

FINAL
Five-Year Review Report

First Five-Year Review Report
for
Longhorn Army Ammunition Plant

- **Sites 18 & 24 (Burning Ground 3)**
- **Site 16 (Old Landfill)**
- **Site 12 (Sanitary Landfill)**

Karnack
Harrison County, Texas

August 2002

PREPARED BY:

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8/13/02



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Five-Year Review Report

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List of Acronyms and Abbreviations

ACD	Air Curtain Destructor
ARAR	Applicable or Relevant and Appropriate Requirements
BG3	Burning Ground No. 3
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Complete Environmental Service
CFR	Code of Federal Regulations
COC	Chemical of Concern
DERA	Defense Environmental Restoration Act
DOD	Department of Defense
DSERTS	Defense Site Environmental Restoration Tracking System
EPA	U.S. Environmental Protection Agency
EPS	Environmental Protection Systems
FBR	Fluidized Bed Reactor
FFA	Federal Facility Agreement
FS	Feasibility Study
ft ³	cubic feet
GWTP	Groundwater Treatment Plant
gpm	gallons per minute
HASP	Health and Safety Plan
ICT	Interceptor Collection Trench
IRA	Interim Remedial Action
IRP	Installation Restoration Program
lbs	pounds
LHAAP	Longhorn Army Ammunition Plant
LTTD	Low Temperature Thermal Desorption
MC	Methylene Chloride
mg/Kg	Milligrams per kilogram
mg/L	Milligrams per liter
MSC	Medium Specific Concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PCL	Protective Concentration Level
PEP	Pyrotechnics, Explosives, and Propellant
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation Recovery Act
RD	Remedial Design
RD/RA	Remedial Design / Remedial Action
RfD	Reference Dose

RG	Regulatory Guidance
RI	Remedial Investigation
RI/FS	Remedial Investigation / Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RP/CP	Release Prevention / Contingency Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SCAPS	Site Characterization and Analysis Penetrometer System
SRI	Supplemental Remedial Investigation
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TBC	To Be Considered
TCE	Trichloroethylene
TDWR	Texas Department of Water Resources
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Carbon
TRRP	Texas Risk Reduction Program
TSDF	Treatment Storage Disposal Facility
TWQB	Texas Water Quality Board
TWQS	Texas Water Quality Standards
TWC	Texas Water Commission
UEP	Unlined Evaporation Pond
µg/L	Micrograms per liter
µg/m ³	Micrograms per cubic meter
USACE	U.S. Army Corps of Engineers
USAEHA	U. S. Army Environmental Hygiene Agency
VOC	Volatile Organic Compounds
yd ³	cubic yards

EXECUTIVE SUMMARY

The purpose of this five-year review is to 1) evaluate whether the selected Early Interim Remedial Action for the Burning Ground No. 3 (BG3) and the Unlined Evaporation Pond/Rocket Motor Washout Facility (UEP) at Longhorn Army Ammunition Plant (LHAAP) have addressed the principal risk to human health and the environment by preventing or reducing further migration of contaminants (high concentrations of chlorinated solvents & heavy metals in the shallow groundwater) into deeper groundwater zones and possibly surface water bodies, and 2) also to evaluate whether the Early Interim Remedial Action for landfills (Sites 12 and 16) has minimized long-term vertical infiltration of water through the landfills and minimized contaminant transport.

BG3 designated as Site 18 and the UEP/Rocket Motor Washout Facility, designated as Site 24, are located within a fenced area of 34.5 acres located in the southeastern quadrant of LHAAP. The UEP was closed as a Resource Conservation Recovery Act (RCRA) interim status surface impoundment in 1985 by removing all wastewater and sludge and capping the impoundment. Approximately 7850 cubic yards of solids and two million gallons of water were hauled offsite as hazardous waste to a permitted RCRA Treatment Storage Disposal Facility (TSDF).

A Record Of Decision (ROD) was signed on May 12, 1995 for an Early Interim Remedial Action consisting of soil and groundwater treatment at the Burning Ground No. 3/UEP area. The Groundwater Treatment Plant (GWTP) was approved for operation in February 1997. Two temporary Low Temperature Thermal Desorption (LTTD) units began treating soil in February 1997. The Remedial Action Construction completion date was August 31, 1999. In 1998 perchlorate was discovered in the groundwater at LHAAP including Burning Ground No. 3, Landfill 16 and other sites at LHAAP. A Fluidized Bed Reactor (FBR) for biological treatment of perchlorate became operational in February 2001 at the GWTP.

The Old Landfill or Retail Sales, subsequently called Site 16, encompasses approximately 16 acres in the south-central portion of LHAAP. Waste disposal and treatment activities took place until sometime in the 1980's when the site became inactive. A ROD was signed in September 1995 for an Early Interim Remedial Action to place a cap on the landfill. Prior to being capped, Site 16 received 35,840 cubic yards of LTTD treated soil from the Site 18/24 remedial action. Eight extraction wells were added to Site 16 as a treatability study under an Accelerated Remedial Investigation/Feasibility Study (RI/FS) to reduce the flow of groundwater transporting contaminants into Harrison Bayou. All water from the extraction wells is pumped to and treated at the Site 18/24 Groundwater Treatment Plant.

Site 12, previously called the "Sanitary Landfill", occupies seven acres just west of Site 16. Site 12 was used for disposal of non-hazardous industrial waste including cafeteria waste, non-hazardous chemical waste, oil/diesel soaked dirt, and asbestos until March 1994. Site 12 was included in the ROD for Site 16 and was signed in September 1995. As with Site 16, the Early Interim Remedial Action for Site 12 consisted of capping the landfill. Site 12 received 2000 cubic yards of treated soil from Burning Ground No. 3.

The Remedial Action Construction completion date was August 31, 1999 for both landfills.

Site 18/24

The Early Interim Remedial Action at Site 18/24 currently protects human health and the environment, because exposure pathways that could result in unacceptable risks are being controlled. The Early Interim Remedial Action at Site 18/24 is serving its intended purpose of minimizing potential risks to the environment by reducing the migration of contaminated groundwater into deeper groundwater zones near the site. Contamination in wells screened in the deeper or intermediate groundwater zones at the site have been stable or declining. An assessment of the site found that the interim remedy was constructed in accordance with the requirements of the ROD for Sites 18/24. The Early Interim Remedial Action to pump and treat groundwater is still in progress and must continue until a final remedy is implemented. As an Early Interim Remedial Action this was not intended to be the final remedy. Although it is recognized that this is not the final remedy, concentrations have not decreased in the five years of operation. Further study is needed to determine an appropriate final remedial action in the near future.

Site 16

The Early Interim Remedial Action at Site 16 consisting of the landfill cap and the eight vertical extraction wells installed as a treatability study under the accelerated RI/FS currently is expected to protect human health and the environment because it is serving its intended purpose to reduce the potential for vertical infiltration of water through the landfill, and to minimize contaminant transport. For the landfill cap to be effective in minimizing contaminant transport, the eight vertical extraction wells will continue to operate until a final remedy is addressed. For the remedy to be protective in the long-term, further remedial actions need to take place as determined by the Feasibility Study. As an early interim action this was not intended to be the final remedy.

Groundwater is currently being removed from Site 16 with eight extraction wells. The eight extraction wells were subsequently installed after the cap as part of the RI/FS. They assist in removing contamination from the environment between a source at the landfill and Harrison Bayou. Operation of the eight wells will continue until a final remedy is implemented. The assessment of the site found the interim remedy was constructed in accordance with the requirements of the ROD for Sites 12 and 16. The Feasibility Study (FS) for Site 16 is final.

Site 12

The Early Interim Remedial Action at Site 12 currently protects human health and the environment because it is serving its intended purpose to reduce the potential for vertical infiltration of water through the landfill and to minimize contaminant transport. The assessment of the site found that the interim remedy was constructed in accordance with the requirements of the ROD for Sites 12 and 16.

Five-Year Review Summary Form (continued)
Burning Ground/UEP Site 18/24

Issues:

1. Site 18/24 - The ROD states that 5,000 feet of Interceptor Collection Trenches (ICT) and eight vertical extraction wells will be used to collect shallow groundwater. The ICT's were constructed and are in use. However, there were no vertical extraction wells constructed or in use.
2. Contracting groundwater plume due to pumping the ICT's may allow reduction in number or frequency of groundwater wells sampled.
3. Growth in fence line around the site.
4. Fencing around site does not contain ICT's.
5. Lack of restricted access signs around the site.
6. Roads in site have potholes.
7. Slip flanges and bolts on pipe junctions at ICT wellheads deteriorating.
8. High frequency of repair of electronic equipment following lightning storms indicates need for lightning arrestors/lightning rods to prevent damage to sensitive equipment.
9. Metal precipitation process may not be required.
10. Control wires at junction box are not protected.
11. Release of approximately 50,000 gallons of untreated groundwater in January 2001 (due to freezing temperatures).
12. Contaminants in monitoring well C-06 may indicate an isolated source area of contamination.
13. Contamination outside of ICT capture zone at northwest of site may require groundwater extraction.
14. Monitoring wells 18WW08 and 18WW17 have high levels of perchlorate and are not in the scheduled sampling.
15. Constituents regularly detected at site during routine groundwater monitoring not included in investigations.

Recommendations and Follow-up Actions:

1. Evaluate need for vertical extraction wells and install or obtain release from State and EPA.
2. Review monitoring wells sampled for most efficient well locations to be sampled.
3. Cut trees along fence line.
4. Determine applicability for fencing around ICT's to be addressed with final disposition of site in Final ROD issue.
5. Place warning signs around site (Final ROD issue).
6. Fill in potholes on roadway.
7. Paint flanges and monitor for deterioration.
8. Perform cost analysis for installing lightning protection.
9. Review data and monitoring information from groundwater analysis and RI.

Five-Year Review Summary Form (continued)
Burning Ground/UEP Site 18/24

10. Protect wires at junctions.
11. Review spill response procedure and freeze protection plan.
12. Further investigation to determine if there is another source area or if the contamination was from Site 18/24.
13. Further study to determine if groundwater needs to be removed and treated.
14. Sample monitor wells 18WW08 and 18WW17 in the scheduled rounds for perchlorate.
15. Review analysis of ICT's and monitoring wells conducted by onsite GWTP contractor for COCs. Include new COCs in subsequent investigations as necessary.

Protectiveness Statement(s):

The Early Interim Remedial Action at Site 18/24 currently protects human health and the environment, because exposure pathways that could result in unacceptable risks are being controlled. The removal action and operation of the ICT's are protective of the environment and human health by greatly reducing the chance of contaminants migrating to deeper groundwater zones and/or leaving the site. As long as the ICT's remain in operation, this will remain true. As an Early Interim Remedial Action measure this was not intended to be a final solution.

Other Comments:

The RI for the site was completed between April 1993 and October 1998. The final RI report was published during April 2001. Risk assessments for human health and the environment are being prepared for the site. The FS for the site is scheduled to be complete in July 2002. The final ROD for the site will be prepared following the completion of the RI/FS.

Five-Year Review Summary Form (Landfill 16 Site 16 & Landfill 12 Site 12)

SITE IDENTIFICATION

Site Name (from WasteLAN): Longhorn Army Ammunition Plant

EPA ID (from WasteLAN): TX6213820529

Region: 6 **State:** TX **City/County:** Karnack, Harrison

SITE STATUS

NPL Status: Final Deleted Other (specify) _

Remediation Status (choose all that apply): Under Construction Operating Complete

Multiple OUs? YES NO **Construction Completion Date:** 2002 (anticipated)

Has Site been put into reuse? YES NO

REVIEW STATUS

Lead Agency: EPA State Tribe Other Federal Agency _

Author Name: William R. Corrigan

Author Title: Project Manager

Author Affiliation: Corps of Engineers
Contractor

Review Period: 09/01/2001 to 01/30/2002

Date(s) of Site Inspection: 10/16/2001 through 10/17/2001

Type of review: Statutory
 Policy (Post-SARA Pre-SARA NPL-Removal only
 Non-NPL Remedial Action Site NPL
 Regional Discretion)State/Tribe-lead

Review Number: 1 (first) 2 (second) 3 (third) Other (specify) __

Triggering Action:

Actual RA On-Site Construction at OU # Landfill 16 – Old Landfill & Landfill Sanitary – Site 12

Actual RA Start at OU #

Construction Completion

Previous Five-Year Review Report

Other (specify) _____

Triggering Action Date (from WasteLAN): 10/25/1996

Due Date (Five Years After Triggering Action Date) 10/25/2001

Five-Year Review Summary Form (continued)
Landfill 16 Site 16 &
Landfill 12 Site 12

Issues:

Site 12

1. Groundwater monitoring (chemical sampling and water levels) not conducted regularly.
2. Erosion on landfill near cap boundary.
3. Need O&M Plan for site.
4. Non-source soils not protected by cap.

Site 16

1. Groundwater monitoring (chemical sampling and water levels) not conducted regularly.
2. Need O&M Plan for Site.
3. Evaluate the hydrogeologic effectiveness of the groundwater extraction system.
4. Groundwater model in RI/FS should provide modeling of perchlorate and possibly other contaminants.
5. Steel covers off of housing at extraction wells.

Recommendations and Follow-up Actions:

Site 12

1. Conduct groundwater monitoring on a regular basis.
2. Repair erosion near cap boundary.
3. Write and implement an O&M Plan for Site.
4. Investigate and determine if action is necessary and include in final ROD.

Site 16

1. Conduct groundwater monitoring on a regular basis.
2. Write and implement an O&M Plan for Site.
3. Perform study to determine effectiveness of extraction system.
4. Perform study to determine impact of other contaminants on environment.
5. Place covers on housing or replace with lightweight covers more easily moved.

Five-Year Review Summary Form (continued)

Landfill 16 Site 16 &

Landfill 12 Site 12

Protectiveness Statement(s):

Site 12

The Early Interim Remedial Action at Site 12 currently protects human health and the environment because it is serving its intended purpose to reduce the potential for vertical infiltration of water through the landfill and to minimize contaminant transport. The assessment of the site found that the interim remedy was constructed in accordance with the requirements of the ROD for Sites 12 & 16.

As an Early Interim Remedial Action this was not intended to be final solution. The cap does not prevent infiltration of surface water through non-source area soil that contains contaminants.

Site 16

The Early Interim Remedial Action at Site 16 consisting of the landfill cap and the eight vertical extraction wells installed as a treatability study under the accelerated RI/FS is expected to protect human health and the environment because it is serving its intended purpose to reduce the potential for vertical infiltration of water through the landfill, and to minimize contaminant transport. For the landfill cap to continue to be effective in minimizing contaminant transport, the eight vertical extraction wells will continue to operate until a final remedy is addressed. For the remedy to be protective in the long-term, further remedial actions need to take place as determined by the Feasibility Study. As an Early Interim Remedial Action this was not intended to be final solution.

Other Comments:

Site 12

Groundwater moving through source material could still be a source of contamination from Site 12. The effectiveness of the cap needs to be further evaluated by monitoring seasonal variations in groundwater levels. A RI/FS is being prepared for the Site and a final ROD will determine subsequent remedial action if necessary. Risk assessments for human health and the environmental are being prepared for the site.

Site 16

The effectiveness of the cap and the extraction system needs to be evaluated. The Baseline Risk Assessment for Human Health states, "Based on the results of the Site 16 baseline risk assessment, it appears that groundwater is the primary medium of concern at the site."

1.0 INTRODUCTION

Complete Environmental Service (CES) under contract with the U.S. Army Corps of Engineers (USACE) has conducted the first five-year review of the Early Interim Remedial Actions implemented at the Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. This report documents the results of the review, conducted from August 2001 to January 2002.

The purpose of this five-year review is to evaluate whether the selected Early Interim Remedial Actions for the Burning Ground No. 3/Unlined Evaporation Pond (Sites 18 and 24) and two landfills (Sites 12 and 16) NPL sites have addressed the principal risk to human health and the environment. The principle risk at Sites 18 and 24 is addressed by preventing or reducing further migration of contaminants (high concentrations of chlorinated solvents & heavy metals in the shallow groundwater) into deeper groundwater zones and possibly surface water bodies. The principle risk at Sites 12 & 16 is addressed by reducing long-term vertical infiltration of water through the landfills and to minimize contaminant transport. Contained in this report are recommendations for addressing any deficiencies found during the review.

This review is required by statute. The statutory five-year review requirement was added to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as part of the Superfund Amendments and Reauthorization Act of 1986. The U.S. Army must implement five-year reviews consistent with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

CERCLA §121(c), as amended, states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the Site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The NCP, Part 300.430(f)(4)(ii) of Title 40 of the Code of Federal Regulations (CFR), states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

This is the first five-year review for any of the sites at LHAAP. The triggering date for this review was 25 October 1996, which was the date of Remedial Action (RA) onsite

construction for Site 12 & 16. The RA construction start date for Sites 18/24 is 12 February 1997. Cleanup criteria have not been achieved and the remedy is still in progress. Because hazardous substances, pollutants, or contaminants remain at the sites above levels that allow for unrestricted use and unlimited exposure, another five-year review is required.

The following sites at LHAAP are still actively being investigated under the Installation Restoration Program (IRP) as active Defense Sites Environmental Restoration Tracking System (DSERTS) sites.

