-Dichlorobenzene	mg/L	0.0003	0.075
1,4-Dioxane	mg/L	--	0.00774
2,2-Dichloropropane	mg/L	0.0035	--
2-Hexanone	mg/L	0.005	0.219
Acetone	mg/L	0.005	0.365
Acrolein	mg/L	0.0004	0.018
Benzene	mg/L	0.0004	0.005
Benzene, 1,2,4-trimethyl	mg/L	0.0013	0.183
Benzene, 1,3,5-trimethyl	mg/L	0.0005	0.183
Benzene, 1-methylethyl	mg/L	--	0.365
Bromobenzene	mg/L	0.0003	0.073
Bromodichloromethane	mg/L	0.0008	0.1
Bromoform	mg/L	0.0012	0.1
Carbon tetrachloride	mg/L	0.0021	0.005
Carbondisulfide	mg/L	0.005	0.365
Chlorobenzene	mg/L	0.0004	0.1
Chlorobromomethane	mg/L	0.0004	0.146
Chlorodibromomethane	mg/L	0.0005	0.1
Chloroethane	mg/L	0.001	1.46
Chloroform	mg/L	0.001	0.1
cis-1,2-Dichloroethene	mg/L	0.0012	0.07
cis-1,3-Dichloropropene	mg/L	0.001	0.000158

Comparison of Typical Laboratory Detection Limits to Screening Levels of Aqueous Samples
Volatile Organic Compounds - Method 8260B
Longhorn Army Ammunition Plant, Karnack, Texas
(continued)

Analyte	Units	Reporting Limit[1]	Groundwater Standard (MCL)[2]
Dichlorodifluoromethane	mg/L	0.001	0.73
Ethylbenzene	mg/L	0.0006	0.7
Hexachlorobutadiene	mg/L	0.0011	0.00073
Isobutyl Alcohol	mg/L	--	1.1
Methyl chloride	mg/L	--	0.00655
Methyl ethyl ketone	mg/L	0.005	2.19
Methyl iodide	mg/L	0.001	0.00511
Methyl isobutylketone (MIBK)	mg/L	0.0015	0.292
Methyl tert-butyl ether	mg/L	0.001	0.015
Methylene bromide	mg/L	0.001	0.0114
Methylene chloride	mg/L	0.0003	0.005
Naphthalene	mg/L	0.0004	0.073
n-Butylbenzene	mg/L	0.0011	0.146
n-Propylbenzene	mg/L	0.0004	0.146
o-Chlorotoluene	mg/L	0.0004	0.073
p-Chlorotoluene	mg/L	0.0006	0.073
p-Cymene	mg/L	--	0.365
sec-Butylbenzene	mg/L	0.0013	0.146
Styrene	mg/L	0.0004	0.1
tert-Butylbenzene	mg/L	0.0014	0.146
Tetrachloroethylene	mg/L	0.0014	0.005
Toluene	mg/L	0.0011	1
trans-1,2-Dichloroethene	mg/L	0.0005	--
trans-1,3-Dichloropropene	mg/L	0.001	0.000852
Trichloroethylene	mg/L	0.001	0.005
Trichlorofluoromethane	mg/L	0.0008	1.1
Vinyl Acetate	mg/L	0.0075	0.107
Vinyl chloride	mg/L	0.0011	0.002
Xylene (total)	mg/L	0.003	8.93

Note:

[1] *Reporting limits are laboratory-specific and will vary. The laboratory will be instructed to report to the method detection limit, which is a laboratory-specific limit less than the reporting limit, in an attempt to meet the groundwater risk standard.*

[2] *Safe Drinking Water Act, 40 CFR 141 and 30 Texas Administrative Code 290*

Comparison of Typical Laboratory Detection Limits to Screening Levels of Aqueous Samples
Explosives - Method 8260
Longhorn Army Ammunition Plant, Karnack, Texas

Analyte	Units	Reporting Limit[1]	Groundwater Risk Standard
2,4-Dinitrotoluene	mg/L	0.001	0.000125
2,6-Dinitrotoluene	mg/L	0.001	0.000125
2-Amino-4,6-dinitrotoluene	mg/L	0.001	0.000608
4-Amino-2,6-dinitrotoluene	mg/L	0.001	0.000608
HMX	mg/L	0.001	0.183
m-Dinitrobenzene	mg/L	0.001	0.000365
m-Nitrotoluene	mg/L	0.001	0.0365
Nitrobenzene	mg/L	0.001	0.00183
o-Nitrotoluene	mg/L	0.001	0.0365
I p-Nitrotoluene	mg/L	0.001	0.0365
RDX	mg/L	0.001	0.000774
sym-Trinitrobenzene	mg/L	0.001	0.11
Tetryl	mg/L	0.001	0.0365
Trinitrotoluene, 2,4,6-(TNT)	mg/L	0.001	0.00183

Note:
[1] *Reporiing limits are laboratory-specific and will vary. The laboratory will be instructed to report to the method detection limit, which is a laboratory-specific limit less than the reporting limit, in an attempt to meet the groundwater risk standard.*

Comparison of Typical Laboratory Detection Limits to Screening Levels of Aqueous Samples
Perchlorate - Method 314
Longhorn Army Ammunition Plant, Karnack, Texas

Analyte	Units	Reporting Limit[1]	Groundwater Standard
Perchlorate	mg/L	0.005	0.004[2]

Note:
[1] *Reporting limits are laboratory-specific and will vary. The laboratory will be instructed to report to the method detection limit, which is a laboratory-specific limit less than the reporting limit, in an attempt to meet the groundwater risk standard.*
[2] *30 Texas Administrative Code 290. Texas has promulgated the federal secondary maximum contaminant levels into Texas Administrative Code*

Comparison of Typical Laboratory Detection Limits to Screening Levels of Aqueous Samples
Metals - Method 7841 or 6020
Longhorn Army Ammunition Plant, Karnack, Texas

Analyte	Units	Reporting Limit[1]	Groundwater Risk Standard
Thallium	mg/L	0.002	0.002[2]
Antimony	mg/L	0.002	0.006[2]

Note:
[1] *Reporting limits are laboratory-specific and will vary. The laboratory will be instructed to report to the method detection limit, which is a laboratory-specific limit less than the reporting limit, in an attempt to meet the groundwater risk standard.*
[2] *Safe Drinking Water Act, 40 CFR 141 and 30 Texas Administrative Code 290*

Appendix H

Project Schedule and Cost Summary

Table 1
Project Schedule

Project Activity	Activity Duration	Project Schedule (Week)	Year
Mobilization and site preparation	2 days	1	1
Install monitoring wells	1 week	1-2	
Site restoration	2 days	4	
Demobilization	2 days	4	
Annual site inspection/document	2 days	4	
Conduct first quarterly groundwater sampling	8 days	4-5	
Develop and submit Institutional Control documents to County and State	1 month	6-10	
Conduct second quarterly groundwater sampling	8 days	13-14	
Conduct third quarterly groundwater sampling	8 days	38-39	
Conduct fourth quarterly groundwater sampling	8 days	51-52	
Annual site inspection/document	2 days	53	2
MNA analysis	3 weeks	55-57	
Prepare year 1 annual report	3 weeks	58-60	
Conduct first quarterly groundwater sampling	8 days	64-65	
Conduct second quarterly groundwater sampling	8 days	77-78	
Conduct third quarterly groundwater sampling	8 days	90-91	
Conduct fourth quarterly groundwater sampling	8 days	103-104	
Annual site inspection/document	2 days	105	3
Prepare year 2 annual report	2 weeks	107-108	
Conduct first semi-annual groundwater sampling	8 days	129-130	
Conduct second semi-annual groundwater sampling	8 days	155-156	
Annual site inspection/document	2 days	157	4
Prepare year 3 annual report	2 weeks	159-160	
Conduct first semi-annual groundwater sampling	8 days	181-182	

Project Activity	Activity Duration	Project Schedule (Week)	Year
Conduct second semi-annual groundwater sampling	8 days	207-208	4
Annual site inspection/document	2 days	209	5
Prepare year 4 annual report	2 weeks	211-212	
Conduct first semi-annual groundwater sampling	8 days	233-234	
Conduct second semi-annual groundwater sampling	8 days	259-260	
Annual site inspection/document	2 days	261	6
Prepare year 5 annual report	2 weeks	263-264	
Prepare first Five-Year Review	1 month	265-268	
Plug and abandon wells	1 day	268	

Table 2

Cost Summary for LHAAP-35B(37)

	Capital Costs	O&M Costs		
Year	Install Wells	LTM	LUC	Total
1	84442	118736	16050	219228
2	0	44716	0	44716
3	3845	25160	0	29005
4	0	25160	0	25160
5	0	44600	0	44600
6	0	15382	0	15382
7	0	15382	0	15382
8	0	15382	0	15382
9	0	15382	0	15382
10	0	34822	0	34822
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	34822	0	34822
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	34822	0	34822
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	34822	0	34822
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	34822	0	34822
	88288	494006	16050	598343

Table 3

Cost Summary for LHAAP-67

	Capital Costs	O&M Costs		
Year	Install Wells	LTM	LUC	Total
1	43068	94037	16050	153155
2	0	33393	0	33393
3	1146	16728	0	17874
4	0	16728	0	16728
5	0	38938	0	38938
6	0	12551	0	12551
7	0	12551	0	12551
8	0	12551	0	12551
9	0	12551	0	12551
10	0	31991	0	31991
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	31991	0	31991
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	31991	0	31991
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	31991	0	31991
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	31991	0	31991
	44214	409979	16050	470243

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	LHAAP-35B(37) Capital Costs Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL
	Install temporary borings, sample and analyze				
	Install 9 new monitoring wells				
	Plug and abandon 2 wells				
	General Conditions				
1	Safety, training, waste, health plans, ect - 80 hrs	1	ea	5778	5778
2	Mob/demob drilling rig- 16 hrs	1	ea	1862	1862
3	Survey crew wells and LUC boundary	1	ea	2500	2500
4	Site orientation - 24 hrs	1	ea	738	738
5	Hazardous material technician -24 hrs	1	ea	1348	1348
6	Geologist - 64 hrs	1	ea	4451	4451
7	Port-let rental - 3	1	ea	343	343
8	Health and Safety/QC officers - 24 hrs	1	ea	1192	1192
9	Site superintendent - 24 hrs	1	ea	1711	1711
	Field Work - temporary borings, sampling, analysis				
1	Mob/demob direct push rig and crew	1	ea	350	350
2	Direct push rig, crew, sampling, decontamination	1	day	610	610
3	Well sampling equipment rental	1	day	60	60
4	Plug temporary borings	11	ea	30	330
5	Portable GC/MS rental	1	day	500	500
6	Operational costs	1	day	150	150
7	Field chemist	8	hours	125	1000
8	Per diem	1	day	110	110

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	LHAAP-35B(37) Capital Costs Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	
9	Car rental + other	1	day	100	100	
	Field Work - install wells					
1	Clear & prepare well site	9	ea	1500	13500	
2	Install shallow wells, 33' ave depth, 4" dia PVC ($82/ft)	9	ea	2706	24354	
3	Well surface completion	9	ea	500	4500	
4	Well drill waste disposal	15	drum	268	4013	
	Subtotal				**69500**	
	Indirects@21.5%				14942	
	Total				**84442**	**year 1**
	Field Work - plug and abandon wells					
2	Mob/demob drilling rig- 16 hrs	1	ea	1862	1862	
1	Plug and abandon wells, 40' ave depth ($12/ft)	2	ea	480	960	
2	Waste disposal	1	ea	343	343	
	Subtotal				3165	
	Indirects@21.5%				680	
	Total				**3845**	**year 3**

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	**LHAAP-35B(37)** **Long Term Monitoring** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
	Number of monitoring wells	16				
	Number of surface water sample locations	2				
	Year 1 (4 sampling events)					
1	Establish initial database, licenses, coordinate well characterization & other well info, develop work plans	1	ea	31565	31565	
2	Collect and prepare samples quarterly (GW) (4 man hrs/sample)	64	ea	306	19584	
3	Collect and prepare samples quarterly (SW) (1 man hr/sample)	8	ea	76	608	
4	Sample analysis (6 wells - natural attenuation parameters - $550)	24	ea	550	13200	
5	Sample analysis (VOCs - $ 100)	72	ea	100	7200	
6	QC/QA analysis (VOCs - 12/sampling event)	48	ea	100	4800	
7	Sample analysis (antimony and thallium - $92 for both)	16	ea	92	1472	
8	QC/QA analysis (metals - 8/sampling event)	8	ea	92	736	
9	MNA analysis	1	ea	10000	10000	
10	Annual report	1	ea	8560	8560	
	Subtotal				**97725**	
	Indirects@21.5%				21011	
	Year 1 Totals				**118736**	**118736**

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	**LHAAP-35B(37)** **Long Term Monitoring** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
	Year 2 (4 sampling events)					
1	Collect and prepare samples quarterly (GW)	64	ea	306	19584	
2	Collect and prepare samples quarterly (SW)	8	ea	76	608	
3	Sample analysis (VOCs - $ 100)	72	ea	100	7200	
4	QC/QA analysis (VOCs - 12/sampling event)	48	ea	100	4800	
5	Annual report	1	ea	4612	4612	
	Subtotal				**36804**	
	Indirects@21.5%				7913	
	Year 2 Totals				**44716**	**44716**
	Year 3-4 (4 sampling events)					
1	Collect and prepare samples semi-annually (GW)	64	ea	306	19584	
2	Collect and prepare samples semi-annually (SW)	8	ea	76	608	
3	Sample analysis (VOCs - $ 100)	72	ea	100	7200	
4	QC/QA analysis (VOCs - 12/sampling event)	48	ea	100	4800	
5	Annual report	2	ea	4612	9223	
	Subtotal				**41415**	
	Indirects@21.5%				8904	
	Year 3-4 Totals				**50320**	**25160**
	Year 5 (2 sampling events)					
1	Collect and prepare samples semi-annually (GW)	32	ea	306	9792	

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
	LHAAP-35B(37) **Long Term Monitoring**					
2	Collect and prepare samples semi-annually (SW)	4	ea	76	304	
3	Sample analysis (VOCs - $ 100)	36	ea	100	3600	
4	QC/QA analysis (VOCs - 12/sampling event)	24	ea	100	2400	
5	Annual report	1	ea	4612	4612	
6	CERCLA 5-yr review	1	ea	16000	16000	
	Subtotal				**36708**	
	Indirects@21.5%				7892	
	Year 5 Totals				**44600**	**44600**
	Year 6-9 (4 sampling events)					
1	Collect and prepare samples annually (GW)	64	ea	306	19584	
2	Collect and prepare samples annually (SW)	8	ea	76	608	
3	Sample analysis (VOCs - $ 100)	72	ea	100	7200	
4	QC/QA analysis (VOCs - 12/sampling event)	48	ea	100	4800	
5	Annual report	4	ea	4612	18447	
	Subtotal				**50639**	
	Indirects@21.5%				10887	
	Year 6-9 Totals				**61526**	**15382**
	Cost for 1 Year: Year 10, 15, 20, 25, 30 (1 sampling event)					
1	Collect and prepare samples annually (GW)	16	ea	306	4896	
2	Collect and prepare samples annually (SW)	2	ea	76	152	
3	Sample analysis (VOCs - $ 100)	18	ea	100	1800	

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	**LHAAP-35B(37)** **Long Term Monitoring** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
4	QC/QA analysis (VOCs - 12/sampling event)	12	ea	100	1200	
5	Annual report	1	ea	4612	4612	
6	CERCLA 5-yr review	1	ea	16000	16000	
	Subtotal				**28660**	
	Indirects@21.5%				6162	
	Cost each Year, Year 10, 15, 20, 25, 30				**34822**	**34822**

Table 4

Cost Breakdown for LHAAP-35B(37)

Item NO	**LHAAP-35B(37)** **Land Use Controls** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	
1	Allowance for Legal Fees, Administration Controls and Documentation	1	lot	16050	16050	
					16050	Year 1 cost

Table 5

Cost Breakdown for LHAAP-67

Item NO	Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL
	LHAAP-67				
	Capital Costs				
	Install temporary borings, sample and analyze				
	Install 6 new monitoring wells				
	Plug and abandon 2 wells				
	General Conditions				
1	Hazardous material technician - 24 hrs	1	ea	1348	1348
2	Geologist - 52 hrs	1	ea	3617	3617
	Field Work - temporary borings, sampling, analysis				
1	Direct push rig, crew, sampling, decontamination	1	day	610	610
2	Well sampling equipment rental	1	day	60	60
3	Plug temporary borings	8	ea	30	240
4	Portable GC/MS rental	1	day	500	500
5	Operational costs	1	day	150	150
6	Field chemist	8	hours	125	1000
7	Per diem	1	day	110	110
8	Car rental + other	1	day	100	100
	Field Work - install wells				
1	Clear & prepare well site	6	ea	1500	9000
2	Install shallow wells, 26' ave depth, 4" dia PVC ($82/ft)	6	ea	2262	13572
3	Well surface completion	6	ea	500	3000
4	Well drill waste disposal	8	drum	268	2140
	Subtotal				**35447**

Table 5

Cost Breakdown for LHAAP-67

Item NO	LHAAP-67 Capital Costs Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	
	Indirects@21.5%				7621	
	Total				**43068**	**year 1**
	Field Work - plug and abandon wells					
1	Plug and abandon wells, 25' ave depth ($12/ft)	2	ea	300	600	
2	Waste disposal	1	ea	343	343	
	Subtotal				**943**	
	Indirects@21.5%				203	
	Total				**1146**	**year 3**

Table 5

Cost Breakdown for LHAAP-67

LHAAP-67
Long Term Monitoring

Item NO	Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
	Number of monitoring wells	11				
	Number of surface water sample locations	2				
	Year 1 (4 sampling events)					
1	Establish initial database, licenses, coordinate well characterization & other well info, develop work plans	1	ea	31565	31565	
2	Collect and prepare samples quarterly (GW)(4 man hrs/ sample)	44	ea	306	13464	
3	Collect and prepare samples quarterly (SW)(1 man hr/ sample)	8	ea	76	608	
4	Sample analysis (2 wells -natural attenuation parameters - $550)	8	ea	550	4400	
5	Sample analysis (VOCs - $100)	52	ea	100	5200	
6	QA/QC analysis (VOCs - 9/sampling event)	36	ea	100	3600	
7	MNA analysis	1	ea	10000	10000	
8	Annual report	1	ea	8560	8560	
	Subtotal				**77397**	
	Indirects@21.5%				16640	
	Year 1 Totals				**94037**	**94037**
	Year 2 (4 sampling events)					
1	Collect and prepare samples quarterly (GW)	44	ea	306	13464	
2	Collect and prepare samples quarterly (SW)	8	ea	76	608	

Table 5

Cost Breakdown for LHAAP-67

Item NO	**LHAAP-67** **Long Term Monitoring** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
3	Sample analysis (VOCs - $100)	52	ea	100	5200	
4	QA/QC analysis (VOCs - 9/sampling event)	36	ea	100	3600	
5	Annual report	1	ea	4612	4612	
	Subtotal				**27484**	
	Indirects@21.5%				5909	
	Year 2 Totals				**33393**	**33393**
	Year 3-4 (4 sampling events)					
1	Collect and prepare samples semi-annually (GW)	44	ea	306	13464	
2	Collect and prepare samples semi-annually (SW)	8	ea	76	608	
3	Sample analysis (VOCs - $100)	52	ea	100	5200	
4	QA/QC analysis (VOCs - 9/sampling event)	36	ea	100	3600	
5	Annual report	2	ea	4612	9223	
	Subtotal				**32095**	
	Indirects@21.5%				1360	
	Year 3-4 Totals				**33456**	**16728**
	Year 5 (2 sampling events)					
1	Collect and prepare samples semi-annually (GW)	22	ea	306	6732	
2	Collect and prepare samples semi-annually (SW)	4	ea	76	304	
3	Sample analysis (VOCs - $100)	26	ea	100	2600	
4	QA/QC analysis (VOCs - 9/sampling event)	18	ea	100	1800	
5	Annual report	1	ea	4612	4612	

Table 5

Cost Breakdown for LHAAP-67

Item NO	LHAAP-67 Long Term Monitoring Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
6	CERCLA 5-yr review	1	ea	16000	16000	
	Subtotal				**32048**	
	Indirects@21.5%				6890	
	Year 5 Totals				**38938**	**38938**
	Year 6-9 (4 sampling events)					
1	Collect and prepare samples annually (GW)	44	ea	306	13464	
2	Collect and prepare samples annually (SW)	8	ea	76	608	
2	Sample analysis (VOCs - $100)	52	ea	100	5200	
3	QA/QC analysis (VOCs - 9/sampling event)	36	ea	100	3600	
4	Annual report	4	ea	4612	18447	
	Subtotal				**41319**	
	Indirects@21.5%				8884	
	Year 6-9 Totals				**50202**	**12551**
	Cost for 1 Year on Years 10, 15, 20, 25, 30 (1 sampling event)					
1	Collect and prepare samples annually (GW)	11	ea	306	3366	
2	Collect and prepare sample annually (SW)	2	ea	76	152	
3	Sample analysis (VOCs - $100)	13	ea	100	1300	
4	QA/QC analysis (VOCs - 9/sampling event)	9	ea	100	900	
5	Annual report	1	ea	4612	4612	
6	CERCLA 5-yr review	1	ea	16000	16000	
	Subtotal				**26330**	

Table 5

Cost Breakdown for LHAAP-67

Item NO	**LHAAP-67** **Long Term Monitoring** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	Annual Cost
	Indirects@21.5%				5661	
	Cost each Year: Year 10, 15, 20, 25, 30				**31991**	**31991**

Table 5

Cost Breakdown for LHAAP-67

Item NO	**LHAAP-67** **Land Use Controls** Description	QTY	UNIT	2010 dollars $/UNIT	2010 dollars TOTAL	
1	Allowance for Legal Fees, Administration Controls and Documentation	1	lot	16050	16050	Year 1 cost

LONGHORN ARMY AMMUNITION PLANT
Karnack, Texas

MONTHLY MANAGERS' MEETING

AGENDA

DATE: Wednesday, August 24, 2011
TIME: 12:30 pm.
PLACE: Call In Number Courtesy of
Shaw: 866-797-9304/4155734

Welcome **RMZ**

Action Items

Army
- Send revised schedule and letter to EPA *Completed*

EPA
- Check to see if regulator concurrence on QA/QC procedures were obtained for SAP

TCEQ
- Check to see if regulator concurrence on QA/QC procedures were obtained for SAP

Shaw
- Write up on the impacts from the elimination of ITS data on current sites *In Progress*
- Installation-wide work plan update/approval
- Responses to public comments *Completed*
- Prepare an acronym list and distribute *In Progress*
- Re-request access for Paul Bruckwicki to portal. *Completed*

Defense Environmental Restoration Program (DERP) PBC Update **PS**
- Document Status/Environmental Sites (Table)
- Groundwater Treatment Plant
- Groundwater and Surface Water Sampling Schedule Spreadsheet. Next sampling round.

DERP Total Environmental Restoration Contract Update **Army**
- LHAAP-37/67 RD Revised – Status
- Pilot Demonstration at LHAAP-37 Status

MMRP Update **Army**
- Status of ROD – DF ROD submitted for regulatory review on Friday, 19 August
- Update IRP Metals Issue

Review of Schedule **Army**

USFWS Update **RMZ/PB**

- Environmental Restoration Issues with Transfer Schedule Impact
- USFWS Comments on Documents

Adjourn

ACRONYM LIST

DERP-	**Defense Environmental Restoration Program**
EPA-	**Environmental Protection Agency**
FS-	**Feasibility Study**
IRP-	**Installation Restoration Program**
ITS-	**Intertek Testing Services**
LHAAP-	**Longhorn Army Ammunition Plant**
MMRP-	**Military Munitions Response Program**
MNA-	**Monitored Natural Attenuation**
PB-	**Paul Bruckwicki**
PBC-	**Performance Based Contract**
PS-	**Praveen Srivastav**
QA-	**Quality Assurance**
QC-	**Quality Control**
RMZ-	**Rose M. Zeiler**
RD-	**Remedial Design**
ROD-	**Record of Decision**
SAP-	**Sampling and Analysis Plan**
TCEQ-	**Texas Commission on Environmental Quality**
USFWS-	**United States Fish and Wildlife Service**

Shaw® Shaw Environmental, Inc.

Subject: **Draft Final Minutes, Monthly Managers Meeting, Longhorn Army Ammunition Plant (LHAAP)**

Location of Meeting: **Teleconference**
Date of Meeting: **August 24, 2011; 1:30 PM – 2:30 PM**

Meeting Participants:

BRAC:	Rose M. Zeiler
USACE-Tulsa:	Aaron Williams, John Lambert
Shaw:	Kay Everett
USEPA Region 6:	Steve Tzhone
TCEQ:	Fay Duke, Dale Vodak
USGS:	Kent Becher
USFWS:	Paul Bruckwicki, Barry Forsythe

Welcome **Rose M. Zeiler**

Action Item Status

Army

- Send revised schedule and letter to EPA- *completed.*

EPA—Topics for Discussion

- Check to see if regulator concurrence on QA/QC procedures were obtained for SAP-*pending; EPA said they would check with Chris (previous EPA regulatory representative for LHAAP) but stated that that we should not worry about the past concurrence and move forward with review and approval process for the revised SAP.*

TCEQ

- Check to see if regulator concurrence on QA/QC procedures were obtained for SAP-*tentative; TCEQ said that there is no indication that they have received the SAP in their records.*

Shaw

- Write up on the impacts from the elimination of ITS data on current sites – *In Progress*
- Responses to public comments – *completed.*
- Prepare an acronym list and distribute – I*n progress, appending to agenda.*
- Re-request access for Paul Bruckwicki to portal. *Completed from last meeting; delete from Action Item Status.*

Defense Environmental Restoration Program (DERP) PBC Update **Praveen Srivastav**

Document Status/ Environmental Sites (Table)

- LHAAP-03: The soil removal work plan is on hold until the EE/CA and AM are completed.
- LHAAP-04: The Final Completion Report was submitted 8/18/11 and the preliminary draft FS is in Army review.
- LHAAP-16: ROD – Draft ROD is in progress and comments will be discussed further later today.

- LHAAP-17: ROD – The Draft Final ROD is in progress and comments are in resolution.
- LHAAP-18/24: FS - Regulatory comments have been received and comment resolution is underway.
- LHAAP-29: Draft ROD is in comment resolution.
- LHAAP-46: The draft RD is in regulatory review.
- LHAAP-47: The final FS has been submitted 7/26/11.
- LHAAP-50: The revised RD is in regulatory review 8/10/11. Fay indicated that she was reviewing this currently.
- LHAAP-58: The revised RD is in regulatory review. EPA indicated that their comments will be returned today.
- LHAAP-12 RA(O): TCEQ regulatory comments received, addressed, and forwarded to Army. EPA comments are pending, and Steve said he needed to review the data with Kent.

Groundwater Treatment Plant
The GWTP is functioning normally. The system treated 337,000 gallons for the first three weeks of August and, due to the drought, has been discharging to the burning ground (via sprinkler system). There were no major problems.

Soil sampling at LHAAP-18/24 was postponed.

GWTP sprinkling is currently being conducted because the creeks are dry. The crew will continue checking to confirm that there is no overland flow caused by the water sprinkling operations.

Groundwater and Surface Water Sampling Schedule Spreadsheet.
The sampling schedule was updated. EPA requested adding 8 wells and deleting 3 from the list of monitoring wells to be sampled in September. A total of 23 wells will be sampled at LHAAP-18/24.

DERP Total Environmental Restoration Contract Update **Army**

LHAAP-37/67 RD Revised– Status
Document has been revised and a hardcopy is going out today.

Pilot Demonstration at LHAAP-37 Status
The pilot demonstration is on schedule.

MMRP Update **Army**

Status of ROD—DF ROD submitted for regulatory review on Friday, 19 August
The ROD for the MMRP is on schedule. Fay said that she sent the ROD to their attorney and Steve indicated that this ROD would be wrapped up by the end of the month.

Update IRP Metals
This is still on the schedule, but has not been completed yet.

Review of Schedule **Army**

The current Task Order the Army issued to Shaw will be de-obligated by the end of September. The GWTP portion of the contract will remain open until the end of February 2012. This de-obligation will not impact the schedule. John indicated that the Army is de-obligating many of the tasks in the contract. There will be some that remain open until February 2012. The Army is planning to go out early in September to conduct a “pre-proposal” with a site visit on September 22.

Shaw will complete the current RODs and RDs. They are on track to finish the RDs for LHAAP-50, -46, and -58. Some tasks will be finished by September, but that Shaw is working in partnership with the Army to complete certain phases and allow for a smooth transition.

Army hopes that the next contract is in place by mid-November.

USFWS Update
Environmental Restoration Issues with Transfer Schedule Impact. *None.*
USFWS Comments on Documents. *None.*

Paul said that he had been contacted by the fire folks to conduct a burn in Unit 3, that is Plant Areas 2 and 3 and to include LHAAP-48/53. In some areas, they are concerned about the fencing as they would have to cut the fence approximately every 50', especially in heavily wooded roadways and some of these areas needed to be fenced off for public safety purposes. Further discussion indicated Army and FWS would work together for mutual benefit by leaving gates open in the areas in question would help prevent the necessity to cut the fences. The next fire season is after the first of the year.

Steve mentioned that he had a note from HQ about the questions brought forward from the RAB group in Wisconsin regarding the DNT Isomers. Rose indicated that some of the RAB has expressed that they are concerned about this issue while others in the group were not, after learning more about the subject. Rose agreed to present a comparison to the RAB between the situations at Badger and Longhorn. Rose noted that there are substantial differences in plume size, migration, concentrations, and ultimately, the adjacent areas and use around both installations. She reminded the group that TNT production at Longhorn was only conducted for about 4 years in the early to mid-40s.

Meeting Adjourned
Next monthly manager's meeting will be at LHAAP, in the Army trailer. The next RAB was tentatively set for October because of the Labor Day holiday weekend but a September date is more desirable. The next RAB has been scheduled for September 15, 2011 with the Monthly Manager's Meeting scheduled for 4:00 PM before the RAB meeting begins.

Acronyms

AM	*Action Memorandum*
DNT	*Dinitrotoluene*
EE/CA	*Engineering Evaluation/Cost Analysis*
FS	*Feasibility Study*
GWTP	*Groundwater Treatment Plant*
IAP	*Installation Action Program*
IRP	*Installation Restoration Program*
MC	*Munitions Constituents*
MMRP	*Military Munitions*
QA/QC	*Quality Assurance/Quality Control*
RAB	*Restoration Advisory Board*
RA(O)	*Remedial Action Operations*
RD	*Remedial Design*
ROD	*Record of Decision*
RTC	*Response to Comments*
SAP	*Sampling Analysis Plan*

TNT	*Trinitrotoluene*
USFWS	*US Fish and Wildlife Service*

Action Items

EPA—Topics for Discussion

- Forward perchlorate waste information on to Army

Shaw

- Send next RAB agenda to the retired Col. V. Metcalf in Shreveport.
- Submit the updated Installation Wide Workplan to the regulators for formal review/approval.

Shaw® Shaw Environmental, Inc.

Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
August 24, 2011

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	**Remarks**
1	Draft Final Soil Removal Work Plan, LHAAP-03									On hold until EE/CA and AM are completed.	
2	Preliminary Draft EE/CA, LHAAP-03	08/30/11	x							In preparation	
3	Draft Final Completion Report, LHAAP-04	05/24/10	x	x	Final	8/18/11	x	x		Final Document submitted.	
4	Preliminary Draft FS, LHAAP-04	2/03/11	x		Draft	9/15/11	x	x		In Army review	
5	Draft ROD, LHAAP-16	06/21/11	x	x	Final	9/15/11	x	x	In progress	Resolving comments	
6	Draft Final Record of Decision, LHAAP-17	1/26/11	x	x	Final	9/15/11	x	x	In progress	Resolving comments	
7	Draft (Final) Feasibility Study, LHAAP-18/24	5/13/09	x	x					In progress	Regulatory comments received. Resolution continuing	
8	Draft ROD, LHAAP-29	6/27/11	x		Final	9/15/11	x	x	In progress	Resolving comments	

Shaw® Shaw Environmental, Inc.

Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
August 24, 2011

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	**Remarks**
9	Draft Remedial Design, LHAAP-46	05/31/11	x	x	Draft Final					In regulatory review	
10	Revised Draft Final Feasibility Study, LHAAP-47	10/27/10	x		Final		x	x		Submitted	
11	Draft Remedial Design, LHAAP-50	6/21/11	x		Draft Final					In regulatory review 8/10/11	
12	Draft Remedial Design, LHAAP-58	7/15/11	x		Draft Final					In regulatory review	
13	Draft Final LHAAP-12 RAO Report	2/10/11	x	x	Final	6/30/11	x	x	In progress		

LONGHORN ARMY AMMUNITION PLANT
RESTORATION ADVISORY BOARD
Karnack, Texas
(479) 635-0110

September 1, 2011

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RESTORATION ADVISORY BOARD
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September 1, 2011, page 2

Dear LHAAP RAB Member,

The next Restoration Advisory Board (RAB) meeting will be held on Thursday, September 15, 2011, from 6:30 to 8:00 p.m. at the Karnack Community Center, Karnack, Texas. We hope that you can attend. If you have any questions, please do not hesitate to contact me.

Shaw Environmental, Inc. (Shaw) is the contractor supporting the U.S. Army environmental restoration activities at the Longhorn Army Ammunition Plant (LHAAP), and will be coordinating the RAB meeting. A tentative agenda for the meeting is attached. If you have additional items for the agenda, please provide to me at rose.zeiler@us.army.mil.

Regards,

Rose M. Zeiler

Dr. Rose Zeiler
Department of the Army
Longhorn Army Ammunition Plant
Box 220
Ratcliff, Arkansas 72951

Copy to:
Dawn Orsack, Rick Lowerre; CLI (TAG)
Janetta Coats, Donn Walters; EPA (TAG)

LONGHORN ARMY AMMUNITION PLANT
RESTORATION ADVISORY BOARD
Karnack, Texas
(479) 635-0110

AGENDA

DATE: Thursday, September 15, 2011
TIME: 6:30 – 8:00 PM
PLACE: Karnack Community Center, Karnack, Texas

06:30 Welcome and Introduction

06:35 Open items {RMZ}
  Charter Revision Discussion
  RAB Question and Answer - AEC
  Election of Co-Chair Discussion

07:05 Defense Environmental Restoration Program (DERP) Performance Based Contract (PBC) Update {Shaw}
  -Documents Status/ Environmental Sites
  -Groundwater Treatment Plant (GWTP) Update
  -Perimeter Well/Surface Water Sampling (Creek) Results and Update

07:25 Other DERP Environmental Restoration Update {RMZ}
  -LHAAP-35B(37) and LHAAP-67 RD

07:30 Military Munitions Response Program (MMRP) {USACE}

07:35 Other Environmental Restoration Issues {RMZ}
DNT Isomers at Longhorn

07:50 Look Ahead at the Schedule

08:00 Adjourn {RMZ}

Shaw Environmental, Inc.

Subject: **Draft Final Minutes, Quarterly Restoration Advisory Board (RAB) Meeting, Longhorn Army Ammunition Plant (LHAAP)**

Location of Meeting: **Karnack Community Center, Karnack, Texas**

Date of Meeting: **September 15, 2011, 6:30 – 08:00 PM**

<u>Meeting Participants:</u>

LHAAP/BRAC: Rose M. Zeiler
USACE: Aaron Williams
Shaw Environmental: Praveen Srivastav
TCEQ: Fay Duke
USEPA Region 6: Steve Tzhone, Rich Mayer, Paul Torcoletti
USGS: Kent Becher, C. Mosley
USAEC: Cathy Kropp
RAB: **Present:** Paul Fortune, Ken Burkhalter, Charles Dixon, Carol Fortune, Lee Guice, Judith Johnson, Jim Lambright, Richard LeTourneau, Nigel Shivers, Judy Van Deventer, Tom Walker, Pickens Winters
Absent: Robert Cargill, Ted Kurz, and E.V. Wilson

Public: Lee Thomas (NETMWD), Glenn Evans (Longview News), George Rice (CLI), Dawn Orsak (CLI), Jeff Thompson (Harrison County)

An agenda for the RAB meeting was distributed prior to the meeting.

Welcome – Rose Zeiler
The meeting was called to order.

Open Items – Rose Zeiler

Kathy Kropp from AEC gave a presentation on the role and functions of RAB. Paper copies of the presentation were available to attendees. A question/answer period followed the presentation.

- Judith Johnson asked who the installation leader is for Longhorn AAP. Cathy responded that the leader is Tom Lederle. Roze Zeiler used to hold that position but now it is Tom Lederle.
- Rose Zeiler stated that there were questions in the past about the process for revisions to the charter. The charter is very old and was prepared before the RAB rule came out in 2006. Cathy Kropp stated that the current charter will be in effect until a new charter is adopted.
- Richard LeTourneau asked what can be discussed at the RAB. Cathy replied that only environmental restoration issues can be discussed during RAB.
- Pickens Winters asked if there was an appellate process if the installation leader cannot resolve an issue. Cathy replied that the issue will be raised to higher levels until it is resolved.
- Paul Fortune asked if it was correct that there cannot be a committee for recruiting RAB members. Cathy responded that it is recommended that the entire RAB be involved in the RAB member selection. The whole community should be involved, not just one segment of the population. She also recommended that the RAB hold a special session just to address line by line revision to the charter.
- Judith Johnson asked if a committee can revise the charter and present it to the entire RAB. Cathy responded that it is not in the LHAAP RAB charter to have a committee for this purpose. First the charter will have to be revised to allow this approach and then a committee can be established for next revision. Cathy also recommended that an Army representative be present during the charter revision meeting to ensure that the changes will not be rejected.
- Judith Johnson asked if all RAB members have to be present for revising the charter. Cathy indicated that all those who show up for the meeting can participate in the revision of the charter.

Defense Environmental Restoration Program (DERP) Performance Based Contract (PBC) Update–Shaw

Document Status/Environmental Sites

Copies of the document status table were distributed and Praveen Srivastav discussed each site.

- LHAAP-03: This document is in preparation and is expected to be submitted for Army's review by September 30.
- LHAAP-04: The draft feasibility study for the groundwater is in Army review.
- LHAAP-16: The Record of Decision (ROD) for LHAAP-16 undergoing comment resolution between the Army and EPA.
- LHAAP-17: The Record of Decision (ROD) for LHAAP-17 undergoing comment resolution between the Army and EPA.

- LHAAP-18/24: Responses to EPA and TCEQ comments on the Draft Final FS are being resolved.
- LHAAP-29: Regulatory comments on the ROD are being resolved.
- LHAAP-46: The Draft RD for LHAAP-46 is currently in regulatory review. This report will be finalized by September 30, 2011.
- LHAAP-50: The Draft RD for LHAAP-50 is currently in regulatory review. This report will be finalized by September 30, 2011.
- LHAAP-58: The Draft RD for LHAAP-58 is currently in regulatory review. This report will be finalized by September 30, 2011.
- LHAAP-12 RA(O): Years 1 and 2 RAO report is in comment resolution phase. Years 3 and 4 RAO report is in Army's review.

George Rice asked if the public will get an opportunity to comment on the remedial designs for LHAAP-46, 50, and 58. Rose Zeiler replied that there is no public comment period for remedial designs but the documents will be in the administrative record. George further asked if LHAAP-12 RAO report will be available for public review. Rose replied that the report will be in the administrative record. To another question from George about the effectiveness of the remedy, Rose replied that operating properly and successfully (OPS) status was achieved.

Groundwater Treatment Plant (GWTP) Update
The GWTP operated normally during the past quarter. No major issues to report. The creeks have been dry and, therefore, effluent water is being injected at the site and also sprinkled.

Perimeter Well/Surface Water Sampling (Creek) Results and Update
The next sampling perimeter well sampling event is scheduled for September but results are not available at this time.

Aaron Williams informed the RAB that Army's current contract with Shaw is coming to an end. Aaron and Rose explained that the problem was with the type of contract not with the contractor. Aaron said that he doesn't know all the details but decision was made by Tulsa District's contracting officer. Paul Fortune requested information about the total award amount to Shaw, amount of money paid to Shaw, the status of the Freedom of Information Act request by CLI, the percentage of RIP that was completed under the current contract, and receiving a copy of the new contract. Aaron stated that he did not have the requested information available to him but will get back to Paul at a later time.

DERP Total Environmental Restoration Contract (TERC) Update – Rose Zeiler

LHAAP-35B(37) and LHAAP-67
Demonstration Project
A request for proposal (RFP) has been sent out by Tulsa District for this work.

Military Munitions Response Program (MMRP) Update – USACE
There are two MMRP sites at LHAAP. RODs for these sites are in final phases. Signs are located along the perimeter of the MMRP sites with warning about the potential presence of unexploded ordnance and a no dig restriction.

Other Environmental Restoration Issues/Concerns

A discussion occurred in connection with a slide presentation Rose made comparing Longhorn and Badger Army Ammunition Plants and their respective (dinitrotoluene) DNT histories. Rose stated that 2,4 DNT and 2.6 DNT form 95% of all DNT isomers and are the only ones with Texas clean up standards. Other isomers don't have standards. Rose compared the Longhorn data with Badger AAP data. Longhorn TNT production ended in 1945 while TNT production at Badger continued until 1975. The Longhorn plume is very small and contained well within Longhorn's installation boundary and there is no impact to the drinking water supply. At Badger the public water supply has been impacted, the plumes are larger and have moved offsite. Regulatory changes (e.g. drinking water standards) are reviewed in 5-year reviews. If regulatory standards for the remaining DNT isomers have been promulgated by TCEQ or EPA, then the Army will have to address the isomers as a result of 5-year review evaluation and recommendation.

George Rice stated that DNT is found at other sites within LHAAP at high concentrations and DNT isomers that have no standards were at much higher concentrations than isomers that have standards. He asked why the Army would not sample for these isomers just to know if they are present. Rose replied that the data will not be useful because there are no standards to compare the data with.

Steve Tzhone added that the issue with DNT isomers at Badger AAP is in Wisconsin, not in Texas. EPA has been collecting toxicological data but so far the data are very limited. Also there are no validated analytical methods for the DNT isomers in question. Fay Duke agreed with Steve that there is very limited data to set a regulatory standard and no validated method for analysis.

Adjourn

March Meeting Attachments and Handouts:

- *Status of Technical Documents PBC*
- *Meeting Agenda*
- *RAB Role Presentation*

Acronyms

ASTDR	Agency for Toxic Substances and Disease Registry
DERP	Defense Environment Response Program
DNT	dinitrotoluene
EE/CA	Engineering Evaluation/Cost Analysis
FS	Feasibility Study
GWTP	Groundwater Treatment Plant
MMRP	military munitions response program
PBC	Performance Based Contract
RA(O)	Remedial Action Operations
RD	Remedial Design
RFI	Request for Information
ROD	Record of Decision

Shaw
Shaw Environmental, Inc.

Longhorn Army Ammunition Plant Restoration Advisory Board Meeting

Location	Karnack Community Center
Date	15-Sep-2011 6:30 PM page 1 of 2

Please sign in the space provided or add your name and address on next page if your name does not appear below.

ATTENDEES

Name (printed)	Signature	Organization	Phone	E-mail
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Shaw Environmental, Inc.

Longhorn Army Ammunition Plant
Restoration Advisory Board Meeting

Location	Karnack Community Center	
Date	15-Sep-2011 6:30 PM	**page 2 of 2**

Please provide your address for future mailings or information.

ATTENDEES

Please print legibly.

Name (printed)	**Signature**	**Organization and/or Address**	**Phone**	**E-mail**
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Shaw Environmental, Inc.

Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
September 15, 2011

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	**Remarks**
1	Preliminary Draft EE/CA, LHAAP-03	9/30/11	x							In preparation	
2	Preliminary Draft Feasibility Study, LHAAP-04	2/03/11	x		Draft	10/15/11	x	x		In Army review	
3	Record of Decision, LHAAP-16	9/30/11	x	x					In progress		
4	Record of Decision, LHAAP-17	9/30/11	x	x					In progress		
5	Record of Decision, LHAAP-29	9/30/11	x	x					In progress		
6	Draft Final Remedial Design, LHAAP-46	05/31/11	x	x	Final	10/30/11	x	x		Regulatory comments received	
7	Draft Final Remedial Design, LHAAP-50	6/21/11	x		Final					In regulatory review 8/10/11	
8	Draft Final Remedial Design, LHAAP-58	7/15/11	x		Final	10/30/11	x	x		In regulatory review	
9	Draft Final LHAAP-12 RAO Report	2/10/11	x	x	Final	10/30/11	x	x	In progress		

Dinitrotoluene (DNT) Fact Sheet

Dinitrotoluene (DNT) is a man-made substance. It is commonly produced as technical grade DNT. It is used in the production of polyurethane foams, automobile air bags, dyes, and explosives (e.g., TNT).[1]

Technical grade DNT is a mixture of six forms (isomers) of DNT: 2,3-DNT, 2,4-DNT, 2,5-DNT, 2,6-DNT, 3,4-DNT, and 3,5-DNT. The 2,4-DNT and 2,6-DNT isomers are the most common and together make up about 95% of the mixture. The other isomers make up the remainder.[2]

DNT is known to cause cancer in rats and methemoglobinemia (a blood disorder) in humans. Chronic exposure may also cause anemia, jaundice, and heart disease[3]. Most toxicological studies have been conducted using technical grade DNT or purified 2,4-DNT or 2,6-DNT. Only a few studies have been done on the other isomers, but those studies suggest that the other isomers are toxicologically similar to 2,4-DNT and 2,6-DNT.[4]

High concentrations of 2,4-DNT and 2,6-DNT have been found in soils, surface water, and groundwater at LHAAP[5]. The Army does not analyze LHAAP samples for the other isomers.

At the Badger Army Ammunition Plant, the Army analyzed groundwater samples for all six DNT isomers. All isomers were detected. In some cases, concentrations of the other isomers were more than ten times higher than concentrations of the most common isomers.[6]

The U.S. EPA does not regulate DNT in groundwater. Texas regulates the two common isomers. Wisconsin regulates all DNT isomers (see table).

DNT Groundwater Standards (μg/L)

Isomer	2,3-DNT	2,4-DNT	2,5-DNT	2,6-DNT	3,4-DNT	3,5-DNT	Sum of all isomers
Regulator							
EPA	NR[7]	NR	NR	NR	NR	NR	NR
Texas (Res)[8]	NR	**0.13**	NR	**0.13**	NR	NR	NR
Texas (Ind)[9]	NR	**0.42**	NR	**0.42**	NR	NR	NR
Wisconson[10]	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**

---

[1] EPA, 2008a, page 7-3.
[2] EPA, 2008a, page 7-3.
[3] OSHA, 2011(?).
[4] Knobeloch, 2007, page 1.
[5] Rice, 2011a. High concentrations are concentrations greater than the standards established to protect health.
[6] CSWAB, 2007b. The Badger plant is in Wisconsin.
[7] NR = not regulated.
[8] TCEQ, 2006, residential use.
[9] TCEQ, 2006, industrial use.
[10] CSWAB, 2007a, page 1.

References

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CSWAB, 2011, letter to Dr. Rose M. Zeiler, U.S. Army, April 18, 2011.

EPA, 2008a, *Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2)*, EPA Report 815-R-08-012, June 2008

Knobeloch, L., 2007, *Drinking Water Health Advisory for Dinitrotoluenes*, June 14, 2007, available at: http://www.cswab.org/DNT%20Health%20Advisories_Jun%2014.pdf

OSHA, 2011(?), *Occupational Safety and Health Guideline for Dinitrotoluene*, available at: http://www.osha.gov/SLTC/healthguidelines/dinitrotoluene/recognition.html.

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http://www.tceq.texas.gov/assets/public/remediation/rrr/msc-rbscn_2006.xls.

-Prepared by George Rice, 2011, for Caddo Lake Institute

Summary of Scheduled Activities at LHAAP NPL Sites and Completed RODs

(Updated September 14, 2011)

Table 1

Scheduled Activities at LHAAP NPL Sites[1]

Site ID	Rank[2]	Site Name	Scheduled Activities	Recent Activities/Comments
LHAAP-001	3	Inert Burning Ground		RA completed and ROD/DD issued January 1998
LHAAP-003	Not yet ranked	Building 722 - Paint Shop	Issue ROD/DD June 2012	Designated as NPL site sometime after October 2010.
LHAAP-004	2	Former Pilot Waste Water Treatment Plant	Begin RI/FS September 2011, Issue ROD/DD June 2012	
LHAAP-011	3	Suspected TNT Burial Site at P&Q Avenues		RA completed and ROD/DD issued January 1998
LHAAP-012	1	Active Landfill	RA/Closure 2040	ROD/DD issued July 2006
LHAAP-013	3	Suspected TNT Burial Site Between Active and Old Landfills		ROD/DD issued February 1996
LHAAP-014	3	Area 54W Burial Site		ROD/DD issued February 1996
LHAAP-016	1	Old Landfill	Issue ROD/DD September 2011	CLI comments submitted to Army November 2010
LHAAP-017	1	No 2 Flashing Area Burning Ground	Issue ROD/DD September 2011	CLI comments submitted to Army July 2010
LHAAP-018	1	Burning Ground / Rocket Motor Washout Pond	Begin RI/FS August 2011, Issue ROD/DD June 2012	

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[1] Most of the information in this table is from US Army, 2011a.

[2] Site rank is based on environmental risk. See explanation at end of table.

Table 1
Scheduled Activities at LHAAP NPL Sites (continued)

Site ID	Rank	Description	Scheduled Activities	Recent Activities/Comments
LHAAP-024	1	Former Unlined Evaporation Pond	Begin RI/FS August 2011, Issue ROD/DD June 2012	
LHAAP-029	1	Former TNT Production Area	Issue ROD/DD November 2011	CLI comments submitted to Army April 2011
LHAAP-032	2	Former TNT Waste Disposal Plant		RA completed and ROD/DD issued August 2008
LHAAP-037 (35B)	2	Quality Assurance Lab Building 29-A	Issue RD August 2011, Complete RA October 2011	ROD/DD issued June 2010, CLI comments submitted to Army April 2010
LHAAP-046	2	Plant 2/ Pyrotechnic Operation	Issue RD August 2011, Complete RA November 2011	ROD/DD issued September 2010, CLI comments submitted to Army February 2010
LHAAP-047	1	Plant 3/Hand Signal Assembly	Begin RI/FS August 2011, Issue ROD/DD June 2012	
LHAAP-049	2	Former Acid Plant		RA completed and ROD/DD issued September 2010
LHAAP-050	2	Former Waste Disposal Facility	Issue RD August 2011	ROD/DD issued September 2010, CLI comments submitted to Army February 2010
LHAAP-054 (LHAAP-003-R-01)	2	Ground Signal Test Area		RA completed and ROD/DD issued January 1998
LHAAP-058 (35A)	1	Maintenance Complex	Issue RD August 2011, Complete RA November 2011	ROD/DD issued September 2010, CLI comments submitted to Army February 2010

Table 1
Scheduled Activities at LHAAP NPL Sites (concluded)

Site ID	Rank	Description	Scheduled Activities	Recent Activities/Comments
LHAAP-067	2	Above Ground Storage Tank	Issue RD August 2011, Complete RA October 2011	ROD/DD issued June 2010, CLI comments submitted to Army April 2010
Pistol Range	3		Complete RA September 2015	ROD/DD issued September 2010
LHAAP-001-R-01 (LHAAP-027)	2	South Test/ Bomb Test Area (MMRP)	Issue ROD/DD September 2011	CLI comments submitted to Army July 2011
LHAAP-003-R-01 (LHAAP-054)	2	Ground Signal Test Area (MMRP)	Issue ROD/DD September 2011	CLI comments submitted to Army July 2011

CLI = Caddo Lake Institute
MMRP Military Munitions Response Program
RA = Remedial Action
RI/FS = Remedial Investigation/Feasibility Study
RD = Remedial Design
ROD/DD = Record of Decision, Decision Document

Site Ranking

Site rank is based on environmental risk.

- Rank 1: Sites that present the highest threat to the environment due to the extent or concentration of contaminants. These sites may have active sources of contaminants.

- Rank 2: Sites that present a moderate threat to the environment. Compared to Rank 1 sites, contaminants are not as widespread or their concentrations are not as high.

- Rank 3: Sites that present a low threat or no threat or to the environment. Contaminants at these sites are confined to relatively small areas and are present in low concentrations.

The rankings are based on a brief review of Army documents. Rankings may change after more thorough reviews are performed.

Table 2
RODs/DDs Issued at LHAAP NPL Sites[3]

Site Rank	Number of sites with rank	Number RODs/DDs issued
1	7[4]	2
2	11	7
3	5	5
Unranked (site 003)	1	0

Table 3
Remedial Actions Selected in RODs

Site	Date of ROD[5]	Remedial Action Selected
LHAAP-001 Inert Burning Ground	January 1998	No further action[6]
LHAAP-011 Suspected TNT Burial Site	January 1998	No further action[7]
LHAAP-012 Active Landfill	April 2006[8]	MNA and LUCs[9] (RD issued June 2007)[10]
LHAAP-013 Suspected TNT Burial Site	February 1996	No further action[11]
LHAAP-014 Area 54W Burial Site	February 1996	No further action[12]
LHAAP-027 (LHAAP-001-R-01) South Test/ Bomb Test Area	January 1998 Non-MMRP	No further action[13]
LHAAP-032 Former TNT Waste Disposal Plant	August 2008	No action[14]

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[3] Most of the information in this table is from US Army, 2010a. The acronyms are defined in the glossary, Appendix 2.

[4] Sites 18 and 24 are considered to be a single site.

[5] U.S. Army, 2011a.

[6] U.S. Army, 1998a, Bates number 022218 (page in ROD unnumbered).

[7] U.S. Army, 1998a, Bates number 022218 (page in ROD unnumbered).

[8] ROD date given in U.S. Army, 2011a is July 2006. This may appears to be a typo.

[9] Shaw Environmental, Inc., 2006a, page 1-2.

[10] Shaw Environmental, Inc., 2007a. ROD date given in U.S. Army, 2011a is July 2006. This may appears to be a typo.

[11] TNRCC, 1995a.

[12] TNRCC, 1995a.

[13] U.S. Army, 1998a, Bates number 022218 (page in ROD unnumbered).

[14] Shaw Environmental, Inc., 2008a, page 1-1.

Table 3
Remedial Actions Selected in RODs (concluded)

Site	Date of ROD	Remedial Action Selected
LHAAP-037 (35B) Quality Assurance Laboratory Building 29-A	June 2010	MNA and LUCs[15]
LHAAP-046 Plant 2/Pyrotechnic Operation	September 2010	MNA (evaluate after two years), LUCs[16]
LHAAP-049 Former Acid Plant	September 2010	No action[17]
LHAAP-050 Former Waste Disposal Facility	September 2010	Excavate soil, MNA (evaluate after two years), LUCs[18]
LHAAP-054 (LHAAP-003-R-01) Ground Signal Test Area	January 1998 Non-MMRP	No further action[19]
58 (35A) Maintenance Complex	September 2010	Bioremediation, MNA (evaluate western plume after two years), LUCs[20]
LHAAP-067 Above Ground Storage Tank	June 2010	MNA and LUCs[21]
Pistol Range	September 2010	No further action[22]

MNA = Monitored Natural Attenuation
LUCs = Land Use Controls

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[15] Shaw Environmental, Inc., 2010e, page 1-2.
[16] Shaw Environmental, Inc., 2010c, page 1-2.
[17] Shaw Environmental, Inc., 2010a, page 1-1.
[18] Shaw Environmental, Inc., 2010d, page 1-2.
[19] U.S. Army, 1998a, Bates number 022218 (page in ROD unnumbered). Note, referred to as Site XX in the ROD.
[20] Shaw Environmental, Inc., 2010b, page 1-2.
[21] Shaw Environmental, Inc., 2010e, page 1-2.
[22] Shaw Environmental, Inc., 2010f, page 1-1.

References

Shaw Environmental, Inc., 2006a, *Final Record of Decision, Landfill 12 (LHAAP-12), Longhorn Army Ammunition Plant, Karnack, Texas*, April 2006.

Shaw Environmental, Inc., 2007a, *Final Remedial Design Addendum, Landfill 12 (LHAAP-12), Longhorn Army Ammunition Plant, Karnack, Texas*, June 2007.

Shaw Environmental, Inc., 2008a, *Final Record of Decision, LHAAP-32, Former TNT Waste Disposal Plant, Longhorn Army Ammunition Plant, Karnack, Texas*, August 2008.

Shaw Environmental, Inc., 2010a, *Final Record of Decision, LHAAP-49, Former Acid Storage Area, Longhorn Army Ammunition Plant, Karnack, Texas*, August 2010.

Shaw Environmental, Inc., 2010b, *Final Record of Decision, LHAAP-35A(58), Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, September 2010.

Shaw Environmental, Inc., 2010c, *Final Record of Decision, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, September 2010.

Shaw Environmental, Inc., 2010d, *Final Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, September 2010.

Shaw Environmental, Inc., 2010e, *Final Record of Decision, LHAAP-35B(37), Chemical Laboratory and LHAAP-67, Aboveground Storage Tank Farm, Longhorn Army Ammunition Plant, Karnack, Texas*, June 2010.

Shaw Environmental, Inc., 2010f, *Final Record of Decision, Former Pistol Range, Longhorn Army Ammunition Plant, Karnack, Texas*, August 2010.

Texas Natural Resources Conservation Commission (TNRCC), 1995a, letter to U.S. EPA: *Re. Longhorn Army Ammunition Plant (LHAAP) Record of Decision (ROD) for No Further Action at LHAAP Sites 13 and 14*, October 30, 1995.

U.S. Army, 1998a, *Record of Decision for No Further Action at Group 1 Sites, Longhorn Army Ammunition Plant, Karnack, Texas*, January 1998.

U.S. Army, 2011a, letter from Rose M. Zeiler, Ph.D. Longhorn AAP Site Manager to Mr. Carlos Sanchez US Environmental Protection Agency, *Update for FY11 LHAAP Site List Schedule, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, 5 July 2010*. Note, the 2010 date in the subject line appears to be a typo. The letter is dated July 28, 2011.

LONGHORN ARMY AMMUNITION PLANT
Karnack, Texas

MONTHLY MANAGERS' MEETING

AGENDA

DATE: Thursday, September 15, 2011
TIME: 4:00 pm.
PLACE: Army Trailer at Longhorn. Call In Number Courtesy of
Shaw: 866-797-9304/4155734

Welcome **RMZ**

Action Items

EPA
- Forward perchlorate waste information on to Army

Shaw
- Send next RAB agenda to the retired Col. V. Metcalf in Shreveport.
- Submit the updated Installation Wide Workplan to the regulators for formal review/approval.
- Write up on the impacts from the elimination of ITS data on current sites

Defense Environmental Restoration Program (DERP) PBC Update **PS**
- Document Status/Environmental Sites (Table)
- Groundwater Treatment Plant
- Groundwater and Surface Water Sampling Schedule Spreadsheet. Next sampling round.

DERP Total Environmental Restoration Contract Update **Army**
- LHAAP-37/67 RD Revised – Status
- Pilot Demonstration at LHAAP-37 Status

MMRP Update **Army**
- Status of ROD RTCs
- Update IRP Metals Issue

Review of Schedule **Army**
- Status of ROD RTCs

USFWS Update **RMZ/PB**
- Environmental Restoration Issues with Transfer Schedule Impact
- USFWS Comments on Documents

Adjourn

Shaw® Shaw Environmental, Inc.

Subject:	**Draft Final Minutes, Monthly Managers Meeting, Longhorn Army Ammunition Plant (LHAAP)**
Location of Meeting:	**Teleconference**
Date of Meeting:	**September 15, 2011; 4:00 PM – 6:00 PM**

<u>Meeting Participants:</u>

BRAC:	Rose M. Zeiler
USACE-Tulsa:	Aaron Williams
Shaw:	Praveen Srivastav
USEPA Region 6:	Steve Tzhone, Rich Mayer, Paul Torcoletti
TCEQ:	Fay Duke, Dale Vodak
USGS:	Kent Becher**,** Craig Mobley
USFWS:	Paul Bruckwicki, Barry Forsythe

Welcome

Rose M. Zeiler

Action Item Status

EPA

- Forward perchlorate waste information on to Army. TBD

Shaw

- Send next RAB agenda to the retired Col. V. Metcalf in Shreveport. Completed.
- Submit the updated Installation Wide Work Plan to the regulators for formal review/approval. Completed.
- Write up on the impacts from the elimination of ITS data on current sites. TBD.

Defense Environmental Restoration Program (DERP) PBC Update

Praveen Srivastav

Document Status/ Environmental Sites (Table)

- LHAAP-03: The EE/CA is in Army's review
- LHAAP-04: The Preliminary Draft FS is in Army review.
- LHAAP-16: ROD – Comment resolution continuing.
- LHAAP-17: ROD – Comment resolution continuing.
- LHAAP-18/24: FS - Regulatory comments have been received and comment resolution is underway.
- LHAAP-29: ROD – Comment resolution continuing.
- LHAAP-46: RD – Regulatory comments received, preparing responses.
- LHAAP-50: RD – In regulatory review.
- LHAAP-58: RD – in regulatory review.
- LHAAP-12 RA(O): In regulatory review.

Groundwater Treatment Plant
The GWTP is functioning normally. The treated effluent water was being discharged to the burning ground (via sprinkler system). There were no major problems reported. Several pumps in the ICTs are in need of maintenance or replacement.

Groundwater and Surface Water Sampling
The next sampling is scheduled for September 2011.

DERP Total Environmental Restoration Contract Update **Army**
LHAAP-37/67 RD is complete.
Document has been revised and a hardcopy is going out today.

Pilot Demonstration at LHAAP-37 Status
The field work for the pilot project is expected to begin in December 2011 or January 2012.

MMRP Update **Army**

Status of ROD – Responses to comments are being resolved.

USFWS Update
Environmental Restoration Issues with Transfer Schedule Impact. *None.*

Meeting Adjourned

Action Items

EPA—Topics for Discussion
- Forward perchlorate waste information on to Army

Shaw
- Submit the ERA memo regarding ITS data elimination to regulators

ACRONYM LIST

DERP- Defense Environmental Restoration Program
EPA- Environmental Protection Agency
FS- Feasibility Study
IRP- Installation Restoration Program
ITS- Intertek Testing Services
LHAAP- Longhorn Army Ammunition Plant
MMRP- Military Munitions Response Program
MNA- Monitored Natural Attenuation
PB- Paul Bruckwicki
PBC- Performance Based Contract
PS- Praveen Srivastav
QA- Quality Assurance
QC- Quality Control
RMZ- Rose M. Zeiler
RD- Remedial Design
ROD- Record of Decision
SAP- Sampling and Analysis Plan
TCEQ- Texas Commission on Environmental Quality
USFWS- United States Fish and Wildlife Service

Shaw® Shaw Environmental, Inc.

Status of Sites and Technical Documents
Longhorn Army Ammunition Plant – PBC Contract
September 15, 2011

No.	Document in Progress	Submittal Date	Army	Regulator	Next Submittal	Expected Date	Army	Regulator	Comment Resolution	Status	**Remarks**
1	Preliminary Draft EE/CA, LHAAP-03	9/30/11	x							In preparation	
2	Preliminary Draft Feasibility Study, LHAAP-04	2/03/11	x		Draft	10/15/11	x	x		In Army review	
3	Record of Decision, LHAAP-16	9/30/11	x	x					In progress		
4	Record of Decision, LHAAP-17	9/30/11	x	x					In progress		
5	Record of Decision, LHAAP-29	9/30/11	x	x					In progress		
6	Draft Final Remedial Design, LHAAP-46	05/31/11	x	x	Final	10/30/11	x	x		Regulatory comments received	
7	Draft Final Remedial Design, LHAAP-50	6/21/11	x		Final					In regulatory review 8/10/11	
8	Draft Final Remedial Design, LHAAP-58	7/15/11	x		Final	10/30/11	x	x		In regulatory review	
9	Draft Final LHAAP-12 RAO Report	2/10/11	x	x	Final	10/30/11	x	x	In progress		

Shaw

LONGHORN ARMY AMMUNITION PLANT
MONTHLY MANAGERS' MEETING

Location		Longhorn AAP	
Date	15-Sep-2011	**Time**	4:00 PM

ATTENDEES

Name (printed)	**Signature**	**Organization**	**Phone**	**E-mail**
Longhorn Team Members				
Rose M. Zeiler	R M Zeiler	BRAC	(479) 635-0110	rose.zeiler@us.army.mil
Marilyn Plitnik		USAEC	(210) 424-8779	marilyn.a.plitnik@us.army.mil
Aaron Williams	Aaron Williams	USACE, Tulsa	(918) 669-4915	aaron.k.williams@usace.army.mil
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Dale Vodak	Dale Vodak	TCEQ, Tyler	(903) 535-5147	dvodak@tceq.state.tx.us
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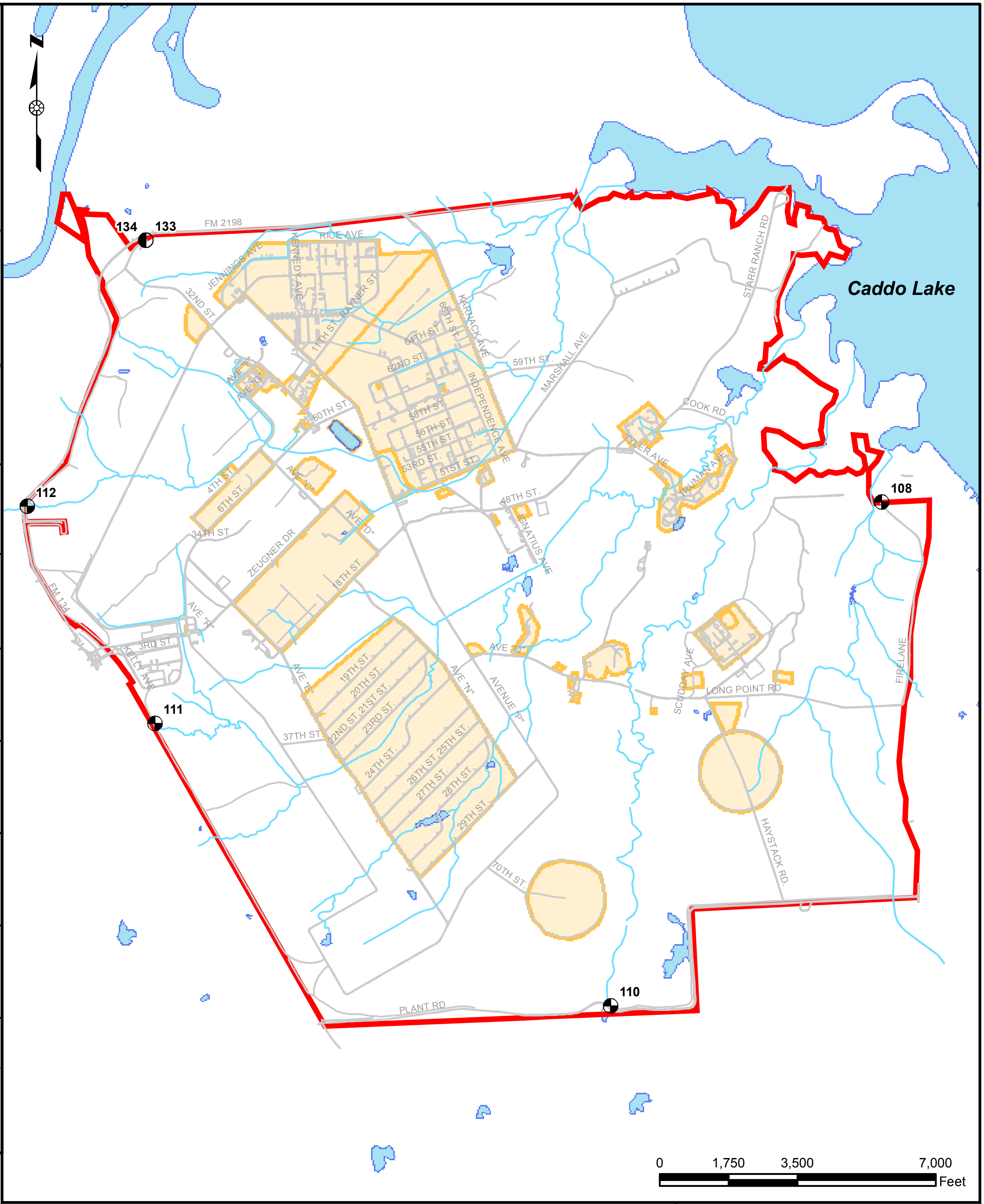
Mark Williams		USFSW, Karnack	(903) 679-9144	mark_williams@fws.gov
Praveen Srivastav		SHAW, Houston	(281) 531-3188	praveen.srivastav@shawgrp.com
Rich Mayer	Rich Mayer	USEPA	214-665-7412	mayer.richard@epa.gov
CRAIG MOBLEY		USGS	817-253-1000	camobley@usgs.gov
PAUL TORCOLETTI		US EPA		TORCOLETTI.PAUL@EPA.GOV

Perchlorate Results for Perimeter Well Sampling
Longhorn Army Ammunition Plant, Karnack, Texas

Well ID	GW Res	Sep 2006	May 2007	Aug 2007	Dec 2007	Mar 2008	Sep 2008	May 2009	Sep 2009	Mar 2010	Sep 2010	Mar 2011	Sep 2011
LHPMW108	26	10 U		0.5U			2.5 U		1.2U		3.0U		0.100U
LHPMW110	26	10 U		10U			5.0 U		6.0U		dry		dry
LHPMW111	26	4 U		0.5U			0.5 U		0.30U		dry		dry
LHPMW112	26	5 U		3U			2.0 U		0.30U		3.0U		0.26
LHPMW133	26	1.08	1 U	1.09	0.5 U	0.5 U	0.5 U	0.47 J	0.32J	0.30U	0.32J	0.59	0.68
LHPMW134	26	0.708 J	1 U	0.949 J	0.5 U	0.5 U	0.829 J	0.40 J	0.30U	0.30U	0.45J	0.636	1.11

NOTES:
all units in µg/L

µg/L	migrograms/liter
U	undetected
J	Present below normal reporting limit but greater than or equal to the MDL and the concentration is an approximate value.
L	Result biased low.
MDL	method detection limit



Legend

- ◐ Shallow Perimeter Well
- ◐ Intermediate Perimeter Well
- Stream
- Road
- Site
- Lake/Pond
- 🟥 LHAAP Approximate Boundary

Shaw

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

FIGURE 1

PERIMETER WELL LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Lu	08/31/06			P. Srivastav	08/31/06	T:\GIS\Longhorn\MXD\PRVMaps\PerimeterWells.mxd

Plot Date: 08/06

Perchlorate Results for Creek Sampling

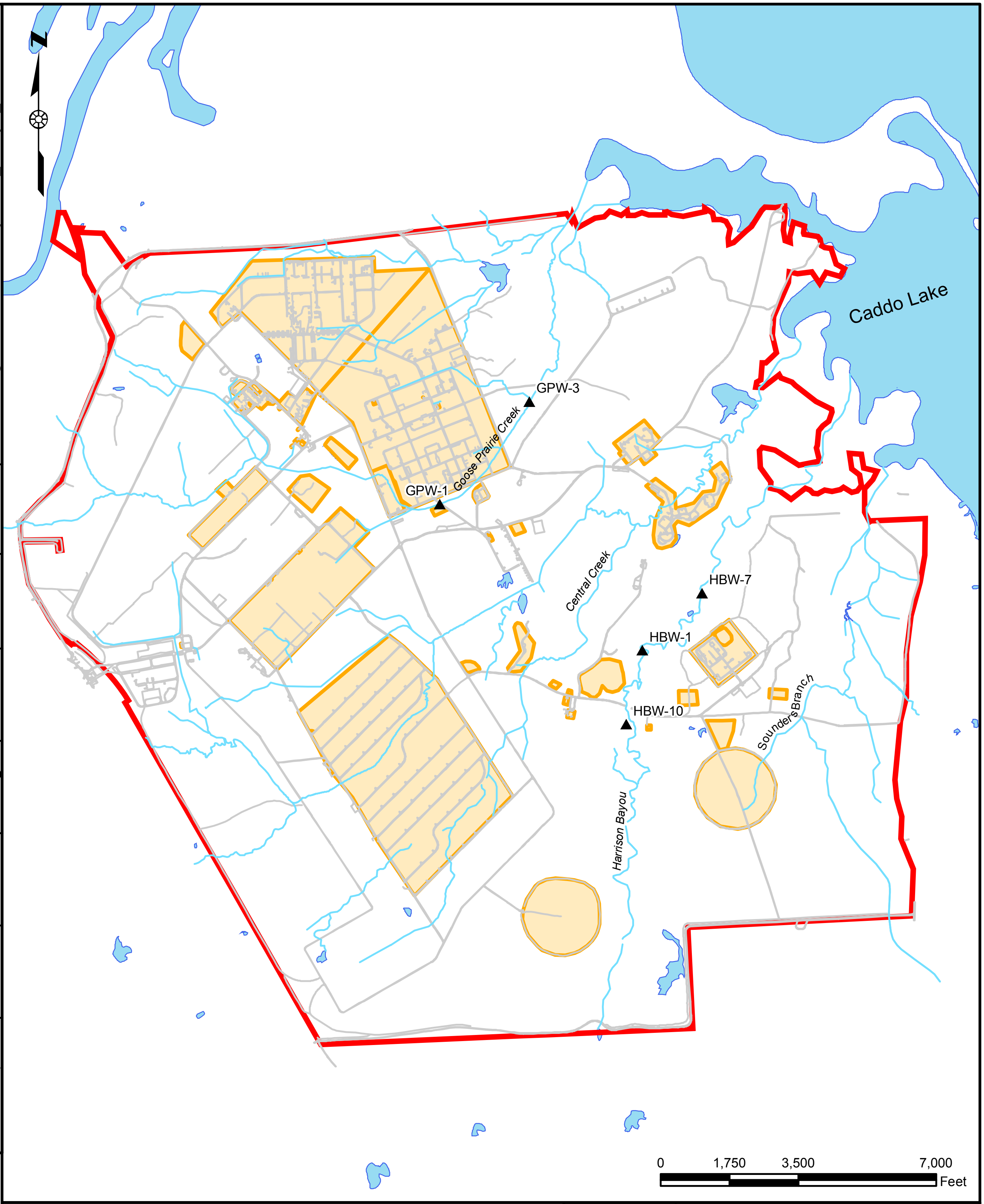
Longhorn Army Ammunition Plant, Karnack, Texas

Creek Sample ID	GW-Res	Mar 2008	Jun 2008	Sep 2008	Dec 2008	May 2009	July 2009	Aug 2009	Sep 2009	Dec 2009	Mar 2010	Jun 2010	Sep 2010	Dec 2010	Mar 2011	Jun 2011	Sep 2011
GPW-1	26	27	0.5U	0.5U	0.22U	16	4U	NS	1.2U	3.7	1.3J	0.6U	dry	0.1U	8.7	dry	dry
GPW-3	26	21.9	9.42	1.1	0.22U	8.9	4U	NS	0.6U	2.8	1.8J	0.6U	dry	0.199J	0.673	dry	dry
HBW-1	26	0.5U	0.5U	0.5U	0.22U	0.55U	4U	NS	1.5U	0.275U	1.5U	0.6U	dry	0.1U	0.2U	dry	dry
HBW-7	26	0.5U	0.5U	0.5U	0.22U	0.55U	4U	24*	1.2U	0.275U	1.5U	0.6U	dry	0.1U	0.2U	dry	dry
HBW-10	26	0.5U	0.5U	0.5U	0.22U	0.55U	4U	NS	1.5U	0.275U	1.2U	0.6U	dry	0.1U	0.2U	dry	dry

NOTES:
all units in micrograms/liter (µg/L)
* One sample taken during GWTP shutdown
U undetected
J approximate value present below normal reporting limit
GW-Res groundwater medium-specific concentration for residential use
NS not sampled
GP is Goose Prairie Creek
HB is Harrison Bayou
W is surface water

Creek Conditions for last five sampling events:
September 2010 conditions: All creek sampling locations were dry in September.
December 2010 conditions: GP sampling locations some water but no visible flow; HB sampling locations plenty of water volume but very little flow
March 2011 conditions: GP sampling locations slow flow; HB sampling locations fairly good flow
June 2011 conditions: All creek sampling locations were dry in June.
September 2011 conditions: All creek sampling locations were dry in September.

FILE PATH	T:\GIS\Longhorn\MXD\VanMaps\SW_Samps_Nov06.mxd
APPROVED BY	
CHECKED BY	V. Vangala 11/30/06
DRAWN BY	B. Lu 11/30/06
OFFICE	Houston, TX



Legend

- ▲ Surface Water Sampling Location
- ─ Stream
- ─ Road
- 🟧 Site
- 🟦 Lake

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1

SURFACE WATER SAMPLING LOCATION

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Plot Date: 11/06

Final
Remedial Design
LHAAP-50
Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Shaw® Shaw Environmental, Inc.

***Date:* <u>September 30, 2011</u>**
***Project No.:*<u>117591</u>**

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 Remedial Design for LHAAP-50***

Contract No. W912QR-04-D-0027/DS02

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

Item No:	*No. of Copies*	*Date:*	*Document Title*
1	2	September 2011	**Final Remedial Design** **LHAAP-50, Former Sump Water Tank, Group 4** **Longhorn Army Ammunition Plant, Karnack, Texas**

Aaron– Enclosed are two copies of Shaw's final version 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:

For Praveen Srivastav
Project Manager

Distribution:
M. Plitnik, USAEC (1)
R. Zeiler, BRAC (1)
S. Tzhone, EPA (2)
F. Duke (2)/ D. Vodak, TCEQ (1)
P. Bruckwicki, FWS (1)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

DAIM-ODB-LO

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

Re: Final Remedial Design, LHAAP-50, Former Sump Water Tank, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

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, Texas 78753

Re: Final Remedial Design, LHAAP-50, Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Ms. Duke,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

From: Tzhone.Stephen@epamail.epa.gov
Sent: Friday, September 30, 2011 4:54 PM
To: Zeiler, Rose Ms CIV USA OSA; Lambert, John R SWT; Williams, Aaron K SWT
Cc: Fay Duke; Srivastav, Praveen; Everett, Kay; Duffield, Robert; Watson, Susan; Sanchez.Carlos@epamail.epa.gov
Subject: Longhorn: EPA Approval of DF LHAAP-50 RD
Attachments: 09 11 Draft Final RD LHAAP-50.pdf

Hi Rose,

The EPA has reviewed the Draft Final Remedial Design for LHAAP-50 and has no further comments. Please proceed with finalization.

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

From: "Srivastav, Praveen" <Praveen.Srivastav@shawgrp.com>
To: Stephen Tzhone/R6/USEPA/US@EPA, Fay Duke <Fay.Duke@tceq.texas.gov>
Cc: "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "Watson, Susan" <Susan.Watson@shawgrp.com>, "Everett, Kay" <Kay.Everett@shawgrp.com>, "Suryanarayanan, Sowmya" <Sowmya.Suryanarayanan@shawgrp.com>
Date: 09/30/2011 04:30 PM
Subject: Draft Final LHAAP-50 RD

Steve/Fay:

The Draft Final Remedial Design for LHAAP-50 is attached. The file contains the main text and figures to keep the size of the file within manageable limits for e-mail. The files for the entire document are being uploaded to the Longhorn Stakeholder portal. We are also shipping out hard copies today.

Thank you,

Praveen Srivastav, PhD, PG, PMP
Project Manager
Federal Division/Project Management
Shaw Environmental & Infrastructure
1401 Enclave Parkway, Suite 250
Houston, TX 77077
281.531.3188 direct
281.639.8743 cell
praveen.srivastav@shawgrp.com

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www.shawgrp.com

From: Fay Duke [mailto:Fay.Duke@tceq.texas.gov]
Sent: Friday, September 30, 2011 5:01 PM
To: Srivastav, Praveen
Subject: TCEQ Approval: Draft Final LHAAP-50 RD

Rose,

The TCEQ has completed its review of the Draft Final RD for LHAAP-50 and has no further comments.

Thank you.

Fay Duke (MC-136)
Remediation Division, TCEQ
PO Box 13087
Austin, Texas 78711-3087
512-239-2443
512-239-2450 (Fax)

>>> On 9/30/2011 at 4:29 PM, <Praveen.Srivastav@shawgrp.com> wrote:
Steve/Fay:

The Draft Final Remedial Design for LHAAP-50 is attached. The file contains the main text and figures to keep the size of the file within manageable limits for e-mail. The files for the entire document are being uploaded to the Longhorn Stakeholder portal. We are also shipping out hard copies today.

Thank you,

Praveen Srivastav, PhD, PG, PMP
Project Manager
Federal Division/Project Management
Shaw Environmental & Infrastructure
1401 Enclave Parkway, Suite 250
Houston, TX 77077
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praveen.srivastav@shawgrp.com

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www.shawgrp.com

Please consider the environment before printing this e-mail.

00111410

Final
Remedial Design
LHAAP-50
Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
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Prepared by Shaw Environmental, Inc.
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Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Table of Contents

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Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
bgs	below ground surface
CDAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	constituents of concern
CQCP	Contractor Quality Control Plan
CQCSM	Contractor Quality Control System Manager
DCA	dichloroethane
DCE	dichloroethene
DHC	*Dehalococcoides* sp.
DO	dissolved oxygen
DPT	direct-push technology
ECP	Environmental Condition of Property
FS	Feasibility Study
GW-Ind	TCEQ groundwater MSC for industrial use
GWP-Ind	TCEQ soil MSC for industrial use based on groundwater protection
GW-Res	TCEQ groundwater MSC for residential use
GWTP	groundwater treatment plant
HASP	Health and Safety Plan
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
LUC O&M	land use control operations and maintenance
MARC	Multiple Award Remediation Contract
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
MSC	medium-specific concentration
NCP	National Contingency Plan
ORP	oxidation-reduction potential
PPE	personal protective equipment
QA	quality assurance
QC	quality control

Acronyms and Abbreviations *(continued)*

RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
ROD	Record of Decision
Shaw	Shaw Environmental, Inc.
STEP	Solutions to Environmental Problems, Inc.
TAC	Texas Administrative Code
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TOC	total organic carbon
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) has been contracted by the U.S. Army Corps of Engineers (USACE) Tulsa District to complete the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response at LHAAP-50, Former Sump Water Tank, at the former Longhorn Army Ammunition Plant (LHAAP) near Karnack, Texas. This Remedial Design (RD) for LHAAP-50 is a part of the response. Subsequent work plans will be prepared to provide more details of the implementation of this RD (i.e., well installation details). This work is being performed under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D-0027, Task Order DS02, with oversight by the USACE, Tulsa District.

1.1 Background

LHAAP is located in central-east Texas in the northeastern corner of Harrison County, approximately 14 miles northeast of Marshall, Texas (**Figure 1-1**). The facility occupies approximately 8,416 acres between State Highway 43 in Karnack, Texas, and the western shore of Caddo Lake. Caddo Lake is a large freshwater lake that bounds LHAAP to the north and east. The eastern fence of LHAAP is 3.5 miles from the Texas-Louisiana state border.

1.1.1 Description

LHAAP-50, known as the Former Sump Water Tank, is located in the north central portion of LHAAP and covers an area of approximately 1 acre (**Figure 1-2**). Historically, LHAAP-50 contained a 47,000-gallon aboveground storage tank (AST) which received industrial wastewater transported from various industrial waste production sumps throughout LHAAP from 1955 to 1988. Discharges from the storage tank were made upstream of the bridge on Crockett Avenue into Goose Prairie Creek. The AST has been removed.

LHAAP-50 is bound by Goose Prairie Creek to the north and by Crockett Avenue to the northeast. The northeast portion of LHAAP-50 is an open area of grass and brush that is bounded by South Crockett Avenue to the northeast. The southwestern half of the site is an area of heavy timber. The site is bounded by South Crockett Avenue to the northeast, a railroad spur to the south, drainage ditch to the west, and Goose Prairie Creek to the north. Two gravel access lanes connect LHAAP-50 to South Crockett Avenue. Runoff from the northeastern half of the site is generally toward the northeast. Runoff is collected by a drainage ditch to the northeast that runs parallel to South Crockett Avenue and eventually joins Goose Prairie Creek. Runoff from the remainder of the site is toward the north directly into Goose Prairie Creek. Runoff from the southwestern portion of the site is collected to the west by a drainage ditch that carries the runoff north into Goose Prairie Creek. Groundwater flow direction is generally east toward Caddo Lake in both the shallow and intermediate zones, consistent with the flow direction at surrounding sites (**Figure 1-3** and **Figure 1-4**). The groundwater flow in the intermediate zone will be reevaluated after additional wells are installed as described in subsequent sections of this RD. The approximate depth of the shallow groundwater zone is 15 to 20 feet below ground surface (bgs) and the intermediate zone is approximately 55 feet bgs at LHAAP-50 (Shaw, 2009).

Several investigations were conducted at LHAAP-50 between 1995 and 2009. The investigations determined that groundwater at LHAAP-50 posed an unacceptable cancer risk and non-cancer hazard for hypothetical future maintenance workers under an industrial scenario. Though the soil did not pose a risk to human health or ecological receptors, it was contaminated with perchlorate at levels that could potentially migrate into the groundwater (Shaw, 2009). There have been no previous remedial actions at LHAAP-50.

The remedial action alternative to be implemented at LHAAP-50 was developed and selected in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Contingency Plan (40 Code of Federal Regulations Part 300). The selected remedy finalized in the Record of Decision (ROD) (U.S. Department of the Army [U.S. Army], 2010) was developed based on the assumption that the reasonably anticipated future land use will be industrial/recreational (e.g., national wildlife refuge). Land use notification will be recorded at the Harrison County courthouse to indicate that the property is suitable for nonresidential use. It is also assumed that this remedial action will be the final action at the site.

1.1.2 Remedial Action Objectives

A remedial action at LHAAP-50 must protect human health and meet applicable or relevant and appropriate requirements (ARARs). As noted in the Final Feasibility Study (FS) (Shaw, 2009), ecological risk is not an issue at LHAAP-50. Therefore, any proposed remedial action need not specifically address ecological risk except as it forms the basis of certain ARARs. The primary environmental issues that must be addressed at LHAAP-50 are:

- Groundwater that exceeds maximum contaminant levels (MCLs) for volatile organic compounds (VOCs) (perchloroethene, trichloroethene [TCE], 1,1,-dichloroethene [DCE], 1,2-dichloroethane (DCA), cis-1,2-DCE, and vinyl chloride).
- Groundwater that exceeds the medium-specific concentration (MSC) for industrial use for perchlorate and has the potential to adversely impact human health.
- Soil that has concentrations of perchlorate in excess of Texas Commission on Environmental Quality (TCEQ) soil MSC for industrial use based on groundwater

protection (GWP-Ind) and has the potential to continue to be a source of groundwater and surface water contamination.

The remedial action objectives (RAOs) for LHAAP-50, consistent with the reasonably anticipated future use as a national wildlife refuge, are as follows:

- Protection of human health by preventing human exposure to the contaminated groundwater;
- Protection of human health by preventing further potential degradation of groundwater and surface water from contaminated soil;
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water; and
- Return of groundwater to its potential beneficial uses as drinking water, wherever practicable (U.S. Army, 2010).

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

1.1.3 Planned Remedial Action

The RAOs were the basis for formulating and evaluating removal alternatives and selecting a remedial action (U.S. Army, 2010). The U.S. Army will implement the following remedial actions at LHAAP-50:

Soil

- Excavation of perchlorate contaminated soil and off-site disposal of the soil at a Resource Conservation and Recovery Act (RCRA) Subtitle D-permitted landfill to eliminate the soil-to-groundwater pathway and soil-to-surface water pathway.

Groundwater

- **Land Use Control.** Land use control (LUC) in the impacted area will ensure the protection of human health by restricting the use of groundwater. The LUC will remain in place until the cleanup levels are met.
- **Monitored natural attenuation (MNA).** MNA is a passive treatment where contaminant concentrations decrease through natural attenuation processes such as biodegradation, dispersion, dilution, sorption, and volatilization (USEPA, 1998).

Data from performance monitoring is used to evaluate whether natural attenuation is occurring and reducing constituents of concern (COCs).

MNA will be implemented to verify that the TCE and perchlorate plumes are 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 two years of MNA. During those two years, groundwater monitoring will be performed quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented.

- **Long-Term Monitoring/Five-Year Reviews.** After MNA is evaluated for two years and verified to be effective, long-term monitoring (LTM) will begin at a semiannual frequency for three years. In subsequent years, LTM will be annual until the next five-year review. The LTM and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue at least once every five years until cleanup levels are achieved. Based on preliminary calculated attenuation rates for LHAAP-50, groundwater cleanup levels are expected to be met through natural attenuation in 50 years. This time-frame will be re-evaluated as part of the MNA evaluation and periodic reviews.

1.2 Cleanup Levels

Soil: Remedial action at LHAAP-50 involves the removal of soil exceeding the cleanup level for perchlorate, and subsequent transport of these soils to an appropriate licensed off-site facility for disposal. Once confirmation sampling results meet the cleanup levels, the excavation area will be backfilled with clean soil and reseeded. **Table 1-1** presents the soil cleanup level at LHAAP-50.

Table 1-1
Soil Cleanup Level

Chemical	Concentration (mg/kg)	Basis
Perchlorate	7.2	GWP-Ind

Notes and Abbreviations:

mg/kg	*milligrams per kilogram*
GWP Ind	*Soil medium specific concentration for industrial use based on groundwater protection*

Groundwater: Cleanup levels were established to meet the RAOs as included in the ROD (U.S. Army, 2010). **Table 1-2** presents the groundwater cleanup levels for LHAAP-50.

Table 1-2
Groundwater Cleanup Levels

Chemical	Concentration (µg/L)	Basis
Perchlorate	72	GW-Ind
Trichloroethene	5	MCL
cis-1,2-dichloroethene (daughter product)	70	MCL
Vinyl Chloride (daughter product)	2	MCL
1,1- Dichloroethene	7	MCL
1,2-Dichloroethane	5	MCL
Tetrachloroethene	5	MCL

Notes and Abbreviations:

µg/L	*micrograms per liter*
MCL	*maximum contaminant level*
GW-Ind	*groundwater medium-specific concentration for industrial use (there is no MCL for perchlorate.)*

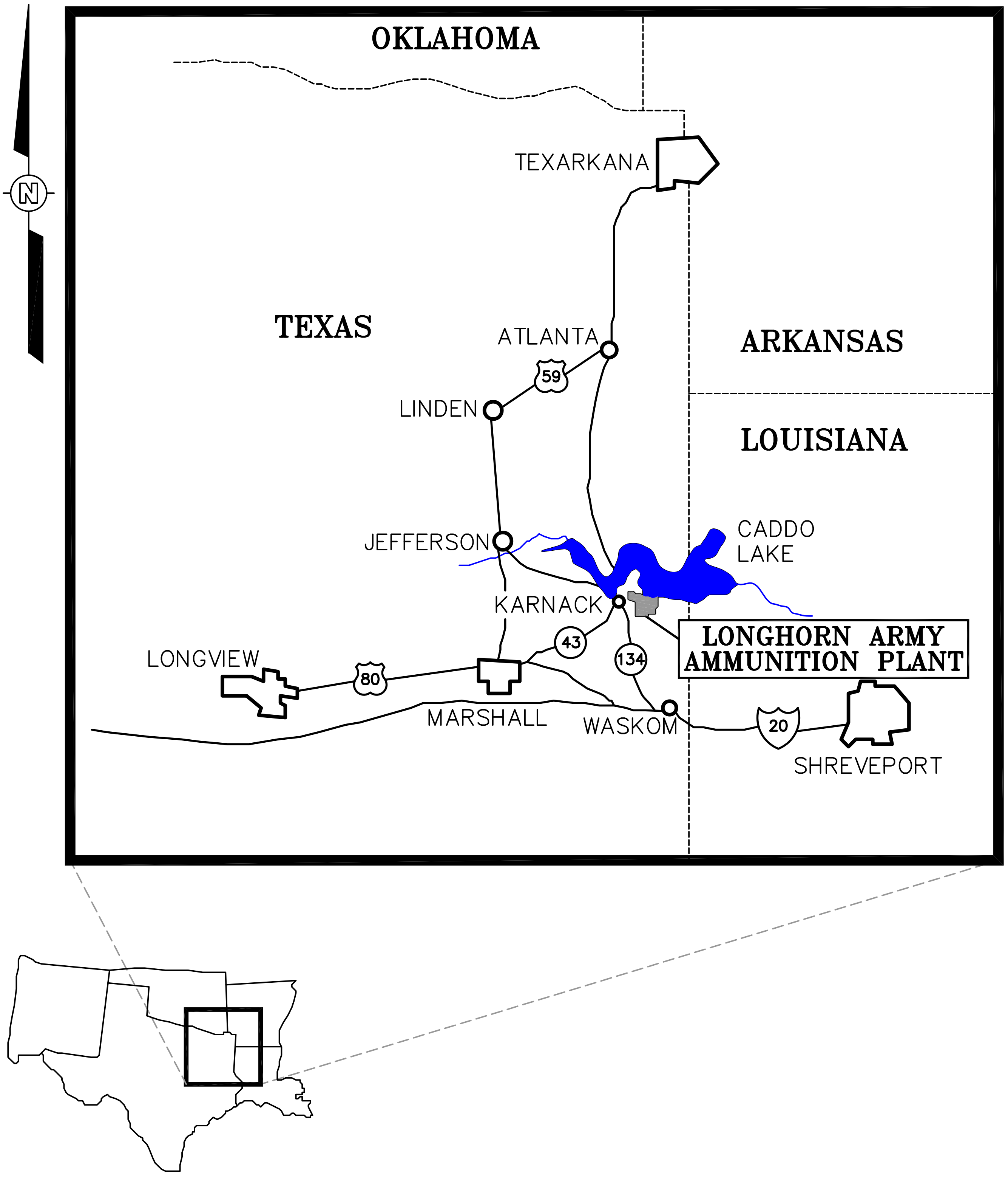
Surface Water: Surface water could potentially be impacted with perchlorate from the soil or groundwater. Periodic sampling of surface water is performed in Goose Prairie Creek to assess this possibility. **Table 1-3** presents the surface water cleanup level at LHAAP-50.

Table 1-3
Surface Water Cleanup Level

Chemical	Concentration (µg/L)	Basis
Perchlorate	26	GW-Res

Notes and Abbreviations:

µg/L	*micrograms per liter*
GW-Res	*groundwater medium-specific concentration for residential use (there is no MCL for perchlorate)*



"DRAWING NOT TO SCALE"

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

FIGURE 1-1

LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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

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

00111422

OFFICE
Houston, TX

DRAWN BY
B. Muske 11/03/10

CHECKED BY
S. Suryanarayanan 11/03/10

APPROVED BY
P. Srivastav 11/05/10

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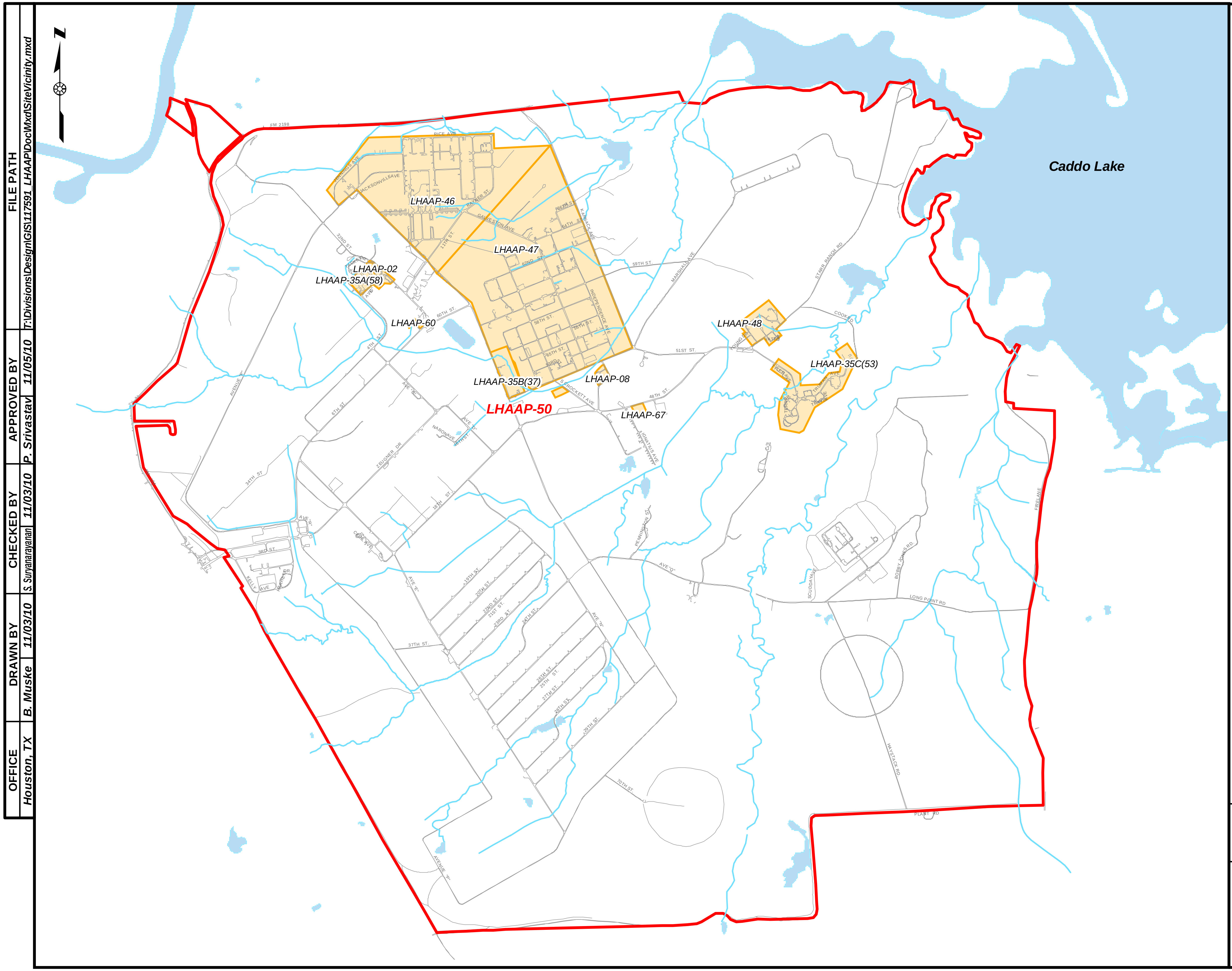

LEGEND

- 〰 Stream
- — Road
- 🟧 Sites
- 🟦 Lake
- 🟥 LHAAP Boundary

0 1,200 2,400 4,800
Feet

Shaw

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

FIGURE 1-2

SITE VICINITY MAP
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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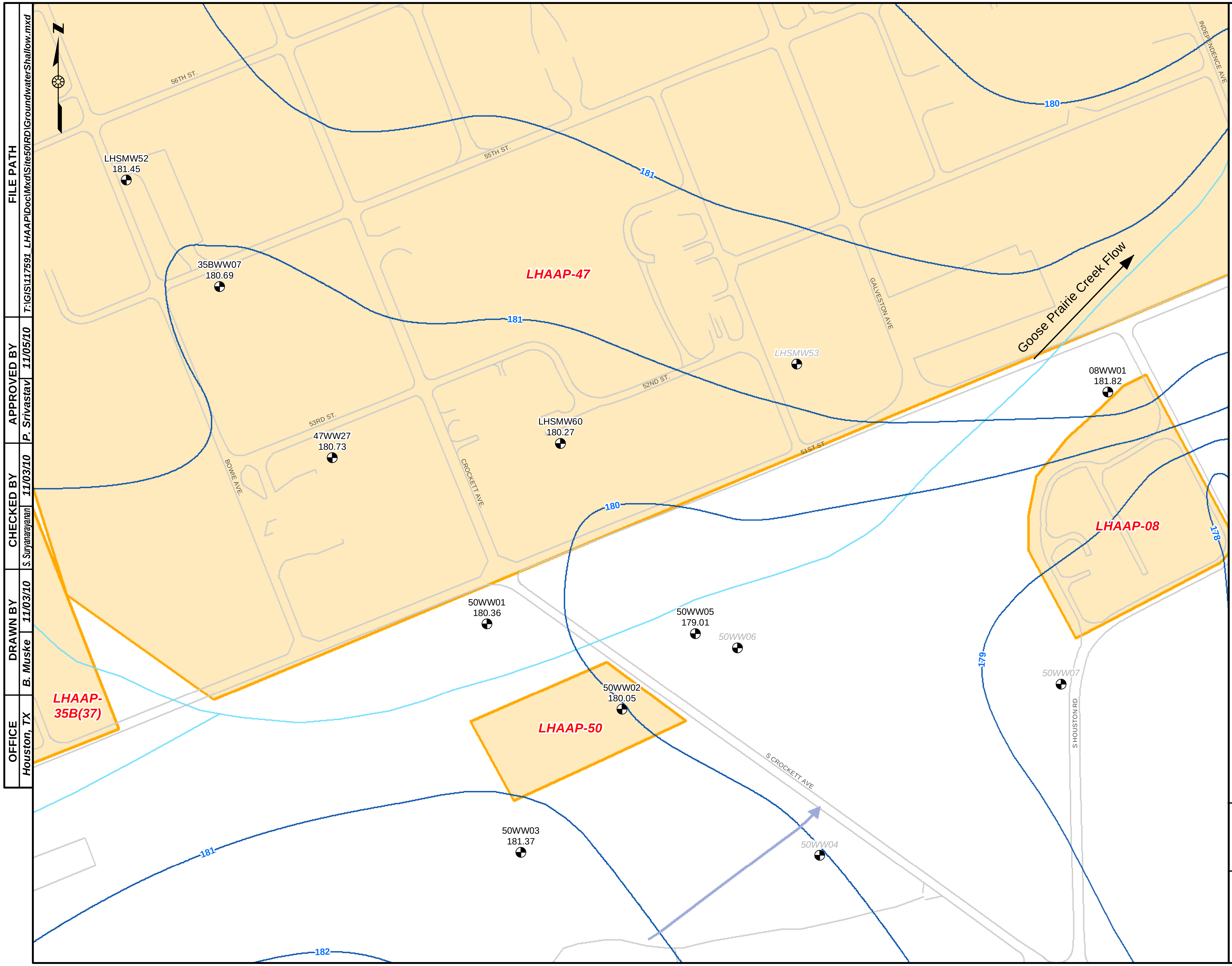
APPROVED BY P. Srivastav 11/05/10

CHECKED BY S. Suryanarayanan 11/03/10

DRAWN BY B. Muske 11/03/10

OFFICE Houston, TX



LEGEND

● Shallow Monitoring Well

∼ Shallow Groundwater Elevation Contour

→ Groundwater Flow Direction

→ Goose Prairie Creek Flow

∼ Stream

— Road

▭ Site

Note:

Groundwater contour elevations collected in November - December 2007 were reported in feet. 50WW07 was installed in 2008; the groundwater contours were not developed using data from this well.

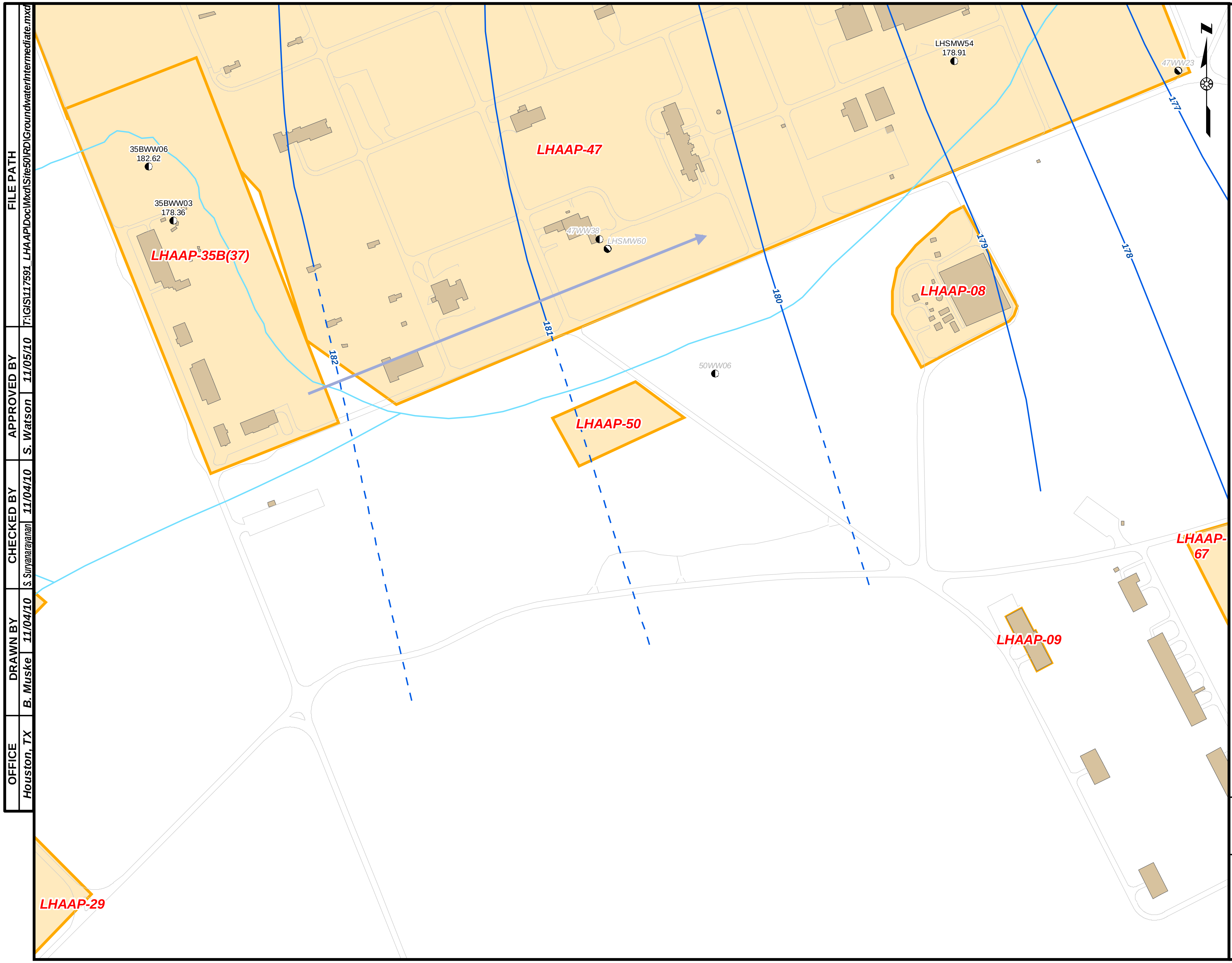
0 95 190 380
Feet

Shaw

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

FIGURE 1-3
GROUNDWATER ELEVATION MAP
SHALLOW ZONE
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Muske 11/04/10	S. Suryanarayanan 11/04/10	S. Watson 11/05/10	T:\GIS\117591_LHAAP\Doc\Mxd\Site50\RD\GroundwaterIntermediate.mxd



LEGEND

◐ Shallow/Intermediate Monitoring Well

◐ Intermediate Monitoring Well

→ Groundwater Flow Direction

Groundwater Elevation Contour

Inferred Groundwater Elevation Contour

Stream

Road

▨ Former Building or Concrete Slab

▨ Site

NOTE:

1. Groundwater elevations reported in feet above mean sea level based on data collected April 3, 2008.
2. Wells with elevations shown are used to generate contours.
3. 35BWW03 elevation was anomalous and not used.

0 150 300 600
Feet

Shaw

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

FIGURE 1-4

GROUNDWATER ELEVATION MAP
INTERMEDIATE ZONE
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

2.0 PRE-REMEDIATION ACTIVITIES IN AUGUST 2010

Additional field investigation activities in August 2010 included soil sampling to determine the excavation boundary and groundwater sampling. The soil boring logs, sample collection logs, analytical reports and tables of the August 2010 sampling event are included in **Appendix A**. Soil and groundwater sampling activities conducted at LHAAP-50 are described in sections below.

2.1 Soil Sampling

Soil samples were collected in August 2010 to better delineate contaminated soil areas. The results from the soil sampling event were used to refine the planned excavation boundaries at LHAAP-50.

Shaw collected soil samples from seven locations around STEP50SS01 and STEP50SS02 to determine excavation boundaries (**Figure 2-1**). Soil samples were collected from 0 to 1 foot bgs and 1 to 2 feet bgs and analyzed for perchlorate. Results at all seven locations indicated perchlorate concentrations below the GWP-Ind. The results for these locations are being used to establish the planned excavation boundary.

Shaw also advanced one boring to the vadose zone/groundwater interface at 50SB17 to verify that perchlorate concentrations in soil did not exceed GWP-Ind at a deeper interval. Although historic samples from this location did not exceed GWP-Ind, perchlorate concentrations increased slightly with increasing depths. Samples were collected from the three deeper intervals at the same location as existing soil boring 50SB17 to determine if perchlorate concentrations were increasing at deeper intervals. Samples were collected from 12 to 14 feet bgs, 14 to 16 feet bgs, and 16 to 18 feet bgs. Initially only the 12 to 14 feet bgs interval was analyzed. The deeper sample intervals (14 to 16 feet bgs, and 16 to 18 feet bgs) were placed on hold pending results of the 12 to 14 feet bgs interval. Perchlorate was not detected in the soil sample collected from the 12 to 14 feet bgs interval, so the deeper samples were not analyzed.

2.2 Groundwater Sampling

Monitoring wells 50WW01, 50WW02, 50WW03, 50WW04, 50WW05, 50WW06, and 50WW07 were sampled in August 2010. The wells were sampled for natural attenuation parameters, metals, perchlorate, semivolatile organic compounds, and VOCs. Six of these wells are located in the shallow zone, while well 50WW06 is located in the intermediate zone. Monitoring wells 50WW02, 50WW03 and 50WW04 were dry during the August 2010 sampling event. The groundwater sampling results for perchlorate and TCE are shown on **Figure 2-2**. Perchlorate was below the groundwater MSC for industrial use (GW-Ind) of

72 micrograms per liter (µg/L) in all wells sampled except intermediate well 50WW06. At 50WW06, perchlorate was observed at a concentration of 113 µg/L, which exceeds the GW-Ind. TCE was not detected or concentrations were below its MCL of 5 µg/L in all wells sampled except shallow well 50WW05, where TCE was observed at a concentration of 788 µg/L. The full analytical results from the sampling event in August 2010 are provided in **Appendix A**. In addition to the LHAAP-50 sampling, a new intermediate well, 47WW38, was installed at LHAAP-47 and high concentrations of perchlorate were detected (**Figure 2-2**) (Shaw, 2010). The cross section shown on **Figure 2-3** shows this new well. Additional cross sections are presented in the LHAAP-50 FS (Shaw, 2009) and the Remedial Investigation report (Jacobs, 2002).

2.3 Areas of Contamination

Soil

Perchlorate was detected in soil at LHAAP-50 near the location of the former AST. Though the soil at LHAAP-50 does not pose a risk to ecological receptors or human health, it is contaminated with perchlorate at levels that could potentially migrate into groundwater. Perchlorate was detected at a maximum concentration of 45.6 milligrams per kilogram (mg/kg) in the surface soil between 0 to 0.5 feet (Solutions to Environmental Problems, Inc. [STEP], 2005). **Figure 2-1** shows the area where perchlorate was detected above the cleanup level of 7.2 mg/kg at 0 to 0.5 feet bgs. The estimated volume of contaminated soil to be removed, based on a 1-foot-deep excavation, is approximately 4,000 cubic feet or 150 cubic yards.

Groundwater

Based on available sampling data, the groundwater at LHAAP-50 has been identified as a medium of concern due to the presence of TCE and perchlorate at concentrations exceeding the MCL of 5 µg/L and GW-Ind of 72 µg/L, respectively. The shallow groundwater contaminated with TCE and perchlorate is shown on **Figures 2-4** and **2-5**. Assuming 25 percent porosity, the total volume of TCE and perchlorate contaminated groundwater in the shallow zone is estimated to be approximately 5.5 million gallons (Shaw, 2009).

VOCs and perchlorate concentrations were below cleanup levels at intermediate zone monitoring well 50WW06 in years 2005 and 2007. The most recent sampling event in August 2010 shows perchlorate at 113 µg/L (above the GW-Ind of 72 µg/L) at 50WW06. Additional monitoring wells were installed in the intermediate zone to the north of 50WW06 as part of the investigations at LHAAP-47 in August 2010, and high perchlorate concentrations were detected at LHAAP-47 as shown on **Figure 2-6**. However, based on the existing data, the source of contamination in the intermediate zone remains undetermined; the perchlorate may be attributed to a source at LHAAP-47 or at LHAAP-50. This

LHAAP-50 RD will include the installation of seven new monitoring wells in the intermediate zone well to determine if the perchlorate plumes at LHAAP-47 and LHAAP-50 in the intermediate zone are comingled.

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APPROVED BY	S. Watson 11/04/10
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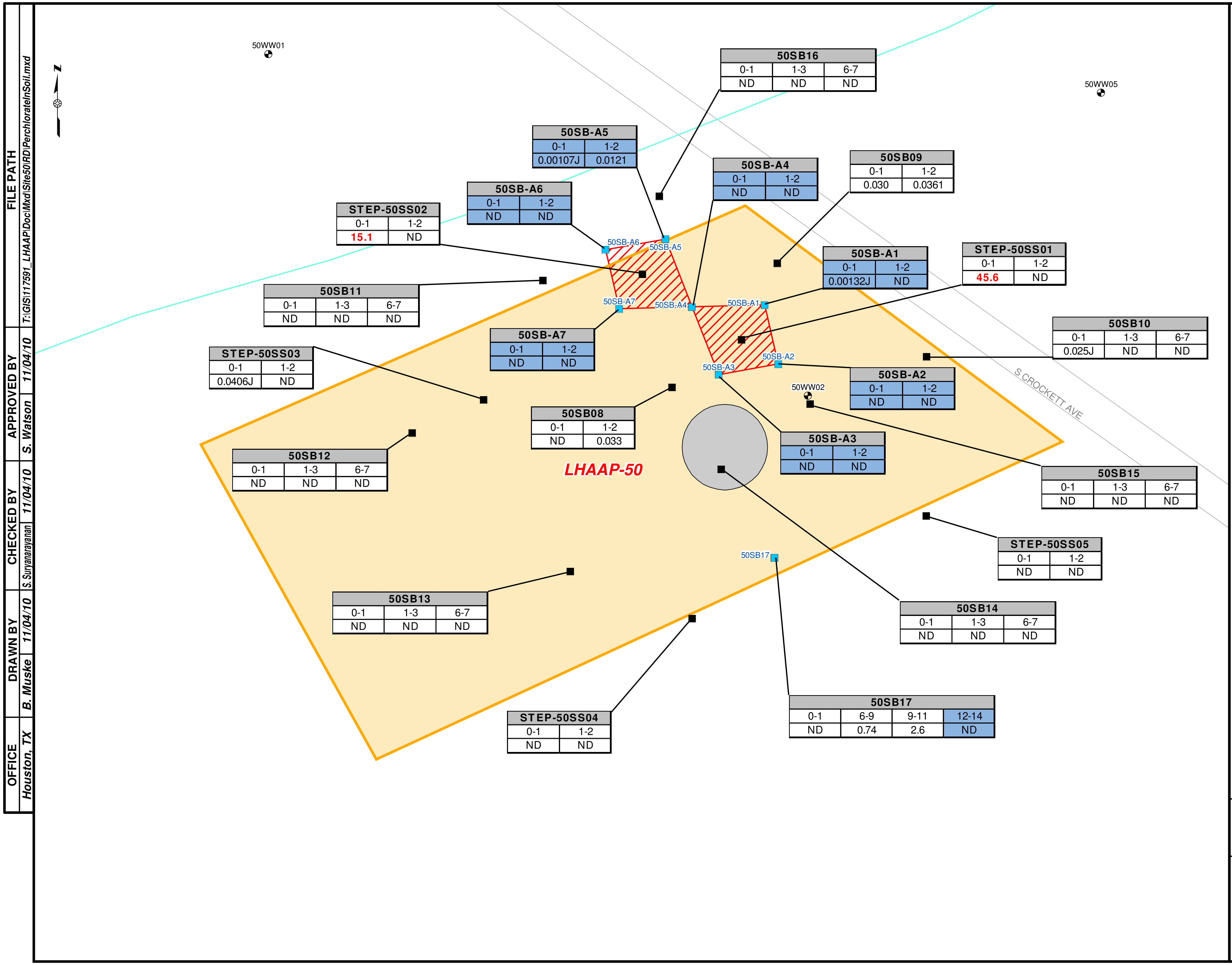

LEGEND

■ Soil Sample Location, August 2010

Historical Sample Locations

◕ Shallow Monitoring Well

◐ Intermediate Monitoring Well

■ Existing Soil Sample Location

〰 Goose Prarie Creek

— Road

⬭ Former Storage Tank Location

▨ Proposed Excavation Area

▭ Building or Concrete Slab

▭ Site

Notes:

1. Perchlorate concentrations are reported in milligrams per kilogram (mg/kg).
2. Soil sample locations where perchlorate was not analyzed are not shown on the figure.
3. Results from August 2010 are shaded in blue.
4. Results prior to August 2010 were obtained from investigations in 2003 by "Solutions to Environmental Problems Inc." and in 2007 by SHAW Environmental Inc.
5. Red - Perchlorate concentration above GWP - Ind (7.2 mg/kg).
6. Initial excavation depth is anticipated to be one foot.

0 25 50 100 Feet

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FIGURE 2-1

PERCHLORATE IN SOIL, AUGUST 2010
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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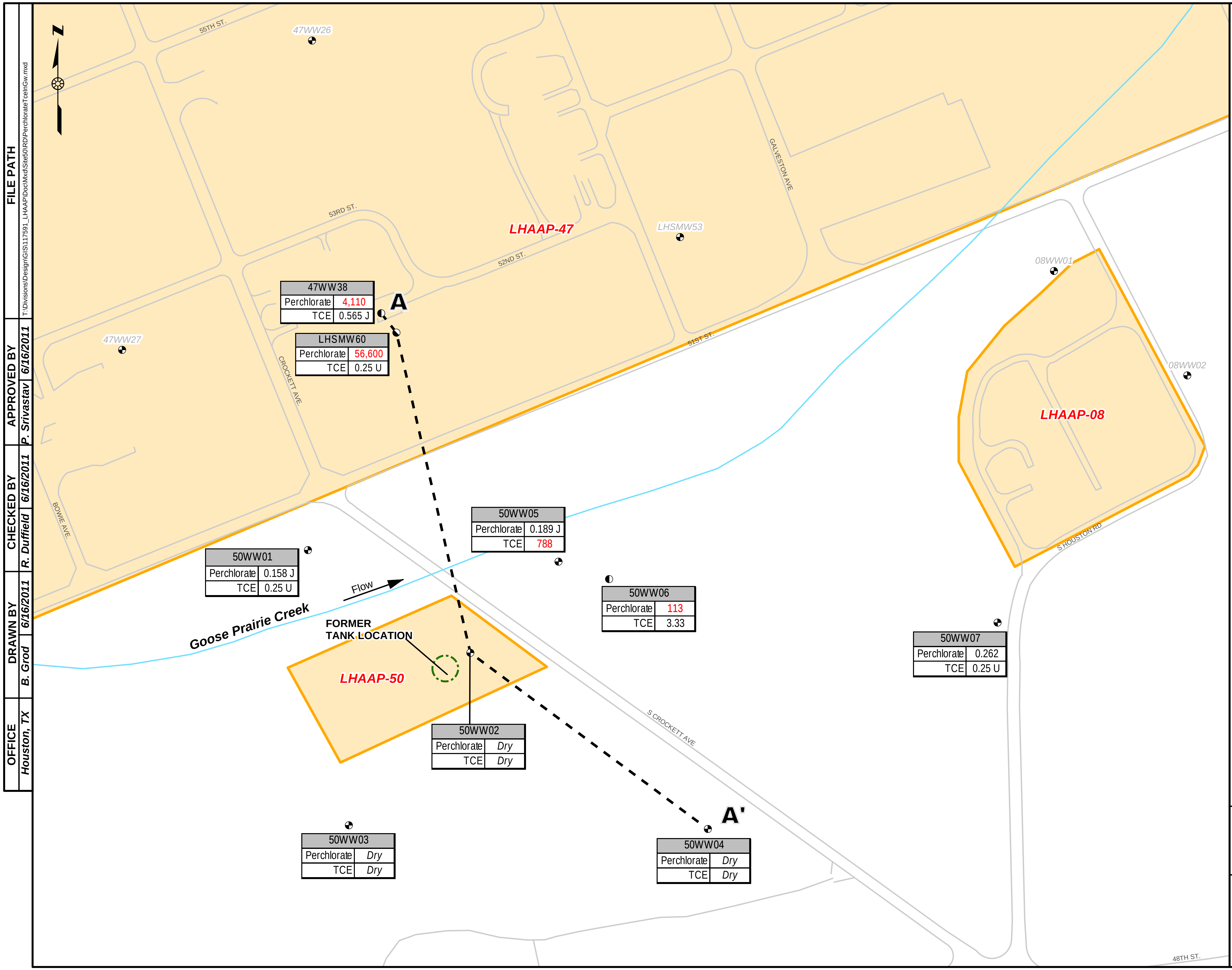

LEGEND

◕	Shallow Monitoring Well
◕	Shallow/Intermediate Monitoring Well
◐	Intermediate Monitoring Well
- - -	Cross Section (A)
〰	Stream
—	Road
🟧	Site

Notes:

1. Perchlorate and trichloroethene concentrations are measured in micrograms per liter (µg/L).
2. 113 - Contaminant concentrations above the clean-up levels as follows:

Perchlorate - 72 µg/L
(medium specific concentration for industrial use)

Trichloroethene (TCE)- 5 µg/L
(maximum contaminant level)

0 75 150 300
Feet

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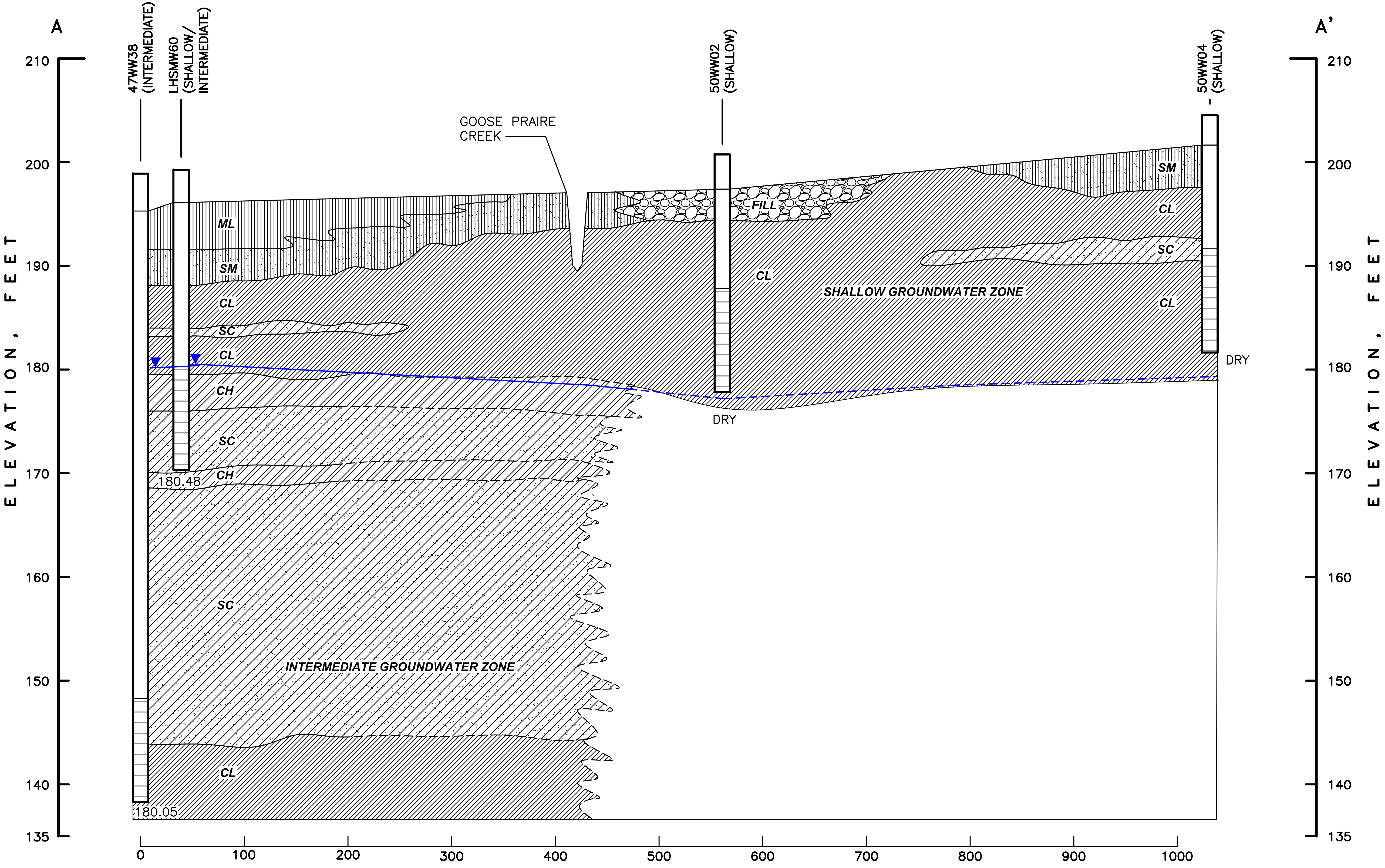
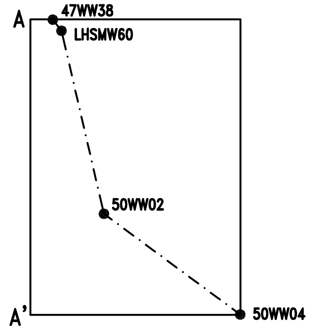
FIGURE 2-2
TCE AND PERCHLORATE CONCENTRATIONS
IN GROUNDWATER, AUGUST 2010
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



SECTION A-A'



LEGEND:

- ▨ CLAY (CL)
- ▨ CLAYEY SAND (SC)
- ▥ SILTY SAND (SM)
- ▩ GRAVEL SAND FILL (FILL)
- ▤ SCREEN
- ▥ INORGANIC SILTS (ML)
- ▨ FAT CLAY (CH)
- ▼ GROUNDWATER ELEVATION (AUG-SEPT 2010)
- 180.05 GROUNDWATER ELEVATION

VERTICAL SCALE
0 10 20 30 FEET

HORIZONTAL SCALE
0 100 200 300 FEET

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FIGURE 2-3
CROSS SECTION A-A'
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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CHECKED BY K. EVERETT 08/09/11
DRAWN BY S. MCCAWLEY 08/09/11
OFFICE Knoxville, TN
X-REF ---
IMAGE ---

PLOT DATE: 04/21/11
FORMAT REVISION 3/25/99

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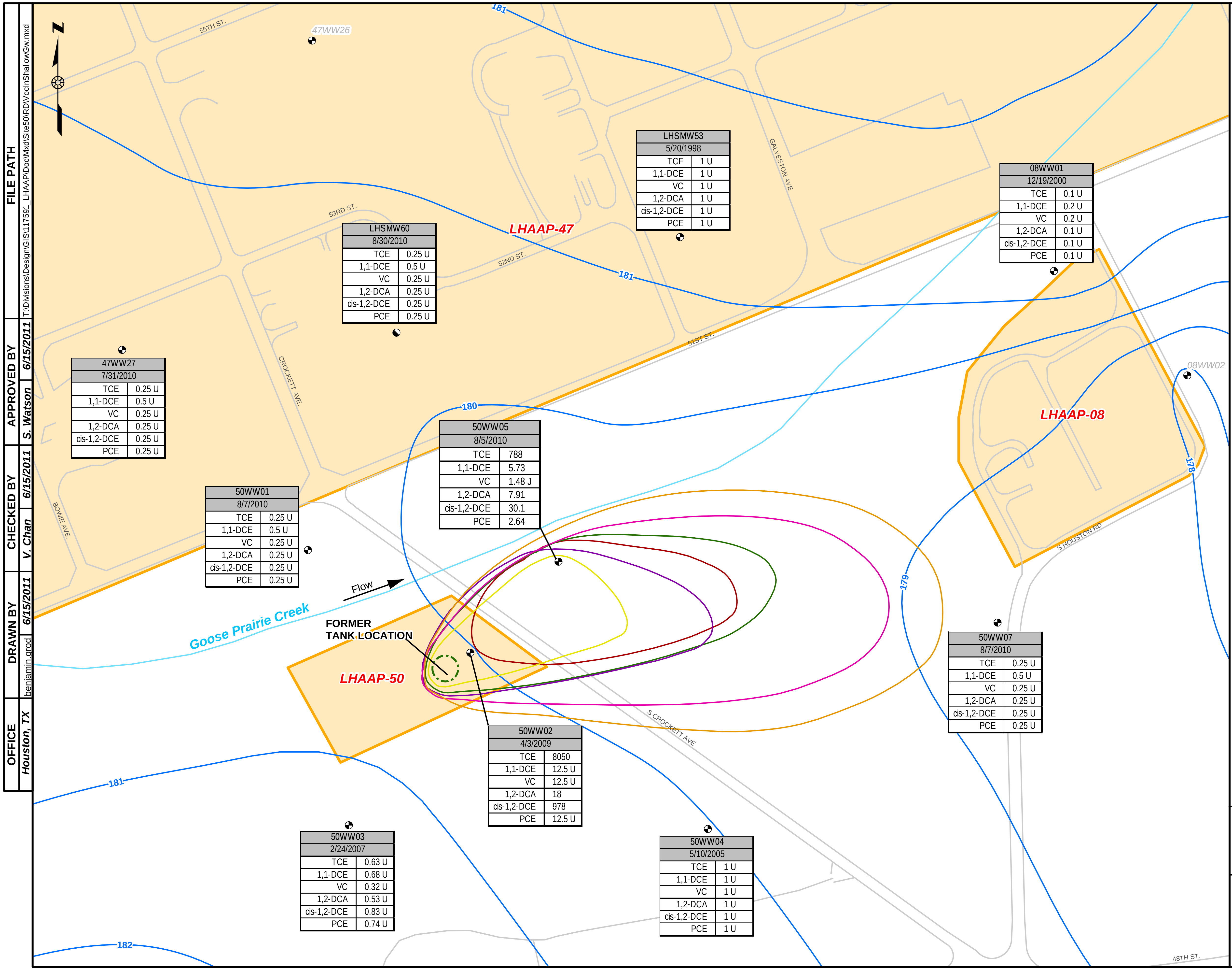
OFFICE	Houston, TX



LHSMW53	
5/20/1998	
TCE	1 U
1,1-DCE	1 U
VC	1 U
1,2-DCA	1 U
cis-1,2-DCE	1 U
PCE	1 U

08WW01	
12/19/2000	
TCE	0.1 U
1,1-DCE	0.2 U
VC	0.2 U
1,2-DCA	0.1 U
cis-1,2-DCE	0.1 U
PCE	0.1 U

LHSMW60	
8/30/2010	
TCE	0.25 U
1,1-DCE	0.5 U
VC	0.25 U
1,2-DCA	0.25 U
cis-1,2-DCE	0.25 U
PCE	0.25 U

47WW27	
7/31/2010	
TCE	0.25 U
1,1-DCE	0.5 U
VC	0.25 U
1,2-DCA	0.25 U
cis-1,2-DCE	0.25 U
PCE	0.25 U

50WW05	
8/5/2010	
TCE	788
1,1-DCE	5.73
VC	1.48 J
1,2-DCA	7.91
cis-1,2-DCE	30.1
PCE	2.64

50WW01	
8/7/2010	
TCE	0.25 U
1,1-DCE	0.5 U
VC	0.25 U
1,2-DCA	0.25 U
cis-1,2-DCE	0.25 U
PCE	0.25 U

50WW07	
8/7/2010	
TCE	0.25 U
1,1-DCE	0.5 U
VC	0.25 U
1,2-DCA	0.25 U
cis-1,2-DCE	0.25 U
PCE	0.25 U

50WW02	
4/3/2009	
TCE	8050
1,1-DCE	12.5 U
VC	12.5 U
1,2-DCA	18
cis-1,2-DCE	978
PCE	12.5 U

50WW03	
2/24/2007	
TCE	0.63 U
1,1-DCE	0.68 U
VC	0.32 U
1,2-DCA	0.53 U
cis-1,2-DCE	0.83 U
PCE	0.74 U

50WW04	
5/10/2005	
TCE	1 U
1,1-DCE	1 U
VC	1 U
1,2-DCA	1 U
cis-1,2-DCE	1 U
PCE	1 U

LEGEND

◕	Shallow Monitoring Well
◕	Shallow/Intermediate Monitoring Well
∼	1,1-DCE Plume (7 µg/L Extent)
∼	1,2-DCA Plume (5 µg/L Extent)
∼	PCE Plume (5 µg/L Extent)
∼	TCE Plume (5 µg/L Extent)
∼	VC Plume (2 µg/L Extent)
∼	cis-1,2-DCE Plume (70 µg/L Extent)
∼	Groundwater Elevation Contour
∼	Stream
—	Road
▨	Site

Notes:

1. Groundwater contour elevations collected in November - December 2007 were reported in feet.
2. COC concentrations were reported in micrograms per liter (µg/L).
3. Concentrations based on the latest data collected at each well.
4. TCE - Trichloroethene
   DCE - Dichloroethene
   VC - Vinyl chloride
   PCE - Tetrachloroethene
   DCA - Dichloroethane
5. Wells 50WW02, 50WW03, 50WW04, and LHSMW53 were dry in August 2010.
6. Plume extent based on maximum contaminant limit.

0 80 160 320
Feet

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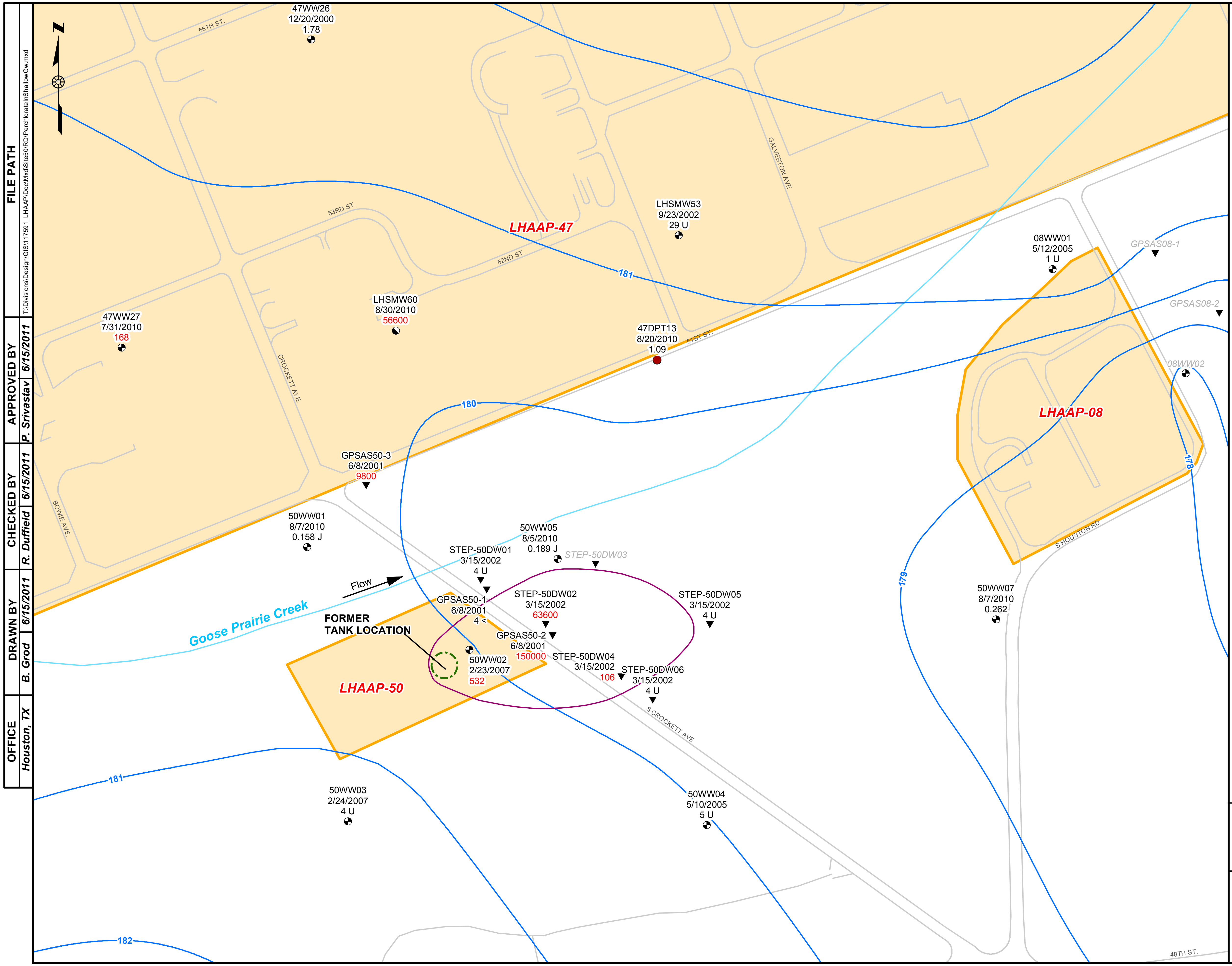
FIGURE 2-4
EXTENT OF VOCS IN
SHALLOW GROUNDWATER
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

▼ DPT and Geoprobe Sample Location

● Shallow Monitoring Well

◐ Shallow/Intermediate Monitoring Well

● Temporary Well

∽ Perchlorate Plume (72 µg/L Extent)

∽ Groundwater Elevation Contour

∽ Stream

— Road

▨ Site

Notes:

1. Groundwater contour elevations collected in November - December 2007 were reported in feet.
2. COC concentrations were reported in micrograms per liter (µg/L).
3. Concentrations based on the latest data collected at each well.
4. Perchlorate north of Goose Prairie Creek has a seperate source at LHAAP-47.
5. Plume extent based on the groundwater medium-specific concentration for industrial use which is 72 µg/L.

0 75 150 300
Feet

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TULSA, OKLAHOMA

FIGURE 2-5
EXTENT OF PERCHLORATE IN
SHALLOW GROUNDWATER
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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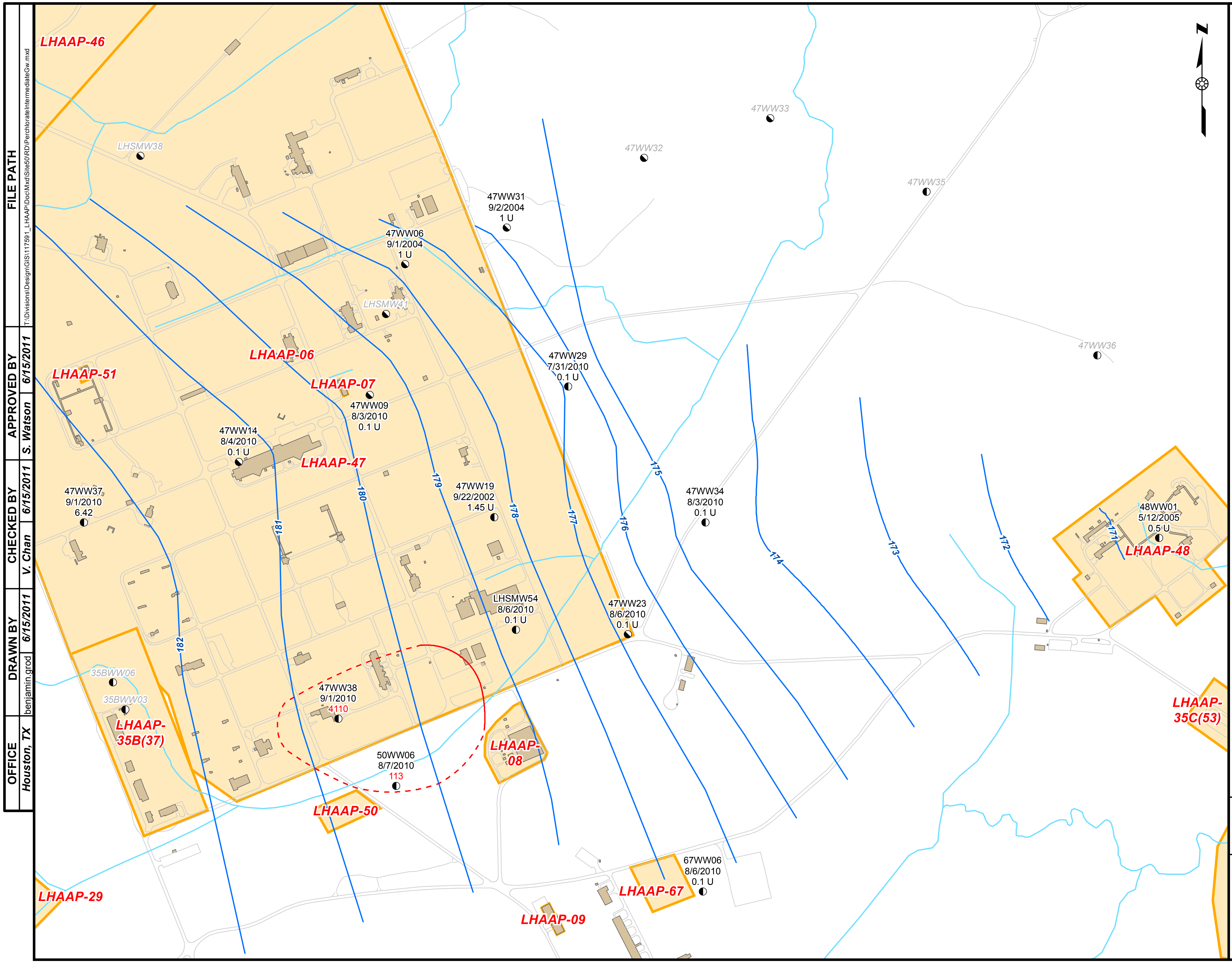

LEGEND

◒ Shallow/Intermediate Monitoring Well

◐ Intermediate Monitoring Well

Perchlorate Exceeding GW-Ind (72 µg/L)

Groundwater Elevation Contour

Stream

Road

Former Building or Concrete Slab

Site

NOTES:

1. Perchlorate Plume at LHAAP-50 may be comingled with LHAAP-47 perchlorate plume.
2. Plume extent based on the groundwater medium-specific concentration for industrial use which is 72 µg/L.

0 300 600 1,200
Feet

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FIGURE 2-6

EXTENT OF PERCHLORATE CONTAMINATION
IN INTERMEDIATE GROUNDWATER
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

3.0 LAND USE CONTROL

The objective of LUC at LHAAP-50 is to 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 until cleanup levels are met. Notification of the groundwater use restriction will accompany all transfer documents and will be recorded at the Harrison County Courthouse in accordance with Texas Administrative Code (TAC) Title 30, §335.566. **Appendix B** provides sample LUC compliance certification documentation.

The LUC addresses the area of LHAAP-50 that has groundwater plumes (in both the shallow and intermediate groundwater zones) with levels of contamination that require implementation of a remedy (see **Section 2.3**). The groundwater restriction LUC would be maintained until the concentration of contaminants and by-product contaminants have been reduced to below their respective cleanup levels.

The U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an LUC objective at this site after it has transferred. The U.S. Army shall obtain USEPA and TCEQ concurrence prior to termination or significant modification of the LUC, or implementation of a change in land use inconsistent with the LUC objectives and use assumptions of the remedy. Although not a remedy, the land use assumption for LHAAP-50 forms the basis for the remedy. The future use of the site as part of a national wildlife refuge is consistent with an industrial risk exposure scenario. Notification of the land use assumption of this site will be made in transfer documentation and will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566. Compliance with the use assumption will be documented in the five-year review reports.

4.0 EXCAVATION DESIGN

The elements of the excavation are provided in the following sections. The details of the implementation of the design will be submitted in a separate work plan.

4.1 Excavation Area

The proposed excavation area is shown in **Figure 2-1**. Total volume of contaminated soils to be excavated at LHAAP-50 is estimated to be 150 cubic yards. A 1-foot-deep excavation within a 4,000 square feet area has been proposed. Soil samples in August 2010 did not exceed the GWP-Ind for perchlorate and were used to refine the extent of excavation required (**Section 2.1**). If soil confirmation samples below the 1-foot depth are found to exceed the GWP-Ind for perchlorate, the area will be excavated further and additional confirmation samples will be collected (Shaw, 2009).

A 5-point composite soil sample will be collected from approximately every 750 square feet of the excavation floor area and of each wall. Since the planned excavation limits will extend to the clean samples collected in August 2010, these samples will be considered representative of wall confirmation samples. Additional wall samples will not be collected unless the depth of excavation is extended beyond 1 foot. Confirmation samples will be collected from the floor after excavation is complete. Based on the current excavation area (as shown in **Figure 2-1**), six composite soil samples will initially be collected for confirmation. If the confirmation results exceed cleanup levels, additional excavation and confirmation sampling will be implemented in accordance with **Section 6.5**.

4.2 Surface Water Monitoring

To ensure that soil at LHAAP-50 is not contaminating nearby surface water, -quarterly monitoring of Goose Prairie adjacent to LHAAP-50 for a minimum of eight quarters will be conducted at two locations after excavation (**Figure 4-1**). A new surface water sampling location (GPW-1A) will be added northwest of GPW-1 to monitor for contaminant contributions from runoff from the perchlorate-contaminated portion of LHAAP-47. This new sampling location will be located in a ditch at the upgradient end of a culvert in LHAAP-47. Evaluation of this data will be included in the annual reports to verify that the RAOs are achieved (e.g., to prevent further potential degradation of surface water from contaminated soil and preventing contaminated groundwater from migrating into nearby surface water). The frequency and location of sampling may be modified after evaluation of data. If perchlorate levels in the creek are consistently above TCEQ groundwater MSC for residential use (GW-Res) after two years of monitoring, then additional evaluation will be conducted and any proposed actions will be included in the annual evaluation report to be submitted after Year 2. The need to continue creek sampling will be evaluated during the five-year reviews.

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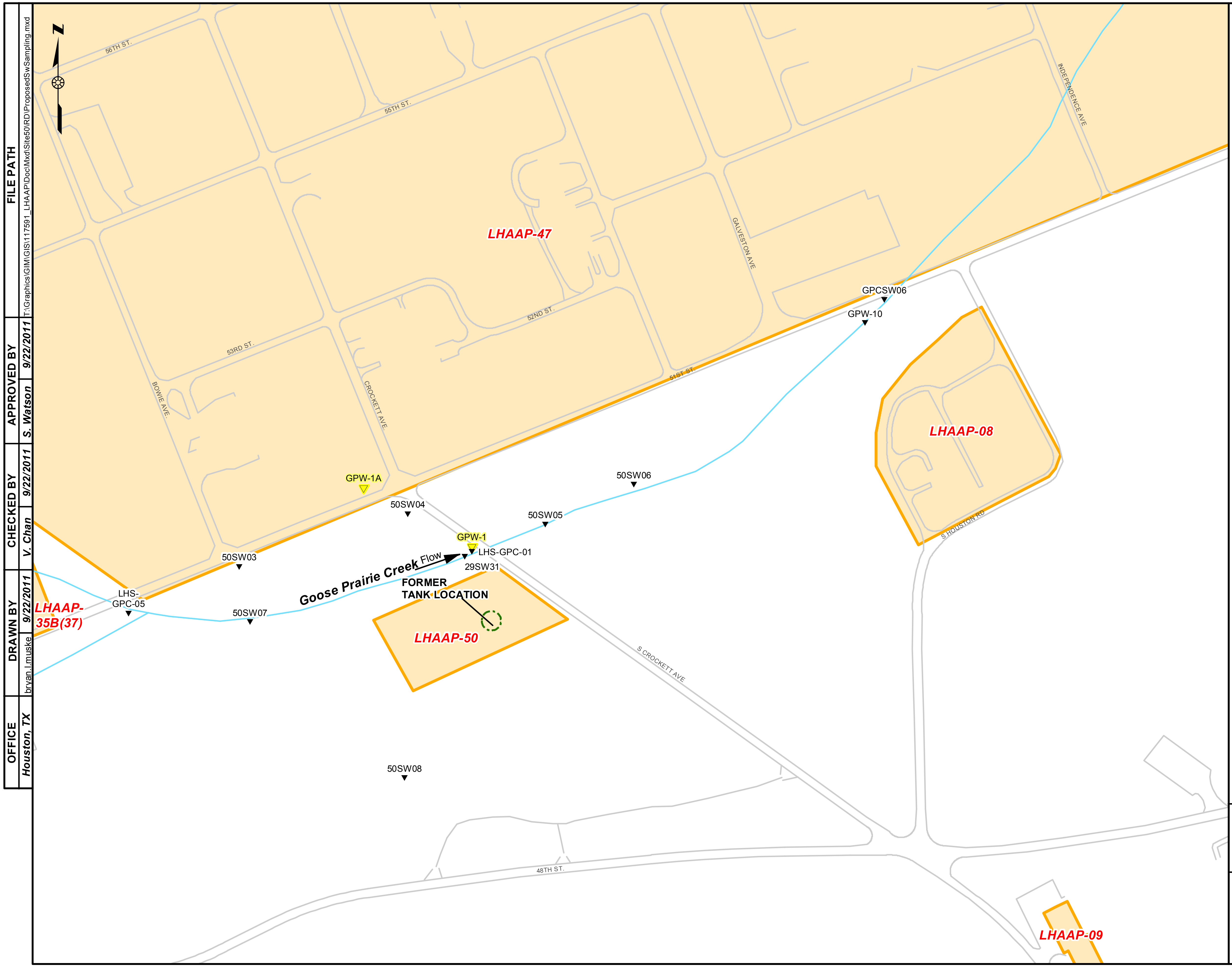

LEGEND

▼ Existing Suface Water Sample Location

▽ Proposed Surface Water Sample Location

Stream

Road

Site

Note:

GPW-1A is located at the culvert on the north side of the road to evaluate contributions from LHAAP-47. The water from this culvert flows into Goose Prairie Creek near LHAAP-50.

0 100 200 400
Feet

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FIGURE 4-1

SURFACE WATER SAMPLING LOCATIONS
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

5.0 MONITORING SYSTEM DESIGN

As part of the remedy, monitoring will be conducted of the groundwater and surface water. This design presents the elements of MNA remedy for the shallow zone and the rationale for addition of new wells and monitoring in the intermediate and deep zone. A more detailed groundwater monitoring plan will be submitted under separate cover to evaluate and monitor groundwater in both the shallow and intermediate plumes, and the surface water to evaluate any potential migration of groundwater to surface water. Generally the MNA performance monitoring network will be designed to provide at least two wells along the axis inside the plume boundary to evaluate MNA effectiveness; four wells to evaluate lateral plume expansion; and at least one well to evaluate vertical migration. This section discusses the rationale of MNA performance monitoring program designed to meet the following objectives:

Objectives for Performance Monitoring of MNA (USEPA, 1999)

1) Demonstrate that natural attenuation is occurring.
2) Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes.
3) Identify any potentially toxic and/or mobile transformation products.
4) Verify that the plume(s) is/are not expanding downgradient, laterally, or vertically.
5) Verify no unacceptable impact to downgradient receptors.
6) Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy.
7) Verify attainment of remediation objectives.

5.1 Monitoring Performance Monitoring Well Locations

In November 2007 a full set of groundwater elevation readings were collected of the entire northern area of LHAAP including LHAAP-50. Each existing well completion was evaluated and wells were assigned to a shallow or intermediate zone. The coordinates and well information is located in **Table 5-1**. Based on these designations, the groundwater contamination is located in the shallow and intermediate zones at LHAAP-50. However, the source of contamination in the intermediate zone remains undetermined; the perchlorate source may be attributed to a source at LHAAP-47 or the perchlorate at LHAAP-50.

5.1.1 Shallow Groundwater Plume and Additional Soil Sampling

The site hydrogeology is important when designing a monitoring system. The site groundwater flow and cross sections have been presented in the LHAAP-50 FS. The shallow groundwater elevations are approximately 7 to 20 feet bgs, and the most recent readings are 14 to 19 feet bgs. Generally the groundwater flow is in a northeasterly direction as documented in groundwater flow assessments. Groundwater elevation readings collected in November 2007, are presented on **Figure 1-3** and **Figure 1-4**. The current shallow zone wells are completed in the sand interval that is approximately 8 to 28 feet bgs.

The shallow zone perchlorate plume currently has one well within the plume boundary whereas the VOC plume has two wells within the plume boundary. Also, 50WW02, the monitoring well close to the source area, 50WW03 and 50WW04 were dry in the August 2010 sampling event. The shallow zone perchlorate and VOC plume are bounded; however, the exact shape and boundary of the plume may be different than depicted. A direct-push rig will be used to further delineate the edges of the plume, especially the eastern edge, as well as optimize the selection of monitoring well locations within and outside the edge of the plume. Grab samples will be collected using well points and analyzed for VOCs and perchlorate as shown on **Figure 5-1**. Based on these results, additional locations may be selected for optimal locations of the performance monitoring wells. If 50WW02 continues to be dry, a new well will be installed in the shallow/intermediate zone close to the existing location. **Figure 5-2** indicates possible locations for fourteen additional wells based on the current data. Use of existing wells will be maximized as they provide historic data that can be used in the MNA evaluation. **Table 5-2** provides the rationale for the selection of wells in the proposed monitoring well system for the shallow zone as shown on **Figure 5-2**.

As part of the direct-push activities, soil samples will be collected from 50DPT03 at various depths above the groundwater interface and analyzed for perchlorate. This additional soil sampling is to address TCEQ's concerns that the soil across the street from the site, in the vicinity of STEP-50DW02 and GPSAS50-2, may be a source of perchlorate. High groundwater results for perchlorate were observed at STEP-50DW02 and GPSAS50-2.

5.1.2 Intermediate Groundwater Plume

The site hydrogeology is important when designing a monitoring system. The intermediate groundwater elevations are approximately 9 to 13 ft bgs, and the most recent reading is 12.65 feet bgs. Generally, the groundwater flows in a northeasterly direction as documented in groundwater flow assessments. The current intermediate zone wells are completed in the sand interval that is approximately 40 to 55 feet bgs.

The intermediate zone plume has one LHAAP-50 well within the plume. The October 2008 sampling event indicated perchlorate concentrations at 50WW06 above the GW-Ind of 72 µg/L. New monitoring wells will be installed and sampled to determine the source of the perchlorate contamination and delineate the edges of the plume. Two wells will be installed within the plume and five more wells will be installed outside the plume in the intermediate zone. One monitoring well (part of a well cluster) will be installed in the deep zone to ensure that groundwater from the shallow/intermediate zone is not contaminating the deep zone. The samples will be analyzed for VOCs and perchlorate. **Figure 5-3** indicates possible locations of eight monitoring wells in both the intermediate and deep zone based on the current data. Use of existing wells will be maximized as they provide historic data that can be used in the MNA evaluation. **Table 5-3** provides the rationale for the selection of wells in the proposed monitoring well system for the intermediate zone as shown on **Figure 5-3**. Additional sampling of these wells will be conducted to gather data to evaluate a remedy.

Table 5-1
Monitoring Wells to be Sampled at LHAAP-50

Well	Groundwater Zone	Approximate depth [a] (ft bgs)	Location		Ground Elevation (ft MSL)	Top of Casing (ft MSL)
			Northing	Easting		
50WW02	Shallow	19	6957436.64	3309569.44	197.40	200.74
50WW03	Shallow	20	6957162.82	3309376.1	199.88	202.94
50WW04	Shallow	20	6957156.94	3309947.41	201.64	204.51
50WW05	Shallow	22	6957581.45	3309709.69	195.34	197.68
50WW07	Shallow	29	6957484.78	3310408.51	199.88	202.55
A1	Shallow	TBD	TBD	TBD	TBD	TBD
B	Shallow	TBD	TBD	TBD	TBD	TBD
C	Shallow	TBD	TBD	TBD	TBD	TBD
D1 (part of a well cluster)	Shallow	TBD	TBD	TBD	TBD	TBD
E	Shallow	TBD	TBD	TBD	TBD	TBD
F	Shallow	TBD	TBD	TBD	TBD	TBD
G	Shallow	TBD	TBD	TBD	TBD	TBD
H	Shallow	TBD	TBD	TBD	TBD	TBD
I	Shallow	TBD	TBD	TBD	TBD	TBD
J	Shallow	TBD	TBD	TBD	TBD	TBD
K	Shallow	TBD	TBD	TBD	TBD	TBD
L	Shallow	TBD	TBD	TBD	TBD	TBD
M	Shallow	TBD	TBD	TBD	TBD	TBD
N	Shallow	TBD	TBD	TBD	TBD	TBD
50WW06	Intermediate	29	6957553.93	3309790.22	199.88	202.55
47WW38	Intermediate	57	6957975.84	3309427.55	195.3	198.91
LHSMW54	Intermediate	42	6958535.21	3310541.19	191.08	193.71
A2(part of a well cluster)	Intermediate	TBD	TBD	TBD	TBD	TBD
D2 (part of a well cluster)	Intermediate	TBD	TBD	TBD	TBD	TBD
P	Intermediate	TBD	TBD	TBD	TBD	TBD
Q	Intermediate	TBD	TBD	TBD	TBD	TBD
R	Intermediate	TBD	TBD	TBD	TBD	TBD

Table 5-1 (*continued*)
Monitoring Wells to be Sampled at LHAAP-50

Well	Groundwater Zone	Approximate depth [a] (ft bgs)	Location		Ground Elevation (ft MSL)	Top of Casing (ft MSL)
			Northing	Easting		
S	Intermediate	TBD	TBD	TBD	TBD	TBD
T	Intermediate	TBD	TBD	TBD	TBD	TBD
A3	Deep	TBD	TBD	TBD	TBD	TBD

Notes and Abbreviations:

[a] *Approximate depth is the bottom of the screen interval.*

Approximate location of the monitoring wells to be added are shown on **Figures** *5-2 and 5-3*

Coordinate system is Texas State Plane, North American Datum 1983

ft bgs	*feet below ground surface*
ft MSL	*feet above mean sea level*
TBD	*to be determined*

Table 5-2
Rationale for Performance Monitoring Wells in Shallow Zone

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
In plume (VOCs and Perchlorate)	This well is considered closest to the source area. Highest concentrations in plume; Extreme drought has caused this well to be dry at times, also the well is completed with 10-foot screen over a silt and clay interval which may be causing the well to be dry.	50WW02	Provides a data point within the perchlorate and VOCs plume to evaluate presence of any toxic products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes. Possible candidate for replacement as a dry well.
In plume (VOCs and Perchlorate)	New well close to source area within the site boundary	New Well A1 (part of shallow/intermediate/deep well cluster)	Provides a data point within the perchlorate and VOCs plume to evaluate presence of any toxic products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes; Calculate distance based attenuation rate; evaluate plume stability; Evaluate seasonal variations and effects on plume boundary
In plume (VOCs and Perchlorate	New well downgradient of the perchlorate source area	New Well D1 (Part of shallow and intermediate well cluster)	Provides a data point downgradient of the source area, within the perchlorate and VOCs plume to evaluate presence of daughter/toxic products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes; Calculate distance based attenuation rate; evaluate plume stability; Evaluate seasonal variations and effects on plume boundary Calculate distance based attenuation rate; evaluate plume stability.
In Plume (VOCs and Perchlorate)	New well downgradient of the source area	New Well B	Provides another data point downgradient of the source area within the perchlorate and VOCs plume to evaluate presence of daughter/toxic products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes; Calculate distance based attenuation rate; evaluate plume stability; Evaluate seasonal variations and effects on plume boundary

Table 5-2 (*continued*)
Rationale for Performance Monitoring Wells in Shallow Zone

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
Downgradient (outside the perchlorate plume edge and within VOCs plume)	New well downgradient of the eastern perchlorate plume edge and within the VOCs plume	New Well C	Provides a data point to evaluate downgradient expansion of perchlorate plume and an "in plume" data point for VOCs plume; Calculate distance based attenuation rate; evaluate plume stability; Evaluate seasonal variations and effects on plume boundary; Verify no unacceptable impact to downgradient receptors
In plume (TCE and Perchlorate)	New well crossgradient of the source area	New Well L	Provides a data point within the perchlorate and TCE plume to evaluate the presence of toxic products, changes of the dissolved plume to evaluate MNA processes; Calculate distance based attenuation rate; evaluate plume stability.
Downgradient (outside the eastern edge of the perchlorate plume and within the VOCs plume)	New well downgradient of the eastern edge of the perchlorate plume and within the VOCs plume.	New Well M	Provides a data point to evaluate downgradient expansion of perchlorate plume and an "in plume" data point for VOCs plume; Verify no unacceptable impact to downgradient receptors
Downgradient (outside the east edge of perchlorate and 1,2-DCA plume and within the TCE plume	New well downgradient of perchlorate and 1,2-DCA plume and within the TCE plume	New Well N	Provides a data point to evaluate the dowgradient expansion of the perchlorate/1,2-DCA plume and an "in-plume" data point for the TCE plume; Verify no unacceptable impact to downgradient receptors
Downgradient (outside the east edge of the TCE plume)	New wells downgradient of the TCE plume	New Wells H & I	Provides a data point to evaluate the downgradient expansion of the TCE plume; Verify no unacceptable impact to downgradient receptors
Crossgradient (outside the south edge of the TCE plume)	New wells crossgradient of the TCE plume	New Wells J & K	Provides a data point to evaluate the lateral expansion of the TCE plume
Crossgradient (outside the north edge of the TCE plume)	New wells crossgradient of the TCE plume	New Well E, F and G	Provides a data point to evaluate the lateral expansion of the TCE plume
Downgradient (outside the east edge of the TCE plume)	Existing well downgradient of the TCE plume	50WW07	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors

Table 5-2 (*continued*)
Rationale for Performance Monitoring Wells in Shallow Zone

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
Crossgradient-North side	Existing well outside plume to the north	50WW05	Evaluate lateral expansion
Crossgradient-South Side (near/ outside plume edge)	Existing well outside of the plume boundary to the south	50WW04	Evaluate lateral expansion; Possible candidate for replacement as a dry well.
Upgradient	Well outside the plume boundary to the south west	50WW03	Detect any new contamination flowing into plume area; Evaluate lateral plume expansion. Possible candidate for replacement as a dry well.

Notes and Abbreviations:

DCA	*dichloroethane*
MNA	*monitored natural attenuation*
TCE	*trichloroethene*
VOC	*volatile organic compound*

Table 5-3
Rationale for Performance Monitoring Wells in Intermediate and Deep Zone

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
In plume	Highest concentrations in plume in LHAAP-47 area;	47WW38	Evaluate presence of any toxic products in the LHAAP-47 area to help determine if perchlorate plume in the intermediate zone in LHAAP-47 and LHAAP-50 are comingled. Also used to evaluate any geochemical and microbiological changes of the dissolved plume to evaluate MNA processes
In plume	New well between LHAAP-47 and LHAAP-50	New Well P	Evaluate any toxic products in the LHAAP-47 area to determine if the perchlorate contamination in the intermediate zone in LHAAP-50 originates from a potential source in LHAAP-47 or from LHAAP-50
In plume	Existing monitoring well in the plume in the LHAAP-50 area	50WW06	Evaluate presence of any toxic products in the LHAAP-50 area to help determine if the perchlorate plume in the intermediate zone in LHAAP-47 and LHAAP-50 are comingled. Also used to evaluate geochemical and microbiological changes of the dissolved plume to evaluate MNA processes
In plume	Downgradient from highest concentration	New Well Q	Evaluate presence of any toxic and mobile daughter products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes
Outside plume (near west plume edge)	New well upgradient of the plume in LHAAP-47 area	New Well T	Detect any new contamination flowing into plume area from LHAAP-47 or LHAAP-35B; Evaluate lateral expansion
Outside plume(near plume edge)	New monitoring well to be installed within the site boundary of LHAAP-50	New Well A2 (part of shallow/intermediate and deep well cluster)	Installed within the LHAAP-50 site boundary to determine if source of the intermediate zone contamination is from LHAAP-50
Outside plume (near southwest plume edge)	New monitoring well to be installed in the Deep zone within the site boundary of LHAAP-50	New Well A3 (part of shallow/intermediate and deep well cluster)	Installed within the LHAAP-50 site boundary close to the source area to check for contamination in the deep zone close to the source area.
Outside plume (north edge of the plume)	New well outside north edge of the plume	New Well S	Evaluate lateral expansion of the plume
Outside plume (southeast edge of the plume)	New well outside south edge of the plume	New Well R	Evaluate lateral expansion of the plume

Table 5-3 (*continued*)
Rationale for Performance Monitoring Wells in Intermediate and Deep Zone

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
Outside plume (south edge of the plume)	New well outside south edge of the plume	New Well D2 (Part of Shallow and Intermediate well cluster)	Evaluate lateral expansion of the plume
Outside plume (near north west edge)	Existing monitoring well within the plume	LHSMW54	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors

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CHECKED BY *V. Chan* *9/21/2011*

APPROVED BY *S. Watson* *9/21/2011*

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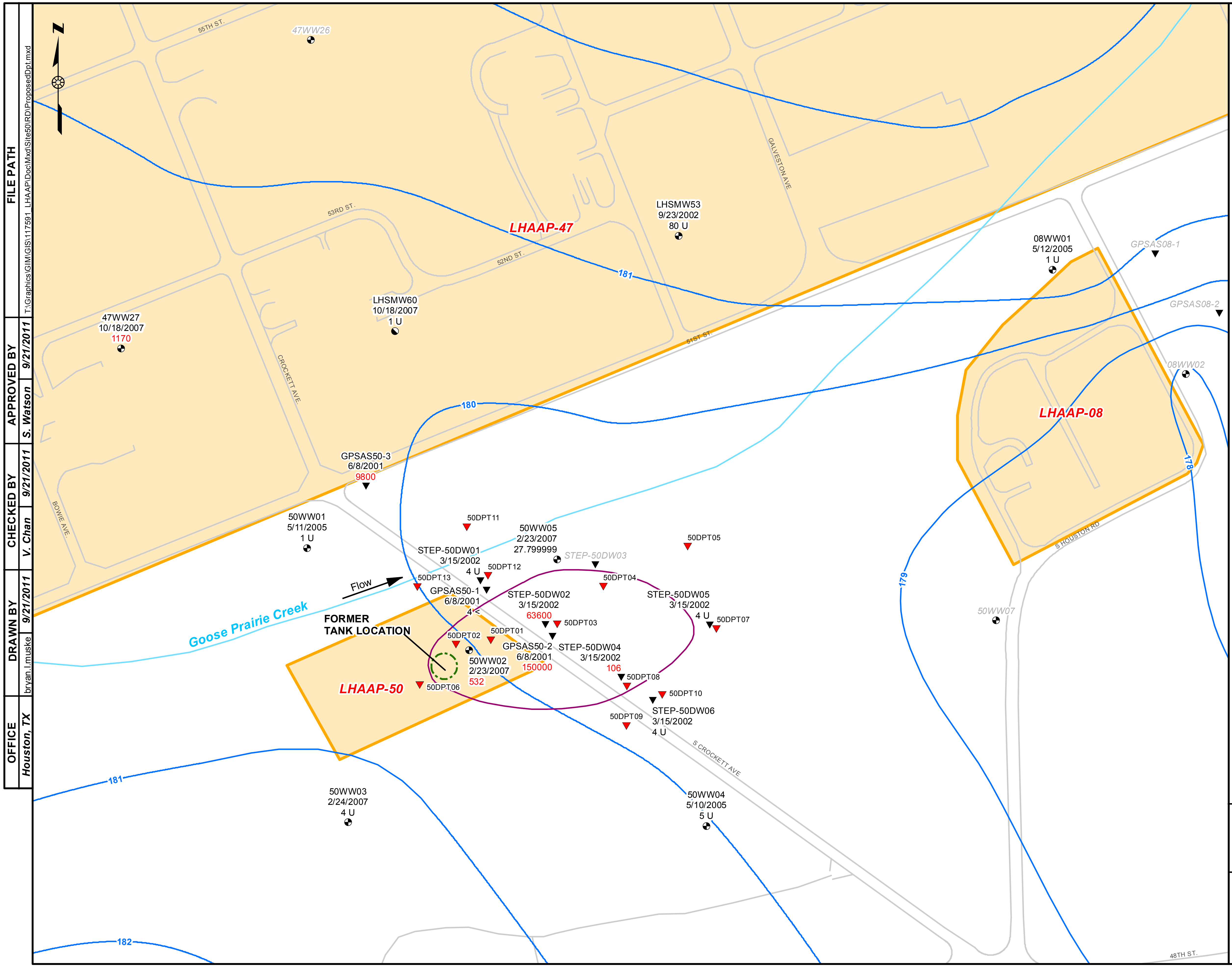

LEGEND

- ▼ DPT and Geoprobe Sample Location
- ⊕ Shallow Monitoring Well
- ◐ Shallow/Intermediate Monitoring Well
- ∽ Perchlorate Plume (72 μg/L Extent)
- ∽ Groundwater Elevation Contour
- ∽ Stream
- — Road
- ▨ Site

Notes:

1. Groundwater contour elevations collected in November - December 2007 were reported in feet.
2. COC concentrations were reported in micrograms per liter (μg/L).
3. Concentrations based on the latest data collected at each well.
4. Plume extent based on groundwater medium specific concentration for industrial use which is 72 ug/L.