Site No.	Description	Contaminants of Concern
LHAAP 12	Sanitary Landfill	Explosives, metals, VOC's, Chlorides
LHAAP 16	Old Landfill	Explosives, metals, VOC's, Perchlorate
LHAAP 18/24	Burning Ground 3	Explosives, metals, VOC's, Perchlorate, chlorides
LHAAP-17	No. 2 Flashing Area/Burning Ground	Explosives, VOC's
LHAAP-29	Former TNT Production Area	Explosives, VOC's, Perchlorate
LHAAP-32	Former TNT Wastewater Treatment Plant	Explosives, metals
LHAAP-35	Process Wastewater Sumps-Variou	Heavy metals, VOC's, Perchlorate
LHAAP-45	Magazine Area	Pentachlorophenol, metals, Perchlorate
LHAAP-50	Former Waste Disposal Facility	Heavy metals, chlorinated solvents
LHAAP-60	Former Storage Building 411 and 714	Pesticides
LHAAP-67	Above Ground Storage Tank	POC, Solvents

Sites 12, 16, and 18/24 are included in this five-year review. Sites 17, 27, 29, 32, 35, 45, 50, 60, and 67 are currently in the Phase III RI/FS stage to address contaminants of concern.

2.0 SITE CHRONOLOGY

Table: 2.0-1 Chronology of Site Events for Sites 18 & 24

Event	Date
Burning Ground 3 (BG#) begins operation for disposal of PEP wastes.	1955
Unlined Evaporation Pond (UEP) constructed for disposal of manufacturing plant wastewater.	1963
United States Army Environmental Hygiene Agency (USAEHA) Water Quality Special Study first identifies contamination at the UEP (Site 24) in BG3 (Site 18)	August 2 -10, 1976
Land Disposal Study No. 38-26-0104-81, LHAAP. USAEHA installs thirteen monitor wells and finds groundwater contamination at UEP (Site 24) in Burning Ground No. 3 (Site 18)	January 23 - February 8, 1980
Environmental Protection Systems (EPS) installs nine monitor wells and samples twenty-two monitor wells	1982
Hazardous Waste Management Special Study No. 39-26-147-83, US Army Material Command Development and Readiness Command (DARCOM) Open Burning/Open Detonation Grounds Evaluation.	September 1, 1983
Waste disposal terminated at UEP.	June 1, 1984
Burning Ground 3/Washout Ponds & Former Unlined Evaporation Pond, Waste Removal and Capping of UEP under the Resource Conservation Recovery Act (RCRA). Quarterly groundwater monitoring was initiated and has continued to the present on a semi-annual basis.	1986
EPS collects groundwater samples from three wells	1987
Closure Report for UEP	June 1, 1986
Installation RCRA Facility Assessment reviewed all sites at LHAAP and assigns numbers to identify them.	April 8, 1988
Compliance groundwater monitoring wells installed by USACE at LHAAP 18 & 24 as a RCRA Facility Investigation.	1989
LHAAP Placed on National Priorities List (NPL)	August 29, 1990
LHAAP, Texas Water Commission, now Texas Natural Resource Conservation Commission (TNRCC), and EPA enter into a Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) Section 120 Agreement for remedial activities at LHAAP, referred to as the Federal Facility Agreement (FFA).	December 30, 1991
RCRA Part B Permit signed. As a result of the RCRA Facility Assessment, 57 potential Sites of concern were identified on LHAAP. Since that time, removal of the non- Defense Environmental Restoration Act (DERA) eligible Sites has resulted in the current DSERTS list of 47 sites.	February 7, 1992
Interim Remedial Action Design Initiated for LHAAP 18 & 24.	1994
Interim Risk Assessment for Burning Ground 3 and UEP Sites 18 & 24.	January 18, 1994

Final ROD for Early Interim Remedial Action at BG3, Sites 18 & 24.	May 12, 1995
Phase II Field Investigation by Sverdrup installed eighteen additional monitoring wells and collected soil, sediment, groundwater, and surface water samples.	1995
Start of construction on ICT's, GWTP, and associated systems for groundwater pump and treat.	March 1995
Final Work Plan for Phase III Interim Remedial Action at Burning Ground 3.	January 3, 1996
Remedial Action Construction start date.	October 25, 1996
GWTP approved for operation. Approximately 5,000 linear feet of interception collection trench installed to control migration of contaminated groundwater.	January 1997
Start date for the excavation of 37,840 cubic yards of soil and treatment by low temperature thermal desorber unit.	Feb. 12, 1997
Proof of Performance Test Conducted for Soil Treatment Plant	February 13-15, 1997
Proof of Performance Test Conducted at GWTP	March 24, 1998
Phase III Field Investigation by Sverdrup collected groundwater, sediment, and surface water samples	1998
Removal of burning cages at Burning Ground No. 3.	1998
RCRA Closure of burning cages No. 4, 5, 7, & 8 as listed in the LHAAP RCRA permit.	October 2, 1998
RCRA Closure of burning cages No. 6 as listed in the LHAAP RCRA permit.	October 2, 1998
Perchlorate discovered in groundwater at Site 18.	April 1999
Remedial Action construction completion date.	August 31, 1999
RCRA Closure of 90-Day Container Storage Areas 41-X and 24-X. Listed as Notice of Registration numbers NOR013 and NOR014.	August 21, 2000
RCRA Closure of 90-Day Container Storage Area 43-X. Listed as Notice of Registration number NOR015.	November 21, 2000
RCRA Closure of 90-Day Container Storage Area 21-X. Listed as Notice of Registration number NOR016.	January 25, 2001
Second Quarter Data Summary for Perchlorate Investigation.	March 2001
Fluidized Bed Reactor (FBR) for treatment of perchlorate in water goes online at GWTP.	April 2001
Final Remedial Investigation Report for Sites 18 & 24, LHAAP	April 2001

Table: 2.0-2 Chronology of Site Events for Site 12

Event	Date
First use of landfill	1963
Land Disposal Study No. 38-26-0104-81, LHAAP. USAEHA installs and samples four monitor wells at Active Landfill (Site 12).	1980
Environmental Protection Systems (EPS) installs two monitor wells and samples all six wells.	1982
Installation RCRA Facility Assessment reviewed all sites at LHAAP and assigns numbers to identify them.	April 8, 1988
LHAAP Placed on National Priorities List (NPL)	August 29, 1990
LHAAP, Texas Water Commission (now TNRCC), and EPA enter into a Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) Section 120 Agreement for remedial activities at LHAAP, referred to as the Federal Facility Agreement (FFA).	December 30, 1991
Phase I Field Investigation by Sverdrup installed seven additional monitoring wells and collected soil, sediment, groundwater, and surface water samples.	1993
Use of landfill stopped by Thiokol, operator of LHAAP. All trenches covered and compacted.	March 1994
Phase II Field Investigation by Sverdrup installed five additional monitoring wells and collected soil, sediment, groundwater, and surface water samples.	1995
Final Report-LHAAP Installation Restoration Program, Sites 12 And 16 Interim Remedial Action Focused Feasibility Study, recommends cap design for Sites 12 and 16.	March 1995
Final ROD for Early Interim Remedial Action at Landfill Sites 12 & 16.	September 1995
Remedial Action Construction start date.	October 25, 1996
2,000 cubic yards of treated soil placed in landfill.	1997
Early Interim Remedial Action Completed (Landfill Cap Construction Completed)	October 1997
Landfill Cap Long-term Maintenance started.	1998
Phase III Field Investigation by Sverdrup installed seven monitoring wells and collected soil, sediment, groundwater, and surface water samples.	1998
Final Construction Completion Report, Interim Remedial Action, Landfills 12 and 16 Cap Construction, LHAAP	December 1998
Remedial Action Construction completion date.	August 31, 1999
Final Remedial Investigation Report for Site 12, LHAAP	April 2001
Second Quarter Data Summary for Perchlorate Investigation.	March 2001

Table: 2.0-3 Chronology of Site Events for Site 16

Event	Date
First use of landfill	1942
U.S. Army Environmental Hygiene Agency (USAEHA) Air and Water Pollution Survey Investigates Old Landfill (Site 16) Five monitoring wells installed. (BH 12-16)	April 20, 1978
Land Disposal Study No. 38-26-0104-81, LHAAP. USAEHA installs and samples three monitor wells at Old Landfill (Site 16).	1980
Environmental Protection Systems (EPS) installs one monitor well (MW-122) and samples collects groundwater and soil samples.	1982
EPS sampled groundwater, surface soil, and sampled twenty soil borings on the landfill.	1987
Installation RCRA Facility Assessment reviewed all Sites at LHAAP and assigns numbers to identify them.	April 8, 1988
LHAAP Placed on National Priorities List (NPL).	August 29, 1990
LHAAP, Texas Water Commission (now TNRCC), and EPA enter into a CERCLA Section 120 Agreement for remedial activities at LHAAP, referred to as the Federal Facility Agreement (FFA).	December 30, 1991
Phase I Field Investigation by Sverdrup installed eleven monitor wells, seven soil borings, and collected groundwater, surface water, and sediment samples.	1993
Phase II Field Investigation by Sverdrup installed seven monitor wells, drilled ten soil borings, and collected twenty-one Geoprobe samples. Groundwater, surface water, and sediment samples were also collected.	1995
USACE begins quarterly sampling of seep near toe of landfill.	1995
Final Report-LHAAP Installation Restoration Program, Sites 12 And 16 Interim Remedial Action Focused Feasibility Study, recommends cap design for Sites 12 & 16.	March 1995
Final ROD for Early Interim Remedial Action at Landfill Sites 12 & 16.	September 1995
USACE conducts a post Phase II investigation collecting surface water and installing two extraction wells and twelve piezometers.	August 1995
Final Project Work Plans for Interim Remedial Action Landfill 12 & 16 Caps complete.	June 10, 1996
Two pilot extraction wells and twelve piezometers installed by Sverdrup as part of Groundwater Treatability Study.	February 1996
Remedial Action Construction start date.	October 25, 1996
Phase III investigation by Sverdrup to install eight piezometers and twenty monitoring wells. Six extraction wells were installed under the Accelerated Remedial Investigation to contain contamination seeping from groundwater into Harrison Bayou. Water piped to GWTP. Groundwater, soil, surface water, and sediment samples collected.	June 1997
35,840 cubic yards of treated soil from Site 18/24 RA placed in landfill.	1997
Phase III investigation by Sverdrup continues to collect geoprobe samples and groundwater samples.	1998
USACE collects 10 SCAPS probe holes in landfill.	1998
Early Interim Remedial Action Completed (Landfill Cap Construction Completed)	October 1998
Landfill Cap Long-term Maintenance begins.	1998
Final Sampling and Data Results Report, Site 16 Phase III RI/FS and Groundwater Treatability Study, LHAAP.	December 1998
Final, Construction Completion Report, Interim Remedial Action, Landfills 12 and 16 Cap Construction, LHAAP.	December 1998
Remedial Action Construction completion date.	August 31, 1999
Site 16 Landfill Draft Remedial Investigation Report	August 1999
Second Quarter Data Summary for Perchlorate Investigation.	March 2001
Draft Final Feasibility Study for Site 16	December 2001

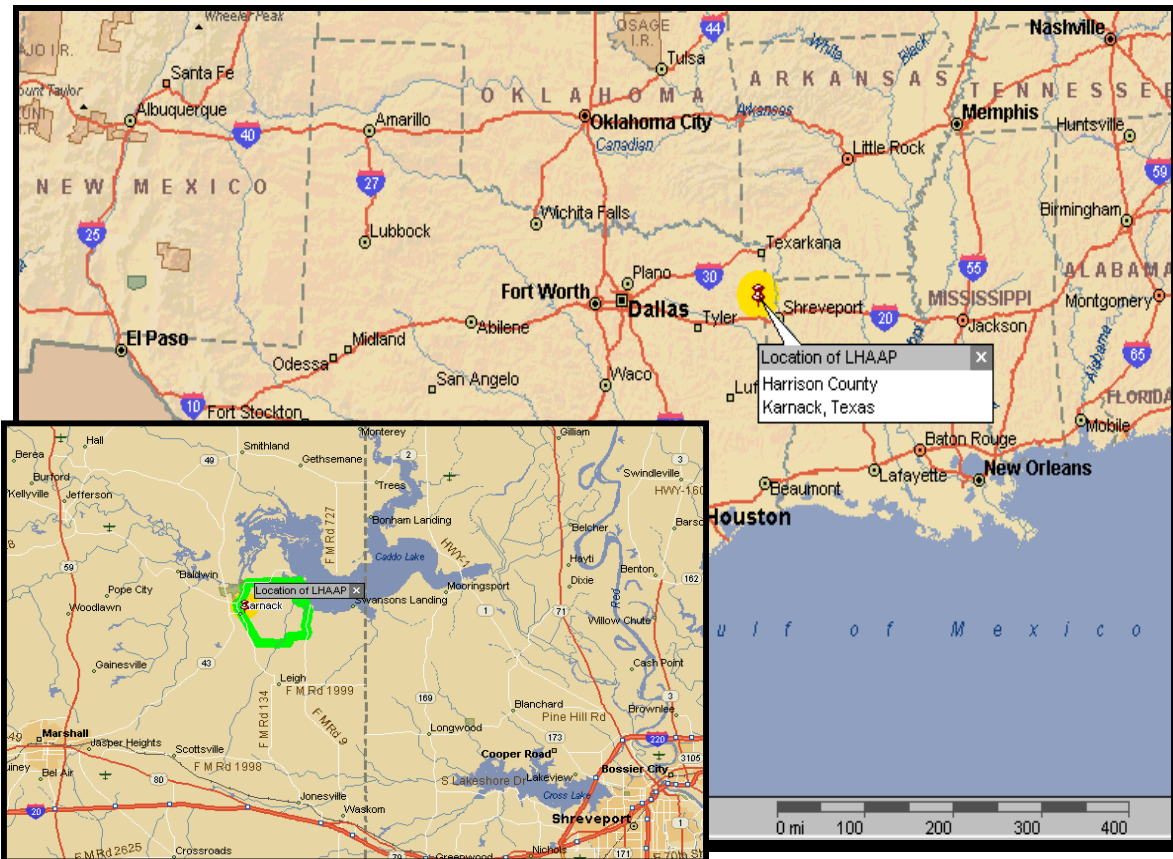
3.0 BACKGROUND

3.1 Physical Characteristics

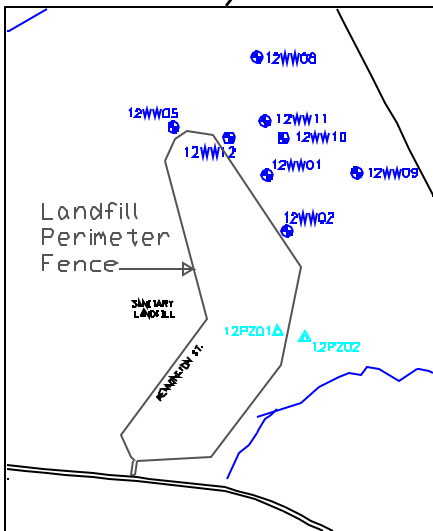
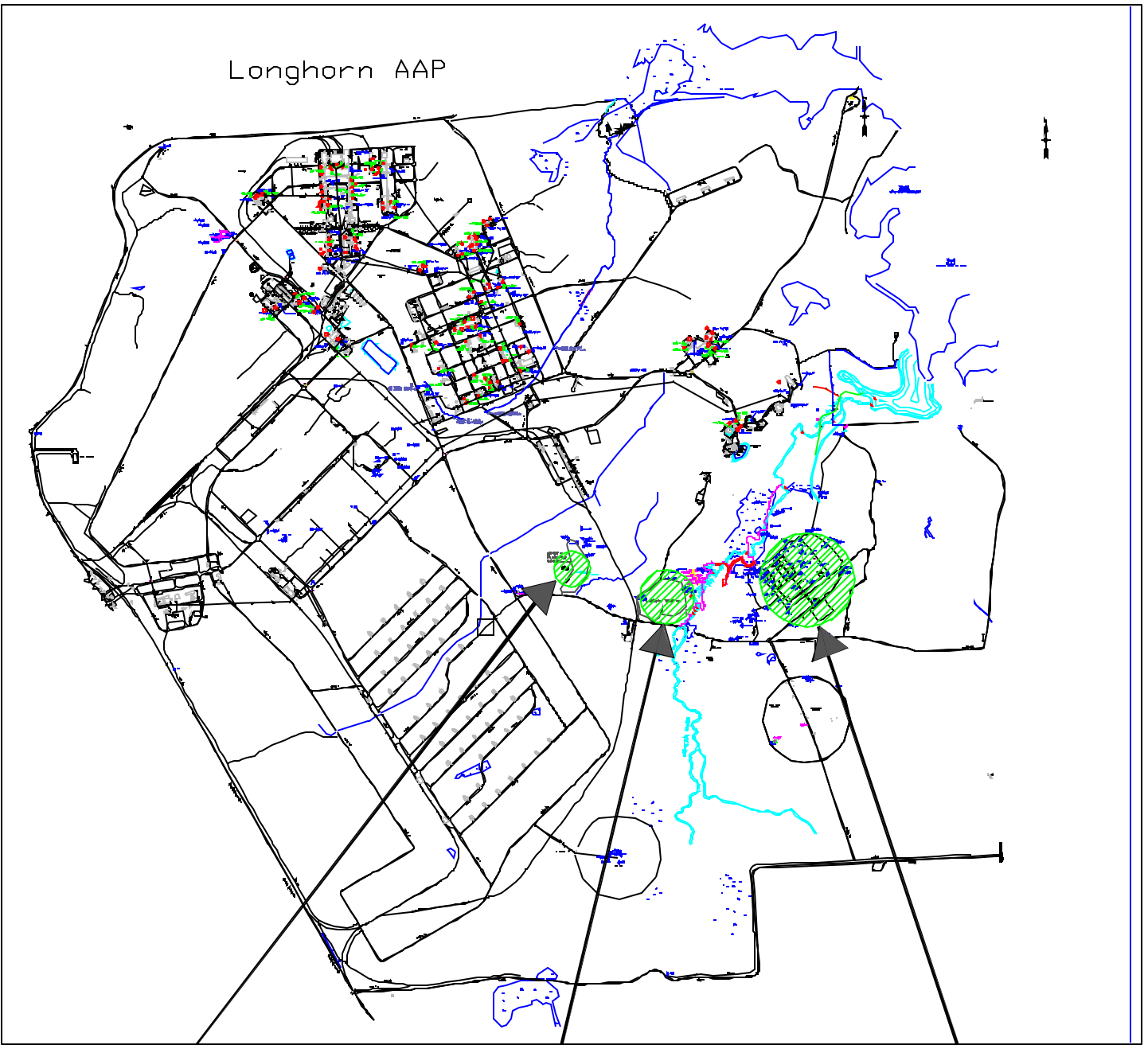
Longhorn Army Ammunition Plant (LHAAP) is located in the northeast corner of Harrison County, Texas, approximately 3.6 miles from the Louisiana border as shown in Figure 3.1-1. Harrison County is located in the northeast corner of Texas. Caddo Lake, Caddo Lake State Park, and the small town of Karnack border LHAAP.