0 75 150 300
Feet

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TULSA, OKLAHOMA

FIGURE 5-1
PROPOSED DPT
LOCATIONS IN SHALLOW GROUNDWATER
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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CHECKED BY	V. Chan 9/21/2011
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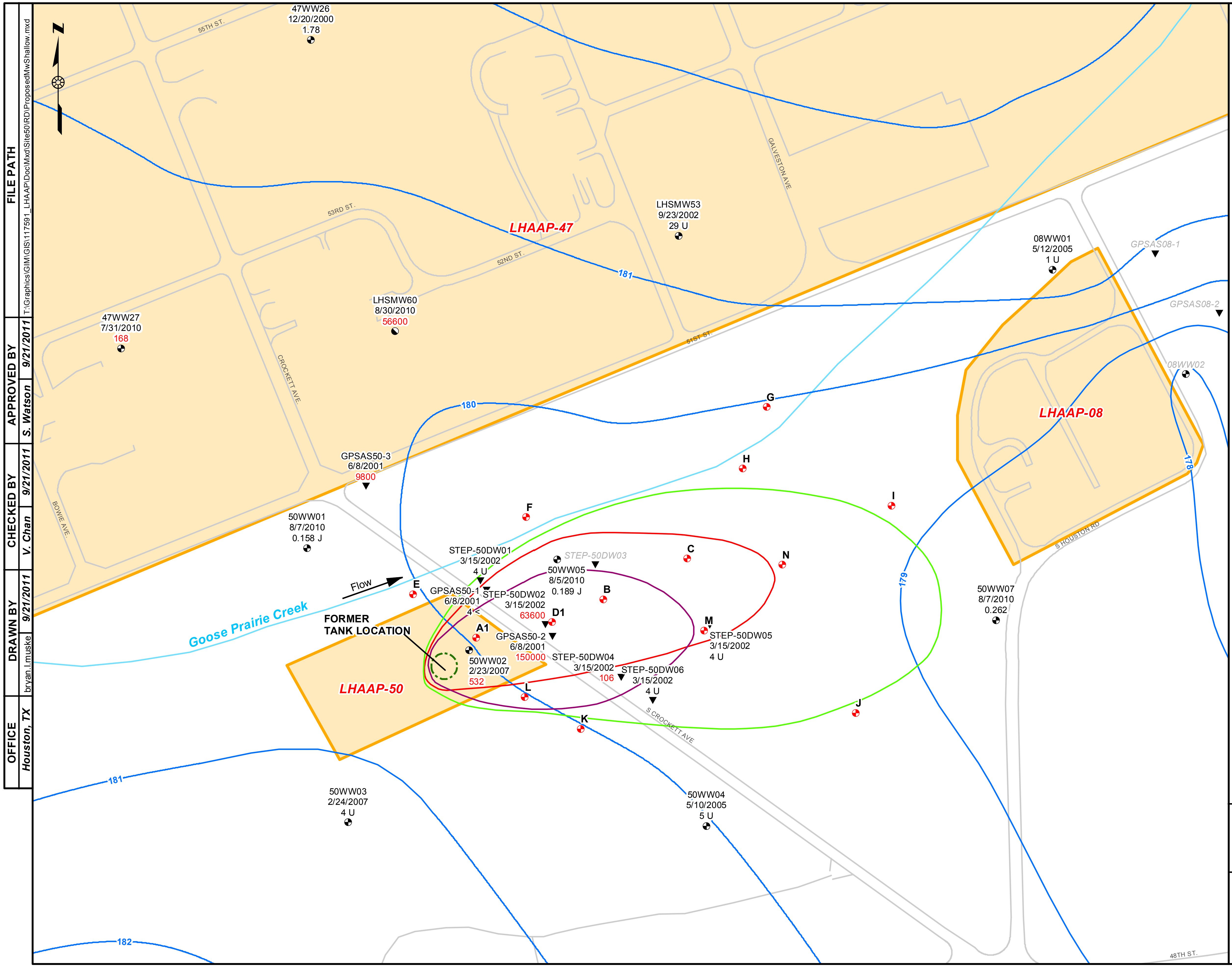

LEGEND

- ⊕ Proposed Shallow Monitoring Well
- ▼ DPT and Geoprobe Sample Location
- ◐ Shallow Monitoring Well
- ◐ Shallow/Intermediate Monitoring Well
- Perchlorate Plume (72 µg/L Extent)
- 1,2-DCA Plume
- TCE Plume
- Groundwater Elevation Contour
- Stream
- Road
- Site

Notes:

1. Groundwater contour elevations collected in November - December 2007 were reported in feet.
2. COC concentrations were reported in micrograms per liter (µg/L).
3. Concentrations based on the latest data collected at each well.
4. Plume extent based on groundwater medium specific concentration for industrial use which is 72 ug/L.

0 75 150 300 Feet

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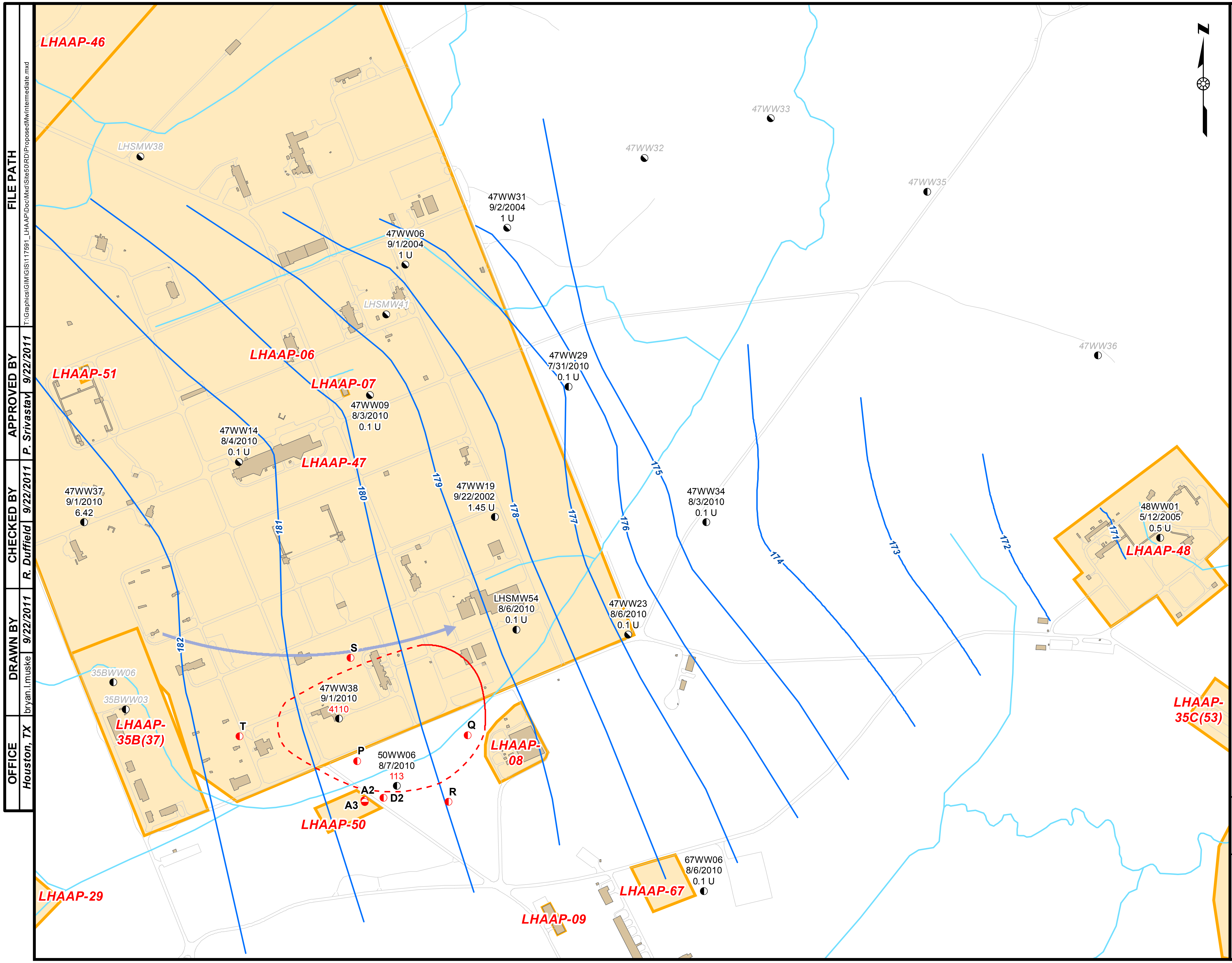
FIGURE 5-2
PROPOSED MONITORING WELL
LOCATIONS IN SHALLOW GROUNDWATER
LHAAP-50 REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

◐ Proposed Intermediate Montioring Well

◒ Proposed Deep Montioring Well

◐ Shallow/Intermediate Monitoring Well

◐ Intermediate Monitoring Well

Perchlorate Exceeding GW-Ind (72 µg/L)

Groundwater Elevation Contour

Groundwater Flow Direction

Stream

Road

Former Building or Concrete Slab

Site

Notes:

1. Plume extent based on groundwater medium specific concentration for industrial use which is 72 ug/L.
2. Well P will be placed adjacent to Shallow well F.

0 300 600 1,200
Feet

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FIGURE 5-3

PROPOSED MONITORING WELL LOCATIONS
IN INTERMEDIATE AND DEEP GROUNDWATER
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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6.0 LAND USE CONTROL DESIGN AND IMPLEMENTATION PLAN

This section describes the LUC design and implementation activities for LHAAP-50. The activities will result in a surveyed and recorded groundwater use restriction boundary and an operation and maintenance plan for the LUC.

The objective of the LUC at LHAAP-50 is to 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 site for anything other than environmental monitoring and testing until cleanup levels are met. Notification of the groundwater use restriction will accompany all transfer documents. The U.S. Army is responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC.

The LUC will address the area of LHAAP-50 that includes two groundwater plumes with levels of contamination that require implementation of a remedy (see **Section 1.3**). The Land Use Control Operation and Maintenance Plan (LUC O&M) will identify the measures required for monitoring and enforcement of the groundwater use restriction. Upon review and concurrence of this RD, the LUC O&M Plan will be coordinated with regulators, finalized, and distributed as part of the Comprehensive LUC Management Plan for LHAAP.

6.1 Land Use Control Implementation

The U.S. Army will undertake the following actions to implement the groundwater restriction LUC for LHAAP-50:

- ***Define the Area of the Groundwater Use Restriction.*** The groundwater use restriction boundary will be defined based on the review of the first round of groundwater sampling data in conjunction with historic data. The extent of plume will be bounded by a buffer and may extend to natural groundwater and surface water boundaries.

- ***Survey the LUC Boundary.*** The proposed boundary will be finalized after all wells are installed and sampled. Concurrence by USEPA and TCEQ will be obtained, and the LUC boundary will be surveyed by a State-licensed surveyor. A legal description of the surveyed area will be appended to the survey plat.

- ***Record the LUC in Harrison County.*** The LUC plat, legal description and groundwater use restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566.

- ***Notify the Texas Department of Licensing and Regulation of the LUC.*** The Texas Department of Licensing and Regulation will be notified of the groundwater restriction which includes the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the U.S. Army, the USEPA, and the TCEQ. The survey plat, legal boundary and description of the groundwater restriction, in conjunction with a locator map, will be provided in hard and electronic copy.
- ***Develop the LUC O&M Plan.*** An LUC O&M Plan for LHAAP-50 will be developed. It will include the elements presented in **Section 6.2**, the county recordation of the LUC survey plat, legal description and restriction language, and the inspection/certification form.

6.2 Land Use Control Operation and Maintenance

The U.S. Army or its representatives will be responsible for the operation and maintenance of the LHAAP-50 LUC. This includes certification, reporting, and enforcement activities. The U.S. Army shall address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable. To facilitate long-term operation and maintenance of the groundwater use restriction LUC remedy, the U.S. Army will develop a plan that will encompass the elements described in the following subsections.

6.2.1 Site Certification and Reporting

Beginning with finalization of this RD and approval of the inspection form, the U.S. Army will undertake inspections and certify continued compliance with the LUC objectives. The U.S. Army or the transferee after transfer will retain the LUC Inspection Certification documents in the project files for incorporation into the five-year review reports, and these documents will be made available to USEPA and TCEQ upon request. In addition, should any violations be found during the certification, the U.S. Army will provide to USEPA and TCEQ, along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue certifications will be revisited at five year reviews.

6.2.2 Notice of Planned Property Conveyances

The U.S. Army shall provide notice to USEPA and TCEQ of plans to convey the LHAAP-50 acreage. The notice shall describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental document for transfer. Although the U.S. Army may transfer responsibility for various implementation actions, the U.S. Army shall retain its responsibility for remedy integrity. This means that the U.S. Army is responsible for addressing substantive violations of the LUC performance objective that would undermine the U.S. Army's CERCLA remedy. The U.S. Army also will be responsible for incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation.

6.2.3 Opportunity to Review Text of Intended Land Use Controls

The U.S. Army will provide a copy of the groundwater use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. The USEPA will also receive a copy for review. In addition, the U.S. Army will produce an ECP or other environmental document for transfer of LHAAP-50, but before executing transfer, the U.S. Army will provide USEPA and TCEQ with a copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before transfer, to review all LUC-related provisions.

6.2.4 Notification Should Action(s) which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover after conveyance of the site any activity on the property inconsistent with the LUC performance objective, the U.S. Army shall notify USEPA and TCEQ within 72 hours of such discovery. Consistent with **Section 6.2.5** below, the U.S. Army will then work with USEPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

6.2.5 Land Use Control Enforcement

Should the LUC remedy reflected in this RD fail, the U.S. Army will coordinate with USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the USFWS or its lessee, to the institution of judicial action against non-federal third parties. Alternatively, should the circumstances warrant such, the U.S. Army could choose to exercise its response authorities under CERCLA. Should the U.S. Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction; the U.S. Army may notify those agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUC.

6.2.6 Modification or Termination of Land Use Controls

The U.S. Army shall not, without USEPA and TCEQ concurrence, make a significant modification to, or terminate an LUC, or make a land use change inconsistent with the LUC objective. Likewise, the U.S. Army shall seek prior USEPA and TCEQ concurrence before commencing actions that may impact remedy integrity. In the case of an emergency action, the U.S. Army shall obtain prior USEPA and TCEQ concurrence as appropriate to the exigencies of the situation.

The LUC shall remain in effect until such time as the U.S. Army and USEPA agree that the concentrations of COCs have met cleanup levels. When this occurs, the LUC will be terminated as needed. The decision to terminate the LUC will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial action completion report. If the property has been transferred and a determination by the U.S. Army and USEPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also timely advise other local stakeholders of the action.

6.2.7 Comprehensive Land Use Control Management Plan

Upon finalization of the LUC O&M Plan, a copy will be inserted into the Comprehensive LUC Management Plan for Longhorn. The Comprehensive LUC Management Plan figure and table will be updated to reflect the inclusion of LHAAP-50.

The Comprehensive LUC Management Plan consists of LHAAP RD documents and a survey plat showing the locations where LUC being implemented at LHAAP are applied. The purpose of this Comprehensive LUC Management Plan is to ensure all site-specific LUC are compiled into one comprehensive location for both pre-transfer use by the installation and for post-transfer use by the transferee. This document will be provided to USEPA and TCEQ and is also accessible to the public. The Comprehensive LUC Management Plan is located in the Marshall Public Library to accompany LHAAP's Administrative Record.

The land use assumption of industrial use as part of a national wildlife refuge forms the basis for the remedy at LHAAP-50 and this land use assumption will be included in the Comprehensive LUC Management Plan with supporting documentation.

7.0 FIELD ACTIVITIES

This section generally describes the field activities planned at LHAAP-50. Site-specific activities are described in associated subsections. The field activities to be conducted are outlined below:

- Pre-mobilization activities
- Preliminary activities/mobilization
- Site setup
- Soil excavation
- Confirmation soil sampling
- Additional Soil Sampling
- Monitoring well installation
- Groundwater sampling
- Surface water sampling
- Waste management
- Decontamination
- Well abandonment
- Demobilization

The field activities will be conducted in accordance with the Site-Specific Supplement to Health and Safety Plan (HASP) in **Appendix C**. The work will be routinely inspected in accordance with the Contractor Quality Control Plan (CQCP) in **Appendix D**. Additional information regarding these tasks and standard operating procedures can be found in Appendix C, Chemical Data Acquisition Plan (CDAP), and Appendix D, Field Procedures of the *Final Installation-Wide Work Plan* (Shaw, 2006).

7.1 Pre-mobilization Activities

A pre-construction meeting will be held by the U.S. Army, USEPA, TCEQ, and Shaw prior to the initiation of field activities.

The survey to determine the metes-and-bounds for the LUC and the notification of non-residential use will be conducted. The survey will be done by a state-licensed surveyor and the coordinate system will be Texas State Plane, North American Datum 1983. **Figure 7-1** indicates the LUC boundary that will be surveyed.

Prior to mobilization, Shaw will secure any applicable permits and notifications. These may include federal, state, and local requirements. Shaw will notify TCEQ 10 days prior to the beginning of any excavation work. Shaw will also secure utility clearance for water, sewer, gas, electric, and communication. Shaw does not require any special permit to perform field work at this site. Field activities will be performed in compliance with action specific ARARs detailed in the Final Record of Decision, LHAAP-50 (U.S. Army, 2010).

Shaw will inspect LHAAP-50 to identify underground and overhead obstructions that may restrict groundwater monitoring activities or excavation activities. If power must be shut down, the power outage will be coordinated with groundwater treatment plant (GWTP) and fire station operations. There are no overhead electrical lines at LHAAP-50 that would restrict field activities.

As part of pre-mobilization activities, waste characterization samples will be collected from the excavation footprint to confirm whether or not the soil is classified as hazardous waste. One composite sample will be collected for each 50 in-place cubic yards and submitted to an off-site laboratory for toxicity characteristic leaching procedure. Three samples are expected. Waste characterization results will be reviewed by the disposal facility prior to shipment of any material off-site.

7.2 Preliminary Activities/Mobilization

Shaw anticipates mobilizing the following personnel:

- Site supervisor
- Contractor Quality Control System Manager (CQCSM)/Site Safety Officer
- Two equipment operators
- One laborer/sample technician
- Drilling subcontractor crew

Those personnel will utilize the following major equipment:

- Pickup trucks
- Water truck
- Tracked Excavator
- Dozer

- Drilling equipment
- Groundwater sampling pumps
- Groundwater monitoring field parameters test equipment

Additional equipment will be mobilized as necessary if the field conditions or planned activities merit additional site clearing or well installation.

7.3 Site Setup

A Global Positioning System will be used to delineate and mark the excavation areas per **Figure 2-1**. The potential areas of excavation will then be marked with survey stakes, pin flags, paint, or other appropriate marking.

The areas to be excavated have been established from the soil sampling event conducted in August 2010 (**Section 2.1**). Once the excavation areas have been delineated, removal of shrubs and other vegetative cover within the excavation areas will commence. Clearing of the vegetation will largely be conducted using a tractor mounted bush hog and other conventional equipment. Small vegetation and vegetation debris will be removed from the area to be excavated and a surrounding zone of approximately 25 feet. The area will be sprayed with a defoliant to destroy any hazardous vegetation (e.g., poison ivy), and then will be cleared using brush mowers and/or weed eaters. Any defoliant use will be coordinated with U.S. Fish and Wildlife Service. The area will be raked by mechanical equipment and/or by hand to remove vegetative debris and allow visual observation of the ground surface. Unless it contains soil, the vegetative debris will be stockpiled on site and allowed to decay naturally. If portions of the vegetative debris contain soil, that material will be disposed with the soil from the excavation.

Site set-up for excavation activities will include setting up for temporary decontamination. Any kind of soil adhering to the equipment will be mechanically removed at LHAAP-50. Final equipment decontamination will occur at the permanent decontamination station at LHAAP-18/24 with high-pressure water. Practices of keeping tracks and wheels of equipment outside the contaminated soil will be conducted to minimize possibility of cross contamination. Any generated wash water at LHAAP-50 will be contained and transported to the GWTP for disposal when necessary. Reusable equipment will be decontaminated between groundwater sampling locations and prior to leaving the site. Further information on decontamination procedures are found in the Final Installation Wide Work Plan, Appendix D, Field Procedures (Shaw, 2006).

Monitoring wells to be sampled (see **Figures 7-2** and **7-3**) will be cleared of vegetation and biohazards (e.g., poison ivy, stinging insects) to ensure safe access for groundwater sampling.

7.4 Soil Excavation

Initial excavation limits will be established as shown on **Figure 2-1** and described in **Section 4.1**. Waste characterization samples will be collected as part of pre-mobilization activities to determine if the soil is hazardous or non-hazardous. The waste stream is expected to be non-hazardous (Shaw, 2009). As the soil is excavated, it will expand; the estimated volume of soil to be disposed at the landfill is approximately 195 cubic yards. Based on waste classification results, the excavated soil will be directly loaded and transported by truck to the appropriate permitted disposal facility. Licensed transporters will follow U.S. Department of Transportation requirements for non-hazardous transport of solids. The haul route across LHAAP is shown on **Figure 7-4**.

Excavation and soil handling activities will be performed utilizing standard health and safety practices to minimize airborne particle generation and exposure pathways that might place workers at risk. Air monitoring will be conducted in work areas to determine if airborne emissions exceed acceptable levels. Modified Level D personal protective equipment (PPE) and decontamination equipment are proposed (**Appendix C**).

To the extent possible, an excavator will be used to excavate the contaminated soils. Additionally, a water truck will be on site during excavation activities for decontamination and dust suppression.

The Site Superintendent and CQCSM will mark the corners of the completed excavation at each site for subsequent surveying. They will also measure and document the depths of excavation, including any depth variations across the excavation. In the event of rainfall, storm water runoff from surrounding areas will be diverted, as feasible, away from the excavation. After the rainfall event, any storm water in the excavation will be pumped to a tank on site, allowed to settle, and then conveyed to the LHAAP-18/24 GWTP.

During excavation, abandoned water lines, sewer lines, and lines to the former tank location may be encountered. Such lines that cross the excavation will be investigated to ensure that they are not active and are truly abandoned. If it is determined that these lines are not active, they will be removed or abandoned in place. Inactive lines that are cut by the excavation will be plugged with grout.

7.5 Confirmation Soil Sampling

Confirmation sampling will be conducted concurrently with excavation activities to document that the remaining soils meet established cleanup levels. Excavation will continue until soils are below the cleanup level established in **Section 1.0**, **Table 1-1**. The soil sample data collected in August 2010 (prior to excavation) will be used for wall confirmation samples. Confirmation samples will be collected from the floor when the proposed excavation depth is reached. All confirmation soil samples will be analyzed for only perchlorate. A 5-point composite soil sample will be collected from approximately every 750 square feet of the excavation floor area. Six floor confirmation samples are expected based on the excavation area of 4,000 square feet. If perchlorate is detected in the composite samples above their cleanup levels, the area will be excavated an additional foot. This would continue until confirmation samples demonstrate the perchlorate remaining in the soil is below the cleanup level or until groundwater is encountered.

In the event that groundwater is encountered and a floor sample cannot be collected, a linear 5-point composite sample will be collected from each excavation sidewall. The individual grab samples will be collected from sidewalls just above the groundwater interface. If the linear 5-point composite sidewall sample is above the cleanup level, then additional excavation of the sidewall will be conducted to the groundwater interface depth. Confirmation soil sampling will be performed in accordance with the requirements presented in CQCP **(Appendix D**). Additional details for sampling and analysis are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP, and Appendix D, Field Procedures (Shaw, 2006).

7.6 Soil Sampling

Soil sampling will be performed at 50DPT03 in accordance with the requirements presented in CQCP **(Appendix D**). Soil samples will be collected continuously over the entire boring over 5 foot intervals with the last interval being collected just above the groundwater interface. Additional details for sampling and analysis are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP, and Appendix D, Field Procedures (Shaw, 2006).

7.7 Monitoring Well Installation

Shaw will add up to fourteen new monitoring wells in the shallow zone as indicated on **Figure 5-2**, and up to seven new monitoring wells in the intermediate zone and one monitoring well in the deep zone as indicated on **Figure 5-3** to better delineate and monitor the groundwater plume. The designations of A through T are temporary locations to facilitate discussion, and the final locations and nomenclature will be selected after the direct-push work. The locations of these monitoring wells and the rationale are indicated on **Figures 5-2** and **5-3** and **Tables 5-2** and **5-3**. Additional details for monitoring well installation can be found in the Final Installation Wide Work Plan (Shaw, 2006). Well construction details will be included in the Remedy Implementation Report under separate cover.

7.8 Groundwater Sampling

Groundwater sampling will be performed in accordance with the requirements presented in the CQCP (**Appendix D**). Additional details for sampling and analysis are found in the *Final Installation-Wide Work Plan,* Appendix C, CDAP, and Appendix D, Field Procedures (Shaw, 2006).

7.8.1 Monitored Natural Attenuation

The monitoring portion of MNA will be accomplished by collecting groundwater samples from the shallow zone wells highlighted in **Figures 7-2** and **7-3**. The frequency of groundwater monitoring for MNA will be quarterly for two years. All collected groundwater samples will be analyzed for perchlorate, VOCs and field parameters (pH, dissolved oxygen [DO], and oxidation-reduction potential [ORP]). A subset of the groundwater samples, those from wells (50WW02, 50WW05, 50WW06 and 47WW38) historically within the groundwater plume and new monitoring wells (A1, B, C, D1, L, M, and N) that will be installed within the plume, will also be tested for MNA parameters (*dehalococcoides* sp. [DHC], alkalinity, chloride, nitrate/nitrite, sulfate/sulfide, total organic carbon [TOC], carbon dioxide, ferric iron, dissolved manganese and iron, and phosphorus). **Table 7-1** indicates the analytes for each well. After the first two years, the effectiveness of MNA will be evaluated. The MNA evaluation criteria are presented in **Section 8.0**. LTM will begin if the MNA evaluation determines MNA to be effective.

Any performance monitoring well found to be dry during quarterly sampling of the MNA performance monitoring will be replaced in the same quarter. The location of the replacement well will be adjacent to the dry well.

7.8.2 Intermediate and Deep Zone Groundwater Sampling

Groundwater samples will be collected from wells in the intermediate and deep zone as shown in **Figure 7-3** to check for vertical migration. The frequency of groundwater monitoring will be quarterly for two years. The collected groundwater samples will be analyzed for perchlorate, VOCs and field parameters (pH, DO, and ORP). A subset of the groundwater samples, those from wells (50WW06 and 47WW38) historically within the groundwater plume and new monitoring wells (P and Q) that will be installed within the plume, will also be tested for MNA parameters (DHC, alkalinity, chloride, nitrate/nitrite, sulfate/sulfide, TOC, carbon dioxide, ferric iron, dissolved manganese and iron, and phosphorus). **Table 7-1** indicates the analytes for each well. The data collected from the intermediate and deep monitoring wells will be used for remedy evaluation.

7.8.3 Long-Term Monitoring

After the first two years, the effectiveness of MNA will be evaluated (**Section 8.0**). If the MNA evaluation determines MNA to be effective, the analytical suite will be reduced to only VOCs and perchlorate and the frequency of sampling will be reduced to semiannual sampling for three years, then annually until the next five-year review. Further reductions in sampling will depend on results of five-year reviews, but sampling will continue at least once every five years until cleanup levels are attained.

7.8.4 Five-Year Reviews

Reviews will be conducted every five years to ensure that the remedy continues to provide adequate protection of human health and the environment. Groundwater sampling will continue once every five years or as determined in the five-year review. Groundwater monitoring results, site inspections, regulatory changes, and other information will be considered to determine whether the current remedy should continue or if a change is required. U.S. Army shall obtain regulatory concurrence prior to termination or significant modification of LTM activities.

Table 7-1
Sample Analytes

Well	Groundwater Zone	VOCs	Perchlorate	Field Parameters	MNA Parameters
50WW02	Shallow	✓	✓	✓	✓
50WW05	Shallow	✓	✓	✓	✓
50WW03	Shallow	✓	✓	✓	
50WW04	Shallow	✓	✓	✓	
50WW07	Shallow	✓	✓	✓	
A1	Shallow	✓	✓	✓	✓
B	Shallow	✓	✓	✓	✓
C	Shallow	✓	✓	✓	✓
D1	Shallow	✓	✓	✓	✓
E	Shallow	✓	✓	✓	
F	Shallow	✓	✓	✓	
G	Shallow	✓	✓	✓	
H	Shallow	✓	✓	✓	
I	Shallow	✓	✓	✓	
J	Shallow	✓	✓	✓	
K	Shallow	✓	✓	✓	

Table 7-1 (*continued*)
Sample Analytes

Well	Groundwater Zone	VOCs	Perchlorate	Field Parameters	MNA Parameters
L	Shallow	✓	✓	✓	✓
M	Shallow	✓	✓	✓	✓
N	Shallow	✓	✓	✓	✓
P	Intermediate	✓	✓	✓	✓
Q	Intermediate	✓	✓	✓	✓
R	Intermediate	✓	✓	✓	
S	Intermediate	✓	✓	✓	
T	Intermediate	✓	✓	✓	
A2	Intermediate	✓	✓	✓	
D2	Intermediate	✓	✓	✓	
A3	Deep	✓	✓	✓	
50WW06	Intermediate	✓	✓	✓	✓
47WW38	Intermediate	✓	✓	✓	✓
LHSMW54	Intermediate	✓	✓	✓	

7.9 Surface Water Sampling

Quarterly performance monitoring of Goose Prairie Creek adjacent to LHAAP-50 will be conducted for at least two years at two locations (**Figure 4-1**) after excavation of the contaminated perchlorate soil. Surface water sampling will be conducted as described in **Section 4.2**.

7.10 Waste Management

This section specifies methods and procedures to be implemented by Shaw to verify that waste generated during site activities are handled, transported, stored, and disposed in compliance with applicable federal, state, and local rules and regulations. The generated solid waste is assumed to be non-hazardous and will be managed in accordance with the requirements of Chapter 335 TAC for industrial solid waste. The waste will be disposed at a facility that meets CERCLA off-site requirements to accept waste from CERCLA sites. Waste management activities will be conducted in accordance with the requirements presented in Task 10 of the CQCP (**Appendix D**).

Description of Wastes

Excavation and groundwater sampling activities at LHAAP-50 are expected to generate the following waste streams:

Field Activity	Waste Type	Estimated Quantity
Excavation	Perchlorate contaminated soil	150 in-place cubic yards 195 cubic yards to dispose
	Decontamination Water and Drill Cuttings	110 gallons [(2) 55 gallon drums]
	Miscellaneous Wastes (PPE, paper towels, rags, etc.)	—
Groundwater Sampling	Decontamination and Purge Water	385 gallons [(7) 55 gallon drums]
	Miscellaneous Wastes (PPE, paper towels, rags, etc.)	—

Notes and Abbreviations:

PPE personal protective equipment

Waste Characterization

Waste characterization samples will be collected in the pre-mobilization stage to confirm whether or not the soil is hazardous. One waste characterization sample will be collected for every 50 in-place cubic yards of contaminated soil and shipped off site to a laboratory for sample analysis. For waste liquids, composite samples will be collected from the 55-gallon drums of waste water generated. The results will be used to classify and code wastes in accordance with the requirements of 30 TAC 335, Subchapter R. Additional details for disposal sampling are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP, and Appendix D, Field Procedures (Shaw, 2006).

Waste Accumulation

The contaminated excavated soil from LHAAP-50 will be directed loaded onto trucks and transported to the disposal facility. The non-hazardous decontamination water and drill cuttings will be stored in 55-gallon drums until disposal of water at the LHAAP GWTP. The miscellaneous wastes will be placed in plastic bags until disposal.

Waste Disposal

The table below summarizes the waste disposal method for the various waste types anticipated at LHAAP-50.

Waste Type	Disposal Method
Soil: RCRA Non-Hazardous	RCRA Subtitle D Landfill
Soil: RCRA Hazardous	RCRA Subtitle C Landfill
Decontamination Water and Purge Water - Non-Hazardous Waste	LHAAP Groundwater Treatment Plant
Miscellaneous Wastes	Municipal Solid Waste

Notes and Abbreviations:

RCRA Resource Conservation and Recovery Act

As noted, the liquid waste will be disposed at the GWTP at LHAAP-18/24. If GWTP operations cease at some point in the future, water will be handled in accordance with regulations current at that time and will be transported and disposed of off-site.

7.11 Decontamination of Equipment and Personnel

Equipment that contacts contaminated soil and groundwater will be inspected for contamination prior to leaving the site. Contaminated soil that adheres to the equipment will be removed by mechanical means. If contamination is still visibly present after mechanical cleaning, equipment will be rinsed with decontamination liquids. If visible contamination cannot be removed from the backhoe bucket on site at LHAAP-50, the bucket will be bagged prior to transport to the GWTP decontamination station.

A permanent decontamination station is located at the on-site GWTP near LHAAP-18/24 and can accommodate large equipment. Final equipment decontamination will be performed at the on-site GWTP.

Reusable sampling equipment will be decontaminated between groundwater sampling locations and prior to leaving the site.

Wash water will be contained at LHAAP-50 and later transported to the GWTP for disposal.

Personnel shall be decontaminated as indicated in the Site-Specific Supplement to HASP (**Appendix C**).

Further information on decontamination procedures are found in the *Final Installation-Wide Work Plan*, Appendix D, Field Procedures (Shaw, 2006).

7.12 Well Abandonment

Wells that have been dry, are not needed to gather groundwater level measurements, or are not part of the planned monitoring system, will be abandoned. Recommendations for well abandonment will be submitted as part of the LTM recommendations in the MNA Performance Evaluation Report. Well abandonment will follow the well abandonment procedures in the *Final Installation-Wide Work Plan*, Section 3.9 (Shaw, 2006).

A separate mobilization will be made for well abandonment activities. The waste generated from these activities (concrete, well casings, etc.) will be disposed off site at an approved solid waste landfill.

Once the well abandonment has been completed, Shaw will restore the areas and demobilize. Areas disturbed in the course of well abandonment will be regraded to blend with the surrounding topography.

7.13 Demobilization

Once excavation and groundwater monitoring have been completed, Shaw will restore the site and demobilize. The area will be graded as necessary to blend with the surrounding topography and to ensure positive drainage. Clean backfill will be imported as needed to ensure the graded excavation area meets the surrounding topography. Approximately 6 inches of clean topsoil will be applied, and the disturbed area will be reseeded per applicable USACE requirements.

7.14 Health and Safety

The HASP (the latest revision of Appendix A of the *Final Installation-Wide Work Plan* [Shaw, 2006]) incorporates health and safety policies and safe operating procedures for individual project site activities. These procedures allow work activities to be carried out in a controlled, effective manner, consistent with Shaw policies and USACE requirements (USACE, 2008).

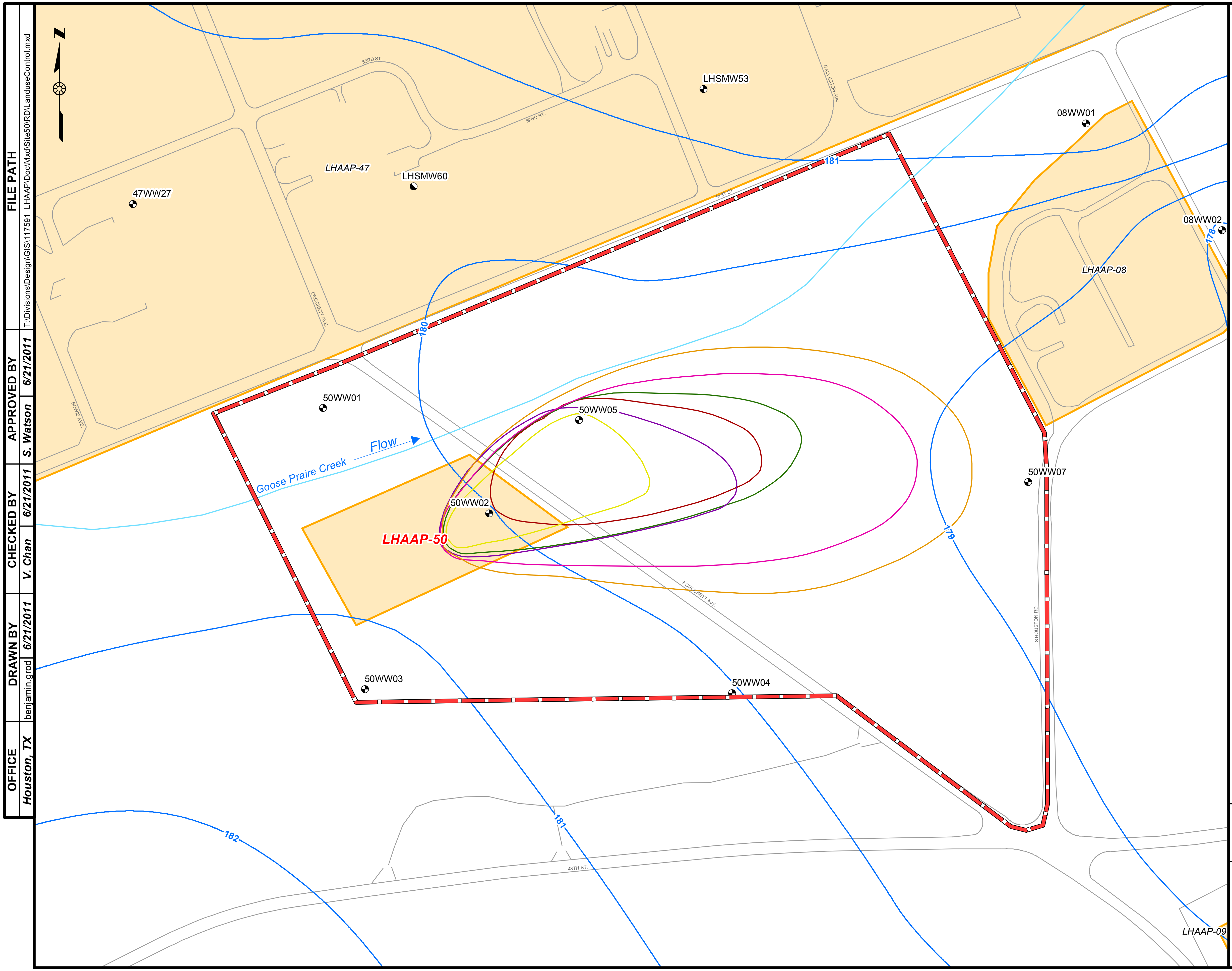
Information specific to the field activities at LHAAP-50 is provided in **Appendix C**. This information includes PPE levels, air monitoring requirements, and activity hazard analyses. These items supplement the HASP; they do not replace it. This information is not addressed by the site-wide HASP because the hazards are unique to the proposed work.

Prior to initiating work at the facility for any site, workers will have signed the HASP to indicate they have read and understood the document. Prior to starting work each day, daily safety meetings will be held with all field crew members to review the day's scope of work, the anticipated site conditions, and hazards that need to be addressed or acknowledged.

7.15 Quality Assurance/Quality Control

The CQCP provides information on quality assurance (QA)/quality control (QC) procedures for this project. The CQCP identifies personnel, procedures, controls, instructions, tests, verifications, documents, and forms to be used and the types of records to be maintained. The CQCP addresses quality control requirements specific to each major feature of work, including special steps that apply to LHAAP-50. The CQCP is provided in **Appendix D**.

The USACE Three-Phase QC process will be used to enforce QA/QC requirements and include preparatory inspections, initial inspections, and follow-up inspections. The three phases of inspections will target each definable feature of work during the execution of project activities.



LEGEND

- 🟥 Land Use Control Boundary *Groundwater use restricted to environmental monitoring and testing only.*
- ● Shallow Monitoring Well
- ● Shallow/Intermediate Monitoring Well
- 1,1-DCE Plume (7 µg/L Extent)
- 1,2-DCA Plume (5 µg/L Extent)
- PCE Plume (5 µg/L Extent)
- TCE Plume (5 µg/L Extent)
- VC Plume (2 µg/L Extent)
- cis-1,2-DCE Plume (70 µg/L Extent)
- Groundwater Elevation Contour
- Stream
- Road
- Sites

0 75 150 300 Feet

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FIGURE 7-1

LAND USE CONTROL MAP
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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APPROVED BY	S. Watson 6/21/2011
CHECKED BY	V. Chan 6/21/2011
DRAWN BY	benjamin.grod 6/21/2011
OFFICE	Houston, TX

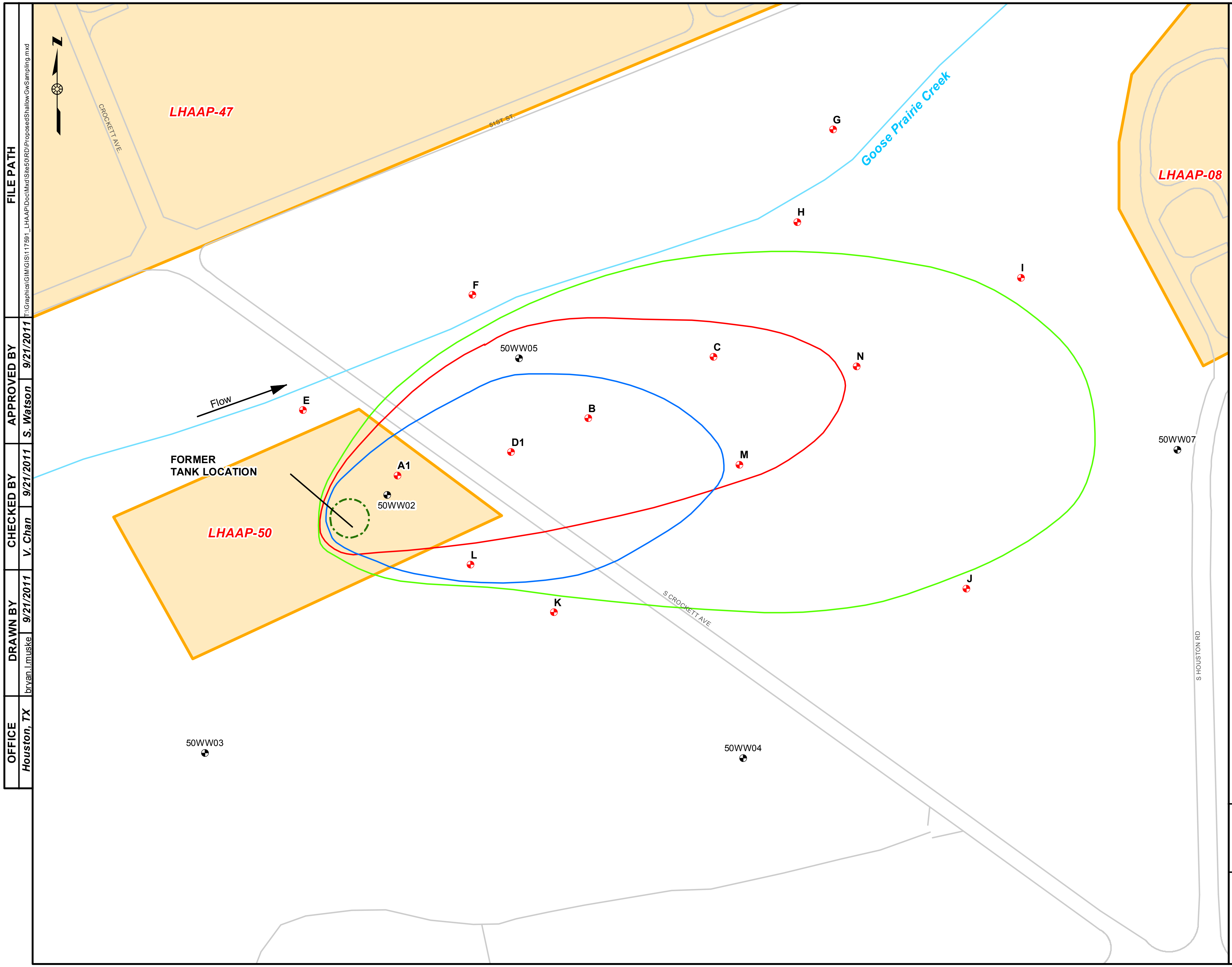
FILE PATH T:\Graphics\GIM\GIS\117591_LHAAP\Doc\Mxd\Site50\RD\ProposedShallowGwSampling.mxd

APPROVED BY *S. Watson* *9/21/2011*

CHECKED BY *V. Chan* *9/21/2011*

DRAWN BY bryan.l.muske *9/21/2011*

OFFICE *Houston, TX*



LEGEND

- ● Shallow Monitoring Well
- ● Proposed Shallow Monitoring Well
- Perchlorate Plume
- 1,2-DCA Plume
- TCE Plume
- Stream
- Road
- Site

Notes:

1. Figure will be revised after final well locations are determined after completion of direct-push drilling.

0 50 100 200 Feet

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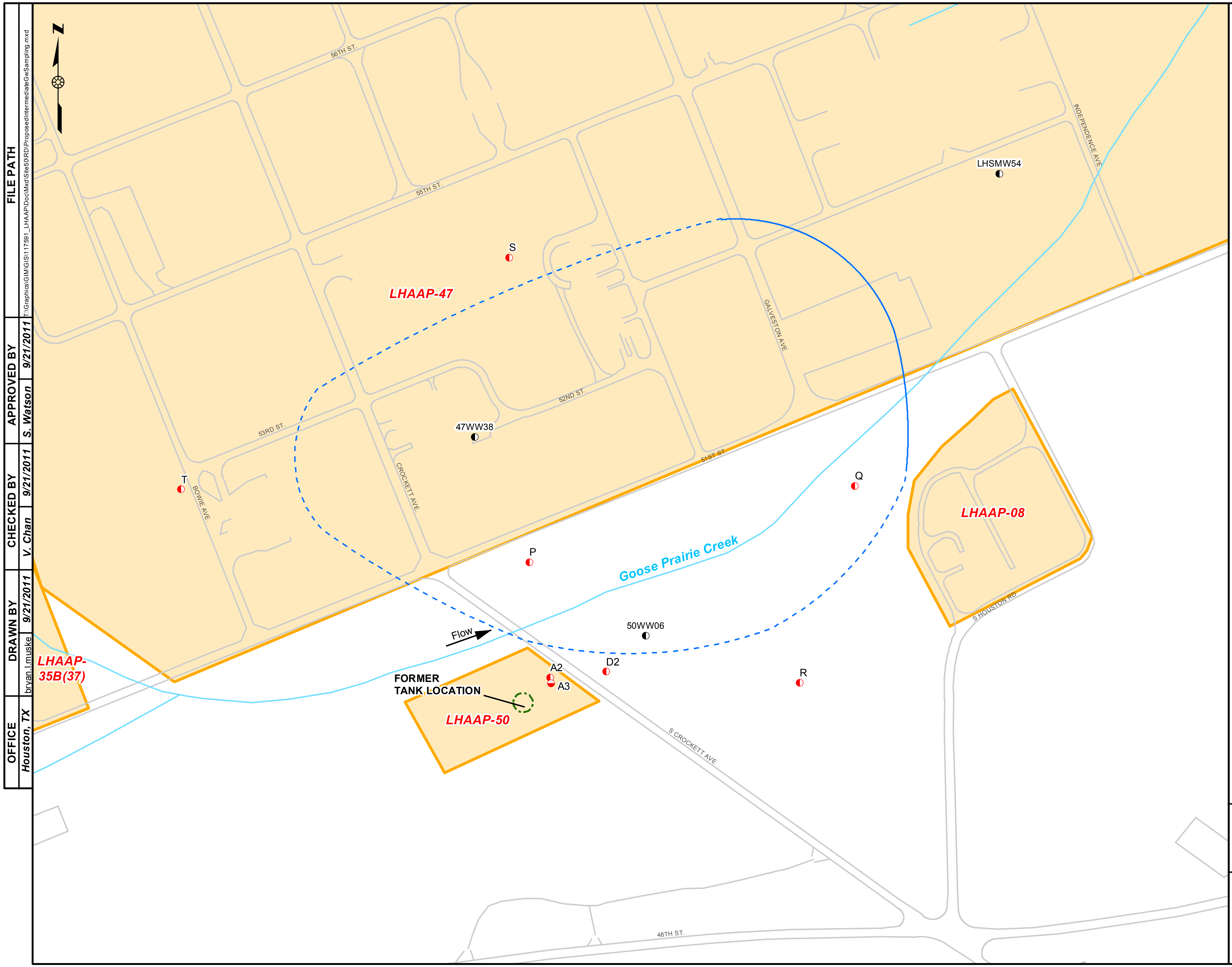
FIGURE 7-2

GROUNDWATER MONITORING LOCATIONS IN SHALLOW ZONE LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

◐ Intermediate Monitoring Well

◐ Proposed Intermediate Monitoring Well

◒ Proposed Deep Monitoring Well

Perchlorate Plume
Dashed where inferred.

Stream

Road

Site

Notes:

1. Figure will be revised after final well locations are determined.
2. D_1 + D_2 cluster of wells
3. A_1 + A_2 + A_3 cluster of wells

0 100 200 400
Feet

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FIGURE 7-3

GROUNDWATER MONITORING LOCATIONS
IN INTERMEDIATE AND DEEP ZONE
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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APPROVED BY	*S. Watson* *9/21/2011*
CHECKED BY	*V. Chan* *9/21/2011*
DRAWN BY	bryan.l.muske *9/21/2011*
OFFICE	*Houston, TX*

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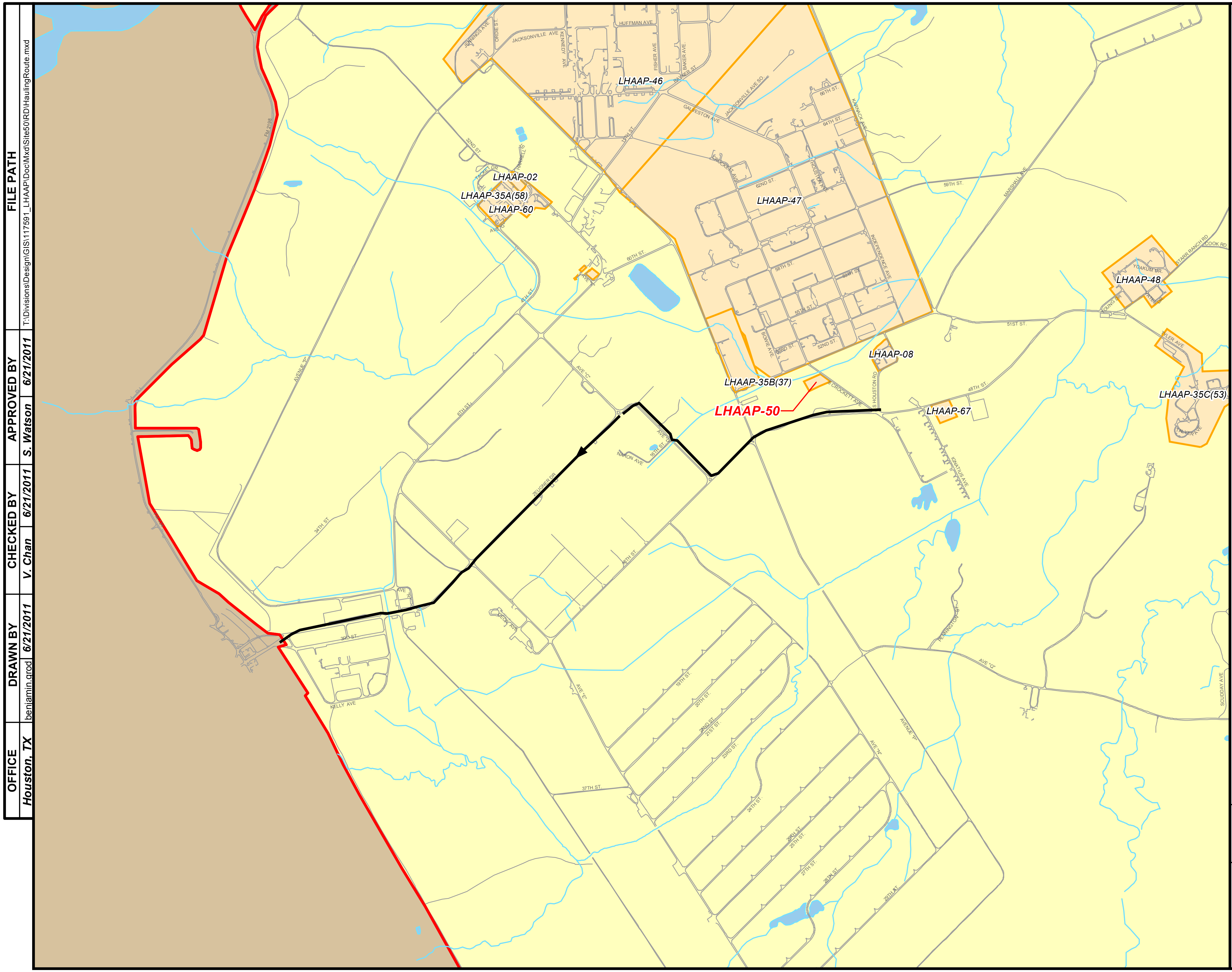

LEGEND

- Proposed Hauling Route
- Stream
- Road
- Sites
- LHAAP Boundary
- Lake

0 750 1,500 3,000 Feet

OFFICE	Houston, TX
DRAWN BY	benjamin.grod 6/21/2011
CHECKED BY	V. Chan 6/21/2011
APPROVED BY	S. Watson 6/21/2011
FILE PATH	T:\Divisions\Design\GIS\117591_LHAAP\Doc\Mxd\Site50\RD\HaulingRoute.mxd

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FIGURE 7-4

PROPOSED HAUL ROUTE WITHIN LHAAP
LHAAP-50 REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

8.0 MONITORED NATURAL ATTENUATION EVALUATION

Monitored natural attenuation (MNA) will be evaluated for TCE, 1,2-DCA and perchlorate plumes. TCE and 1,2-DCA attenuation will be evaluated using the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998). Perchlorate attenuation will generally follow the published criteria as stated in *Monitored Natural Attenuation of Inorganic Contaminants in Groundwater* (USEPA, 2007) and is discussed separately.

Table 8-1
Monitored Natural Attenuation Evaluation Performance Criteria

Performance Criteria	Type	Goal	Explanation
1) Migration/Expansion	Qualitative	Stable or shrinking size; stable position	An expanding or migrating plume indicates MNA should not be continued
2) Concentrations	Quantitative	Falling concentrations or mass in the majority of performance wells	First Line of Evidence (USEPA, 2007) (USEPA, 1998)
3) Aquifer Conditions	Qualitative	Conditions favorable for natural attenuation	Second Line of Evidence (USEPA, 2007) (USEPA, 1998)
4) Microcosm Studies	Qualitative	Presence of appropriate microorganisms	Third Line of Evidence (USEPA, 2007) (USEPA, 1998)

Notes and Abbreviations:

MNA	*monitored natural attenuation*
USEPA	*U.S. Environmental Protection Agency*

8.1 Migration/Expansion (TCE, 1,2-DCA and Perchlorate)

For the evaluation of MNA at LHAAP-50 to be favorable, the MNA evaluation should demonstrate that the contaminant plume is either stable or shrinking. Chlorinated solvents plume includes both TCE and 1,2-DCA plumes.

A decreasing plume is diminishing in concentration and its location is not migrating or expanding; this occurs when the attenuation rate of dissolved-phase pollutants exceeds their generation rate from all sources. Sources that are sustaining the dissolved-phase plume may include pollutants sorbed to fine-grained, low-permeability materials located throughout the plume.

Monitoring must occur over a time period sufficient to demonstrate plume stability or decrease under natural conditions. The time period may depend on site-specific factors, including the monitoring data trend analysis, potential threats to beneficial uses, and other uncertainties. If monitoring data do not demonstrate plume stability/decrease, this may indicate that more active plume remediation is necessary. The two years of quarterly sampling, combined with historic sampling data, will provide data for stability and trend analysis. MNA cannot continue as a sole remedy if the plume is clearly migrating.

8.2 First Line of Evidence

The first line of evidence is to evaluate historical groundwater data seeking to demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. Thus, other performance wells will be evaluated to determine if the plume is migrating.

Chlorinated Solvents

Concentrations of chlorinated solvents can be evaluated at individual wells to calculate a time-based attenuation rate. They can be evaluated across multiple wells through the centerline of a plume to calculate a distance-based attenuation rate. Average plume concentrations or mass can be evaluated if a consistent set of wells is sampled over multiple sampling episodes. These calculations will be performed using the methods contained in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998).

Time-based attenuation rates will be calculated for any monitoring well that shows consistent COC concentration exceedances of cleanup levels during the eight episodes of quarterly sampling. Distance-based attenuation rates will be calculated through the highest concentration wells along the direction of groundwater flow. Attenuation rates based on average plume concentrations or mass will be calculated if the dataset will support the process. Data from at least two wells within the chlorinated solvent plume will be evaluated to determine if there is a clear and meaningful trend of decreasing concentrations and/or mass.

Perchlorate

The first line of evidence in determining natural attenuation of perchlorate effectiveness is a decreasing trend in the parent compound perchlorate. As perchlorate is biologically reduced, daughter products, chlorate, chlorite, and chloride are observed. The presence of these daughter products and their eventual decrease as the more highly oxidative compounds are eliminated also aid in determining the occurrence of natural attenuation.

Data from at least two wells within the perchlorate plume will be evaluated to determine if there is a clear and meaningful trend of decreasing concentrations and/or mass.

8.3 Second Line of Evidence

The second line of evidence uses chemical analytical data in mass balance to show that decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in metabolic end products or daughter compounds. The evidence can be used to show the groundwater conditions are sufficiently favorable to natural attenuation so that degradation of COCs can occur.

Chlorinated Solvents

The second line of evidence evaluates parameters such as nitrates, sulfates, ferrous iron, DO, ORP, nitrate, ferrous iron, sulfate, methane, ethane and ethene, chloride, TOC, carbon dioxide, alkalinity, pH and phosphorous. The results of tests for these analytes will be interpreted using the *Technical Protocol for Evaluating Attenuation of Chlorinated Solvents in Ground Water* (USEPA, 1998).

If the groundwater conditions in the plume area are favorable to the occurrence of degradation, then MNA may continue to be applied at the site. If groundwater conditions are unfavorable to the extent that any decrease in concentrations must be attributed to migration, then more aggressive treatment will be evaluated as a contingency remedy.

Perchlorate

The second line of evidence used to determine if natural attenuation of perchlorate is occurring is the evaluation of the geochemical parameters including DO, ORP, and nitrate levels. Since perchlorate is being used as a respiratory substrate, DO levels must be reduced to levels near or below 0.5 milligrams per liter (mg/L). Nitrate can also compete with the reductive process of perchlorate when nitrate is present at levels above 1 mg/L. The reduction of perchlorate occurs in slightly reducing conditions which can be measured using ORP. In general, reductive processes are possible at ORP levels less than 50 millivolts.

For the MNA evaluation, if the groundwater conditions in the plume area are favorable to the occurrence of degradation, then MNA may continue to be applied at the site. If groundwater conditions are unfavorable to the extent that any decrease in concentrations must be attributed to migration, then more aggressive treatment will be evaluated as a contingency remedy.

8.4 Third Line of Evidence

The third line of evidence consists of data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern. This line of evidence is typically used only to demonstrate biological degradation processes.

Chlorinated Solvents

For the MNA evaluation, the presence of microorganisms (DHC) in the groundwater capable of degrading the chlorinated solvents would be favorable to continued MNA. If such organisms are present, in conjunction with favorable groundwater conditions as demonstrated via the Second Line of Evidence, MNA effectiveness is confirmed and LTM will be initiated. If not, then implementation of a contingency remedy will be evaluated.

Perchlorate

The third line of evidence used to determine if natural attenuation is occurring is the use of microbial data, including microcosm studies using site-specific groundwater. The use of microcosm studies is the primary option for this line of evidence since the organisms that reduce perchlorate are ubiquitous. Site soil and groundwater would be used to conduct a laboratory study to determine the effectiveness of the native site conditions to reduce perchlorate.

9.0 REMEDY PERFORMANCE REPORTING

Reporting will consist of annual reports, an MNA evaluation report at the end of the eight quarters of sampling, a remedy implementation plan report and five-year review reports. Annual reports will be prepared at the end of each calendar year for every year in which groundwater samples are collected. A single MNA evaluation will be prepared based on the eight episodes of quarterly sampling results from the first two years combined with historic sampling results. The remedy implementation plan report will be prepared on completion of soil excavation activities, direct-push technology (DPT) investigation and installation of new monitoring wells. The five-year reviews will be prepared once every five years for so long as groundwater sampling is required.

9.1 Monitored Natural Attenuation Evaluation Report

After eight quarters of groundwater monitoring has been completed, an MNA evaluation will be conducted and an MNA Evaluation Report prepared. MNA performance criteria are listed in **Table 8-1**. Compilation of the information for the evaluation will occur throughout the first two years of quarterly groundwater monitoring. The MNA Evaluation Report for each of the plumes (TCE, 1,2-DCA and perchlorate) will include:

- Figures of the site, wells, and groundwater level contours
- Tables of groundwater and surface water analytical results
- Comparison of plume extent and concentration over time (**Table 8-1**, Performance Criteria 1)
- Consideration of the first and second lines of evidence for MNA and the third line of evidence if necessary (**Table 8-1**, Performance)
- An evaluation of the effectiveness of MNA at the site
- A recommendation for continued MNA, in situ bioremediation, or another remedy

The completed Preliminary Draft Monitored Natural Attenuation Evaluation will be submitted to the U.S. Army for review and comment. Following this, a Draft Final Monitored Natural Attenuation Evaluation will be submitted to the regulatory agencies for review and comment. A Draft Final Monitored Natural Attenuation Evaluation will address the regulatory comments and will be submitted for review. When regulatory agency comments have been resolved, the Final Monitored Natural Attenuation Evaluation will be issued. The Final Monitored Natural Attenuation Evaluation will conclude whether MNA should continue to be the remedial action applied at LHAAP-50, or whether another more aggressive treatment should be evaluated as a contingency remedy.

The first and second lines of evidence will be evaluated for decreasing COC concentrations and optimal geochemical conditions to demonstrate MNA. The third line of evidence will be evaluated if necessary. If the MNA evaluation determines that MNA is not an effective sole remedy, then an explanation of significant difference will be prepared and an amendment to this document will be made to design and implement a contingency remedy. The contingency remedy would likely be a form of bioremediation which was an alternative evaluated in the FS and also described in the ROD; however, the final design of the contingency remedy would be determined by the results of groundwater samples collected during the MNA performance monitoring period. The MNA Performance Evaluation Report will also include recommendations for future LTM and well abandonments.

9.2 Remedy Implementation Report

The Remedy Implementation Plan Report will be submitted to the U.S. Army for review on completion of soil excavation, DPT investigation and monitoring well installation. This report will include the following:

- A narrative of field activities
- Confirmation soil sampling results from the perchlorate contaminated soil excavation
- DPT investigation results
- Monitoring well installation details

9.3 Annual Reports

An annual report will be prepared at the end of each year of LTM to present groundwater sample results and a description of field activities, and to document other information considered relevant for the five-year review. The annual report will include:

- A narrative of field activities
- Figures presenting the site, monitoring well locations, and groundwater levels
- Tables of groundwater and surface water analytical results
- Copies of field paperwork, including sample collection forms and waste disposal documentation
- Relevant photographs

Data from wells outside the plume will be evaluated for plume migration while data from wells within the plume areas will be evaluated for MNA performance.

9.4 Five-Year Review Reports

Five-year reviews will be performed for LHAAP-50 (U.S. Army, 2010). While the intent is to perform these reviews every five years after the implementation of the remedy (i.e., remedy in place), the performance of the first five-year review of LHAAP-50 will be aligned with the next base-wide five-year review. The five-year review report will present summaries of information from the annual reports and from the five-year sampling event, evaluate that information, and recommend the future course of action. The five-year review will include:

- A narrative of field activities for the past five years
- Figures presenting the site, monitoring well locations, and groundwater levels
- Summary of groundwater and surface water analytical results
- Site inspection with relevant photographs
- Certification of LUC compliance
- Evaluation of progress toward cleanup levels
- Revisions to the LUC or monitoring schedules
- Recommendations for future actions

The progress toward cleanup levels will be evaluated in the five-year review report. The five-year review offers the periodic opportunity to declare whether the site is successfully and completely remediated, progressing satisfactorily toward remediation, or in need of a more aggressive remedy. When groundwater cleanup levels are reached, groundwater monitoring may cease when recommended in the five-year review.

10.0 SCHEDULE

The estimated length of time for excavation and groundwater monitoring activities including site setup, clearing, groundwater sampling, confirmation sampling, waste management, and site restoration is approximately 14 work days. The estimated length of time to complete eight quarters of groundwater sampling and prepare the MNA evaluation report is approximately two and one half years. **Table 10-1** shows the anticipated duration for each of the major site activities. Shaw's mobilization to LHAAP-50 for the first round of MNA performance sampling is anticipated to begin in 2011 after final approval of the ROD and this document.

Table 10-1
Durations for Major Site Activities

Activities	Duration	Elapsed Time
Establish land use control	1 month	1 month
Mobilization / Site setup	1 day	—
Excavation	5 days	—
Confirmation Sampling and Analysis	2 days	—
Backfill	2 days	—
Installation and development of new monitoring wells	7 days	—
Groundwater and surface water sampling	3 days	—
Site Restoration	1 day	—
Demobilization	1 day	—
Estimated duration	22 work days	—
Second / third / fourth quarterly sampling	9 months	1 year
Second year of quarterly sampling	1 year	2 years
MNA Evaluation (final document)	0.5 year	2.5 years
Well Abandonment	1 day	—
Three years of semi-annual sampling	3 years	5 years
Five-year review	0.5 year	5 years
Annual sampling (years 5 through 10)	5 years	10 years
Sample once every 5 years (repeated until cleanup levels are met)	—	15, 20, 25, 30 years
Achieve cleanup levels	—	50 years

Notes and Abbreviations:

Does not include pre-mobilization activities or rerouting of utilities.

Includes expectation of favorable MNA Evaluation.

Schedule revision expected after MNA Evaluation and five-year review.

MNA monitored natural attenuation

11.0 REFERENCES

Jacobs, 2002, *Final Remedial Investigation Report for the Group 4 Sites, Longhorn Army Ammunition Plant, Karnack, Texas*, January.

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Solutions to Environmental Problems (STEP), 2005, *Plantwide Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, Texas, Final, Oakridge, Tennessee*, April.

U.S. Army, 2010, Final *Record of Decision, LHAAP-50, Former Sump Water Tank, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, September.

U.S. Army Corps of Engineers (USACE), 2008, *Safety and Health Requirements Manual*, EM 385-1-1, September.

U.S. Environmental Protection Agency (USEPA), 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, September.

USEPA, 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, Directive 9200.4-17P. USEPA Office of Solid Waste and Emergency Response, Washington, DC.

USEPA, 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Groundwater*, EPA/600/R-07/140, October.

Appendix A

Analytical Results and Field Forms

(on compact disc)

Appendix B

Inspection/Certification Form

Sample Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design dated ___________ for LHAAP-50, a certification of the site was conducted by _______________________ [indicate transferee] on ___________.

A summary of land use control mechanisms is as follows:

- Groundwater restriction – restriction of the use of groundwater to environmental monitoring and testing until cleanup goals are met. [Indicate whether groundwater restrictions are still required at LHAAP-50]

A summary of compliance with land use and restriction covenants is as follows:

- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-50.

I, the undersigned, do document that the certification was performed as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: _________________________________

Name/Title: _________________________________

Signature: _________________________________

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year.

Attachments

- **Metes and Bound Survey of Area for LUC Implementation**
- **Monitoring Well Logs**
- **Notice of Filed Land Use Controls for LHAAP-50**

The attachments will be submitted once the surveys are completed, the well system is defined and wells are installed, and the notification is filed

Appendix C

Site-Specific Supplement to Health and Safety Plan

Appendix C
Site-Specific Supplement to Health and Safety Plan

Final
Remedial Design
LHAAP-50
Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
DPT	direct-push technology
HASP	Health and Safety Plan
HSM	Health and Safety Manager
LEL/O_2	lower explosive limit/oxygen
mg/m^3	milligrams per cubic meter
PID	photoionization detector
PPE	personal protective equipment
TWA	time-weighted average

Personal Protective Equipment (PPE) Levels

LHAAP-50 – Monitoring Well Sampling/Well Installation or Abandonment/ Direct-Push Technology (DPT) Operations

Level D – Modified PPE:

- Hard hat meeting American National Standards Institute (ANSI) Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Nitrile surgical gloves (inner or double layer).
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Chemical resistant boot covers and/or outer boots (polyvinyl chloride/latex/neoprene when there is potential for shoe/boot contact with contaminated soil or water).
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

LHAAP-50 – Brush Clearing for Access

Level D – Modified PPE:

- Hard hat meeting ANSI Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

Air Monitoring

Particulates

Real-Time Aerosol Monitor

Real-time aerosol monitors (MIE pDR-1000 or equivalent) shall be used to monitor dust emissions during dust generating activities. The only dust generating activity anticipated is clearing brush for well access or during well abandonment. The real-time aerosol monitors will be placed in the work area (near areas where ground personnel are working) and at the downwind site perimeter. The selected placement of these instruments may need to be adjusted throughout the workday to compensate for changes of wind direction.

Real-Time Aerosol Monitoring Action Levels

The real-time aerosol monitors will be set to alarm when the instantaneous aerosol concentration reaches 1.0 milligrams per cubic meter (mg/m^3). The alarm will be used to indicate that additional dust control is necessary.

The real-time aerosol monitors are capable of collecting and integrating the aerosol concentrations throughout the workday into a time-weighted average (TWA). Aerosol monitors shall be visually checked on an hourly basis during dust generating activities to verify that the TWA remains below 1.0 mg/m^3. Aerosol monitors registering time-weighted average aerosol concentrations at or above 2.0 mg/m^3 require that workers upgrade to Level C PPE and indicate that additional dust control measures are necessary. Failure to control workday time-weighted average dust concentrations to below 4.0 mg/m^3 shall necessitate ceasing dust generating activities and contacting the Project Manager and Health and Safety Manager (HSM) for implementing alternate work practices.

The full work-shift time-integrated concentrations will be evaluated at the conclusion of each workday to verify aerosol concentrations are maintained below action levels.

Volatiles/Oxygen

Photoionization detectors (PIDs) and lower explosive limit/oxygen (LEL/O_2) detectors shall be used to monitor emissions during sampling and well abandonment. Measurements will be collected from the work area and breathing zone during sampling or well abandonment activities. The action levels for the area monitoring are provided in the table below:

Direct Reading Air Monitoring Summary for Volatiles/Oxygen

Monitoring Device	Monitoring Location/Personnel	Monitoring Frequency	Action Level [a]	Action
PID/OVA (breathing zone)	DPT operations, groundwater sampling, and well installation	At start-up, minimum four times daily in work area and breathing zone	>5 ppm	Test for vinyl chloride (colorometric detector tubes)
LEL/O_2 meters	DPT operations, groundwater sampling, and well installation	At start-up, minimum four times daily in work area.	>10% LEL	Stop operations; allow vapors to vent and reach <10% before continuing

Notes and Abbreviations:

[a]	*Sustained levels above background for 5 minutes in breathing zone*
DPT	*direct-push technology*
LEL/O_2	*lower explosive limit/oxygen*
ppm	*parts per million*
PID/OVA	*photo ionization detector/organic vapor analyzer*

Personal Air Sampling (time-integrated)

Time-integrated air sampling may be performed at the discretion of the HSM, if air-monitoring action levels are exceeded.

Medical Surveillance

LHAAP-50

There are no special medical surveillance requirements in addition to the requirements of 29 Code of Federal Regulations 1910.120(f), which are already in place.

ACTIVITY HAZARD ANALYSIS FOR GROUNDWATER SAMPLING OR DPT OPERATIONS

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Groundwater Sampling or DPT Operations	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before sampling operations begin	Latex inner gloves, Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Flammable, explosive atmospheres	• Test well head atmosphere for flammable/toxic vapors • Wear proper level of PPE for the type of atmospheric contaminants • Eliminate sources of ignition from the work area • Prohibit smoking in development area	Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Struck by/against flying particles, protruding objects, liquid splash	• Wear hard hats, safety glasses with side shields and steel-toe safety boots at all times • Wear splash shields and safety goggles when sampling, cleaning, decontaminating test equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Cut resistant gloves	—
	High / low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools	Small equipment as specified by operations manual	40 hour Hazardous Waste Training Review Health and Safety Plan (HASP) Review site-specific Activity Hazard Analysis (AHA) with all task personnel. Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR BRUSH CLEARING PREPARATION

Principle Steps	Potential Safety/Health Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Clearing Brush	Operation of power clearing tools (brush saws, weed whackers)	• Wear eye, face, hand and hearing protection when operating power clearing equipment • Shut-off / idle power tools walking between work areas • Store flammable liquids in well ventilated areas, away from work areas • Shut off equipment during re-fueling • Allow equipment to cool before re-fueling • Use funnels to avoid fuel spillage • Prohibit smoking while operating clearing equipment • Provide ABC (or equivalent) fire extinguishers for all work areas	Face shield, goggles, cloth gloves, ear plugs, steel toe work boots	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut-resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain hand and power tools in a safe condition • Keep guards in place during use	Leather gloves with reinforced palm	—
	Eye injuries	• Wear face shield, goggles when operating powered clearing / grubbing equipment	Face shield, goggles, safety glasses	—
Mobilization/Site Setup and Survey/Layout	Slips, trips, falls	• Clear walkways, work areas of equipment, tools, vegetation, excavated material and debris • Mark, identify, or barricade other obstructions • Ensure footing. Look before you step	—	—
	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 decibels, A-scale (dBA) over an 8-hour work period)	Ear plugs	—
	High/low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools	Daily heavy equipment inspections Small equipment as specified by operations manual	Review Health and Safety Plan (HASP) Review site-specific Activity Hazard Analysis (AHA) with all task personnel. Review equipment safety operations manual Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring Well Installation or Abandonment	Slips, trips, falls	• Clear walkways, work areas of equipment, debris and excavated materials • Mark, identify, or barricade other obstructions • Halt exterior work in high winds, severe weather	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use	Leather gloves	—
	Handling heavy objects (piping/casings)	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb. maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads • Move long sections of piping/casing with at least two workers or mechanical equipment • Add tag lines to loads, if necessary, to minimize side-to-side movement • Prohibit workers from standing on top of piping during loading/unloading/transferring pipe or rolling stock • Stand clear of rolling stock/piping; do not attempt to stop rolling piping • Use slip handles to move slips; prohibit kicking slip handles into place	—	—
	Flammable, toxic emissions	• Monitor for flammable/toxic vapors, particulates, and gases • Wear proper level of PPE for the type of atmospheric contaminants	Portable fire extinguishers	PID
	Underground utilities	• Identify all underground utilities around the excavation site before work commences • Cease work immediately if unknown utility markers are uncovered	—	—
	Struck by/against heavy equipment, protruding objects, splashes	• Wear reflective warning vests when exposed to vehicular traffic • Isolate equipment swing areas • Make eye contact with operators before approaching equipment	Warning vest, hard hat safety glasses, steel toe work boots	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring well installation or abandonment *(cont.)*	Struck by/against heavy equipment, protruding objects, splashes *(cont.)*	• Wear hard hats, safety glasses with side shields, face shields and goggles, and steel-toe safety boots • Understand and review hand signals • Chock piping/rolling stock stored on trailers/racks/etc to prevent rolling	Warning vest, hard hat safety glasses, steel toe work boots	—
	Equipment failure	• Inspect drilling equipment daily according to manufacturer's specifications • Block and level drilling equipment before use • Ensure equipment not in use is properly stored • Examine fittings, drive rods, hydraulic lines for condition and wear	—	—
	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before operations begin • Monitor breathing zone air to determine levels of contaminants	Tyvek® coveralls, nitrile gloves, latex or neoprene boots	PID
	Insect/ snake bites	• Review injury potential and types of snakes with workers • Avoid insect nests areas, likely habitats of snakes outside work areas • Emphasize The Buddy System where such injury potential exists • Use insect repellant, wear PPE to protect against sting/bite injuries	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	Contact dermatitis	• Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants • Identify and review poisonous plants with workers • Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	Caught in/between moving parts	• Identify and understand parts of equipment which may cause crushing, pinching, rotating or similar motions • Assure guards are in place to protect from these parts of equipment during operation • Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects • Maintain all equipment in a safe condition • Keep all guards in place during use • De-energize and lock-out machinery before maintenance or service	—	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring Well Installation or Abandonment *(cont.)*	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) • Assess noise level with sound level meter if possibility exists that level may exceed 85dBA TWA	Ear plugs	Sound level meter
	High/low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw E & I Health and Safety Program, HS400, HS401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Drill rig Hand tools	Daily heavy equipment inspections Daily Drill Rig Inspections Small equipment as specified by operations manual	40 hour Hazardous Waste Training Review Health and Safety Plan (HASP) Review site-specific Activity Hazard Analysis (AHA) with all task personnel Review equipment safety operations manual Safe driver's training (HS 800)

Appendix D

Contractor Quality Control Plan

Appendix D
Contractor Quality Control Plan

Final
Remedial Design
LHAAP-50
Former Sump Water Tank, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

CDAP	Chemical Data Acquisition Plan
CQC	contractor quality control
CQCP	Contractor Quality Control Plan
CQCSM	Contractor Quality Control System Manager
DPT	direct-push technology
GPS	Global Positioning System
HASP	Health and Safety Plan
LHAAP	Longhorn Army Ammunition Plant
MARC	Multiple Award Remediation Contract
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
QAR	quality assurance representative
QC	quality control
Shaw	Shaw Environmental, Inc.
SSO	Site Safety Officer
TO	task order
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Tulsa District, contracted Shaw Environmental, Inc. (Shaw), under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D0027, Task Order (TO) No. DS02, to perform closure of multiple environmental sites at Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. TO DS02 is being administered by the Tulsa District of USACE.

LHAAP is located in central-east Texas, in Harrison County, between State Highway 43 at Karnack, Texas, and Caddo Lake. Figure 1-1 of the Remedial Design shows the location of LHAAP and surrounding communities.

The objective of this TO is to perform investigations, collect data, perform remediation activities at multiple sites on an expedited basis to achieve site closures, and bring as many sites as possible into the long-term management/long-term operation stage as early as possible. This Contractor Quality Control Plan (CQCP) documents quality control (QC) requirements that will be implemented during remediation at LHAAP-50.

2.0 CONTRACTOR QUALITY CONTROL PLAN PURPOSE AND SCOPE

2.1 Contractor Quality Control Plan Purpose

This CQCP establishes procedures that enable common project field activities to be completed successfully and documents QC requirements for services provided by Shaw and its subcontractors during project activities at LHAAP-50. This plan describes requirements for organizing, planning, performing, reviewing, documenting, and reporting activities that may affect the quality of the work. This CQCP applies the specific requirements of Shaw's Contractor Quality Control (CQC) System to this project by establishing controls for:

- QC staff organization and authority
- Workmanship
- Construction activities for major definable features of work
- Records
- Inspections and tests
- Documentation
- Audits
- Subcontractor performance

This plan references standard field procedures, policies, regulations, and practices required to implement the work. A controlled copy of applicable Field Procedures from Appendix D of the *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant* (Shaw, 2006) will be available as a reference document.

2.2 Contractor Quality Control Plan Scope

This CQCP is applicable to the work proposed at LHAAP-50, including the major definable features of site work (or major project tasks) identified below:

Task 1 – Pre-mobilization Activities
Task 2 – Preliminary Activities/Mobilization
Task 3 – Site Setup
Task 4 – Soil Excavation
Task 5 – Confirmation Soil Sampling
Task 6 – Monitoring Well Installation
Task 7 – Groundwater Sampling
Task 8 – Surface Water Sampling
Task 9 – Waste Management
Task 10 – Decontamination
Task 11 – Well Abandonment
Task 12 – Demobilization

2.3 Acceptance of Contractor Quality Control Plan

Work within the scope of this plan will not be started prior to providing this CQCP to USACE, unless otherwise permitted by USACE. Any proposed changes to this CQCP will require notification to USACE in writing. Proposed changes are subject to the approval of USACE.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Personnel and Structure

The Contractor Quality Control System Manager (CQCSM) coordinates implementation of this CQCP with the Project Manager, Remediation Manager, Program QC Manager, and subcontractors.

3.2 Duties and Responsibilities

The duties and responsibilities of personnel with regard to the CQC program are briefly outlined below. Duties and responsibilities of health and safety personnel are presented in Appendix A, Health and Safety Plan (HASP) (Shaw, 2006).

Project Manager: The Project Manager is responsible for all activities on the project, and directs and monitors the Site Superintendent in planning, coordinating, and controlling the work. The Project Manager has overall responsibility for establishing the CQCP and for its implementation, and he has the authority to access the required resources throughout Shaw to ensure compliance with the contract requirements.

Remediation Manager: The Remediation Manager reports to the Project Manager and is responsible for site remediation technical assurance. This individual will oversee the site remediation activities. The Remediation Manager has the following duties and authorities:

- Perform and/or oversee the purging and sampling of monitoring wells
- Perform and/or oversee the preservation, packaging, and shipping of samples to an off-site, fixed laboratory for environmental analyses
- Ensure documentation accuracy, completeness, and consistency among field team members
- Stop work that deviates from the contract documents or is otherwise nonconforming or unsafe.

CQCSM: The CQCSM is responsible for the overall management of the project CQC program during field activities. The CQCSM receives administrative and day-to-day direction from the Remediation Manager. The CQCSM is responsible to the Shaw Program QC Manager for direction on matters that may affect the QC requirements for the project. The CQCSM is assigned the following duties:

- Monitor and verify that the work is performed in accordance with the contract requirements

- Review and verify the disposition of discrepancy and corrective action reports
- Perform QC inspections and surveillance, and report daily on project QC
- Monitor project submittals in accordance with submittal register requirements
- Submit QC reports to the USACE Field Representative/Quality Assurance Representative (QAR) on a daily basis, unless other arrangements are agreed to by the USACE

The CQCSM has the authority to reject materials and workmanship that do not comply with project requirements, and to stop nonconforming work activities (see **Figure 3-1**).

Due to the limited size of the field effort at LHAAP-50, the CQCSM may also serve as the Site Safety Officer (SSO). In this dual role, the CQCSM/SSO is responsible to the Shaw Program Health and Safety Manager for safety-related matters. The SSO duties are discussed in detail in the Installation-Wide CQCP provided as Appendix B of the Installation-Wide Work Plan.