LHAAP is located approximately 30 miles west of Shreveport, Louisiana, with the nearest major city being Marshall, Texas, 15 miles to the southwest. The installation has a total area of approximately 8,493 acres. State Highways 43 and 134 access the installation.

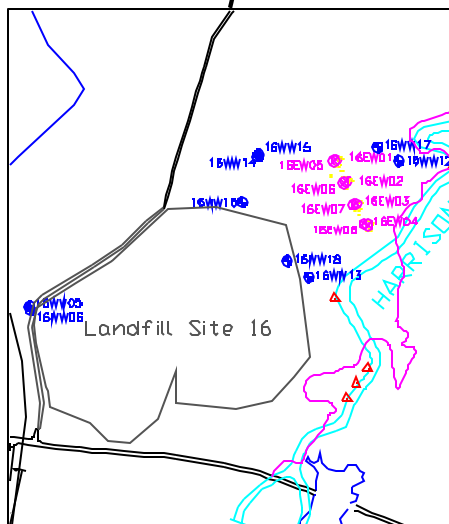
Figure: 3.1-1 Location of LHAAP in Texas



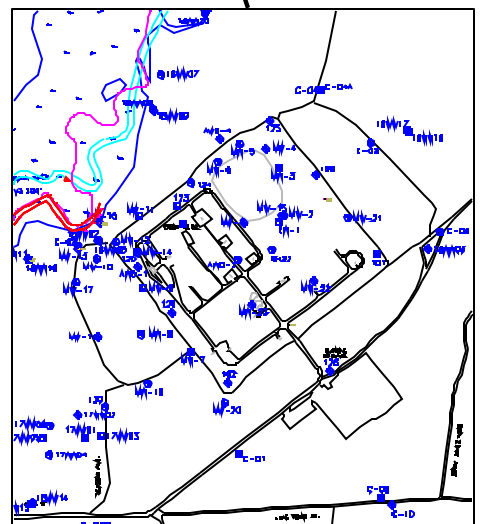
Longhorn AAP



Site 12



Site 16



Site 18/24

All four Sites considered in this five-year review are located in a remote area in the southeastern portion of LHAAP as indicated in Figure 3.1-2. The Old Landfill (Site 16) encompasses approximately 16 acres in the south-central portion of LHAAP. Harrison Bayou borders Site 16 along the east and southeast edge. Along the southeastern edge of the landfill is the 100-year floodplain. Burning Ground No. 3 (Sites 18 and 24) is east of Site 16 and on the east side of Harrison Bayou and a portion of this site is along the 100-year flood plain. Site 12 is west of the Old Landfill and on higher ground. Site 12 encompasses approximately seven acres of grass and is surrounded by timber.

3.2 Geology of LHAAP

LHAAP, including Sites 18, 24, 12, & 16, is situated on an out crop of the Wilcox Group, which crops out over a large part of the eastern half of Harrison County. The Wilcox consists mostly of fine- to medium-grained sands interbedded with a considerable amount of clay and seams of lignite. The Wilcox Group is underlain conformably by the predominantly calcareous clay of the Midway Group. Regional dip of the Wilcox is to the northwest into the East Texas Syncline, while the ground surface generally dips to the southeast.

The Wilcox Group has been identified by the Texas Water Development Board as the basal unit of the Cypress aquifer, also known as the Carrizo-Wilcox aquifer. The Cypress aquifer outcrops over most of Harrison County and is comprised of, in ascending order, the Wilcox Group, the Carrizo Sand, the Reklaw Formation, and the Queen City Sand. All units are believed to be hydraulically connected. All of these units dip to the northwest into the East Texas Syncline.

The availability of groundwater in Harrison County is largely dependant on the hydrologic characteristics of the units comprising the Cypress aquifer. The Wilcox Group, outcropping in the area of LHAAP yields small (less than 50 gallons per minute) (gpm) to moderate (50-500 gpm) quantities of fresh water to wells throughout the county. As a basal unit of the Cypress aquifer, the Wilcox is also considered as the base of fresh water in the area. The Midway Group, which does not yield usable quantities of water, tends to serve as a relatively impermeable basement of the overlying water-bearing Wilcox. The top of the Midway Group has been encountered 75 to 190 feet below the ground surface under Burning Ground No. 3 (Sites 18 and 24). It is 141 feet below ground surface at Landfill 12 (Site 12). It is 225 to 307 feet below ground surface at the Old Landfill (Site 16).

LHAAP Site 12 landfill is located on the outcrop of the Wilcox. Sites 16 landfill and 18 & 24 are along Harrison Bayou, which has recent alluvium in its floodplain. The 100-year floodplain elevation of 180 feet mean sea level (msl) marks the contact between the Wilcox and recent alluvium on the surface. Borings drilled at all three Sites have shown that correlation is difficult due to the lateral and vertical heterogeneity of the materials

comprising the Wilcox Group. Subsurface data from soil borings and monitor wells drilled and constructed as part of past investigations show very few strata to be continuous across the Sites.

Groundwater at all three Sites generally occurs under unconfined conditions and the elevation fluctuates with seasonal variations in rainfall. The groundwater is encountered at depths of 20-25 feet beneath the surface at LHAAP 12 landfill and flows to the east and northeast. The groundwater is encountered at depths of 5-10 feet beneath the surface of the LHAAP 16 landfill and flows generally to the east and southeast. The groundwater is encountered at depths of 5 to 20 feet beneath the surface of the LHAAP 18 & 24 burning ground and flows generally to the northeast. Maps showing typical groundwater elevations for the Sites are in Appendix F (Site 12) and Appendix G (Site 16).

3.3 Land and Resource Use

Before LHAAP was constructed in 1940, the area was rural farms and forests. For the past 60 years the land surrounding the Sites has been part of the plant. The Landfills (Sites 12 and 16) and the Burning Ground No. 3 are no longer in use by LHAAP. Ammunition plants have maintained buffer areas for safety in case of explosions. Much of LHAAP is forest and the disposal sites are located within the plant. The nearest boundary of LHAAP to any of the sites is 3000 feet east of Burning Ground No. 3 (Site 18). Future use of the land is going to be limited. Clean areas may be turned over to the U. S. Fish and Wildlife Service for use as a wildlife refuge. The U.S. Army will hold contaminated areas as long as necessary. Caddo Lake and its tributaries are considered sensitive environmental areas. Harrison Bayou, which runs between Sites 16, and 18/24, is a tributary to Caddo Lake. Caddo Lake is a water supply for several nearby communities.

3.4 History of contamination

3.4.1 Burning Ground No. 3 LHAAP Site 18/24

Burning Ground No. 3 was in operation from 1955 to 1997 and historical waste management units included open burn pits, an Unlined Evaporation Pond (UEP), stockpiles of solvent-soaked sawdust, and suspected waste burial pits. The UEP was constructed at the burning ground in 1963 as a holding pond to store flammable, volatile, and pyrotechnic wastes resulting from the washout of rocket motor casings. In 1973, the pond also began receiving wash water containing solvent residues and solids collected from operations involving pyrotechnic material preparation and mixing commonly containing the metallic cations aluminum, arsenic, barium, cadmium, chromium, iron, lead, magnesium, sodium, strontium, and zinc; nonmetallic anions including nitrite, nitrate, perchlorate, and phosphate, and; various organic solvents such as acetone, 1,1,1-trichloroethane, trichloroethene, ethyl alcohol, methyl ethyl ketone, methylene chloride, and toluene. An Air Curtain Destructor (ACD) was built in 1979 for the purpose of disposing of explosive-contaminated wastes by burning.

Use of burn pits and trenches was reportedly discontinued in 1984 and subsequent burning took place in aboveground pans or burning cages. A RCRA Interim Status Hazardous Waste Permit for the thermal treatment of Pyrotechnics, Explosives, and Propellant (PEP) wastes at Burning Ground No. 3 was issued to LHAAP on 7 February 1992.

In 1976 the U.S. Army Environmental Hygiene Agency (USAEHA) first identified a suspected release of contaminants from the site. The use of the UEP was discontinued in 1984 when it was discovered that the pond was contaminating groundwater beneath the Site. The UEP was closed as a RCRA interim status surface impoundment in 1986 by removing all wastewater and sludge and capping the impoundment. Use of the burning ground was discontinued in 1997. Final closure of the burning cages was completed in 1999.

3.4.2 LHAAP Site 12

Landfill 12, previously called the “Sanitary Landfill”, was used for disposal of non-hazardous industrial waste including cafeteria waste, non-hazardous chemical waste, oil/diesel soaked dirt, transite siding, and asbestos. The landfill was used intermittently since 1963. Continuous use of the landfill began in approximately 1978. As early as 1980 an USAEHA Land disposal study recommended changes in disposal practices due to leachate escaping from the landfill. The last used portion of the landfill was closed in March 1994.

3.4.3 LHAAP Site 16

The Old Landfill (Site 16) was originally used from 1942 to 1944 for the disposal of TNT red water ash. The central section of the site was reportedly used as an all-purpose junkyard for disposal of such materials as substandard TNT, barrels of chemicals, oil, paint, scrap iron, and wood. In the mid to late 1950's, rocket motor casings were reportedly burned and possibly buried at the site. Burn pits, waste storage, and landfill operations continued as waste disposal and treatment activities until sometime in the 1980's. As early as 1980 an USAEHA Land disposal study recommended changes in disposal practices due to leachate escaping from the landfill. Leachate escaping from Landfill 16 is of particular interest due to the proximity of the landfill to Harrison Bayou, a surface water stream that feeds Caddo Lake.

3.5 Initial response (removal)

3.5.1 LHAAP Site 18/24

Industrial wastes ceased going to the UEP in June of 1984. The UEP was closed in 1986 under RCRA. Approximately two million gallons of water were pumped out of the UEP and disposed offsite at a RCRA permitted hazardous waste injection well. Approximately 7,850 cubic yards of sludge were removed, mixed with concrete for

stabilization and disposed at a RCRA permitted hazardous waste landfill offsite. The pond was backfilled with clean fill and capped.

In 1990 LHAAP was placed on the NPL as a “fence to fence” Site, and in 1991 the U.S. Army, EPA, and State Regulatory Agency, then known as the Texas Water Commission entered into a Federal Facility Agreement (FFA). The Burning Ground and UEP were included in the FFA as solid waste management units.

Due to the proximity of Site 18/24 to Harrison Bayou and high concentrations of chlorinated solvents, further action to control the spread of contamination was required. A ROD was subsequently finalized in 1995 to remove and thermally treat source material. The ROD also required for groundwater to be pumped and treated in an onsite Groundwater Treatment Plant (GWTP).

LHAAP ceased to be an active production facility in 1995. Subsequently, the use of the Burning Ground was ceased in 1997 with the final open burning of all waste PEP. Radian International removed the burning cage structures in 1998 and subsequent RCRA closure of the units took place between 1998 and 2001.

The RA construction start date at Site 18/24 was 12 February 1997. The project was to remove and treat contaminated soil, install a series of interceptor collection trenches & extraction wells, and build a groundwater treatment plant for treatment of the groundwater extracted from the site. Approximately 30,000 yd³ of contaminated soil was thermally treated onsite in low temperature thermal desorbers. The GWTP was constructed and placed online in 1997 for the treatment of groundwater.

To date there have been approximately 60 million gallons of groundwater treated to remove metals and volatiles, and subsequently released from the GWTP to Harrison Bayou. Due to concerns over perchlorate contamination at the site, a Fluidized Bed Reactor (FBR) was placed online at the GWTP in April 2001. The FBR is a biological treatment process that removes perchlorate from the water. From April 2001 through January 2002 the FBR has treated approximately 11 million gallons of water.

3.5.2 LHAAP Site 12

Monitor wells were first installed at the site in 1980. In 1990, LHAAP was placed on the NPL, and in 1991 the U.S. Army, EPA, and Texas Water Commission entered into a FFA designating LHAAP as a “fence to fence” site. The landfill Site 12 was included in the FFA as a solid waste management unit.

Industrial waste stopped going to Landfill 12 in March 1994. Any open trenches were covered with soil and compacted.

In 1995 an Interim Remedial Action Feasibility Study recommended that a cap be designed for the landfill and constructed to control surface water migration into and

12

through the landfill. A ROD was finalized in September 1995 directing the capping of the landfill. Construction began to place a cap on the landfill in 1996. Some of the treated material from Site 18/24 was placed on the landfill prior to the construction of the cap. The cap was completed in 1997 and the Site was fenced with barbed wire and warning signs were placed around the landfill.

Long-term maintenance of the cap began in 1998. A Final Remedial Investigation Study was completed in April of 2001. The RI/FS Report will include a groundwater to surface water interface model.

3.5.3 LHAAP Site 16

In 1976 the USAEHA identified a suspected release of contaminants from the site. As a result of the USAEHA Air and Water Pollution Survey, monitor wells were first installed at the site in 1980. In the 1980's, Landfill 16 ceased to be utilized for waste disposal.

In 1990 LHAAP was placed on the NPL, and in 1991 the U.S. Army, EPA, and Texas Water Commission entered into a FFA designating LHAAP as a "fence to fence" site. The landfill Site 16 was included in the FFA as a solid waste management unit.

In 1995 an Interim Remedial Action Feasibility Study recommended that a cap be designed for the landfill and constructed to control surface water migration into and through the landfill. A ROD was finalized in September 1995 directing the capping of the landfill. Construction began to place a cap on the landfill in 1996. Some of the treated material from Site 18/24 was placed on the landfill prior to the construction of the cap. The cap was completed in 1997 and the site was fenced with barbed wire and warning signs were placed around the landfill.

As a treatability study under an accelerated RI/FS to keep landfill leachate from entering Harrison Bayou, two vertical extraction wells were installed in 1996, and an additional six vertical extraction wells were installed in 1997. Groundwater extracted from these wells is pumped to the GWTP and treated for release. These extraction wells have produced an estimated 4.5 million gallons of groundwater for treatment at the GWTP.

Long-term maintenance of the cap began in 1998. As a part of the RI/FS, a Baseline Risk Assessment for Human Health was completed during June 2001 and an Ecological Risk Assessment was completed during October 2001. The RI/FS will include a groundwater to surface water interface model. With current information, a Monitored Natural Attenuation Study is planned to begin at the site in 2002.

3.6 Basis for Taking Action

3.6.1 Site 18/24 Constituents of Concern

The chemicals of concern presented for Sites 18/24 are based on the Final Remedial Investigation. The results of the RI are documented in the Final Remedial Investigation Report Volume 1, April 2001.

As documented by the RI, the following chemicals of concern have exceeded the TNRCC soil and groundwater Protective Concentration Level (PCL) and LHAAP background values. When PCL's were not available, EPA Region 6 Human Health Medium-Specific Screening Levels were utilized. The hazardous substances that have been released at the site in each media are included in Table 3.6.1-1.

Table 3.6.1-1: Site 18/24 Constituents of Concern Based on Remedial Investigation

<u>Soil</u>	<u>Surface water</u>	<u>Sediment</u>	<u>Groundwater</u>
Methylene-chloride	Arsenic	Trichloroethene	Trichloroethene
Barium	Copper	1,2-Dichloroethane	Methylene chloride
Cadmium	Lead	cis-1,2-Dichloroethylene	cis-1,2-Dichloroethylene
Lead		Barium	Antimony
Mercury		Lead	Barium
		Selenium	Chromium
		Perchlorate	Iron
			Nickel
			Silver
			Thallium
			Chloride
			Nitrate+Nitrite
			Perchlorate

In addition to the constituents listed in the Remedial Investigation Report, Volume I, the chemicals in Table 3.6.1-2 have been regularly detected in groundwater sampled from ICT's and monitoring wells. The table illustrates the COCs that exceeded the TNRCC MSC's groundwater and soil protection standards for residential use effective September 23, 1999. The table compares only the groundwater samples collected from the ICT's and monitoring wells during the November 2001 sampling event.

Table 3.6.1-2: Site 18/24 Constituents of Concern Based on Semi-Annual Monitoring Events

<u>Groundwater</u>	<u>Constituent Exceeds Groundwater Protection Standard for Residential Use</u>	
	<u>ICT's</u>	<u>Monitoring Wells</u>
Benzene	Yes	Yes
Carbon Tetrachloride	Yes	Yes
Chloroform	Yes	Yes
1,1-Dichloroethane	No	No
1,2-Dichloroethane	Yes	Yes
1,1-Dichloroethene	Yes	Yes
Ethylbenzene	Yes	No
Methylene Chloride	Yes	Yes
Tetrachloroethene	Yes	Yes
Toluene	No	No
1,1,1-Trichloroethane	No	No
1,1,2-Trichloroethene	Yes	Not Analyzed
Trichloroethene	Yes	Yes
Vinyl Chloride	Yes	Yes
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	Yes	Not Analyzed
Perchlorate	Yes	Yes

3.6.1.1 Human Health and Ecological Risk Assessment

A Risk Assessment for human and ecological risks is currently being performed as part of the RI/FS. When the risk assessment is available the contaminants of concern may change.

3.6.2 Site 12 Constituents of Concern

The chemicals of concern presented for Site 12 are based on the Remedial Investigation Report Volume 1, April 2001. The hazardous substances that have been detected at the site in each media are included in Table 3.6.2-1. The COCs have exceeded the TNRCC soil and groundwater PCL and LHAAP background values.

3.6.2.1 Human Health and Ecological Risk Assessment

A Risk Assessment for human and ecological risks is currently being performed as part of the RI/FS. When the risk assessment is available the contaminants of concern may change.

Table 3.6.2-1: Site 12 Constituents of Concern Based on Remedial Investigation

Soil	Surface water	Sediment	Groundwater
Methylene chloride Arsenic Barium Lead Silver	Copper Zinc	Barium Cadmium Lead	Trichloroethene 1,2-Dichloroethene Bis(2-ethylhexyl)phthalate Antimony Cadmium Chromium Iron Lead Nickel Chloride Sulfate

3.6.3 Site 16 Constituents of Concern

The COC presented for Site 16 in Table 3.6.3-1 are based on the Remedial Investigation Report Volume 1, August 1999.

Table 3.6.3-1: Site 16 Constituents of Concern Based on Remedial Investigation

Soil	Surface water	Sediment	Groundwater
Trichloroethene Vinyl chloride	Copper Lead Zinc	None	1,1,2-Trichloroethane 1,1-Dichloroethene 1,2-Dichloroethane 1,2-Dichloroethene cis-1,2-Dichloroethylene trans-1,2-Dichloroethene Methylene chloride Trichloroethene Vinyl chloride Bis(2-ethylhexyl)phthalate) Barium Beryllium Chromium Iron Lead Manganese Nickel Silver Thallium Zinc Perchlorate

The chemical concentration levels are based on Medium Specific Concentrations (MSC) from TNRCC Risk Reduction No. 2 (August 1998) and the Texas Water Quality Standards (TWQS). See Section 4.1 of RI for Site 16 (Sverdrup, August 1999).

3.6.3.1 Human Health Baseline Risk Assessment

In accordance with the Baseline Risk Assessment: Human Health Evaluation for Site 16, June 2001, it was determined that human health risks at Site 16 are mainly driven by exposure to groundwater and less significantly, soil.

Soil health risks at the site are associated mainly with arsenic. Concentrations of arsenic are above the Reasonable Maximum Exposure (RME) limit in subsurface soils, surficial soils, Harrison Bayou surface water, sediment, and fish ingestion. However, there is some question about the concentration of acceptable background levels of arsenic. In the study, arsenic concentrations above the RME in soil are thought to be a result of background concentrations.

Groundwater risk estimates place the carcinogenic risk estimate above EPA acceptable thresholds. The groundwater carcinogenic risk estimates were largely driven by cis-1,2-dichloroethylene, trichloroethene, and vinyl chloride. The groundwater noncarcinogenic risk estimates were well above the EPA acceptable risk threshold and were driven by cis-1,2-dichloroethylene and trichloroethene.

Further information can be found in the Baseline Risk Assessment: Human Health Evaluation Volume 1 report.

3.6.3.2 Ecological Risk Assessment

In accordance with the Ecological Risk Assessment for Site 16, constituents of potential concern were identified for further evaluation. It was recommended in the document that the screening process continue in accordance with the Superfund Ecological Risk Assessment Process. The screening process will be completed in a site-wide baseline ERA.

4.0 REMEDIAL ACTIONS

The following sections discuss the remedies selected, remedy implementation, and system operations.

4.1 Remedy Selection

4.1.1 Site 18/24

The ROD for Site 18/24 addressed both groundwater contamination and soil contamination. The selected remedy for addressing the site contaminants and meeting the remedial objectives of the Early Interim Remedial Action is a combination of groundwater extraction and treatment and soil removal and treatment. The EPA signed the ROD on May 12, 1995.

The Remedial Action Objectives (RAO) of the ROD were to mitigate potential risks posed by high concentrations of chlorinated solvents and heavy metals in the shallow groundwater and buried source material at the site. The selected remedy addresses the principal risk at the site by reducing or preventing further migration of contaminants into deeper groundwater zones and possibly surface water bodies. The major components of the selected remedy include:

- Extraction of shallow groundwater and treatment using metal precipitation, air-stripping, and off-gas treatment for VOC's, and
- Excavation of source material and treatment using low temperature thermal desorption and off-gas treatment for VOC's.

The Remedial Actions at the site associated with the contaminated soils and source materials excavation, treatment, and disposal required by the ROD consisted of the following:

- Construction of a Soil Handling and Dewatering Pad for ICT excavated soils and contaminated soils and source material.
- Construction of a storage pad for treated soils and source material.
- Mobilization, setup, and performance testing of a Low Temperature Thermal Desorption (LTTD) soil treatment system.
- Excavation and treatment of source material.
- Perimeter monitoring of site during source material excavation.
- Disposal/placement of treated soils and source material.
- Drilling of 20 soil borings to investigate the potential presence of other source material.
- Restoration of the site by importing clean fill material and backfilling source material excavations, and restoration of utility lines.

The Remedial Actions at the Site associated with the groundwater extraction and treatment system consisted of the following:

- Construction of a total of 5,000 feet of ICT Sections.
- Installation of a piping network to collect the extracted water and convey it to the GWTP.
- Construction of the GWTP to treat the extracted groundwater.
- Installation of a piping system to convey the treated water to Harrison Bayou.
- Startup of the GWTP and completion of proof of performance testing.
- Operation and maintenance of the GWTP.
- Evaluation of the hydraulic effectiveness of the treatment system.

In addition to the requirements in the ROD, an Agreed Order issued by the State required remedial activities and submittals in relation to Site 18/24. LHAAP was issued the Agreed Order by the TNRCC on December 4, 1995 for ongoing RCRA violations. Items required by the Agreed Order in relation to the CERCLA work at Site 18/24 are listed in Table 4.1.1-1. Only the items that require ongoing submittals are listed. Items that were answered to the satisfaction of the State are not listed. It was agreed with the State that the requirements of RCRA would be addressed under CERCLA activities as an ARAR.

Table 4.1.1-1: LHAAP Agreed Order Items related to CERCLA Site 18/24

Agreed Order Item	Requirement	Submittal	Submittal Date
Number 7	Revise Groundwater Sampling & Analysis Plan	LHAAP Groundwater Sampling and Analysis Plan (CERCLA RI/FS Workplan – Amended as additional work is performed.)	Ongoing
Number 8	Maintain all Documents, Records and Reports	Documents submitted and maintained per FFA	Ongoing
Number 9	Submit copies of final FFA primary documents and work plans to TNRCC Region V office and TNRCC Project Manager	Documents submitted and maintained per FFA	Ongoing
Number 12	Annual Report Summarizing previous year’s remedial activities and schedule for future activities	Annual Report (Requirement met with Installation Action Plan)	Ongoing
Number 15(2)	Complete construction or abandonment of monitoring wells in accordance with State rules	As Required	Ongoing

Number 16	Construct monitoring wells in accordance with State Rules or receive approval from State	As Required	Ongoing
Number 17	Submit an Annual Groundwater Monitoring and Remediation Report Summary	Annual Report (Requirement met per monthly, quarterly, and annual GWTP Reports)	Ongoing
Number 18	Corrective Action Measures to remediate existing contamination in the UEP and Burning Ground areas	As Required	Ongoing
Number 20	Provide survey information of UEP	Letter with Survey Information	May 20, 1996

In addition to the ROD and the Agreed Order issued by the State, several non-CERCLA removal activities have taken place at the site. Each RCRA permitted unit and 90-day permit exempt RCRA unit at the site has undergone a RCRA closure in accordance with closure plans approved by the TNRCC.

There were five burning cages located at the Burning Ground. The burning cages were permitted as interim status units in the LHAAP Hazardous Waste Permit Number 50195. Each burning cage was closed in accordance with RCRA closure requirements to the TNRCC Risk Reduction Standard in effect at the time.

Risk Reduction Standards are the medium-specific concentrations (MSC), standards, and criteria for health-based closure/remediation and are based on Title 30 Chapter 335 Subchapter S. The Risk Reduction Standards may be defined as follows:

- Risk Reduction Standard No. 1 (RR1S) – Closure/Remediation to Background
- Risk Reduction Standard No. 2 (RR2S) – Closure/Remediation to Health-Based Standards and Criteria
- Risk Reduction Standard No. 3 (RR3S) – Closure/Remediation with Controls

Once a property owner has a closure to RR1S approved by the State regulatory agency, no further action is necessary by the property owner. Closure to RR2S requires a deed record of the site but no post closure care is required. Closure to RR3S requires a corrective measure study by the property owner to determine an acceptable remedy or remedies. Once the RR3S remedy is achieved, a document to fulfill the requirements of a deed record is required.

Table 4.1.1-2: Closure Status of Permitted Thermal Treatment Units at Site 18/24

Cage Permit Number	Cage Notice of Registration (NOR) Number	Cage Description	Closure Date	Closure Status	Reason for Risk Reduction Status
No. 4	NOR 003	East Burning Cage	2 Oct. 1998	RR2S	Metals
No. 5	NOR 155	Center Burning Cage	2 Oct. 1998	RR2S	Metals, Volatiles
No. 6	NOR 156	West Burning Cage	27 May 1999	RR3S	Volatiles, Semi-Volatiles
No. 7	NOR 157	North Burning Cage	2 Oct. 1998	RR2S	Metals
No. 8	NOR 158	South Burning Pan	2 Oct. 1998	RR2S	Metals, Volatiles, RDX

In accordance with the closure plan, the structures were removed and decontaminated and surrounding surface soils were sampled for metals, explosives, volatiles, perchlorate, and explosives. Where contamination was present above Risk Reduction Standard No. 2 (RR2S) concentrations, the soils were removed for disposal offsite to a permitted waste Treatment Storage Disposal Facility (TSDF). Soils at each burning cage location contaminated with volatiles were not removed due to widespread contamination at the burning ground and the fact that the units are present on a CERCLA site undergoing remedial action for volatiles. The location of each cage was surveyed and deed recorded after closure. Table 4.1.1-2 describes each cage identification and final closure date.

As indicated in Table 4.1.1-2, NOR 156 could not be closed to RR2S due to the elevated levels of contamination from volatiles. Comments in the closure report indicate visible areas of contamination were evident in the soils several feet beneath the area of the burning cage and that contamination in the soils was from previous waste disposal activities rather than contamination from the burning cage.

Four ninety-day permit exempt container storage areas at the burning ground were also closed in accordance with closure plans approved by the TNRCC. The closure of each 90-day unit followed the same guidelines as the permitted units including structure decontamination, soil sampling & analysis, soil removal as required, and deed recording. Table 4.1.1-3 describes each 90-day unit and the final closure status.

Table 4.1.1-3: Closure Status of 90-Day Permit Exempt Areas at Site 18/24

Notice of Registration Number	LHAAP Building Number	Description	Closure Date	Closure Status	Reason for Risk Reduction Status
NOR 013	41-X	Container Storage Area	21 Aug. 2000	RRS No. 2	Metals
NOR 014	24-X	Washout Area	21 Aug. 2000	RRS No. 2	Metals, Perchlorate
NOR 015	43-X	Container Storage Area	21 Nov. 2000	RRS No. 2	Metals, Perchlorate
NOR 016	21-X	Container Storage Area	25 Jan. 2001	RRS No. 2	Metals

Since the implementation of the Remedial Action, the pump & treat system is performing as expected. The groundwater plume is well defined and maps are updated regularly. Groundwater elevations are measure monthly and mapped. The groundwater drawdown area at the site is well defined. Volume of groundwater removed from the site is documented monthly. From the groundwater volume and contaminant concentrations, volatiles removed from the site are calculated twice per year. Contaminant trends in monitoring wells are updated twice per year and should assist in long-term trend analysis.

4.1.2 Sites 12 & 16

The ROD for Sites 12 & 16 addressed an Early Interim Remedial Action. The Early Interim Remedial Action was necessary to mitigate potential risks posed by buried source material at the Site. The ROD was signed on September 27, 1995.

In addition to the requirements in the ROD, an Agreed Order issued by the State required remedial activities and submittals in relation to Sites 12 & 16. LHAAP was issued the Agreed Order by the TNRCC on December 4, 1995 for ongoing RCRA violations. Items required by the Agreed Order in relation to the CERCLA work at Site 12 & 16 are listed in Table 4.1.2-1. Only the items that require ongoing submittals are listed. Items that were answered to the satisfaction of the State are not listed.

The Remedial Action Objective is to provide reliable long-term protection by minimizing the infiltration of water into the landfills. This reduces the possibility of contaminant transport into surface water bodies. Groundwater monitoring will be carried out during and after placement of the landfill caps.

Table 4.1.2-1: LHAAP Agreed Order Items related to CERCLA Site 12 & 16

Agreed Order Item	Requirement	Submittal	Submittal Date
Number 7	Revise Groundwater Sampling & Analysis Plan	LHAAP Groundwater Sampling and Analysis Plan (CERCLA RI/FS Workplan – Amended as additional work is performed.)	Ongoing
Number 8	Maintain all Documents, Records and Reports	Documents submitted and maintained per FFA	Ongoing
Number 9	Submit copies of final FFA primary documents and work plans to TNRCC Region V office and TNRCC Project Manager	Documents submitted and maintained per FFA	Ongoing
Number 12	Annual Report Summarizing previous year' remedial activities and schedule for future activities	Annual Report (Requirement met with Installation Action Plan)	Ongoing
Number 15(2)	Complete construction or abandonment of monitoring wells in accordance with State rules	As Required	Ongoing
Number 16	Construct monitoring wells in accordance with State Rules or receive approval from State	As Required	Ongoing
Number 17	Submit an Annual Groundwater Monitoring and Remediation Report Summary	Annual Report (Requirement met per monthly, quarterly , and annual GWTP Reports)	Ongoing

The selected remedy consisted of a multilayer landfill cap section, which included the following components:

- Foundation soil layer,
- A low permeability sodium bentonite geocomposite, geosynthetic membrane liner,
- A final soil cover with adequate slopes and vegetation,
- Perimeter berms and drainage swales to control surface water runoff,

As a result of an accelerated treatability study, two extraction wells were installed in February of 1996 and tested to develop a more complete extraction system. Six more extraction wells were installed in June of 1997 as part of the treatability study under the

accelerated RI/FS. Water extracted from the system during 1996 was stored in Frac-Tanks, until the GWTP was operational. In 1997, a sixty-thousand gallon storage tank was constructed at Site 16. A double wall containment pipeline was built to transport groundwater from the storage tank at Site 16 to the GWTP.

4.2 Remedy Implementation

This section discusses implementation of the remedy at each Site, addressing Sites 18 & 24 as a unit and Sites 12 & 16 as a unit.

4.2.1 Site 18/24 Remedy

In the Federal Facility Agreement, signed 30 December 1991, the US Army agreed to perform the remedial design/remedial action (RD/RA) and pay costs for cleaning up and monitoring the Site. The EPA approved the ROD on 12 May 1995.

In accordance with the ROD an Interim Remedial Action was implemented prior to the RI/FS and a Remedial Design. The IRA consisted of three phases.

- Phase I work included several laboratory treatability verifications for the onsite contaminated soils and groundwater.
- Phase II work was to determine the effectiveness of different systems for groundwater extraction. In the spring of 1994, a pilot study was conducted to determine the most effective method to extract the contaminated shallow groundwater. Three systems were installed and used in the pilot study:
 - An Interceptor Collection Trench,
 - A horizontal extraction well,
 - A vertical extraction well.
- Phase III work included the activities associated with the IRA, which consisted of the construction and maintenance of a groundwater extraction and treatment system, contaminated soils and source material excavation and treatment, and site restoration. The workplan was designed to meet the early interim remedial action objectives to address and mitigate potential risks associated with the high concentrations of contaminants in the shallow groundwater and source material.

Figure 4.2.1-1 illustrates the Site 18/24 Area with the layout of the ICT's and the location of the Groundwater Treatment Plant.

Conducted simultaneously with the construction of the GWTP, was treatment of soil as required by the ROD and incorporated into the Phase III workplan. The following work was completed:

- Construction of a Soil Handling and Dewatering Pad for ICT excavated soils and contaminated soils and source material.
- Construction of a storage pad for treated soils and source material.
- The mobilization, setup, and performance testing of a LTTD soil treatment system.