Program QC Manager: The Program QC Manager is responsible to review, monitor, and report the conformance to QC requirements set forth in the CQCP. He may also advise the CQCSM on QC methods and practices. He will maintain a record of his quality monitoring activities and will inform the CQCSM of his monitoring activities. He shall also be responsible for performing periodic internal audits, and reporting his findings to the CQCSM.

Subcontractors: Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services. Subcontractors are responsible to the Project Manager and Remediation Manager for completing the portion of work assigned to them, and to the CQCSM for CQCP activities. They shall verify that their construction and materials comply with the requirements of the contract plans and specifications. Subcontractors include organizations supplying quality-related items or services to the project.

3.3 Qualification of Personnel

Shaw personnel assigned to the project are qualified to perform the tasks to which they are assigned. The Project Manager and the Remediation Manager will appraise the qualification of professional and/or technical personnel assigned to the project. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee.

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

To:	To Be Determined
From:	John W. Patin, QC Manager
Date:	October 2011
Subject:	Contractor Quality Control System Manager, Letter of Authority U.S. Army Corps of Engineers, Tulsa District MARC Contract No. W912QR-04-D0027, Task Order No. DS02

This letter describes the responsibilities and authority delegated to you in your capacity as the Contractor Quality Control System Manager for Remediation of LHAAP-50 at Longhorn Army Ammunition Plant, Karnack, Texas.

In this position, you are responsible for the implementation and enforcement of the CQCP and site specific addenda. You will use the plan to verify that the quality of materials, workmanship, operations, and safety monitoring conforms to the Remedial Design/Work Plan, its appendices, and addenda.

Your responsibilities include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and requesting solutions for nonconforming activities. You have the authority to control or stop project activities until satisfactory disposition and implementation of corrective actions are achieved. Detailed responsibilities and guidelines are given in the Remedial Design, its appendices, and addenda.

Figure 3-1
Letter of Authority

4.0 CONTRACTOR QUALITY CONTROL SYSTEMS

4.1 Control Measures

The CQCP provides measures to verify and document that the work performed complies with the requirements specified in the contract documents. These measures include:

- CQC inspections
- Document control
- Submittals
- Completion inspection
- Records

Procedures for implementing the above measures are included throughout the CQCP. The CQCP may be supplemented by additional guidelines or instructions for implementing the work and/or verifying compliance with the contract requirements.

4.2 Quality Control Monitoring

The project CQC program is monitored to verify that the program is in compliance with the CQCP. Monitoring activities are performed by the Shaw Program QC Manager, or his representative, and include the review of daily QC reporting and instructions, or directions given to the CQCSM on QC matters. If required, an assessment of the project's CQC system is performed. If performed, the assessment includes the following items:

- Subcontractor performance
- Field operation and records
- CQC and health and safety inspections, testing, and records
- Document control
- Training records

4.3 Quality Control Testing

As applicable, the CQCSM monitors the equipment/materials testing firm and/or analytical laboratory activities to verify the following:

- Execution of required tests
- Location of tests
- Timely and accurate reporting of test results
- Correct frequency of tests
- Completeness of documentation

5.0 INSPECTION PLAN

QC inspections include inspection of equipment, materials, testing procedures, documentation/submittals, and workmanship before, during, and after each definable feature of work. QC inspections are performed by the CQCSM in accordance with the Three-Phase CQC system. The CQCSM gives the USACE QAR advance notification (at least 24 hours) of formal inspections.

Definable features of site work (or major work tasks) for which QC inspections will be performed are addressed below.

Definable Features of Site Work:

Task 1 – Pre-mobilization Activities
Task 2 – Preliminary Activities/Mobilization
Task 3 – Site Setup
Task 4 – Soil Excavation
Task 5 – Confirmation Soil Sampling
Task 6 – Additional Soil Sampling
Task 7 – Monitoring Well Installation
Task 8 – Groundwater Sampling
Task 9 – Surface Water Sampling
Task 10 – Waste Management
Task 11 – Decontamination
Task 12 – Well Abandonment
Task 13 – Demobilization

Other site remediation activities that constitute definable features of site work will be defined within site-specific addenda to the work plan. Those addenda will also identify related QC inspection requirements.

5.1 Task 1 – Pre-mobilization Activities

Surveying may be conducted as a pre-mobilization activity, or in conjunction with other tasks. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- A qualified land surveyor licensed by the State of Texas is employed to perform well surveying and metes and bounds land-use control boundary surveys.
- Survey datum (vertical and horizontal) used is consistent with the work plan requirements and/or historical datum.

- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled (e.g., notch in the top of casing and/or brass surveying marker embedded in surface pad).
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

For identifying locations of soil samples and limits of excavation, a Global Positioning System (GPS) may be used in lieu of land surveying. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

5.2 Task 2 – Preliminary Activities/Mobilization

Following approval of the Remedial Design, Shaw will mobilize the necessary personnel and equipment. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Site personnel have the necessary Occupational Safety and Health Administration (OSHA) training and medical surveillance statements/certifications
- Heavy equipment (e.g., drilling rig) has undergone safety and preventive maintenance checks, and is suitable for the task for which it will be used.
- Measuring and test equipment has undergone calibration and/or calibration checks to assure accuracy and precision.
- The project team understands the investigation/remediation requirements.

- Site personnel have reviewed the HASP provided by the SSO and have acknowledged this review by signing the HASP acknowledgment form.

5.3 Task 3 – Site Setup

Shaw will prepare the site for remedial activities. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Installed government property plan (when applicable) is reviewed and implemented for the equipment to be installed on site.
- Work zones and decontamination facilities are established in accordance with the HASP.
- Material storage areas are kept orderly.
- Site security measures are adequately maintained to prevent unauthorized access.
- Work zones are clearly demarcated using temporary barricading or fencing as required.

Once the site is mobilized and set up, field activities will commence.

5.4 Task 4 – Soil Excavation

The field work involves soil excavation and disposal off-site. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for soil excavation, transportation, and disposal off-site.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- Waste generated during activities is handled and disposed according to the waste management plan.

- Excavation locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.
- The excavation is backfilled with clean soil and regraded as appropriate.

5.5 Task 5 – Confirmation Soil Sampling

Confirmation soil samples will be collected from the excavation walls or floors to verify that contaminated soil has been removed to cleanup levels. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the Chemical Data Acquisition Plan (CDAP) (Appendix C of the Final Installation-Wide Work Plan [Shaw, 2006]) and Work Plan and understand the scope of work.
- The SSO has briefed sampling personnel on task hazards and the appropriate personal protective equipment (PPE) level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- Soil cuttings are contained in drums and managed in accordance with Work Plan waste handling requirements. Field screening procedures are found in Appendix D of the *Final Installation-Wide Work Plan*, Attachment 1.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., Remediation Manager) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.

- Sampling and analytical records are maintained in the project file (in secured area).

5.6 Task 6 – Additional Soil Sampling

Soil sampling will be performed using direct-push technology (DPT) method. The DPT method will involve the use of a high-capacity hydraulic ram mounted on an all-terrain vehicle to advance a drive sampler attached to steel push rods. Soil samples will be collected continuously during drilling using a 24- to 48-inch-long sampler with a disposable liner. The exact total depths of the borings will be based on the groundwater depth and will be determined during drilling. The procedures for sampling each boring are summarized as follows:

- Execute work in accordance with Shaw and other applicable site-specific health and safety plan.
- Set up portable sample table and cover with plastic sheeting.
- Calibrate field analytical and health and safety instruments.
- Don a new pair of disposable sample gloves between sampling intervals to prevent cross-contamination.
- Decontaminate the sampling equipment as described in Section 4.5 in the Chemical Data Acquisition Plan, Appendix C of the Work Plan (Shaw, 2006).
- Observe the drilling operations to verify that proper safety, sampling, and drilling methods are being instituted.
- When soil sample is received from the driller, open the soil-filled sampler, remove the sample liner from the barrel, cut open the liner, and place the sample liner and sample on the plastic sheeting.
- Describe the length of the sample according to ASTM D2488-93, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* and record on the Shaw Drilling Log Form.
- After determining the appropriate sampling intervals based on the lithology, collect composite soil samples for laboratory analysis by filling the appropriate number and types of sample containers specified by the laboratory.
- Samples will be composited by collecting representative portions of soil from the designated interval, placing in a decontaminated stainless steel bowl or disposable container for mixing, and placing in the appropriate laboratory-supplied sample jar.

- Label each sample container as described in Section 4.6.2 of Appendix C of the Work Plan (Shaw, 2006), enclose each container in a sealable plastic bag, and place in a cooler containing ice.
- Repeat the above sequence of procedures for each interval to the total boring depth.
- Record the drilling activities and sampling procedures on a Field Sampling Report or logbook. Complete chain-of-custody documentation.

5.7 Task 7 – Monitoring Well Installation

Well installation is proposed for this site. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well installation.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Drilling operations will employ a well driller licensed in the state of Texas.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- Well installation locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.
- Waste generated during activities is handled and disposed according to the waste management plan.

5.8 Task 8 – Groundwater Sampling

Following the installation of groundwater monitoring wells, Shaw will collect groundwater samples for laboratory analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP (Appendix C of the Final Installation-Wide Work Plan [Shaw, 2006]) and Work Plan and understand the scope of work.
- The SSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- Well depth and depth-to-water measurements are performed consistently from a common location at top-of-well casing (e.g., notch in top of casing or northern lip of casing).
- Well water volume is calculated accurately using well measurements.
- Well is purged of the required quantity of well water and water quality is stabilized as defined by the CDAP prior to sample collection.
- Purged water is contained in drums and managed in accordance with Work Plan waste handling requirements. Field screening procedures are found in Appendix D of the Final Installation-Wide Work Plan, Attachment 1.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., Remediation Manager) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.

- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.9 Task 9 – Surface Water Sampling

Shaw will collect surface water samples for laboratory analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the CDAP (Appendix C of the Final Installation-Wide Work Plan [Shaw, 2006]) and Work Plan and understand the scope of work.
- The SSO has briefed sampling personnel on task hazards and the appropriate PPE level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., Remediation Manager) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.10 Task 10 – Waste Management

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Waste generated during the project activities will be segregated by type (e.g., soil cuttings, used PPE, well development and purging liquids, trash/debris) and stored in approved 55-gallon drums or other containers.
- Waste containers are labeled with a waterproof marker according to the Work Plan, indicating the content, accumulation date, waste code(s) (if known) and pertinent analytical information.
- Waste handling activities are documented in the field logbook and a tracking log is prepared that indicates waste type, point of waste generation (i.e., well number) container size and type, accumulation date, storage location, disposal destination, transporter name, shipping paper/manifest number, and transportation and disposal dates.
- Waste containers are leak proof and stored in a secure storage area.
- Waste storage area is clearly demarcated using barricade tape and/or temporary barricade fencing, as required.
- Waste container and storage area inspections are performed on a weekly basis (at a minimum) and documented in the field logbook and/or in a standard inspection form.

5.11 Task 11 – Decontamination

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Personnel are decontaminated in accordance with the *Final Installation-Wide Work Plan*, Appendix D, Field Procedures (Shaw, 2006).
- Equipment that contacts contaminated soil and groundwater are inspected for contamination prior to leaving the site.
- Contaminated soil that adheres to the equipment is removed by mechanical means. If contamination is still visibly present after mechanical cleaning, equipment will be rinsed with decontamination liquids. If visible contamination cannot be removed from the backhoe bucket on-site, the bucket will be bagged prior to transport to the permanent decontamination station at the Groundwater Treatment Plant at LHAAP-18/24.

- Reusable sampling equipment is decontaminated between groundwater sampling locations and prior to leaving the site.
- Wash water is contained on-site and later transported to the Groundwater Treatment Plant for disposal.

5.12 Task 12 – Well Abandonment

Shaw will abandon monitoring wells that were installed during any investigation and remediation activities as needed. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well abandonment.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Abandonment activities will employ a well driller licensed in the state of Texas.
- Well abandonment materials and equipment are suitable and approved for use prior to starting the work.
- Well locations and top of casing elevations are verified and recorded in a logbook prior to abandonment.
- Required agency permits and/or notifications are completed prior to starting abandonment activities.
- Waste generated during abandonment activities is handled and disposed according to the waste management plan.
- Quantity and depth measurements are made and recorded accurately the amount of grout used, depth below ground surface of the top of the grout once the grout has settled and hardened, and the amount of cover soil placed and compacted above the top of the grout to re-establish a level ground surface.
- A multi-purpose completion report and/or well abandonment log is accurately completed for each abandoned well and submitted to the State of Texas. Copies are maintained in the project file until submitted to the USACE with the final report.

5.13 Task 13 – Demobilization

Shaw will restore the site and demobilize once response complete is attained. Using the Three-Phase CQC system, the CQCSM will affirm the following:

- Equipment installed for the purposes of this project, and not intended to be operated after this project is demobilized.
- Information for remaining equipment or installed materials has been submitted to LHAAP and USACE.

5.14 Other Site Remediation Tasks

Shaw will perform various site remedial activities to include optimizing the existing on-site groundwater treatment plant, soil/groundwater flushing, and instituting bioremedial solutions where applicable. Using the Three-Phase CQC system, the CQCSM will monitor these tasks as appropriate. Specific QC requirements for these tasks will be identified in site-specific addenda to the work plan.

6.0 DOCUMENT CONTROL

6.1 Documentation

The CQCSM maintains current records of QC activities and tests performed, including those of suppliers and subcontractors. The records will be maintained as evidence that required control measures and tests have been performed, and indicate the results of the activities. Photographic documentation is also maintained for this project in accordance with **Section 6.4** of this plan.

6.2 Daily CQC Report

The daily CQC Report is completed and maintained by the CQCSM using a standard form. The form is provided in **Attachment 1**. As applicable, standard forms used to document safety, technical, and operations aspects of daily field activities will be attached to the Daily CQC Report.

6.3 Daily Weather Conditions/Lost Time Report

A Daily Weather Conditions/Lost Time Report is prepared daily by the CQCSM. A report form is provided at the end of this section. Lost time will be logged into the report in increments of 25% (in other words, 0%, 25%, 50%, 75% or 100%). The amount of lost time incurred will be agreed upon and initialed by the CQCSM and the USACE QAR or Technical Manager overseeing the project work. Upon completion of the report for the specified period of time, one copy of the report should be submitted to the QAR/Technical Manager once each month during fieldwork and an extra copy should be maintained by the CQCSM for future reference.

6.4 Photographs

The CQCSM will photograph the project activities. Photographs will be taken on a regular basis during the course of the project to document the work, events, and equipment used. The frequency and number of pictures taken will depend upon the activities occurring and the amount of documentation needed. The Project Manager or Remediation Manager will use judgment to determine the frequency and number of pictures taken; however, a sufficient quantity of pictures will be taken to effectively document the TO.

Pictures will be taken using 35mm film or digital medium (using a digital camera or video camera). Photos will be documented on a project log (see standard form in **Attachment 1**), which includes the photo number, date, time, description of the task depicted, and the view direction (e.g., facing northwest). A copy of the photo log, pictures, slides/videos, and digital media will be maintained in Project Files.

6.5 Review of Vendor Submittals

Vendors and subcontractors are required to expeditiously submit items such as drawings, test data, and specifications to Shaw for review to enable timely submittals to USACE. Shaw technical and CQC personnel review each submittal for compliance with contract documents. If acceptable, the item is stamped or indicated as such, and forwarded to USACE for review and acceptance.

If unacceptable, errors or deficiencies are identified and returned to the vendor or subcontractor for correction. The corrected document is resubmitted to Shaw for review until it meets contract requirements.

6.6 Government Property Accounting and Control

If applicable, Shaw will acquire, manage, and dispose of government property. At the completion of the project, all real property (removed and/or installed) will be listed on a Property Inventory Sheet.

6.7 Submittals

The Project Manager, Remediation Manager, the Program Controls Engineer, and the CQCSM are responsible for project submittals. A submittal register prepared for this project is given in **Figure 6-1**.

SUBMITTAL REGISTER

DACA56-94-D-0020
TO No. 0109

TITLE AND LOCATION: **Longhorn Army Ammunition Plant – LHAAP-50**

CONTRACTOR: Shaw Environmental Inc.

				TYPE OF SUBMITTAL									CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVT. ACTION		
TRANSMITTAL NO	ITEM NO	SPEC PARA NO	DESCRIPTION OF ITEM SUBMITTED	DATA	DRAWINGS	INSTRUCTIONS	SCHEDULES	STATEMENTS	REPORTS	CERTIFICATES	SAMPLES	RECORDS	INFO ONLY	GOVT. APPROVED	REVIEWER	SUBMIT	APPROVAL NEEDED BY	MAT'L NEEDED BY	CODE	DATE	SUBMIT TO GOVT	CODE	DATE	REMARKS
a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	
			Work Plan (and Appendices)		X	X	X							X		Per Project Schedule								
			Site Personnel OSHA Medical & Training Certificates							X		X	X			Prior to start of work								
			CQC and Safety Reports						X				X			Daily								
			Well Construction Methods/Specifications	X	X								X			Per Work Plan								
			Transporter ID, Insurance Cert							X			X			Prior to subcontract award								
			Manifests/Shipping Papers									X	X			Prior to shipment								
			Disposal Facility ID	X									X			Prior to subcontract award								
			Environmental Inspection Sheets									X	X			Per Work Plan								
			Groundwater Sampling Results	X					X				X			Upon data evaluation								
			Survey Drawings (As-built)		X									X		Upon completion								
			Well Construction Completion Forms									X		X		To State of Texas within 30 days of construction completion								
			Well Abandonment Forms									X		X		To the State of Texas within 30 days of construction completion								
			Drilling Logs & Groundwater Sampling Forms									X				With Daily QC Reports								

Figure 6-1
Submittal Register

7.0 SUBCONTRACTOR QUALITY CONTROL

Subcontractors for this project are responsible for compliance with the QC requirements of their respective subcontract. Subcontractors include organizations supplying quality related items or services to the project. Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services.

Subcontract documents should include the requirements for personnel qualifications, technical performance levels, QC procedures, acceptability criteria, and documentation. The CQCSM, or his designee, reviews the subcontract procurement documents to verify that the QC requirements are communicated to the subcontractor.

Each subcontractor is required to identify an adequately qualified individual within the organization to perform QC duties. The qualifications of this individual are submitted to the CQCSM for review and approval. The CQCSM coordinates the QC functions with the designated subcontractor QC representative. The Project Manager, or his authorized designee, assists the CQCSM in managing subcontractor QC.

The CQCSM is responsible for the performance of inspections, surveillance, document reviews, audits, and other QC functions to verify compliance with the subcontract requirements. These activities are documented on inspection reports, checklists, audit reports, field logs, or other forms appropriate to the function performed.

For field operations, the CQCSM performs QC inspections before, during, and after the subcontractor activities, to the extent required, to verify that the subcontractor is in compliance with the QC requirements of the contract and the applicable subcontract documents.

Audits of subcontractor activities are conducted by the CQCSM as necessary to verify compliance with the CQCP. Objective evidence of conformance to the subcontract documents is reviewed during the audits.

8.0 REFERENCES

Shaw Environmental, Inc. (Shaw), 2006, *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas, January.

Attachment 1

Field Forms

- Preparatory Inspection Check List
- Initial/Follow-Up Inspection Form
- Final Inspection Form(s)
- Daily Contractor Quality Control Report
- Daily Weather Conditions/Lost Time Report
- Photo Log Form
- Corrective Action Report

PREPARATORY INSPECTION CHECKLIST

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:____________________
Project Location:__________________
Project No.:_______________________

Plan or Specification Title/Section:___________________ **Drawing Nos.:**____________________

A. Personnel present *(use back of form to list additional personnel)*

Name	Position	Company

B. Submittals involved: *(use back of form to list additional submittals)*

Number and Type	Description	Indicate Contractor of Government Approval

C. Are all materials on hand and in accordance with approvals: ☐ Yes ☐ No
List all deficiencies:

D. Test required: (list/reference all quality control tests with their required frequencies):

E. Accident prevention preplanning (list all health and safety items discussed):

CQCSM: ______________________________

INITIAL/FOLLOW-UP INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:__________________
Project Location:________________
Project No.:____________________

(check one)
INITIAL PHASE CHECK LIST ☐ **OR**
FOLLOW-UP PHASE CHECK LIST ☐

Plan or Specification Section:______________________________ **Drawing Nos.:**______________________

A. Personnel present:

Name	Position	Company

B. Materials are in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

C. Work being performed is in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

D. Workmanship is acceptable: ☐ Yes ☐ No
If improvement is needed, explain:

CQCSM: ____________________________

FINAL INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:________________________
Project Location:_______________________
Project No.:__________________________

FINAL INSPECTION FORM

Plan or Specification Title/Section:________________________Drawing Nos.:_______________________

Inspected Work (list feature(s) of work inspected):

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Performance Specification by Contract Delivery Order Reference	Status of Inspection

On behalf of Shaw, I certify that the work inspected is complete and meets the performance specifications cited above and that all material and equipment used and work performed was completed in accordance with approved plans and work instructions and meets contract delivery order requirements.

CQCSM ___________________________________ **Date**______/______/______

Site Manager_________________________________ **Date**______/______/______

DAILY CONTRACTOR QUALITY CONTROL REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:________________________________
Project Location:______________________________
Shaw Report No.:______________________________

WEATHER: ( ) Clear ( ) P. Cloudy ( ) Cloudy
Wind________________________
Temperature: High_______ Low_______
Precipitation: Today________________ Previous Period (i.e., weekend)________________________
Site Conditions:____
Lost Time Due to Inclement Weather: ________________%

PRIME CONTRACTOR/SUBCONTRACTORS AND AREAS OF RESPONSIBILITY/LABOR COUNT: (Include number, trade, hours, employer, location, and description of work.)

a.

b.

c.

d.

e.

f.

WORK PERFORMED: (Include location and description of work performed including equipment used. Refer to work performed by prime and/or subcontractors as previously designated by letter above. Attached subcontractor daily activity reports when applicable):

MATERIALS AND/OR EQUIPMENT DELIVERED: (Include a description of materials and/or equipment, quantity, date/hours used, date of safety check, and supplier)

Page 1 of 3

DAILY CONTRACTOR QUALITY CONTROL REPORT *(cont.)*

RESULTS OF SURVEILLANCE: (Include satisfactory work completed or deficiencies with action to be taken.)
a. Preparatory Inspection: (Attach Minutes)

b. Initial Inspection: (Attach Minutes)

c. Follow-up Inspection: (List results of inspection compared to specification requirements.)

d. Safety Inspection: (Include safety violations and corrective actions taken.)

OFF-SITE SURVEILLANCE ACTIVITIES: (Include action taken.)

QC TESTS PERFORMED AND RESULTS: (As required by plans and/or specifications.)

VERBAL INSTRUCTIONS RECEIVED OR GIVEN: (List any instructions received from government personnel or given by Shaw on construction deficiencies identified, required retesting, etc., and the corresponding action to be taken.)

CHANGED CONDITIONS/DELAYS/CONFLICTS ENCOUNTERED: (List any conflicts with the delivery order [i.e., Scope of Work and/or drawings], delays to the project attributable to site, and weather conditions, etc.)

Page 2 of 3

DAILY CONTRACTOR QUALITY CONTROL REPORT *(cont.)*

SUBMITTALS REVIEWED: (Include submittal number, specification reference, and name of submitter.)

MEETINGS: (List the meetings, i.e., Health and Safety, Site Operations, Cost/Schedule, etc.)

VISITORS:

REMARKS: (Any additional information pertinent to the project not defined by the previous entries.)

CONTRACTOR'S VERIFICATION: The above report is complete and correct. All material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

____
Shaw CQCSM (or designee)

_____/_____/_____
Date

Page 3 of 3

DAILY WEATHER CONDITIONS / LOST TIME REPORT

DAILY WEATHER CONDITIONS/LOST TIME REPORT FOR WEEK/MONTH OF_____________

Contract No.:___________________________ Delivery Order No.:____________ Project:___________________

Contractor:______________________________

DAY	DATE	W/C. L/T	% LOST	ACTIVITY DELAYED	REMARKS	CONCUR	
						CQCR	QAR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

Weather Conditions (W/C): R-Precipitation C-Extreme Temperature M-Muddy Site Conditions W-Extreme Winds
Other Lost Time Conditions (L/T): D-Demobilized S-Standby

Representative of the Contractor______________________________

Representative of the Government______________________________

PHOTO LOG FORM

PROJECT PHOTO LOG

Project Name:______________________ Project Location:___________________________________ Project No.:_____________

Photo No.	Date	Time	Task and Description	View Direction

CORRECTIVE ACTION REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:______________________________
Project Location:____________________________
Report No.:________________________________

DESCRIPTION OF PROBLEM:____

PERSONNEL RESPONSIBLE FOR INVESTIGATIVE PROCESS:____________________________

RECOMMENDED CORRECTIVE ACTIONS:____

PERSONNEL RESPONSIBLE FOR IMPLEMENTATION OF CORRECTIVE ACTIONS:________________

RESULTING ACTIONS AND EFFECTIVENESS OF THOSE ACTIONS:_________________________

PERSONNEL RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CORRECTIVE ACTIONS:________

FINAL DISPOSITION APPROVED BY:

Name:______________________________ Title:___________________________________

Date:________________________

Name:______________________________ Title:___________________________________

Date:________________________

COPIES TO:

Final
Remedial Design
LHAAP-35A(58), Shops Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

Shaw® a world of Solutions™

Shaw® Shaw Environmental, Inc.

Date: ***September 30, 2011***

Project No.: ***117591***

TRANSMITTAL LETTER:

To: Mr. Aaron Williams

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

Re: ***Final Remedial Design LHAAP-35A(58)***

Contract No. W912QR-04-D-0027/DS02

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

Item No:	*No. of Copies*	*Date:*	*Document Title*
1	2	September 2011	**Final Remedial Design** **LHAAP-35A(58), Shops Area, Group 4** **Longhorn Army Ammunition Plant, Karnack, Texas**

Aaron– Enclosed are two copies of Shaw's final version of the above-named document.

Please call with any questions or comments.

Sincerely:

for Praveen Srivastav
Project Manager

Distribution:
M. Plitnik, USAEC (1)
R. Zeiler, BRAC (1)
S. Tzhone, EPA (2)
F. Duke (2)/ D. Vodak, TCEQ (1)
P. Bruckwicki, FWS (1)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

DAIM-ODB-LO

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

Re: Final Remedial Design, LHAAP-35A(58), Shops Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

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, Texas 78753

Re: Final Remedial Design, LHAAP-35A(58), Shops Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Ms. Duke,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

From: Tzhone.Stephen@epamail.epa.gov
Sent: Friday, September 30, 2011 5:06 PM
To: Zeiler, Rose Ms CIV USA OSA; Lambert, John R SWT; Williams, Aaron K SWT
Cc: Fay Duke; Srivastav, Praveen; Everett, Kay; Duffield, Robert; Watson, Susan; Sanchez.Carlos@epamail.epa.gov
Subject: Longhorn: EPA Approval of DF LHAAP-58 RD
Attachments: (Main Text) 09 2011 DRAFT FINAL LHAAP-35A(58) RD.pdf

Hi Rose,

The EPA has reviewed the Draft Final Remedial Design for LHAAP-58 and has no further comments. Please proceed with finalization.

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

From: "Srivastav, Praveen" <Praveen.Srivastav@shawgrp.com>
To: Stephen Tzhone/R6/USEPA/US@EPA, Fay Duke <Fay.Duke@tceq.texas.gov>
Cc: "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "Watson, Susan" <Susan.Watson@shawgrp.com>, "Chan, Vincent" <vincent.chan@shawgrp.com>
Date: 09/30/2011 04:57 PM
Subject: D-F RD, LHAAP-35A(58)

Steve/Fay:

The Draft Final Remedial Design for LHAAP-58 is attached. The file contains the main text and figures to keep the size of the file within manageable limits for e-mail. The files for the entire document are being uploaded to the Longhorn Stakeholder portal. We are also shipping out hard copies today.

Thank you,

Praveen Srivastav, PhD, PG, PMP
Project Manager
Federal Division/Project Management
Shaw Environmental & Infrastructure
1401 Enclave Parkway, Suite 250
Houston, TX 77077
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From: Fay Duke [Fay.Duke@tceq.texas.gov]
Sent: Friday, September 30, 2011 5:02 PM
To: Tzhone.Stephen@epa.gov; Srivastav, Praveen
Cc: Watson, Susan; Chan, Vincent; JohnR SWT Lambert; Rose Ms CIV USA OSA Zeiler; Aaron K SWT Williams
Subject: TCEQ Approval: D-F RD, LHAAP-35A(58)

Rose,

The TCEQ has completed its review of the Draft Final RD for LHAAP-35A(58) and has no further comments.

Thank you.

Fay Duke (MC-136)
Remediation Division, TCEQ
PO Box 13087
Austin, Texas 78711-3087
512-239-2443
512-239-2450 (Fax)

00111539

Final
Remedial Design
LHAAP-35A(58), Shops Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

µg/L	micrograms per liter
bgs	below ground surface
CDAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	chemical of concern
CQCP	Contractor Quality Control Plan
DCE	dichloroethene
DHC	*dehalococcoides* sp.
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DPT	direct-push technology
ECP	environmental condition of property
FS	Feasibility Study
GPS	global positioning system
GW-Res	groundwater MSC for residential use
GWTP	groundwater treatment plant
HASP	Health and Safety Plan
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
MARC	Multiple Award Remediation Contract
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Contingency Plan
O&M	operation and maintenance
ORP	oxidation reduction potential
PCE	tetrachloroethene
QA/QC	quality assurance/quality control
RAO	remedial action objective
RD	Remedial Design
ROD	Record of Decision

Acronyms and Abbreviations *(continued)*

Shaw	Shaw Environmental, Inc.
SOP	standard operating procedures
STEP	Solutions to Environmental Problems, Inc.
TAC	Texas Administrative Code
TCA	trichloroethane
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TOC	total organic carbon
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) has been contracted by the U.S. Army Corps of Engineers (USACE) Tulsa District to complete the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response at LHAAP-35A(58), Shops Area at the former Longhorn Army Ammunition Plant (LHAAP) near Karnack, Texas. This Remedial Design (RD) for LHAAP-35A(58) is a part of the response. Subsequent work plans will be prepared to provide more details of the implementation of this RD. This work is being performed under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D-0027, Task Order DS02, with oversight by the USACE, Tulsa District.

1.1 Longhorn Army Ammunition Plant Background

Longhorn Army Ammunition Plant (LHAAP) is located in central-east Texas in the northeastern corner of Harrison County, approximately 14 miles northeast of Marshall, Texas (**Figure 1-1**). The facility occupies approximately 8,416 acres between State Highway 43 in Karnack, Texas, and the western shore of Caddo Lake. Caddo Lake is a large freshwater lake that bounds LHAAP to the north and east. The eastern fence of LHAAP is 3.5 miles from the Texas-Louisiana state border.

1.1.1 LHAAP-35A(58) Description

LHAAP-35A(58), also known as the Shops Area, is located in the north-central portion of LHAAP. LHAAP-35A(58) was established in 1942 as part of the installation's initial construction. The facility was used to provide plant-operated laundry, automotive, woodworking, metalworking, painting, refrigeration, and electrical services. The site was active throughout LHAAP's mission and became inactive in 1996-1997, along with the entire installation. The LHAAP-35A(58) site boundary has been defined differently in the past. **Figure 1-2** shows the historic site boundary and the current site boundary defined by USACE in November 2006 (USACE, 2006). Earlier investigations for LHAAP-35A(58) covered additional areas to the south, however the current boundary only covers approximately 11 acres. Located within the boundaries of LHAAP-35A(58) are additional sites including LHAAP-02, vacuum truck overnight parking; LHAAP-03, the Paint Shop Building 722 (waste collection); LHAAP-60, pesticide storage buildings; LHAAP-68, a mobile storage tank parking area; and LHAAP-69, a service station that includes underground storage tanks.

The surface features are a mixture of asphalt-paved roads, a parking area, and areas of wooded and grassy vegetation. The topography is relatively flat with the surface drainage flowing into the tributaries of Goose Prairie Creek. Runoff from the site enters Caddo Lake via Goose Prairie Creek.

Investigations of the soil, groundwater, surface water, and sediments at LHAAP-35A(58) include the following: From 1992 to 2001, investigations were conducted and the results were published in 2002 as the *Remedial Investigation* for Group 4 sites (Jacobs, 2002). From 2000 to 2002, a plant-wide perchlorate investigation was conducted that included LHAAP-35A(58) (STEP, 2005). In 2003, an environmental site assessment was conducted (Plexus Scientific Corporation, 2005), and the *Baseline Human Health Risk Assessment* was completed (Jacobs, 2003). In 2004, a data gaps investigation was conducted (Shaw, 2007a). In 2007, the *Baseline Ecological Risk Assessment* was published (Shaw, 2007b). In 2008, a sumps/waste rack sumps report was completed (Shaw, 2008). In 2009, the *Feasibility Study* (FS) was completed, which included the natural attenuation evaluation (Shaw, 2009). The findings from these investigations was that the shallow zone groundwater was impacted with volatile organic compounds (VOCs), while the soil and former sump/waste rack sump areas posed no unacceptable threat to human health or the environment (Shaw, 2009). There have been no previous remedial actions at LHAAP-35A(58).

The remedial action alternative to be implemented at LHAAP-35A(58) was developed and selected in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Contingency Plan (NCP) (40 Code of Federal Regulations Part 300). The selected remedy finalized in the Record of Decision (ROD) (U.S. Army, 2010) was developed based on the assumption that future land use will be industrial/recreational (e.g., national wildlife refuge). The land use control (LUC) to restrict groundwater to environmental monitoring and testing will be recorded at the Harrison County courthouse. Additionally, the notification will indicate that the property is suitable for nonresidential use. It is also assumed that this remedial action will be the final action at the site.

1.2 Remedial Action Objectives

A remedial action at LHAAP-35A(58) must protect human health and meet applicable or relevant and appropriate requirements. As noted in the FS, there are no ecological risks at LHAAP-35A(58); and therefore, the proposed remedial action will address human health risks. At LHAAP-35A(58), the only risk that needs be addressed is the groundwater contamination that may adversely affect human health via ingestion, inhalation, and direct contact (Shaw, 2009).

The remedial action objectives (RAOs) for LHAAP-35A(58), consistent with the anticipated future use as a national wildlife refuge, 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 the U.S. Environmental Protection Agency's (USEPA) policy to return all groundwater to beneficial uses based on the non-binding programmatic expectation in the NCP. The RAO is also consistent with the NCP regulations requiring the lead agency, the U.S. Department of the Army (U.S. Army), to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

1.3 Planned Remedial Action

The RAOs were the basis for formulating and evaluating remedial alternatives and selecting a remedial action. The U.S. Army will implement the selected remedy described in the ROD (U.S. Army, 2010). The description of the remedy is organized as two geographic areas: 1) eastern plume and 2) western plume. **Figure 1-3** identifies these areas on a map of LHAAP-35A(58).

- **Eastern plume area.** The eastern plume remedy will include LUC; in situ bioremediation in the area of highest levels of contamination followed by monitored natural attenuation (MNA) near wells LHSMW05, 35AWW08, and 03WW01; MNA for the balance of the plume; and long-term monitoring (LTM)/Five-Year Reviews.
- **Western plume area.** The western plume remedy will consist of LUC, MNA, and LTM/Five-Year Reviews.

1.3.1 In Situ Bioremediation (eastern plume target area only)

In situ bioremediation is the process of removing contaminant mass by utilizing contaminants in the groundwater during respiratory or metabolic activities. The treatment involves injecting amendments which may include microbial cultures, electron donor sources, nutrients, and carbon sources into the subsurface. This is further discussed in **Section 5.0**.

At LHAAP-35A(58), the highest concentrations of contaminants have been observed in the shallow groundwater zone and will be the target area for active treatment. This area is designated as the eastern plume target area. The target area is located roughly in the center of the eastern plume near wells LHSMW05, 35AWW08, and 03WW01. The major components of the remedy are:

- **In Situ Bioremediation.** First, a treatability study will be conducted to evaluate the effectiveness of bioremediation using site groundwater, to determine amendment requirements, and to provide specific design parameters for field implementation. After the treatability study has been completed, a Remedial Action Work Plan incorporating the results of the treatability study and specifying the design parameters of the in situ bioremediation system will be prepared and submitted prior to the implementation in the target area. The Remedial Action Work Plan will include performance monitoring criteria used to evaluate the effectiveness of the bioremediation treatment. At a minimum, six quarterly post-injection sampling events will be used to evaluate the effectiveness of the remedy and to determine if a second round of injections will be necessary. If the in situ bioremediation treatment is effective, MNA will begin. If ineffective, a second round of injections may be followed by additional performance monitoring.

- **Monitored Natural Attenuation and Long-Term Monitoring/Five-Year Reviews**. After in situ bioremediation is used to reduce the highest contaminate concentrations, MNA will be utilized to address the lower levels observed at LHAAP-35A(58) (see **Section 1.3.2**). MNA will begin after the completion of the six quarterly performance sampling events. At that point, monitoring of the target area will be aligned with the schedule for the eastern plume. If well 03WW01 is abandoned as a consequence of excavation activities at LHAAP-03, a replacement well will be installed and added to the MNA program. Five-year reviews as described in **Section 1.3.4** will also cover the eastern plume target area.

- **Land Use Control**. The LUC that will be implemented for the site as described in **Section 1.3.3** will also cover the eastern plume target area.

1.3.2 Monitored Natural Attenuation (eastern and western plumes)

MNA is a passive treatment where contaminant concentrations decrease through natural attenuation processes such as biodegradation, dispersion, dilution, sorption, and volatilization (USEPA, 1998). Data from performance monitoring is used to evaluate whether natural attenuation is occurring and reducing chemicals of concern (COCs).

The portion of the eastern plume outside of the target area described in **Section 1.3.1** is designated as the eastern plume MNA area. MNA will be implemented in the entire western plume. Thus, the eastern plume MNA area and the western plume have the same remedial action, MNA. For both the eastern and western plumes, monitoring will be conducted in both the shallow and intermediate zones to ensure that the plumes do not migrate vertically. In the eastern plume, the intermediate well 35AWW01 will be grouped with the wells of the eastern plume MNA area.

MNA will be implemented to verify that the VOC levels are decreasing, plumes are stable, and the plume will not migrate to nearby surface water. MNA is expected to return groundwater to its potential beneficial use.

During the first two years, groundwater monitoring will be performed quarterly. At the end of the quarterly sampling events, performance objectives will be evaluated. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented.

1.3.3 Land Use Control (eastern and western plumes)

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 be implemented after the design is approved. The LUC will remain in place until the cleanup levels are met.

1.3.4 Long-Term Monitoring/Five-Year Reviews (eastern and western plumes)

After MNA is evaluated for two years and verified to be effective, LTM will begin at a semiannual frequency for the following three years. In subsequent years, LTM events will be annual until the next five-year review. The LTM and reporting associated with this remedy will be used to track the effectiveness of the MNA remedy and will continue at least once every five years until cleanup levels are achieved. Based on preliminary calculated attenuation rates for LHAAP-35A(58), groundwater cleanup levels are expected to be met through natural attenuation in 200 years in the western plume. This time-frame will be re-evaluated as part of the MNA evaluation and periodic reviews. 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.

1.4 Cleanup Levels

Cleanup levels were established to meet the RAOs as included in the ROD (U.S. Army, 2010). **Table 1-1** presents the groundwater cleanup levels for LHAAP-35A(58).

1.5 Areas of Contamination

Based on the risk assessment and subsequent evaluations, it was determined that the COCs for the shallow groundwater at this site are tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (DCE), cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride (VC). In addition, cleanup levels are provided for 1,1,2-trichloroethane (TCA) and its daughter products 1,1-dichloroethane and chloroethane, even though they are not currently classified as COCs due to their low detections during recent sampling. 1,1,2-TCA and its daughter products will be included as COCs for LTM as discussed in the ROD Section 2.12.2 (U.S. Army, 2010) because the historical level of 1,1,2-TCA was a concern in the past. **Figure 1-4** shows the plume boundaries for PCE, TCE, and 1,1-DCE, as determined by their respective maximum contaminant levels (MCLs), and VOC results from 2003 through 2008. The COCs are carcinogenic. No principal threat source material (such as dense non-aqueous phase liquid [DNAPL]) was identified or suspected to exist at LHAAP-35A(58).

Table 1-1
Cleanup Levels

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

Notes and Abbreviations:

[a] *Not currently classified as a chemical of concern, but will be included in the list of chemicals of concern for long-term monitoring (see Record of Decision Section 2.12.2)*

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

µg/L	*micrograms per liter*
GW-Ind	*Texas Commission on Environmental Quality groundwater medium-specific concentration for industrial use using updated toxicity information through March 31, 2010*
MCL	*Safe Drinking Water Act maximum contaminant level*

The eastern plume has an area of approximately 270,000 square feet, and a vertical extent of approximately 5 feet. Assuming a groundwater-filled porosity of 0.3, the calculated volume of contaminated groundwater is 3.03 million gallons. The highest concentrations detected are as follows: PCE was 9,590 micrograms per liter (µg/L) from well 35AWW08 in November 2008. TCE was 1,150 µg/L from 35AWW08 in May 2011. 1,1-DCE and VC were 24 µg/L and 4.1 µg/L, respectively, from well 1004TW001 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 an area of approximately 180,000 square feet, 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. The highest concentrations detected are as follows: PCE was 7.19 µg/L from well 35AWW06 in November 2008. 1,1-DCE and TCE were 669 µg/L and 41.3 µg/L, respectively, from well LHSMW07 in May 2011. VC was 14.4 from well LHSMW07 in November 2008. Three shallow zone wells, LHSMW07, 35AWW06, and 1004TW006, are within the western plume boundary.

For both the eastern and western plumes, the intermediate zone wells did not have contaminants above cleanup levels.

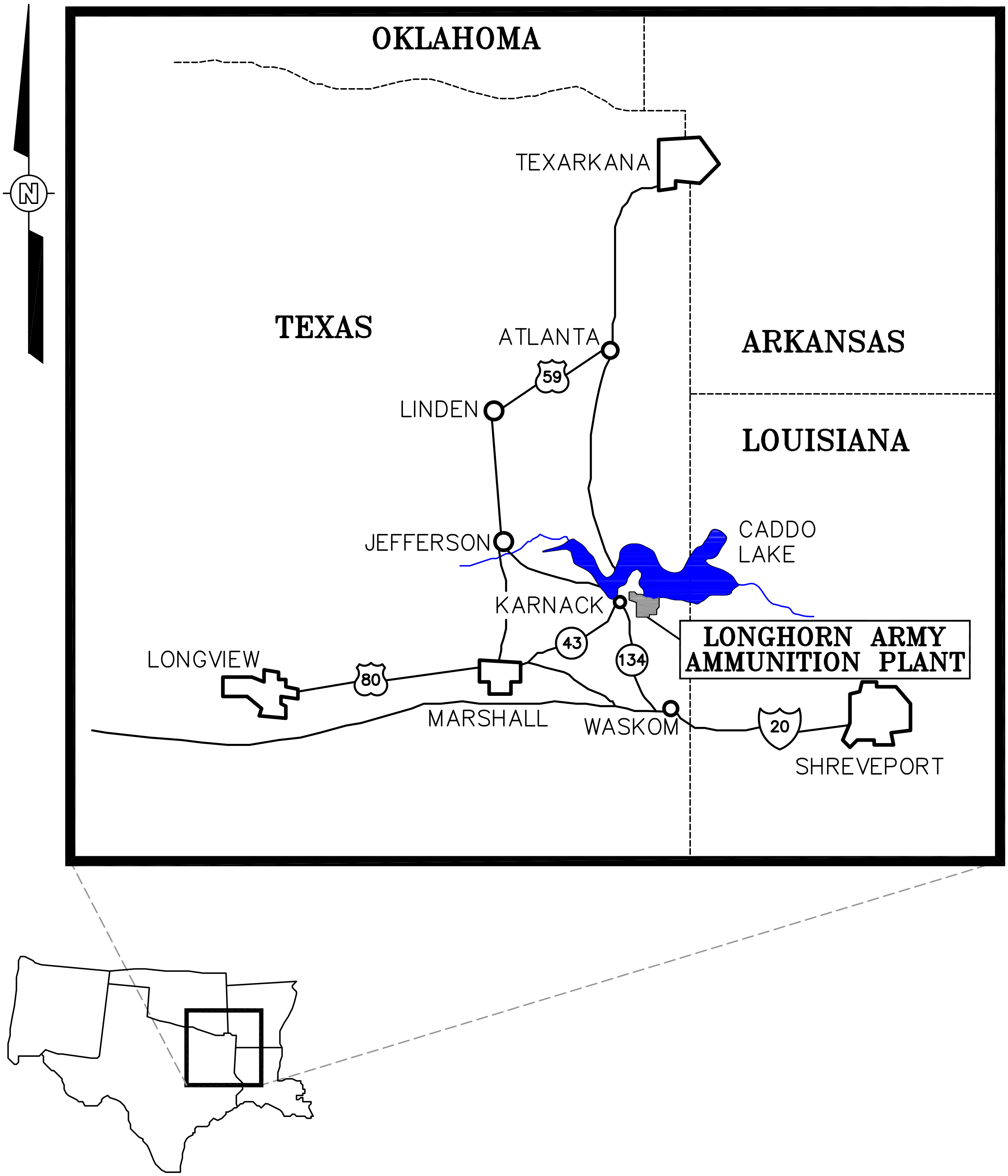
1.6 Hydrogeology

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 1-5**.

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 (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 1-6**.

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	*Houston, Texas*	*S. MCCAWLEY 7/27/11*	*K. EVERETT 7/27/11*	*S. WATSON 7/27/11*	117591-A55



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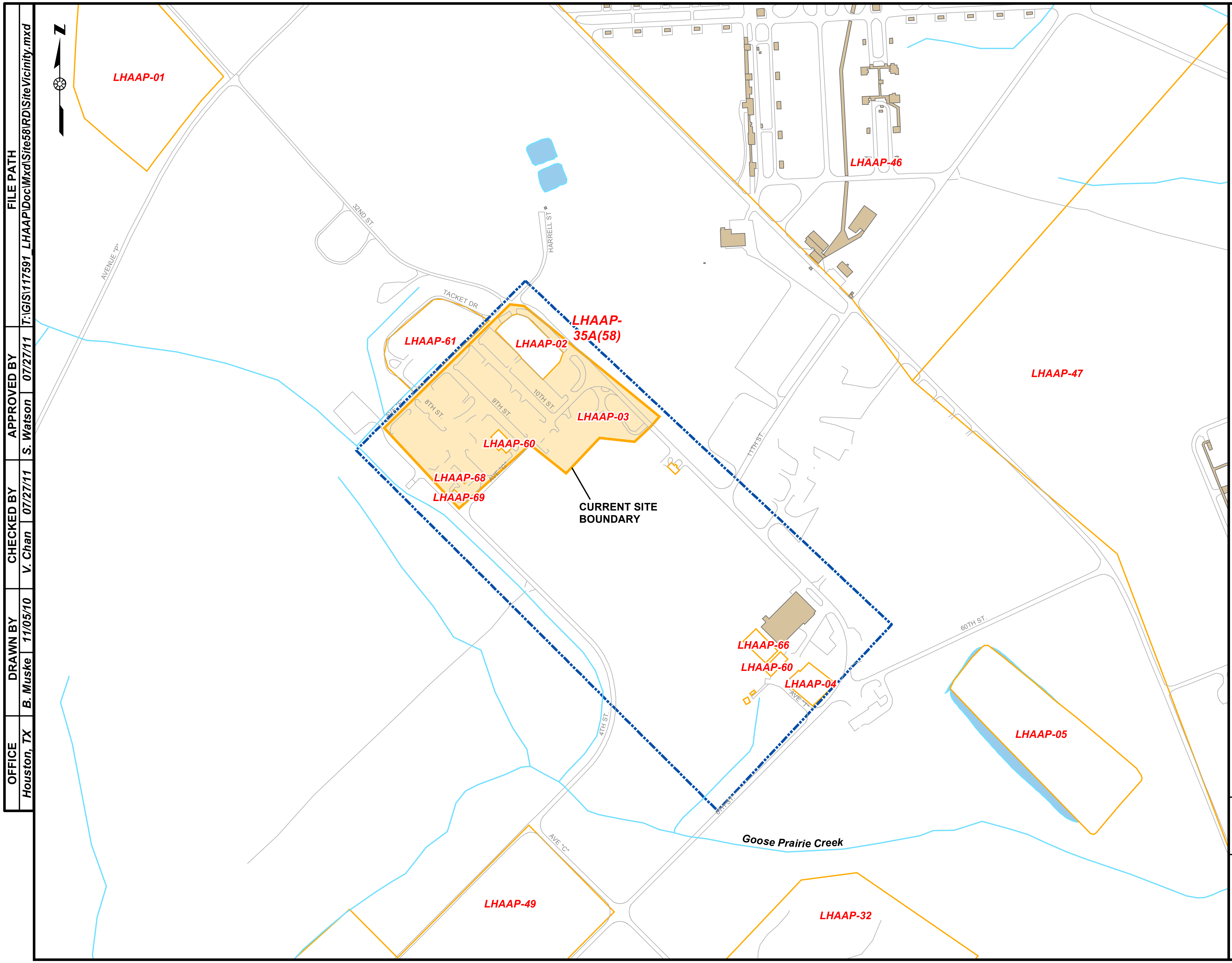
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1-1
LHAAP LOCATION MAP
LHAAP-35A(58), GROUP 4
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

PLOT DATE: 07/27/11
FORMAT REVISION 3/25/99

00111553

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	*B. Muske 11/05/10*	*V. Chan 07/27/11*	*S. Watson 07/27/11*	*T:\GIS\117591_LHAAP\Doc\Mxd\Site58\RD\SiteVicinity.mxd*



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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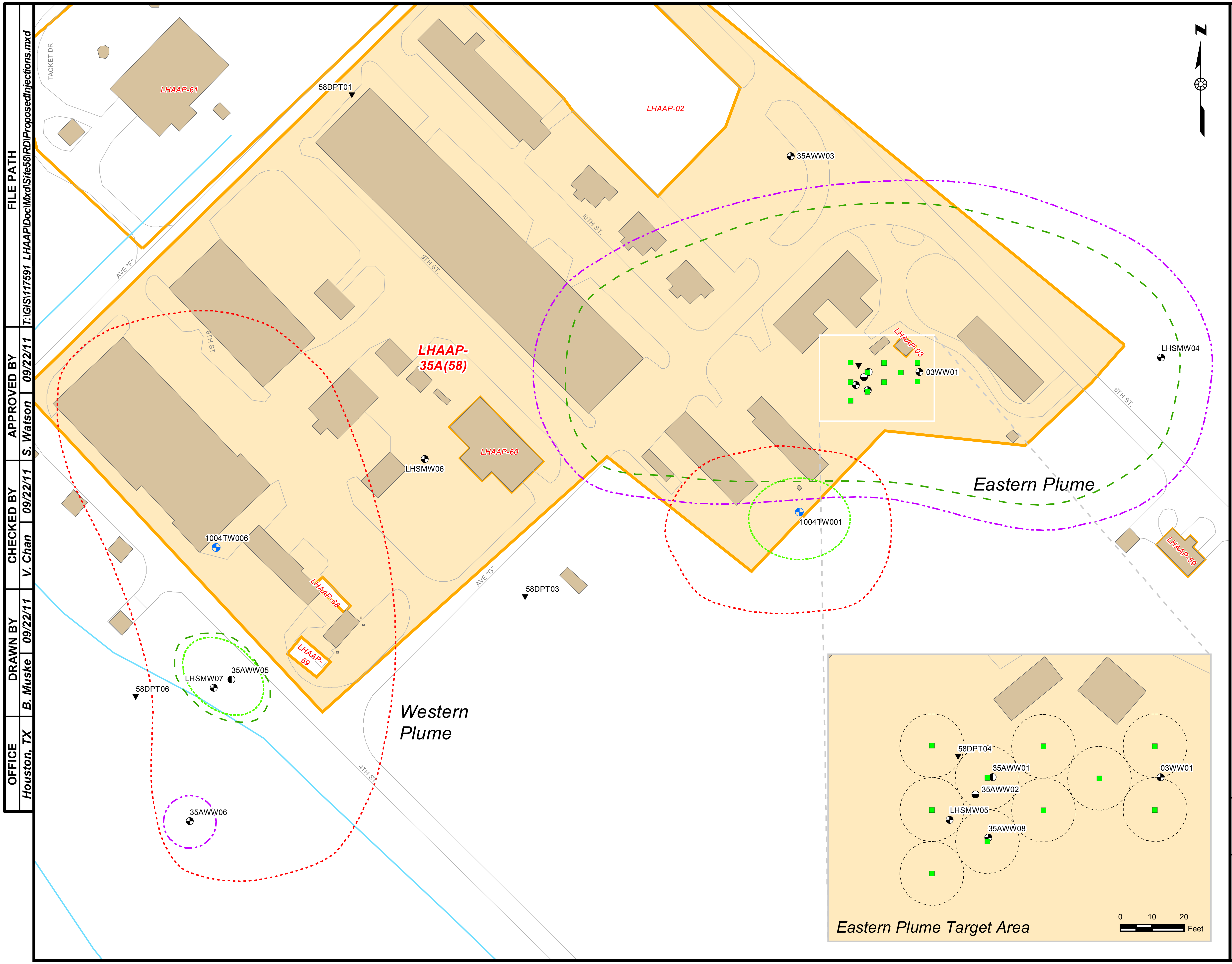
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1-2

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

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



LEGEND

- 🟩 Proposed Injection Locations
- ● Plexus Temporary Monitoring Well
- ● Shallow Monitoring Well
- ◐ Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- ▼ DPT Location
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Stream
- Road
- Former Building or Tank
- Other LHAAP Site
- LHAAP-35A(58) Site

Notes:

1. Circles illustrate a radius of influence of 10 ft.
2. Concentration contours are based on data from 2003 through 2008.

1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 50 100 200 Feet

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1-3

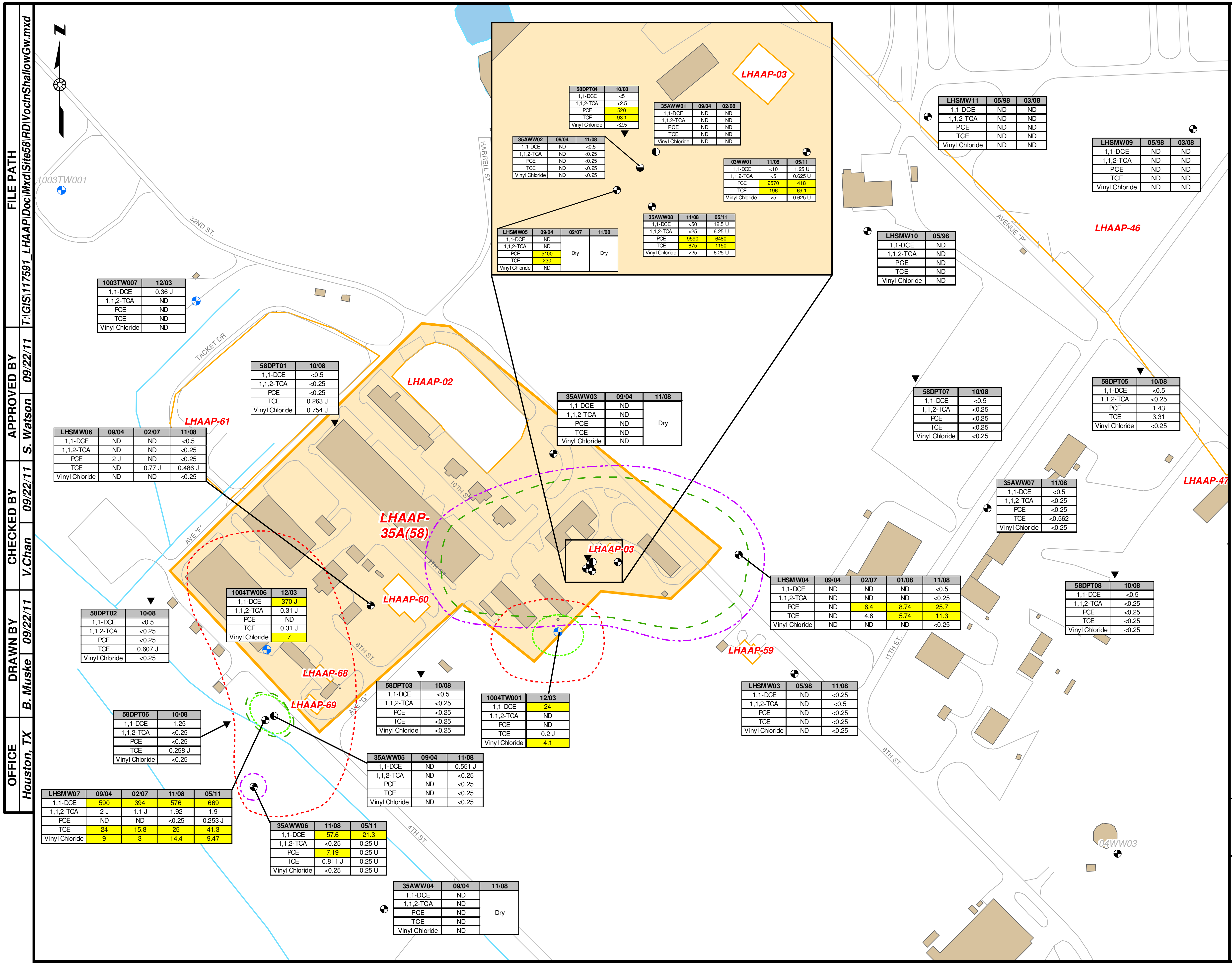
PROPOSED INJECTION LOCATIONS
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH	T:\GIS\117591 LHAAP\Doc\Mxd\Site58\RD\ProposedInjections.mxd
APPROVED BY	S. Watson 09/22/11
CHECKED BY	V. Chan 09/22/11
DRAWN BY	B. Muske 09/22/11
OFFICE	Houston, TX

FILE PATH T:\GIS\117591_LHAAP\Doc\Mxd\Site58\RD\VocInShallowGw.mxd

APPROVED BY	S. Watson	09/22/11
CHECKED BY	V.Chan	09/22/11
DRAWN BY	B. Muske	09/22/11
OFFICE	Houston, TX	



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

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

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

03WW01	11/08	05/11
1,1-DCE	<10	1.25 U
1,1,2-TCA	<5	0.625 U
PCE	2570	418
TCE	196	69.1
Vinyl Chloride	<5	0.625 U

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

35AWW08	11/08	05/11
1,1-DCE	<50	12.5 U
1,1,2-TCA	<25	6.25 U
PCE	9590	6480
TCE	675	1150
Vinyl Chloride	<25	6.25 U

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LHSMW07	09/04	02/07	11/08	05/11
1,1-DCE	590	394	576	669
1,1,2-TCA	2 J	1.1 J	1.92	1.9
PCE	ND	ND	<0.25	0.253 J
TCE	24	15.8	25	41.3
Vinyl Chloride	9	3	14.4	9.47

35AWW06	11/08	05/11
1,1-DCE	57.6	21.3
1,1,2-TCA	<0.25	0.25 U
PCE	7.19	0.25 U
TCE	0.811 J	0.25 U
Vinyl Chloride	<0.25	0.25 U

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

LEGEND

▼	DPT Sample Location
◕	Shallow Monitoring Well
◔	Shallow/Intermediate Monitoring Well
◐	Intermediate Monitoring Well
◒	Deep Monitoring Well
◕	Plexus Temporary Monitoring Well
- - -	Estimated 1,1-DCE Contamination Extent at Concentration = 7 µg/L
- - -	Estimated TCE Contamination Extent at Concentration = 5 µg/L
- - -	Estimated PCE Contamination Extent at Concentration = 5 µg/L
- - -	Estimated Vinyl Chloride Contamination Extent at Concentration = 2 µg/L
～	Stream
—	Road
▭	Other LHAAP Site
▨	Former Building or Tank
▭	LHAAP-35A(58) Site
🟨	COC Concentration Exceeds MCL

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

Notes:

Concentrations are in µg/L (micrograms per liter).

1,1-DCE: 1,1-dichloroethene
1,1,2-TCA: 1,1,2-trichloroethane
PCE: tetrachloroethene
TCE: trichloroethene
ND: not detected
COC: chemical of concern

0 100 200 400 Feet

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TULSA, OKLAHOMA

FIGURE 1-4

GROUNDWATER RESULTS FOR VOCs
2003 THROUGH 2011
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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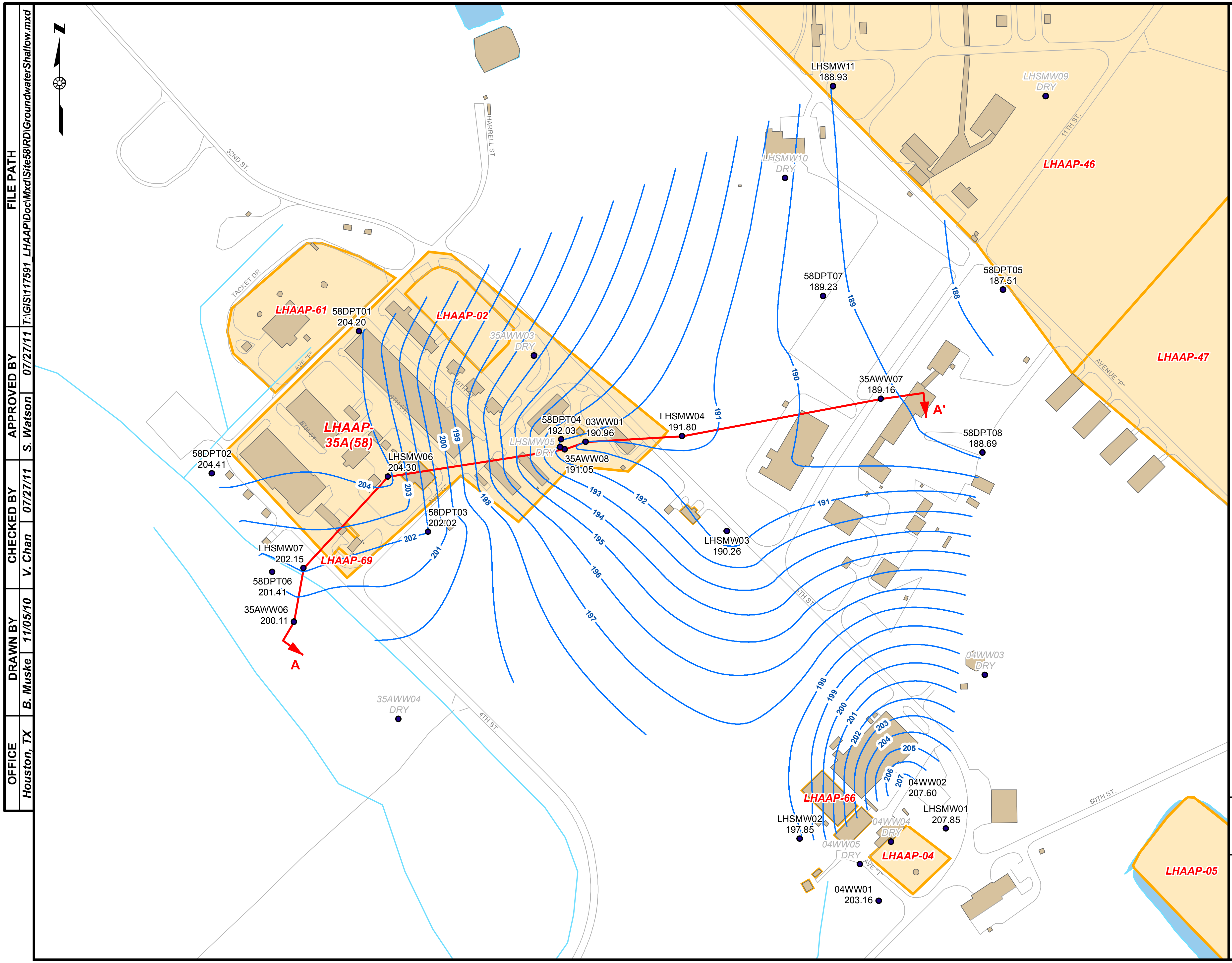
Houston, TX	B. Muske 11/05/10	V. Chan 07/27/11	S. Watson 07/27/11	T:\GIS\117591_LHAAP\Doc\Mxd\Site58\RD\GroundwaterShallow.mxd



LEGEND

- ● SampleLocation
- Groundwater Elevation Contour
- Cross-Section Line
- Stream
- Road
- Former Building or Tank
- Site

0 125 250 500 Feet

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FIGURE 1-5

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

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00111557

PLOT DATE: 05/12/10
FORMAT REVISION

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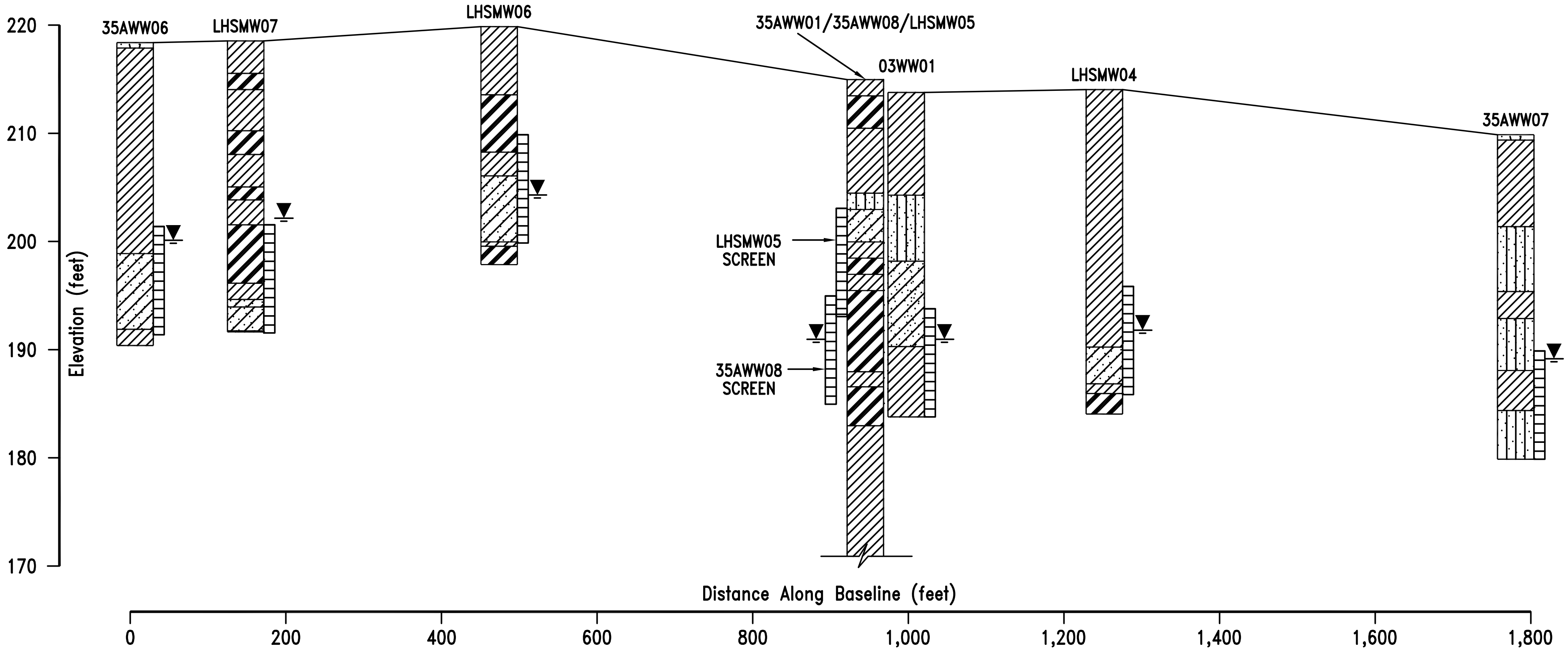

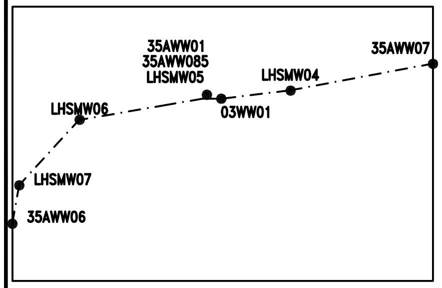

LEGEND:

- ▨ (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

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FIGURE 1-6
CROSS SECTION A-A'
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

2.0 LAND USE CONTROL

The objective of the LUC at LHAAP-35A(58) is to 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 site for anything other than environmental monitoring and testing until cleanup goals are met. Notification of the groundwater use restriction will accompany all transfer documents and will be recorded at the Harrison County Courthouse in accordance with Texas Administrative Code (TAC) Title 30, §335.566. **Appendix A** provides sample LUC compliance certification documentation.

The LUC addresses the two groundwater plumes at LHAAP-35A(58) with levels of contamination that require implementation of a remedy (see **Section 1.3**). The U.S. Army is responsible for implementing, maintaining, monitoring, reporting on, and enforcing the LUC.

U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an LUC objective at this site after it has transferred. U.S. Army shall obtain USEPA and Texas Commission on Environmental Quality (TCEQ) concurrence prior to termination or significant modification of the LUC, or implementation of a change in land use inconsistent with the LUC objectives and use assumptions of the remedy. Although not a remedy, the land use assumption for LHAAP-35A(58) forms the basis for the remedy. The future use of the site as part of a national wildlife refuge is consistent with the industrial risk exposure scenario. Notification of the land use assumption of this site will be made in transfer documentation and will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566. Compliance with the use assumption will be documented in the five-year review reports.

3.0 MONITORED NATURAL ATTENUATION DESIGN

As part of the remedy, monitoring will be conducted of the groundwater and surface water. The groundwater monitoring plan was designed to evaluate and monitor natural attenuation in the shallow plume, and to monitor for any potential migration of shallow zone groundwater contaminants into the intermediate zone or to surface water. Generally the MNA performance monitoring network will be designed to provide at least two wells along the axis inside the plume boundary to evaluate MNA effectiveness; four wells to evaluate lateral plume expansion; and at least one well to evaluate vertical migration. This section discusses the rationale of MNA performance monitoring program designed to meet the following objectives:

Objectives for Performance Monitoring of MNA (USEPA, 1999)

1) Demonstrate that natural attenuation is occurring
2) Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes,
3) Identify any potentially toxic and/or mobile transformation products,
4) Verify that the plume(s) is/are not expanding downgradient, laterally, or vertically,
5) Verify no unacceptable impact to downgradient receptors,
6) Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy,
7) Verify attainment of remediation objectives.

3.1 Monitored Natural Attenuation Performance Monitoring Well Locations

In November 2007 a full set of groundwater elevation readings were collected of the entire northern area of LHAAP including LHAAP-35A(58). Each existing well completion was evaluated and wells were assigned to a shallow, shallow-intermediate, or intermediate zone. Based on these designations, the groundwater contamination is located in one zone at LHAAP-35A(58), the shallow groundwater zone. Intermediate and deep groundwater zones also exist, but contamination has not been observed there. The coordinates and well information are located in **Table 3-1**.

3.1.1 Direct-Push Technology Groundwater Sampling and Installation of Monitoring Wells

The site hydrogeology is important when designing a monitoring system. The shallow groundwater elevations are approximately 10 to 25 feet bgs. 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. The current shallow zone wells are completed in the sand interval that is approximately 20 to 30 ft bgs on the eastern side and approximately 17 to 28 feet bgs on the western side of the plume. The eastern plume boundary currently contains 4 shallow wells, and will contain 5 shallow wells after the completion of the monitoring well network. The western plume boundary contains 2 shallow wells.

Prior to the installation of new wells, direct-push technology (DPT) will be used for groundwater sampling to optimize the location of new monitoring wells for the MNA evaluation. It is anticipated that up to 17 DPT points will be drilled. Grab samples will be collected from the 17 proposed locations, labeled as 58DPT09 through 58DPT25 on **Figure 3-1**. The samples will be analyzed for VOCs. Location 58DPT11 will serve to confirm that the existing well LHSMW06 provides data that is representative of conditions upgradient of the eastern plume. The screen interval of LHSMW06 is 10 to 20 feet bgs, which is not as deep as the screen intervals of the hot wells in the eastern plume, generally 20 to 30 feet bgs. Therefore, deeper groundwater will be collected from 58DPT11 to confirm that concentrations in these two intervals are the same. Proposed locations for new monitoring wells are shown on **Figure 3-2**, and labeled as 35AWW09 through 35AWW21. The number and locations may be adjusted based on DPT groundwater sampling results.

Table 3-2 provides the rationale for each new and existing monitoring well that will be part of the monitoring well network. **Figure 3-3** identifies the wells to be included in the monitoring well network, and the analytes for each. **Appendix B** provides well construction diagrams and associated boring logs.

3.1.2 Vertical Well Clusters (eastern and western plumes)

The areas of highest concentration in the eastern and western plumes are monitored by a cluster of wells that are installed in different groundwater zones to assess vertical migration. In the eastern plume, the cluster is comprised of 35AWW01, 35AWW02, and 35AWW08. In the western plume, the cluster includes LHSMW07 and 35AWW05. Intermediate groundwater zone wells 35AWW01 and 35AWW05 will be monitored as part of the MNA network.

3.2 Monitored Natural Attenuation Evaluation (western plume)

The schedule for groundwater monitoring for MNA will be quarterly for two years. This data will be used to evaluate seasonal variation, and attenuation rates. Historical data will be used to evaluate MNA effectiveness and determine if monitoring should continue or a contingent action should be implemented. All collected groundwater samples will be analyzed for VOCs and field parameters (pH, dissolved oxygen [DO], and oxidation reduction potential [ORP]). A subset of the groundwater samples, those from wells historically within the groundwater plume, will also be tested for MNA parameters (*Dehalococcoides* sp. [DHC], alkalinity, chloride, nitrate/nitrite, sulfate/sulfide, total organic carbon [TOC], carbon dioxide, ferric iron, dissolved manganese and iron, and phosphorus). After the first two years, the effectiveness of MNA will be evaluated (**Section 7.1**). LTM will begin if the MNA evaluation determines MNA to be effective.

3.3 Long-Term Monitoring (eastern and western plumes)

LTM will be initiated in the following year after the 2 years of MNA evaluation. For LTM, the analytical suite will be VOCs, and the frequency of sampling will be semiannual for three years, then annually until the next five-year review. Further reductions in sampling frequency will depend on results of five-year reviews, but sampling will continue at least once every five years until cleanup levels are achieved. Based on the LTM results, a reduction in the number of wells to be sampled may be included in the five-year review. Recommendations for reducing the number of wells will be included in monitoring and/or five-year reports.

3.4 Five-Year Reviews (eastern and western plumes)

Reviews will be conducted every five years to ensure that the remedy continues to provide adequate protection of human health and the environment. Groundwater sampling will continue for VOCs as determined in the five-year review. Groundwater monitoring results, site inspections, regulatory changes, and other information will be evaluated to determine whether the current remedy should continue or if a change is required. U.S. Army shall obtain regulatory concurrence prior to termination or significant modification of LTM activities.

3.5 Surface Water Monitoring

One surface water sample (35ASW03) will be collected quarterly for two years from a ditch that runs parallel to 4th Street, and is downstream of where groundwater-to-surface water interaction would potentially exist (**Figure 3-4**). The location may be adjusted based on the DPT investigation. The sample will be analyzed for VOCs. The purpose of the sampling will be to ensure that groundwater contaminants are not migrating into surface water.

Evaluation of this data will be included in the annual reports. The frequency and location of sampling may be modified after evaluation of data. If VOC levels in the ditch are consistently above TCEQ groundwater MSC for residential use (GW-Res) after two years of monitoring, then additional evaluation will be conducted and any proposed actions will be included in the annual evaluation report to be submitted after Year 2. The need to continue surface water sampling will be evaluated during the five-year reviews.