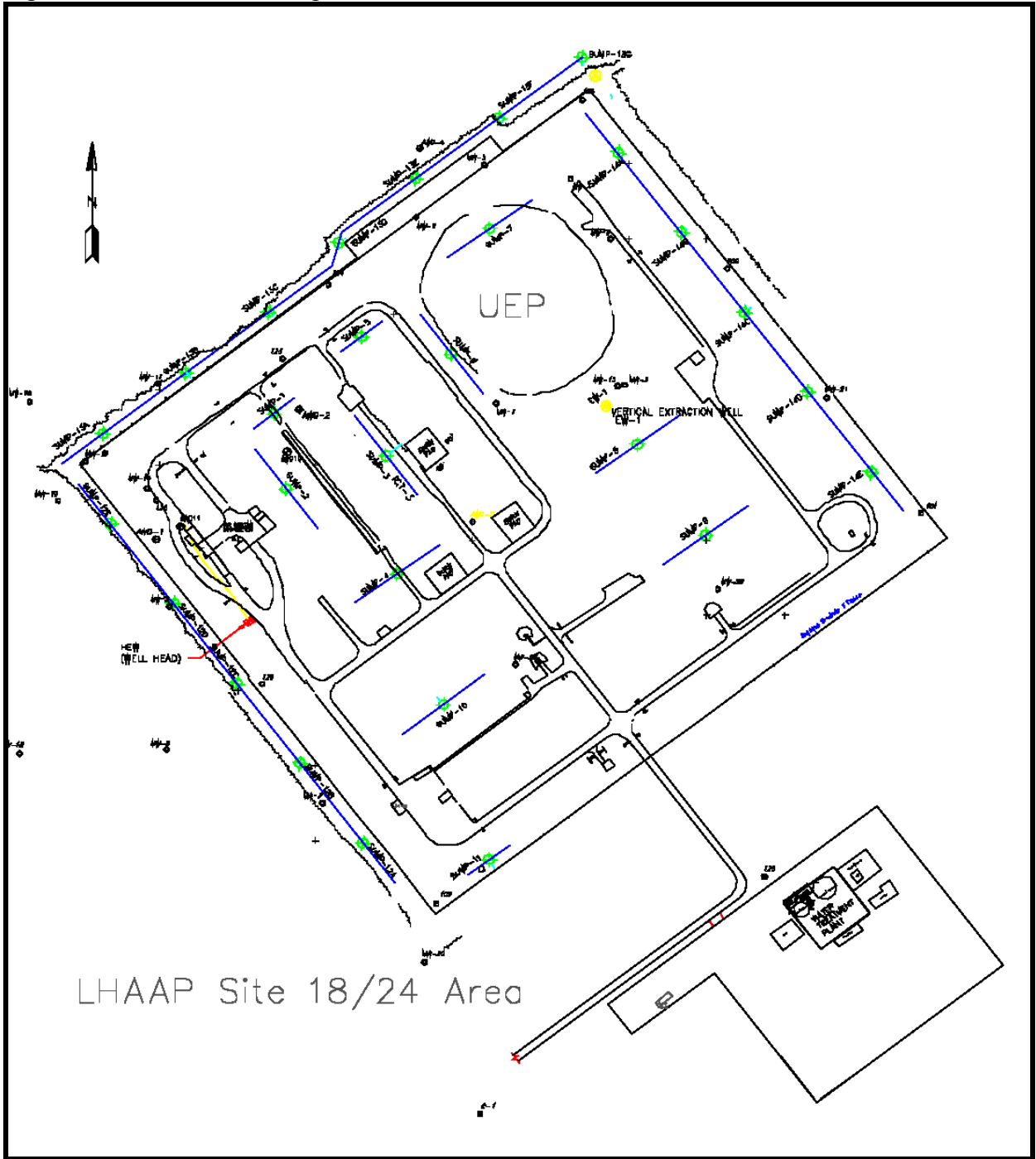
- LTTD Proof of Performance test conducted on February 13-15, 1997.
- Excavation and treatment of source material. Soil treatment took place from February 22, 1997 through December 10, 1997. Soil treated was as follows:
 - 30,000 cubic yards source material
 - 1,029 cubic yards of material from ICT trenches
 - 105 yards of material from burning cages
 - 1,157 yards of material from floor of storage and treatment areas.
- Perimeter air monitoring during excavation and soil treatment.
- Placement of clean ICT material, evaluated by sampling, into source material excavations during August 1997. ICT material was sampled to meet a 95% confidence level that it was clean.
- Disposal/placement of treated soils and source material on Landfills Site 12 and Site 16.
- Drilling 20 soil borings to investigate the potential presence of other source material.
- Restoring the site by importing clean fill material and backfilling source material excavations, and restoring utility lines.

The tasks for the groundwater extraction and treatment system are described as follows:

- Construction of tank, tank containment, and HDPE dual wall piping system at Site 16 during May 1997.
- Construction of a total of 5,000 feet of ICT Sections. The last ICT well was developed in October 1997.
- Installation of a piping network to collect the extracted water and convey it to the GWTP. Piping system composed of HDPE dual wall containment pipe.
- Construction of the GWTP to treat the extracted groundwater.
- Installation of a piping system to convey the treated water to Harrison Bayou.
- Starting up the GWTP.
- GWTP Proof of Performance test conducted on March 24, 1998. The test was conducted with the GWTP operating at full capacity.
- Addition of carbon treatment units to the GWTP placed online in October 1997.
- Operating and maintaining the GWTP for 1st year prove-out to May 1998.
- Evaluating the hydraulic effectiveness of the treatment system.

Dow Environmental prepared the Phase III workplan on December 28, 1995. The workplan generally followed the ROD, but a couple of exceptions apply. The Phase III workplan, incorporated information from the ROD that a combination of 5,000 feet of ICT's and eight vertical extraction wells would be used to collect onsite shallow groundwater at Site 18/24. The vertical extraction wells were not installed.

Figure 4.2.1-1 Site 18/24 Map



Changes that may have enhanced the performance of the GWTP system during construction and after operations began include the following:

1. Addition of carbon adsorption units to the process. It was found that water from Site 16 has a yellow color that was difficult to remove in the GWTP process. A Model 8 granular carbon adsorption system manufactured by Calgon was installed as an “end of pipe” treatment. Two vessels were installed with a capacity of 10,000 pounds each.
2. The backfill in the ICT’s was changed from geotextile to a “washed gravel screen” and smaller screen size to inhibit small sand particles from entering the ICT. Engineering studies concluded that the wash gravel screen would produce water in greater quantities than the geotextile.
3. ICT’s 12 and 13 have a HDPE liner installed between the Site and Harrison Bayou as an impermeable barrier. This barrier is intended to inhibit the plume from Site 18/24 from further migrating towards Harrison Bayou and to focus the water extraction within the fenced area rather than pull-ins from the bayou.
4. In 2000, heat trace was added to all twenty-eight ICT header systems at the site. With the installation of heat trace, no freezing of the pipelines has occurred during winter months.
5. A pipeline for treated effluent was installed to a lined pond, formerly the INF Pond. The pond capacity is about 3-million gallons. The pond is used for a holding pond when flow in Harrison Bayou does not allow for discharge of effluent to the bayou. This allows the GWTP more latitude in operating when the plant would not otherwise be able to operate.
6. Prior to June 1999, the GWTP had ongoing problems with the catalytic oxidizer fan needing to be balanced due to corrosion, with bearing wear, and the fan shaft bending. The carbon steel fan was replaced with a stainless steel fan and the fan shaft upgraded to high tensile strength steel.
7. During August 1999 chemical tests were performed to optimize polymer addition to process. Polymer process changed to premix a .5% solution rather than injecting a 100% solution to the process. The premix goes into solution much better and allows for more efficient use of the polymer.
8. Installation of a Fluidized Bed Reactor (FBR) that went into operation on 16 February 2001 to treat all water at the GWTP for perchlorate. With the installation of the FBR, sumps at ICT No. 4 and ICT 12-B were placed back online. The ICT’s had been valved off due to the elevated levels of perchlorate.
9. Check valve installed in HCl line during January 2001 to prevent process water from entering acid line when acid pump is off. If water enters line during cold weather, line would freeze and GWTP would not be able to operate.
10. During 2001 a desiccant air dryer was added to the instrument air system at the GWTP. With moisture in instrument air adequately controlled, automated control valves will not degrade and need repairs nearly as often as otherwise.

4.2.2 Sites 12 & 16 Remedy

The ROD, signed on 27 September 1995, in order to address and mitigate potential risks posed by buried source material at the Site, called for the following components:

- Foundation soil layer,
- A low permeability sodium bentonite geocomposite, geosynthetic membrane liner,
- A final soil cover with adequate slopes and vegetation,
- Perimeter berms and drainage swales to control surface water runoff.

The Remedial Action construction began in July 1996 by mobilization of personnel and equipment from an OHM office in Houston, Texas. The following tasks were completed as follows:

- A temporary support facility was constructed east of the entrance to Landfill 16 off Avenue Q.
- Construction of temporary access roads to the borrow pit and both landfills.
- Preparation of 8.5 acres at LHAAP Borrow Area.
- Installation of stormwater controls around the borrow source and each landfill to control silt migration caused by stormwater.
- Preliminary site survey to set up control points and grade stakes at the landfills.
- Construction and operation of Landfill 12 and Landfill 16 stockpiles of treated soil from the Site 18/24 Thermal Desorbers.
- Perimeter air monitoring of treated soil stockpiles when being handled by employees.
- Plugging and abandonment of existing monitoring wells within the limits of the new landfill caps.
- Demolition of existing stormwater culverts, pavement, signage, etc. at landfills and disposed of items in landfills prior to installing cap.
- Construction of Landfill 12 and Landfill 16 Cap, including:
 - Clear and proofroll the surface
 - Place grading layer which included treated soil. A total of 2000 cubic yards of treated soil went into landfill 12 and 35,840 cubic yards of treated soil went into landfill 16.
 - Installation of geosynthetic membrane liner and flexible membrane liner.
 - Placement of cover layer
 - Placement of topsoil.
 - Construction of landfill drainage swales.
 - Vegetation of the Landfill Cap surface.
- Construction of perimeter fence around each Site comprised of a four-strand barbwire fence and access gate.
- Posting of warning signs on perimeter fence.
- Demobilization including trailers and housekeeping of Site.

The final Construction Completion Report was approved in December 1998. The construction completion date for both landfills is 31 August 1999.

4.3 System Operations & Maintenance

4.3.1 Site 18/24 Operations and Maintenance

USACE has currently contracted to Complete Environmental Service (CES) to carry out the O&M activities according to the O&M plan for Sites 18 and 24. The primary activities for Sites 18 and 24 are as follows:

- Operate and maintain the GWTP
- Maintain the ICT system in Burning Ground No. 3
- Maintain the Storage Tank and groundwater extraction system at Site 16
- Evaluate the effectiveness of the groundwater collection system
- Perform compliance monitoring of GWTP and monitoring wells
- Perform chemical monitoring of ICT's
- Maintain the fences, signs, and mow the associated areas
- Submit scheduled reports on the operation of the GWTP to USACE

A full-time staff of five employees works at the GWTP and they are responsible for operations, maintenance, administration, and management. The staff is supported as necessary by outside consultants and engineering firms.

In accordance with contract requirements an "Onsite Remediation System Operations Plan for Groundwater Treatment Plant and Wellfields" is maintained at the site and updated annually. The plan consists of all written procedures, plans, permits, records, equipment database, spare parts inventory, etc. All records pertaining to compliance of the GWTP such and sampling and analysis records, discharge flow calculations, and CEM data are maintained as part of the database. This database is maintained in a hard copy format at the GWTP as well as in a computer database. The database is updated throughout the year and distributed to the USACE and Army Staff once per year. Recent additions to the plan include a Freeze Protection Plan and procedures for responding to electrical callouts.

Provided is an abbreviated index to the "*ONSITE REMEDIATION SYSTEM OPERATIONS PLAN FOR GROUNDWATER TREATMENT PLANT AND WELLFIELDS*".

**ONSITE REMEDIATION SYSTEM OPERATIONS PLAN FOR GROUNDWATER
TREATMENT PLANT AND WELLFIELDS**

VOLUME I

- | | |
|---|--|
| <ul style="list-style-type: none"> • Annual Calendar • Bacteriological Site Sampling Plan • TNRCC Water Rules • Installation Spill Contingency Plan Parts A&B • Onsite Health & Safety Plan • RCRA Training Plan • Staffing Plan • Transition Training Plan • Waste Analysis Plan • Property Inventory • Database Management Plan • Reports <ul style="list-style-type: none"> o Annual Reports o Quarterly Reports o Quality Control Reports – FBR o Various Daily Construction Reports o Miscellaneous Meetings o Monthly Summary Report o Weekly Status Memos • GWTP Sampling and Analysis Program • Record of Decision • Sampling and Analysis Records <ul style="list-style-type: none"> o Weekly Perchlorate o BiWeekly o Monthly Metals o Quarterly Influent | <ul style="list-style-type: none"> • Sampling and Analysis Records (continued) <ul style="list-style-type: none"> o Quarterly Effluent o Quarterly FBR Samples o Quarterly Site 16 o Semi-Annual Site 16 o Semi-Annual ICT Wells o Semi-Annual Monitoring Wells o Special Analysis o Chain of Custody • Harrison Bayou Discharge Calculations <ul style="list-style-type: none"> o Outfall calculation sheets o Open channel discharge sheets o Flow from INF Pond to Harrison Bayou Outfall Calculation Sheets • Monitoring Wells <ul style="list-style-type: none"> o Site 18&24 Contaminant Plume Maps o Sample Field Measurements o Purge Data • Quarterly Inspections • Weekly Flowmeter Inspections • Chemical Data <ul style="list-style-type: none"> o Chemical Trends at GWTP o ICT Information 2001 o ICT Summaries o Monitoring Well Trends • Groundwater Elevations • Freeze Protection Plan |
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**ONSITE REMEDIATION SYSTEM OPERATIONS PLAN FOR GROUNDWATER
TREATMENT PLANT AND WELLFIELDS**

VOLUME II

- | | |
|--|--|
| <ul style="list-style-type: none"> • Air Monitoring Plan • Electrical Callout Procedure • Equipment Lists and Descriptions • GWTP English Language Control Strategy • PLC Operating Programs • IC Procedure • INF Pond Discharge Procedure • Fluidized Bed Reactor <ul style="list-style-type: none"> o FBR Discharge Calculation Chart o Monitoring Program for FBR System o Nutrient Solution and Pump Settings o FBR Bed Sample Collection Procedure | <ul style="list-style-type: none"> • FBR Reports • Spare Parts Inventory • Standing Operating Instructions • Well Maintenance • Potable Water Log <ul style="list-style-type: none"> o ICT Sump Information o PZ Total Depth |
|--|--|

Reports pertaining to the site are provided to USACE weekly, monthly, quarterly, and annually. The reports summarize all compliance monitoring and events that take place at the GWTP.

As part of the LHAAP GWTP preventative maintenance system, CES has developed written checklists for inspections of all pumps, gauges, pH meters, and other process controlling hardware. Equipment is inspected and maintained according to manufactures guidelines and experience.

CES has developed a comprehensive database and spare parts inventory for maintenance parts that are practical to keep in stock. Parts that are not available locally or that routinely have to be replaced, such as pumps in the Site 18/24 wellfield are kept in the spare parts inventory.

As part of contractual requirements, the O&M contractor maintains the Administrative Record and Index of Records at LHAAP. This record was last updated in July 2000 for information through December 1999. Copies of the record are distributed to EPA and TNRCC. During 2001, the entire Administrative Record was scanned and placed in an electronic "PDF" file. Copies of the file were distributed on compact disc to USACE and the Army Commander's Representative.

4.3.1.1 GWTP Processes

The GWTP is located at Site 18/24. The treatment plant processes include the following:

- Pretreatment and Sludge Conditioning – This step removes excessive scaling and fouling chemicals dissolved in the groundwater as well as heavy metals. These materials are removed by conventional alkaline precipitation and chemical adsorption followed by flocculation with a cationic polymer into a plate clarifier. The water is then gravity fed into a sand filter.
- Air Stripping – An eighty-foot tall air stripper is utilized to remove volatile contaminants from the water after pretreatment. The contaminated water is fed into the top of the air-stripping tower that contains a packing material that provides the proper environment for the transfer of Volatile Organic Compounds (VOC) to the airstream. An air supply of 4600 CFM is fed into the bottom of the air stripper that flows upward through the tower.
- Catalytic Oxidation and Vent Scrubbing – The VOC's in the airstream are routed to a thermal catalytic oxidizer. The VOC's in the airstream are converted to carbon dioxide, water and hydrogen chloride gases. These gases are then scrubbed using water to produce a very dilute acid stream. The dilute acid is then utilized in the water treatment process for pH adjustment.
- Carbon Columns – Two Calgon carbon columns are utilized to polish the water that has been treated for metal removal and VOC removal. The carbon columns contain 10,000 pounds of carbon each.

- Fluidized Bed Reactor – The FBR follows the carbon columns. The FBR is a twenty-one foot tall by five-foot diameter column that contains a carbon bed. The circulation of water fluidizes the carbon bed. The FBR is fed a nutrient stream and a carbon donor. A biomass grows on the carbon bed and consumes perchlorate in the influent water stream. The FBR process takes place as the last treatment step in the water treatment process prior to discharge.
- Sludge Treatment - Sludge is processed into settling tanks and devolatilized. Upon devolatilizing, the sludge can be fed through a belt press where a filtercake is generated. The filtercake is transferred to a rolloff box. When the rolloff box is full, the filtercake is shipped for disposal to a hazardous waste landfill. Land ban requirements apply to the filtercake waste.

Besides water from Site 18/24, water from Site 16 is treated at the GWTP. Other water treated at the GWTP includes water captured in the containment area from rainfall, process water generated at the GWTP, and purge water generated on LHAAP from monitoring wells at other sites. Treated water from the GWTP is discharged into Harrison Bayou.

4.3.1.2 Interceptor Collection Trench Operations

The Interceptor Collection Trench (ICT) system in Burning Ground No. 3 is composed of 14 sections ranging in length between 100 feet and 1,300 feet. Approximately 5,000 linear feet of trench were installed within and around three sides of the Burning Ground. The trench sections extend approximately 25 to 55 feet in depth. The trenches are as deep as the confining clay layer of the shallow groundwater zone.

Upon construction of the ICT system, piezometers were installed for evaluation of ICT effectiveness. Groundwater levels are measured monthly in twelve piezometers and approximately forty-seven monitoring wells. Groundwater contours of the Site are mapped monthly from these water level readings.

Twenty-eight sumps and pumps remove water from the ICT sections. The ICT's are piped into dual wall containment piping and transferred to a 300,000-gallon equalization-holding tank at the GWTP.

Electronic probes control water levels within the trenches. The probes are set at various levels to activate or deactivate the electric pumps and to maximize groundwater capture. As the level of the probes are adjusted, the groundwater level and probe settings are placed in maintenance records.

4.3.1.3 Chemical Monitoring

Chemical monitoring is performed in accordance with State and Federal regulatory requirements. A Site Sampling and Analysis Plan is maintained as a part of the onsite operations plan. The GWTP influent & effluent, ICT's, Site 16 extraction wells,

monitoring wells, and plant emissions are sampled according to a schedule maintained in the plan. Provided in Table 4.3.1.3-1 is the current onsite testing plan.

4.3.1.3.1 Changes to Chemical Monitoring Procedures

During a Quarterly Technical Review Committee meeting at LHAAP, CES requested some changes in sampling analysis and frequency at the LHAAP GWTP and wellfields. Most of these changes were to reduce sampling frequency and the number of chemical parameters. Some of these changes were approved at the meeting. Other changes, having to do with effluent monitoring, had to be approved by TNRCC. The TNRCC subsequently submitted a memorandum on 26 July 2000 to the Commander's Representative that approved some changes to the sampling frequency for the GWTP influent and effluent sampling. These changes were incorporated into the site sampling and analysis plan.

In addition to the changes in sampling parameters and collection frequency, the collection of samples has changed to include the collection of effluent "grab" samples in addition to the "composite" samples. The GWTP standard permit conditions require the collection of grab and composite effluent samples.

Table 4.3.1.3-1 Groundwater Treatment Plant and Wellfields Testing Plan

Location	Frequency Of Testing	Parameters	Test Method
GWTP Air Emissions	Continuous	1. Total Hydrocarbons	1. Model 51 FID
GWTP Air Emissions	Quarterly	1. Volatile Organics	1. TO-14
GWTP Influent	Monthly FLOW WEIGHTED COMPOSITE SAMPLE	1. Chromium (hexavalent), Silver (Total Equivalent), Selenium (Total), Lead (Total)	1. 6010B
GWTP Influent	Quarterly FLOW WEIGHTED COMPOSITE SAMPLE FOR ALL BUT VOLATILES	1. Record of Decision Table 2 Volatiles 2. Hexachlorobenzene 3. Record of Decision Metals 4. Oil & Grease 5. Chemical Oxygen Demand 6. Chloride 7. Sulfate 8. Perchlorate	1. 8260B 2. 8270B 3. 6010B, 7000, 7421 4. 9070/1664 5. 410.4 6. 325.3/9056 7. 375.4/9056 8. 9058/314 (IC)
GWTP Effluent	Continuous	1. pH 2. Flow	1. pH probes and Transmitter 2. Endress Hauser Electromagnetic Flowmeter
GWTP Effluent	Daily (Onsite)	1. Chloride 2. Sulfate	1. 325.3/9056 2. 375.4/9056
GWTP Effluent	BiWeekly (Every Other Week) GRAB SAMPLE & FLOW WEIGHTED COMPOSITE FOR ALL BUT VOLATILES	1. Record of Decision Table 2 Volatiles 2. Barium (Total) 3. Lead (Total) 4. Chloride 5. Sulfate 6. Perchlorate	1. 8260B 2. 6010B 3. 6010B 4. 325.3/9056 5. 375.4/9056 6. 9058/314 (IC)
GWTP Effluent	Monthly GRAB AND FLOW WEIGHTED COMPOSITE	1. Chromium (hexavalent), Silver (Total Equivalent), Selenium (Total), Lead (Total)	1. 6010B
GWTP Effluent	Quarterly GRAB AND FLOW WEIGHTED COMPOSITE FOR ALL BUT VOLATILES	1. Record of Decision Table 2 Volatiles 2. Hexachlorobenzene 3. Record of Decision Table 2 Metals 4. Oil & Grease 5. Chemical Oxygen Demand 6. Chloride 7. Sulfate 8. Perchlorate	1. 8260B 2. 8270B 3. 6010B, 7000, 7421 4. 9070/1664 5. 410.4 6. 325.3/9056 7. 375.4/9056 8. 9058/314 (IC)
Site 16 Extraction Wells	Quarterly 8-each Vertical Extraction Wells	1. Perchlorate	1. 9058/314 (IC)
Site 16 Extraction Wells	Semi-Annual 8-each Vertical Extraction Wells	1. Volatiles 2. Chloride	1. 8260B 2. 9253
Site 18/24 Interceptor Collection Trenches	Semi-Annual 28-each Interceptor Collection Trench Sumps	1. Volatiles 2. Perchlorate 3. Chloride	1. 8260B 2. 9058/314 3. 325.3/2253
Site 18/24 Monitoring Wells	Semi-Annual 47-each monitoring wells	1. Record of Decision Table 2 Volatiles 2. Arsenic (Total), Barium (Total), Cadmium (Total), Chromium (Total), Lead (Total), Silver (Total), Selenium (Total), Zinc (Total), Nickel (Total) 3. Perchlorate 4. Chloride	1. 8260B 2. 6010B, 7000, 7421 3. 9058/314 (IC) 4. 9253

4.3.1.3.2 Compliance Sampling at GWTP

During the years since the operation of the GWTP began, there were intermittent difficulties documented concerning excursions of the effluent discharge limitations. These various difficulties appear to have been resolved.

1. There was an excursion of an effluent for lead during the 11 July 2000 Bi-weekly sampling event for lead and the monthly sample for lead. This problem was carried over from June, when there was also an excursion for lead. At that time, sampling frequencies were increased. An extensive review of the treatment process revealed no significant changes to the metals precipitation process during that time period.

As part of the technical review, samples of tap water and deionized water were collected and analyzed for lead. The lead levels in the potable water were 0.011 mg/L, which is in excess of the maximum allowable discharge level of 4.6 ug/L. Levels of lead in the deionized water were non-detect at 0.01 mg/L. Because of the levels of lead in the tap water, procedures to clean the vessel used to collect the composite sample were changed to utilize deionized water for decontamination rather than tap water. Since the decontamination procedure has been changed, no excursions for lead in the effluent have been noted.

2. Compliance samples collected from the FBR on 4 January 2002 exceeded the discharge limitations for perchlorate. The excursion was attributed to the Media Capture Tank eductor system. The GWTP Operators periodically vacuum out the media capture tank into the FBR using the eductor system. The carbon/biomass vacuumed from the media capture tank is piped from the media capture tank up over the top of the FBR and down into the FBR approximately 6-7 feet.

A valve on the piping between the FBR and the media capture tank was left open and when the vacuum system was not in operation, untreated water was siphoning into the media capture tank from the FBR. This is a 1-inch dia. pipe and a full stream was flowing. Any sample collected on 3rd. or 4th. of January 2002 would have water not fully treated for perchlorate added to the treated effluent.

Closing the valve has been added to the GWTP procedures and all employees were notified of the problems with leaving the valve open. The manufacturer of the FBR was notified to place this valve on the piping drawings for future systems.

4.3.2 Site 18/24 Operations and Maintenance Costs

The table below is copied from the 1995 ROD for Site 18/24. The estimated annual operations & maintenance expense utilizes air stripping and metals precipitation as the selected remedy.

Table 4.3.2-1 Estimated Operations and Maintenance Costs from 1995 ROD

Item	Shallow Groundwater Treatment & Disposal	Source Material Excavation, Treatment, & Onsite Disposal
Annual Operations & Maintenance	\$400,000	\$50,000 (One-year Only)

As illustrated in Table 4.3.2-2 below, soil treatment was conducted in 1997 only. Many expenses were associated with the operation of the LTTD including, LTTD Setup & Teardown, soil excavation, soil treatment, soil backfill, transport, and air monitoring. Expenses are included in the table below.

Table 4.3.2-2 Annual Operations & Maintenance Cost for Soil Treatment

Year	Estimated Maintenance Costs per ROD	Actual Operations and Maintenance Costs	Notes
1997	\$50,000	\$4,311,055	1) Soil treatment was conducted in 1997 only. 2) Labor costs were approximately \$750,000. Other costs include subcontracts & materials. 3) Excavation and backfill cost were \$871,052

Table 4.3.2-3 illustrates the actual costs for O&M of the onsite GWTP. Actual operations and maintenance costs of the GWTP exceed the estimated costs in the ROD. Several reasons may be considered why the actual costs are more than the estimated cost. They are listed as follows:

1. Other expenses, besides routine operation and maintenance expenses, such as emergency maintenance due to storm damage, are included in the cost of O&M.
2. Carbon treatment added a capital expense. This was added to the O&M expense.
3. The FBR added an additional O&M expense in 2001, due to chemical expense and additional monitoring requirements.

Table 4.3.2-3 Annual Operations & Maintenance Cost for Water Treatment

Year	Estimated Maintenance Costs per ROD	Actual Operations and Maintenance Costs	Notes
1997	\$400,000	\$907,721 estimated. Some costs mixed due to construction contract.	GWTP began treating groundwater as test phase in February 1997. Carbon treatment added to process.
1998	\$400,000	\$779,278 estimated. Some costs mixed due to construction contract.	GWTP O&M contract began in April 1998
1999	\$400,000	\$1,007,209	Some emergency maintenance expenses incurred due to storm damage.
2000	\$400,000	\$692,370	
2001	\$400,000	Actual cost through August and projected to rest of calendar year: \$1,345,000	Fluidized Bed Reactor Installed in February 2001 at a cost of \$645,000

Looking forward five years, the actual GWTP expense is expected to exceed the estimated operating expense as listed in the ROD due to the addition of perchlorate treatment and current operational requirements. Some maintenance costs associated with the extraction system and Site 16 is included with the GWTP expenses.

4.3.3 Sites 12 & 16 Operations & Maintenance

The Operations and Maintenance of Sites 12 and 16 have fallen to different contractors since the maintenance of the landfills began in 1998. This maintenance includes the following:

- Inspect the caps for both Sites and perform repairs as required
- Maintain the fences, signs, and mow the areas for Sites 12 and 16

The operation of the extraction wells and collection of piezometer well water levels near the extraction wells is now included with the contract to operate the GWTP. Since 2000, CES has performed this task. Prior to June 2000, Radian International performed the O&M activities.

For calendar year 2001, CES is performing the O&M activities for Sites 12 and 16. The primary activities for Sites 12 and 16 are as follows:

- Maintain the extraction well system for the old Landfill (Site 16)
- Collect water levels from piezometers associated with the extraction wells
- Inspect the caps for both Sites and do repairs as required
- Maintain the fences, signs, and mow the areas for Sites 12 and 16
- Perform chemical monitoring of Site 16 extraction wells

As of January 2002, over 4.5 million gallons of water have been removed from Site 16 extraction wells for treatment at the GWTP.

The following tables illustrate the costs for maintaining the landfills.

Table 4.3.3-1 Annual Operations & Maintenance Cost for Site 12

Year	Estimated Costs per ROD	Actual Costs	Notes
1997	\$75,000	None	
1998	\$75,000	None	Long-term maintenance begins.
1999	\$75,000	\$1,920.00	
2000	\$75,000	\$1,920.00	
2001	\$75,000	\$2,800.00	

To date, maintenance at Site 12 has been comprised of grounds maintenance. Grounds maintenance consists of cutting the grass, and, as required, repairing erosion, replacing warning signs and repairing the fence. Without any further remedial action, maintenance costs at Site 12 should not exceed the estimated \$75,000 costs in the ROD. During the next five years, maintenance costs will increase due to long term monitoring of the groundwater. Maintenance costs will be driven largely by the groundwater sampling and monitoring schedule.

Table 4.3.3-2 Annual Operations & Maintenance Cost for Site 16

Year	Estimated Costs per ROD	Actual Costs	Notes
1997	\$75,000	None	
1998	\$75,000	None	Long-term maintenance begins.
1999	\$75,000	\$11,342.14	Maintenance of Extraction Wells included in GWTP contract costs. \$9,422.14 included in actual cost for watering landfill cap to establish grass.
2000	\$75,000	\$1,920.00	Maintenance of Extraction Wells included in GWTP contract costs.
2001	\$75,000	\$2,800.00	Maintenance of Extraction Wells included in GWTP contract costs.

Maintenance at Site 16 has included two areas, O&M of the extraction system and grounds maintenance for the cap.

Since the operation of the groundwater extraction system began in 1998, the onsite contractor for the GWTP has been responsible for operating and maintaining the extraction system. Costs for maintaining this system are largely mixed with costs with maintaining the GWTP. The onsite records indicate that the compressor at Site 16 has been replaced once and the well pumps are removed for maintenance regularly. Other routine maintenance procedures consist of cleaning check valves, changing the oil in the compressor, and quarterly extraction well monitoring.

Grounds maintenance consists of cutting the grass, and, as required, repairing erosion, replacing warning signs, and repairing the fence.

Maintenance costs at Site 16 during the next five years will likely increase due to long term groundwater monitoring. The final ROD may also affect long term monitoring and maintenance costs according to the final remedial action.

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

This was the first five-year review for any of the Sites at LHAAP.

6.0 FIVE-YEAR REVIEW PROCESS

6.1 Administrative Components

Survey forms were sent out on September 17, 2001 and a public notice was run in the Marshall News Messenger on the 6th. and 7th of October, 2001.

A team composed of the following members listed in Table 6.1-1 completed the five-year review at the Site.

Table 6.1-1 Five-Year Review Team Members

Complete Environmental Service	Onsite Manager – William R. Corrigan III Chemist – Ken Poush Quality Control Manager – Scott Beesinger Project Administrator – LaNita Burchfield
Outside Consulting Company - Sniffen Around	Geologist – Bill Sniffen
U.S. Army	Installation Restoration Program Manager – David Tolbert
U.S. Army Corps of Engineers	Geologist/Environmental – Cliff Murray Civil/Environmental - Dawn Knight
Environmental Protection Agency	Project Manager – Chris Villarreal

The LHAAP Five-Year Review team was led by William (Bill) R. Corrigan III of Complete Environmental Service, Project Manager for the Site 18/24 Operations and Maintenance, and included members from the USACE with expertise in geology, civil, and environmental engineering. An outside consultant, of Sniffen Around assisted with review of hydrogeology. The local Army Installation Restoration Program Manager David Tolbert and EPA Project Manager Chris Villarreal assisted with background reviews of the Site and regulatory guidance.

From August 1 through October 30, 2001, the review team established the review schedule whose components consisted of the following activities:

1. a review of relevant documents
2. data review
3. site inspections
4. local interviews
5. community involvement
6. interviews with local Army officials

The five-year review was conducted in accordance with EPA's Comprehensive Five-Year Review Guidance (June 2001). The purpose of the five-year review is to determine whether the remedy selected and implemented at the Site is protective of human health

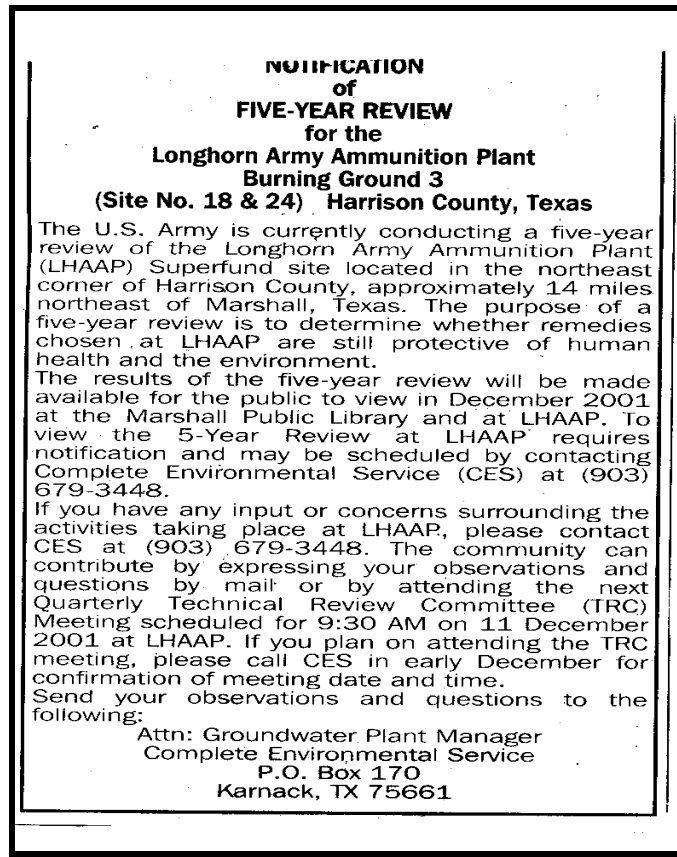
and the environment. The five-year review documents any deficiencies identified during the review and recommends specific actions to ensure that a remedy is protective.

6.2 Community Involvement

Community Notification was accomplished by sending out questionnaires, interviews, and publishing a notice in the local newspaper. The Public Notice was run in the Marshall News Messenger on October 6 and 7, 2001.

The public notice reads as follows:

Figure 6.2-1 Five-Year Review Newspaper Notification



Five-Year Review Survey Forms were also placed at the Karnack Post Office during the months of October and November, 2001. The Forms were left at the post office until the review was complete.

6.3 Document Review

This five-year review consisted of a review of relevant documents including O&M records, ROD's, remedial investigations, risk assessments, work plans, construction reports, LHAAP Federal Facility Agreement, LHAAP Installation Action Plan, LHAAP Agreed Order, monitoring data, and various maintenance and operation reports (see References).