Table 3-1
Monitoring Wells to be Sampled at LHAAP-35A(58)

Well	Groundwater Zone	Approximate depth [a] (ft bgs)	Location		Ground Elevation (ft MSL)	Top of Casing (ft MSL)
			Northing	Easting		
Eastern Plume Target Area (in situ bioremediation) [b]						
03WW01	Shallow	30	6960156.55	3305145.17	213.78	216.29
35AWW08	Shallow	30	6960152.00	3305091.27	214.25	216.95
35AWW09	Shallow	TBD	TBD	TBD	TBD	TBD
Eastern Plume (MNA)						
35AWW01	Intermediate	70	6960170.97	3305092.61	214.96	218.03
35AWW10	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW11	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW12	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW13	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW14	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW21	Shallow	TBD	TBD	TBD	TBD	TBD
LHSMW04	Shallow	28.2	6960185.99	3305398.12	214.04	216.95
Western Plume (MNA)						
35AWW05	Intermediate	71	6959849.64	3304426.14	219.01	221.41
35AWW06	Shallow	27	6959701.31	3304382.89	218.38	220.43
35AWW15	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW16	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW17	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW18	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW19	Shallow	TBD	TBD	TBD	TBD	TBD
35AWW20	Shallow	TBD	TBD	TBD	TBD	TBD
LHSMW06	Shallow	20	6960079.99	3304628.53	219.86	223.18
LHSMW07	Shallow	27	6959841.17	3304408.12	218.54	221.27

Notes and Abbreviations:

[a] *Approximate depth is the bottom of the screen interval.*

[b] *Well 35AWW08 will be used for MNA monitoring post in situ bioremediation. Well 03WW01 may need to be abandoned as a consequence of excavation activities at LHAAP-03, in which case a replacement well will be installed for performance monitoring at LHAAP-35A(58)..*

Coordinate system is Texas State Plane, NAD 1983

ft bgs	*feet below ground surface*
ft MSL	*feet mean sea level*
MNA	*monitored natural attenuation*
TBD	*to be determined*

Table 3-2
Rationale for Performance Monitoring Wells at LHAAP-35A(58)

Performance Monitoring Well Location	Monitoring Well Location Relative to the Plume	Well ID	Purpose
Eastern Plume Target Area (in situ bioremediation)			
In plume	Highest concentrations in eastern plume	35AWW08	Evaluate in situ enhanced bioremediation (ISEB)
In plume	Downgradient from highest concentrations in eastern plume	03WW01	Evaluate ISEB; this well may be abandoned as part of a remedial action at LHAAP-03, and will be replaced with 35AWW09
In plume	Downgradient from highest concentrations in eastern plume	35AWW09 (new well)	Evaluate ISEB; replaces 03WW01 after it is abandoned
Eastern Plume (MNA)			
Below plume (intermediate zone)	Below plume (intermediate zone)	35AWW01	Evaluate any vertical migration
In plume	Eastern edge of plume	LHSMW04	Evaluate presence of daughter products, geochemical, geochemical and microbiological changes of the dissolved plume to evaluated monitored natural attenuation (MNA) processes; calculate distance based attenuation rate; evaluate plume stability
In plume	Inside west half of plume	35AWW10 (new well)	Evaluate presence of daughter products, geochemical , geochemical and microbiological changes of the dissolved plume to evaluated MNA processes; calculate distance based attenuation rate; evaluate plume stability
In plume	On south side of plume	35AWW11 (new well)	Evaluate presence of daughter products, geochemical , geochemical and microbiological changes of the dissolved plume to evaluated MNA processes; calculate distance based attenuation rate; evaluate plume stability; replaces temporary well 1004TW001
Downgradient	Outside east edge of plume	35AWW12 (new well)	Evaluate downgradient expansion; replaces 35AWW07 and LHSMW03 whose locations were not satisfactory to serve as downgradient wells
Downgradient	Outside southeast edge of plume	35AWW21 (new well)	Evaluate downgradient expansion; replaces 35AWW07 and LHSMW03 whose locations were not satisfactory to serve as downgradient wells
Cross gradient	Outside north edge of plume	35AWW13 (new well)	Evaluate lateral plume expansion; replaces 35AWW03 which was dry in 2008
Cross gradient	Outside south edge of plume	35AWW14 (new well)	Evaluate lateral plume expansion
Upgradient	Outside west edge of plume	LHSMW06	Detect any new contamination flowing into the plume; evaluate lateral plume expansion

Table 3-2 *(continued)*
Rationale for Performance Monitoring Wells at LHAAP-35A(58)

Western Plume (MNA)			
Below plume (intermediate zone)	Below plume (intermediate zone)	35AWW05	Evaluate any vertical migration
In plume	Highest concentrations in western plume	LHSMW07	Evaluate presence of daughter products, geochemical , geochemical and microbiological changes of the dissolved plume to evaluated MNA processes; calculate distance based attenuation rate; evaluate plume stability
In plume	Downgradient from highest concentrations in western plume	35AWW06	Evaluate presence of daughter products, geochemical , geochemical and microbiological changes of the dissolved plume to evaluated MNA processes; calculate distance based attenuation rate; evaluate plume stability
In plume	On north side of plume	35AWW20	Evaluate presence of daughter products, geochemical , geochemical and microbiological changes of the dissolved plume to evaluated MNA processes; calculate distance based attenuation rate; evaluate plume stability
Upgradient	Outside north edge of plume	35AWW15 (new well)	Detect any new contamination flowing into the plume; evaluate lateral plume expansion
Cross gradient	Outside west edge of plume	35AWW16 (new well)	Evaluate lateral plume expansion
Downgradient	Outside south edge of plume	35AWW17 (new well)	Evaluate downgradient expansion; replaces 35AWW04 which was dry in 2008
Down gradient	Outside southeast edge of plume	35AWW18 (new well)	Evaluate downgradient expansion; replaces 35AWW04 which was dry in 2008
Cross gradient	Outside east edge of plume	35AWW19 (new well)	Evaluate lateral plume expansion
Cross gradient	Outside east edge of plume	LHSMW06	Evaluate lateral plume expansion

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APPROVED BY	S. Watson 09/22/11
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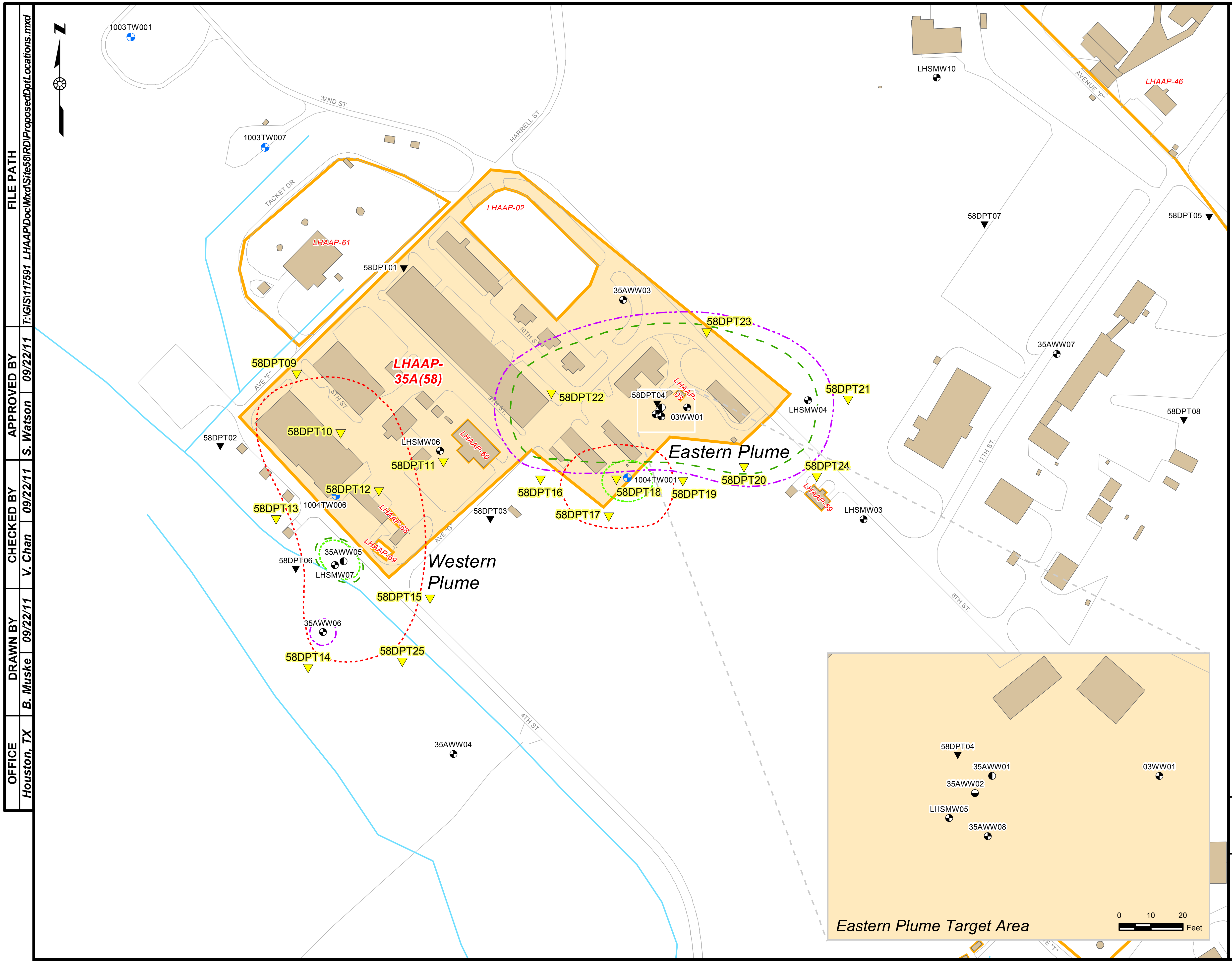

LEGEND

- ▼ Proposed DPT Locations
- ● Plexus Temporary Monitoring Well
- ● Shallow Monitoring Well
- ● Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- ▼ Previous DPT Location
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Stream
- Road
- ▨ Former Building or Tank
- Other LHAAP Site
- LHAAP-35A(58) Site

Notes:

1. Concentration contours are based on data from 2003 through 2008.

1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 100 200 400 Feet

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FIGURE 3-1

PROPOSED DPT LOCATIONS
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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APPROVED BY	S. Watson 09/22/11
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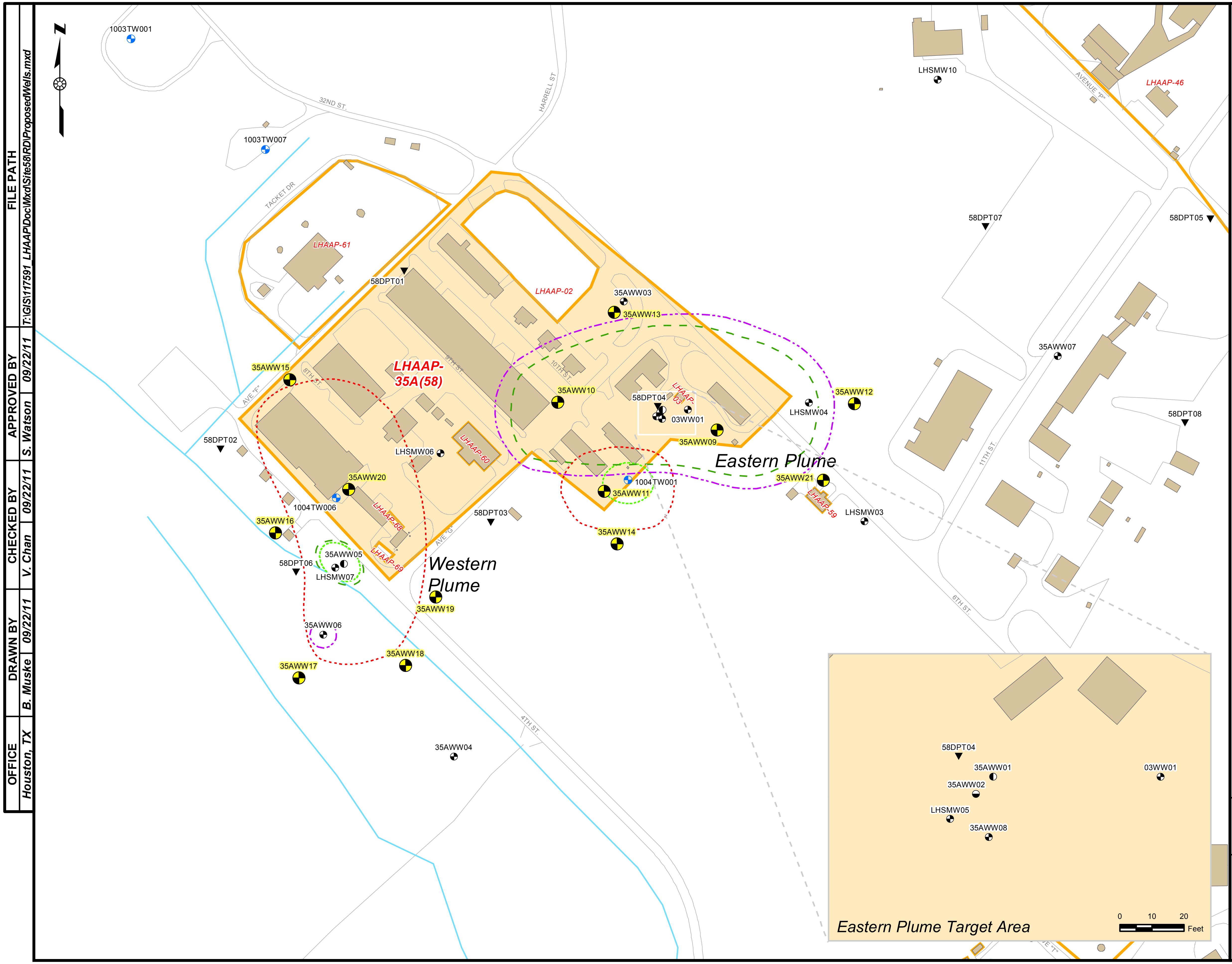

LEGEND

- ● Proposed Well
- ● Plexus Temporary Monitoring Well
- ● Shallow Monitoring Well
- ◕ Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- ▼ Previous DPT Location
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Stream
- Road
- Former Building or Tank
- Other LHAAP Site
- LHAAP-35A(58) Site

Notes:

1. Concentration contours are based on data from 2003 through 2008.

1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 100 200 400 Feet

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FIGURE 3-2

PROPOSED WELL LOCATIONS
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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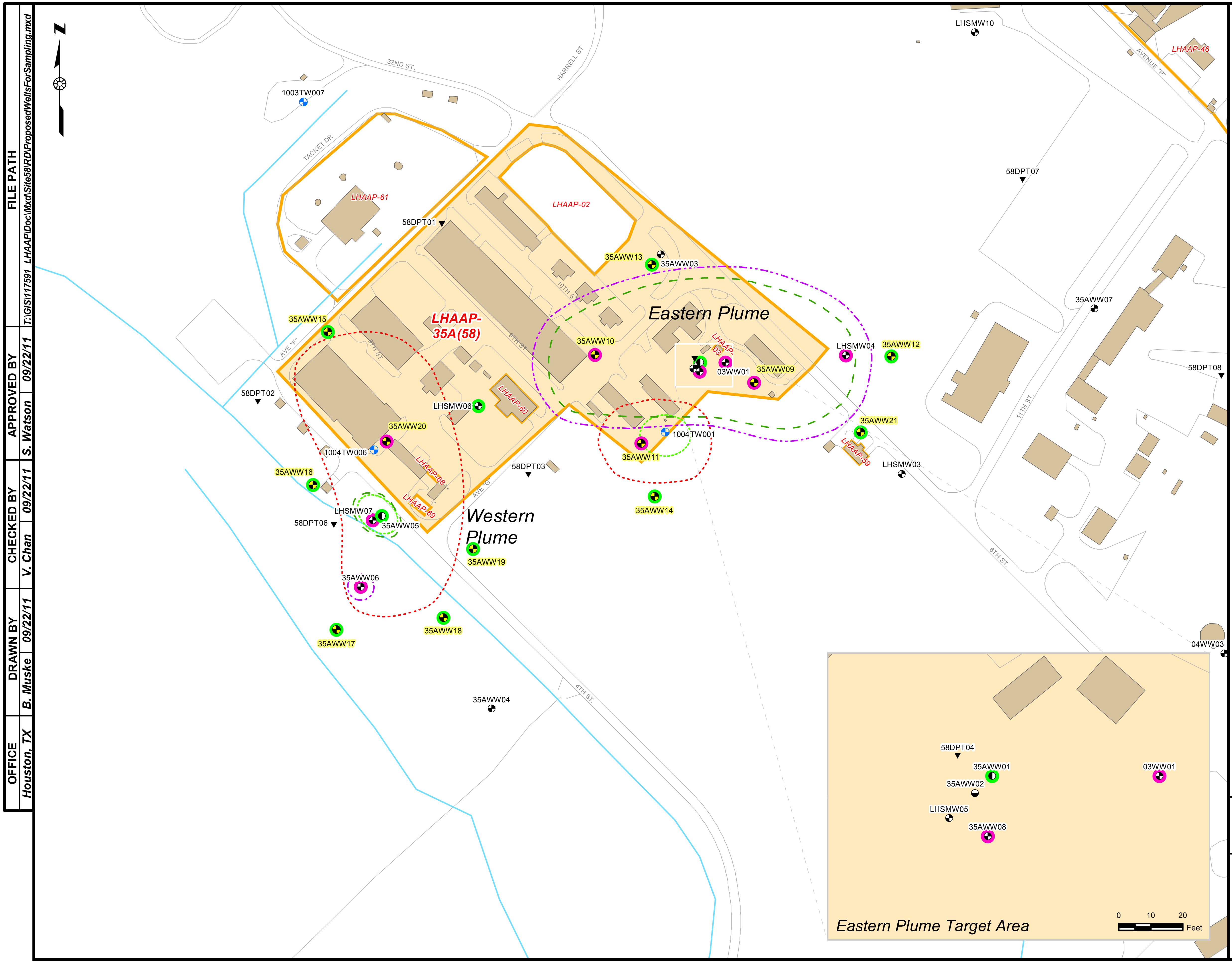

LEGEND

- ⊕ Proposed Well
- ⊕ Plexus Temporary Monitoring Well
- ◕ Shallow Monitoring Well
- ◔ Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- ▼ DPT Location
- 🟢 VOCs and Field Parameters Only (12)
- 🟣 VOCs, Field Parameters, and MNA Parameters (9)
- - - - Estimated 1,1-DCE Concentration Contour (7 µg/L)
- - - - Estimated TCE Concentration Contour (5 µg/L)
- - - - Estimated PCE Concentration Contour (5 µg/L)
- - - - Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- 〰 Stream
- — Road
- ▨ Former Building or Tank
- ▭ Other LHAAP Site
- ▭ LHAAP-35A(58) Site

Notes:

1. Concentration contours are based on data from 2003 through 2008.

2. Well 03WW01 may need to be abandoned as a consequence of excavation activities at LHAAP-03. 35AWW09 would be the replacement well.

MNA: Monitored Natural Attenuation
VOC: Volatile Organic Compund
1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 100 200 400
Feet

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FIGURE 3-3

PROPOSED WELLS FOR SAMPLING
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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APPROVED BY
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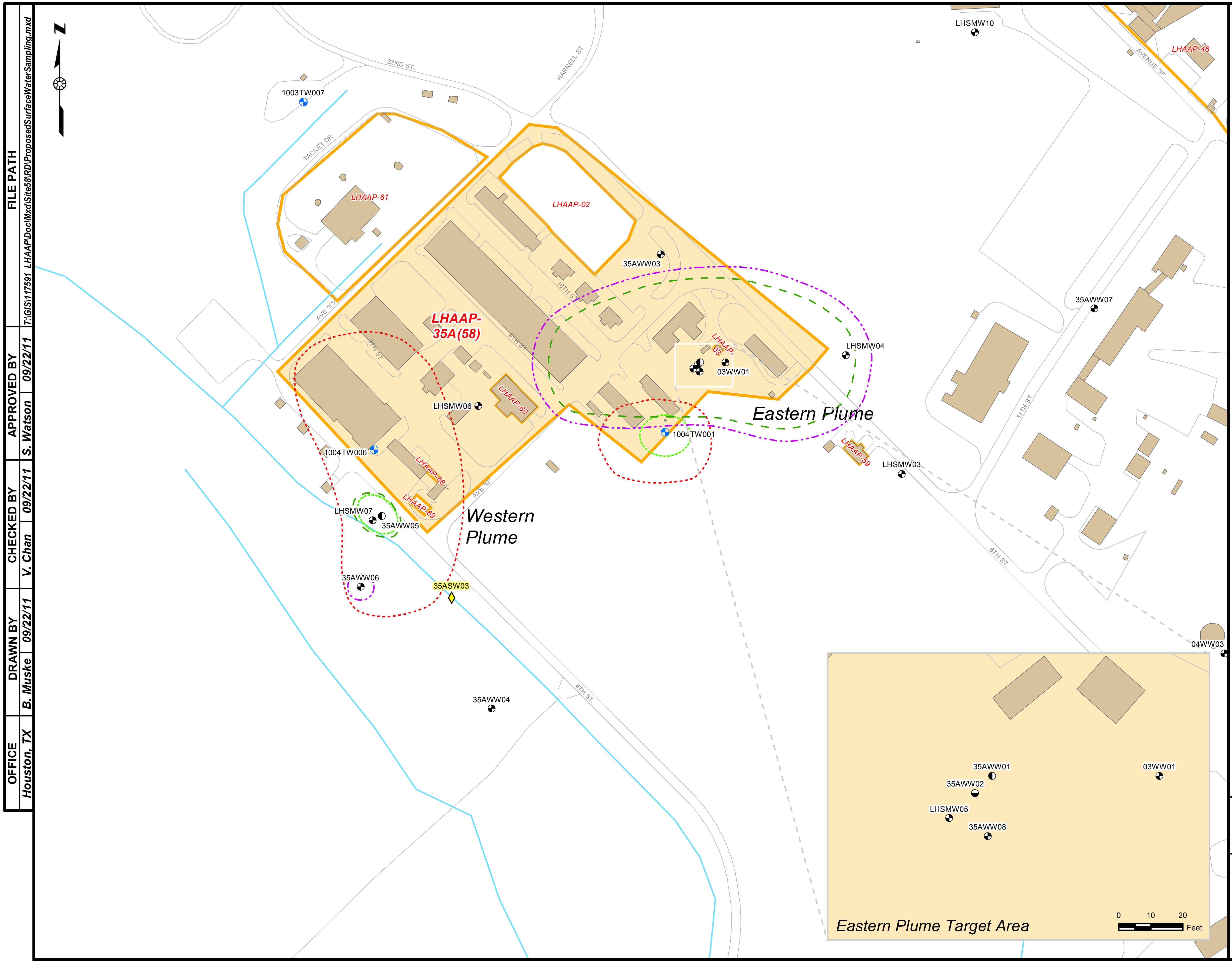
Houston, TX



LEGEND

- ◆ New Surface Water Sample Location
- ● Plexus Temporary Monitoring Well
- ● Shallow Monitoring Well
- ◐ Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Stream
- Road
- Former Building or Tank
- Other LHAAP Site
- LHAAP-35A(58) Site

Notes:

1. Concentration contours are based on data from 2003 through 2008.

MNA: Monitored Natural Attenuation
VOC: Volatile Organic Compund
1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 100 200 400 Feet

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FIGURE 3-4

SURFACE WATER SAMPLING LOCATION
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

4.0 LAND USE CONTROL DESIGN AND IMPLEMENTATION PLAN

This section describes the LUC design and implementation activities for LHAAP-35A(58). The activities will result in a surveyed and recorded groundwater use restriction boundary and an operation and maintenance plan for the LUC.

The objective of the LUC at LHAAP-35A(58) is to 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 site for anything other than environmental monitoring and testing until cleanup goals are met. Notification of the groundwater use restriction will accompany all transfer documents. The U.S. Army is responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC.

The LUC will address the area of LHAAP-35A(58) that includes two groundwater plumes with levels of contamination that require implementation of a remedy (see **Section 1.3**). The Land Use Control Operation and Maintenance (LUC O&M) Plan will identify the measures required for monitoring and enforcement of the groundwater use restriction. Upon review and concurrence of this RD, the LUC O&M Plan will be coordinated with regulators, finalized, and distributed as part of the Comprehensive LUC Management Plan.

4.1 Land Use Control Implementation

The U.S. Army will undertake the following actions to implement the groundwater restriction LUC for LHAAP-35A(58):

- <u>Define the Area of the Groundwater Use Restriction.</u> The groundwater use restriction boundary will be defined based on the review of the first round of groundwater sampling data in conjunction with historic data. The extent of plume will be bounded by a buffer and may extend to natural groundwater and surface water boundaries.

- <u>Survey the LUC Boundary.</u> The proposed boundary will be finalized after all wells are installed and sampled. Concurrence by USEPA and TCEQ will be obtained, and the LUC boundary will be surveyed by a State-licensed surveyor. A legal description of the surveyed area will be appended to the survey plat.

- <u>Record the LUC in Harrison County.</u> The LUC plat, legal description and groundwater use restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566.

- Notify the Texas Department of Licensing and Regulation of the LUC. The Texas Department of Licensing and Regulation will be notified of the groundwater restriction which includes the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the Army, the USEPA, and the TCEQ. The survey plat, legal boundary and description of the groundwater restriction, in conjunction with a locator map, will be provided in hard and electronic copy.

- Develop the LUC O&M Plan. A LUC O&M Plan for LHAAP-35A(58) will be developed. It will include the elements presented in **Section 4.2**, the county recordation of the LUC survey plat, legal description and restriction language, and the inspection/certification form.

4.2 Land Use Control Operation and Maintenance

The U.S. Army or its representatives will be responsible for the operation and maintenance of the LHAAP-35A(58) LUC. This includes certification, reporting and enforcement activities. The U.S. Army shall address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable. To facilitate long-term operation and maintenance of the groundwater use restriction LUC remedy, the U.S. Army will develop a plan that will encompass the elements described in the following subsections.

4.2.1 Site Certification and Reporting

Beginning with finalization of this RD and approval of the inspection form, the U.S. Army will undertake inspections and certify continued compliance with the LUC objectives. The U.S. Army, or the transferee after transfer, will retain the LUC Inspection Certification documents in the project files for incorporation into the five-year review reports, and these documents will be made available to USEPA and TCEQ upon request. In addition, should any violations be found during the certification, the U.S. Army will provide to USEPA and TCEQ, along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue certifications will be revisited at five year reviews.

4.2.2 Notice of Planned Property Conveyances

The U.S. Army shall provide notice to USEPA and TCEQ of plans to convey the LHAAP-35A(58) acreage. The notice shall describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental document for transfer. Although the U.S. Army may transfer responsibility for various implementation actions, the U.S. Army shall retain its responsibility for remedy integrity. This means that the U.S. Army is responsible for addressing substantive violations of the LUC performance objective that would undermine the U.S. Army's CERCLA remedy. The U.S. Army also will be responsible for incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation.

4.2.3 Opportunity to Review Text of Intended Land Use Controls

U.S. Army will provide a copy of the groundwater use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. USEPA will also receive a copy for review. In addition, the U.S. Army will produce an ECP or other environmental document for transfer of LHAAP-35A(58), but before executing transfer, the U.S. Army will provide USEPA and TCEQ with a copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before transfer, to review all LUC-related provisions.

4.2.4 Notification Should Action(s) Which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover after conveyance of the site any activity on the property inconsistent with the LUC performance objective, the U.S. Army shall notify USEPA and TCEQ within 72 hours of such discovery. Consistent with **Section 4.2.5** below, the U.S. Army will then work with USEPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

4.2.5 Land Use Control Enforcement

Should the LUC remedy reflected in this RD fail, the U.S. Army will coordinate with USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the United States Fish and Wildlife Service (USFWS) or its lessee, to the institution of judicial action against non-federal third-parties. Alternatively, should the circumstances warrant such, the U.S. Army could choose to exercise its response authorities under CERCLA. Should the U.S. Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction, the U.S. Army may notify those agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUC.

4.2.6 Modification or Termination of Land Use Controls

The U.S. Army shall not, without USEPA and TCEQ concurrence, make a significant modification to, or terminate a LUC, or make a land use change inconsistent with the LUC objective. Likewise, the U.S. Army shall seek prior USEPA and TCEQ concurrence before commencing actions that may impact remedy integrity. In the case of an emergency action, the U.S. Army shall obtain prior USEPA and TCEQ concurrence as appropriate to the exigencies of the situation.

The LUC shall remain in effect until such time as the U.S. Army and USEPA agree that the concentrations of COCs have met cleanup levels. When this occurs, the LUC will be terminated as needed. The decision to terminate the LUC will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial action completion report. If the property has been transferred and a determination by the U.S. Army and USEPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also timely advise other local stakeholders of the action.

4.2.7 Comprehensive Land Use Control Management Plan

Upon finalization of the LUC O&M Plan, a copy will be inserted into the Comprehensive LUC Management Plan for Longhorn. The Comprehensive LUC Management Plan figure and table will be updated to reflect the inclusion of LHAAP-35A(58).

The Comprehensive LUC Management Plan consists of LHAAP RD documents and a survey plat showing the locations where LUCs being implemented at LHAAP are applied. The purpose of this Comprehensive LUC Management Plan is to ensure all site specific LUCs are compiled into one comprehensive location for both pre-transfer use by the installation and for post-transfer use by the transferee. This document will be provided to USEPA and TCEQ, and is also accessible to the local government and the public. The Comprehensive LUC Management Plan is located in the Marshall Public Library to accompany LHAAP's Administrative Record.

The land use assumption of industrial use as part of a national wildlife refuge forms the basis for the remedy at LHAAP-35A(58) and this land use assumption will be included in the Comprehensive LUC Management Plan with supporting documentation.

5.0 IN SITU BIOREMEDIATION DESIGN (EASTERN PLUME TARGET AREA)

The purpose of the in situ bioremediation design at LHAAP-35A(58) is to accelerate the rate of biological degradation of chlorinated ethenes in the shallow groundwater zone of the eastern plume and to create subsurface conditions that are favorable for MNA. In situ bioremediation will be implemented in accordance with the approved Remedial Action Work Plan in a target area where PCE and TCE hotspots are present. The target area encompasses shallow wells 03WW01, 35AWW08, and LHSMW05.

Active treatment was selected for the eastern plume and not the western plume based on the findings of the MNA evaluation of the site, which is provided in Appendix A of the FS (Shaw, 2009). For the western plume, indicators of natural attenuation were adequate to estimate a cleanup time of approximately 200 years. For the eastern plume, indicators of natural attenuation were not adequate to estimate a cleanup time. Thus, a remedy was selected to reduce contaminant mass in the eastern plume and to create more favorable conditions for natural attenuation. In the course of the remedy, additional data will be collected and used to estimate the time to attain cleanup levels.

The active treatment involves injecting a carbon source and a dechlorinating microbial consortium that includes DHC. The role of the carbon source is to provide a food source for indigenous and bioaugmented microorganisms. As the carbon source is metabolized, hydrogen is released which provides available protons required for reductive dechlorination. Competing processes include those that involve other electron acceptors such as oxygen and sulfate. Reductive dechlorination may be delayed until competing electron acceptors have decreased below competing levels.

The microbial consortium SDC-9™ has been shown to completely degrade PCE and TCE to ethene via reductive dechlorination (Environmental Security Technology Certification Program, 2005; Lo, 2008). During reductive dechlorination, the chlorinated ethenes (such as PCE) serve as an electron acceptor and chlorine atoms are sequentially replaced with protons to yield TCE, cis-1,2-DCE, VC, and ethene as daughter products. A common observation is that PCE and TCE are reductively dechlorinated under relatively mild reducing conditions (e.g., sulfate-reducing conditions), whereas reductive dechlorination of cis-1,2-DCE and VC require increasingly stronger reducing conditions (e.g., methanogenic conditions).

A conceptual design of the in situ bioremediation system is presented but the specific design parameter for field implementation is subject to change based on the result of the treatability study. A Remedial Action Work Plan providing more specific design details will be submitted and approved prior to field implementation.

5.1 Injections

The in situ bioremediation injections will utilize ten injection points with a spacing of approximately 20 feet, and with an expected radius of influence of 10 feet, to distribute amendments in the target area, as shown in **Figure 1-3**. The target area is approximately 3,600 square feet. The actual injection spacing will be determined after the completion of the treatability study.

The amendment solution will be injected in the range of 23 to 30 ft bgs. The actual interval will depend on the local lithology at each injection point and the current groundwater elevation. The injection interval was determined by the local lithology as documented in soil borings logs, cross-sections, and the monitoring well construction logs for LHSMW05 and 03WW01. The contaminated saturated zone was determined to be between approximately 23 to 30 feet bgs and therefore is the target interval for this injection.

5.2 Amendments

This section discusses the role of the various amendments, and the bench-scale treatability study that will be conducted. The tentative quantities of amendments to be injected are also presented but are subject to change based on the treatability study. The material safety data sheets for the amendments are included in **Appendix C**.

5.2.1 Components

The injection of the following amendments into the contaminated groundwater will provide the needed elements to reduce the chlorinated ethene mass at LHAAP-35A(58):

- **Emulsified vegetable oil.** A long lasting (3 to 5 years) carbon source to provide both a food and a hydrogen source for the indigenous and bioaugmented microorganisms
- **Sodium bicarbonate or equivalent product.** A buffering agent to maintain the pH of the groundwater at approximately seven, which is optimal for microbial growth
- **SDC-9™ (Shaw's dechlorinating culture) or equivalent product.** A microbial consortium shown to reductively dechlorinate PCE and its degradation daughter products, ultimately yielding harmless by-products

5.2.2 Treatability Study

A treatability test will be conducted to aid in the design and confirm the effectiveness of in situ bioremediation treatment at LHAAP-35A(58). The purpose of the study is to determine the requirements for carbon sources, nutrients, pH buffer, and the microbial consortium

SDC-9™ to stimulate the complete anaerobic reductive dechlorination of PCE and its daughter products. This study will also provide specific parameters for field implementation. A Treatability Study Work Plan will be prepared and submitted prior to the implementation of the Treatability Study.

5.3 Performance Monitoring and Transition to Monitored Natural Attenuation

A baseline sampling event will take place prior to the in situ bioremediation injections. Performance monitoring for in situ bioremediation will be detailed in the Remedial Action Work Plan. Performance monitoring will be used to evaluate the effectiveness of the bioremediation treatment and to determine if additional amendment injections will be necessary.

The duration of the in situ bioremediation segment of the remedy is considered to be from the start of field work in the target area (such as baseline sampling) to the end of the performance sampling program. After six quarters of performance monitoring for in situ bioremediation, the data will be evaluated to determine the effectiveness of the bioremediation in meeting the RAOs. After the end of performance monitoring for in situ bioremediation, the monitoring schedule for the target area will be aligned with the schedule for the rest of the eastern plume.

6.0 FIELD ACTIVITIES

Field activities to be conducted at LHAAP-35A(58) including the field implementation of the in situ bioremediation treatment system will be fully described in the subsequent Remedial Action Work Plan. This section generally describes the field activities planned at LHAAP-35A(58). Site-specific activities are described in associated subsections. The field activities to be conducted under this RD are outlined below:

- Pre-mobilization activities
- Preliminary activities/mobilization
- Site clearing
- DPT groundwater sampling and well installation
- Groundwater and surface water sampling
- Waste management
- Decontamination
- Well abandonment
- Demobilization
- Health and safety
- Quality assurance/quality control

The field activities will be conducted in accordance with the Site-Specific Supplement to Health and Safety Plan (HASP) in **Appendix D**. The work will be routinely inspected in accordance with the Contractor Quality Control Plan (CQCP) in **Appendix E**. Additional information regarding these tasks and standard operating procedures (SOP) can be found in Appendix C, Chemical Data Acquisition Plan (CDAP), and Appendix D, Field Procedures of the *Final Installation-Wide Work Plan* (Shaw, 2006).

6.1 Pre-mobilization Activities

A pre-construction meeting will be held for the U.S. Army, USEPA, TCEQ, and Shaw prior to the initiation of field activities.

The survey to determine the metes-and-bounds for the LUC and the notification of non-residential use will be conducted. The survey will be done by a state-licensed surveyor and the coordinate system will be Texas State Plane, NAD 1983. **Figure 6-1** indicates the LUC boundary that will be surveyed.

Prior to mobilization, Shaw will secure any applicable permits and notifications. These may include federal, state and local requirements, such as obtaining an underground injection control permit and notifying Texas811. Shaw will also secure utility clearance for water, sewer, gas, electric, and communication.

Shaw will inspect LHAAP-35A(58) to identify underground and overhead obstructions that may restrict groundwater monitoring activities or in situ bioremediation and may relocate injection locations to avoid underground and surface obstructions. If power must be shut down, the power outage will be coordinated with groundwater treatment plant (GWTP) and fire station operations.

6.2 Preliminary Activities/Mobilization

Shaw anticipates mobilizing the following personnel:

- Quality control/safety manager
- One laborer/sample technician
- Field engineer for injections
- Geologist
- Drilling subcontractor crew

Those personnel will utilize the following equipment:

- Pickup trucks
- Groundwater monitoring field parameters test equipment
- Groundwater sampling pumps
- Injection rig/DPT rig and injection trailer

Additional equipment will be mobilized as necessary if the field conditions or planned activities merit additional site clearing or well installation.

6.3 Site Clearing

Site maps and a global positioning system (GPS) will be used to locate and identify monitoring wells selected for sampling as shown on **Figure 3-3**. Monitoring wells to be sampled will be cleared of vegetation and biohazards (e.g., poison ivy, stinging insects) to ensure safe access for groundwater sampling.

6.4 Direct-Push Technology Groundwater Sampling and Well Installation

Figures 3-1 and **3-2** show the proposed DPT groundwater sampling locations and 9 proposed new monitoring well locations. The DPT groundwater sampling will improve the delineation of the plumes and aid in finalizing the locations and screen intervals of the new wells. The purposes of the new well locations are provided in **Table 3-2**.

6.5 Groundwater and Surface Water Sampling

Groundwater and surface water sampling will be performed in accordance with the requirements presented in the CQCP (**Appendix E**). Additional details for sampling and analysis are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP and Appendix D, Field Procedures (Shaw, 2006). Once the RD is approved, the schedule for sampling will be determined and added to the LHAAP-wide monitoring schedule.

6.5.1 Monitored Natural Attenuation

The monitoring portion of MNA will be accomplished by collecting groundwater samples from the 17 wells shown on **Figure 3-3**. In the eastern plume MNA area and the western plume, performance monitoring for MNA begins with the start of field work. In the eastern plume target area, performance monitoring for MNA will follow the in situ bioremediation segment of the remedy. Groundwater elevations will be measured in these and several surrounding wells to evaluate groundwater flow direction. Groundwater elevations are particularly important at LHAAP-35A(58) because the water table has been changing over the years, and has generally been getting deeper.

The electronic interface probe used to measure depth to groundwater in monitoring wells and pumps used for well development, purging and sampling will be decontaminated prior to use at each well. The equipment will be decontaminated using a non-phosphate detergent (such as Alconox, Liquinox, or equivalent), followed by two potable water rinses, one deionized water rinse, and air dried. Decontamination fluids will be containerized for subsequent disposal. Clean single use disposable equipment (tubing or bailers) may be used for sampling a well without this decontamination process.

Groundwater monitoring for MNA will be conducted quarterly for two years. All collected groundwater samples will be analyzed for VOCs and the following field parameters: pH, temperature, ORP, DO, conductivity, and turbidity. A subset of the groundwater samples (03WW01, 35AWW06, 35AWW08, 35AWW09, LHSMW04, LHSMW07), those from wells historically within the groundwater plume, will also be tested for the following MNA parameters: DHC, alkalinity, common anions (chloride, sulfate, nitrate, nitrite), sulfide, TOC, dissolved iron and manganese, total phosphorus, carbon dioxide and dissolved gases (methane, ethane, ethene), total iron, and ferric iron. Also, the following additional MNA parameters are considered optional, and may be collected: hydrogen and volatile fatty acids. **Table 6-1** indicates the analytical parameters for each well. **Table 6-2** lists the test methods, sample container, and sample preservation requirements.

Any performance monitoring well found to be dry during quarterly sampling of the MNA performance monitoring will be replaced in the same quarter. The location of the replacement well will be adjacent to the dry well.

6.5.2 Long-Term Monitoring

After the first two years, the effectiveness of MNA will be evaluated (**Section 7.1**). If the MNA evaluation determines MNA to be effective, the analytical suite will be reduced to only VOCs, and the frequency of sampling will be reduced to semiannual sampling for three years, then annually until the next five-year review. Further reductions in sampling will depend on results of five-year reviews, but sampling will continue at least once every five years until cleanup levels are attained.

6.5.3 Surface Water Sampling

Annual sampling of the surface water location indicated in **Figure 3-4** will be conducted as described in **Section 3.6**.

6.6 In Situ Bioremediation

Field implementation of the in situ bioremediation will be performed in accordance with the approved Remedial Action Work Plan.

6.7 Waste Management

This section specifies methods and procedures to be implemented by Shaw to verify that waste generated during site activities are handled, transported, stored, and disposed in compliance with applicable federal, state, and local rules and regulations. Waste management activities will be conducted in accordance with the requirements presented in Task 3 of the CQCP (**Appendix E**).

Description of Wastes. Groundwater sampling activities at LHAAP-35A(58) are expected to generate the following waste streams:

Waste Type	Estimated Quantity	Disposal Method
Decontamination Water – Non-Hazardous Waste	100 gallons [(2) 55-gallon drums]	LHAAP Groundwater Treatment Plant (GWTP)
Miscellaneous Wastes (personal protective equipment, paper towels, rags, well casings, etc.)	---	Municipal Solid Waste

Waste Handling. The liquid waste will be disposed at the GWTP at LHAAP-18/24. If at some point in the future when the GWTP may cease its operations, water will be handled in accordance with current regulations at that time, and will be transported and disposed of off-site. Additional details for disposal sampling are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP and Appendix D, Field Procedures (Shaw, 2006).

The non-hazardous decontamination and purge water will be stored in 55-gallon drums until disposal at the LHAAP GWTP. The miscellaneous wastes will be placed in plastic bags until disposal.

The miscellaneous wastes will be disposed of at an off-site municipal solid waste facility.

6.8 Decontamination of Equipment and Personnel

A permanent decontamination station is located at the on-site GWTP at LHAAP-18/24 and can accommodate large equipment. Temporary decontamination pads will be constructed at an approved on-site location as needed to decontaminate equipment and prevent cross-contamination between well locations. The decontamination pad will be approximately 15 feet in length and width, bermed, and covered with high-density polyethylene sheeting. Wash water will be contained and transported to the GWTP for disposal when necessary. Reusable equipment will be decontaminated between groundwater sampling locations and prior to leaving the site. Further information on decontamination procedures are found in the *Final Installation-Wide Work Plan*, Appendix D, Field Procedures (Shaw, 2006).

6.9 Well Abandonment

Wells that have been dry, are not needed to gather groundwater level measurements, or are not part of the planned monitoring system, will be abandoned. The wells tentatively planned to be abandoned are indicated on **Figure 6-2**. Final recommendation for well abandonment will be submitted as part of the LTM recommendations in the MNA Performance Evaluation Report. Well abandonment will follow the well abandonment procedures in the *Final Installation-Wide Work Plan*, Section 3.9 (Shaw, 2006).

A separate mobilization will be made for well abandonment activities. The waste generated from these activities (concrete, well casings, etc.) will be disposed off site at an approved solid waste landfill.

Once the well abandonment has been completed, Shaw will restore the areas and demobilize. Areas disturbed in the course of well abandonment will be regraded to blend with the surrounding topography.

6.10 Demobilization

Upon completion of well abandonment operations, Shaw will remove any temporary facilities, perform final equipment decontamination, and demobilize personnel and equipment.

6.11 Health and Safety

The HASP (the latest revision of Appendix A of the *Final Installation-Wide Work Plan* [Shaw, 2006]) incorporates health and safety policies and safe operating procedures for individual project site activities. These procedures allow work activities to be carried out in a controlled, effective manner, consistent with Shaw policies and USACE requirements (USACE, 2008).

Information specific to the activities at the LHAAP-35A(58) is provided in **Appendix D**. This information includes personal protective equipment levels, air monitoring requirements, and activity hazard analyses. These items supplement the HASP; they do not replace it. This information is not addressed by the site-wide HASP because the hazards are unique to the proposed work.

Prior to initiating work at the facility for any site, workers will have signed the HASP in the designated area to indicate they have read and understood the document. Also, daily safety meetings will be held with all field crew members prior to starting work each day in order to review the day's scope of work, any site conditions expected, and any hazards that need to be addressed or acknowledged.

6.12 Quality Assurance/Quality Control

The CQCP provides information on quality assurance/quality control (QA/QC) procedures for this project. The CQCP identifies personnel, procedures, controls, instructions, tests, verifications, documents, and forms to be used and the types of records to be maintained. The CQCP addresses quality control requirements specific to each major feature of work, including special steps that apply to LHAAP-35A(58). The CQCP is provided in **Appendix E**.

The USACE Three-Phase QC process will be used to enforce QA/QC requirements and include preparatory inspections, initial inspections, and follow-up inspections. The three-phases of inspections will target each definable feature of work during the execution of project activities.

Table 6-1
Sample Parameters

Well	Groundwater Zone	VOCs	Field Parameters	MNA Parameters
Eastern Plume Target Area (in situ bioremediation)				
03WW01 [a]	Shallow	✓	✓	✓
35AWW08	Shallow	✓	✓	✓
35AWW09 (proposed)	Shallow	✓	✓	✓
Eastern Plume (MNA)				
35AWW01	Intermediate	✓	✓	
35AWW10 (proposed)	Shallow	✓	✓	✓
35AWW11 (proposed)	Shallow	✓	✓	✓
35AWW12 (proposed)	Shallow	✓	✓	
35AWW13 (proposed)	Shallow	✓	✓	
35AWW14 (proposed)	Shallow	✓	✓	
35AWW21 (proposed)	Shallow	✓	✓	
LHSMW04	Shallow	✓	✓	✓
Western Plume (MNA)				
35AWW05	Intermediate	✓	✓	
35AWW06	Shallow	✓	✓	✓
35AWW15 (proposed)	Shallow	✓	✓	
35AWW16 (proposed)	Shallow	✓	✓	
35AWW17 (proposed)	Shallow	✓	✓	
35AWW18 (proposed)	Shallow	✓	✓	
35AWW19 (proposed)	Shallow	✓	✓	
35AWW20 (proposed)	Shallow	✓	✓	✓
LHSMW06	Shallow	✓	✓	
LHSMW07	Shallow	✓	✓	✓

Notes and Abbreviations:

[a] *If 03WW01 is abandoned as a consequence of excavation activities at LHAAP-03, a replacement well will be installed.*

Field parameters: pH, temperature, oxidation reduction potential, dissolved oxygen, conductivity, and turbidity.

MNA parameters (only first two years): dehalococcoides, alkalinity, common anions (chloride, sulfate, nitrate, nitrite), sulfide, total organic carbon, dissolved iron and manganese, total phosphorus, carbon dioxide and dissolved gases (methane, ethane, ethene), total iron, and ferric iron. Optional parameters: hydrogen and volatile fatty acids.

MNA	*monitored natural attenuation*
VOCs	*volatile organic compounds included in the COC list in* Table 1-1

Table 6-2
Sample Methods, Containers, and Preservation

Parameter	Minimum Sample Volume	Holding Time	Preservation	Method
Water				
Volatile organic compounds (VOCs)	3x40 mL glass vial with PTFE septa cap	14 days	pH < 2 HCl, Cool to 4°C, no headspace	8260B (or latest method)
Dehalococcoides (DHC)	2x1 L amber glass bottles with teflon-lined cap(s)	14 days	Cool to 4°C	polymerase chain reaction (PCR)
Alkalinity (total, carbonate and bicarbonate)	250 mL polyethylene bottles	14 days	Cool to 4°C	EPA 310.2
Common anions (chloride [Cl], sulfate [SO4], nitrate [NO3], nitrite	250 mL polyethylene bottles	28 days (Cl/SO4) and 48 hours (individual NO3 and NO2)	Cool to 4°C	EPA 300.0
Nitrate/nitrite as N	500 mL polyethylene bottles	28 days	pH<2 H2SO4, Cool to 4°C	EPA 353.2
Sulfide	250 mL polyethylene bottles	7 days	pH>9 zinc acetate plus NaOH, Cool to 4°C	EPA 376.1
Total organic carbon (TOC)	125 mL polyethylene bottles	28 days	pH<2 H2SO4 or HCl, Cool to 4°C	EPA 415.1
Dissolved iron and manganese	500 mL polyethylene bottles	6 months	pH<2 HNO3, Cool to 4°C	6010B
Phosphorus, total	100 mL polyethylene bottles	28 days	pH<2 H2SO4, Cool to 4°C	EPA 365.4
Carbon dioxide and dissolved gases (methane/ethane/ethene)	3x40 mL glass vial with PTFE septa cap	14 days	Cool to 4°C	RSK 175
Iron, total	500 mL polyethylene bottles	6 months	pH<2 HNO3, Cool to 4°C	6010B
Ferrous iron	100 mL polyethylene bottles	Immediate	Cool to 4°C	3500-Fe
**Ferric iron	NA	NA	NA	NA

Notes and Abbreviations:

The above listed volumes provide an adequate quantity of samples to anaylyze a matrix spike (MS) and matrix spike duplicate (MSD).

** Ferric Iron is difference between total iron and ferrous iron

°C - degrees centigrade

EPA - Environmental Protection Agency
H2SO4 - sulfuric acid
HCl - hydrochloric acid
HNO_3 - nitric acid
L - liter
mL - milliliter
NA - not analyzed
PTFE - polytetrafluoroethylene

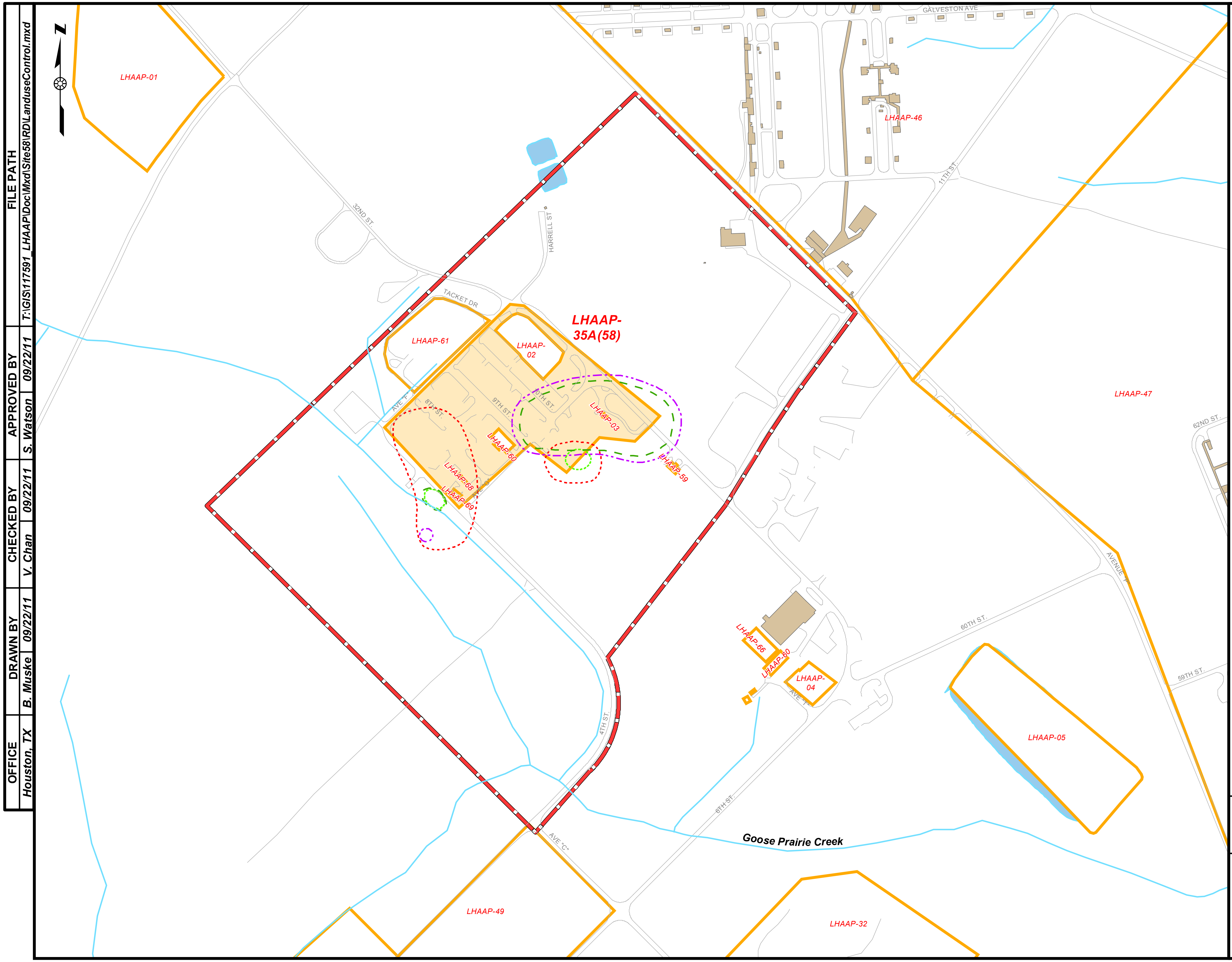
FILE PATH T:\GIS\117591_LHAAP\Doc\Mxd\Site58\RD\LanduseControl.mxd

APPROVED BY S. Watson 09/22/11

CHECKED BY V. Chan 09/22/11

DRAWN BY B. Muske 09/22/11

OFFICE Houston, TX



LEGEND

- Stream
- Road
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Preliminary Land Use Control Boundary *Groundwater use restricted to environmental monitoring and testing only.*
- Existing Building
- Other LHAAP Site
- LHAAP-35A(58) Site
- Lake/Pond

0 200 400 800 Feet

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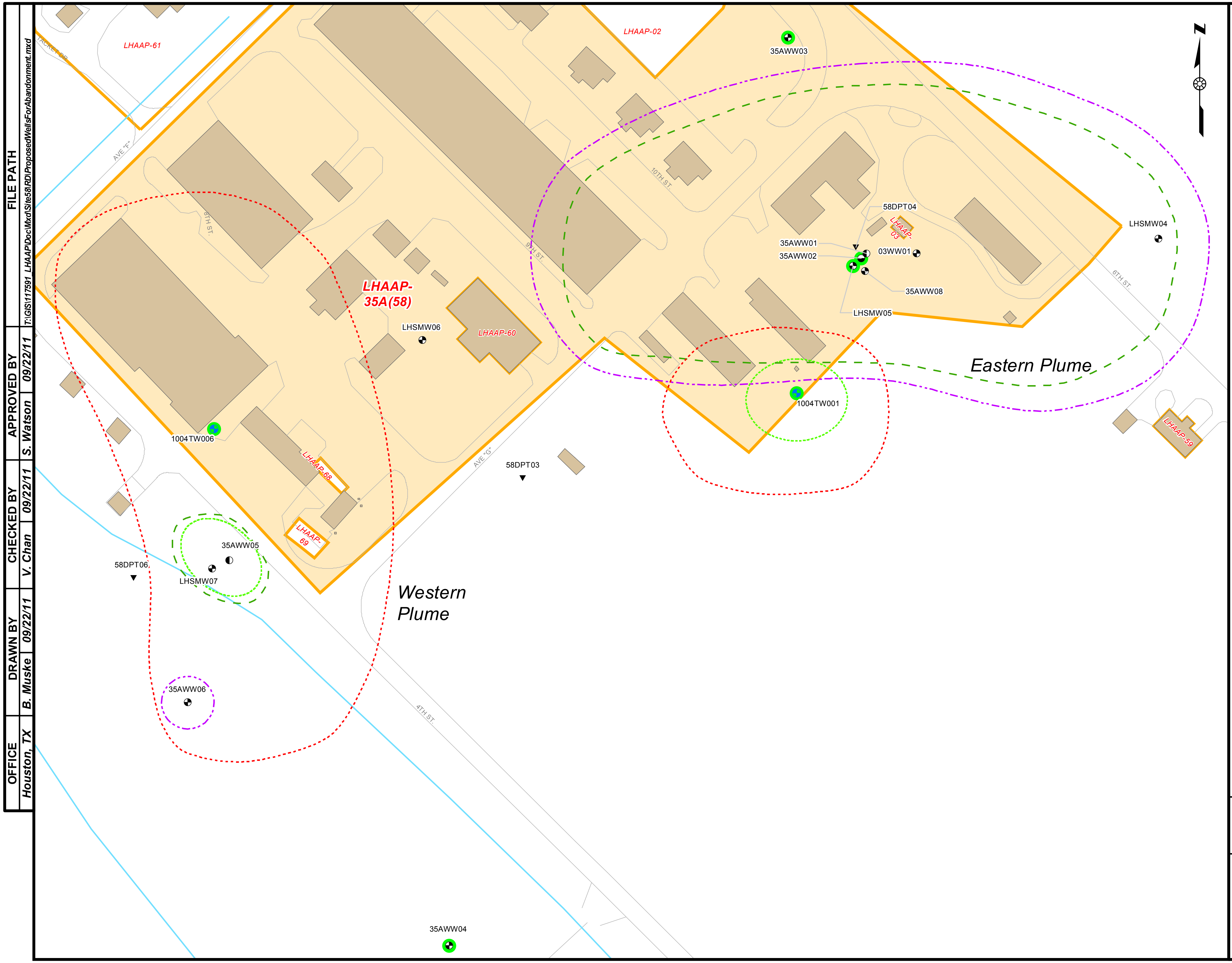
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 6-1

LAND USE CONTROL MAP
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FILE PATH	APPROVED BY	CHECKED BY	DRAWN BY	OFFICE
T:\GIS\117591_LHAAP\Doc\Mxd\Site58\RD\ProposedWellsForAbandonment.mxd	S. Watson 09/22/11	V. Chan 09/22/11	B. Muske 09/22/11	Houston, TX



LEGEND

- Plexus Temporary Monitoring Well
- Shallow Monitoring Well
- Shallow/Intermediate Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- ▼ DPT Location
- ● Proposed Wells for Abandonment (6)
- Estimated 1,1-DCE Concentration Contour (7 µg/L)
- Estimated TCE Concentration Contour (5 µg/L)
- Estimated PCE Concentration Contour (5 µg/L)
- Estimated Vinyl Chloride Concentration Contour (2 µg/L)
- Stream
- Road
- Former Building or Tank
- Other LHAAP Site
- LHAAP-35A(58) Site

Notes:

1. Concentration contours are based on data from 2003 through 2008.

1,1-DCE: 1,1-dichloroethene
PCE: tetrachloroethene
TCE: trichloroethene
µg/L: micrograms per liter

0 50 100 200
Feet

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FIGURE 6-2

PROPOSED WELLS FOR ABANDONMENT
LHAAP-35A(58), GROUP 4

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

7.0 REMEDY PERFORMANCE REPORTING

Reporting will consist of annual reports, the MNA evaluation report for the western plume and eastern plume MNA area, the in situ bioremediation evaluation report for the eastern plume target area, and five-year review reports. Annual reports will be prepared at the end of each calendar year in which groundwater samples are collected. The MNA evaluation will be prepared once, using the eight episodes of quarterly sampling results from the first two years combined with historical sampling results. The in situ bioremediation report will be prepared once, using the six episodes of quarterly sampling results for the eastern plume target area. The five-year reviews will be prepared once every five years for as long as groundwater sampling is required (until cleanup levels are achieved).

7.1 Monitored Natural Attenuation Evaluation

After eight quarters of groundwater monitoring have been completed, an MNA evaluation will be conducted and an MNA Evaluation Report prepared. MNA performance criteria are listed in **Table 7-1**. Compilation of the information for the evaluation will occur throughout the first two years of quarterly groundwater monitoring. The MNA Evaluation Report will include:

- Figures of the site, wells, and groundwater level contours
- Tables of groundwater and surface water sample results
- Comparison of plume extent and concentration over time (**Table 7-1**, Performance Criteria 1)
- Consideration of the first and second lines of evidence for MNA and optionally the third line if necessary (**Table 7-1**, Performance Criteria 2 through 4)
- An evaluation of the effectiveness of MNA at the site
- A recommendation for continued MNA, in situ bioremediation, or another remedy

7.1.1 Migration/Expansion

For the evaluation of MNA at LHAAP-35A(58) to be favorable, the MNA evaluation should demonstrate decreasing plumes, although stable plumes may be considered acceptable in the short term. A groundwater plume is stable when pollutant concentrations and the plume's footprint are stable. A stable plume shows that pollutant migration in groundwater is under control. The determination of plume dynamics should be performed for all relevant contaminants and their biodegradation daughter products.

A decreasing plume is diminishing in concentration and its location is not migrating or expanding. This occurs when the attenuation rates for dissolved-phase pollutants exceed their generation rates from all sources. Sources that are sustaining the dissolved-phase plume may include pollutants sorbed to fine-grained, low-permeability materials located throughout the plume. A decreasing plume supports natural attenuation as a viable remedial alternative.

Table 7-1
Monitored Natural Attenuation Evaluation Performance Criteria

Performance Criteria	Type	Expected Performance	Commentary
1) Migration/Expansion	Qualitative	Stable or shrinking size, stable position	An expanding or migrating plume indicates MNA should not be continued
2) Concentrations	Quantitative	Falling concentrations or mass in the majority of performance wells	First Line of Evidence
3) Aquifer Conditions	Qualitative	Conditions favorable for natural attenuation	Second Line of Evidence
4) Microcosm Studies	Qualitative	Detectable presence of appropriate microorganisms	Third Line of Evidence

Monitoring must occur over a time period sufficient to demonstrate plume stability or plume reduction under natural conditions. This may take up to several years depending on site-specific conditions, including the monitoring data trend analysis, potential threats to beneficial uses, and other uncertainties. If monitoring data do not demonstrate plume stability/decrease, this may indicate that further plume remediation is necessary. The two years of quarterly sampling, combined with historic sampling data, will provide sufficient data for stability and trend analysis. MNA cannot continue as a sole remedy if the plume is clearly migrating.

7.1.2 First Line of Evidence

The first line of evidence is to evaluate historical groundwater data seeking to demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. Thus, other performance wells will be evaluated to determine if the plume is migrating.

Concentrations of COCs can be evaluated at individual wells to calculate a time-based attenuation rate. They can be evaluated across multiple wells through the centerline of a plume to calculate a distance–based attenuation rate. Average plume concentrations or mass can be evaluated if a consistent set of wells is sampled over multiple sampling episodes.

These calculations will be performed using the methods contained in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998).

Time-based attenuation rates will be calculated for any monitoring well that shows COC concentration exceedances of cleanup levels during the eight episodes of quarterly sampling. Distance-based attenuation rates will be calculated through the highest concentration wells along the direction of groundwater flow. Attenuation rates based on average plume concentrations or mass will be calculated if the dataset will support the process. Monitoring wells 35AWW08 and 03WW01 are expected to be the primary focus of analysis at LHAAP-35A(58) because they represent the highest concentration area at LHAAP-35A(58). Thus, the data from these wells will be evaluated to determine if there is a clear and meaningful trend of decreasing concentrations and/or mass.

7.1.3 Second Line of Evidence

Decreasing concentration trends by themselves are not sufficient evidence that COCs are being destroyed. The second line of evidence uses chemical analytical data in mass balance to show that decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in metabolic end products or daughter compounds. The evidence can be used to show the groundwater conditions are sufficiently favorable to natural attenuation so that degradation of chlorinated solvent contaminants can occur.

The second line of evidence evaluates parameters such as nitrates, sulfates, ferrous iron, dissolved oxygen, ORP, nitrate, ferrous iron, sulfate, methane, ethane and ethene, chloride, TOC, carbon dioxide, alkalinity, pH and phosphorous. The results of tests for these analytes will be interpreted using the *Technical Protocol for Evaluating Attenuation of Chlorinated Solvents in Ground Water* (USEPA, 1998).

For the MNA evaluation, if COC concentrations are decreasing and the groundwater geochemistry in the plume area are favorable for the occurrence of degradation, then MNA may continue to be applied at the site. If groundwater conditions are unfavorable to the extent that any decrease in concentrations must be attributed to migration, then more aggressive treatment will be evaluated as a contingency remedy.

7.1.4 Third Line of Evidence

The third line of evidence consists of data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of natural attenuation processes at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

For the MNA evaluation, the presence of microorganisms (DHC) in the groundwater capable of degrading the COCs would be favorable to continued MNA. If such organisms are absent, and the first two lines of evidence are not favorable, then more aggressive treatment should be evaluated as a contingency remedy.

7.1.5 Monitored Natural Attenuation Performance Evaluation

The completed Preliminary Draft Monitored Natural Attenuation Evaluation will be submitted to the U.S. Army for review and comment. Following this, a Draft Final Monitored Natural Attenuation Evaluation will be submitted to the regulatory agencies for review and comment. A Draft Final Monitored Natural Attenuation Evaluation will address the regulatory comments and will be submitted for review. When regulatory agency comments have been resolved, the Final Monitored Natural Attenuation Evaluation will be issued. The Final Monitored Natural Attenuation Evaluation will determine whether MNA continues to be the remedial action applied at LHAAP-35A(58), or whether another more aggressive treatment should be evaluated as a contingency remedy.

The first and second lines of evidence will be evaluated for decreasing COC concentrations and optimal geochemical conditions to demonstrate MNA. The third line of evidence will be evaluated if necessary. If the MNA evaluation determines that MNA is not an effective sole remedy, then an explanation of significant difference will be prepared and an amendment to this document will be made to design and implement a contingency remedy. This contingency remedy is expected to be a form of bioremediation as included in the ROD (U.S. Army, 2010), but the final design of the contingency remedy will be determined by the results of groundwater samples collected during the MNA performance monitoring period. The MNA Performance Evaluation Report will also include recommendations for future LTM and well abandonments.

7.2 In Situ Bioremediation Evaluation

After six quarters of performance monitoring have been completed in the eastern plume target area, an in situ bioremediation evaluation will be conducted and the report will be prepared. The objective of the evaluation will be to determine whether the injections in the eastern plume target area have been effective, or whether a second round of injections is appropriate. If there is a second round of injections, the final design for that will be determined by the results of groundwater sampling during performance monitoring. The report will include:

- Figures of the site, wells, and groundwater level contours
- Tables of groundwater sample results for the target area

- Comparison of plume extent and concentrations over time; the overall level of VOCs is anticipated to be reduced by approximately 90% over the course of the 1.5 years of performance monitoring
- An evaluation of the effectiveness of in situ bioremediation in the target area at creating conditions favorable for MNA, based on the first and second lines of evidence
- A recommendation on whether a second round of injections is appropriate; if there is a second round of injections, the final design for that will be determined by the results of groundwater samples collected during performance monitoring

The completed Preliminary Draft In Situ Bioremediation Evaluation will be submitted to the U.S. Army for review and comment. Following this, a Draft In Situ Bioremediation Evaluation will be submitted to the regulatory agencies for review and comment. A Draft Final In Situ Bioremediation Evaluation will address the regulatory comments and will be submitted for review. When regulatory agency comments have been resolved, the Final In Situ Bioremediation Evaluation will be issued.

7.3 Annual Reports

An annual report will be prepared at the end of each year of LTM in which groundwater samples are collected to present groundwater sample results, a description of field activities, and to document other relevant information that may be considered useful for the five-year review. The annual report will include:

- A narrative of field activities
- Figures of the site and wells and groundwater levels
- Tables of groundwater and surface water sample results
- Copies of field paperwork, including disposal documentation
- Relevant photographs

Perimeter well data will be evaluated for plume migration while the data from wells within the plume areas will be evaluated for MNA performance.

7.4 Five-Year Review Reports

Five-year reviews will be performed for LHAAP-35A(58) (U.S. Army, 2010). While the intent is to perform these reviews every 5 years after the implementation of the remedy (i.e., remedy in place), the performance of the first Five-Year Review will be aligned with the Base-Wide Five-Year Review. The Five-Year Review report will present summaries of information from the annual reports and from the five-year sampling event, evaluate that information, and recommend the future course of action. The Five-Year Review will include:

- A narrative of field activities for the past five years
- Figures of the site and well locations
- Summary of groundwater and surface water sample results
- Site inspection with relevant photographs
- Evaluation of progress toward cleanup levels
- Results/summary of the annual LUC inspections
- Revisions to the LUC or monitoring schedules
- Recommendations for future actions

The progress toward cleanup levels will be evaluated in the five-year report. The Five-Year Review offers the periodic opportunity to declare the site successfully and completely remediated, progressing satisfactorily toward remediation, or in need of more aggressive remedy. When cleanup levels are reached, monitoring may cease as recommended in the Five-Year Review.

8.0 SCHEDULE

The estimated length of time for groundwater monitoring activities including site setup, clearing, groundwater sampling, waste management and site restoration is approximately one week for each sampling episode. The estimated length of time to complete eight quarters of groundwater sampling and prepare the MNA evaluation report is approximately two and one half years. The estimated lengths of time for the treatability study and for injection field work are two months and one week, respectively. **Tables 8-1** and **8-2** show the anticipated duration for each of the major site activities for the eastern plume target area and the MNA areas, respectively. Shaw's mobilization to LHAAP-35A(58) for the first round of MNA performance sampling is anticipated to begin in July 2011 after final approval of this document.

Table 8-1
Durations for Major Site Activities – Eastern Plume Target Area

Activities	Duration	Elapsed Time
Establish land use control	1 month	1 month
DPT GW sampling and well installation	1 month	1 month
Treatability study	2 months	2 months
In situ bioremediation injections	1 week	3 months
Mobilization / site setup	1 day	-
Production of anaerobic water	1 day	-
Direct push injections	5 days	-
Demobilization	1 day	-
Quarterly monitoring for bioremediation, quarter 1	3 months	6 months
Mobilization / site setup	1 day	-
Groundwater sampling	4 days	-
Demobilization	1 day	-
Estimated duration	6 days per episode	-
Quarterly monitoring, quarters 2 through 6	15 months	2 years
In situ bioremediation evaluation	0.5 year	2.5 years
Quarterly monitoring for MNA	2 years	4 years
MNA evaluation (final document)	0.5 year	4.5 years
Well abandonment	2 days	4.5 years
Five-year review	0.5 year	5 years
Semi-annual monitoring	3 years	7 years
Annual monitoring (years 8 through 10)	2 years	10 years
Sample once every 5 years (repeat until cleanup levels are met)	-	15, 20, 25 years, etc.
Achieve cleanup levels	-	Estimate TBD

Notes and Abbreviations:

Does not include pre-mobilization activities or rerouting of utilities.
Includes expectation of favorable in situ bioremediation and MNA evaluations.
Schedule revision expected after MNA evaluation and five-year review.

MNA	*monitored natural attenuation*
TBD	*to be determined*

Table 8-2
Durations for Major Site Activities – Eastern Plume Monitored Natural Attenuation Area and Western Plume

Activities	Duration	Elapsed Time
Establish land use control	1 month	1 month
DPT GW sampling and well installation	1 month	1 month
Quarterly monitoring for MNA (quarter 1)	3 months	3 months
Mobilization / site setup	1 day	-
Groundwater sampling	4 days	-
Demobilization	1 day	-
Estimated duration	6 days per episode	-
Quarterly monitoring, quarters 2 through 8	1.75 year	2 years
MNA Evaluation (final document)	0.5 year	2.5 years
Well abandonment	2 days	2.5 years
Semi-annual monitoring	3 years	5 years
Five-year review	0.5 year	5 years
Annual monitoring (years 5 through 10)	5 years	10 years
Sample once every 5 years (repeat until cleanup levels are met)	-	15, 20, 25 years, etc.
Achieve cleanup levels	-	200 years

Notes and Abbreviations:

Does not include pre-mobilization activities or rerouting of utilities.

Includes expectation of favorable MNA evaluation.

Schedule revision expected after MNA evaluation and five-year review.

MNA	*monitored natural attenuation*

9.0 REFERENCES

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USACE, 2008, *Safety and Health Requirements Manual*, EM 385-1-1, September.

U.S. Environmental Protection Agency (USEPA), 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, September.

USEPA, 1999, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, Directive 9200.4-17P. USEPA Office of Solid Waste and Emergency Response, Washington, DC.

Appendix A

Inspection/Certification Form

Sample Annual Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design dated __________ for LHAAP-35A(58) a certification of site was conducted by _____________________ [indicate transferee] on __________.

A summary of land use control mechanisms is as follows:

- Groundwater restriction –restriction of the use of groundwater to environmental monitoring and testing until cleanup goals are met [Indicate whether groundwater restrictions are still required at LHAAP-35A(58)]

A summary of compliance with land use and restriction covenants is as follows:

- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-35A(58)

I, the undersigned, do document that the certification was performed as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: ______________________________

Name/Title: ____

Signature: ______________________________

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year.

Attachments

- **Metes and Bound Survey of Area for LUC Implementation**
- **Monitoring Well Logs**
- **Notice of Filed Land Use Controls for LHAAP-35A(58)**

The attachments will be submitted once the surveys are completed; the well system is defined and wells are installed; and the notification is filed.

Appendix B

Well Construction Diagrams and Boring Logs

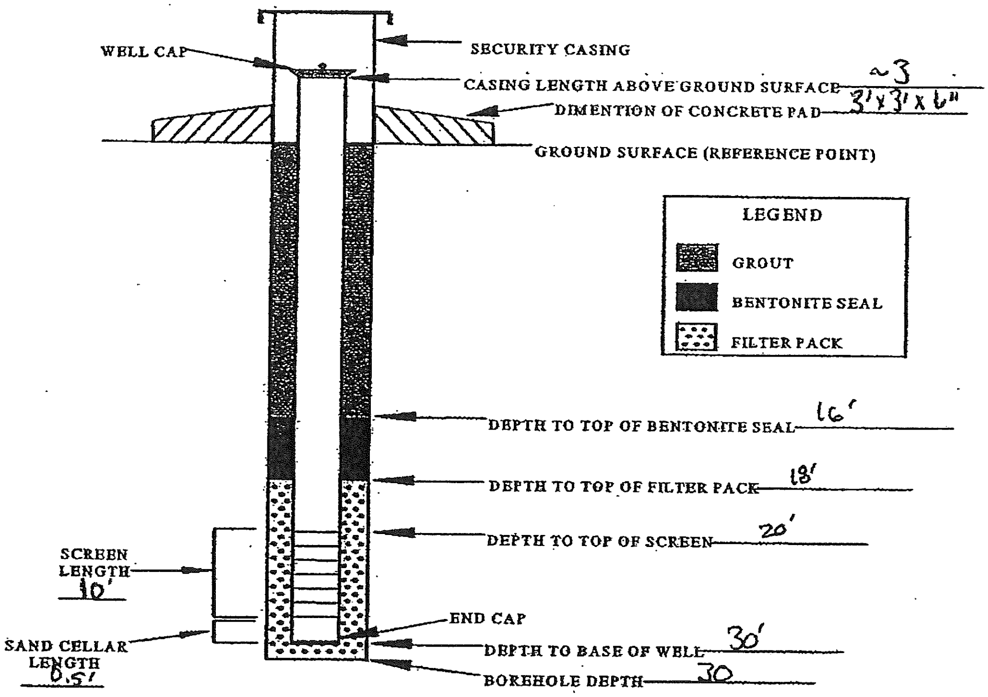
03WW01

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: Allen Willmore
DRILLING CONTRACTOR: ETTL
DRILLING TECHNIQUE: H.SA.
AUGER SIZE AND TYPE: 8" I.D.
BOREHOLE IDENTIFICATION: 03WW01
BOREHOLE DIAMETER: 4"
WELL IDENTIFICATION: 07WW01
WELL CONSTRUCTION START DATE: 11/18/08
WELL CONSTRUCTION COMPLETE DATE: 11/18/08
SCREEN MATERIAL: sch. 40 PVC
SCREEN DIAMETER: 4"
STRATUM-SCREENED INTERVAL (FT): 10'
CASING MATERIAL: sch. 40 PVC
CASING DIAMETER: 4"

TYPE OF FILTER PACK: Silica Sand
GRADIATION: 20/40
AMOUNT OF FILTER PACK USED: 9-bags 50lbs
TYPE OF BENTONITE: pellets
AMOUNT BENTONITE USED: 1-50lb bucket
TYPE OF CEMENT: portald cement
AMOUNT CEMENT USED: NR
GROUT MATERIALS USED: Bent.
DIMENSIONS OF SECURITY CASING: 8"x8"x~3'
TYPE OF WELL CAP: plugging cap
TYPE OF END CAP: sch. 40 PVC
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: Doug Hinds/Billy Ragan INSTALLATION OBSERVED BY: Allen Willmore
DISCREPANCIES: none

HOLE NO. 03WW01

DRILLING LOG

DIVISION FEDERAL

INSTALLATION Longhorn

SHEET 1 OF 3 SHEETS

1. PROJECT LHAAP
2. LOCATION (Coordinates or Station) Karnack, Texas
3. DRILLING AGENCY ETTL
4. HOLE NO. (As shown on drawing title and file number) 03WW01
5. NAME OF DRILLER Doug Hinds
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED 0° DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 30'
8. DEPTH DRILLED INTO ROCK 0'
9. TOTAL DEPTH OF HOLE 30'
10. SIZE AND TYPE OF BIT 8" I.D. HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL 5500 CME
13. OVERBURDEN SAMPLES DISTURBED UNDISTURBED ✓
14. TOTAL NUMBER CORE BOXES NR
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 11/18/08 COMPLETED 11/18/08
17. ELEVATION TOP OF HOLE NR
18. TOTAL CORE RECOVERY FOR BORING NR %

Allen Willmore INSPECTOR

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
0.0		CL	CLAY, SANDY, LOW TO NO PLASTICITY, BROWN, MOIST, NO ODOR, STIFF, iron staining	90%		
			- Becomes DRY			
0.0						
0.0			- Becomes hard			
	5					
0.0				100%		
0.0			- Becomes more sandy			
0.0						
0.0	10	SM	SAND, SILTY, Brownish-gray, moist	100%	☒	- Sample collected from 10'-11' bgs
0.0						
0.0						

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE NR	Hole No. 03WW01
PROJECT LHAAP - MARC	INSTALLATION LHAAP	SHEET 2 OF 3 SHEETS

~~ELEVATION~~ PID	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
a	b	c	d	e	f	g
			Same as above			
6.0						
		SM			☒	→Sample collected 14'-15' bgs (~~above~~ bottom of vadose) AC
	15			90%		
0.0						▼
		SC	Sand, clayey, wet, dense, brown, poorly-sorted, no odor			
0.0						
			~~CLAY, sandy, dark gray to gray, very stiff, low plasticity, moist~~ AC 11/[illegible]08			
0.0	20			95%		
0.0			– becomes more moist			
0.0			CLAY, SANDY, dark gray to gray, very stiff, low plasticity, moist			
	25	CL		85%		
0.0						
0.0						
				100%		

ENG FORM 1836–A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

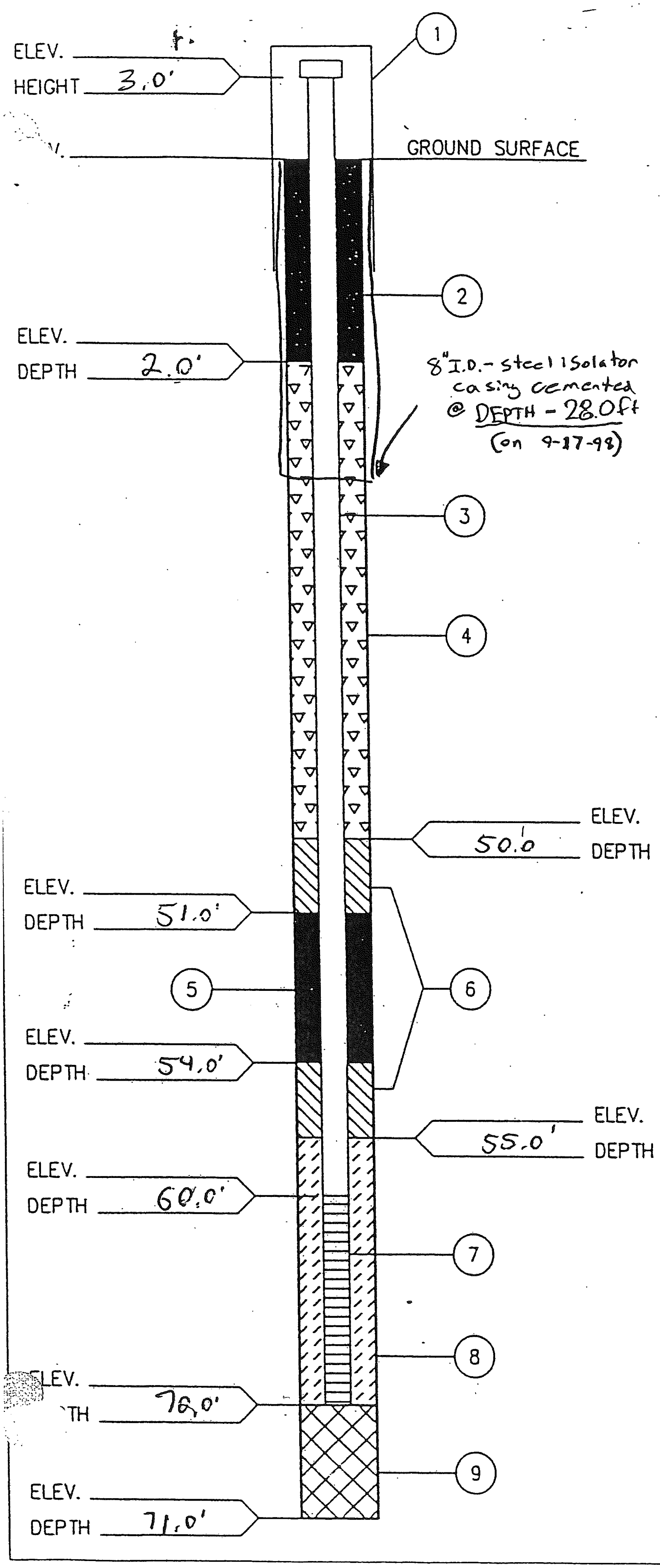
DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE NR	Hole No. 03WW01
PROJECT LHAAP-MARC	INSTALLATION LHAAP	SHEET 3 OF 3 SHEETS

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
		CL	SAME AS Above	100%		
	30		End of boring @ 30' bgs			

ENG FORM 1836—A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

00111607

35AWW01 (I)



ELEV. f.
HEIGHT 3.0'

ELEV.

ELEV.
DEPTH 2.0'

8" I.D. - steel isolator casing cemented @ DEPTH - 28.0ft (on 9-27-98)

ELEV.
DEPTH 50.0'

ELEV.
DEPTH 51.0'

ELEV.
DEPTH 54.0'

ELEV.
DEPTH 55.0'

ELEV.
DEPTH 60.0'

ELEV.
DEPTH 70.0'

ELEV.
DEPTH 71.0'

MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 35AWW01 (I)

DATE 9-29-98

CHIEF/UNIT BB / Mobile B-61

1. PROTECTIVE CASING [✓ YES] NO
   LOCKING [✓ YES] NO
2. TYPE OF SURFACE SEAL (IF INSTALLED)
   Cement
3. SOLID PIPE TYPE stainless steel
   SOLID PIPE LENGTH 63.0' ft.
   JOINT TYPE SLIP/GLUED/[✓ THREADED]
4. TYPE OF BACKFILL Bent./cement. grout
   HOW INSTALLED – [✓ TREMIE] (1" I.D.)
   FROM SURFACE
5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite seal (hydrated)
6. TYPE OF SECONDARY FILTER PACK
   Sand (30-70)
7. SCREEN TYPE Stainless steel
   SCREEN LENGTH 10.0' ft.
   SLOT SIZE #10 machine in.
   SCREEN DIAMETER 4 in. (I.D
8. TYPE OF PRIMARY FILTER PACK
   Primary Sand (16-30)
9. TYPE OF BACKFILL (as above)
10. DRILLING METHOD Mud Rotory (8" tricone sawtooth)

WATER LEVEL ______ DATE ______

*ALL DEPTHS MEASURED FROM GROUND SURFACE

Sverdrup
ENVIRONMENTAL

Shaw

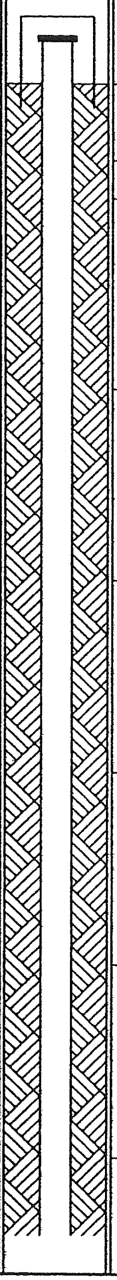
Drilling Log

Monitoring Well **35AWW05** (58)

Page: 1 of 3

Project Longhom Army Ammunition Plant
Owner Shaw E&I, Inc.
Location Kamack, Texas
Proj. No. 845714
Surface Elev. 219.0 ft.
Total Hole Depth 75.5 ft.
North 6959849.641 ft.
East 3304426.136 ft.
Top of Casing 221.41 ft.
Water Level Initial ▽ 43.5 ft.
Static ▼ 38.2 ft.
Diameter 10 in.
Screen: Dia 4 in.
Length 10 ft.
Type/Size PVC/0.01 in.
Casing: Dia 4 in.
Length 67.91 ft.
Type Sch. 40 PVC
Fill Material 20/40 Sand, Bentonite Grout
Rig/Core Foremost 5500/5' Core Barrel
Drill Co. ETTL
Method Hollow Stem Auger w/Mud Rotary Capabilities
Driller Doug Hines
Log By Dale Jayne
Date 4/18/04
Driller # NA
Checked By Kay Everett
License No. NA

COMMENTS
12" CARBON STEEL SURFACE CASING SET AT 38' BGS; APPROXIMATE DIAMETER OF SECTION 1 BOREHOLE IS 19" AND SECTION 2 IS 9"



Depth (ft.)	PID (ppm)	Sample ID % Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.	Elevation (ft.)
				4'x4'x6" Conc. Pad w/ 4" diameter bollards	
0	0.0	NA 75%	ML	SILT, YELLOWISH-RED, MEDIUM STIFF, DRY	219.01 218
2	0.0	NA 50%	CL	CLAY, RED-GRAY, MOTTLING PRESENT	216
4 6	0.0	NA 100%			214
8			CL	-BECOMES LIGHT BLUISH-GRAY IN COLOR	212
10	0.0	NA 80%			210 208
12			SP	SAND, FINE-GRAINED	
			CL	SILTY CLAY, LIGHT BLUISH GRAY	
14 16	0.0	NA 100%	ML	CLAYEY SILT, LIGHT BLUISH GRAY, SOFT, MOIST	206 204 202
18				-BECOMES LIGHT GREENISH-GRAY	200
20 22	0.0	NA 100%	CL	SILTY CLAY, LAYER OF LIGNITE, LIGHT GREENISH-GRAY, SOFT, MOIST	198
				-BECOMES MEDIUM STIFF	196
24			SP	SAND, FINE GRAINED, TRACES OF CLAY, LIGHT BLUISH GRAY	194
26	0.0	NA 100%	ML	SILT, TRACES OF CLAY, LIGHT GREENISH-GRAY, SOFT, MOIST	192
28 30	0.0	NA 100%	CL	SILTY CLAY, LIGHT BLUISH-GREEN, SOFT, MOIST -BECOMES BROWN AND LIGHT BLUISH GRAY IN COLOR	190

Continued Next Page

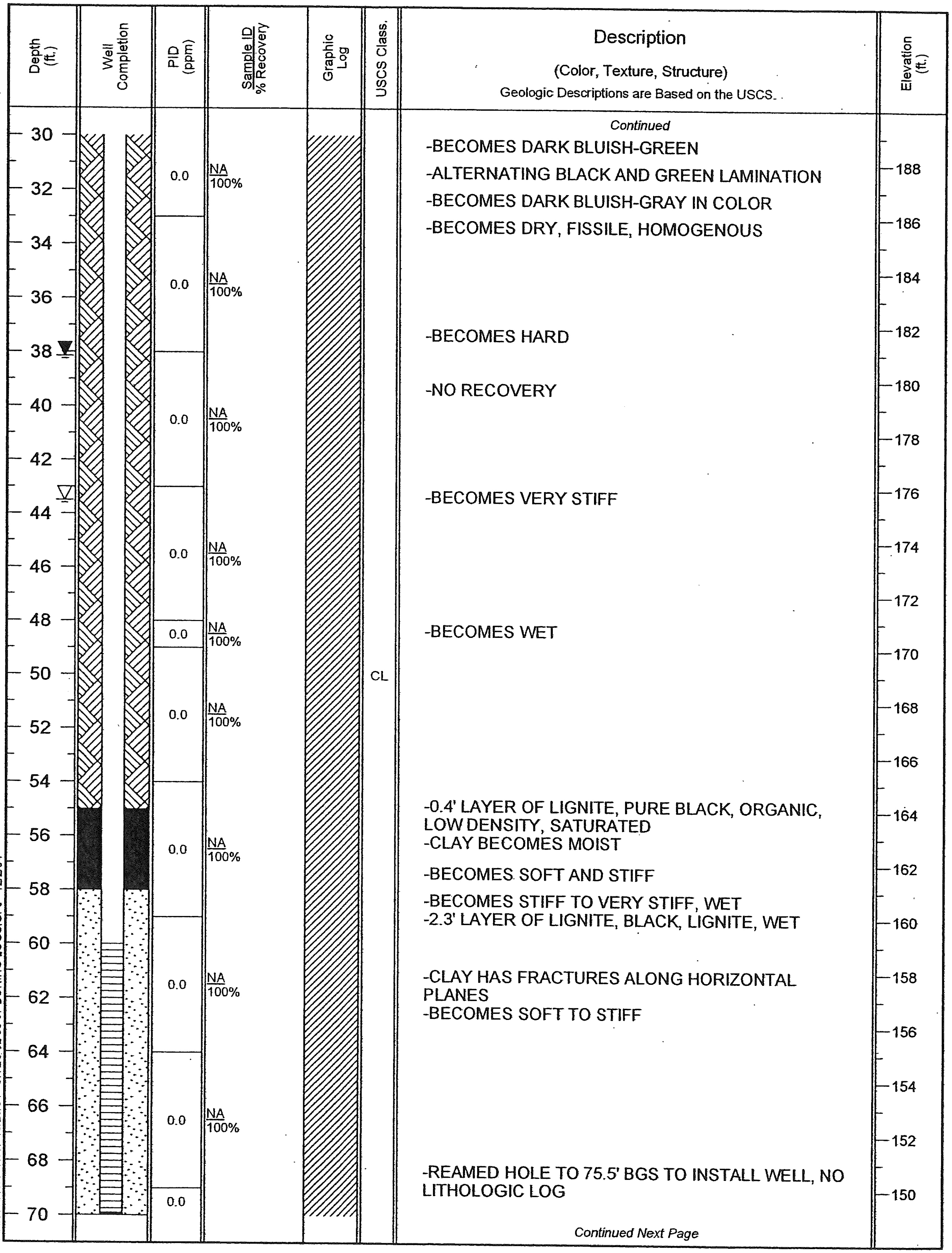
Shaw™

Drilling Log

Monitoring Well 35AWW05

Page: 2 of 3

Project Longhorn Army Ammunition Plant Owner Shaw E&I, Inc.
Location Karnack, Texas Proj. No. 845714



Description (Color, Texture, Structure)
Geologic Descriptions are Based on the USCS.