6.4 Data Review

6.4.1 Site 18/24 Groundwater Monitoring

Groundwater sampling was first carried out in 1980 at Site 18/24. Continuous groundwater monitoring started at Site 18/24 in 1986 on a quarterly basis and became semi-annual in 1996. Even though a large amount of data is available, this review will concentrate on the information collected just before and following the Interim Remedial Action (IRA). Data collected during this time period should best determine the protectiveness of the IRA.

As part of groundwater studies, environmental monitoring has been conducted by sampling monitoring wells in 1980, 1982, and 1987. As part of Remedial Investigation sampling, environmental monitoring has been conducted as follows:

- Sampling of monitor wells in Site 18/24 has been carried out in 1980, 1982, 1987, 1993, 1995, and 1998.
- Site 18/24 had surface water and sediment sampling in 1993, 1995, and 1998.
- Site 18/24 had soil sampling carried out in 1995.
- Sampling specifically for perchlorate has been conducted in May 2000, September 2000, and January 2001.

As part of contractual requirements, the contractor performing O&M of the site is required to perform regular sampling of the monitoring wells and ICT's. The sampling schedule is maintained in the Sampling and Analysis Plan for the site. Currently 47 monitoring wells are sampled semi-annually, the ICT's are sampled quarterly. Groundwater elevations are measured monthly.

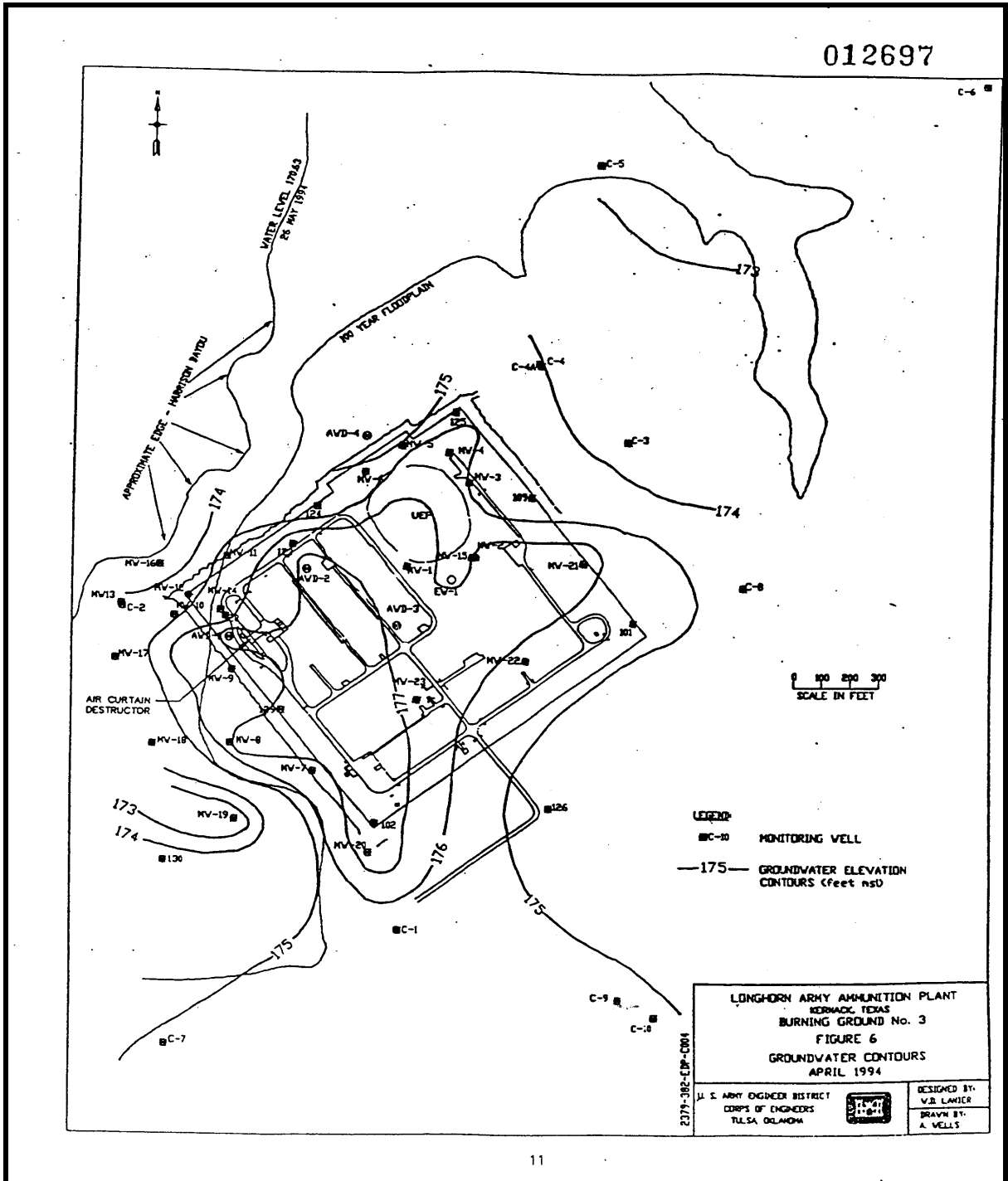
Figures No. 6.4.1-1 and No. 6.4.1-2 show the shallow groundwater for Site 18/24 as measured in April of 1994 and in April of 2001, respectively. The April 1994 contour drawing was provided in the ROD for Site 18/24. Extraction of water from the ICT's has made a very noticeable depression in the groundwater contours of Site 18/24 since their installation. This is an indication that the extraction system is functioning as designed.

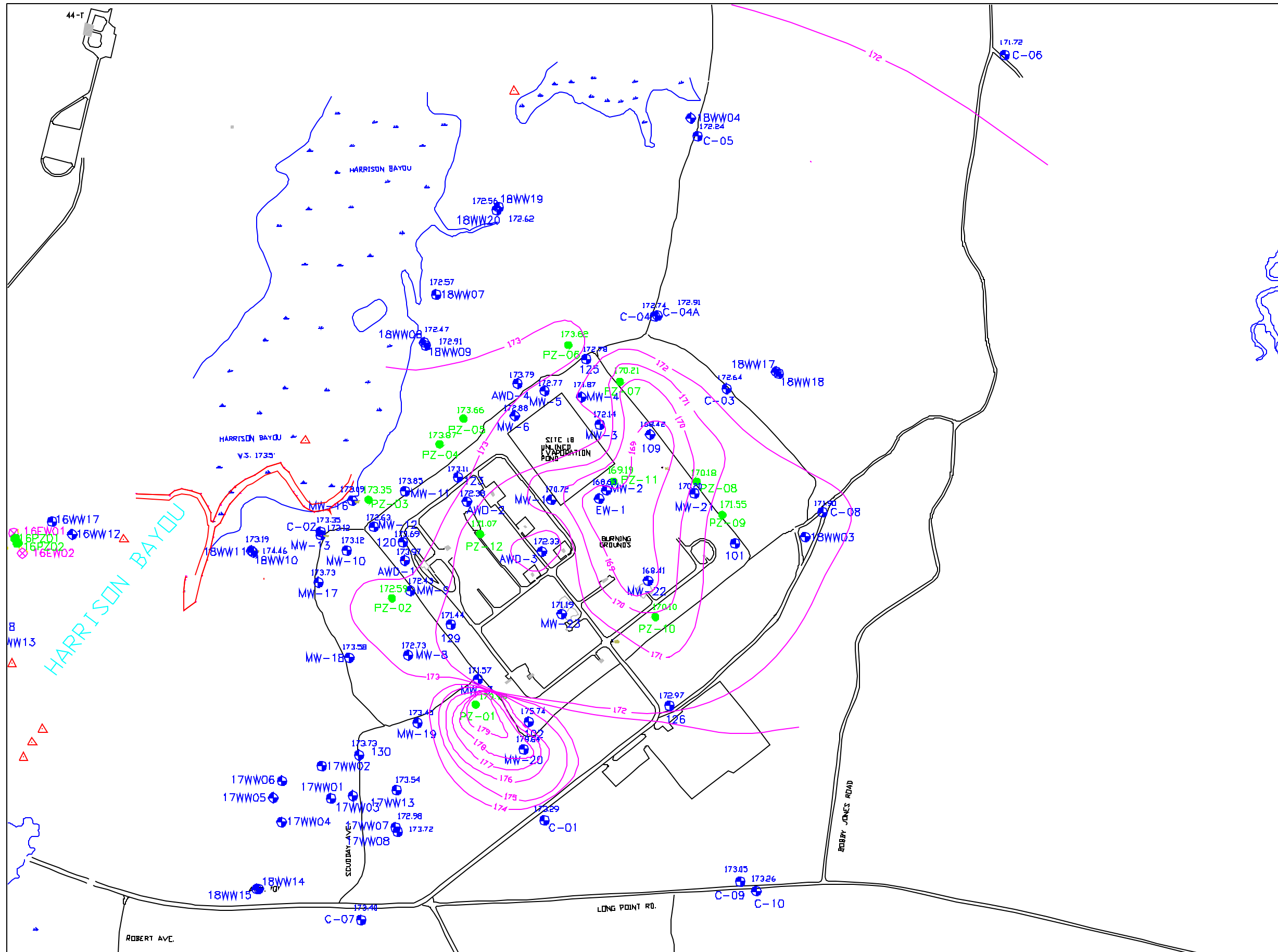
Contaminant concentration maps for Site 18/24 dated April 2001 are located in Appendix E. These may be compared to the methylene chloride and trichloroethene contours dated April 1994 that were provided in the ROD and also reproduced in Appendix E. The highest concentrations are within the interior portion of the site around monitor wells

MW-2 and MW-120. They are basically unchanged from 1994 data. The plumes of TCE and MC have receded from the outer fringes of the area as indicated by comparing the contours. There is a very noticeable reduction in the concentrations and extent of methylene chloride. The changes in the trichloroethylene plume are not as pronounced as in the reduction in the concentrations of methylene chloride.

Perchlorate was not a COC when the ROD was signed, therefore there was not any historical sample data from 1995. Monitoring of perchlorate began at Site 18/24 in September 2000. The perchlorate concentration drawings for April 2001 are located in Appendix E. High concentrations of perchlorate are located near the UEP and also near the northwest corner of the Burning Ground. Some high concentrations are also near MW-7 and MW-8. MW-7 and MW-8 are located on the southwest side of Site 18/24. High levels of perchlorate have been found in monitor wells 18WW08 and 18WW17. Site 17, Burning Ground No. 2 has high levels in monitor wells 17WW02 and 17WW06 which are 1000 feet southwest of Site 18/24. All of these areas appear to be interconnected making perchlorate the most widespread contaminant at the site.

Figure 6.4.1-1 April 1994 Groundwater Contours





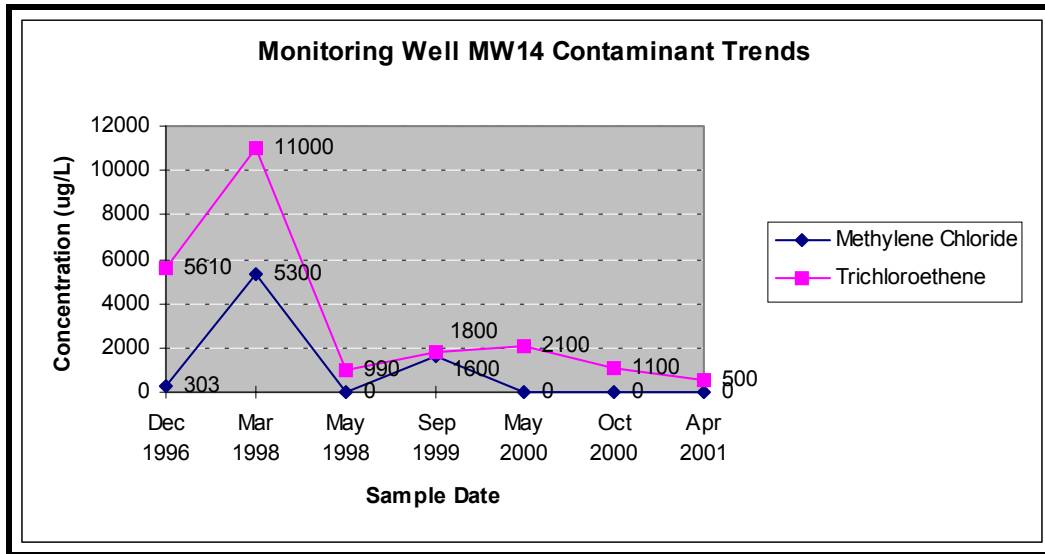
Complete Environmental Service
 Site 18/24
 DATE: April 4, 2001
 Groundwater Contours

Data from the semi-annual sampling done by Radian and continued by CES indicates many of the monitor wells have declining contaminant concentrations in them. Most of the eleven C-Series monitor wells have declining contaminant concentrations to below the detection limit for volatiles at 5 ppb. The C-Series wells were installed in 1984 by Camp, Dresser, & McKee, Inc., and generally surround the 34.5-acre site.

In other monitor wells, contaminant concentrations, namely methylene chloride, trichloroethene, and perchlorate, are steady and some are increasing. Most of these monitoring wells are located within the confines of the BG3 perimeter fence. Some of the wells with increasing concentrations are between the ICT and high concentrations of contaminants. The ICT may be pulling the contaminants into the area of the well bore.

The deep wells do not have increases of contaminant concentrations, indicating a lack of downward movement of groundwater. The following table presents the sampling history of monitor well MW-14, considered a deep well that is located near a highly contaminated area near the northwest corner of the Burning Ground. MW-14 is a well that is 51 feet in depth and screened from 43 feet to 48 feet depth.

Figure 6.4.1-3 MW-14 Contaminant Trends



Some monitoring wells that have high concentrations of contaminants continue to exhibit high concentrations. The most highly contaminated well for methylene chloride and trichloroethene is MW-2. MW-2 is located near the center of the burning ground. Also highly contaminated, and in the northwest portion of the Burning Ground is MW-120. MW-120 is also located near MW-14, a deeper well that exhibits a decrease in contaminant concentrations. Both MW-2 and MW-14 exhibit a concentration of contaminants that has not increased or decreased significantly as illustrated in figures 6.4.1-4, 6.4.1-5, 6.4.1-6 and 6.4.1-7.

Figure 6.4.1-4 Monitor Well MW-2 Historical TCE Concentrations

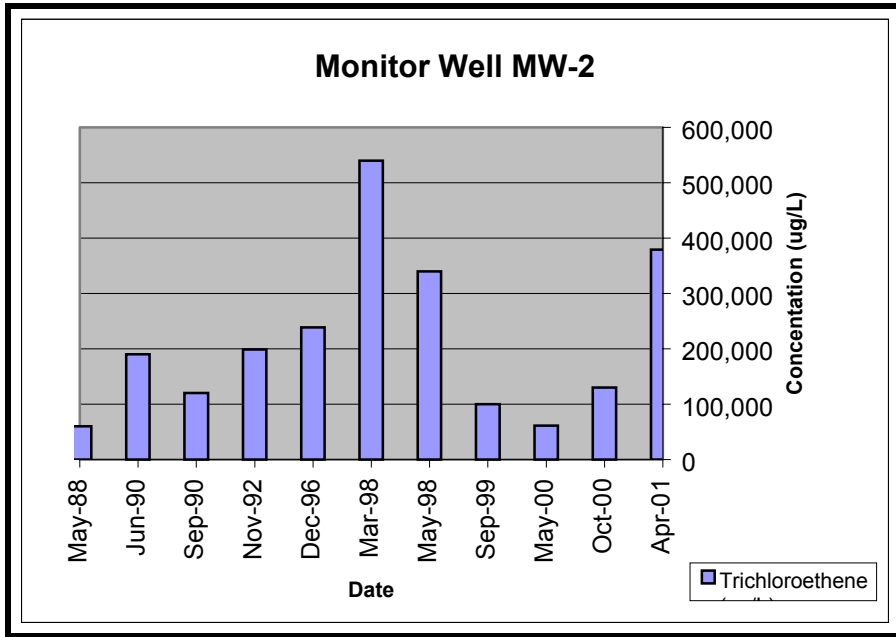


Figure 6.4.1-5 Monitor Well MW-2 Historical MC Concentrations

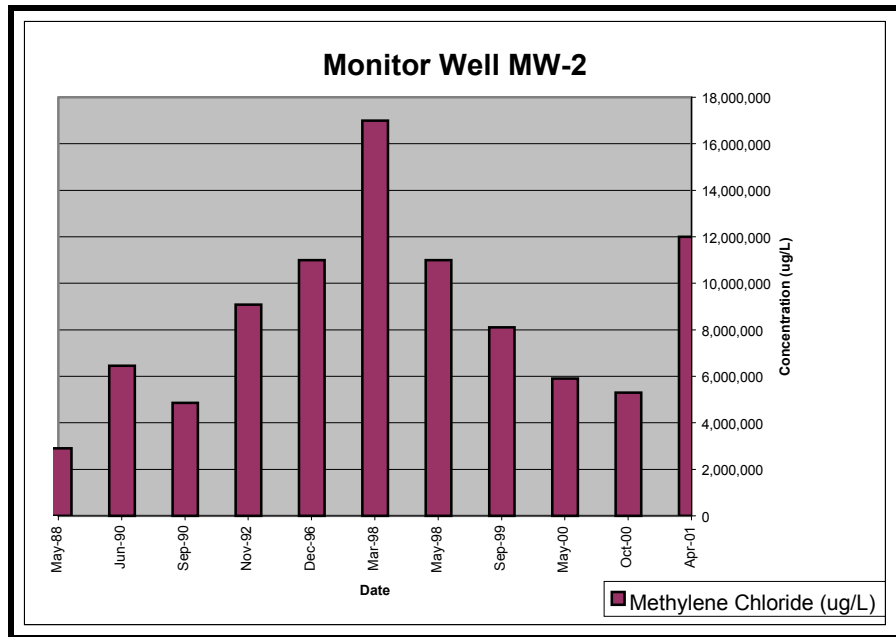


Figure 6.4.1-6 Monitor Well MW-120 Historical TCE Concentrations

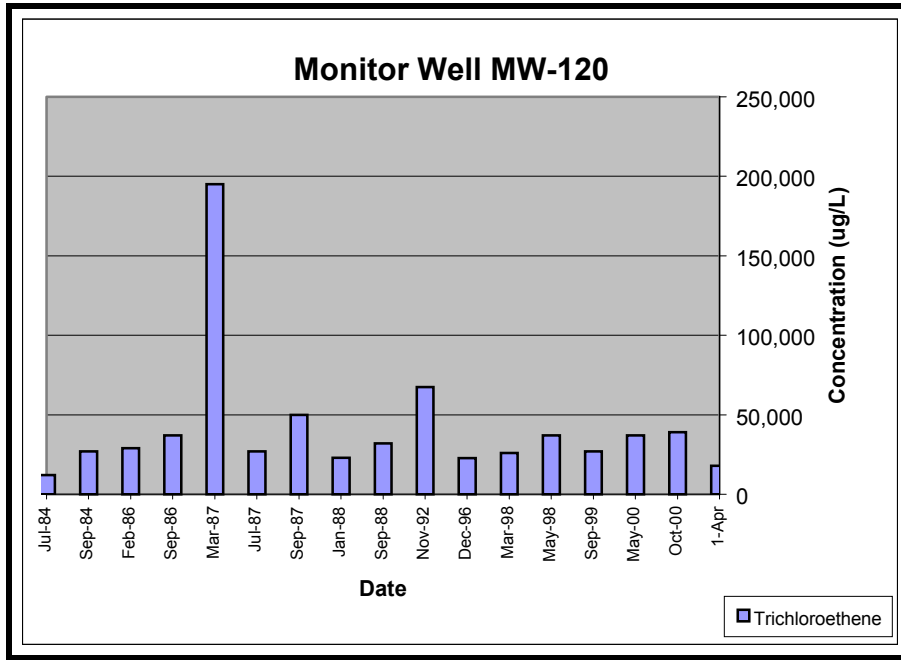
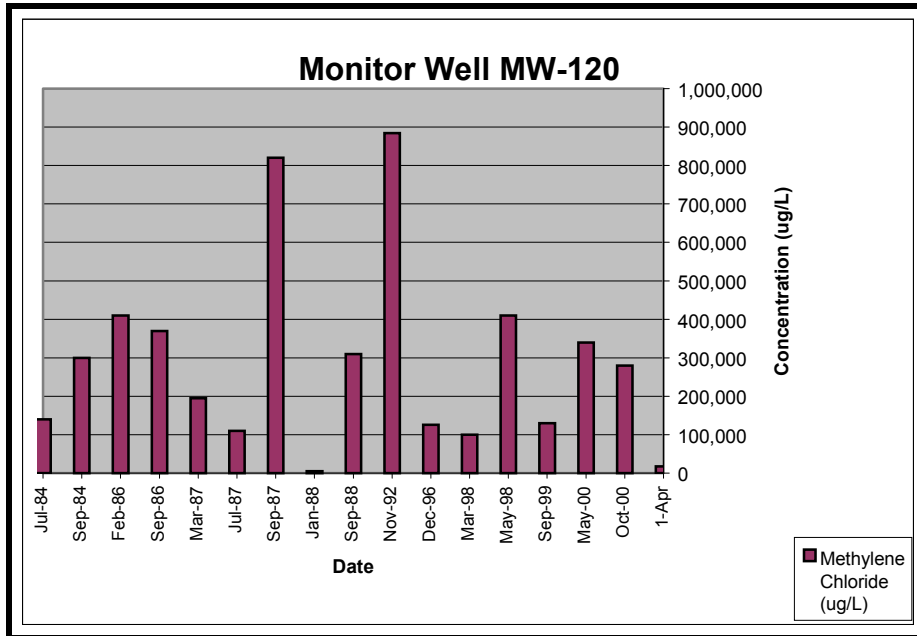


Figure 6.4.1-7 Monitor Well MW-120 Historical MC Concentrations



Towards the west side of Site 18/24 and near monitoring wells MW-7 and MW-8, Trichloroethylene (TCE) plumes are outside the perimeter of the Burning Ground and on the outside perimeter of the ICT extraction trenches. ICT-12 (west side) and CT-13 (north side) each have an impermeable synthetic liner in them on the outer wall to help contain contaminated groundwater within Site 18/24. The groundwater sampling of these monitor wells shows no decline in TCE contamination. Perchlorate is also high in MW-7 and MW-8. This should be addressed in the evaluation of the extraction system.

Figure 6.4.1-8 Monitor Well MW-07 Historical MC and TCE Concentrations

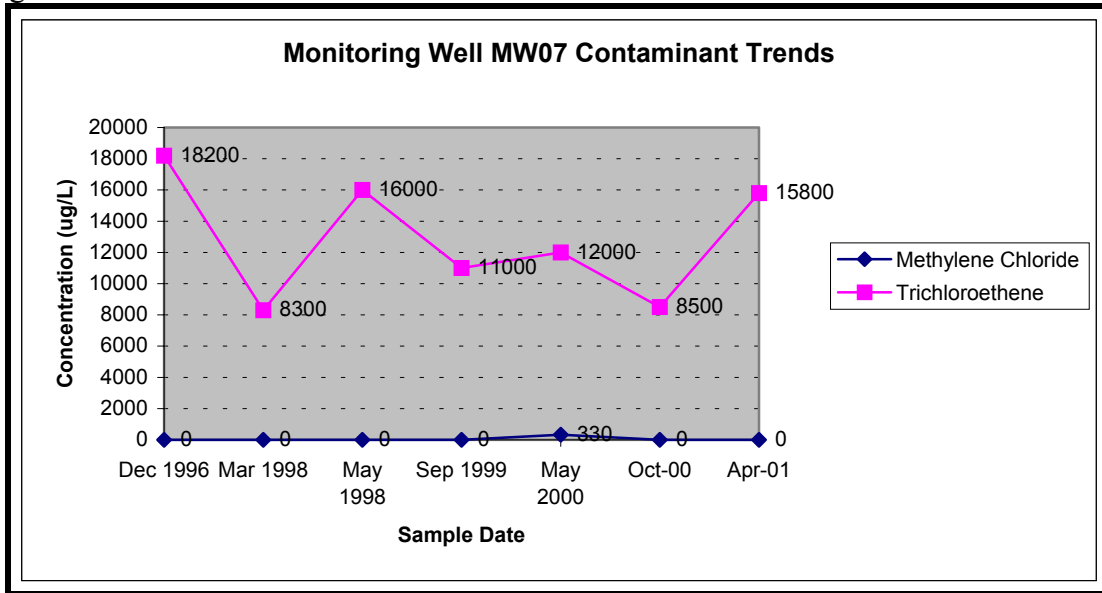
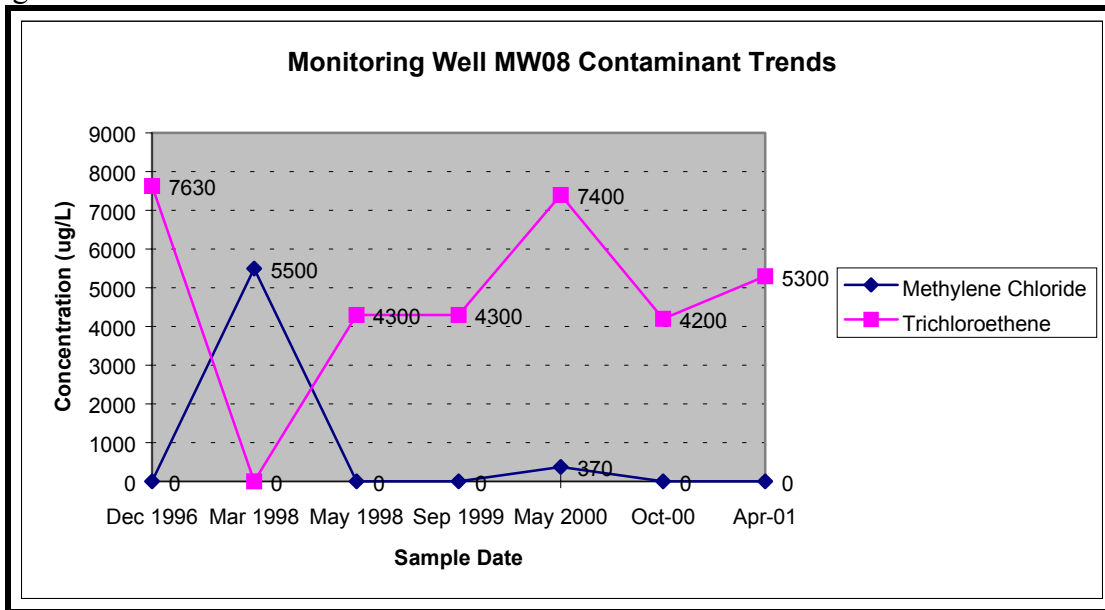
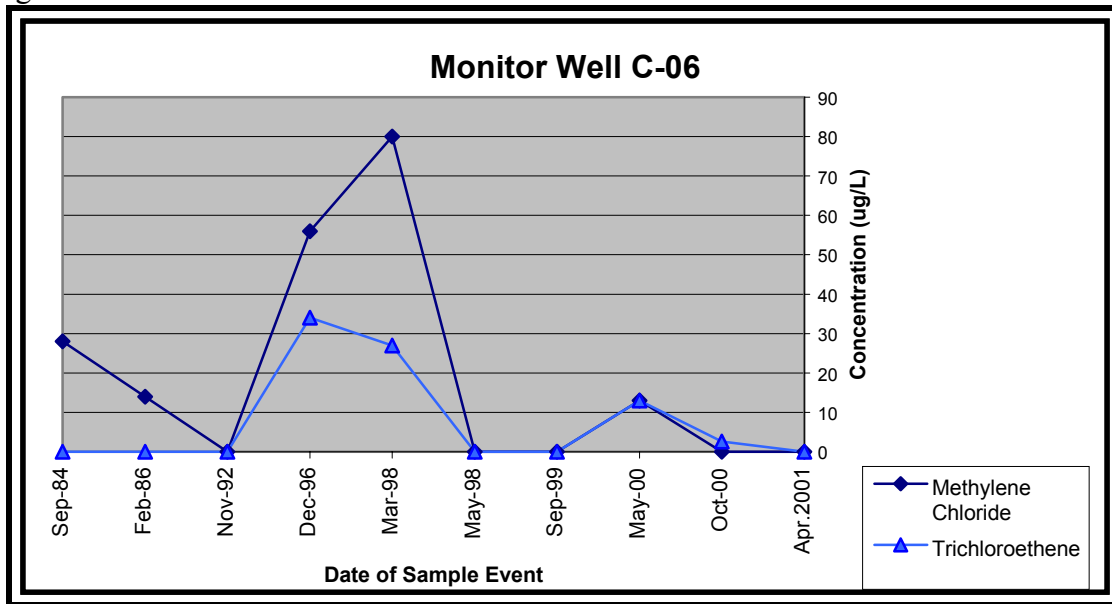


Figure 6.4.1-9 Monitor Well MW-08 Historical MC and TCE Concentrations



Monitor well C-06 has had detections of contaminants through the years and may be too far from Site 18/24 for it to be the source. Air photos do not indicate any activity and a ground search around the well did not find any indications of disposal activity. Figure 6.4.1-10 shows some of the significant detections in well C-06. Further investigation is recommended to locate a source or to establish that the contamination may have been from Site 18/24.

Figure 6.4.1-10 Monitor Well C-06 Contaminant Trends



6.4.2 Site 12 Groundwater Monitoring

Groundwater sampling was first carried out in 1980 and repeated in 1982 as a part of the environmental studies at Site 12.

As part of the Remedial Investigation sampling, environmental monitoring has been conducted as follows:

- Sampling of monitor wells in Site 12 has been carried out in 1980, 1982, 1993, 1995, and 1998.
- Site 12 had surface water and sediment sampling in 1993, 1995, and 1998.
- Site 12 had soil sampling carried out in 1993.
- Three monitoring wells sampled in May 2000, September 2000, and January 2001 specifically for perchlorate. Five soil samples also collected in May 2000.

The first figure in Appendix F, from the Site 12 & 16 1995 ROD shows the groundwater level at Site 12 in 1994. The contours indicate a relatively low gradient of about one foot vertical per 200 feet horizontal, which indicates a low groundwater velocity. The next figure shows the groundwater levels in August 1998. When the landfill was capped, many of the wells were plugged which reduced the available information. This makes a

comparison of the data more difficult. It would be useful to have seasonal water levels measured for Site 12.

Groundwater sampling at Site 12 was performed in 1993, 1995, 1998, and during April 2001. Table 6.4.2-1 shows some of the available data for TCE from a hits only table included in the Final RI Report for Group 2, April 2001. The detections for TCE in the Site 12 wells are very low compared to the other sites in this review and there were very few detections. The low number of detections indicates low levels of source materials and low concentrations in groundwater.

Table 6.4.2-1 Site 12 Trichloroethene Concentration (ug/L)

Monitor Well No.	Sample Date Jun-93	Sample Date April 95	Sample Date July-98
12WW01	27	<5	Not Analyzed
12WW03	16	<5	Plugged
12WW12	Not Drilled	495	Not Analyzed

Perchlorate sampling began in May 2000 as a part of the LHAAP plant wide investigation, and was repeated in September 2000, and January 2001 in four monitor wells. The highest concentration was 56 ug/l in well 12WW01. More sampling is planned for Site 12.

Table 6.4.2-2 Site 12 Perchlorate Concentration (ug/L)

Monitor Well No.	Sample Date May 00	Sample Date Sept. 00	Sample Date Jan. 01
12WW01	8.6	<8	56
12WW02	1.6	<4	<4
12WW05	<1	6	<4
12WW12	8.7	Not sampled	Not sampled

6.4.3 Site 16 Groundwater Monitoring

Groundwater sampling was first carried out in 1980 at Site 16. As part of the groundwater studies, environmental monitoring has been conducted by sampling monitoring wells in 1980, 1982, and 1987. Surface water, sediment, and soil sampling has been conducted in 1982.

As part of the Remedial Investigation sampling, environmental monitoring has been conducted as follows:

- Sampling of monitor wells in Site 16 has been carried out in 1993, 1995, 1997, and 1998 (two sets).
- Site 16 had surface water and sediment sampling in 1993, 1995, 1997, and 1998.

- Site 16 had soil sampling carried out in 1987, 1993, 1995, and 1997.
- Groundwater samples specifically for perchlorate were collected from 10 wells in May 2000, 37 wells in September 2000, and 20 wells in January 2001. Four soil samples were collected in May 2000.

Figures provided in Appendix G show the shallow groundwater elevation maps for Site 16 from the September 1995 ROD, October 1997 and in October 1998. Figures No. 11 and No. 12 illustrate the intermediate groundwater for Site 16 in October 1997 and October 1998. A distinct depression has resulted in both levels in the 1998 data due to the operation of the extraction wells at Site 16. This is an indication the groundwater extraction system is functioning as designed.

Like Site 12, wells at Site 16 were plugged in the vicinity of the landfill cap, which reduces the available information to evaluate the impact of the cap. It would be useful to have seasonal water levels measured for Site 16.

Monitoring of groundwater around the landfills was in the ROD for Sites 12 and 16. The ROD does not detail how to monitor the sites, but it could be assumed that measuring groundwater levels and sampling of groundwater on a regular basis are implied.

Sampling for perchlorate was started in 2000 as part of a LHAAP wide study. This is separate from the sampling of the extraction wells done by the contractors operating the GWTP. The data is provided in a separate report.

USACE contractors have sampled the extraction wells for Site 16 periodically. The data from the last sampling event is summarized for perchlorate and TCE in Table 6.4.3-1. The extraction well data does not indicate any distinct trends. The data does indicate the water being treated is highly contaminated. Water levels have been measured for the piezometers associated with the extraction wells. These measurements show a distinct depression around the extraction wells.

Table 6.4.3-1 Site 16 Extraction Well Analysis June 2001

Extraction Well No.	Analyte	Result (ug/L)	Analyte	Result (ug/L)
1.	Perchlorate	610	Trichloroethene	24000
2.	Perchlorate	467	Trichloroethene	18000
3.	Perchlorate	512	Trichloroethene	21000
4.	Perchlorate	446	Trichloroethene	20000
5.	Perchlorate	486	Trichloroethene	24000
6.	Perchlorate	323	Trichloroethene	21000
7.	Perchlorate	387	Trichloroethene	13000
8.	Perchlorate	486	Trichloroethene	20000

The main concern at Landfill 16 is the potential of groundwater to transport contaminants into Harrison Bayou. It is not clear from the review of the reports if the extraction system at Site 16 protects Harrison Bayou adequately from groundwater contamination moving east or southeast directly to the bayou. Geologic cross sections in the Draft RI done by Sverdrup (August 1999) show the shallow sands as continuous down to well 16WW27 on Harrison Bayou. Historical RI monitor well samples show that the contaminants are moving northeast along the bayou. Since there is not a clearly defined explanation for this movement it may warrant further study.

Sverdrup (August 1999) sampled groundwater from wells surrounding the extraction system from 1995 through 1998 for Site 16. This gives an indication of the effectiveness of the extraction system. This data is summarized for TCE in Table 6.4.3-2. It is believed that a detailed evaluation would show the extraction system is beginning to be effective.

Groundwater levels measured before the landfills were capped covered the whole site at both landfills. This established pre-construction groundwater