Continued

-BECOMES DARK BLUISH-GREEN
-ALTERNATING BLACK AND GREEN LAMINATION
-BECOMES DARK BLUISH-GRAY IN COLOR
-BECOMES DRY, FISSILE, HOMOGENOUS

-BECOMES HARD

-NO RECOVERY

-BECOMES VERY STIFF

-BECOMES WET

-0.4' LAYER OF LIGNITE, PURE BLACK, ORGANIC, LOW DENSITY, SATURATED
-CLAY BECOMES MOIST

-BECOMES SOFT AND STIFF

-BECOMES STIFF TO VERY STIFF, WET
-2.3' LAYER OF LIGNITE, BLACK, LIGNITE, WET

-CLAY HAS FRACTURES ALONG HORIZONTAL PLANES
-BECOMES SOFT TO STIFF

-REAMED HOLE TO 75.5' BGS TO INSTALL WELL, NO LITHOLOGIC LOG

Continued Next Page

Shaw™

Drilling Log

Monitoring Well 35AWW05

Page: 3 of 3

Project *Longhorn Army Ammunition Plant* Owner *Shaw E&I, Inc.*

Location *Karnack, Texas* Proj. No. *845714*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.	Elevation (ft.)
						Continued	
70							
							148
72		0.0	NA 100%				
					CL		146
74							
		0.0	NA 100%				144
76						END OF BORING	
							142
78							
							140
80							
							138
82							
							136
84							
							134
86							
							132
88							
							130
90							
							128
92							
							126
94							
							124
96							
							122
98							
							120
100							
							118
102							
							116
104							
							114
106							
							112
108							
							110
110							

35AWW06

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: Allen Willmore

DRILLING CONTRACTOR: ETTL

DRILLING TECHNIQUE: H.S.A.

AUGER SIZE AND TYPE: 8" I.D.

BOREHOLE IDENTIFICATION: 35A WW06

BOREHOLE DIAMETER: 4"

WELL IDENTIFICATION: 35AWW06

WELL CONSTRUCTION START DATE: 11/14/08

WELL CONSTRUCTION COMPLETE DATE: 11/14/08

SCREEN MATERIAL: sch. 40 pvc

SCREEN DIAMETER: 4"

STRATUM-SCREENED INTERVAL (FT):

CASING MATERIAL: sch. 40 PVC

CASING DIAMETER: 4"

TYPE OF FILTER PACK: Silica Sand

GRADIATION: 20/40

AMOUNT OF FILTER PACK USED: 9-bags 50lbs

TYPE OF BENTONITE: pellets

AMOUNT BENTONITE USED: 1-50lb bucket

TYPE OF CEMENT: portald -cement

AMOUNT CEMENT USED: NR

GROUT MATERIALS USED: Bent.

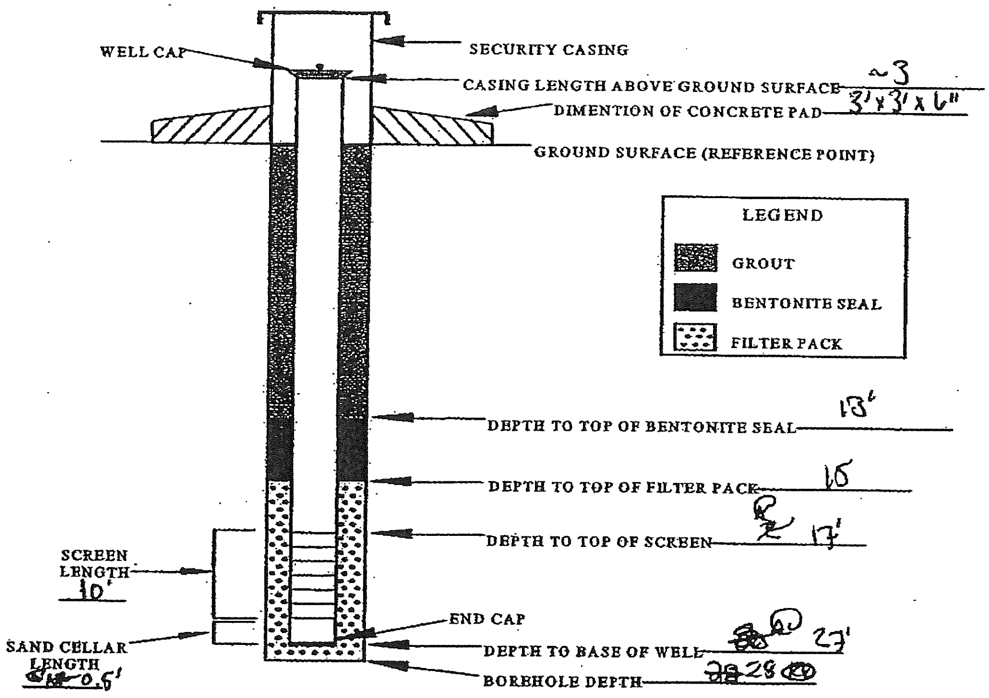
DIMENSIONS OF SECURITY CASING: 8"x8"x~3'

TYPE OF WELL CAP: plugging cap

TYPE OF END CAP: sch. 40 pvc

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



CASING LENGTH ABOVE GROUND SURFACE ~3

DIMENTION OF CONCRETE PAD 3'x3'x6"

GROUND SURFACE (REFERENCE POINT)

DEPTH TO TOP OF BENTONITE SEAL 13'

DEPTH TO TOP OF FILTER PACK 15

DEPTH TO TOP OF SCREEN 17'

SCREEN LENGTH 10'

DEPTH TO BASE OF WELL ~~30~~ 27'

SAND CELLAR LENGTH ~~6"~~ 0.5'

BOREHOLE DEPTH ~~28~~ 28

NOT TO SCALE

INSTALLED BY: Doug Hinds/Billy Rogers INSTALLATION OBSERVED BY: Allen Willmore

DISCREPANCIES: none

HOLE NO. 35AWW06

DRILLING LOG	DIVISION FEDERAL	INSTALLATION Longhorn AAP	SHEET 1 OF 2 SHEETS

1. PROJECT Longhorn MARC
2. LOCATION (Coordinates or Station) Karnack, Tx
3. DRILLING AGENCY ETTL
4. HOLE NO. (As shown on drawing title and file number) 35AWW06
5. NAME OF DRILLER Billy Ragon
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED 0° DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 28'
8. DEPTH DRILLED INTO ROCK 0'
9. TOTAL DEPTH OF HOLE 28'
10. SIZE AND TYPE OF BIT 10" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Foremost 5500
13. OVERBURDEN SAMPLES DISTURBED ✓ UNDISTURBED
14. TOTAL NUMBER CORE BOXES NR
15. ELEVATION GROUND WATER NR
16. DATE HOLE STARTED 11/14/00 COMPLETED 11/14/00
17. ELEVATION TOP OF HOLE NR
18. TOTAL CORE RECOVERY FOR BORING NR %

Allen Willmore INSPECTOR

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
0.0			TOPSOIL, CLAY, MOIST, SOFT, DISTURBED			
			CLAY, SILTY, HARD, NO PLASTICITY, DRY GRAY, IRON STAINING, NO ODOR	60%		
0.0						
0.0		CL				
0.0	5					
6.0				100%		
0.0						
0.0	10					
6.0				100%		
			— BECOMES SOFTER, MORE SAND CONTENT			
0.0						

DRILLING LOG (Cont Sheet)	ELEVATION TOP OF HOLE	Hole No. 35AWW06
PROJECT Longhorn MARC	INSTALLATION Longhorn AAP	SHEET 2 OF 2 SHEETS

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
0.0			Sameas above			
0.0	15	~~SC-SP~~	~~SAND, very clayey, gray, moist, dense poorly-sorted, no odor~~ AW 1/14/08	100%		
		CL				
0.0						
0.0						
0.0	20	SC-SP	SAND, very clayey, gray, moist, dense, poorly-sorted, no odor	100%	▼	
0.0						
0.0						
0.0	25			100%		
0.0		CL	CLAY, SILTY, GRAY, HARD, NO PLASTICITY DRY TO DAMP, NO ODOR.			
			END OF BORING @ 28' bgs			

ENG FORM 1836—A PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71

PROJECT Longhorn MARC

HOLE NO. 35AWW06

35AWW08

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: Allen Willmore

DRILLING CONTRACTOR: ETTL

DRILLING TECHNIQUE: H.SA.
AUGER SIZE AND TYPE: 8" I.D.

BOREHOLE IDENTIFICATION: 35A WW08
BOREHOLE DIAMETER: 4"
WELL IDENTIFICATION: 35AWW08

WELL CONSTRUCTION START DATE: 11/18/08
WELL CONSTRUCTION COMPLETE DATE: 11/18/08

SCREEN MATERIAL: sch. 40 pvc
SCREEN DIAMETER: 4"
STRATUM-SCREENED INTERVAL (FT): 10'

CASING MATERIAL: sch. 40 PVC
CASING DIAMETER: 4"

TYPE OF FILTER PACK: Silica Sand
GRADIATION: 20/40
AMOUNT OF FILTER PACK USED: 9-bags 50lbs

TYPE OF BENTONITE: pellets
AMOUNT BENTONITE USED: 1- 50lb bucket

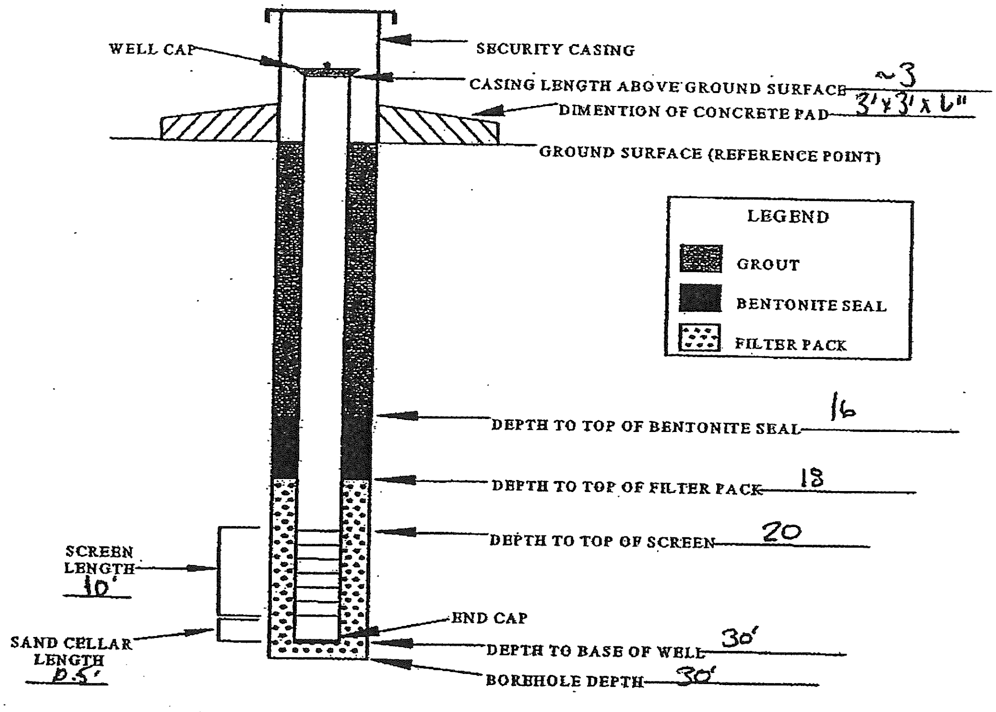
TYPE OF CEMENT: portald cement
AMOUNT CEMENT USED: NR
GROUT MATERIALS USED: bent.

DIMENSIONS OF SECURITY CASING: 8" x 8" x ~3'

TYPE OF WELL CAP: plugging cap
TYPE OF END CAP: sch. 40 pvc

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



CASING LENGTH ABOVE GROUND SURFACE ~3
DIMENTION OF CONCRETE PAD 3'x3'x6"
DEPTH TO TOP OF BENTONITE SEAL 16
DEPTH TO TOP OF FILTER PACK 18
DEPTH TO TOP OF SCREEN 20
SCREEN LENGTH 10'
SAND CELLAR LENGTH 0.5'
DEPTH TO BASE OF WELL 30'
BOREHOLE DEPTH 30'

NOT TO SCALE

INSTALLED BY: Doug Hinds/Billy Rogers INSTALLATION OBSERVED BY: Allen Willmore

DISCREPANCIES: none

HOLE NO. 35AWW08

DRILLING LOG

DIVISION FEDERAL

INSTALLATION Longhorn

SHEET 1 OF 1 SHEETS

1. PROJECT LHAAP
2. LOCATION (Coordinates or Station) Karnack, Texas
3. DRILLING AGENCY ETTL
4. HOLE NO. (As shown on drawing title and file number) 35AWW08
5. NAME OF DRILLER Doug Hinds
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED 0° DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 30'
8. DEPTH DRILLED INTO ROCK 0'
9. TOTAL DEPTH OF HOLE 30'
10. SIZE AND TYPE OF BIT 8" I.D. HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL 5500 CME
13. OVERBURDEN SAMPLES DISTURBED UNDISTURBED ✓
14. TOTAL NUMBER CORE BOXES NR
15. ELEVATION GROUND WATER NR
16. DATE HOLE STARTED 11/18/08 COMPLETED 11/18/08
17. ELEVATION TOP OF HOLE NR
18. TOTAL CORE RECOVERY FOR BORING NR %

Allen Willmore INSPECTOR

~~ELEVATION~~ PID a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
NR			Same lithology as 35AWW01. See boring log ~~35AWW01~~ LHSMW05 (AW) for lithologic decription. This boring ends @ 30' bgs			Well completed to replace well LHSMW05; however this well was completed @ a deeper depth.
	30'		END OF BORING			
	~~5~~					
	~~10~~					

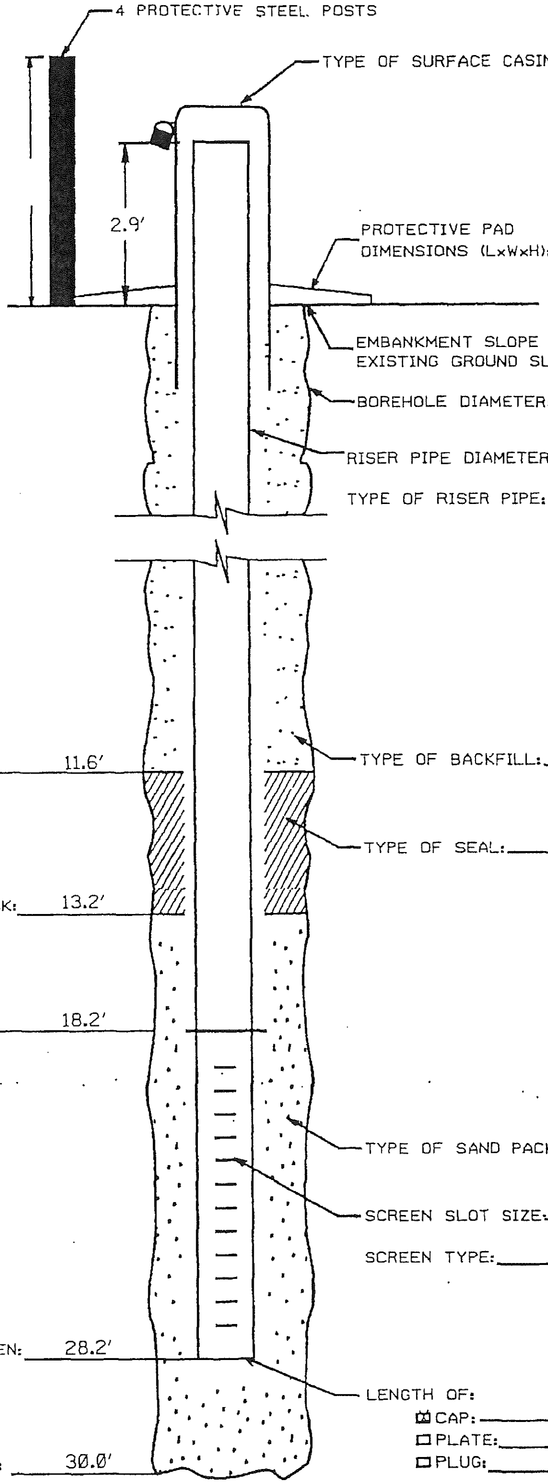
WELL NO. LHS-MW4

MONITORING WELL SHEET

PROJECT & INSTALLATION:
LONGHORN ARMY AMMUNITION PLANT - SUMPS

DATE STARTED:
8-22-1994

DATE COMPLETED:
8-23-1994



TYPE OF SURFACE CASING: STEEL

PROTECTIVE PAD DIMENSIONS (LxWxH): 4'X4'X6'

EMBANKMENT SLOPE OR EXISTING GROUND SURFACE.

GROUNDWATER DEPTH: 13.2'

GROUNDWATER DATE: 8-23-1994

BOREHOLE DIAMETER: 8'

RISER PIPE DIAMETER: 4'

TYPE OF RISER PIPE: PVC

TOP OF SEAL: 11.6'

TYPE OF BACKFILL: GROUT/5% BENTONITE

TYPE OF SEAL: BENTONITE

TOP OF SAND PACK: 13.2'

TOP OF SCREEN: 18.2'

TYPE OF SAND PACK: 16/30

SCREEN SLOT SIZE: .010'

SCREEN TYPE: 316 SS

BOTTOM OF SCREEN: 28.2'

LENGTH OF:
☒ CAP: 6'
☐ PLATE:
☐ PLUG:

BOTTOM OF HOLE: 30.0'

INSPECTOR:
STEVE BREWER

LHWCD.DGN LORI KRUSE

LHS-MW04

KOB
7/28/04

HOLE NO. LHS-MW4

DRILLING LOG

DIVISION SOUTHWEST

INSTALLATION LHAAP

SHEET 1 OF 1 SHEETS

1. PROJECT LHAAP-WASTE SUMPS
2. LOCATION (Coordinates or Station) 6960183.80 3305398.40
3. DRILLING AGENCY TULSA DISTRICT COE
4. HOLE NO. (As shown on drawing title and file number) LHS-MW4
5. NAME OF DRILLER TOM BEAVERS
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 30.0
8. DEPTH DRILLED INTO ROCK 0.0
9. TOTAL DEPTH OF HOLE 30.0
10. SIZE AND TYPE OF BIT 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL CME 75
13. OVERBURDEN SAMPLES DISTURBED 12 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES 0
15. ELEVATION GROUND WATER SEE REMARKS
16. DATE HOLE STARTED 08/22/1994 COMPLETED 08/23/1994
17. ELEVATION TOP OF HOLE 214.0
18. TOTAL CORE RECOVERY FOR BORING 0.0 %

STEVE BREWER

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f
205.0	3 6 9	▨	LEAN CLAY (CL) (0.0 - 9.0) SANDY, OLIVE BROWN TO BROWNISH GRAY, MOIST, ROOTS TO 3.4'.		J-1 J-2 J-3
198.0	12 15	▨	LEAN CLAY (CL) (9.0 - 16.0) OLIVE YELLOW, MOIST.		J-4 J-5
195.1	18	▨	LEAN CLAY (CL) (16.0 - 18.9) SANDY, LIGHT YELLOWISH BROWN, MOIST.		J-6
190.2	21 24	▨	LEAN CLAY (CL) (18.9 - 23.8) WITH SAND, YELLOWISH BROWN, MOIST, SILTY.		J-7
188.8		○	CLAY SAND (SC) (23.8 - 25.2) WITH GRAVEL, REDDISH BROWN, MOIST, GRAVELS TO 1/2".		J-8
186.8	27	○	CLAY SAND (SC) (25.2 - 27.2) PALE BROWN, MOIST, ROOTS.		J-9
185.9		▨	LEAN CLAY (CL) (27.2 - 28.1) SANDY, REDDISH BROWN, MOIST, GRAVELS TO 1/2".		J-10
185.0		▩	FAT CLAY (CH) (28.1 - 29.0) SANDY, REDDISH BROWN, MOIST, GRAVEL TO 1/2".		J-11
184.0	30	▩	FAT CLAY (CH) (29.0 - 30.0) WITH SAND, LIGHT BROWNISH GRAY MOIST.		J-12

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

WATER ENCOUNTERED @ 13.2'

SAMPLE TYPE	ZONE
SPLITSPOON	0.0- 30.0

SAMPLE	DEPTH
J-1	0.3- 1.2
J-2	1.2- 3.4
J-3	3.4- 9.0
J-4	9.0- 13.2
J-5	13.2- 16.0
J-6	16.0- 18.9
J-7	18.9- 23.8
J-8	23.8- 25.2
J-9	25.2- 27.2
J-10	27.2- 28.1
J-11	28.1- 29.0
J-12	29.0- 30.0

PROJECT LHAAP-WASTE SUMPS

HOLE NO. LHS-MW4

WELL NO. LHS-MW5

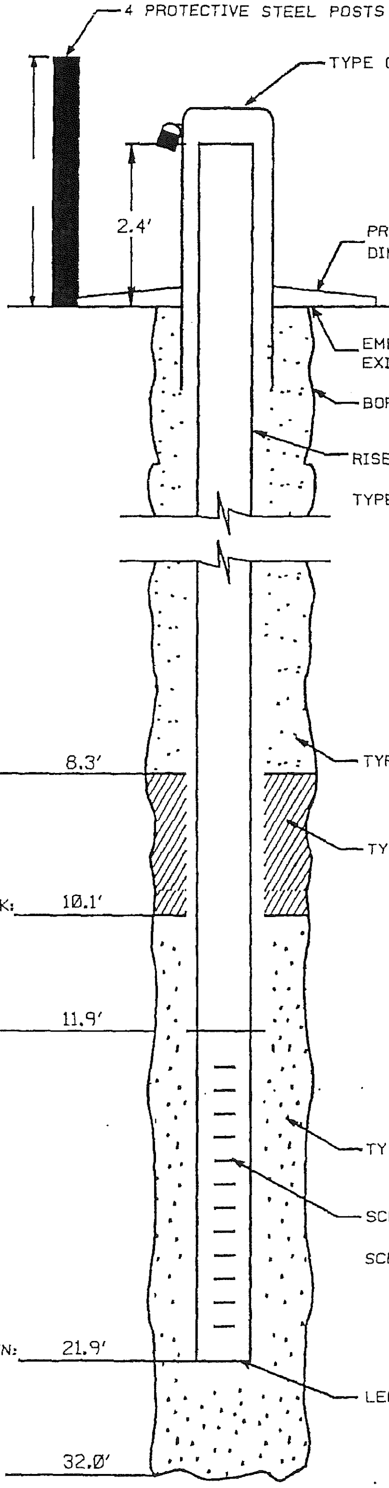
MONITORING WELL SHEET

PROJECT & INSTALLATION:
LONGHORN ARMY AMMUNITION PLANT - SUMPS

DATE STARTED:
8-22-1994

DATE COMPLETED:
8-22-1994

GROUNDWATER DEPTH: NOT OBSERVED
GROUNDWATER DATE:



TYPE OF SURFACE CASING: STEEL
PROTECTIVE PAD DIMENSIONS (LxWxH): 4'X4'X6"
BOREHOLE DIAMETER: 8"
RISER PIPE DIAMETER: 4'
TYPE OF RISER PIPE: PVC
TYPE OF BACKFILL: GROUT/5% BENTONITE
TYPE OF SEAL: BENTONITE
TYPE OF SAND PACK: 16/30
SCREEN SLOT SIZE: .010'
SCREEN TYPE: 316 SS
LENGTH OF:
☒ CAP: 6"
☐ PLATE:
☐ PLUG:

TOP OF SEAL: 8.3'
TOP OF SAND PACK: 10.1'
TOP OF SCREEN: 11.9'
BOTTOM OF SCREEN: 21.9'
BOTTOM OF HOLE: 32.0'

INSPECTOR:
MERLIN DEAN

LHWCD.DGN LORI KRUSE

LHS-MW05

KDB
7/28/04

HOLE NO. LHS—MW5

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION LHAAP	SHEET 1 OF 2 SHEETS

1. PROJECT LHAAP—WASTE SUMPS
2. LOCATION (Coordinates or Station) 6960159.80 3305079.10
3. DRILLING AGENCY TULSA DISTRICT COE
4. HOLE NO. (As shown on drawing title and file number) LHS—MW5
5. NAME OF DRILLER RAY VOILS
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED: ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 32.0
8. DEPTH DRILLED INTO ROCK 0.0
9. TOTAL DEPTH OF HOLE 32.0
10. SIZE AND TYPE OF BIT 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
13. OVERBURDEN SAMPLES DISTURBED 9 UNDISTURBED 13
14. TOTAL NUMBER CORE BOXES 0.
15. ELEVATION GROUND WATER NOT DETERMINED
16. DATE HOLE STARTED 08/22/1994 COMPLETED 08/22/1994
17. ELEVATION TOP OF HOLE 215.1
18. TOTAL CORE RECOVERY FOR BORING 0.0 %

STEVE BREWER

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
213.6		▨	LEAN CLAY (CL) (0.0 – 1.5) SANDY, BROWNISH GRAY, MOIST, VERY STIFF, NUMEROUS ROOTS IN TOP, BLACK IRON—OXIDE STAINS, ASPHALTIC MATERIAL FROM 0.7'—0.8', GRAYISH BROWN FAT CLAY IN BOTTOM 0.7'.		ST—1	SAMPLE TYPE ZONE SHELBY 0.0— 19.5 SPLITSPOON 19.5— 32.0 SAMPLE DEPTH ST—1 0.0— 1.5 ST—2 1.5— 3.0 ST—3 3.0— 4.5 ST—4 4.5— 6.0 ST—5 6.0— 7.5 ST—6 7.5— 9.0 ST—7 9.0— 10.5 ST—8 10.5— 12.0 ST—9 12.0— 13.5 ST—10 13.5— 14.7 ST—11 15.0— 16.5 ST—12 16.5— 18.0 ST—13 18.0— 19.5 J—1 19.5— 21.0 J—2 21.0— 22.5 J—3 23.0— 24.5 J—4 24.5— 26.0 J—5 26.0— 27.0 J—6 27.0— 28.0 J—7 28.0— 28.4 J—8 28.4— 30.0 J—9 30.0— 32.0
212.1	2	▨	FAT CLAY (CH) (1.5 – 3.0) WITH SAND, BROWNISH GRAY WITH RED, VERY MOIST, STIFF.		ST—2	
210.6	4	▨	FAT CLAY (CH) (3.0 – 4.5) WITH SAND, RED ANDY GRAY, MOIST, STIFF TO VERY STIFF, FEW NODULES.		ST—3	
209.1	6	▨	LEAN CLAY (CL) (4.5 – 6.0) WITH SAND, GRAY WITH YELLOW AND RED, HARD, SCATTERED BLACK IRON—OXIDE STAINS, TOP 0.5'.		ST—4	
206.1	8	▨	LEAN CLAY (CL) (6.0 – 9.0) SANDY, GRAY WITH YELLOW, MOIST HARD TO VERY STIFF.		ST—5 ST—6	
204.6	10	▨	LEAN CLAY (CL) (9.0 – 10.5) WITH SAND, LIGHT GRAY WITH YELLOW, MOIST, HARD, BECOMING SANDY WITH DEPTH.		ST—7	
203.1	12	○	SILTY SAND (SM) (10.5 – 12.0) LIGHT GRAY WITH YELLOW, VERY MOIST.		ST—8	
201.6		▨○	CLAY SAND (SC) (12.0 – 13.5) SILTY, YELLOW WITH LIGHT GRAY, VERY MOIST.		ST—9	
200.1	14	▨○	CLAY SAND (SC) (13.5 – 15.0) YELLOW WITH LIGHT GRAY, VERY MOIST, VERY STIFF, TOP 0.9' SILTY SAND (SM), VERY SOFT.		ST—10	
198.6	16	▨	LEAN CLAY (CL) (15.0 – 16.5) SANDY, DARK YELLOW WITH LIGHT GRAY, MOIST, VERY STIFF, SMALL POCKET OF GRAVEL AT 15.9'.		ST—11	
197.1	18	▨	FAT CLAY (CH) (16.5 – 18.0) WITH SAND, YELLOW AND LIGHT GRAY, MOIST, VERY STIFF TO HARD SCATTERED BLACK IRON—OXIDE STAINS, TOP 0.6' SANDY LEAN CLAY, VERY MOIST.		ST—12	
195.6		▨	LEAN CLAY (CL) (18.0 – 19.5) WITH SAND, YELLOW AND LIGHT GRAY, MOIST, VERY STIFF.		ST—13	
195.1	20	▨	FAT CLAY (CH) (19.5 – 23.0) LIGHT BROWNISH GRAY, MOIST		J—1	

LHSMW05

KDB
7/28/04

HOLE NO. LHS-MW5

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION LHAAP	SHEET 2 OF 2 SHEETS

1. PROJECT LHAAP-WASTE SUMPS	10. SIZE AND TYPE OF BIT 8" AUGER
2. LOCATION (Coordinates or Station) 6960159.80 3305079.10	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY TULSA DISTRICT COE .	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) LHS-MW5	13. OVERBURDEN SAMPLES DISTURBED 9 UNDISTURBED 13
5. NAME OF DRILLER RAY VOILS	14. TOTAL NUMBER CORE BOXES 0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER NOT DETERMINED
	16. DATE HOLE STARTED 08/22/1994 COMPLETED 08/22/1994
	17. ELEVATION TOP OF HOLE 215.1
7. THICKNESS OF OVERBURDEN 32.0	18. TOTAL CORE RECOVERY FOR BORING 0.0 %
8. DEPTH DRILLED INTO ROCK 0.0	
9. TOTAL DEPTH OF HOLE 32.0	STEVE BREWER

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
192.1	22	▨	FAT CLAY (CH) (19.5 – 23.0) LIGHT BROWNISH GRAY, MOIST.		J-1 J-2	
190.6	24	▨	FAT CLAY (CH) (23.0 – 24.5) WITH SAND, LIGHT YELLOWISH BROWN, MOIST.		J-3	
188.1	26	▨	FAT CLAY (CH) (24.5 – 27.0) LIGHT YELLOWISH BROWN TO GRAY, MOIST.		J-4 J-5	
186.7	28	▧	LEAN CLAY (CL) (27.0 – 28.4) GRAY TO DARK GRAY, MOIST.		J-6 J-7	
183.1	30 32	▨	FAT CLAY (CH) (28.4 – 32.0) GRAY TO LIGHT BROWNISH GRAY, MOIST.		J-8 J-9	
	34 36 38 40					

PROJECT LHAAP-WASTE SUMPS	HOLE NO. LHS-MW5

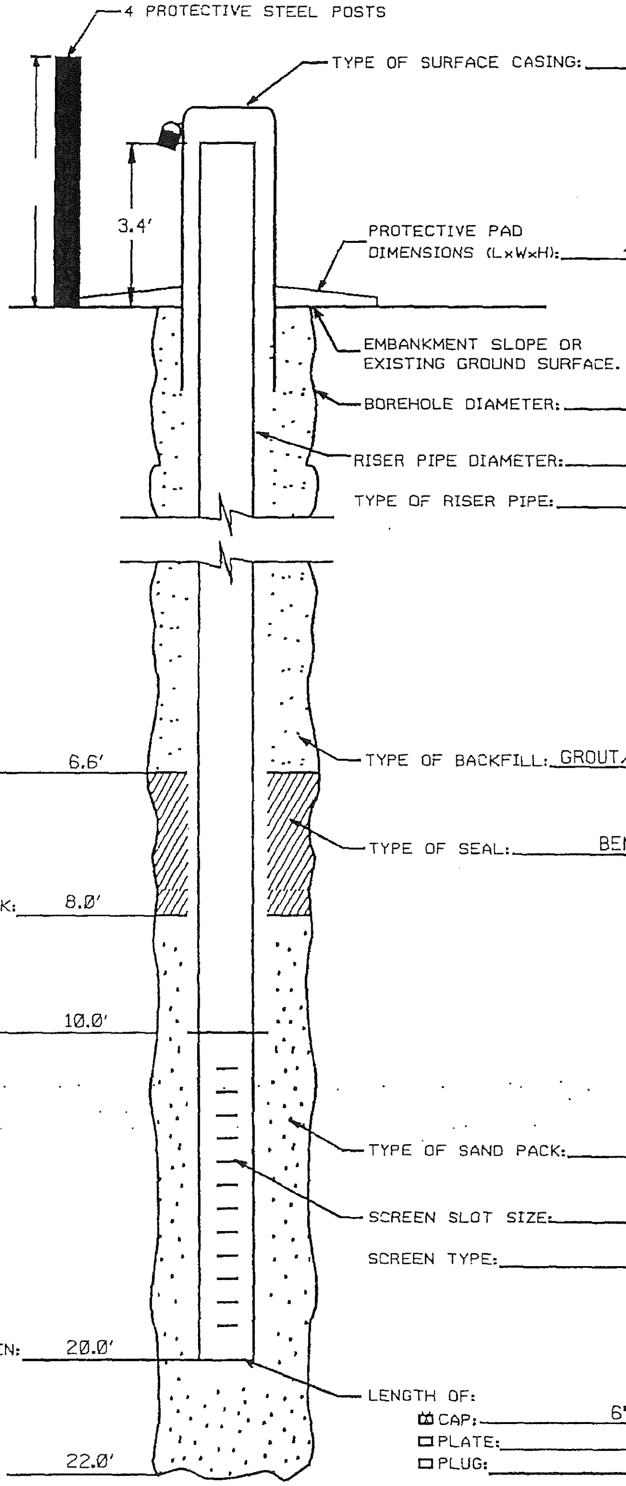
WELL NO. LHS-MW6

MONITORING WELL SHEET

PROJECT & INSTALLATION:
LONGHORN ARMY AMMUNITION PLANT - SUMPS

DATE STARTED:
8-23-1994

DATE COMPLETED:
8-24-1994



TYPE OF SURFACE CASING: STEEL

PROTECTIVE PAD DIMENSIONS (L×W×H): 4'X4'X6'

GROUNDWATER DEPTH: 10.0'

GROUNDWATER DATE: 8-24-1994

BOREHOLE DIAMETER: 8'

RISER PIPE DIAMETER: 4'

TYPE OF RISER PIPE: PVC

TOP OF SEAL: 6.6'

TYPE OF BACKFILL: GROUT/5% BENTONITE

TYPE OF SEAL: BENTONITE

TOP OF SAND PACK: 8.0'

TOP OF SCREEN: 10.0'

TYPE OF SAND PACK: 16/30

SCREEN SLOT SIZE: .010'

SCREEN TYPE: 316 SS

BOTTOM OF SCREEN: 20.0'

LENGTH OF:
☒ CAP: 6'
☐ PLATE:
☐ PLUG:

BOTTOM OF HOLE: 22.0'

INSPECTOR:
STEVE BREWER

LHWCD.DGN LORI KRUSE

LHSMW06

KDB
7/28/04

HOLE NO. LHS-MW6

DRILLING LOG

DIVISION: SOUTHWEST
INSTALLATION: LHAAP
SHEET 1 OF 1 SHEETS

1. PROJECT: LHAAP-WASTE SUMPS
2. LOCATION (Coordinates or Station): 6960080.10 3304630.70
3. DRILLING AGENCY: TULSA DISTRICT COE
4. HOLE NO. (As shown on drawing title and file number): LHS-MW6
5. NAME OF DRILLER: RAY VOILS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 22.0
8. DEPTH DRILLED INTO ROCK: 0.0
9. TOTAL DEPTH OF HOLE: 22.0
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. OVERBURDEN SAMPLES: DISTURBED 10, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: SEE REMARKS
16. DATE HOLE: STARTED 08/23/1994, COMPLETED 08/24/1994
17. ELEVATION TOP OF HOLE: 219.9
18. TOTAL CORE RECOVERY FOR BORING: 0.0 %

STEVE BREWER

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f
219.0			LEAN CLAY (CL) (0.0 - 0.9) WITH SAND, DARK YELLOWISH BROWN, MOIST.		J-1
217.8			LEAN CLAY (CL) (0.9 - 2.1) SANDY, DARK REDDISH BROWN, MOIST, ROOTS.		J-2
213.6	3 6		LEAN CLAY (CL) (2.1 - 6.3) WITH SAND, DARK YELLOWISH BROWN, MOIST.		J-3 J-4
208.3	9		FAT CLAY (CH) (6.3 - 11.6) WITH SAND, DARK YELLOWISH BROWN TO OLIVE, MOIST.		J-5 J-6
206.1	12		LEAN CLAY (CL) (11.6 - 13.8) SANDY, OLIVE, MOIST.		J-7
200.0	15 18		CLAY SAND (SC) (13.8 - 19.9) OLIVE, MOIST.		J-8
199.6			LEAN CLAY (CL) (19.9 - 20.3) WITH SAND, OLIVE, MOIST.		J-9
197.9	21		FAT CLAY (CH) (20.3 - 22.0) LIGHT OLIVE GRAY, MOIST.		J-10
	24 27 30				

REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

WATER ENCOUNTERED @ 13.8'

OVERNIGHT WATER LEVEL @ 10.0'

SAMPLE TYPE	ZONE
SPLITSPOON	0.0- 22.0

SAMPLE	DEPTH
J-1	0.2- 0.9
J-2	0.9- 2.1
J-3	2.1- 2.8
J-4	2.8- 6.3
J-5	6.3- 10.1
J-6	10.1- 11.6
J-7	11.6- 13.8
J-8	13.8- 19.9
J-9	19.9- 20.3
J-10	20.3- 22.0

PROJECT: LHAAP-WASTE SUMPS
HOLE NO.: LHS-MW6

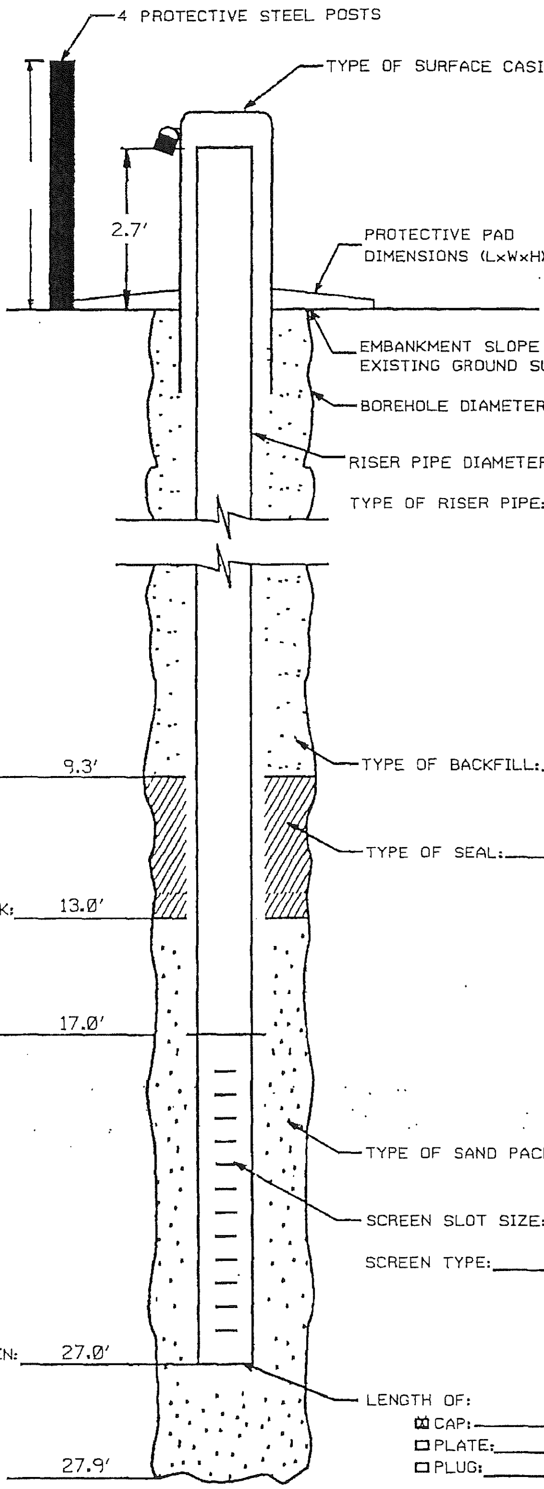
WELL NO. LHS-MW7

MONITORING WELL SHEET

PROJECT & INSTALLATION: LONGHORN ARMY AMMUNITION PLANT - SUMPS

DATE STARTED: 8-20-1994

DATE COMPLETED: 8-20-1994



GROUNDWATER DEPTH: 17.0'

GROUNDWATER DATE: 8-20-1994

TYPE OF SURFACE CASING: STEEL

PROTECTIVE PAD DIMENSIONS (LxWxH): 4'X4'X6"

EMBANKMENT SLOPE OR EXISTING GROUND SURFACE.

BOREHOLE DIAMETER: 8"

RISER PIPE DIAMETER: 4"

TYPE OF RISER PIPE: PVC

TOP OF SEAL: 9.3'

TYPE OF BACKFILL: GROUT/5% BENTONITE

TYPE OF SEAL: BENTONITE

TOP OF SAND PACK: 13.0'

TOP OF SCREEN: 17.0'

TYPE OF SAND PACK: 16/30

SCREEN SLOT SIZE: .010"

SCREEN TYPE: 316 SS

BOTTOM OF SCREEN: 27.0'

LENGTH OF:
☒ CAP: 6"
☐ PLATE:
☐ PLUG:

BOTTOM OF HOLE: 27.9'

INSPECTOR: STEVE BREWER

LHWCD.DGN LORI KRUSE

LHSMW07 KDB 7/28/04

HOLE NO. LHS-MW7

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION LHAAP	SHEET 1 OF 2 SHEETS
1. PROJECT LHAAP-WASTE SUMPS		10. SIZE AND TYPE OF BIT 8" AUGER	
2. LOCATION (Coordinates or Station) 6959841.50 3304410.30		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT COE		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number)	LHS-MW7	13. OVERBURDEN SAMPLES	DISTURBED 3 UNDISTURBED 17
5. NAME OF DRILLER RAY VOILS		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.		15. ELEVATION GROUND WATER SEE REMARKS	
		16. DATE HOLE	STARTED 08/20/1994 COMPLETED 08/20/1994
7. THICKNESS OF OVERBURDEN 27.9		17. ELEVATION TOP OF HOLE 218.6	
8. DEPTH DRILLED INTO ROCK 0.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 27.9		STEVE BREWER	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
217.1		▨	LEAN CLAY (CL) (0.0 - 1.5) SANDY, GRAYISH BROWN WITH RED, MOIST, VERY STIFF, NUMEROUS THIN ROOTS IN TOP 0.5'.		ST-1	WATER ENCOUNTERED @ 17.0'
215.6	2	▨	LEAN CLAY (CL) (1.5 - 3.0) WITH SAND, BROWN WITH GRAY AND RED, MOIST, VERY STIFF, SCATTERED POCKETS OF FINE SAND		ST-2	
214.1	4	▩	FAT CLAY (CH) (3.0 - 4.5) WITH SAND, GRAY AND RED MOIST, VERY STIFF.		ST-3	
212.6	6	▨	LEAN CLAY (CL) (4.5 - 6.0) WITH SAND, GRAY AND YELLOW AND RED, MOIST, VERY STIFF.		ST-4	
211.8		▨	LEAN CLAY (CL) (6.0 - 6.8) SANDY, GRAY AND YELLOW WITH RED, MOIST, VERY STIFF.		ST-5	
210.3	8	▨	LEAN CLAY (CL) (6.8 - 8.3) WITH SAND,OLIVE AND YELLOW AND GRAY, MOIST,VERY STIFF TO HARD SEVERAL BLACK IRON-OXIDE STAIN		J-1 ST-6	
208.1	10	▩	FAT CLAY (CH) (8.3 - 10.5) OLIVE YELLOW AND GRAY, MOIST, VERY STIFF, SLIGHTLY SLICKENSIDED, BLACK IRON-OXIDE STAINS THROUGHOUT.		J-2 ST-7	
205.1	12	▨	LEAN CLAY (CL) (10.5 - 13.5) OLIVE GRAY AND YELLOW, MOIST, STIFF TO VERY STIFF, IRON-OXIDE STAINS, THIN SAND LENSES THROUGHOUT, FRIABLE.		ST-8 ST-9	
203.9	14	▩	FAT CLAY (CH) (13.5 - 14.7) OLIVE WITH GRAY, MOIST, VERY STIFF, SEVERAL THIN SAND AND SILT LENSES, FRIABLE.		ST-10	
201.6	16	▨	LEAN CLAY (CL) (14.7 - 17.0) OLIVE WITH GRAY, MOIST, VERY STIFF, VERY THIN FINE SAND AND SILT LENSES IN TOP HALF OF SAMPLE, FRIABLE.		ST-11	
198.6	18 20	▩	FAT CLAY (CH) (17.0 - 22.4) LIGHT OLIVE GRAY, MOIST, HARD, SLIGHTLY SLICKENSIDED, FRIABLE		ST-12 ST-13 ST-14	

TYPE	ZONE
SHELBY	0.0- 26.9

SAMPLE	DEPTH
ST-1	0.0- 1.5
ST-2	1.5- 3.0
ST-3	3.0- 4.5
ST-4	4.5- 6.0
ST-5	6.0- 6.8
J-1	6.8- 7.5
ST-6	7.5- 8.3
J-2	8.3- 9.0
ST-7	9.0- 10.5
ST-8	10.5- 12.0
ST-9	12.0- 13.5
ST-10	13.5- 14.7
ST-11	14.7- 16.4
ST-12	17.0- 17.7
ST-13	17.7- 19.0
ST-14	19.0- 19.8
ST-15	22.4- 23.9
ST-16	23.9- 24.6
ST-17	24.6- 25.6
J-3	26.8- 26.9

PROJECT LHAAP-WASTE SUMPS

HOLE NO. LHS-MW7

HOLE NO. LHS-MW7

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION LHAAP	SHEET 2 OF 2 SHEETS

1\. PROJECT LHAAP-WASTE SUMPS

2\. LOCATION (Coordinates or Station) 6959841.50 3304410.30

3\. DRILLING AGENCY TULSA DISTRICT COE

4\. HOLE NO. (As shown on drawing title and file number) LHS-MW7

5\. NAME OF DRILLER RAY VOILS

6\. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.

7\. THICKNESS OF OVERBURDEN 26.9

8\. DEPTH DRILLED INTO ROCK 0.0

9\. TOTAL DEPTH OF HOLE 26.9

10\. SIZE AND TYPE OF BIT 8" AUGER

11\. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL

12\. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500

13\. OVERBURDEN SAMPLES DISTURBED 3 UNDISTURBED 17

14\. TOTAL NUMBER CORE BOXES 0

15\. ELEVATION GROUND WATER SEE REMARKS

16\. DATE HOLE STARTED 08/20/1994 COMPLETED 08/20/1994

17\. ELEVATION TOP OF HOLE 218.6

18\. TOTAL CORE RECOVERY FOR BORING 0.0 %

STEVE BREWER

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	22		FAT CLAY (CH) (17.0 – 22.4) LIGHT OLIVE GRAY, MOIST, HARD, SLIGHTLY SLICKENSIDED, FRIABLE			
196.2			LEAN CLAY (CL) (22.4 – 23.9) WITH SAND, OLIVE, MOIST, HARD, FRIABLE, LAMINATION OF VERY FINE SAND AND SILT.		ST–15	
194.7	24		CLAY SAND (SC) (23.9 – 24.6) OLIVE, MOIST, STIFF, SILTY, FRIABLE, CRUMBLES EASILY, TOP 1.0' DISTURBED WITH FALL–IN MATERIAL		ST–16	
194.0					ST–17	
	26		CLAY SAND (SC) (24.6 – 26.8) OLIVE, VERY MOIST, FRIABLE, CRUMBLES EASILY.			
181.8					J–3	
			LEAN CLAY (CL) (26.8 – 26.9) WITH SAND, LIGHT OLIVE BROWN, MOIST, CALCAREOUS.			
	28					
	30					
	32					
	34					
	36					
	38					
	40					

PROJECT LHAAP–WASTE SUMPS

HOLE NO. LHS–MW7

Appendix C

MSDSs for In Situ Bioremediation Materials

MATERIAL SAFETY DATA SHEET

EOS® 600 EMULSIFIED EDIBLE OIL SUBSTRATE

D.O.T. HAZARD CLASSIFICATION: NONE

----HMIS----	
HEALTH	1
FLAMMABILITY	0
REACTIVITY	0
PERSONAL PROTECTION	B

MANUFACTURER'S NAME

EOS Remediation, Inc
1101 Nowell Road
Raleigh, NC 27607
www.EOSRemediation.com

DATE OF PREPARATION
01-24-03, Rev. 04-19-05

INFORMATION TELEPHONE NO.
919-873-2204

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME	**EOS® 600**
PRODUCT CLASS	**VEGETABLE OIL BASED EMULSION**
CAS NUMBER	**MIXTURE**

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT(S)	EXPOSURE LIMIT

THIS PRODUCT IS A MIXTURE OF EDIBLE FOOD GRADE ADDITIVES AND CONTAINS NO HAZARDOUS INGREDIENTS.

SECTION III - PHYSICAL DATA

BOILING POINT:	**212°F**
SPECIFIC GRAVITY:	**0.97; .92 (pure oil phase)**
VAPOR PRESSURE:	**NOT ESTABLISHED**
PERCENT VOLATILE BY VOLUME (%):	**24 (AS WATER)**
VAPOR DENSITY:	**HEAVIER THAN AIR**
EVAPORATION RATE:	**NOT ESTABLISHED**
SOLUBILITY IN WATER:	**SOLUBLE**
APPEARANCE AND ODOR:	**OFF WHITE LIQUID WITH VEGETABLE OIL ODOR**
pH	**NEUTRAL**

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:	**>300°F**
FLAMMABLE LIMITS:	**NOT ESTABLISHED**
EXTINGUISHING MEDIA:	**CO_2, FOAM, DRY CHEMICAL** **NOTE: WATER, FOG, AND FOAM MAY CAUSE FROTHING AND SPATTERING.**
UNUSUAL FIRE AND EXPLOSION HAZARDS:	**BURNING WILL CAUSE OXIDES OF CARBON.**
SPECIAL FIRE FIGHTING PROCEDURES:	**WEAR SELF CONTAINED BREATHING APPARATUS AND CHEMICAL RESISTANT CLOTHING. USE WATER SPRAY TO COOL FIRE EXPOSED CONTAINERS.**

SECTION V - PHYSICAL HAZARDS

STABILITY:	**STABLE**
CONDITIONS TO AVOID:	**NONE**
INCOMPATIBILITY:	**STRONG ACIDS AND OXIDIZERS.**
HAZARDOUS DECOMPOSITION PRODUCTS:	**THERMAL DECOMPOSITION MAY PRODUCT OXIDES OF CARBON.**
HAZARDOUS POLYMERIZATION:	**WILL NOT OCCUR**

SECTION VI - HEALTH HAZARDS

SIGNS AND SYMPTOMS OF EXPOSURE:

1. Acute Overexposure -	**NONE**
2. Chronic Overexposure -	**NONE**
MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:	**NONE KNOWN**

CHEMICAL LISTED AS CARCINOGEN OR POTENTIAL CARCINOGEN:

N.T.P. - **NO** I.A.R.C. - **NO** OSHA - **NO**

EMERGENCY AND FIRST AID PROCEDURES:

1.) Inhalation-	**REMOVE TO FRESH AIR.**
2.) Eyes-	**FLUSH WITH WATER FOR 15 MINUTES, IF IRRITATION PERSISTS SEE PHYSICIAN.**
3.) Skin-	**WASH WITH MILD SOAP AND WATER.**
4.) Ingestion-	**PRODUCT IS NON-TOXIC. IF NAUSEA OCCURS, INDUCE VOMITING AND SEEK MEDICAL ATTENTION.**

SECTION VII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:	**NOT NORMALLY REQUIRED**
VENTILATION:	**LOCAL EXHAUST**
PROTECTIVE GLOVES:	**NOT NORMALLY REQUIRED**
EYE PROTECTION:	**NOT NORMALLY REQUIRED**
OTHER PROTECTIVE CLOTHING OR EQUIPMENT:	**NONE**

SECTION VIII - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:	**DO NOT STORE NEAR EXCESSIVE HEAT OR OXIDIZERS.**
OTHER PRECAUTIONS:	**NONE**
STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED:	**SOAK UP WITH DRY ABSORBENT AND FLUSH AREA WITH LARGE AMOUNTS OF WATER.**
WASTE DISPOSAL METHODS:	**DISPOSE OF ACCORDING TO FEDERAL, STATE, AND LOCAL REGULATIONS.**

SECTION IX - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III

UNDER THE PROVISIONS OF TITLE 111, SECTION 311/312 OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATIONS ACT, THIS PRODUCT IS CLASSIFIED INTO THE FOLLOWING HAZARD CATEGORIES: **NONE**

THIS PRODUCT DOES **NOT** CONTAIN SECTION 313 REPORTABLE INGREDIENTS.

THE INFORMATION CONTAINED HEREIN IS BASED ON AVAILABLE DATA AND IS BELIEVED TO BE CORRECT. HOWEVER, EOS REMEDIATION, INC. MAKES NO WARRANTY, EXPRESSED OR IMPLIED, REGARDING THE ACCURACY OF THIS DATA OR THE RESULTS TO BE OBTAINED THEREOF. THIS INFORMATION AND PRODUCT ARE FURNISHED ON THE CONDITION THAT THE PERSON RECEIVING THEM SHALL MAKE HIS/HER OWN DETERMINATION AS TO THE SUITABILITY OF THE PRODUCT FOR HIS/HER PARTICULAR PURPOSE.

Material Safety Data Sheet

Shaw Environmental, Inc.

17 PRINCESS ROAD
LAWRENCEVILLE, N.J.   08648
(609) 895-5340

SECTION 1 - MATERIAL IDENTIFICATION AND INFORMATION

Material Name: DHC microbial consortium (SDC-9)   MSDS #: ENV 1033

Date Prepared: 10/06/2003   CAS #: N/A (Not Applicable)

Prepared By: Simon Vainberg   Formula #: N/A

Material Description: Non-hazardous, naturally occurring non-altered anaerobic microbes and enzymes in a water-based medium.

SECTION 2 - INGREDIENTS

Components	%	OSHA PEL	ACGIH TLV	OTHER LIMITS
Non-Hazardous Ingredients	100	N/A	N/A	N/A

SECTION 3 - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point: 100°C (water)   Specific Gravity (H_2O = 1): 0.9 - 1.1

Vapor Pressure @ 25°C: 24 mm Hg (water)   Melting Point: 0°C (water)

Vapor Density: N/A   Evaporation Rate (H_2O = 1): 0.9 - 1.1

Solubility in Water: Soluble   Water Reactive: No

pH: 6.0 - 8.0

Appearance and Odor: Murky, yellow water. Musty odor.

SECTION 4 - FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A

Flammable Limits: N/A

Extinguishing Media: Foam, carbon dioxide, water

Special Fire Fighting Procedures: None

Unusual Fire and Explosion Hazards: None

SECTION 5 - REACTIVITY DATA

Stability: Stable

Conditions to Avoid: None

Incompatibility (Materials to Avoid): Water-reactive materials

Hazardous Decomposition Byproducts: None

SECTION 6 - HEALTH HAZARD DATA

HEALTH EFFECTS

The effects of exposure to this material have not been determined. Safe handling of this material on a long-term basis will avoid any possible effect from repetitive acute exposures. Below are possible health effects based on information from similar materials. Individuals hyper allergic to enzymes or other related proteins should not handle.

Ingestion: Ingestion of large quantities may result in abdominal discomfort including nausea, vomiting, cramps, diarrhea, and fever.

Inhalation: Hypersensitive individuals may experience breathing difficulties after inhalation of aerosols.

Skin Absorption: N/A

Skin Contact: May cause skin irritation. Hypersensitive individuals may experience allergic reactions to enzymes.

Eye Contact: May cause eye irritation.

FIRST AID

Ingestion: Get medical attention if allergic symptoms develop (observe for 48 hours). Never give anything by mouth to an unconscious or convulsing person.

Inhalation: Get medical attention if allergic symptoms develop.

Skin Absorption: N/A

Skin Contact: Wash affected area with soap and water. Get medical attention if allergic symptoms develop.

Eye Contact: Flush eyes with plenty of water for at least 15 minutes using an eyewash fountain, if available. Get medical attention if irritation occurs.

NOTE TO PHYSICIANS: All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this material may have occurred.

SECTION 7 - SPILL AND LEAK PROCEDURES

Reportable quantities (in lbs of EPA Hazardous Substances): N/A

Steps to be taken in case of spill or release: No emergency results from spillage. However, spills should be cleaned up promptly. All personnel involved in the cleanup must wear protective clothing and avoid skin contact. Absorb spilled material or vacuum into a container. After clean-up, disinfect all cleaning materials and storage containers that come in contact with the spilled liquid.

Waste Disposal Method: No special disposal methods are required. The material may be sewered, and is compatible with all known biological treatment methods. To reduce odors and permanently inactivate microorganisms, mix 100 parts (by volume) of DHC consortium with 1 part (by volume) of bleach. Dispose of in accordance with local, state and federal regulations.

SECTION 8 - HANDLING AND STORAGE

Hand Protection: Rubber gloves.

Eye Protection: Safety goggles with side splash shields.

Protective Clothing: Use adequate clothing to prevent skin contact.

Respiratory Protection: Surgical mask.

Ventilation: Provide adequate ventilation to remove odors.

Storage & Handling:
Material may be stored for up to 3 weeks at 2-4°C without aeration.

Other Precautions: An eyewash station in the work area is recommended.

While the information and recommendations set forth herein are believed to be accurate as of the date hereof, Shaw Environmental, Inc. MAKES NO WARRANTY WITH RESPECT HERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

MSDS Number: **S2954** * * * * * *Effective Date:* ***11/26/07*** * * * * * *Supercedes:* ***05/23/06***

MSDS *Material Safety Data Sheet*

From: **Mallinckrodt Baker, Inc.**
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS

J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SODIUM BICARBONATE

1. Product Identification

Synonyms: Sodium hydrogen carbonate; sodium acid carbonate; baking soda; bicarbonate of soda
CAS No.: 144-55-8
Molecular Weight: 84.01
Chemical Formula: NaHCO3
Product Codes:
J.T. Baker: 3506, 3508, 3509, 3510
Mallinckrodt: 7285, 7396, 7397, 7412, 7749, 7903

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Bicarbonate	144-55-8	99 - 100%	No

3. Hazards Identification

Emergency Overview

As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
High concentrations of dust may cause coughing and sneezing.
Ingestion:
Extremely large oral doses may cause gastrointestinal disturbances.
Skin Contact:
No adverse effects expected.
Eye Contact:
Contact may cause mild irritation, redness, and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.
Skin Contact:
Not expected to require first aid measures.
Eye Contact:
Wash thoroughly with running water. Get medical advice if irritation develops.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
Use protective clothing and breathing equipment appropriate for the surrounding fire.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Small amounts of residue may be flushed to sewer with plenty of water.

---

7. Handling and Storage

Keep in a well closed container stored under cold to warm conditions, 2 to 40 C, (36 to 104F). Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White crystalline powder.
Odor:
Odorless.
Solubility:
7.8g/100g water @ 18C (64F).
Density:
2.2
pH:
8.3 (0.1 molar @ 25C (77F))
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
Not applicable.
Melting Point:
60C (140F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Gaseous carbon dioxide.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Reacts with acids to form carbon dioxide. Dangerous reaction with monoammonium phosphate or a sodium-potassium alloy.
Conditions to Avoid:
Heat, moisture, incompatibles.

11. Toxicological Information

Investigated as a mutagen, reproductive effector. Oral rat LD50: 4220 mg/kg. Irritation data: human,skin, 30mg/3D-I mild, rabbit,eye, 100 mg/30 S, mild.

--------\Cancer Lists\--

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Sodium Bicarbonate (144-55-8)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
For Sodium Bicarbonate:
48 hour EC50 Daphnia magna (water flea) : 2350 mg/L.
96 hour LC50 Lepomis macrochirus (bluegill) : > 5000 mg/L.
120 hour EC50 Nitzschia linearis (diatom) : 650 mg/L.

This material is not expected to be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

---------\Chemical Inventory Status - Part 1\----------------------------------

Ingredient	TSCA	EC	Japan	Australia
Sodium Bicarbonate (144-55-8)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\-----------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.

Sodium Bicarbonate (144-55-8)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Sodium Bicarbonate (144-55-8)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sodium Bicarbonate (144-55-8)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: No Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.
Label Precautions:
None.
Label First Aid:
Not applicable.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 12.
Disclaimer:
****

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Appendix D

Site-Specific Supplement to Health and Safety Plan

00111642

Appendix D
Site-Specific Supplement to Health and Safety Plan

Final
Remedial Design
LHAAP-35A(58), Shops Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
DPT	direct-push technology
HSM	Health and Safety Manager
LEL/O_2	lower explosive limit/oxygen
mg/m^3	milligrams per cubic meter
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
TWA	time-weighted average

Personal Protective Equipment (PPE) Levels

LHAAP-35A(58) – Monitoring Well Sampling/Well Installation or Abandonment/ Direct-Push Technology (DPT) Operations

Level D – Modified PPE:

- Hard hat meeting American National Standards Institute (ANSI) Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Nitrile surgical gloves (inner or double layer).
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Chemical resistant boot covers and/or outer boots (polyvinyl chloride/latex/neoprene when there is potential for shoe/boot contact with contaminated soil or water).
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

LHAAP-35A(58) – Brush Clearing for Access

Level D – Modified PPE:

- Hard hat meeting ANSI Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

Air Monitoring

Particulates

Real-Time Aerosol Monitor

Real-time aerosol monitors (MIE pDR-1000 or equivalent) shall be used to monitor dust emissions during dust generating activities. The only dust generating activity anticipated is clearing brush for well access or during well abandonment. The real-time aerosol monitors will be placed in the work area (near areas where ground personnel are working) and at the downwind site perimeter. The selected placement of these instruments may need to be adjusted throughout the workday to compensate for changes of wind direction.

Real-Time Aerosol Monitoring Action Levels

The real-time aerosol monitors will be set to alarm when the instantaneous aerosol concentration reaches 1.0 milligrams per cubic meter (mg/m^3). The alarm will be used to indicate that additional dust control is necessary.

The real-time aerosol monitors are capable of collecting and integrating the aerosol concentrations throughout the workday into a time-weighted average (TWA). Aerosol monitors shall be visually checked on an hourly basis during dust generating activities to verify that the TWA remains below 1.0 mg/m^3. Aerosol monitors registering time-weighted average aerosol concentrations at or above 2.0 mg/m^3 require that workers upgrade to Level C PPE and indicate that additional dust control measures are necessary. Failure to control workday time-weighted average dust concentrations to below 4.0 mg/m^3 shall necessitate ceasing dust generating activities and contacting the Project Manager and Health and Safety Manager (HSM) for implementing alternate work practices.

The full work-shift time-integrated concentrations will be evaluated at the conclusion of each workday to verify aerosol concentrations are maintained below action levels.

Volatiles/Oxygen

Photoionization detectors (PIDs) and lower explosive limit/oxygen (LEL/O_2) detectors shall be used to monitor emissions during sampling and well abandonment. Measurements will be collected from the work area and breathing zone during sampling or well abandonment activities. The action levels for the area monitoring are provided in the table below:

Direct Reading Air Monitoring Summary for Volatiles/Oxygen

Monitoring Device	Monitoring Location/Personnel	Monitoring Frequency	Action Level [a]	Action
PID/OVA (breathing zone)	DPT operations, groundwater sampling, and well installation	At start-up, minimum four times daily in work area and breathing zone	>5 ppm	Test for vinyl chloride (VC) (colorometric detector tubes)
LEL/O2 meters	DPT operations, groundwater sampling, and well installation	At start-up, minimum four times daily in work area.	>10% LEL	Stop operations; allow vapors to vent and reach <10% before continuing

Notes and Abbreviations:

[a] *Sustained levels above background for 5 minutes in breathing zone*

DPT	*direct-push technology*
LEL/O2	*lower explosive limit/oxygen*
ppm	*parts per million*
PID/OVA	*photo ionization detector/organic vapor analyzer*

Personal Air Sampling (time-integrated)

Time-integrated air sampling may be performed at the discretion of the HSM, if air-monitoring action levels are exceeded.

Medical Surveillance

LHAAP-35A(58)

There are no special medical surveillance requirements in addition to the requirements of 29 Code of Federal Regulations 1910.120(f), which are already in place.

ACTIVITY HAZARD ANALYSIS FOR GROUNDWATER SAMPLING OR DPT OPERATIONS

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Groundwater Sampling or DPT Operations	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before sampling operations begin	Latex inner gloves, Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Flammable, explosive atmospheres	• Test well head atmosphere for flammable/toxic vapors • Wear proper level of PPE for the type of atmospheric contaminants • Eliminate sources of ignition from the work area • Prohibit smoking in development area	Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Struck by/against flying particles, protruding objects, liquid splash	• Wear hard hats, safety glasses with side shields and steel-toe safety boots at all times • Wear splash shields and safety goggles when sampling, cleaning, decontaminating test equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Cut resistant gloves	—
	High / low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools	Small equipment as specified by operations manual	40 hour Hazardous Waste Training Review HASP Review site-specific AHA with all task personnel. Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR BRUSH CLEARING PREPARATION

Principle Steps	Potential Safety/Health Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Clearing Brush	Operations of power clearing tools (brush saws, weed whackers)	• Wear eye, face, hand and hearing protection when operating power clearing equipment • Shut-off / idle power tools walking between work areas • Store flammable liquids in well ventilated areas, away from work areas • Shut off equipment during re-fueling • Allow equipment to cool before re-fueling • Use funnels to avoid fuel spillage • Prohibit smoking while operating clearing equipment • Provide ABC (or equivalent) fire extinguishers for all work areas	Face shield, goggles, cloth gloves, ear plugs, steel toe work boots	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut-resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain hand and power tools in a safe condition • Keep guards in place during use	Leather gloves with reinforced palm	—
	Eye injuries	• Wear face shield, goggles when operating powered clearing / grubbing equipment	Face shield, goggles, safety glasses	—
Mobilization/Site Setup and Survey/Layout	Slips, trips, falls	• Clear walkways, work areas of equipment, tools, vegetation, excavated material and debris • Mark, identify, or barricade other obstructions • Ensure footing. Look before you step	—	—
	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 decibels, A-scale (dBA) over an 8-hour work period)	Ear plugs	—
	High/low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Hand tools	Daily heavy equipment inspections Small equipment as specified by operations manual	Review Site Safety and Health Plan (HASP) Review site-specific Activity Hazard Analysis (AHA) with all task personnel. Review equipment safety operations manual Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring Well Installation or Abandonment	Slips, trips, falls	• Clear walkways, work areas of equipment, debris and excavated materials • Mark, identify, or barricade other obstructions • Halt exterior work in high winds, severe weather	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use	Leather gloves	—
	Handling heavy objects (piping/casings)	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb. maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads • Move long sections of piping/casing with at least two workers or mechanical equipment • Add tag lines to loads, if necessary, to minimize side-to-side movement • Prohibit workers from standing on top of piping during loading/unloading/transferring pipe or rolling stock • Stand clear of rolling stock/piping; do not attempt to stop rolling piping • Use slip handles to move slips; prohibit kicking slip handles into place	—	—
	Flammable, toxic emissions	• Monitor for flammable/toxic vapors, particulates, and gases • Wear proper level of PPE for the type of atmospheric contaminants	Portable fire extinguishers	PID
	Underground utilities	• Identify all underground utilities around the excavation site before work commences • Cease work immediately if unknown utility markers are uncovered	—	—
	Struck by/against heavy equipment, protruding objects, splashes	• Wear reflective warning vests when exposed to vehicular traffic • Isolate equipment swing areas • Make eye contact with operators before approaching equipment	Warning vest, hard hat safety glasses, steel toe work boots	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring well installation or abandonment *(cont.)*	Struck by/against heavy equipment, protruding objects, splashes *(cont.)*	• Wear hard hats, safety glasses with side shields, face shields and goggles, and steel-toe safety boots • Understand and review hand signals • Chock piping/rolling stock stored on trailers/racks/etc to prevent rolling	Warning vest, hard hat safety glasses, steel toe work boots	—
	Equipment failure	• Inspect drilling equipment daily according to manufacturer's specifications • Block and level drilling equipment before use • Ensure equipment not in use is properly stored • Examine fittings, drive rods, hydraulic lines for condition and wear	—	—
	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before operations begin • Monitor breathing zone air to determine levels of contaminants	Tyvek® coveralls, nitrile gloves, latex or neoprene boots	PID
	Insect/ snake bites	• Review injury potential and types of snakes with workers • Avoid insect nests areas, likely habitats of snakes outside work areas • Emphasize The Buddy System where such injury potential exists • Use insect repellant, wear PPE to protect against sting/bite injuries	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	Contact dermatitis	• Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants • Identify and review poisonous plants with workers • Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	Caught in/between moving parts	• Identify and understand parts of equipment which may cause crushing, pinching, rotating or similar motions • Assure guards are in place to protect from these parts of equipment during operation • Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects • Maintain all equipment in a safe condition • Keep all guards in place during use • De-energize and lock-out machinery before maintenance or service	—	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring Well Installation or Abandonment *(cont.)*	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) • Assess noise level with sound level meter if possibility exists that level may exceed 85dBA TWA	Ear plugs	Sound level meter
	High/low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw E & I Health and Safety Program, HS400, HS401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
Drill rig Hand tools	Daily heavy equipment inspections Daily Drill Rig Inspections Small equipment as specified by operations manual	40 hour Hazardous Waste Training Review SSHP Review site-specific AHA with all task personnel. Review equipment safety operations manual Safe driver's training (HS 800)

Appendix E

Contractor Quality Control Plan

Appendix E
Contractor Quality Control Plan

Final
Remedial Design
LHAAP-35A(58), Shops Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

CDAP	Chemical Data Acquisition Plan
CQC	contractor quality control
CQCP	Contractor Quality Control Plan
CQCSM	Contractor Quality Control System Manager
DPT	direct-push technology
GPS	Global Positioning System
HASP	Health and Safety Plan
LHAAP	Longhorn Army Ammunition Plant
LUC	land use control
MARC	Multiple Award Remediation Contract
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
QAR	quality assurance representative
QC	quality control
Shaw	Shaw Environmental, Inc.
SSO	Site Safety Officer
TO	task order
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Tulsa District, contracted Shaw Environmental, Inc. (Shaw), under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D0027, Task Order (TO) No. DS02, to perform closure of multiple environmental sites at Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. TO DS02 is being administered by the Tulsa District of USACE.

LHAAP is located in central-east Texas, in Harrison County, between State Highway 43 at Karnack, Texas, and Caddo Lake. Figure 1-1 of the Remedial Design shows the location of LHAAP and surrounding communities.

The objective of this TO is to perform investigations, collect data, perform remediation activities at multiple sites on an expedited basis to achieve site closures, and bring as many sites as possible into the long-term management/long-term operation stage as early as possible. This Contractor Quality Control Plan (CQCP) documents quality control (QC) requirements that will be implemented during remediation at LHAAP-35A(58).

2.0 CONTRACTOR QUALITY CONTROL PLAN PURPOSE AND SCOPE

2.1 Contractor Quality Control Plan Purpose

This CQCP establishes procedures that enable common project field activities to be completed successfully and documents QC requirements for services provided by Shaw and its subcontractors during project activities at LHAAP-35A(58). This plan describes requirements for organizing, planning, performing, reviewing, documenting, and reporting activities that may affect the quality of the work. This CQCP applies the specific requirements of Shaw's Contractor Quality Control (CQC) System to this project by establishing controls for:

- QC staff organization and authority
- Workmanship
- Construction activities for major definable features of work
- Records
- Inspections and tests
- Documentation
- Audits
- Subcontractor performance

This plan references standard field procedures, policies, regulations, and practices required to implement the work. A controlled copy of applicable Field Procedures from Appendix D of the *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant* (Shaw, 2006) will be available as a reference document.

2.2 Contractor Quality Control Plan Scope

This CQCP is applicable to the work proposed at LHAAP-35A(58), including the major definable features of site work (or major project tasks) identified below:

Task 1 – Mobilization/Site Setup/Site Clearing
Task 2 – Direct Push Technology (DPT) Operations
Task 3 – Monitoring Well Installation
Task 4 – Groundwater Sampling
Task 5 – Waste Management
Task 6 – Monitoring Well Abandonment
Task 7 – Surveying
Task 8 – Site Restoration and Demobilization

2.3 Acceptance of Contractor Quality Control Plan

Work within the scope of this plan will not be started prior to providing this CQCP to USACE, unless otherwise permitted by USACE. Any proposed changes to this CQCP will require notification to USACE in writing. Proposed changes are subject to the approval of USACE.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Personnel and Structure

The Contractor Quality Control System Manager (CQCSM) coordinates implementation of this CQCP with the Project Manager, Remediation Manager, Program QC Manager, and subcontractors.

3.2 Duties and Responsibilities

The duties and responsibilities of personnel with regard to the CQC program are briefly outlined below. Duties and responsibilities of health and safety personnel are presented in Appendix A, Health and Safety Plan (HASP) (Shaw, 2006).

Project Manager: The Project Manager is responsible for all activities on the project, and directs and monitors the Site Superintendent in planning, coordinating, and controlling the work. The Project Manager has overall responsibility for establishing the CQCP and for its implementation, and he has the authority to access the required resources throughout Shaw to ensure compliance with the contract requirements.

Remediation Manager: The Remediation Manager reports to the Project Manager and is responsible for site remediation technical assurance. This individual will oversee the site remediation activities. The Remediation Manager has the following duties and authorities:

- Perform and/or oversee the purging and sampling of monitoring wells
- Perform and/or oversee the preservation, packaging, and shipping of samples to an off-site, fixed laboratory for environmental analyses
- Ensure documentation accuracy, completeness, and consistency among field team members
- Stop work that deviates from the contract documents or is otherwise nonconforming or unsafe.

CQCSM: The CQCSM is responsible for the overall management of the project CQC program during field activities. The CQCSM receives administrative and day-to-day direction from the Remediation Manager. The CQCSM is responsible to the Shaw Program QC Manager for direction on matters that may affect the QC requirements for the project. The CQCSM is assigned the following duties:

- Monitor and verify that the work is performed in accordance with the contract requirements

- Review and verify the disposition of discrepancy and corrective action reports
- Perform QC inspections and surveillance, and report daily on project QC
- Monitor project submittals in accordance with submittal register requirements
- Submit QC reports to the USACE Field Representative/Quality Assurance Representative (QAR) on a daily basis, unless other arrangements are agreed to by the USACE

The CQCSM has the authority to reject materials and workmanship that do not comply with project requirements, and to stop nonconforming work activities (see **Figure 3-1**).

Due to the limited size of the field effort at LHAAP-35A(58), the CQCSM may also serve as the Site Safety Officer (SSO). In this dual role, the CQCSM/SSO is responsible to the Shaw Program Health and Safety Manager for safety-related matters. The SSO duties are discussed in detail in the Installation-Wide CQCP provided as Appendix B of the Installation-Wide Work Plan.

Program QC Manager: The Program QC Manager is responsible to review, monitor, and report the conformance to QC requirements set forth in the CQCP. He may also advise the CQCSM on QC methods and practices. He will maintain a record of his quality monitoring activities and will inform the CQCSM of his monitoring activities. He shall also be responsible for performing periodic internal audits, and reporting his findings to the CQCSM.

Subcontractors: Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services. Subcontractors are responsible to the Project Manager and Remediation Manager for completing the portion of work assigned to them, and to the CQCSM for CQCP activities. They shall verify that their construction and materials comply with the requirements of the contract plans and specifications. Subcontractors include organizations supplying quality-related items or services to the project.

3.3 Qualification of Personnel

Shaw personnel assigned to the project are qualified to perform the tasks to which they are assigned. The Project Manager and the Remediation Manager will appraise the qualification of professional and/or technical personnel assigned to the project. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee.

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

To: To Be Determined
From: John W. Patin, QC Manager
Date: June 2011
Subject: Contractor Quality Control System Manager, Letter of Authority
U.S. Army Corps of Engineers, Tulsa District
MARC Contract No. W912QR-04-D0027, Task Order No. DS02

This letter describes the responsibilities and authority delegated to you in your capacity as the Contractor Quality Control System Manager for Remediation of LHAAP-35A(58) at Longhorn Army Ammunition Plant, Karnack, Texas.

In this position, you are responsible for the implementation and enforcement of the CQCP and site specific addenda. You will use the plan to verify that the quality of materials, workmanship, operations, and safety monitoring conforms to the Remedial Design/Work Plan, its appendices, and addenda.

Your responsibilities include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and requesting solutions for nonconforming activities. You have the authority to control or stop project activities until satisfactory disposition and implementation of corrective actions are achieved. Detailed responsibilities and guidelines are given in the Remedial Design, its appendices, and addenda.

Figure 3-1
Letter of Authority

4.0 CONTRACTOR QUALITY CONTROL SYSTEMS

4.1 Control Measures

The CQCP provides measures to verify and document that the work performed complies with the requirements specified in the contract documents. These measures include:

- CQC inspections
- Document control
- Submittals
- Completion inspection
- Records

Procedures for implementing the above measures are included throughout the CQCP. The CQCP may be supplemented by additional guidelines or instructions for implementing the work and/or verifying compliance with the contract requirements.

4.2 Quality Control Monitoring

The project CQC program is monitored to verify that the program is in compliance with the CQCP. Monitoring activities are performed by the Shaw Program QC Manager, or his representative, and include the review of daily QC reporting and instructions, or directions given to the CQCSM on QC matters. If required, an assessment of the project's CQC system is performed. If performed, the assessment includes the following items:

- Subcontractor performance
- Field operation and records
- CQC and health and safety inspections, testing, and records
- Document control
- Training records

4.3 Quality Control Testing

As applicable, the CQCSM monitors the equipment/materials testing firm and/or analytical laboratory activities to verify the following:

- Execution of required tests
- Location of tests
- Timely and accurate reporting of test results
- Correct frequency of tests
- Completeness of documentation

5.0 INSPECTION PLAN

QC inspections include inspection of equipment, materials, testing procedures, documentation/submittals, and workmanship before, during, and after each definable feature of work. QC inspections are performed by the CQCSM in accordance with the Three-Phase CQC system. The CQCSM gives the USACE QAR advance notification (at least 24 hours) of formal inspections.

Definable features of site work (or major work tasks) for which QC inspections will be performed are addressed below.

Definable Features of Site Work:

Task 1 – Mobilization/Site Setup/Site Clearing
Task 2 – DPT Operations Including Injection
Task 3 – Monitoring Well Installation
Task 4 – Groundwater Sampling
Task 5 – Waste Management
Task 6 – Monitoring Well Abandonment
Task 7 – Surveying
Task 8 – Site Restoration and Demobilization

Other site remediation activities that constitute definable features of site work will be defined within site-specific addenda to the work plan. Those addenda will also identify related QC inspection requirements.

5.1 Task 1 – Mobilization and Site Setup

Following approval of the Remedial Design, Shaw will mobilize the necessary personnel and equipment to prepare the site for remedial activities. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Site personnel have the necessary Occupational Safety and Health Administration (OSHA) training and medical surveillance statements/certifications

- Heavy equipment (e.g., drilling rig) has undergone safety and preventive maintenance checks, and is suitable for the task for which it will be used.

- Measuring and test equipment has undergone calibration and/or calibration checks to assure accuracy and precision.

- The project team understands the investigation/remediation requirements.

- Site personnel have reviewed the HASP provided by the SSO and have acknowledged this review by signing the HASP acknowledgment form.
- Installed government property plan (when applicable) is reviewed and implemented for the equipment to be installed on site.
- Work zones and decontamination facilities are established in accordance with the HASP.
- Material storage areas are kept orderly.
- Site security measures are adequately maintained to prevent unauthorized access.
- Work zones are clearly demarcated using temporary barricading or fencing as required.

Once the site is mobilized and set up, field activities will commence.

5.2 Task 2 – Direct Push Technology Operations Including Injection

The field work involves DPT operations by drilling subcontractors. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for DPT operations.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- DPT operations will employ a well driller licensed in the state of Texas.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- Waste generated during activities is handled and disposed according to the waste management plan.

<u>Injection Activities</u>:

- Injection locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.

- Water for DPT injections is transported to the site, combined with amendments, allowed to sit, and verified to be anaerobic.
- Injections for bioremediation are complete, and borings are abandoned.

5.3 Task 3 – Monitoring Well Installation

Well installation is proposed for this site. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well installation.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Drilling operations will employ a well driller licensed in the state of Texas.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- Well installation locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.
- Waste generated during activities is handled and disposed according to the waste management plan.

5.4 Task 4 – Groundwater Sampling

Following the installation of groundwater monitoring wells, Shaw will collect groundwater samples for laboratory analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the Chemical Data Acquisition Plan (CDAP) (Appendix C of the Final Installation-Wide Work Plan [Shaw, 2006]) and Work Plan and understand the scope of work.
- The SSO has briefed sampling personnel on task hazards and the appropriate personal protective equipment (PPE) level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.

- Well depth and depth-to-water measurements are performed consistently from a common location at top-of-well casing (e.g., notch in top of casing or northern lip of casing).
- Well water volume is calculated accurately using well measurements.
- Well is purged of the required quantity of well water and water quality is stabilized as defined by the CDAP prior to sample collection.
- Purged water is contained in drums and managed in accordance with Work Plan waste handling requirements. Field screening procedures are found in Appendix D of the Final Installation-Wide Work Plan, Attachment 1.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., Remediation Manager) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.5 Task 5 – Waste Management

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Waste generated during the project activities will be segregated by type (e.g., soil cuttings, used PPE, well development and purging liquids, trash/debris) and stored in approved 55-gallon drums or other containers.

- Waste containers are labeled with a waterproof marker according to the Work Plan, indicating the content, accumulation date, waste code(s) (if known) and pertinent analytical information.
- Waste handling activities are documented in the field logbook and a tracking log is prepared that indicates waste type, point of waste generation (i.e., well number) container size and type, accumulation date, storage location, disposal destination, transporter name, shipping paper/manifest number, and transportation and disposal dates.
- Waste containers are leak proof and stored in a secure storage area.
- Waste storage area is clearly demarcated using barricade tape and/or temporary barricade fencing, as required.
- Waste container and storage area inspections are performed on a weekly basis (at a minimum) and documented in the field logbook and/or in a standard inspection form.

5.6 Task 6 – Monitoring Well Abandonment

Shaw will abandon monitoring wells that were installed during any investigation and remediation activities as needed. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well abandonment.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Abandonment activities will employ a well driller licensed in the state of Texas.
- Well abandonment materials and equipment are suitable and approved for use prior to starting the work.
- Well locations and top of casing elevations are verified and recorded in a logbook prior to abandonment.
- Required agency permits and/or notifications are completed prior to starting abandonment activities.
- Waste generated during abandonment activities is handled and disposed according to the waste management plan.

- Quantity and depth measurements are made and recorded accurately the amount of grout used, depth below ground surface of the top of the grout once the grout has settled and hardened, and the amount of cover soil placed and compacted above the top of the grout to re-establish a level ground surface.
- A multi-purpose completion report and/or well abandonment log is accurately completed for each abandoned well and submitted to the State of Texas. Copies are maintained in the project file until submitted to the USACE with the final report.

5.7 Task 7 – Surveying

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- A qualified land surveyor licensed by the State of Texas is employed to perform well surveying and metes and bounds land-use control (LUC) boundary surveys.
- Survey datum (vertical and horizontal) used is consistent with the work plan requirements and/or historical datum.
- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled (e.g., notch in the top of casing and/or brass surveying marker embedded in surface pad).
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

For identifying locations of soil samples and limits of excavation, a Global Positioning System (GPS) may be used in lieu of land surveying. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled

- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

5.8 Task 8 – Site Restoration and Demobilization

Shaw will restore the site and demobilize once response complete is attained. Using the Three-Phase CQC system, the CQCSM will affirm the following:

- Equipment installed for the purposes of this project, and not intended to be operated after this project is demobilized.
- Information for remaining equipment or installed materials has been submitted to LHAAP and USACE.

5.9 Other Site Remediation Tasks

Shaw will perform various site remedial activities to include optimizing the existing on-site groundwater treatment plant, soil/groundwater flushing, and instituting bioremedial solutions where applicable. Using the Three-Phase CQC system, the CQCSM will monitor these tasks as appropriate. Specific QC requirements for these tasks will be identified in site-specific addenda to the work plan.

6.0 DOCUMENT CONTROL

6.1 Documentation

The CQCSM maintains current records of QC activities and tests performed, including those of suppliers and subcontractors. The records will be maintained as evidence that required control measures and tests have been performed, and indicate the results of the activities. Photographic documentation is also maintained for this project in accordance with **Section 6.4** of this plan.

6.2 Daily CQC Report

The daily CQC Report is completed and maintained by the CQCSM using a standard form. The form is provided in **Attachment 1**. As applicable, standard forms used to document safety, technical, and operations aspects of daily field activities will be attached to the Daily CQC Report.

6.3 Daily Weather Conditions/Lost Time Report

A Daily Weather Conditions/Lost Time Report is prepared daily by the CQCSM. A report form is provided at the end of this section. Lost time will be logged into the report in increments of 25% (in other words, 0%, 25%, 50%, 75% or 100%). The amount of lost time incurred will be agreed upon and initialed by the CQCSM and the USACE QAR or Technical Manager overseeing the project work. Upon completion of the report for the specified period of time, one copy of the report should be submitted to the QAR/Technical Manager once each month during fieldwork and an extra copy should be maintained by the CQCSM for future reference.

6.4 Photographs

The CQCSM will photograph the project activities. Photographs will be taken on a regular basis during the course of the project to document the work, events, and equipment used. The frequency and number of pictures taken will depend upon the activities occurring and the amount of documentation needed. The Project Manager or Remediation Manager will use judgment to determine the frequency and number of pictures taken; however, a sufficient quantity of pictures will be taken to effectively document the TO.

Pictures will be taken using 35mm film or digital medium (using a digital camera or video camera). Photos will be documented on a project log (see standard form in **Attachment 1**), which includes the photo number, date, time, description of the task depicted, and the view direction (e.g., facing northwest). A copy of the photo log, pictures, slides/videos, and digital media will be maintained in Project Files.

6.5 Review of Vendor Submittals

Vendors and subcontractors are required to expeditiously submit items such as drawings, test data, and specifications to Shaw for review to enable timely submittals to USACE. Shaw technical and CQC personnel review each submittal for compliance with contract documents. If acceptable, the item is stamped or indicated as such, and forwarded to USACE for review and acceptance.

If unacceptable, errors or deficiencies are identified and returned to the vendor or subcontractor for correction. The corrected document is resubmitted to Shaw for review until it meets contract requirements.

6.6 Government Property Accounting and Control

If applicable, Shaw will acquire, manage, and dispose of government property. At the completion of the project, all real property (removed and/or installed) will be listed on a Property Inventory Sheet.

6.7 Submittals

The Project Manager, Remediation Manager, the Program Controls Engineer, and the CQCSM are responsible for project submittals. A submittal register prepared for this project is given in **Figure 6-1**.

SUBMITTAL REGISTER

DACA56-94-D-0020
TO No. 0109

TITLE AND LOCATION: Longhorn Army Ammunition Plant – LHAAP-35A(58)

CONTRACTOR: Shaw Environmental Inc.

				TYPE OF SUBMITTAL									CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVT. ACTION		
TRANSMITTAL NO a.	ITEM NO b.	SPEC PARA NO c.	DESCRIPTION OF ITEM SUBMITTED d.	DATA e.	DRAWINGS f.	INSTRUCTIONS g.	SCHEDULES h.	STATEMENTS i.	REPORTS j.	CERTIFICATES k.	SAMPLES l.	RECORDS m.	INFO ONLY n.	GOVT. APPROVED o.	REVIEWER p.	SUBMIT q.	APPROVAL NEEDED BY r.	MAT'L NEEDED BY s.	CODE t.	DATE u.	SUBMIT TO GOVT v.	CODE w.	DATE x.	REMARKS
			Work Plan (and Appendices)		X	X	X							X		Per Project Schedule								
			Site Personnel OSHA Medical & Training Certificates							X		X	X			Prior to start of work								
			CQC and Safety Reports						X				X			Daily								
			Well Construction Methods/Specifications	X	X								X			Per Work Plan								
			Transporter ID, Insurance Cert							X			X			Prior to subcontract award								
			Manifests/Shipping Papers									X	X			Prior to shipment								
			Disposal Facility ID	X									X			Prior to subcontract award								
			Environmental Inspection Sheets									X	X			Per Work Plan								
			Groundwater Sampling Results	X					X				X			Upon data evaluation								
			Survey Drawings (As-built)		X									X		Upon completion								
			Well Construction Completion Forms									X		X		To State of Texas within 30 days of construction completion								
			Well Abandonment Forms									X		X		To the State of Texas within 30 days of construction completion								
			Drilling Logs & Groundwater Sampling Forms									X				With Daily QC Reports								

Figure 6-1
Submittal Register

7.0 SUBCONTRACTOR QUALITY CONTROL

Subcontractors for this project are responsible for compliance with the QC requirements of their respective subcontract. Subcontractors include organizations supplying quality related items or services to the project. Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services.

Subcontract documents should include the requirements for personnel qualifications, technical performance levels, QC procedures, acceptability criteria, and documentation. The CQCSM, or his designee, reviews the subcontract procurement documents to verify that the QC requirements are communicated to the subcontractor.

Each subcontractor is required to identify an adequately qualified individual within the organization to perform QC duties. The qualifications of this individual are submitted to the CQCSM for review and approval. The CQCSM coordinates the QC functions with the designated subcontractor QC representative. The Project Manager, or his authorized designee, assists the CQCSM in managing subcontractor QC.

The CQCSM is responsible for the performance of inspections, surveillance, document reviews, audits, and other QC functions to verify compliance with the subcontract requirements. These activities are documented on inspection reports, checklists, audit reports, field logs, or other forms appropriate to the function performed.

For field operations, the CQCSM performs QC inspections before, during, and after the subcontractor activities, to the extent required, to verify that the subcontractor is in compliance with the QC requirements of the contract and the applicable subcontract documents.

Audits of subcontractor activities are conducted by the CQCSM as necessary to verify compliance with the CQCP. Objective evidence of conformance to the subcontract documents is reviewed during the audits.

8.0 REFERENCES

Shaw Environmental, Inc. (Shaw), 2006, *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas, January.

Attachment 1

Field Forms

- Preparatory Inspection Check List
- Initial/Follow-Up Inspection Form
- Final Inspection Form(s)
- Daily Contractor Quality Control Report
- Daily Weather Conditions/Lost Time Report
- Photo Log Form
- Corrective Action Report

PREPARATORY INSPECTION CHECKLIST

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:____________________
Project Location:_________________
Project No.:______________________

Plan or Specification Title/Section:___________________ **Drawing Nos.:**____________________

A. Personnel present *(use back of form to list additional personnel)*

Name	**Position**	**Company**

B. Submittals involved: *(use back of form to list additional submittals)*

Number and Type	**Description**	**Indicate Contractor of Government Approval**

C. Are all materials on hand and in accordance with approvals: ☐ Yes ☐ No
List all deficiencies:

D. Test required: (list/reference all quality control tests with their required frequencies):

E. Accident prevention preplanning (list all health and safety items discussed):

CQCSM: ______________________________

INITIAL/FOLLOW-UP INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:__________________
Project Location:__________________
Project No.:__________________

(check one)

INITIAL PHASE CHECK LIST ☐ **OR**
FOLLOW-UP PHASE CHECK LIST ☐

Plan or Specification Section:____________________ **Drawing Nos.:**__________________

A. Personnel present:

Name	Position	Company

B. Materials are in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

C. Work being performed is in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

D. Workmanship is acceptable: ☐ Yes ☐ No
If improvement is needed, explain:

CQCSM: ____________________

FINAL INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:________________________
Project Location:______________________
Project No.:__________________________

FINAL INSPECTION FORM

Plan or Specification Title/Section:________________________Drawing Nos.:_______________________

Inspected Work (list feature(s) of work inspected):

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Performance Specification by Contract Delivery Order Reference	Status of Inspection

On behalf of Shaw, I certify that the work inspected is complete and meets the performance specifications cited above and that all material and equipment used and work performed was completed in accordance with approved plans and work instructions and meets contract delivery order requirements.

CQCSM ___________________________________ **Date**______/______/______

Site Manager_________________________________ **Date**______/______/______

DAILY CONTRACTOR QUALITY CONTROL REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:________________________________
Project Location:______________________________
Shaw Report No.:______________________________

WEATHER: ( ) Clear ( ) P. Cloudy ( ) Cloudy
Wind________________________
Temperature: High_______ Low_______
Precipitation: Today________________ Previous Period (i.e., weekend)________________________
Site Conditions:____
Lost Time Due to Inclement Weather: ________________%

PRIME CONTRACTOR/SUBCONTRACTORS AND AREAS OF RESPONSIBILITY/LABOR COUNT:
(Include number, trade, hours, employer, location, and description of work.)

a.

b.

c.

d.

e.

f.

WORK PERFORMED: (Include location and description of work performed including equipment used. Refer to work performed by prime and/or subcontractors as previously designated by letter above. Attached subcontractor daily activity reports when applicable):

MATERIALS AND/OR EQUIPMENT DELIVERED: (Include a description of materials and/or equipment, quantity, date/hours used, date of safety check, and supplier)

Page 1 of 3

DAILY CONTRACTOR QUALITY CONTROL REPORT *(cont.)*

RESULTS OF SURVEILLANCE: (Include satisfactory work completed or deficiencies with action to be taken.)
a. Preparatory Inspection: (Attach Minutes)

b. Initial Inspection: (Attach Minutes)

c. Follow-up Inspection: (List results of inspection compared to specification requirements.)

d. Safety Inspection: (Include safety violations and corrective actions taken.)

OFF-SITE SURVEILLANCE ACTIVITIES: (Include action taken.)

QC TESTS PERFORMED AND RESULTS: (As required by plans and/or specifications.)

VERBAL INSTRUCTIONS RECEIVED OR GIVEN: (List any instructions received from government personnel or given by Shaw on construction deficiencies identified, required retesting, etc., and the corresponding action to be taken.)

CHANGED CONDITIONS/DELAYS/CONFLICTS ENCOUNTERED: (List any conflicts with the delivery order [i.e., Scope of Work and/or drawings], delays to the project attributable to site, and weather conditions, etc.)

Page 2 of 3

DAILY CONTRACTOR QUALITY CONTROL REPORT *(cont.)*

SUBMITTALS REVIEWED: (Include submittal number, specification reference, and name of submitter.)

MEETINGS: (List the meetings, i.e., Health and Safety, Site Operations, Cost/Schedule, etc.)

VISITORS:

REMARKS: (Any additional information pertinent to the project not defined by the previous entries.)

CONTRACTOR'S VERIFICATION: The above report is complete and correct. All material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

Shaw CQCSM (or designee)

_____/_____/_____
Date

Page 3 of 3

DAILY WEATHER CONDITIONS / LOST TIME REPORT

DAILY WEATHER CONDITIONS/LOST TIME REPORT FOR WEEK/MONTH OF____________

Contract No.:________________________ Delivery Order No.:___________ Project:_________________

Contractor:__________________________

DAY	DATE	W/C. L/T	% LOST	ACTIVITY DELAYED	REMARKS	CONCUR	
						CQCR	QAR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

Weather Conditions (W/C): R-Precipitation C-Extreme Temperature M-Muddy Site Conditions W-Extreme Winds
Other Lost Time Conditions (L/T): D-Demobilized S-Standby

Representative of the Contractor____________________________

Representative of the Government____________________________

PHOTO LOG FORM

PROJECT PHOTO LOG

Project Name:______________________ Project Location:___________________________________ Project No.:______________

Photo No.	Date	Time	Task and Description	View Direction

CORRECTIVE ACTION REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:______________________________
Project Location:____________________________
Report No.:________________________________

DESCRIPTION OF PROBLEM:____

PERSONNEL RESPONSIBLE FOR INVESTIGATIVE PROCESS:______________________________

RECOMMENDED CORRECTIVE ACTIONS:____

PERSONNEL RESPONSIBLE FOR IMPLEMENTATION OF CORRECTIVE ACTIONS:________________

RESULTING ACTIONS AND EFFECTIVENESS OF THOSE ACTIONS:__________________________

PERSONNEL RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CORRECTIVE ACTIONS:________

FINAL DISPOSITION APPROVED BY:

Name:____________________________________ Title:____

Date:___________________________

Name:____________________________________ Title:____

Date:___________________________

COPIES TO:

Final
Remedial Design
LHAAP-46
Plant 2 Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Project No. 117591
Rev 0
September 2011

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Shaw® Shaw Environmental, Inc.

Date:* *September 30, 2011
Project No.:* *117591

TRANSMITTAL LETTER:

To: Mr. Aaron Williams
***Address*:** U.S. Army Corps of Engineers – Tulsa
CESWT-PP-M
1645 South 101st East Ave
Tulsa, Oklahoma 74128

Re: ***Final Remedial Design for LHAAP-46***

Contract No. W912QR-04-D-0027/DS02

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

Item No:	*No. of Copies*	*Date:*	*Document Title*
1	2	September 2011	**Final Remedial Design** **LHAAP-46, Plant 2 Area, Group 4** **Longhorn Army Ammunition Plant, Karnack, Texas**

Aaron– Enclosed are two copies of Shaw's final version of the above-named document.

Please call with any questions or comments.

Sincerely:

for Praveen Srivastav
Project Manager

Distribution:
M. Plitnik, USAEC (1)
R. Zeiler, BRAC (1)
S. Tzhone, EPA (2)
F. Duke (2)/ D. Vodak, TCEQ (1)
P. Bruckwicki, FWS (1)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

DAIM-ODB-LO

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

Re: Final Remedial Design, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Mr. Tzhone,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

September 30, 2011

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, Texas 78753

Re: Final Remedial Design, LHAAP-46, Plant 2 Area, Group 4,
Longhorn Army Ammunition Plant, Karnack, Texas, September 2011

Dear Ms. Duke,

The above-referenced document is being transmitted to you in hard copy as follow-up to the electronic version sent earlier today. 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

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
M. Plitnik, USAEC, San Antonio, TX
P. Srivastav, Shaw, Houston, TX (for project files)

From: Tzhone.Stephen@epamail.epa.gov
Sent: Friday, September 30, 2011 4:47 PM
To: Zeiler, Rose Ms CIV USA OSA; Lambert, John R SWT; Williams, Aaron K SWT
Cc: Fay Duke; Srivastav, Praveen; Everett, Kay; Duffield, Robert; Watson, Susan; Sanchez.Carlos@epamail.epa.gov
Subject: Longhorn: EPA Approval of DF LHAAP-46 RD
Attachments: (Main Text) 09 11 DRAFT FINAL RD LHAAP-46.pdf

Hi Rose,

The EPA has reviewed the Draft Final Remedial Design for LHAAP-46 and has no further comments. Please proceed with finalization.

Thanks,

Stephen L. Tzhone
Superfund Remedial Project Manager
USEPA Region 6 (6SF-RA)
214.665.8409
tzhone.stephen@epa.gov

From: "Srivastav, Praveen" <Praveen.Srivastav@shawgrp.com>
To: Stephen Tzhone/R6/USEPA/US@EPA, Fay Duke <Fay.Duke@tceq.texas.gov>
Cc: "Williams, Aaron K SWT" <Aaron.K.Williams@usace.army.mil>, "Lambert, John R SWT" <John.R.Lambert@SWT03.usace.army.mil>, "Zeiler, Rose Ms CIV USA OSA" <rose.zeiler@us.army.mil>, "Watson, Susan" <Susan.Watson@shawgrp.com>, "Duffield, Robert" <robert.duffield@shawgrp.com>, "Everett, Kay" <Kay.Everett@shawgrp.com>
Date: 09/30/2011 04:13 PM
Subject: D-F RD, LHAAP-46

Steve/Fay:

The Draft Final Remedial Design for LHAAP-46 is attached. The file contains the main text and figures to keep the size of the file within manageable limits for email. The files for the entire document are being uploaded to the Longhorn Stakeholder portal. We are also shipping out hard copies today.

Thank you,

Praveen Srivastav, PhD, PG, PMP
Project Manager
Federal Division/Project Management
Shaw Environmental & Infrastructure
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Houston, TX 77077
281.531.3188 direct
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www.shawgrp.com

From: Fay Duke [Fay.Duke@tceq.texas.gov]
Sent: Friday, September 30, 2011 5:00 PM
To: Srivastav, Praveen; Tzhone.Stephen@
Cc: Duffield, Robert; Everett, Kay; Lambert, JohnR SWT; Watson, Susan; Williams, Aaron K SWT; Zeiler, Rose Ms CIV USA OSA
Subject: TCEQ Approval: D-F RD, LHAAP-46

Rose,

The TCEQ has completed its review of the Draft Final RD for LHAAP-46 and has no further comments.

Thank you.

Fay Duke (MC-136)
Remediation Division, TCEQ
PO Box 13087
Austin, Texas 78711-3087
512-239-2443
512-239-2450 (Fax)

>>> On 9/30/2011 at 4:12 PM, <Praveen.Srivastav@shawgrp.com> wrote:

> Steve/Fay:
>
> The Draft Final Remedial Design for LHAAP-46 is attached. The file contains the main text and figures to keep the size of the file within manageable limits for email. The files for the entire document are being uploaded to the Longhorn Stakeholder portal. We are also shipping out hard copies today.
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> Thank you,
>
> **Praveen Srivastav, PhD, PG, PMP**
> Project Manager
> Federal Division/Project Management
> Shaw Environmental & Infrastructure
> 1401 Enclave Parkway, Suite 250
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>
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00111695

Final
Remedial Design
LHAAP-46, Plant 2 Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st, East Avenue
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Acronyms and Abbreviations

µg/L	micrograms per liter
bgs	below ground surface
CDAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	chemicals of concern
CQCP	Contractor Quality Control Plan
DHC	dehalococcoides
DO	dissolved oxygen
ECP	Environmental Condition of Property
GWTP	groundwater treatment plant
HASP	Health and Safety Plan
Jacobs	Jacobs Engineering, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
LUC O&M	Land Use Control Operation and Maintenance
MARC	Multiple Award Remediation Contract
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Oil and Hazardous Substances Contingency Plan
ORP	oxidation reduction potential
PPE	personal protective equipment
QA/QC	Quality Assurance/Quality Control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
ROD	Record of Decision
Shaw	Shaw Environmental, Inc.
TAC	Texas Administrative Code
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TOC	total organic carbon
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) has been contracted by the U.S. Army Corps of Engineers (USACE) Tulsa District to complete the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response at LHAAP-46, Plant 2 Area at the former Longhorn Army Ammunition Plant (LHAAP) near Karnack, Texas. This Remedial Design (RD) for LHAAP-46 is a part of the response. Subsequent work plans will be prepared to provide more details of the implementation of this remedial design (i.e., well installation details). This work is being performed under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D-0027, Task Order DS02, with oversight by the USACE, Tulsa District.

1.1 LHAAP Background

LHAAP is located in central-east Texas in the northeastern corner of Harrison County, approximately 14 miles northeast of Marshall, Texas (see **Figure 1-1**). The facility occupies approximately 8,416 acres between State Highway 43 in Karnack, Texas, and the western shore of Caddo Lake. Caddo Lake is a large freshwater lake that bounds LHAAP to the north and east. The eastern fence of LHAAP is 3.5 miles from the Texas-Louisiana state border.

1.1.1 LHAAP-46 Description

LHAAP-46 (Plant 2 Area) is in the north-central portion of LHAAP in an industrial area as shown on **Figure 1-2** where pyrotechnic and illumination devices were produced until 1997. LHAAP-46 is approximately 190 acres and is triangular in shape, bounded by Avenue "P" to the southwest, the LHAAP property boundary fence to the north, and LHAAP-47 to the southeast. The surface features at LHAAP-46 are a mixture of asphalt-paved roads, parking areas, building foundation remnants, old buildings, and overgrown wooded and grassy vegetation-covered areas. The topography in this area is relatively flat with the surface drainage flowing east into tributaries of Goose Prairie Creek. Runoff from the site enters Caddo Lake via Goose Prairie Creek.

Preliminary field investigations were conducted at the Plant 2 Area between 1991 and 2001, with subsequent site investigations in 2003, 2006, 2007, and 2008 (soil, groundwater and pit sampling for site characterization). The investigations showed that there had been impacts to groundwater in the shallow and intermediate zones, but soil and pit residues posed no threat to human health or the environment (Shaw, 2009). There have been no previous remedial actions at LHAAP-46.

The remedial action alternative to be implemented at LHAAP-46 was developed and selected in accordance with the CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Contingency Plan (NCP) (40 Code of Federal Regulations Part 300). The selected remedy finalized in the Record of Decision (ROD) (U.S. Army, 2010) was developed based on the assumption that future land use will be industrial/recreational (e.g., national wildlife refuge). The remedial action assumes that land use notification will be recorded at the Harrison County courthouse to indicate that the property is suitable for nonresidential use. It is also assumed that this remedial action will be the final action at the site.

1.1.2 Remedial Action Objectives

A remedial action at LHAAP-46 must protect human health and meet applicable or relevant and appropriate requirements. As noted in the *Final Feasibility Study* (Shaw, 2009), there is no ecological risk at LHAAP-46. Therefore, the proposed remedial action addresses human health risk. The threat that must be addressed at LHAAP-46 is groundwater contamination that could adversely affect human health via ingestion, inhalation, and direct contact (Shaw, 2009).

The remedial action objectives (RAOs) for LHAAP-46, consistent with the reasonably anticipated future use as a national wildlife refuge, 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 to nearby surface water; and
- Return of groundwater to its potential beneficial uses as drinking water, wherever practicable.

The above RAO recognizes the U.S. Environmental Protection Agency's (USEPA) 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. Department of the Army (U.S. Army) in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

1.1.3 Planned Remedial Action

The RAOs were the basis for formulating and evaluating removal alternatives and selecting a remedial action (U.S. Army, 2010). The U.S. Army will implement the following response at LHAAP-46:

- **Land Use Control.** Land use control (LUC) in the impacted area will ensure the protection of human health by restricting the use of groundwater. The LUC for groundwater restriction will remain in place until the cleanup levels are met.
- **Monitored Natural Attenuation (MNA).** MNA will be implemented to verify that the trichloroethene (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 two years of MNA. During those two years, groundwater monitoring will be performed quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented.
- **Long-Term Monitoring/Five-Year Reviews.** If MNA is found to be effective, it will be continued, and long-term monitoring (LTM) will begin at a semiannual frequency for three years. In subsequent years, LTM will be annual until the next five-year review. The LTM and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue at least once every five years until cleanup levels are achieved. Based on preliminary calculated attenuation rates for LHAAP-46, groundwater cleanup levels are expected to be met through natural attenuation in 23 to 30 years. This time frame will be re-evaluated as part of the MNA evaluation and periodic reviews.

1.2 Cleanup Levels

Cleanup levels were established to meet the RAOs as included in the ROD (U.S. Army, 2010). **Table 1-1** presents the cleanup levels for LHAAP-46.

Table 1-1
Cleanup Levels

Chemical	Concentration (µg/L)	Basis
Trichloroethene	5	MCL
cis-1,2-Dichloroethene (daughter product)	70	MCL
trans-1,2-Dichloroethene (daughter product)	100	MCL
Vinyl Chloride (daughter product)	2	MCL

Notes and Abbreviations:

µg/L	micrograms per liter
MCL	Safe Drinking Water Act maximum contaminant level

1.3 Areas of Contamination

Based on available sampling data, the groundwater at LHAAP-46 has been identified as a medium of concern due to the presence of TCE concentrations exceeding the U.S. Safe

Drinking Water Act maximum contaminant level (MCL) value of 5 micrograms per liter (µg/L) in both the shallow and intermediate groundwater zones. Based on the sampling results, the area of TCE contaminated shallow zone groundwater exceeding the MCL is estimated to be approximately 5 acres (1.41 million gallons). This area of contaminated shallow groundwater bounded by the 5 µg/L concentration contour is illustrated on **Figure 1-3**. The area of TCE contaminated intermediate zone groundwater exceeding the MCL is estimated to be approximately 16 acres (7.85 million gallons). This area of contaminated intermediate groundwater zone bounded by the 5 µg/L concentration contour is illustrated on **Figure 1-4**.

1.4 Hydrogeology

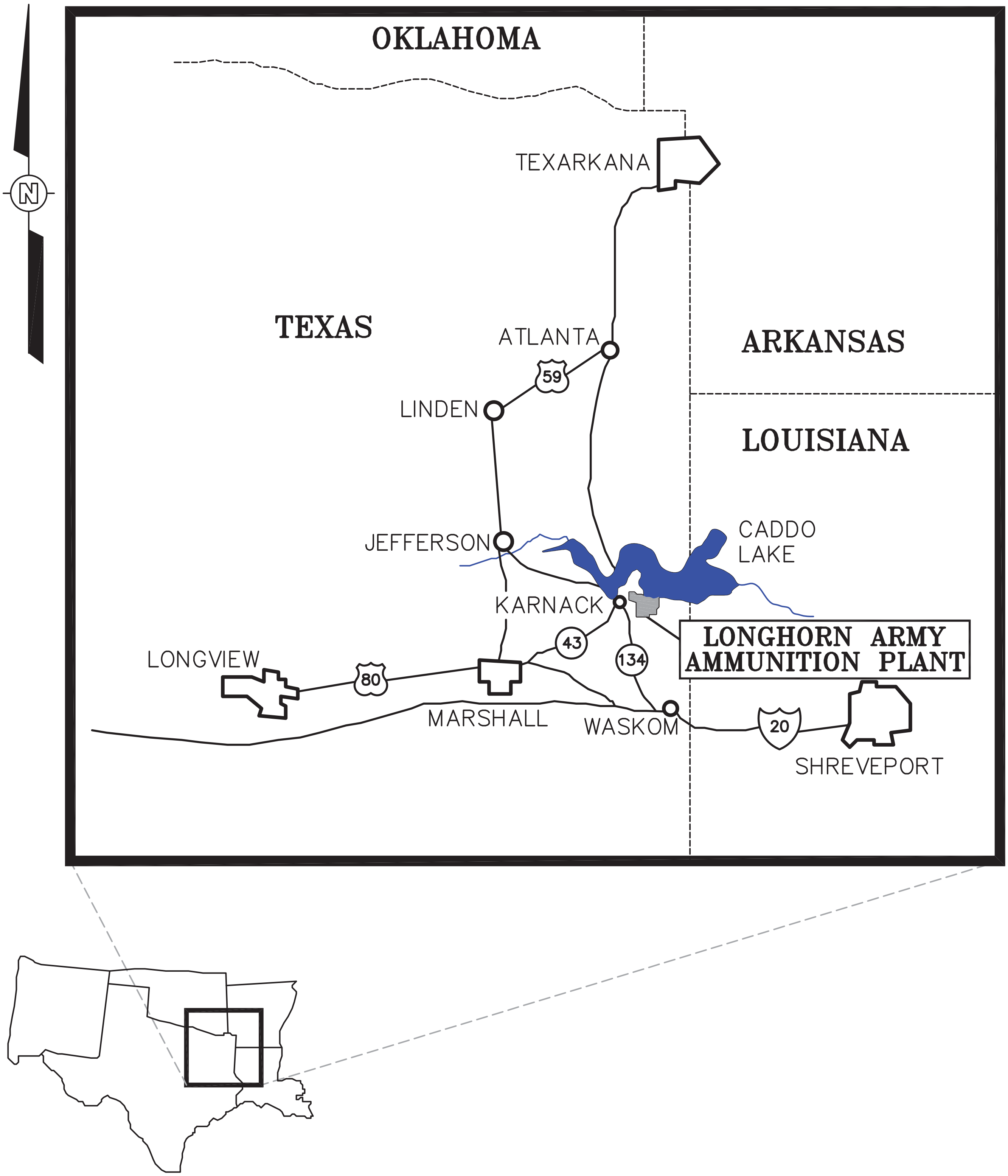
Groundwater at the site was encountered approximately 13 to 28 feet below ground surface (bgs) in the shallow groundwater zone, approximately 27 to 37 feet bgs in the intermediate zone, and approximately 33 feet bgs in the deep zone. The groundwater flow in the shallow zone at the site is generally to the east and in the intermediate zone is generally to the northeast. When there is no apparent separation between the zones or sand layers, the layers are considered interconnected. This occurs at LHAAP-46 near wells LHSMW23 and LHSMW26 and the groundwater bearing zone has been designated as a composite shallow/intermediate zone. A new set of groundwater elevations were collected on April 15, 2011 and are shown on **Figure 1-3** and **Figure 1-4**. **Figure 1-3** shows groundwater elevation contours in the shallow zone and **Figure 1-4** shows groundwater elevation contours in the intermediate zone. The tabular form of the data is shown in **Table 1-2**.

Table 1-2
Groundwater Elevations – April 15, 2011

Well ID	Zone	Depth to Water (feet)	Total Well Depth (feet)	Top of Casing Elevation (feet MSL)	Groundwater Elevation (feet MSL)
46WW01	Shallow	25.02	26.75	212.82	187.80
46WW02	Intermediate	33.93	47.40	212.21	178.28
46WW03	Deep	38.30	103.35	212.47	174.17
46WW04	Shallow	21.80	27.70	215.39	193.59
46WW05	Intermediate	35.42	45.00	208.24	172.82
46WW06	Intermediate	36.86	52.20	213.84	176.98
LHSMW08	Intermediate	27.80	35.49	207.85	180.05
LHSMW09	Shallow	22.29	26.30	210.68	188.39
LHSMW11	Shallow	24.94	26.95	212.91	187.97
LHSMW12	Shallow	Dry	16.85	209.02	Dry
LHSMW13	Shallow	Dry	18.00	209.50	Dry
LHSMW14	Shallow	13.17	20.10	244.78	231.61
LHSMW15	Shallow	23.20	24.90	226.65	203.45
LHSMW16	Shallow	18.92	24.60	232.19	213.27
LHSMW17	Shallow	26.55	26.80	214.58	188.03
LHSMW18	Shallow	23.53	28.70	215.35	191.82
LHSMW19	Shallow	22.83	29.80	212.96	190.13
LHSMW20	Shallow	22.87	24.80	209.29	186.42
LHSMW21	Shallow	18.35	29.55	207.67	189.32
LHSMW22	Shallow	27.97	28.80	209.60	181.63
LHSMW23	Shallow-Intermediate	29.55	47.00	208.82	179.27
LHSMW24	Shallow	25.07	28.60	203.84	178.77
LHSMW25	Intermediate	27.28	42.41	201.97	174.69
LHSMW26	Shallow-Intermediate	28.25	37.47	204.72	176.47
LHSMW27	Shallow	Dry	20.00	202.10	Dry

Notes:

MSL	mean sea level



"DRAWING NOT TO SCALE"

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

FIGURE 1-1

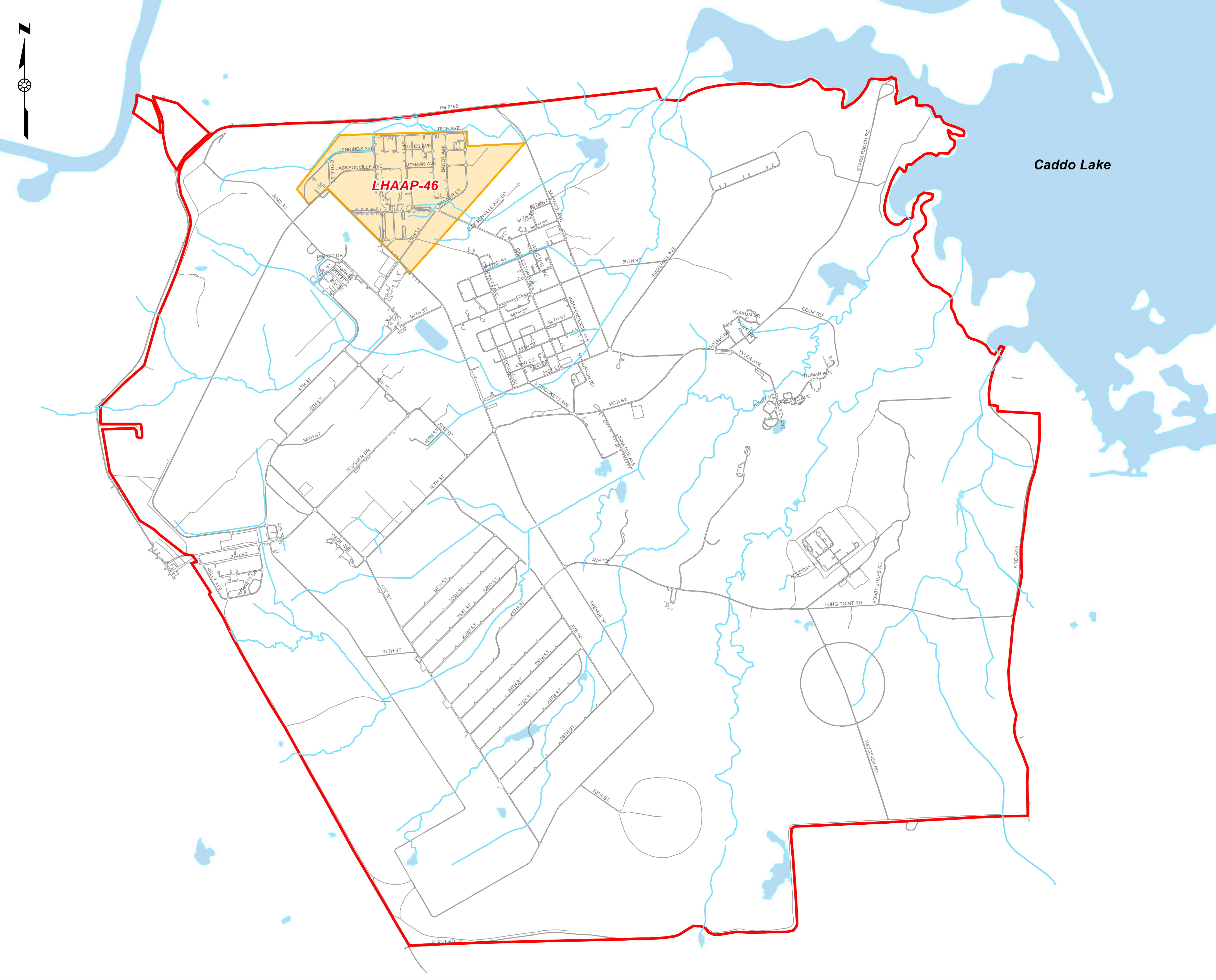
LHAAP LOCATION MAP

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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

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

00111706



LEGEND

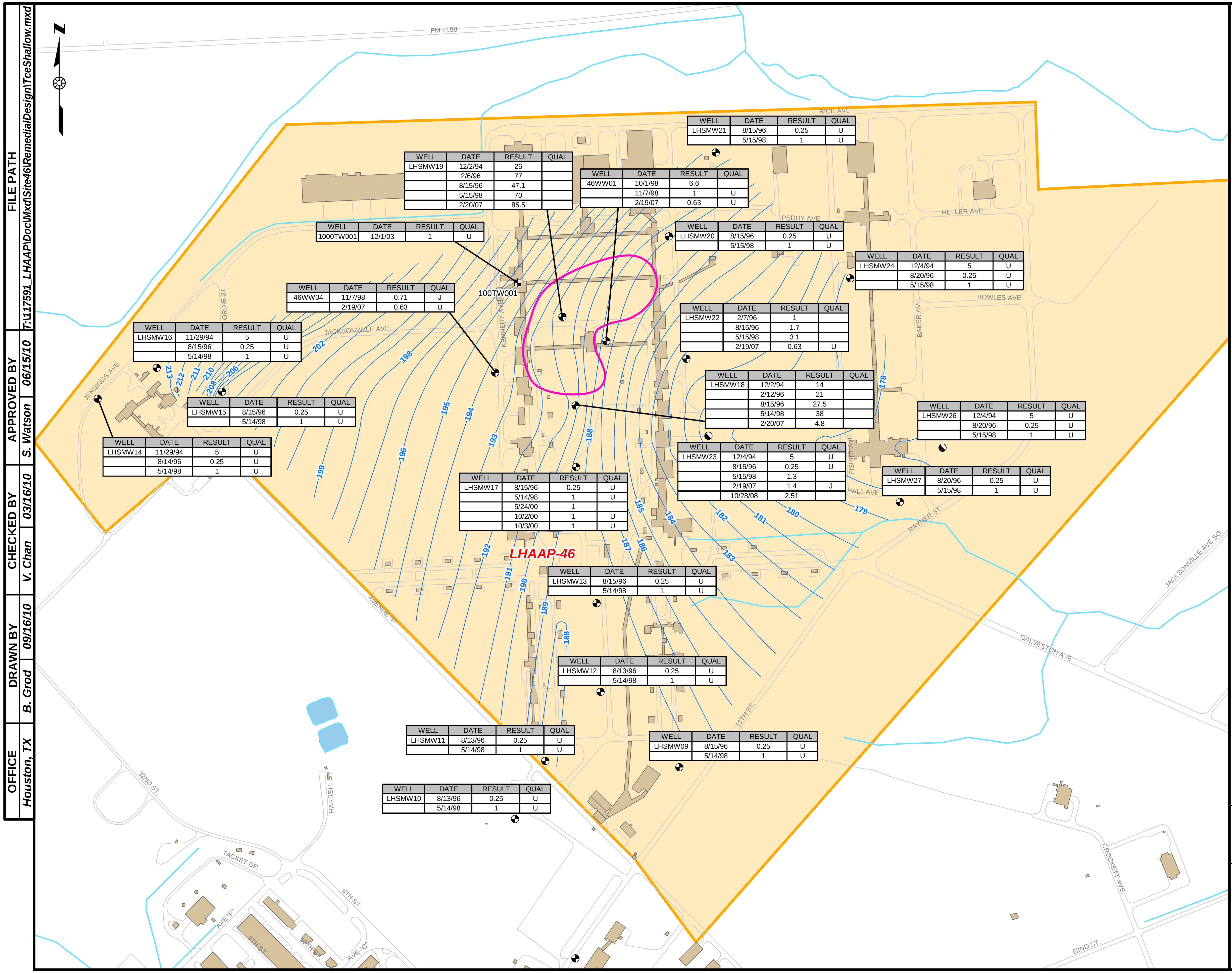
U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1-2

SITE VICINITY MAP
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod 09/16/10	R. Duffield 09/20/10	S. Watson 09/20/10	T:\Divisions\Design\GIS\117591_LHAAP\Doc\Mxd\Site46\SiteVicinity.mxd



WELL	DATE	RESULT	QUAL
LHSMW21	8/15/96	0.25	U
	5/15/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW19	12/2/94	26	
	2/6/96	77	
	8/15/96	47.1	
	5/15/98	70	
	2/20/07	85.5	

WELL	DATE	RESULT	QUAL
46WW01	10/1/98	6.6	
	11/7/98	1	U
	2/19/07	0.63	U

WELL	DATE	RESULT	QUAL
1000TW001	12/1/03	1	U

WELL	DATE	RESULT	QUAL
LHSMW20	8/15/96	0.25	U
	5/15/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW24	12/4/94	5	U
	8/20/96	0.25	U
	5/15/98	1	U

WELL	DATE	RESULT	QUAL
46WW04	11/7/98	0.71	J
	2/19/07	0.63	U

WELL	DATE	RESULT	QUAL
LHSMW22	2/7/96	1	
	8/15/96	1.7	
	5/15/98	3.1	
	2/19/07	0.63	U

WELL	DATE	RESULT	QUAL
LHSMW16	11/29/94	5	U
	8/15/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW18	12/2/94	14	
	2/12/96	21	
	8/15/96	27.5	
	5/14/98	38	
	2/20/07	4.8	

WELL	DATE	RESULT	QUAL
LHSMW15	8/15/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW26	12/4/94	5	U
	8/20/96	0.25	U
	5/15/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW14	11/29/94	5	U
	8/14/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW23	12/4/94	5	U
	8/15/96	0.25	U
	5/15/98	1.3	
	2/19/07	1.4	J
	10/28/08	2.51	

WELL	DATE	RESULT	QUAL
LHSMW27	8/20/96	0.25	U
	5/15/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW17	8/15/96	0.25	U
	5/14/98	1	U
	5/24/00	1	
	10/2/00	1	U
	10/3/00	1	U

WELL	DATE	RESULT	QUAL
LHSMW13	8/15/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW12	8/13/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW11	8/13/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW09	8/15/96	0.25	U
	5/14/98	1	U

WELL	DATE	RESULT	QUAL
LHSMW10	8/13/96	0.25	U
	5/14/98	1	U

LEGEND

◕	Shallow Monitoring Well
◐	Shallow/Intermediate Monitoring Zone
▣	Temporary Monitoring Well
〰	Shallow Zone TCE Plume (5 µg/L)
〰	Groundwater Elevation Contour
〰	Stream
╱╲	Road
▨	Former Building or Concrete Slab
▭	Site

Note:

1. Sampling results reported in micrograms per liter (µg/L).
2. Groundwater elevation levels collected in April 2011.

0 200 400 800
Feet

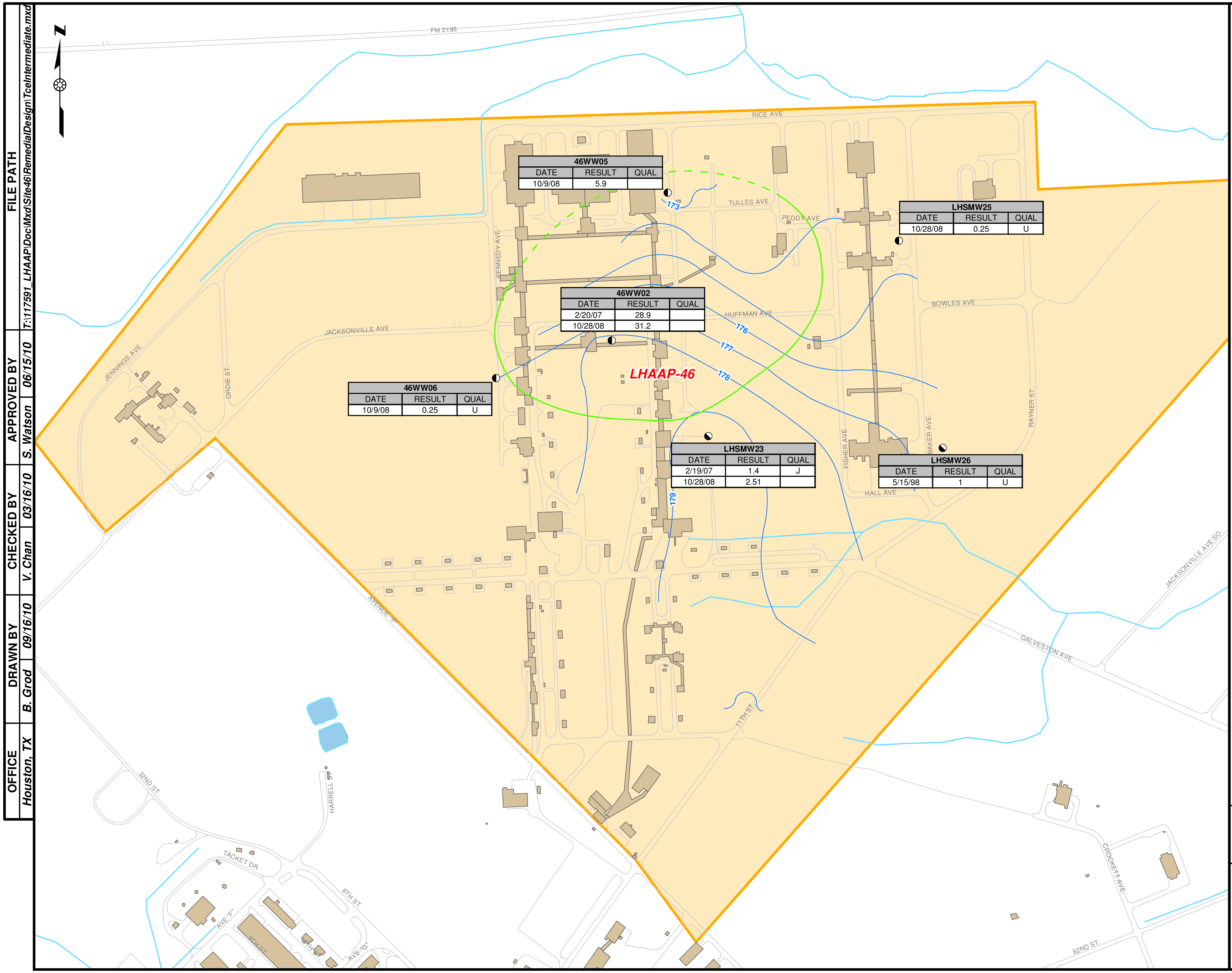
U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 1-3

TCE IN SHALLOW ZONE
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	B. Grod 09/16/10	V. Chan 03/16/10	S. Watson 06/15/10	T:\117591_LHAAP\Doc\Mxd\Site46\RemedialDesign\TceShallow.mxd



46WW05

DATE	RESULT	QUAL
10/9/08	5.9	

LHSMW25

DATE	RESULT	QUAL
10/28/08	0.25	U

46WW02

DATE	RESULT	QUAL
2/20/07	28.9	
10/28/08	31.2	

46WW06

DATE	RESULT	QUAL
10/9/08	0.25	U

LHSMW23

DATE	RESULT	QUAL
2/19/07	1.4	J
10/28/08	2.51	

LHSMW26

DATE	RESULT	QUAL
5/15/98	1	U

LEGEND

◒	Shallow/Intermediate Monitoring Well
◐	Intermediate Monitoring Well
〰	Intermediate Zone TCE Plume (5 µg/L) *Dashed where inferred*
〰	Groundwater Elevation Contour
〰	Stream
╱╲	Road
▨	Former Building or Concrete Slab
▭	Site

Note:

1. Sampling results reported in micrograms per liter (µg/L).
2. TCE - trichloroethene
3. TCE MCL is 5 µg/L.
4. Groundwater elevation levels collected in April 2011.

0 200 400 800
Feet

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TULSA, OKLAHOMA

FIGURE 1-4

TCE IN INTERMEDIATE ZONE
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	FILE PATH
Houston, TX	*B. Grod 09/16/10*	*V. Chan 03/16/10*	*S. Watson 06/15/10*	*T:\117591_LHAAP\Doc\Mxd\Site46\RemedialDesign\TceIntermediate.mxd*

2.0 LAND USE CONTROL

The objective of the LUC at LHAAP-46 is to 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 until cleanup goals are met Notification of the groundwater use restriction will accompany all transfer documents and will be recorded at the Harrison County Courthouse in accordance with Texas Administrative Code (TAC) Title 30, §335.566. **Appendix A** provides sample LUC compliance certification documentation.

The LUC addresses the area of LHAAP-46 that includes two groundwater plumes at LHAAP-46 with levels of contamination that require implementation of a remedy (see **Section 1.3**). The U.S. Army is responsible for implementing, maintaining, monitoring, reporting on, and enforcing the LUC.

U.S. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an LUC objective at this site after it has transferred. U.S. Army shall obtain USEPA and Texas Commission on Environmental Quality (TCEQ) concurrence prior to termination or significant modification of the LUC, or implementation of a change in land use inconsistent with the LUC objectives and use assumptions of the remedy. Although not a remedy, the land use assumption for LHAAP-46 forms the basis for the remedy. The future use of the site as part of a national wildlife refuge is consistent with an industrial risk exposure scenario. Notification of the land use assumption of this site will be made in transfer documentation and will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566. Compliance with the use assumption will be documented in the five-year review reports.

3.0 MONITORING SYSTEM DESIGN

As part of the remedy, monitoring will be conducted of the groundwater and surface water. The groundwater monitoring system was designed to evaluate and monitor natural attenuation in both the shallow and intermediate plumes and the surface water system was designed to evaluate any potential migration of groundwater to surface water. Generally the MNA performance monitoring network will be designed to provide at least two wells along the axis inside the plume boundary to evaluate MNA effectiveness; four wells to evaluate lateral plume expansion; and at least one well to evaluate vertical migration. This section discusses the rationale of MNA performance monitoring program designed to meet the following objectives:

Objectives for Performance Monitoring of MNA (USEPA, 1999)

1. Demonstrate that natural attenuation is occurring according to expectations
2. Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes
3. Identify any potentially toxic and/or mobile transformation products,
4. Verify that the plume(s) is not expanding downgradient, laterally or vertically,
5. Verify no unacceptable impact to downgradient receptors,
6. Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy
7. Verify attainment of remediation objectives.

3.1 MNA Performance Monitoring Well Locations

In November 2007 a full set of groundwater elevation readings were collected of the entire northern area of LHAAP including LHAAP-46. Each existing well completion was evaluated and wells were assigned to a shallow, shallow-intermediate, or intermediate zone. Based on these designations, the groundwater contamination is located in two zones at LHAAP-46, shallow and intermediate. A deep groundwater zone also exists, but contamination has not been observed in the deep zone. The coordinates and well information are located in **Table 3-1**.

3.1.1 Shallow Groundwater Plume

The site hydrogeology is important when designing a monitoring system. The shallow groundwater elevations are approximately 13 to 28 feet bgs. Generally the groundwater flow is in an easterly direction as documented in groundwater flow assessments. The current shallow zone wells are completed in the sand interval that is approximately 15 to 25 feet bgs.

The shallow zone plume boundary has shrunk over time and currently has one well within the plume boundary. The plume is bounded; however, the exact shape and boundary of the plume may be smaller than depicted. A direct-push rig will be used to further delineate the edges of the plume, especially the eastern edge, as well as optimize the selection of a second well location within the plume. Approximately 10 grab samples will be collected using well points and analyzed for volatile organic compounds (VOCs). Based on these results, additional locations may be selected for optimal locations of the performance monitoring wells. **Figure 3-1** indicates possible locations of four additional monitoring wells based on the current data and groundwater elevations. Use of existing wells will be maximized as they provide historic data that can be used in the MNA evaluation. **Table 3-2** provides the rationale for the selection of wells in the proposed monitoring well system for the shallow zone as shown on **Figure 3-1**. The cross sections have been shown on **Figure 3-3**. Additional cross sections are presented in the LHAAP-46 Feasibility Study (Shaw, 2009) and Remedial Investigation report (Jacobs, 2002).

3.1.2 Intermediate Groundwater Plume

The site hydrogeology is important when designing a monitoring system. The intermediate groundwater elevations are approximately 27 to 37 feet bgs. Generally, the groundwater flows in a north-easterly direction as documented in groundwater flow assessments. The current intermediate zone wells are completed in the sand interval that is approximately 36 to 43 feet bgs.

The intermediate zone plume has two wells within the plume. The February 2007 sampling event indicated TCE concentrations at 46WW05 above the MCL at 5.9 µg/L. New monitoring wells will be installed and sampled to delineate the edges of the plume, especially the northern, north-eastern and north-western edge. A third well location will also be installed within the plume. The samples will be analyzed for VOCs. **Figure 3-2** indicates possible locations of four additional monitoring wells based on the current data and groundwater elevations. Use of existing wells will be maximized as they provide historic data that can be used in the MNA evaluation. **Table 3-3** provides the rationale for the selection of wells in the proposed monitoring well system for the intermediate zone as shown on **Figure 3-2**. The cross sections have been shown on **Figure 3-3**. Additional cross sections are presented in the LHAAP-46 Feasibility Study (Shaw, 2009) and Remedial Investigation report (Jacobs, 2002).

3.1.3 Vertical Well Cluster

Well cluster 46WW01, 46WW02 and 46WW03 have been completed close to the highest concentration wells. 46WW03 has been installed in the deep zone and will be monitored as part of the MNA network to assess any vertical migration.

3.2 MNA Evaluation

The schedule for groundwater monitoring for MNA will be quarterly for two years. This data will be used to evaluate seasonal variation, and attenuation rates. Historical data will be used to evaluate MNA effectiveness and determine if monitoring should continue or a contingent action should be implemented. All collected groundwater samples will be analyzed for VOCs and field parameters (pH, dissolved oxygen [DO], and oxidation reduction potential [ORP]). A subset of the groundwater samples, those from wells historically within the groundwater plume, will also be tested for MNA parameters (dehalococcoides [DHC] (optional), alkalinity, chloride, nitrate/nitrite, sulfate/sulfide, total organic carbon [TOC], carbon dioxide, ferric iron, dissolved manganese and iron, and phosphorus). After the first two years, the effectiveness of MNA will be evaluated (**Section 6.1**). LTM will begin if the MNA evaluation determines MNA to be effective.

3.3 Long-Term Monitoring

LTM will be initiated in the following year after the 2 years of MNA evaluation. For LTM, the analytical suite will be VOCs, and the frequency of sampling will be semiannual for three years, then annually until the next five-year review. Further reductions in sampling frequency will depend on results of five-year reviews, but sampling will continue at least once every five years until cleanup levels are achieved. Based on the LTM results, a reduction in the number of wells to be sampled may be included in the five-year review. Recommendations for reducing the number of wells will be included in monitoring and/or five-year reports.

3.4 Five-Year Reviews

Reviews will be conducted every five years to ensure that the remedy continues to provide adequate protection of human health and the environment. Groundwater sampling will continue for VOCs once every five years or as determined in the five-year review. Groundwater monitoring results, site inspections, regulatory changes, and other information will be considered to determine whether the current remedy should continue or if a change is required. U.S. Army shall obtain regulatory concurrence prior to termination or significant modification of LTM activities.

3.5 Thallium Monitoring

In addition to monitoring the chemicals of concern (COCs) at LHAAP-46, monitoring for thallium will also be conducted every quarter for the first year (U.S. Army, 2010). Thallium was detected at LHAAP-46 above its MCL of 2 µg/L during the remedial investigation phase and during subsequent monitoring for a geochemical evaluation of metals. Historically the highest thallium concentration was observed in LHMW27. However this data has not been reproducible in the following sampling events (Jacobs, 2002). Shaw will monitor all the monitoring wells in the shallow, intermediate and deep zone. Even though the conclusions of the geochemical evaluation were that thallium was naturally occurring, it was decided that additional groundwater sampling for thallium would be conducted at all monitoring wells to confirm this decision (U.S. Army, 2010).

3.6 Surface Water Monitoring

To ensure that groundwater at LHAAP-46 is not contaminating nearby surface water, semi-annual monitoring of Goose Prairie adjacent to LHAAP-46 will be conducted at one location (**Figure 3-4**). A new surface water sampling location (46SW01) will be added to monitor for contaminant contributions from the groundwater at LHAAP-46. Evaluation of this data will be included in the annual reports. The frequency and location of sampling may be modified after evaluation of data. If TCE levels in the creek are consistently above TCEQ groundwater MSC for residential use after two years of monitoring, then additional evaluation will be conducted and any proposed actions will be included in the annual evaluation report to be submitted after Year 2. The need to continue creek sampling will be evaluated during the five-year reviews.

Table 3-1
Monitoring Wells to be Sampled at LHAAP-46

Well	Groundwater Zone	Approximate depth [a] (ft bgs)	Location		Ground Elevation (ft MSL)	Top of Casing (ft MSL)
			Northing	Easting		
46WW01	Shallow	24	6962839.74	3306046.3	209.75	212.82
46WW02	Intermediate	45	6962842.6	3306068.17	209.16	212.21
46WW03	Deep	100	6962841.67	3306057.06	209.8	212.47
46WW04	Shallow	24	6962709.27	3305584.77	212.47	215.39
46WW05	Intermediate	44	6963454.92	3306300.8	205.59	208.24
46WW06	Intermediate	52.20	6962687.89	3305588.7	211.24	213.84
*46WW07	Intermediate	TBD	TBD	TBD	TBD	TBD
*46WW08	Intermediate	TBD	TBD	TBD	TBD	TBD
*46WW09	Intermediate	TBD	TBD	TBD	TBD	TBD
*46WW10	Shallow	TBD	TBD	TBD	TBD	TBD
*46WW11	Shallow	TBD	TBD	TBD	TBD	TBD
*46WW12	Shallow	TBD	TBD	TBD	TBD	TBD
*46WW13	Shallow	TBD	TBD	TBD	TBD	TBD
*46WW14	Intermediate	TBD	TBD	TBD	TBD	TBD
LHSMW08	Intermediate	33.8	6961325.2	3306617.02	204.49	207.85
LHSMW11	Shallow	24	6961100.93	3305792.93	209.89	212.91
LHSMW12	Shallow	13.6	6961387.04	3306021.93	205.98	209.02
LHSMW14	Shallow	17.4	6962600.77	3303935.98	241.67	244.78
LHSMW15	Shallow	21.6	6962630.67	3304451.98	223.68	226.65
LHSMW16	Shallow	21.6	6962728.61	3304181.02	229.3	232.19
LHSMW18	Shallow	24.5	6962572.94	3305918.42	212.38	215.35
LHSMW19	Shallow	26.6	6962939.93	3305863.42	209.8	212.96
LHSMW20	Shallow	22	6963272.98	3306305.05	206.21	209.29
LHSMW21	Shallow	26.6	6963621.13	3306499.52	204.66	207.67
LHSMW22	Shallow	25.5	6962766.71	3306377.68	206.41	209.6
LHSMW23	Shallow/ Intermediate	38.4	6962446.76	3306469.07	205.8	208.82
LHSMW24	Shallow	25.6	6963099.29	3307057.41	200.52	203.84
LHSMW25	Intermediate	39.2	6963255.59	3307259.52	199.07	201.97
LHSMW27	Shallow	17.6	6962173.9	3307262.99	199.2	202.1

Notes and Abbreviations:

Coordinate system is Texas State Plane, NAD 1983

* Proposed Monitoring Well

[a] Approximate depth is the bottom of the screen interval

ft bgs	feet below ground surface
ft MSL	feet mean sea level
TBD	to be determined

Table 3-2
Rationale for Shallow Plume Performance Monitoring Wells

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
In plume	Highest concentrations in plume; Extreme drought has caused this well to be dry at times, but the well is completed with 10-foot screen over the 2.5-foot sand interval where contamination was found.	LHSMW19	Evaluate presence of any toxic and mobile daughter products, geochemical and microbiological changes of the dissolved plume to evaluate monitored natural attenuation (MNA) processes
In plume	Downgradient from highest concentration in same sand zone	New Well 46WW11	Evaluate presence of daughter products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes; calculate distance based attenuation rate; evaluate plume stability
Downgradient (near plume edge)	Existing well near eastern plume edge	46WW01	Evaluate downgradient plume stability (expansion/contraction), evaluate seasonal variations and effects on plume boundary, and evaluate MNA processes
Downgradient (near plume edge)	Near eastern plume edge	New Well 46WW12	Evaluate downgradient plume stability (expansion/contraction), evaluate seasonal variations and effects on plume boundary, and evaluate MNA processes
Downgradient (near plume edge)	Near eastern plume edge	New Well 46WW13	Evaluate downgradient plume stability (expansion/contraction), evaluate seasonal variations and effects on plume boundary, and evaluate MNA processes
Downgradient	Existing well downgradient of eastern plume edge	LHSMW22	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors; Demonstrate groundwater to surface water contamination will not occur since plume is stable
Crossgradient – North side	Existing well outside plume to the north	LHSMW20	Evaluate lateral expansion
Crossgradient – South side (near/outside plume edge)	Existing well outside of the plume boundary to the south	LHSMW18	Evaluate lateral expansion; evaluate seasonal variations if it is determined that this well is on the plume boundary – if not on the plume boundary, this will be the primary cross gradient well.
Crossgradient – South side (outside plume edge; optional location)	Existing well outside of the plume boundary to the south	LHSMW17	Evaluate lateral expansion of the plume. If direct-push technology (DPT) investigation determines that the plume boundary is not near LHSMW18, than this well will not be part of the monitoring network and LHSMW18 would be the used as the cross gradient well.
Upgradient	Well outside the plume boundary to the west	New Well 46WW10	Detect any new contamination flowing into plume area; Evaluate lateral plume expansion
Upgradient (optional location)	Existing well outside the plume boundary to the west	46WW04	Detect any new contamination flowing into plume area; Evaluate lateral expansion

Table 3-3
Rationale for Intermediate Plume Performance Monitoring Wells

Performance Monitoring Well Location	Monitoring Well Location Relative to Plume	Well ID	Utility
In plume	Highest concentrations in plume;	46WW02	Evaluate presence of any toxic and mobile daughter products, geochemical and microbiological changes of the dissolved plume to evaluate monitored natural attenuation (MNA) processes
In plume	New monitoring well to be installed within the plume	New Well 46WW09	Evaluate presence of any toxic and mobile daughter products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes
In plume (near north boundary edge)	Downgradient from highest concentration in same sand zone	46WW05	Evaluate presence of daughter products, geochemical and microbiological changes of the dissolved plume to evaluate MNA processes; Calculate distance based attenuation rate; evaluate plume stability; Evaluate seasonal variations and effects on plume boundary
Cross-gradient (near/outside the plume edge)	Existing well near south-western plume edge	46WW06	Evaluate lateral expansion (expansion/contraction) and evaluate seasonal variations and effects on plume boundary
Downgradient (outside the plume edge)	Existing well downgradient of the plume	LHSMW25	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors
Downgradient (outside the plume edge)	New monitoring well to be installed outside the plume to the north	New Well 46WW07	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors; Demonstrate groundwater to surface water contamination will not occur since plume is stable
Downgradient (outside the plume edge)	New monitoring well to be installed outside the plume to the north-west	New Well 46WW08	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors; Demonstrate groundwater to surface water contamination will not occur since plume is stable
Upgradient (outside the plume edge)	Existing well outside plume to the south. Well has 20-foot screen; screened over shallow-intermediate and intermediate sands.	LHSMW23	Detect any new contamination flowing into plume area; Evaluate lateral expansion
Downgradient (outside the plume edge)	New monitoring well to be installed outside the plume to the north-east	New Well 46WW14	Evaluate downgradient expansion; Verify no unacceptable impact to downgradient receptors; Demonstrate groundwater to surface water contamination will not occur since plume is stable; Evaluate MNA processes

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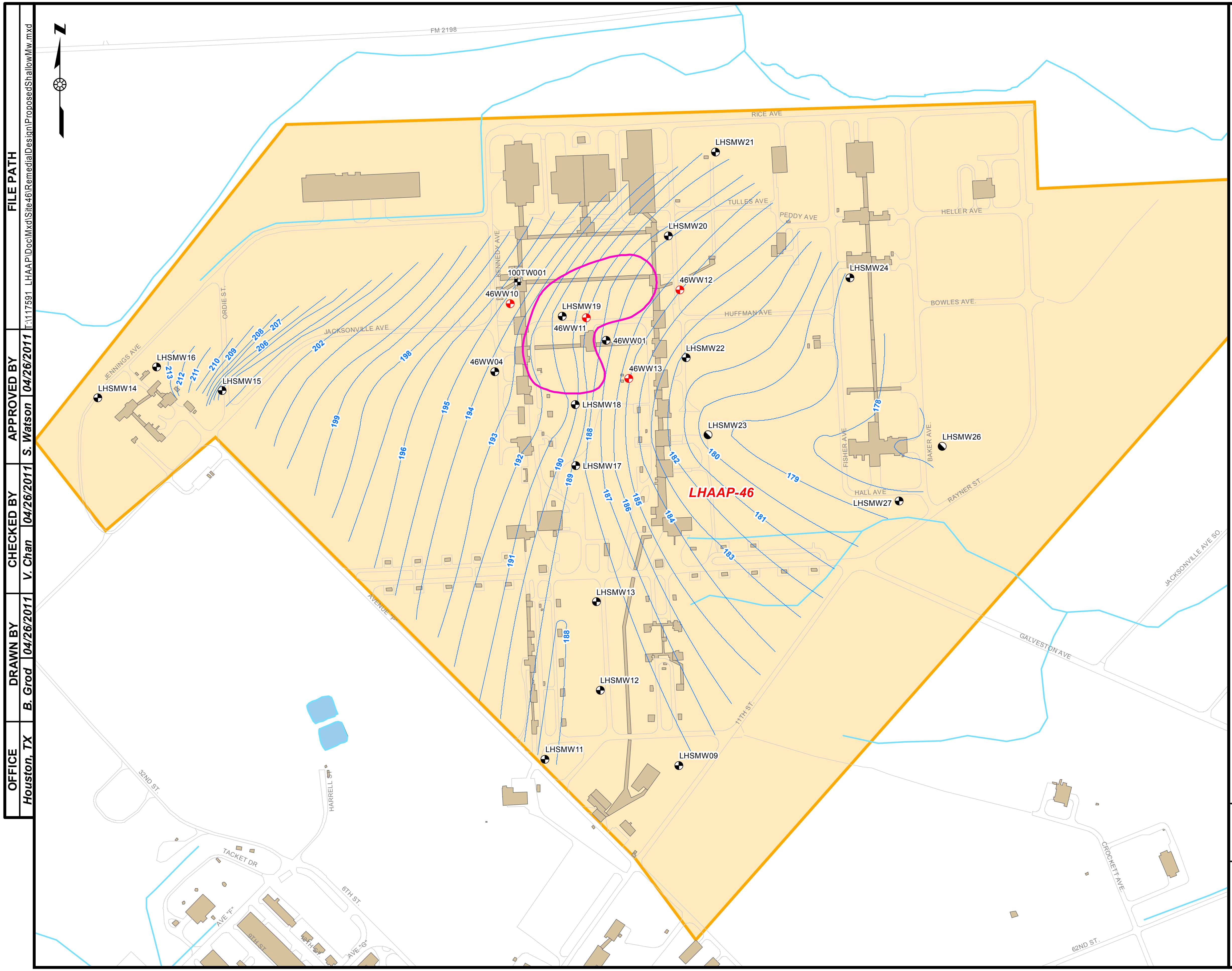
Houston, TX	*B. Grod* 04/26/2011	*V. Chan* 04/26/2011	*S. Watson* 04/26/2011	T:\117591 LHAAP\Doc\Mxd\Site46\RemedialDesign\ProposedShallowMw.mxd



LEGEND

◕ Shallow Monitoring Well

◐ Shallow/Intermediate Monitoring Well

🔴 Proposed Shallow Monitoring Well

⊞ Temporary Monitoring Well

∿ Groundwater Elevation Contour

∿ Shallow Zone TCE Plume (5 µg/L)

∿ Stream

╱ Road

▨ Former Building or Concrete Slab

☐ Site

Note:

1. Groundwater elevation measured on April 15, 2011.

0 200 400 800 Feet

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TULSA, OKLAHOMA

FIGURE 3-1
PROPOSED MONITORING WELLS
FOR INSTALLATION IN
THE SHALLOW ZONE
LHAAP-46, REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

00111718

OFFICE	Houston, TX	
DRAWN BY	B. Grod	04/26/2011
CHECKED BY	S. Suryanarayanan	04/26/2011
APPROVED BY	S. Watson	04/26/2011
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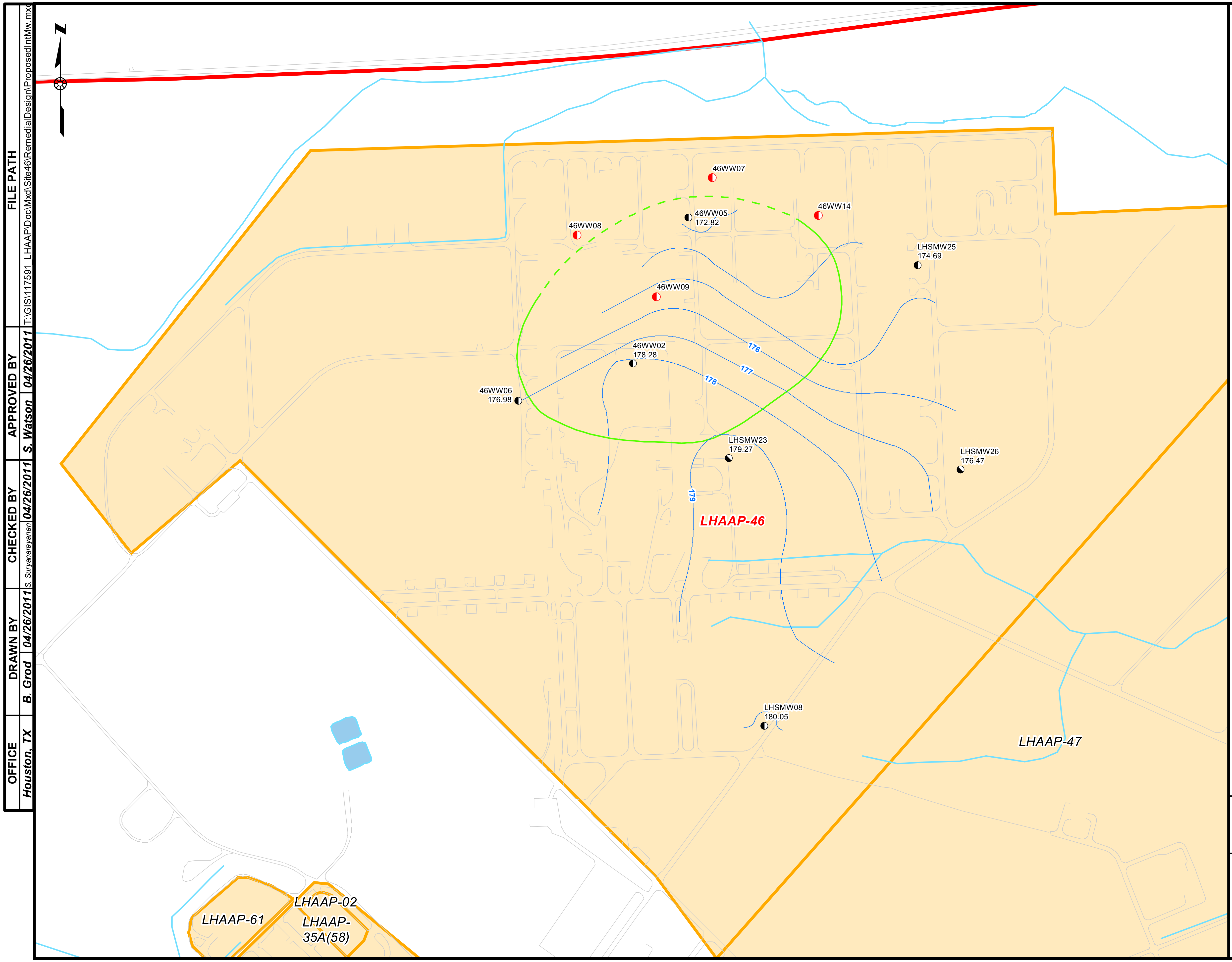

LEGEND

◐ Intermediate Monitoring Well

◐ Shallow/Intermediate Monitoring Well

◐ Proposed Intermediate Monitoring Well

Groundwater Elevation Contour

Intermediate Zone TCE Plume (5 µg/L)
Dashed where inferred

Stream

Road

▭ Approximate LHAAP Boundary

▭ Site

Note:

1. Groundwater elevation measured on April 15, 2011.

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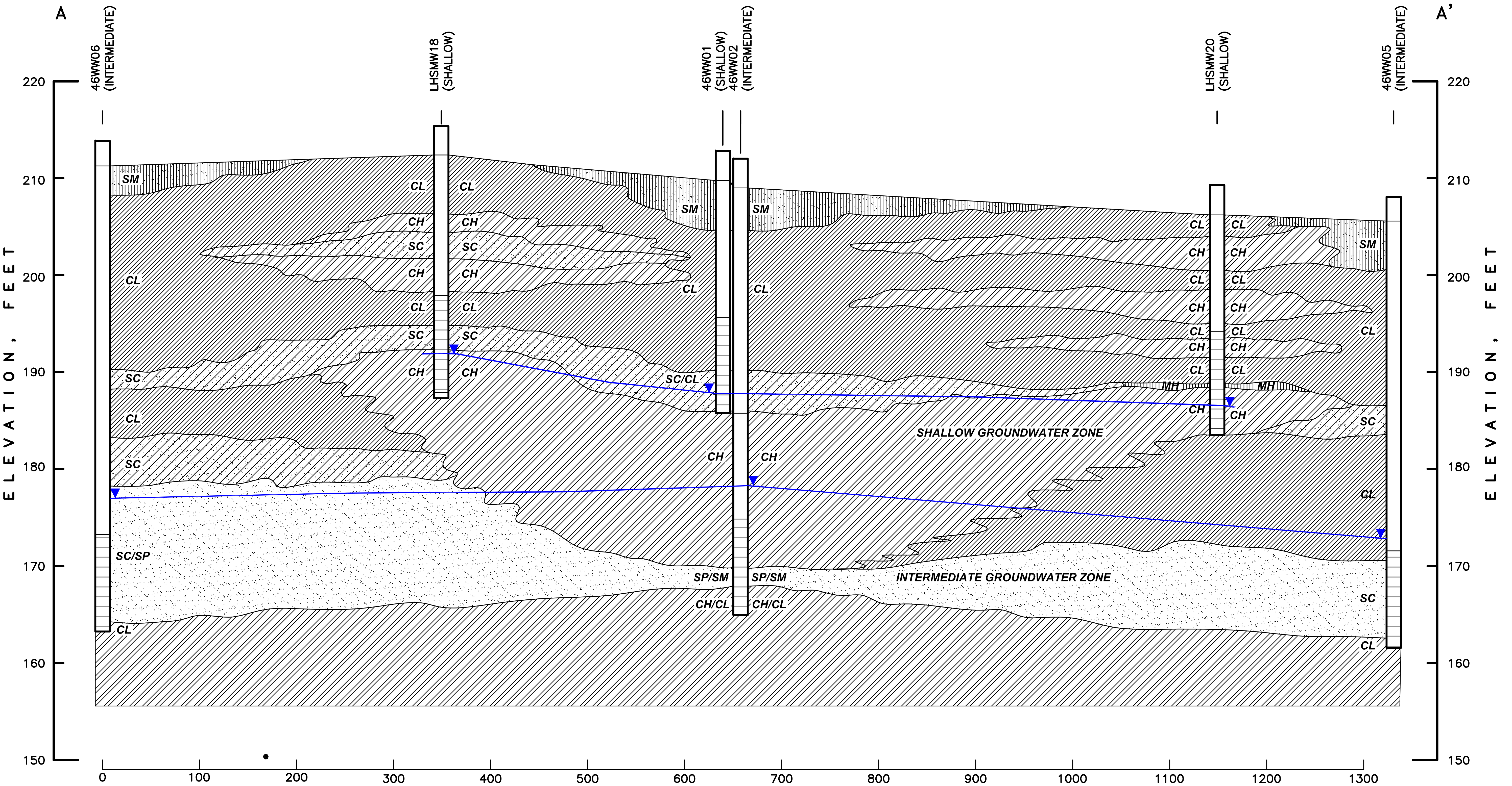
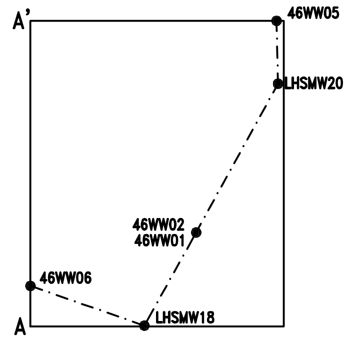
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 3-2
PROPOSED MONITORING WELLS
FOR INSTALLATION IN
THE INTERMEDIATE ZONE
LHAAP-46, REMEDIAL DESIGN
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS



SECTION A–A'



LEGEND:

- ▨ CLAY (CL)
- ▨ CLAYEY SAND (SC)
- ▥ SILTY SAND (SM)
- ▒ POORLY GRADED SAND (SP)
- ▥ SCREEN
- ▥ INORGANIC SILTS (MH)
- ▨ FAT CLAY (CH)
- ▼ GROUNDWATER ELEVATION APRIL 15, 2011

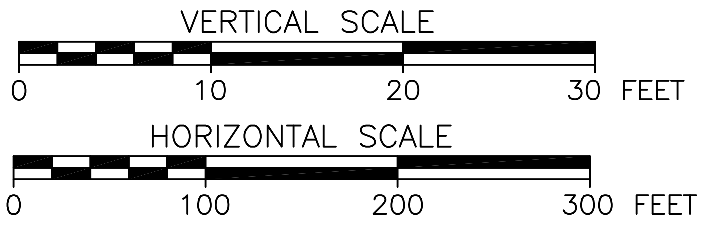


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FIGURE 3–3

CROSS SECTION A–A'

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DRAWING NUMBER 117591–B20

APPROVED BY

CHECKED BY

DRAWN BY C. BENTLEY 04/21/11

OFFICE Knoxville, TN

X–REF ---

IMAGE ---

PLOT DATE: 04/21/11
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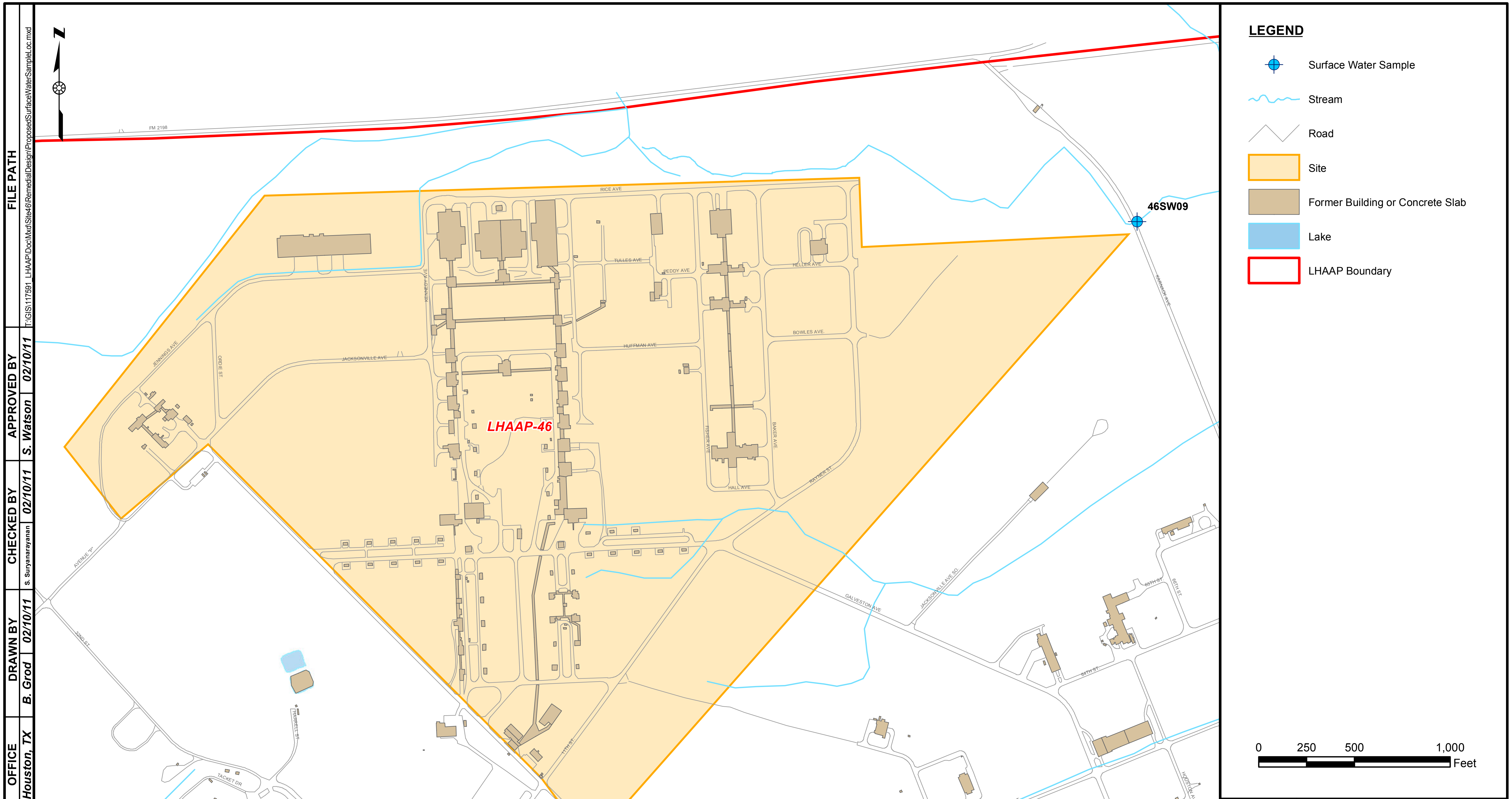

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Houston, TX	*B. Grod* 02/10/11	S. Suryanarayanan 02/10/11	*S. Watson* 02/10/11

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FIGURE 3-4

PROPOSED SURFACE WATER
SAMPLING LOCATION
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

4.0 LAND USE CONTROL DESIGN AND IMPLEMENTATION PLAN

This section describes the LUC design and implementation activities for LHAAP-46. The activities will result in a surveyed and recorded groundwater use restriction boundary and an operation and maintenance plan for the LUC.

The objective of the LUC at LHAAP-46 is to 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 until cleanup goals are met. Notification of the groundwater use restriction will accompany all transfer documents. The U.S. Army is responsible for long-term implementation, maintenance, inspection, reporting, and enforcement of the LUC.

The LUC will address the area of LHAAP-46 that includes two groundwater plumes with levels of contamination that require implementation of a remedy (see **Section 1.3**). The Land Use Control Operation and Maintenance (LUC O&M) Plan will identify the measures required for the monitoring and enforcement of the groundwater use restriction.

Upon review and concurrence of this RD, the LUC O&M Plan will be coordinated with regulators, finalized and distributed as part of the Comprehensive LUC Management Plan.

4.1 Land Use Control Implementation

The U.S. Army will undertake the following actions to implement the groundwater restriction LUC for LHAAP-46:

- Define the Area of the Groundwater Use Restriction. The groundwater use restriction boundary will be defined based on the review of the first round of groundwater sampling data in conjunction with historic data. The extent of plume will be bounded by a buffer and may extend to natural groundwater and surface water boundaries.

- Survey the LUC Boundary. The proposed boundary will be finalized after all wells are installed and sampled. Concurrence by USEPA and TCEQ will be obtained, and the LUC boundary will be surveyed by a State-licensed surveyor. A legal description of the surveyed area will be appended to the survey plat.

- Record the LUC in Harrison County. The LUC plat, legal description and groundwater use restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.56.

- Notify the Texas Department of Licensing and Regulation of the LUC. The Texas Department of Licensing and Regulation will be notified of the groundwater restriction which includes the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the U.S. Army, the USEPA, and the TCEQ. The survey plat, legal boundary and description of the groundwater restriction, in conjunction with a locator map, will be provided in hard and electronic copy.

- Develop the LUC O&M Plan. A LUC O&M Plan for LHAAP-46 will be developed. It will include the elements presented in **Section 4.2** below, the county recordation of the LUC survey plat, legal description and restriction language and the annual inspection/certification form.

4.2 Land Use Control Operation and Maintenance

The U.S. Army or its representatives will be responsible for the operation and maintenance of the LHAAP-46 LUC. This includes certification, reporting and enforcement activities. The U.S. Army shall address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable. To facilitate long-term operation and maintenance of the groundwater use restriction LUC remedy, U.S. Army will develop a plan that will encompass the elements described in the following subsections.

4.2.1 Site Certification and Reporting

Beginning with finalization of this RD and approval of the annual inspection form, the U.S. Army will undertake annual inspections and certify continued compliance with the LUC objectives. The U.S. Army, or the transferee after transfer, will retain the annual LUC Inspection/Certification documents in the project files for incorporation into the Five Year Review Reports, and these documents will be made available to USEPA and TCEQ upon request. In addition, should any violations be found during the annual certification, the U.S. Army will provide to USEPA and TCEQ along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue annual certifications will be revisited at five year reviews.

4.2.2 Notice of Planned Property Conveyances

The U.S. Army shall provide notice to USEPA and TCEQ of plans to convey the LHAAP-46 acreage. The notice shall describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental document for transfer. Although the U.S. Army may transfer responsibility for various implementation actions, the

U.S. Army shall retain its responsibility for remedy integrity. This means that the U.S. Army is responsible for addressing substantive violations of the LUC performance objective that would undermine the U.S. Army's CERCLA remedy. The U.S. Army also will be responsible for incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation.

4.2.3 Opportunity to Review Text of Intended Land Use Controls

U.S. Army will provide a copy of the groundwater use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. USEPA will also receive a copy for review. In addition, the U.S. Army will produce an ECP or other environmental document for transfer of LHAAP-46, but before executing transfer, the U.S. Army will provide USEPA and TCEQ with a copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before transfer, to review all LUC-related provisions.

4.2.4 Notification Should Action(s) which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover after conveyance of the site any activity on the property inconsistent with the LUC performance objective, the U.S. Army shall notify USEPA and TCEQ within 72 hours of such discovery. Consistent with **Section 4.2.5** below, the U.S. Army will then work with USEPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

4.2.5 Land Use Control Enforcement

Should the LUC remedy reflected in this LUC RD fail, the U.S. Army will coordinate with USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the U.S. Fish and Wildlife Service or its lessee, to the institution of judicial action against nonfederal third parties. Alternatively, should the circumstances warrant such, the U.S. Army could choose to exercise its response authorities under CERCLA. Should the U.S. Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction, the U.S. Army may notify those agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUC.

4.2.6 Modification or Termination of Land Use Controls

The U.S. Army shall not, without USEPA and TCEQ concurrence, make a significant modification to, or terminate a LUC, or make a land use change inconsistent with the LUC objective. Likewise, the U.S. Army shall seek prior USEPA and TCEQ concurrence before commencing actions that may impact remedy integrity. In the case of an emergency action, the U.S. Army shall obtain prior USEPA and TCEQ concurrence as appropriate to the exigencies of the situation.

The LUCs shall remain in effect until such time as the U.S. Army and USEPA agree that the concentrations of COCs have met cleanup levels. When this occurs, the LUC will be terminated as needed. The decision to terminate the LUC will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial action completion report. If the property has been transferred and a determination by the U.S. Army and USEPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also timely advise other local stakeholders of the action.

4.2.7 Comprehensive Land Use Control Management Plan

Upon finalization of the LUC O&M Plan a copy will be inserted into the Comprehensive LUC Management Plan for Longhorn. The Comprehensive LUC Management Plan figure and table will be updated to reflect the inclusion of LHAAP-46.

The Comprehensive LUC Management Plan consists of LHAAP RD documents and a survey plat showing the locations where LUCs being implemented at LHAAP are applied. The purpose of this Comprehensive LUC Management Plan is to ensure all site-specific LUCs are compiled into one comprehensive location for both pre-transfer use by the installation and for post-transfer use by the transferee. This document will be provided to USEPA and TCEQ, and will also be accessible to the local government and the public. The Comprehensive LUC Management Plan is located in the Marshall Public Library to accompany LHAAP's Administrative Record.

The land use assumption of industrial reuse as part of a national wildlife refuge forms the basis for the remedy at LHAAP-46 and this land use assumption will be in included in the Comprehensive LUC Management Plan with supporting documentation.

5.0 FIELD ACTIVITIES

This section describes the field activities planned at LHAAP-46. General activities would apply to any site with similar characteristics. Site-specific activities are described in associated subsections. The field activities to be conducted under this RD are outlined below:

- Pre-Mobilization Activities
- Preliminary Activities/Mobilization
- Site Clearing
- Monitoring Well Installation
- Groundwater Sampling
- Surface Water Sampling
- Waste Management
- Decontamination
- Well Abandonment
- Demobilization
- Health and Safety
- Quality Assurance/Quality Control

The field activities will be conducted in accordance with the Site-Specific Supplement to Health and Safety Plan (HASP) in **Appendix B**. The work will be routinely inspected in accordance with the Contractor Quality Control Plan (CQCP) in **Appendix C**. Additional information regarding these tasks can be found in Appendix C, Chemical Data Acquisition Plan (CDAP), and Appendix D, Field Procedures of the *Final Installation-Wide Work Plan* (Shaw, 2006).

5.1 Pre-mobilization Activities

A pre-construction meeting will be held for the U.S. Army, USEPA, (TCEQ), and Shaw prior to the initiation of field activities.

The survey to determine the metes-and-bounds for the LUC and the notification of non-residential use will be conducted. The survey will be a state-licensed surveyor and the coordinate system will be Texas State Plane, NAD 1983.

Prior to mobilization, Shaw will secure any applicable permits and notifications. These may include federal, state and local requirements. Shaw will also secure utility clearance for water, sewer, gas, electric, and communication if any intrusive work is needed. At this time, no intrusive work is planned at LHAAP-46.

Shaw will inspect LHAAP-46 to identify overhead electrical lines that may restrict groundwater monitoring activities. As necessary, Shaw will either shut down power, reroute power, remove poles, and/or ensure that the poles are guy-wired for stability. If power must be shut down, the power outage will be coordinated with groundwater treatment plant (GWTP) and fire station operations.

5.2 Preliminary Activities/Mobilization

Shaw anticipates mobilizing the following personnel:

- Quality control/safety manager
- One laborer/sample technician

Those personnel will utilize the following equipment:

- Pickup trucks
- Groundwater monitoring field parameters test equipment
- Groundwater sampling pumps

Additional equipment will be mobilized as necessary if the field conditions or planned activities merit additional site clearing or well installation.

5.3 Site Clearing

Site maps and a Global Positioning System will be used to locate and identify monitoring wells selected for sampling as shown on **Figure 5-1** and **Figure 5-2**. Monitoring wells to be sampled will be cleared of vegetation and biohazards (e.g., poison ivy, stinging insects) to ensure safe access for groundwater sampling.

5.4 Monitoring Well Installation

Shaw will add five monitoring wells in the shallow and intermediate zone as shown in **Figures 3-1, 3-2,** and **5-1**. Up to 10 DPT groundwater samples will be collected prior to installing the monitoring wells to better define the shallow and intermediate plumes.

5.5 Groundwater Sampling

Groundwater sampling will be performed in accordance with the requirements presented in the CQCP (**Appendix C**). Additional details for sampling and analysis are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP and Appendix D, Field Procedures (Shaw, 2006).

5.5.1 Monitored Natural Attenuation

The monitoring portion of the MNA will be accomplished by collecting groundwater samples from the seventeen wells shown on **Figure 5-1**. Eight of these wells are located in the shallow zone, seven are located in the intermediate zone, one in the shallow-intermediate zone and one in the deep groundwater zone. These wells were selected for their placement relative to the TCE plumes to monitor the effectiveness of natural attenuation at LHAAP-46. Groundwater levels will be measured in these and several surrounding wells to evaluate groundwater flow direction.

The electronic interface probe used to measure depth to groundwater in monitoring wells and pumps used for well development, purging and sampling will be decontaminated prior to use at each well. The equipment will be decontaminated using a non-phosphate detergent (such as Alconox, Liquinox, or equivalent), followed by two potable water rinses, one deionized water rinse, and air dried. Decontamination fluids will be containerized for subsequent disposal. Clean single use disposable equipment (tubing or bailers) may be used for sampling a well without this decontamination process.

The schedule for groundwater monitoring for MNA will be quarterly for two years. All seventeen collected groundwater samples will be analyzed for VOCs and the following field parameters: pH, temperature, ORP, DO, conductivity, and turbidity. A subset of the groundwater samples (LHSMW19, 46WW11, 46WW02, 46WW05 and 46WW09), those from wells historically within the groundwater plume, will also be tested for the following MNA parameters: alkalinity, common anions (chloride, sulfate, nitrate, nitrite), sulfide, TOC, dissolved iron and manganese, total phosphorus, carbon dioxide and dissolved gases (methane, ethane, ethene), total iron, and ferric iron. Also, the following MNA parameters are optional in the MNA analysis, and may or may not be collected: DHC, hydrogen and volatile fatty acids. **Table 5-1** indicates the analytes for each well. **Table 5-2** lists the analytes, test methods, and other sampling information.

Any performance monitoring well found to be dry during any quarter of the MNA performance monitoring will be replaced in the same quarter. The location of the replacement well will be installed adjacent to the dry well.

5.5.2 Thallium

Groundwater samples will be collected from all monitoring wells for thallium as shown on **Figure 5-2**. Samples will be analyzed for thallium at an off-site lab, for the field parameters listed in **Section 5.5.1**, and for an additional field parameter, ferric iron. Sampling for thallium will be conducted concurrently with MNA sampling for the first year (4 quarters). If any well has concentrations below the MCL for four quarters, it will be dropped from the thallium sampling program. The data will be evaluated to determine if the thallium monitoring will continue until the first five-year review. If it is determined that thallium monitoring will continue, the wells and frequency will be selected. A letter report documenting the conclusions and transmitting the analytical data reports will be produced.

5.5.3 Long-Term Monitoring

After the first two years, the effectiveness of MNA will be evaluated (**Section 6.1**). If the MNA Evaluation determines MNA to be effective, the analytical suite will be reduced to only VOCs for the wells indicated on **Figure 5-1**, and the frequency of sampling will be reduced to semiannual sampling for three years, then annually until the next five-year review. Further reductions in sampling will depend on results of five-year reviews, but sampling will continue at least once every five years until cleanup levels are attained.

5.6 Surface Water Sampling

Semi-annual performance monitoring of Goose Prairie Creek adjacent to LHAAP-46 will be conducted at one location as shown in **Figure 3-4**. Surface water sampling will be conducted as described in **Section 3.6**.

5.7 Waste Management

This section specifies methods and procedures to be implemented by Shaw to verify that waste generated during site activities are handled, transported, stored, and disposed in compliance with applicable federal, state, and local rules and regulations. Waste management activities will be conducted in accordance with the requirements presented in Task 3 of the CQCP (**Appendix C**).

Description of Wastes. Groundwater sampling activities at LHAAP-46 are expected to generate the following waste streams:

Waste Type	Estimated Quantity
Decontamination and Purge Water	330 gallons [(6) 55-gallon drums]
Miscellaneous Wastes (personal protective equipment, paper towels, rags, well casings, etc.)	—

Waste Handling. The liquid waste will be disposed at the GWTP at LHAAP-18/24. If at some point in the future when the GWTP may cease its operations, water will be handled in accordance with current regulations at that time, and will be transported and disposed of off-site. Additional details for disposal sampling are found in the *Final Installation-Wide Work Plan*, Appendix C, CDAP and Appendix D, Field Procedures (Shaw, 2006).

The non-hazardous decontamination and purge water will be stored in 55-gallon drums until disposal at the LHAAP GWTP. The miscellaneous wastes will be placed in plastic bags until disposal.

The miscellaneous wastes will be disposed of at an off-site municipal solid waste facility.

Waste Type	Disposal Method
Decontamination Water-Non-Hazardous Waste	LHAAP Groundwater Treatment Plant (GWTP)
Miscellaneous Wastes	Municipal Solid Waste

5.8 Decontamination of Equipment and Personnel

A permanent decontamination station is located at the on-site GWTP at LHAAP-18/24 and can accommodate large equipment. Temporary decontamination pads will be constructed at an approved on-site location as needed to decontaminate equipment and prevent cross-contamination between well locations. The decontamination pad will be approximately 15 feet in length and width, bermed, and covered with high-density polyethylene sheeting. Wash water will be contained and transported to the GWTP for disposal when necessary. Reusable equipment will be decontaminated between groundwater sampling locations and prior to leaving the site. Further information on decontamination procedures are found in the *Final Installation-Wide Work Plan*, Appendix D, Field Procedures (Shaw, 2006).

5.9 Well Abandonment

Wells that have been dry, are not needed to gather groundwater level measurements, or are not part of the planned monitoring system, will be abandoned. Tentative wells planned to be abandoned are indicated on **Figure 5-3**. LHSMW12, LHSMW15, and LHSMW27 will be monitored for thallium in the first four quarters and abandoned after one year, if thallium concentrations are below the MCL. Final recommendation for well abandonment will be submitted as part of the LTM recommendations in the MNA Performance Evaluation Report. Well abandonment will follow the well abandonment procedures in the *Final Installation-Wide Work Plan*, Section 3.9 (Shaw, 2006). These abandonment procedures were developed in reference to and conform to the requirements of 16 TAC 76.1004.

A separate mobilization will be made for well abandonment activities. The waste generated from these activities (concrete, well casings, etc.) will be disposed off site at an approved solid waste landfill.

Once the well abandonment has been completed, Shaw will restore the areas and demobilize. Areas disturbed in the course of well abandonment will be regraded to blend with the surrounding topography.

5.10 Demobilization

Upon completion of well abandonment operations, Shaw will remove any temporary facilities, perform final equipment decontamination, and demobilize personnel and equipment.

5.11 Health and Safety

The HASP (the latest revision of Appendix A of the *Final Installation-Wide Work Plan* [Shaw, 2006]) incorporates health and safety policies and safe operating procedures for individual project site activities. These procedures allow work activities to be carried out in a controlled, effective manner, consistent with Shaw policies and USACE requirements (USACE, 2008).

Information specific to the groundwater monitoring activities at the LHAAP-46 is provided in **Appendix B**. This information includes personnel protective equipment levels, air monitoring requirements, and activity hazard analyses. These items supplement the HASP; they do not replace it. This information is not addressed by the site-wide HASP because the hazards are unique to the proposed work.

Prior to initiating work at the facility for any site, workers will have signed the HASP in the designated area to indicate they have read and understood the document. Also, daily safety meetings will be held with all field crew members prior to starting work each day in order to review the day's scope of work, any site conditions expected, and any hazards that need to be addressed or acknowledged.

5.12 Quality Assurance/Quality Control

The CQCP provides information on quality assurance/quality control (QA/QC) procedures for this project. The CQCP identifies personnel, procedures, controls, instructions, tests, verifications, documents, and forms to be used and the types of records to be maintained. The CQCP addresses quality control requirements specific to each major feature of work, including special steps that apply to LHAAP-46. The CQCP is provided in **Appendix C**.

The USACE Three-Phase QC process will be used to enforce QA/QC requirements and include preparatory inspections, initial inspections, and follow-up inspections. The three-phases of inspections will target each definable feature of work during the execution of project activities.

Table 5-1
Sample Analytes

Well ID	VOCs	Thallium	Field Parameters	MNA Parameters
Shallow				
46WW01	✓	✓	✓	✓
46WW04	✓	✓	✓	
*46WW10	✓	✓	✓	
*46WW11	✓	✓	✓	✓
*46WW12	✓	✓	✓	✓
*46WW13	✓	✓	✓	✓
LHSMW11		✓	✓	
LHSMW12		✓	✓	
LHSMW14		✓	✓	
LHSMW15		✓	✓	
LHSMW16		✓	✓	
LHSMW18	✓	✓	✓	
LHSMW19	✓	✓	✓	✓
LHSMW20	✓	✓	✓	
LHSMW21		✓	✓	
LHSMW22	✓	✓	✓	
LHSMW24		✓	✓	
LHSMW27		✓	✓	
Shallow/Intermediate				
LHSMW23	✓	✓	✓	
Intermediate				
46WW02	✓	✓	✓	✓
46WW05	✓	✓	✓	✓
46WW06	✓	✓	✓	
*46WW07	✓	✓	✓	
*46WW08	✓	✓	✓	
*46WW09	✓	✓	✓	✓
*46WW14	✓	✓	✓	✓
LHSMW08		✓	✓	
LHSMW25	✓	✓	✓	
Deep				
46WW03	✓		✓	

Notes and Abbreviations:

Field parameters for all wells: pH, temperature, oxidation reduction potential, dissolved oxygen, conductivity, turbidity, and ferrous iron. In addition, for wells analyzed for thallium: ferric iron.

MNA parameters (only first two years): alkalinity, common anions (chloride, sulfate, nitrate, nitrite), sulfide, total organic carbon, dissolved iron and manganese, total phosphorus, carbon dioxide and dissolved gases (methane, ethane, ethene), total iron, and ferric iron. Optional parameters: hydrogen, volatile fatty acids, and dehalococcoides,.

* Proposed monitoring wells to be installed

MNA	monitored natural attenuation
VOCs	volatile organic compounds (i.e., trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride)

Table 5-2
Sample Methods, Containers, and Preservation

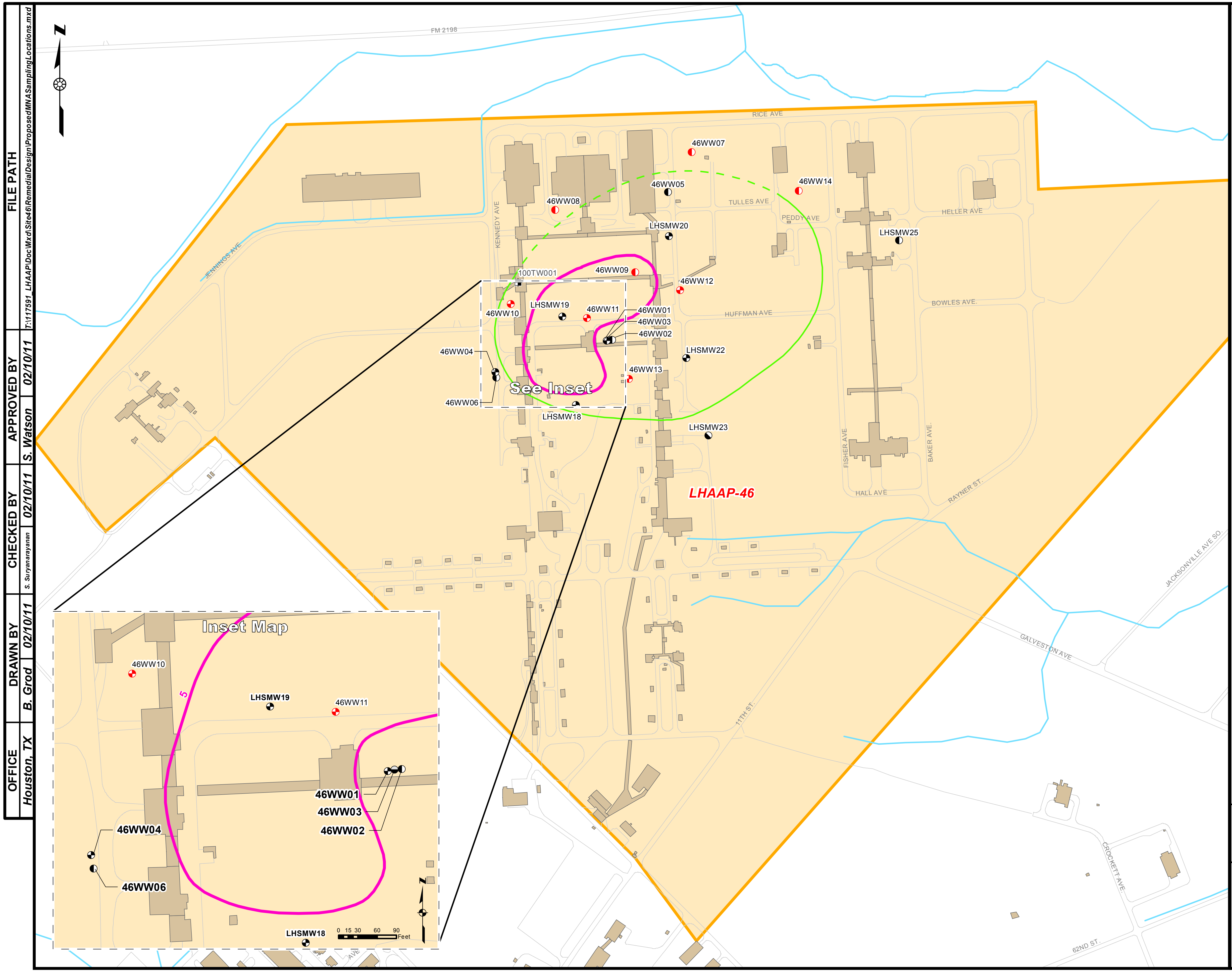
Parameter	Minimum Sample Volume	Holding Time	Preservation	Method
Water				
Volatiles	3x40 mL glass vial with PTFE septa cap	14 days	pH < 2 HCl, Cool to 4°C, no headspace	8260B (or latest method)
Dehalococcoides (DHC)	2x1 L amber glass bottles with teflon-lined cap(s)	14 days	Cool to 4°C	polymerase chain reaction (PCR)
Alkalinity (total, carbonate and bicarbonate)	250 mL polyethylene bottles	14 days	Cool to 4°C	EPA 310.2
Common anions (chloride [Cl], sulfate [SO4], nitrate [NO3], nitrite	250 mL polyethylene bottles	28 days (Cl/SO4) and 48 hours (individual NO3 and NO2)	Cool to 4°C	EPA 300.0
Nitrate/nitrite as N	500 mL polyethylene bottles	28 days	pH<2 H2SO4, Cool to 4°C	EPA 353.2
Sulfide	250 mL polyethylene bottles	7 days	pH>9 zinc acetate plus NaOH, Cool to 4°C	EPA 376.1
Total organic carbon (TOC)	125 mL polyethylene bottles	28 days	pH<2 H2SO4 or HCl, Cool to 4°C	EPA 415.1
Dissolved iron and manganese	500 mL polyethylene bottles	6 months	pH<2 HNO3, Cool to 4°C	6010B
Phosphorus, total	100 mL polyethylene bottles	28 days	pH<2 H2SO4, Cool to 4°C	EPA 365.4
Carbon dioxide and dissolved gases (methane/ethane/ethene)	3x40 mL glass vial with PTFE septa cap	14 days	Cool to 4°C	RSK 175
Iron and thallium, Total	500 mL polyethylene bottles	6 months	pH<2 HNO3, Cool to 4°C	6010B/6020A
Ferrous iron	NA	Immediately in field	NA	NA
**Ferric iron	NA	NA	NA	NA

Notes and Abbreviations:

The above listed volumes provide an adequate quantity of samples to anaylyze a matrix spike (MS) and matrix spike duplicate (MSD).

** Ferric Iron is difference between total iron and ferrous iron

°C - degrees centigrade
H2SO4 - sulfuric acid
HCl - hydrochloric acid
HNO_3 - nitric acid
L - liter
mL - milliliter
PTFE - polytetrafluoroethylene



LEGEND

●	Shallow Monitoring Well
●	Shallow/Intermediate Monitoring Well
◐	Intermediate Monitoring Well
●	Deep Monitoring Well
●	Temporary Monitoring Well
●	Proposed Shallow Monitoring Well
◐	Proposed Intermediate Monitoring Well
〰	Intermediate Zone TCE Plume (5 µg/L) *Dashed where inferred*
〰	Shallow Zone TCE Plume (5 µg/L)
〰	Stream
〰	Road
▨	Former Building or Concrete Slab
🟧	Site

Note:

1. TCE - Trichloroethene

2. 46WW07, 46WW08, 46WW09, 46WW10, and 46WW11 are the proposed monitoring well locations.

3. Monitoring wells within the plumes (LHSMW19, 46WW11, 46WW02, 46WW05, and 46WW09) will be sampled for MNA parameters in addition to TCE.

0 200 400 800
Feet

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TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 5-1

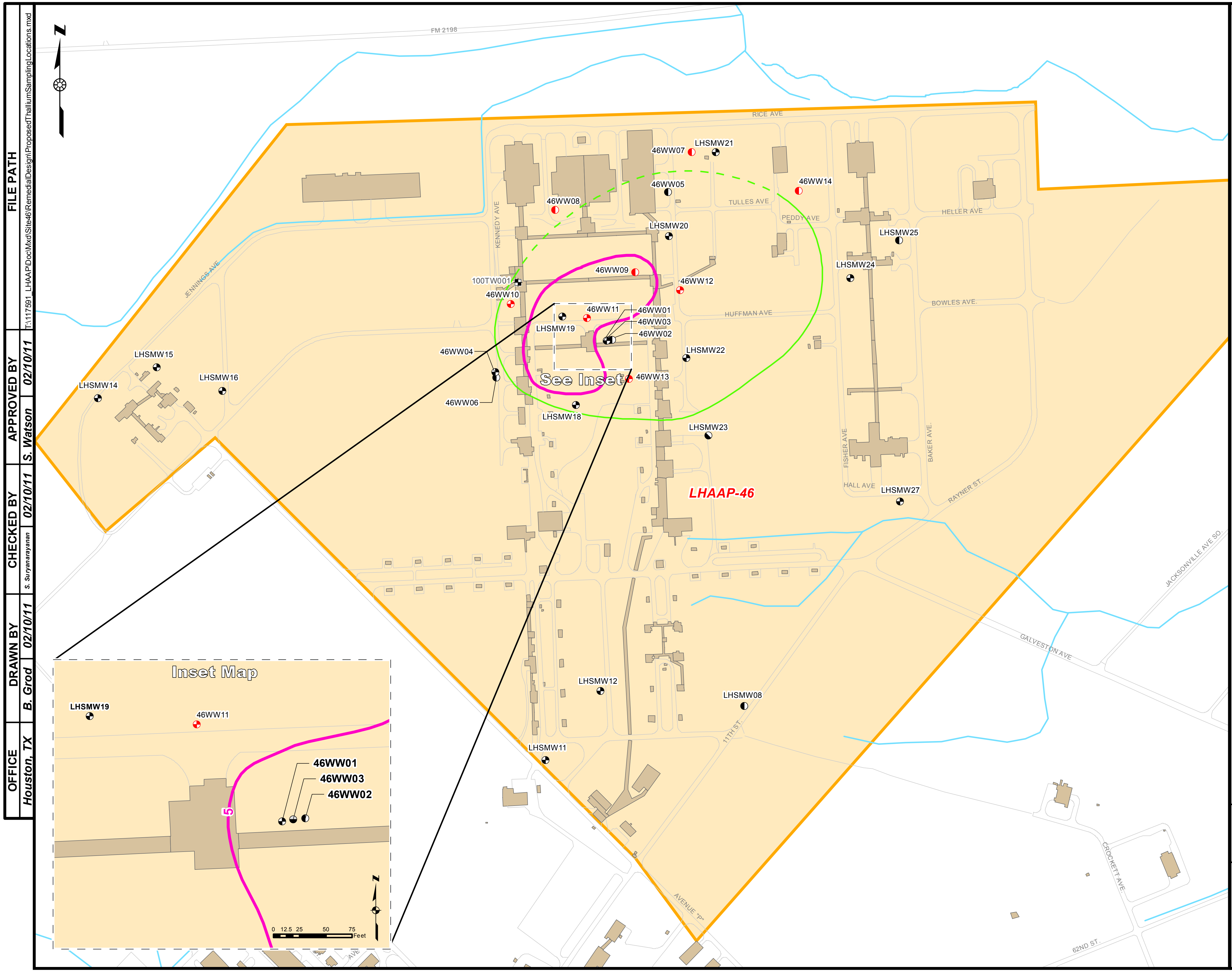
PROPOSED WELLS FOR MNA SAMPLING
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	Houston, TX
DRAWN BY	B. Grod 02/10/11
CHECKED BY	S. Suryanarayanan 02/10/11
APPROVED BY	S. Watson 02/10/11
FILE PATH	T:\117591_LHAAP\Doc\Mxd\Site46\RemedialDesign\ProposedMNASamplingLocations.mxd

FILE PATH T:\117591_LHAAP\DocMxd\Site46\RemedialDesign\ProposedThalliumSamplingLocations.mxd

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY
Houston, TX	B. Grod 02/10/11	S. Suryanarayanan 02/10/11	S. Watson 02/10/11



LEGEND

- ◕ Shallow Monitoring Well
- ◔ Shallow/Intermediate Monitoring Well
- ◐ Intermediate Monitoring Well
- ◒ Deep Monitoring Well
- ✚ Temporary Monitoring Well
- ● Proposed Shallow Monitoring Well
- ◐ Proposed Intermediate Monitoring Well
- Intermediate Zone TCE Plume (5 µg/L) *Dashed where inferred*
- Shallow Zone TCE Plume (5 µg/L)
- Stream
- Road
- ▨ Former Building or Concrete Slab
- 🟧 Site

Note:

1. TCE - Trichloroethene

2. 46WW07, 46WW08, 46WW09, 46WW10, and 46WW11 are the proposed monitoring well locations.

0 200 400 800 Feet

Shaw

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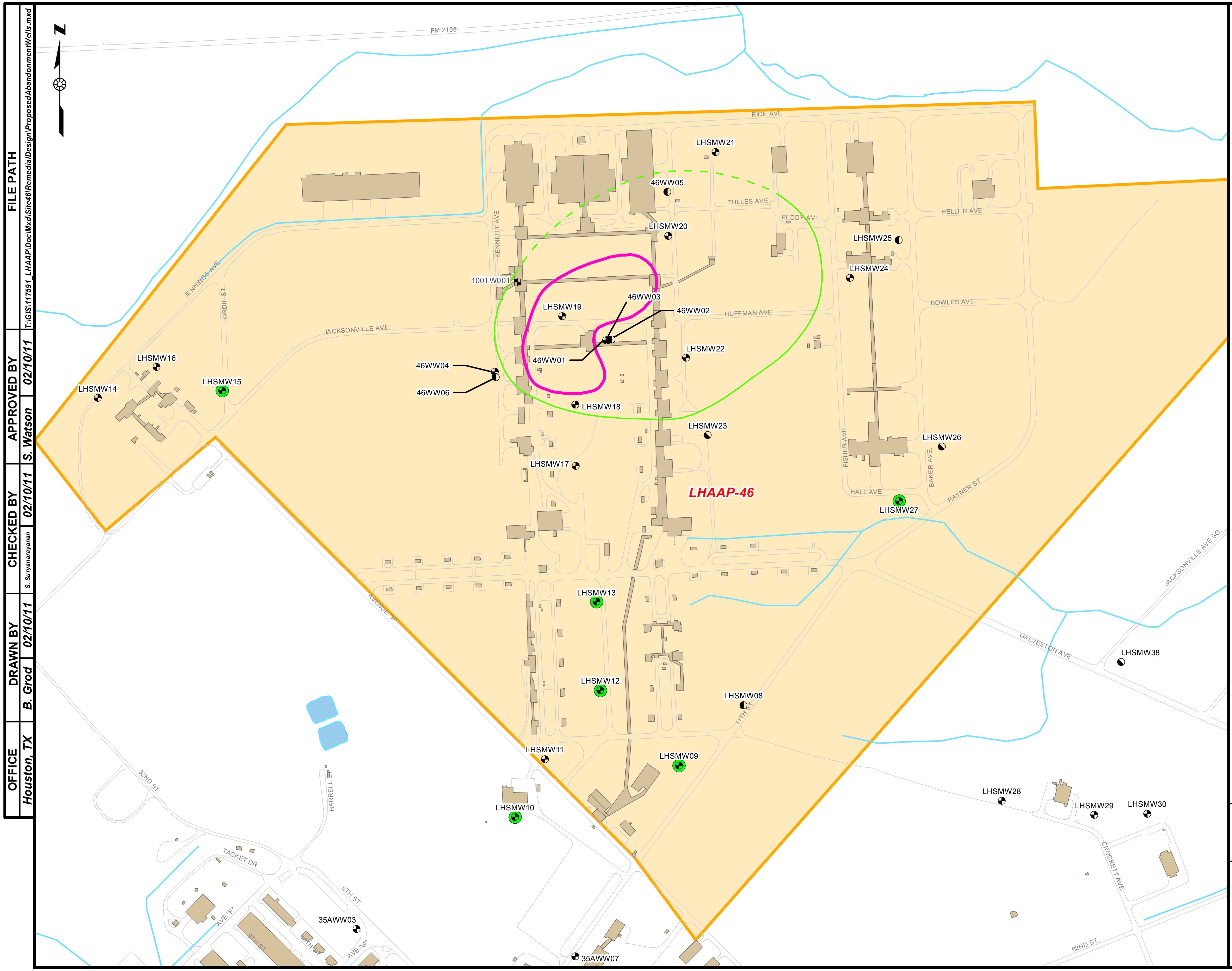
TULSA DISTRICT
TULSA, OKLAHOMA

FIGURE 5-2

PROPOSED WELLS
FOR THALLIUM SAMPLING
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OFFICE	DRAWN BY		CHECKED BY		APPROVED BY		FILE PATH
Houston, TX	B. Grod	02/10/11	S. Suryanarayanan	02/10/11	S. Watson	02/10/11	T:\GIS\117591_LHAAP\Doc\Mxd\Site46\RemedialDesign\ProposedAbandonmentWells.mxd



LEGEND

◕ Shallow Monitoring Well

◑ Shallow/Intermediate Monitoring Well

◐ Intermediate Monitoring Well

◒ Deep Monitoring Well

◘ Temporary Monitoring Well

🟢 Well Location to be Abandoned (6)

〰 Shallow Zone TCE Plume (5 µg/L)

〰 Intermediate Zone TCE Plume (5 µg/L)
Dashed where inferred

〰 Stream

〰 Road

▨ Former Building or Concrete Slab

▭ Site

Note:

1. LHSMW012, LHSMW015, and LHSMW027, will be abandoned, if Thallium concentration in these wells are below MCL for the first four quarters.

0 200 400 800
Feet

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TULSA, OKLAHOMA

FIGURE 5-3

PROPOSED WELLS FOR ABANDONMENT
LHAAP-46, REMEDIAL DESIGN

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

6.0 REMEDY PERFORMANCE REPORTING

Reporting will consist of annual reports, an MNA evaluation report at the end of the eight quarters of sampling, and a five-year review report. Annual reports will be prepared at the end of each calendar year for every year in which groundwater samples are collected. The MNA evaluation will be prepared once, using the eight episodes of quarterly sampling results from the first two years combined with historical sampling results. The five-year reviews will be prepared once every five years for so long as groundwater sampling is required (until cleanup levels are achieved, see **Section 3.0**).

6.1 MNA Evaluation

After eight quarters of groundwater monitoring has been completed, an MNA evaluation will be conducted and an MNA Evaluation Report prepared. MNA performance criteria are listed in **Table 6-1** Compilation of the information for the evaluation will occur throughout the first two years of quarterly groundwater monitoring. The MNA Evaluation Report will include:

- Figures of the site, wells, and groundwater level contours
- Tables of groundwater and surface water sample results
- Comparison of plume extent and concentration over time (**Table 6-1**, Performance Criteria 1)
- Consideration of the first and second lines of evidence for MNA and the third line of evidence if necessary (**Table 6-1**, Performance Criteria)
- An evaluation of the effectiveness of MNA at the site
- A recommendation for continued MNA, in situ bioremediation, or another remedy

6.1.1 Migration/Expansion

For the evaluation of MNA at LHAAP-46 to be favorable, the MNA evaluation should demonstrate plume stability. A groundwater plume is stable when pollutant concentrations and the plume's footprint are stable. A stable plume shows that pollutant migration in groundwater is under control. The determination of plume dynamics should be performed for all relevant contaminants and their biodegradation daughter compounds.

A decreasing plume is diminishing in concentration and its location is not migrating or expanding. This occurs when the attenuation rate of dissolved-phase pollutants exceeds their generation rate from all sources. Sources that are sustaining the dissolved-phase plume may include pollutants sorbed to fine-grained, low-permeability materials located throughout the plume. A decreasing plume supports natural attenuation as a viable remedial alternative.

Table 6-1
MNA Evaluation Performance Criteria

Performance Criteria	Type	Expected Performance	Commentary
1) Migration/Expansion	Qualitative	Stable or shrinking size, stable position	An expanding or migrating plume indicates MNA should not be continued
2) Concentrations	Quantitative	Falling concentrations or mass in the majority of performance wells	First Line of Evidence
3) Aquifer Conditions	Qualitative	Conditions favorable for natural attenuation	Second Line of Evidence
4) Microcosm Studies	Qualitative	Detectable presence of appropriate microorganisms	Third Line of Evidence

Monitoring must occur over a time period sufficient to demonstrate plume stability or decrease under natural conditions. This may take up to several years depending on site-specific conditions, including the monitoring data trend analysis, potential threats to beneficial uses, and other uncertainties. Specifically, the TCEQ recommends the non-parametric Mann-Kendall statistic be used to evaluate solute plume stability (with null hypotheses tested at $\alpha = 0.10$ and $\alpha = 0.20$). If monitoring data do not demonstrate plume stability/decrease, this may indicate that further plume remediation is necessary. The two years of quarterly sampling, combined with historic sampling data, will provide sufficient data for stability and trend analysis. MNA cannot continue as a sole remedy if the plume is clearly migrating.

6.1.2 First Line of Evidence

The first line of evidence is to evaluate historical groundwater data seeking to demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. Thus, other performance wells will be evaluated to determine if the plume is migrating.

Concentrations of COCs can be evaluated at individual wells to calculate a time-based attenuation rate. They can be evaluated across multiple wells through the centerline of a plume to calculate a distance-based attenuation rate. Average plume concentrations or mass can be evaluated if a consistent set of wells is sampled over multiple sampling episodes. These calculations will be performed using the methods contained in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998).

Time-based attenuation rates will be calculated for any monitoring well that shows consistent COC concentration exceedances of cleanup levels during the eight episodes of quarterly sampling. Distance-based attenuation rates will be calculated through the highest concentration wells along the direction of groundwater flow. Attenuation rates based on average plume concentrations or mass will be calculated if the dataset will support the process. Monitoring wells LHSMW19, 46WW05, and 46WW02 are expected to be the primary focus of analysis at LHAAP-46 because they show the highest COC concentrations. Thus, the data from these wells will be evaluated to determine if there is a clear and meaningful trend of decreasing concentrations and/or mass.

6.1.3 Second Line of Evidence

Decreasing concentration trends by themselves are not sufficient evidence that COCs are being destroyed. The second line of evidence uses chemical analytical data in mass balance to show that decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in metabolic end products or daughter compounds. The evidence can be used to show the groundwater conditions are sufficiently favorable to natural attenuation so that degradation of chlorinated solvent contaminants can occur.

The second line of evidence evaluates parameters such as nitrates, sulfates, ferrous iron, dissolved oxygen, ORP, nitrate, ferrous iron, sulfate, methane, ethane and ethene, chloride, TOC, carbon dioxide, alkalinity, pH and phosphorous. The results of tests for these analytes will be interpreted using the *Technical Protocol for Evaluating Attenuation of Chlorinated Solvents in Ground Water* (USEPA, 1998).

For the MNA evaluation, if the groundwater conditions in the plume area are favorable to the occurrence of degradation, then MNA may continue to be applied at the site. If groundwater conditions are unfavorable to the extent that any decrease in concentrations must be attributed to migration, then more aggressive treatment should be evaluated as a contingency remedy.

6.1.4 Third Line of Evidence

The third line of evidence consists of data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

For the MNA evaluation, the presence of microorganisms (DHC) in the groundwater capable of degrading the COCs would be favorable to continued MNA. If such organisms are completely absent, and the first two lines of evidence are not favorable, then more aggressive treatment should be evaluated as a contingency remedy. General microcosm studies are time-consuming and expensive. Performing analyses related to general microcosm studies will be deferred until such time as the initial two-year groundwater monitoring program is concluded and such a study is found to be necessary.

6.1.5 MNA Performance Evaluation Report

The completed Preliminary Draft Monitored Natural Attenuation Evaluation Report will be submitted to the U.S. Army for review and comment. Following this, a Draft Final Monitored Natural Attenuation Evaluation Report will be submitted to the regulatory agencies for review and comment. A Draft Final Monitored Natural Attenuation Evaluation will address the regulatory comments and will be submitted for review. When regulatory agency comments have been resolved, the Final Monitored Natural Attenuation Evaluation Report will be issued. The Final Monitored Natural Attenuation Evaluation Report will determine whether MNA continues to be the remedial action applied at LHAAP-46, or whether another more aggressive treatment should be evaluated as a contingency remedy.

The first and second lines of evidence will be evaluated for decreasing COC concentrations and optimal geochemical conditions to demonstrate MNA. The third line of evidence will be evaluated if necessary. If the MNA evaluation determines that MNA is not an effective sole remedy, then an explanation of significant difference will be prepared and an amendment to this document will be made to design and implement a contingency remedy. This contingency remedy is expected to be a form of bioremediation as included in the ROD, but the final design of the contingency remedy will be determined by the results of groundwater samples collected during the MNA performance monitoring period. The MNA Performance Evaluation Report will also include recommendations for future LTM and well abandonments.

6.2 LTM Annual Reports

An annual report will be prepared at the end of each year of LTM to present groundwater sample results, a description of field activities, and to document other relevant information that may be considered useful for the five-year review. The annual report will include:

- A narrative of field activities
- Figures of the site and wells and groundwater levels
- Tables of groundwater and surface water sample results
- Copies of field paperwork, including disposal documentation
- Relevant photographs

Perimeter well data will be evaluated for plume migration while the data from wells within the plume areas will be evaluated for MNA performance.

6.3 Five-Year Review Reports

Five-year reviews will be performed for LHAAP-46 (U.S. Army, 2010). While the intent is to perform these reviews every 5 years after the implementation of the remedy (i.e., remedy in place), the performance of the first five-year review will be aligned with the first base-wide five-year review. The five-year review report will present summaries of information from the annual reports as from the five-year sampling event, evaluate that information, and recommend the future course of action. The five-year review will include:

- A narrative of field activities for the past five years
- Figures of the site and wells locations
- Summary of groundwater and surface water sample results
- Results and summary of the annual LUC inspections
- Site inspection with relevant photographs
- Evaluation of progress toward cleanup levels
- Revisions to the LUC or monitoring schedules
- Recommendations for future actions

The progress toward cleanup levels will be evaluated in the five-year report. The five-year review offers the periodic opportunity to declare the site successfully and completely remediated, progressing satisfactorily toward remediation, or in need of more aggressive remedy. When cleanup levels are reached, monitoring may cease as recommended in the five-year review.

7.0 SCHEDULE

The estimated length of time for groundwater monitoring activities including site setup, clearing, groundwater sampling, waste management and site restoration is approximately one week for each sampling episode. The estimated length of time to complete eight quarters of groundwater sampling and prepare the MNA evaluation report is approximately two and one half years. **Table 7-1** shows the anticipated duration for each of the major site activities. Shaw's mobilization to LHAAP-46 for the first round of MNA performance sampling is anticipated to begin in June 2011 after final approval of the ROD and this document.

Table 7-1
Durations for Major Site Activities

Activities	Duration	Elapsed Time
Establish land use control	1 month	1 month
First quarterly sampling episode	3 months	3 months
Mobilization / Site setup	1 day	—
Monitoring well installation	3 days	—
Groundwater and surface water sampling	4 days	—
Demobilization	1 day	—
Estimated duration	6 days per episode	—
Second / third / fourth quarterly sampling	9 months	1 year
Second year of quarterly sampling	1 year	2 years
MNA Evaluation (final document)	0.5 year	2.5 years
Well Abandonment	1 day	—
Three years of semi-annual sampling	3 years	5 years
Five-year review	0.5 year	5 years
Annual sampling (years 5 through 10)	5 years	10 years
Sample once every 5 years (repeated until cleanup levels are met)	—	15, 20, 25, 30 years
Achieve cleanup levels	—	23 to 30 years

Notes:

Does not include pre-mobilization activities or rerouting of utilities.

Includes expectation of favorable MNA Evaluation.

Schedule revision expected after MNA Evaluation and Five-Year Review.

8.0 REFERENCES

Jacobs Engineering, Inc. (Jacobs), 2002, *Final Remedial Investigation Report, Sites 35A, 35B, 35C, 46, 47, 48, 50, 60 and Goose Prairie Creek, Longhorn Army Ammunition Plant, Karnack, Texas*, January.

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Shaw, 2009, *Final Feasibility Study, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, October.

U.S. Army, 2010, *Record of Decision, LHAAP-46, Plant 2 Area, Group 4, Longhorn Army Ammunition Plant, Karnack, Texas*, September.

U.S. Army Corps of Engineers (USACE), 2008, *Safety and Health Requirements Manual, EM 385-1-1*, September.

U.S. Environmental Protection Agency (USEPA), 1998, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, September.

USEPA, 1999, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Directive 9200.4-17P, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

Appendix A

Inspection/Certification Form

Sample Annual Land Use Control Compliance Certification Documentation

In accordance with the Remedial Design dated __________ for LHAAP-46 a certification of site was conducted by _____________________ [indicate transferee] on __________.

A summary of land use control mechanisms is as follows:

- Groundwater restriction – restriction of the use of groundwater to environmental monitoring and testing until cleanup goals are met [Indicate whether groundwater restrictions are still required at LHAAP-46]

A summary of compliance with land use and restriction covenants is as follows:

- No use of groundwater, installation of new groundwater wells, or tampering with existing wells at LHAAP-46

I, the undersigned, do document that the certification was performed as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: ______________________________

Name/Title: ____

Signature: ______________________________

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year.

Attachments

- **Metes and Bound Survey of Area for LUC Implementation**
- **Monitoring Well Logs**
- **Notice of Filed Land Use Controls for LHAAP-46**

The attachments will be submitted once the surveys are completed; the well system is defined and wells are installed; and the notification is filed.

Appendix B

Site-Specific Supplement to Health and Safety Plan

00111748

Appendix B
Site-Specific Supplement to Health and Safety Plan

Final
Remedial Design
LHAAP-46, Plant 2 Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st, East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Shaw Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

ANSI	American National Standards Institute
DPT	direct-push technology
HSM	Health and Safety Manager
LEL/O_2	lower explosive limit/oxygen
mg/m^3	milligrams per cubic meter
PID	photoionization detector
PPE	personal protective equipment
TWA	time-weighted average

1.0 PERSONAL PROTECTIVE EQUIPMENT (PPE) LEVELS

1.1 LHAAP-46 – Direct Push Technology (DPT) Operations/Monitoring Well Sampling/Well Installation/Well Abandonment

1.1.1 Level D – Modified PPE:

- Hard hat meeting American National Standards Institute (ANSI) Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Nitrile surgical gloves (inner or double layer).
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Chemical resistant boot covers and/or outer boots (polyvinyl chloride/latex/neoprene when there is potential for shoe/boot contact with contaminated soil or water).
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

1.2 LHAAP-46 – Brush Clearing for Access

1.2.1 Level D – Modified PPE:

- Hard hat meeting ANSI Z89.1 specifications.
- Safety glasses with side shields meeting ANSI Z87.1 specifications.
- Safety-toed work boots meeting ANSI Z41 specifications.
- Disposable Tyvek® coveralls with hoods, elastic wrists, and elastic ankles.
- Hearing protection (if necessary or required).
- High visibility vests (ground personnel when working near heavy equipment or vehicular traffic).
- Work gloves, such as leather, cotton, or other material that provides cut/abrasion resistance (as necessary).

2.0 AIR MONITORING

2.1 Particulates

2.1.1 Real-Time Aerosol Monitor

Real-time aerosol monitors (MIE pDR-1000 or equivalent) shall be used to monitor dust emissions during dust generating activities. The only dust generating activity anticipated is clearing brush for well access or during well abandonment. The real-time aerosol monitors will be placed in the work area (near areas where ground personnel are working) and at the downwind site perimeter. The selected placement of these instruments may need to be adjusted throughout the workday to compensate for changes of wind direction.

2.1.2 Real-Time Aerosol Monitoring Action Levels

The real-time aerosol monitors will be set to alarm when the instantaneous aerosol concentration reaches 1.0 milligrams per cubic meter (mg/m^3). The alarm will be used to indicate that additional dust control is necessary.

The real-time aerosol monitors are capable of collecting and integrating the aerosol concentrations throughout the workday into a time-weighted average (TWA). Aerosol monitors shall be visually checked on an hourly basis during dust generating activities to verify that the TWA remains below 1.0 mg/m^3. Aerosol monitors registering time-weighted average aerosol concentrations at or above 2.0 mg/m^3 require that workers upgrade to Level C PPE and indicate that additional dust control measures are necessary. Failure to control workday time-weighted average dust concentrations to below 4.0 mg/m^3 shall necessitate ceasing dust generating activities and contacting the Project Manager and Health and Safety Manager (HSM) for implementing alternate work practices.

The full work-shift time-integrated concentrations will be evaluated at the conclusion of each workday to verify aerosol concentrations are maintained below action levels.

2.2 Volatiles/Oxygen

Photoionization detectors (PIDs) and lower explosive limit/oxygen (LEL/O_2) detectors shall be used to monitor emissions during sampling and well abandonment. Measurements will be collected from the work area and breathing zone during sampling or well abandonment activities. The action levels for the area monitoring are provided in the table on the next page:

Direct Reading Air Monitoring Summary for Volatiles/Oxygen

Monitoring Device	Monitoring Location/Personnel	Monitoring Frequency	Action Level [a]	Action
PID/OVA (breathing zone)	Groundwater sampling and well installation	At start-up, minimum four times daily in work area and breathing zone	>5 ppm	Test for vinyl chloride (VC) (colorometric detector tubes)
LEL/O2 meters	Groundwater sampling and well installation	At start-up, minimum four times daily in work area.	>10% LEL	Stop operations; allow vapors to vent and reach <10% before continuing

Notes and Abbreviations:

[a] Sustained levels above background for 5 minutes in breathing zone

LEL/O2	lower explosive limit/oxygen
ppm	parts per million
PID/OVA	photo ionization detector/organic vapor analyzer

Personal Air Sampling (time-integrated)

Time-integrated air sampling may be performed at the discretion of the HSM, if air-monitoring action levels are exceeded.

3.0 MEDICAL SURVEILLANCE

3.1 LHAAP-46

There are no special medical surveillance requirements in addition to the requirements of 29 Code of Federal Regulations 1910.120(f), which are already in place.

ACTIVITY HAZARD ANALYSIS FOR GROUNDWATER SAMPLING OR DPT OPERATIONS

Task Breakdown	Potential Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Groundwater sampling or DPT operations	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before sampling operations begin	Latex inner gloves, Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Flammable, explosive atmospheres	• Test well head atmosphere for flammable/toxic vapors • Wear proper level of PPE for the type of atmospheric contaminants • Eliminate sources of ignition from the work area • Prohibit smoking in development area	Tyvek® coveralls, nitrile gloves	LEL / O_2, PID
	Struck by / against flying particles, protruding objects, liquid splash	• Wear Hard hats, safety glasses with side shields and steel-toe safety boots at all times • Wear splash shields and safety goggles when sampling, cleaning, decontaminating test equipment	Hard hat, safety glasses	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all tools in a safe condition • Keep guards in place during use	Cut resistant gloves	—
	High / low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hand tools	• Small equipment as specified by operations manual	• 40 hour Hazardous Waste Training • Review HASP • Review site-specific AHA with all task personnel. • Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR BRUSH CLEARING PREPARATION

Principle Steps	Potential Safety/Health Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Clearing Brush		• De-energize or shut off utility lines at their source before work begins • Use double insulated or properly grounded electric power-operated tools • Maintain tools in a safe condition • Provide an equipment-grounding conductor program or employ ground-fault circuit interrupters • Use qualified electricians to hook up electrical circuits • Inspect extension cords daily for structural integrity, ground continuity, and damaged insulation • Cover or elevate electric wire or flexible cord passing through work areas to protect from damage • Keep all plugs and receptacles out of water • Use approved waterproof, weather-proof equipment if exposure to moisture is likely • Inspect electrical power circuits prior to commencing work • Follow lockout-tagout procedures in accordance with Shaw Health & Safety Program, Volumes I & II, HS315	—	—
	Handling heavy objects	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads	—	—
	Sharp objects	• Wear cut-resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain hand and power tools in a safe condition • Keep guards in place during use	Leather gloves with reinforced palm	—
Mobilization / Site setup and survey / Layout	Slips, trips, falls	• Clear walkways, work areas of equipment, tools, vegetation, excavated material and debris • Mark, identify, or barricade other obstructions • Ensure footing. Look before you step	—	—

ACTIVITY HAZARD ANALYSIS FOR BRUSH CLEARING PREPARATION

Principle Steps	Potential Safety/Health Hazards	Hazard Control Measures	Personal Protective Equipment	Monitoring Devices
Mobilization / Site setup and survey / Layout (*cont.*)	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 decibels, A-scale (dBA) over an 8-hour work period)	Ear plugs	—
	High / low ambient temperature	• Monitor for heat/cold stress in accordance with Shaw Health & Safety Program, Volumes I & II, HS400 / HS 401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
• Hand tools	• Daily heavy equipment inspections • Small equipment as specified by operations manual	• Review Site Safety and Health Plan (HASP) • Review site-specific Activity Hazard Analysis (AHA) with all task personnel. • Review equipment safety operations manual • Safe driver's training (HS800)

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring well installation or abandonment	Slips, trips, falls	• Clear walkways, work areas of equipment, debris and excavated materials • Mark, identify, or barricade other obstructions • Halt exterior work in high winds, severe weather	—	—
	Sharp objects	• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use	Leather gloves	—
	Handling heavy objects (piping/ casings)	• Observe proper lifting techniques • Obey sensible lifting limits (60 lb. maximum per person manual lifting) • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads • Move long sections of piping/casing with at least two workers or mechanical equipment • Add tag lines to loads, if necessary, to minimize side-to-side movement • Prohibit workers from standing on top of piping during loading/unloading/transferring pipe or rolling stock • Stand clear of rolling stock/piping; do not attempt to stop rolling piping • Use slip handles to move slips; prohibit kicking slip handles into place	—	—
	Eye injuries	• Wear face shield, goggles when operating powered clearing / grubbing equipment	Face shield, goggles, safety glasses	—
	Flammable, toxic emissions	• Monitor for flammable/toxic vapors, particulates, and gases • Wear proper level of PPE for the type of atmospheric contaminants	Portable fire extinguishers	PID
	Underground utilities	• Identify all underground utilities around the excavation site before work commences • Cease work immediately if unknown utility markers are uncovered	—	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring well installation or abandonment *(cont.)*	Struck by/against heavy equipment, protruding objects, splashes	• Wear reflective warning vests when exposed to vehicular traffic • Isolate equipment swing areas • Make eye contact with operators before approaching equipment • Wear hard hats, safety glasses with side shields, face shields and goggles, and steel-toe safety boots • Understand and review hand signals • Chock piping/rolling stock stored on trailers/racks/etc to prevent rolling	Warning vest, hard hat safety glasses, steel toe work boots	—
	Equipment failure	• Inspect drilling equipment daily according to manufacturer's specifications • Block and level drilling equipment before use • Insure equipment not in use is properly stored • Examine fittings, drive rods, hydraulic lines for condition and wear	—	—
	Inhalation and contact with hazardous substances	• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before operations begin • Monitor breathing zone air to determine levels of contaminants	Tyvek® coveralls, nitrile gloves, latex or neoprene boots	PID
	Insect/ snake bites	• Review injury potential and types of snakes with workers • Avoid insect nests areas, likely habitats of snakes outside work areas • Emphasize The Buddy System where such injury potential exists • Use insect repellant, wear PPE to protect against sting/bite injuries	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—
	Contact dermatitis	• Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants • Identify and review poisonous plants with workers • Apply protective cream/lotion to exposed skin to prevent poison ivy or similar reactions	Tyvek® coveralls, duct tape bottom of coveralls to boots or latex boot covers	—

ACTIVITY HAZARD ANALYSIS FOR MONITORING WELL INSTALLATION OR ABANDONMENT

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Monitoring well installation or abandonment *(cont.)*	Caught in/between moving parts	• Identify and understand parts of equipment which may cause crushing, pinching, rotating or similar motions • Assure guards are in place to protect from these parts of equipment during operation • Wear proper work gloves when the possibility of pinching, or other injury may be caused by moving/ handling large or heavy objects • Maintain all equipment in a safe condition • Keep all guards in place during use • De-energize and lock-out machinery before maintenance or service	—	—
	High noise levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) • Assess noise level with sound level meter if possibility exists that level may exceed 85dBA TWA	Ear plugs	Sound level meter
	High/low ambient temperature	• Monitor for Heat/Cold stress in accordance with Shaw E & I Health and Safety Program, HS400, HS401 • Provide fluids to prevent worker dehydration	Insulated clothing (subject to ambient temperature)	Meteorological equipment

EQUIPMENT TO BE USED	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
—	• Daily heavy equipment inspections • Daily Drill Rig Inspections • Small equipment as specified by operations manual	• 40 hour Hazardous Waste Training • Review SSHP • Review site-specific AHA with all task personnel. • Review equipment safety operations manual • Safe driver's training (HS 800)

Appendix C

Contractor Quality Control Plan

00111761

Appendix C
Contractor Quality Control Plan

Final
Remedial Design
LHAAP-46, Plant 2 Area, Group 4
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for U.S. Army Corps of Engineers – Tulsa District
1645 South 101st, East Avenue
Tulsa, Oklahoma 74128

Prepared by Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Contract No. W912QR-04-D-0027, Task Order No. DS02
Shaw Project No. 117591
Rev 0
September 2011

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Acronyms and Abbreviations

CDAP	Chemical Data Acquisition Plan
CQC	contractor quality control
CQCP	Contractor Quality Control Plan
CQCSM	Contractor Quality Control System Manager
DPT	direct-push technology
GPS	Global Positioning System
HASP	Health and Safety Plan
LHAAP	Longhorn Army Ammunition Plant
MARC	Multiple Award Remediation Contract
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
QAR	quality assurance representative
QC	quality control
Shaw	Shaw Environmental, Inc.
SSO	Site Safety Officer
TO	task order
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Tulsa District, contracted Shaw Environmental, Inc. (Shaw), under the Louisville District's Multiple Award Remediation Contract (MARC) No. W912QR-04-D0027, Task Order (TO) No. DS02, to perform closure of multiple environmental sites at Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. TO No. DS02 is being administered by the Tulsa District of USACE.

LHAAP is located in central-east Texas, in Harrison County, between State Highway 43 at Karnack, Texas, and Caddo Lake. Figure 1-1 of the Remedial Design shows the location of LHAAP and surrounding communities.

The objective of this TO is to perform investigations, collect data, perform remediation activities at multiple sites on an expedited basis to achieve site closures and bring as many sites as possible into the long-term management/long-term operation stage as early as possible. This Contractor Quality Control Plan (CQCP) documents quality control (QC) requirements that will be implemented during remediation at LHAAP-46.

2.0 CONTRACTOR QUALITY CONTROL PLAN PURPOSE AND SCOPE

2.1 Contractor Quality Control Plan Purpose

This CQCP establishes procedures that enable common project field activities to be completed successfully and documents QC requirements for services provided by Shaw and its subcontractors during project activities at LHAAP-46. This plan describes requirements for organizing, planning, performing, reviewing, documenting, and reporting activities that may affect the quality of the work. This CQCP applies the specific requirements of Shaw's Contractor Quality Control (CQC) System to this project by establishing controls for:

- QC staff organization and authority
- Workmanship
- Construction activities for major definable features of work
- Records
- Inspections and tests
- Documentation
- Audits
- Subcontractor performance

This plan references standard field procedures, policies, regulations, and practices required to implement the work. A controlled copy of applicable Field Procedures from Appendix D of the *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant* (Shaw, 2006) will be available as a reference document.

2.2 Contractor Quality Control Plan Scope

This CQCP is applicable to the work proposed at LHAAP-46, including the major definable features of site work (or major project tasks) identified below:

Task 1 – Mobilization/Site Setup/Site Clearing
Task 2 – Direct-Push Technology (DPT) Operations
Task 3 – Monitoring Well Installation
Task 4 – Groundwater Sampling
Task 5 – Waste Management
Task 6 – Monitoring Well Abandonment
Task 7 – Surveying
Task 8 – Site Restoration and Demobilization

2.3 Acceptance of Contractor Quality Control Plan

Work within the scope of this plan will not be started prior to providing this CQCP to USACE, unless otherwise permitted by USACE. Any proposed changes to this CQCP will require notification to USACE in writing. Proposed changes are subject to the approval of USACE.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Personnel and Structure

The Contractor Quality Control System Manager (CQCSM) coordinates implementation of this CQCP with the Project Manager, Remediation Manager, Program QC Manager, and subcontractors.

3.2 Duties and Responsibilities

The duties and responsibilities of personnel with regard to the CQC program are briefly outlined below. Duties and responsibilities of health and safety personnel are presented in Appendix A, Health and Safety Plan (HASP) (Shaw, 2006).

Project Manager: The Project Manager is responsible for all activities on the project, and directs and monitors the Site Superintendent in planning, coordinating, and controlling the work. The Project Manager has overall responsibility for establishing the CQCP and for its implementation, and he has the authority to access the required resources throughout Shaw to ensure compliance with the contract requirements.

Remediation Manager: The Remediation Manager reports to the Project Manager and is responsible for site remediation technical assurance. This individual will oversee the site remediation activities. The Remediation Manager has the following duties and authorities:

- Perform and/or oversee the purging and sampling of monitoring wells
- Perform and/or oversee the preservation, packaging, and shipping of samples to an off-site, fixed laboratory for environmental analyses
- Ensure documentation accuracy, completeness, and consistency among field team members
- Stop work that deviates from the contract documents or is otherwise nonconforming or unsafe.

CQCSM: The CQCSM is responsible for the overall management of the project CQC program during field activities. The CQCSM receives administrative and day-to-day direction from the Remediation Manager. The CQCSM is responsible to the Shaw Program QC Manager for direction on matters that may affect the QC requirements for the project. The CQCSM/Site Safety Officer (SSO) is assigned the following duties:

- Monitor and verify that the work is performed in accordance with the contract requirements

- Review and verify the disposition of discrepancy and corrective action reports
- Perform QC inspections and surveillance, and report daily on project QC
- Monitor project submittals in accordance with submittal register requirements
- Submit QC reports to the USACE Field Representative/Quality Assurance Representative (QAR) on a daily basis, unless other arrangements are agreed to by the USACE

The CQCSM has the authority to reject materials and workmanship that do not comply with project requirements, and to stop nonconforming work activities (see **Figure 3-1**).

Due to the limited size of the field effort at LHAAP-46, the CQCSM may also serve as the SSO. In this dual role, the CQCSM/SSO is responsible to the Shaw Program Health and Safety Manager for safety-related matters. The SSO duties are discussed in detail in the HASP and the Supplement provided as Appendix B of the Remedial Design/Work Plan.

Program QC Manager: The Program QC Manager is responsible to review, monitor, and report the conformance to QC requirements set forth in the CQCP. He may also advise the CQCSM on QC methods and practices. He will maintain a record of his quality monitoring activities and will inform the CQCSM of his monitoring activities. He shall also be responsible for performing periodic internal audits, and reporting his findings to the CQCSM.

Subcontractors: Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services. Subcontractors are responsible to the Project Manager and Remediation Manager for completing the portion of work assigned to them, and to the CQCSM for CQCP activities. They shall verify that their construction and materials comply with the requirements of the contract plans and specifications. Subcontractors include organizations supplying quality-related items or services to the project.

3.3 Qualification of Personnel

Shaw personnel assigned to the project are qualified to perform the tasks to which they are assigned. The Project Manager and the Remediation Manager will appraise the qualification of professional and/or technical personnel assigned to the project. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee.

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

To:	To Be Determined
From:	John W. Patin, QC Manager
Date:	June 2011
Subject:	Contractor Quality Control System Manager, Letter of Authority U.S. Army Corps of Engineers, Tulsa District MARC Contract No. W912QR-04-D0027, Task Order No. DS02

This letter describes the responsibilities and authority delegated to you in your capacity as the Contractor Quality Control System Manager for remediation of LHAAP-46 at Longhorn Army Ammunition Plant, Karnack, Texas.

In this position, you are responsible for the implementation and enforcement of the CQCP and site specific addenda. You will use the plan to verify that the quality of materials, workmanship, operations, and safety monitoring conforms to the Remedial Design/Work Plan, its appendices, and addenda.

Your responsibilities include identifying and reporting quality problems, rejecting nonconforming materials, initiating corrective actions, and requesting solutions for nonconforming activities. You have the authority to control or stop project activities until satisfactory disposition and implementation of corrective actions are achieved. Detailed responsibilities and guidelines are given in the Remedial Design, its appendices, and addenda.

Figure 3-1
Letter of Authority

4.0 CONTRACTOR QUALITY CONTROL SYSTEMS

4.1 Control Measures

The CQCP provides measures to verify and document that the work performed complies with the requirements specified in the contract documents. These measures include:

- CQC inspections
- Document control
- Submittals
- Completion inspection
- Records

Procedures for implementing the above measures are included throughout the CQCP. The CQCP may be supplemented by additional guidelines or instructions for implementing the work and/or verifying compliance with the contract requirements.

4.2 Quality Control Monitoring

The project CQC program is monitored to verify that the program is in compliance with the CQCP. Monitoring activities are performed by the Shaw Program QC Manager, or his representative, and include the review of daily QC reporting and instructions, or directions given to the CQCSM on QC matters. If required, an assessment of the project's CQC system is performed. If performed, the assessment includes the following items:

- Subcontractor performance
- Field operation and records
- CQC and health and safety inspections, testing, and records
- Document control
- Training records

4.3 Quality Control Testing

As applicable, the CQCSM monitors the equipment/materials testing firm and/or analytical laboratory activities to verify the following:

- Execution of required tests
- Location of tests
- Timely and accurate reporting of test results
- Correct frequency of tests
- Completeness of documentation

5.0 INSPECTION PLAN

QC inspections include inspection of equipment, materials, testing procedures, documentation/submittals, and workmanship before, during, and after each definable feature of work. QC inspections are performed by the CQCSM in accordance with the Three-Phase CQC system. The CQCSM gives the USACE QAR advance notification (at least 24 hours) of formal inspections.

Definable features of site work (or major work tasks) for which QC inspections will be performed are addressed below.

Definable Features of Site Work:

Task 1 – Mobilization/Site Setup/Site Clearing
Task 2 – DPT Operations
Task 3 – Monitoring Well Installation
Task 4 – Groundwater Sampling
Task 5 – Investigation-Derived Waste Management
Task 6 – Monitoring Well Abandonment
Task 7 – Surveying
Task 8 – Site Restoration and Demobilization

Other site remediation activities that constitute definable features of site work will be defined within site-specific addenda to the work plan. Those addenda will also identify related QC inspection requirements.

5.1 Task 1 – Mobilization and Site Setup

Following approval of the Remedial Design, Shaw will mobilize the necessary personnel and equipment to prepare the site for remedial activities. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Site personnel have the necessary Occupational Safety and Health Administration (OSHA) training and medical surveillance statements/certifications
- Heavy equipment (e.g., drilling rig) has undergone safety and preventive maintenance checks, and is suitable for the task for which it will be used.
- Measuring and test equipment has undergone calibration and/or calibration checks to assure accuracy and precision.
- The project team understands the investigation/remediation requirements.

- Site personnel have reviewed the HASP provided by the SSO and have acknowledged this review by signing the HASP acknowledgment form.
- Installed government property plan (when applicable) is reviewed and implemented for the equipment to be installed on site.
- Work zones and decontamination facilities are established in accordance with the HASP.
- Material storage areas are kept orderly.
- Site security measures are adequately maintained to prevent unauthorized access.
- Work zones are clearly demarcated using temporary barricading or fencing as required.

Once the site is mobilized and set up, field activities will commence.

5.2 Task 2 – Direct Push Technology Operations

The field work involves DPT operations by a drilling subcontractor. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for DPT operations.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- DPT operations will employ a well driller licensed in the state of Texas.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- DPT locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.
- Borings are abandoned.
- Waste generated during activities is handled and disposed according to the waste management plan.

5.3 Task 3 – Monitoring Well Installation

Well installation is proposed for this site. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well installation.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Drilling operations will employ a well driller licensed in the state of Texas.
- Materials and equipment are suitable and approved for use prior to starting the work.
- Required agency permits and/or notifications are completed prior to starting activities.
- Well installation locations are marked in the field by Shaw personnel or under the direction of Shaw personnel, based on the Remedial Design/Work Plan, and recorded in a logbook.
- Waste generated during activities is handled and disposed according to the waste management plan.

5.4 Task 4 – Groundwater Sampling

Following the installation of groundwater monitoring wells, Shaw will collect groundwater samples for laboratory analyses. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Sampling personnel have reviewed the Chemical Data Acquisition Plan (CDAP) (Appendix C of the Final Installation-Wide Work Plan [Shaw, 2006]) and Work Plan and understand the scope of work.
- The SSO has briefed sampling personnel on task hazards and the appropriate personal protective equipment (PPE) level before sampling begins.
- A sampling equipment checklist is developed for this task and is reviewed with sampling personnel before sampling begins.
- Well depth and depth-to-water measurements are performed consistently from a common location at top-of-well casing (e.g., notch in top of casing or northern lip of casing).
- Well water volume is calculated accurately using well measurements.

- Well is purged of the required quantity of well water and water quality is stabilized as defined by the CDAP prior to sample collection.
- Purged water is contained in drums and managed in accordance with Work Plan waste handling requirements. Field screening procedures are found in Appendix D of the Final Installation-Wide Work Plan, Attachment 1.
- The specified sampling equipment and materials are used for sample collection.
- The sampling team leader (i.e., Remediation Manager) has instructed samplers on the sampling procedures and protocols and has assigned specific duties and responsibilities to each team member.
- Sampling equipment decontamination procedures are performed according to the CDAP.
- Sampling documentation procedures in the CDAP are followed and field documentation is legible, accurate, and complete.
- Quality assurance and QC samples are collected at prescribed frequencies in accordance with CDAP protocols and procedures.
- Sample labels, custody seals, and chain-of-custody forms contain pertinent sampling and analytical information before samples are packaged and shipped off site for laboratory analysis.
- Sampling and analytical records are maintained in the project file (in secured area).
- All field instruments are calibrated at the start of the testing day.

5.5 Task 5 – Investigation-Derived Waste Management

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Waste generated during the project activities will be segregated by type (e.g., soil cuttings, used PPE, well development and purging liquids, trash/debris) and stored in approved 55-gallon drums or other containers.
- Waste containers are labeled with a waterproof marker according to the Work Plan, indicating the content, accumulation date, waste code(s) (if known) and pertinent analytical information.
- Waste handling activities are documented in the field logbook and a tracking log is prepared that indicates waste type, point of waste generation (i.e., well number) container size and type, accumulation date, storage location, disposal

destination, transporter name, shipping paper/manifest number, and transportation and disposal dates.

- Waste containers are leak proof and stored in a secure storage area.
- Waste storage area is clearly demarcated using barricade tape and/or temporary barricade fencing, as required.
- Waste container and storage area inspections are performed on a weekly basis (at a minimum) and documented in the field logbook and/or in a standard inspection form.

5.6 Task 6 – Monitoring Well Abandonment

Shaw will abandon monitoring wells that were installed during any investigation and remediation activities as needed. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Preparatory meetings are held with work crews to discuss the regulatory requirements for well abandonment.
- Personnel associated with this task have applicable OSHA training and medical surveillance certifications.
- Worker protection is adequate for the associated task hazards.
- Abandonment activities will employ a well driller licensed in the state of Texas.
- Well abandonment materials and equipment are suitable and approved for use prior to starting the work.
- Well locations and top of casing elevations are verified and recorded in a logbook prior to abandonment.
- Required agency permits and/or notifications are completed prior to starting abandonment activities.
- Waste generated during abandonment activities is handled and disposed according to the waste management plan.
- Quantity and depth measurements are made and recorded accurately the amount of grout used, depth below ground surface of the top of the grout once the grout has settled and hardened, and the amount of cover soil placed and compacted above the top of the grout to re-establish a level ground surface.
- A multi-purpose completion report and/or well abandonment log is accurately completed for each abandoned well and submitted to the State of Texas. Copies are maintained in the project file until submitted to the USACE with the final report.

5.7 Task 7 – Surveying

Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- A qualified land surveyor licensed by the State of Texas is employed to perform well surveying and metes and bounds land-use control boundary surveys.
- Survey datum (vertical and horizontal) used is consistent with the work plan requirements and/or historical datum.
- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled (e.g., notch in the top of casing and/or brass surveying marker embedded in surface pad).
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

For identifying locations of soil samples and limits of excavation, a Global Positioning System (GPS) may be used in lieu of land surveying. Using the Three-Phase CQC system, the CQCSM will monitor this task to affirm the following:

- Survey team undergoes preparatory meeting to verify their understanding of the scope of work.
- Surveying equipment is operative and properly calibrated.
- Instrument calibration is performed per manufacturer instructions.
- Survey points are clearly marked or labeled
- Field documentation is legible, accurate, and complete.
- Worker protection is adequate for the associated task hazards.

5.8 Task 8 – Site Restoration and Demobilization

Shaw will restore the site and demobilize once response complete is attained. Using the Three-Phase CQC system, the CQCSM will affirm the following:

- Equipment installed for the purposes of this project, and not intended to be operated after this project is demobilized.
- Information for remaining equipment or installed materials has been submitted to LHAAP and USACE.

5.9 Other Site Remediation Tasks

Shaw will perform various site remedial activities to include optimizing the existing on site groundwater treatment plant, soil/groundwater flushing, and instituting bioremedial solutions where applicable. Using the Three-Phase CQC system, the CQCSM will monitor these tasks as appropriate. Specific QC requirements for these tasks will be identified in site-specific addenda to the work plan.

6.0 DOCUMENT CONTROL

6.1 Documentation

The CQCSM maintains current records of QC activities and tests performed, including those of suppliers and subcontractors. The records will be maintained as evidence that required control measures and tests have been performed, and indicate the results of the activities. Photographic documentation is also maintained for this project in accordance with **Section 6.4** of this plan.

6.2 Daily CQC Report

The daily CQC Report is completed and maintained by the CQCSM using a standard form. The form is provided in **Attachment 1**. As applicable, standard forms used to document safety, technical, and operations aspects of daily field activities will be attached to the Daily CQC Report.

6.3 Daily Weather Conditions/Lost Time Report

A Daily Weather Conditions/Lost Time Report is prepared daily by the CQCSM. A report form is provided at the end of this section. Lost time will be logged into the report in increments of 25% (in other words, 0%, 25%, 50%, 75% or 100%). The amount of lost time incurred will be agreed upon and initialed by the CQCSM and the USACE QAR or Technical Manager overseeing the project work. Upon completion of the report for the specified period of time, one copy of the report should be submitted to the QAR/Technical Manager once each month during fieldwork and an extra copy should be maintained by the CQCSM for future reference.

6.4 Photographs

The CQCSM will photograph the project activities. Photographs will be taken on a regular basis during the course of the project to document the work, events, and equipment used. The frequency and number of pictures taken will depend upon the activities occurring and the amount of documentation needed. The Project Manager or Remediation Manager will use judgment to determine the frequency and number of pictures taken; however, a sufficient quantity of pictures will be taken to effectively document the TO.

Pictures will be taken using 35mm film or digital medium (using a digital camera or video camera). Photos will be documented on a project log (see standard form in **Attachment 1**), which includes the photo number, date, time, description of the task depicted, and the view direction (e.g., facing northwest). A copy of the photo log, pictures, slides/videos, and digital media will be maintained in Project Files.

6.5 Review of Vendor Submittals

Vendors and subcontractors are required to expeditiously submit items such as drawings, test data, and specifications to Shaw for review to enable timely submittals to USACE. Shaw technical and CQC personnel review each submittal for compliance with contract documents. If acceptable, the item is stamped or indicated as such, and forwarded to USACE for review and acceptance.

If unacceptable, errors or deficiencies are identified and returned to the vendor or subcontractor for correction. The corrected document is resubmitted to Shaw for review until it meets contract requirements.

6.6 Government Property Accounting and Control

If applicable, Shaw will acquire, manage, and dispose of government property. At the completion of the project, all real property (removed and/or installed) will be listed on a Property Inventory Sheet.

6.7 Submittals

The Project Manager, Remediation Manager, the Program Controls Engineer, and the CQCSM are responsible for project submittals. A submittal register prepared for this project is given in **Figure 6-1**.

SUBMITTAL REGISTER

DACA56-94-D-0020
TO No. 0109

TITLE AND LOCATION: **Longhorn Army Ammunition Plant – LHAAP-46**

CONTRACTOR: Shaw Environmental Inc.

				TYPE OF SUBMITTAL									CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVT. ACTION		
TRANSMITTAL NO	ITEM NO	SPEC PARA NO	DESCRIPTION OF ITEM SUBMITTED	DATA	DRAWINGS	INSTRUCTIONS	SCHEDULES	STATEMENTS	REPORTS	CERTIFICATES	SAMPLES	RECORDS	INFO ONLY	GOVT. APPROVED	REVIEWER	SUBMIT	APPROVAL NEEDED BY	MAT'L NEEDED BY	CODE	DATE	SUBMIT TO GOVT	CODE	DATE	REMARKS
a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	
			Work Plan (and Appendices)		X	X	X							X		Per Project Schedule								
			Site Personnel OSHA Medical & Training Certificates							X		X	X			Prior to start of work								
			CQC and Safety Reports						X				X			Daily								
			Well Construction Methods/Specifications	X	X								X			Per Work Plan								
			Transporter ID, Insurance Cert							X			X			Prior to subcontract award								
			Manifests/Shipping Papers									X	X			Prior to shipment								
			Disposal Facility ID	X									X			Prior to subcontract award								
			Environmental Inspection Sheets									X	X			Per Work Plan								
			Groundwater Sampling Results	X					X				X			Upon data evaluation								
			Survey Drawings (As-built)		X									X		Upon completion								
			Well Construction Completion Forms									X		X		To State of Texas within 30 days of construction completion								
			Well Abandonment Forms									X		X		To the State of Texas within 30 days of construction completion								
			Drilling Logs & Groundwater Sampling Forms									X				With Daily QC Reports								

Figure 6-1
Submittal Register

7.0 SUBCONTRACTOR QUALITY CONTROL

Subcontractors for this project are responsible for compliance with the QC requirements of their respective subcontract. Subcontractors include organizations supplying quality related items or services to the project. Shaw assumes overall responsibility for conformance to the quality requirements for the subcontracted items and services.

Subcontract documents should include the requirements for personnel qualifications, technical performance levels, QC procedures, acceptability criteria, and documentation. The CQCSM, or his designee, reviews the subcontract procurement documents to verify that the QC requirements are communicated to the subcontractor.

Each subcontractor is required to identify an adequately qualified individual within the organization to perform QC duties. The qualifications of this individual are submitted to the CQCSM for review and approval. The CQCSM coordinates the QC functions with the designated subcontractor QC representative. The Project Manager, or his authorized designee, assists the CQCSM in managing subcontractor QC.

The CQCSM is responsible for the performance of inspections, surveillance, document reviews, audits, and other QC functions to verify compliance with the subcontract requirements. These activities are documented on inspection reports, checklists, audit reports, field logs, or other forms appropriate to the function performed.

For field operations, the CQCSM performs QC inspections before, during, and after the subcontractor activities, to the extent required, to verify that the subcontractor is in compliance with the QC requirements of the contract and the applicable subcontract documents.

Audits of subcontractor activities are conducted by the CQCSM as necessary to verify compliance with the CQCP. Objective evidence of conformance to the subcontract documents is reviewed during the audits.

8.0 REFERENCES

Shaw Environmental, Inc. (Shaw), 2006, *Final Installation-Wide Work Plan, Longhorn Army Ammunition Plant, Karnack, Texas*, Houston, Texas, January.

Attachment 1

Field Forms

- Preparatory Inspection Check List
- Initial/Follow-Up Inspection Form
- Final Inspection Form(s)
- Daily Contractor Quality Control Report
- Daily Weather Conditions/Lost Time Report
- Photo Log Form
- Corrective Action Report

PREPARATORY INSPECTION CHECKLIST

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:________________________
Project Location:______________________
Project No.:___________________________

Plan or Specification Title/Section:____________________ Drawing Nos.:_______________________

A. Personnel present *(use back of form to list additional personnel)*

Name	Position	Company

B. Submittals involved: *(use back of form to list additional submittals)*

Number and Type	Description	Indicate Contractor of Government Approval

C. Are all materials on hand and in accordance with approvals: ☐ Yes ☐ No
List all deficiencies:

D. Test required: (list/reference all quality control tests with their required frequencies):

E. Accident prevention preplanning (list all health and safety items discussed):

CQCSM: ___________________________

INITIAL/FOLLOW-UP INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:______________________
Project Location:____________________
Project No.:________________________

(check one)
INITIAL PHASE CHECK LIST ☐ **OR**
FOLLOW-UP PHASE CHECK LIST ☐

Plan or Specification Section:________________________ **Drawing Nos.:**__________________

A. Personnel present:

Name	Position	Company

B. Materials are in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

C. Work being performed is in strict conformance with contract specifications: ☐ Yes ☐ No
If no, explain:

D. Workmanship is acceptable: ☐ Yes ☐ No
If improvement is needed, explain:

CQCSM: ______________________

FINAL INSPECTION FORM

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:_______________________________
Project Location:_____________________________
Project No.:_________________________________

FINAL INSPECTION FORM

Plan or Specification Title/Section:______________________Drawing Nos.:______________________

Inspected Work (list feature(s) of work inspected):

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Performance Specification by Contract Delivery Order Reference	Status of Inspection

On behalf of Shaw, I certify that the work inspected is complete and meets the performance specifications cited above and that all material and equipment used and work performed was completed in accordance with approved plans and work instructions and meets contract delivery order requirements.

CQCSM ___________________________________ **Date______/______/______**

Site Manager_______________________________ **Date______/______/______**

DAILY CONTRACTOR QUALITY CONTROL REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:______________________________
Project Location:____________________________
Shaw Report No.:___________________________

WEATHER: ( ) Clear ( ) P. Cloudy ( ) Cloudy
Wind________________________
Temperature: High_______ Low_______
Precipitation: Today____________________ Previous Period (i.e., weekend)__________________
Site Conditions:____
Lost Time Due to Inclement Weather: ________________%

PRIME CONTRACTOR/SUBCONTRACTORS AND AREAS OF RESPONSIBILITY/LABOR COUNT: (Include number, trade, hours, employer, location, and description of work.)

a.

b.

c.

d.

e.

f.

WORK PERFORMED: (Include location and description of work performed including equipment used. Refer to work performed by prime and/or subcontractors as previously designated by letter above. Attached subcontractor daily activity reports when applicable):

MATERIALS AND/OR EQUIPMENT DELIVERED: (Include a description of materials and/or equipment, quantity, date/hours used, date of safety check, and supplier)

Page 1 of 3

RESULTS OF SURVEILLANCE: (Include satisfactory work completed or deficiencies with action to be taken.)
a. Preparatory Inspection: (Attach Minutes)

b. Initial Inspection: (Attach Minutes)

c. Follow-up Inspection: (List results of inspection compared to specification requirements.)

d. Safety Inspection: (Include safety violations and corrective actions taken.)

OFF-SITE SURVEILLANCE ACTIVITIES: (Include action taken.)

QC TESTS PERFORMED AND RESULTS: (As required by plans and/or specifications.)

VERBAL INSTRUCTIONS RECEIVED OR GIVEN: (List any instructions received from government personnel or given by Shaw on construction deficiencies identified, required retesting, etc., and the corresponding action to be taken.)

CHANGED CONDITIONS/DELAYS/CONFLICTS ENCOUNTERED: (List any conflicts with the delivery order [i.e., Scope of Work and/or drawings], delays to the project attributable to site, and weather conditions, etc.)

Page 2 of 3

SUBMITTALS REVIEWED: (Include submittal number, specification reference, and name of submitter.)

MEETINGS: (List the meetings, i.e., Health and Safety, Site Operations, Cost/Schedule, etc.)

VISITORS:

REMARKS: (Any additional information pertinent to the project not defined by the previous entries.)

CONTRACTOR'S VERIFICATION: The above report is complete and correct. All material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

____
Shaw CQCSM (or designee)

_____/_____/_____
Date

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DAILY WEATHER CONDITIONS/LOST TIME REPORT

DAILY WEATHER CONDITIONS/LOST TIME REPORT FOR WEEK/MONTH OF_____________

Contract No.:__________________________ Delivery Order No.:_________________________

Project:_____________________

Contractor:____________________________

DAY	DATE	W/C. L/T	% LOST	ACTIVITY DELAYED	REMARKS	CONCUR	
						CQCR	QAR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

Weather Conditions (W/C): R–Precipitation C–Extreme Temperature M–Muddy Site Conditions W–Extreme Winds
Other Lost Time Conditions (L/T): D–Demobilized S–Standby

Representative of the Contractor______________________________

Representative of the Government______________________________

PHOTO LOG FORM

PROJECT PHOTO LOG

Project Name:________________________ Project Location:______________________ Project No.:___________

Photo No.	Date	Time	Task and Description	View Direction

CORRECTIVE ACTION REPORT

Shaw Environmental, Inc.
1401 Enclave Parkway, Suite 250
Houston, Texas 77077

Project Name:______________________________
Project Location:____________________________
Report No.:________________________________

DESCRIPTION OF PROBLEM:____

PERSONNEL RESPONSIBLE FOR INVESTIGATIVE PROCESS:____________________________

RECOMMENDED CORRECTIVE ACTIONS:____

PERSONNEL RESPONSIBLE FOR IMPLEMENTATION OF CORRECTIVE ACTIONS:______________

RESULTING ACTIONS AND EFFECTIVENESS OF THOSE ACTIONS:_______________________

PERSONNEL RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CORRECTIVE ACTIONS:_______

FINAL DISPOSITION APPROVED BY:

Name:__________________________________ Title:____________________________

Date:_________________________

Name:__________________________________ Title:____________________________

Date:_________________________

COPIES TO: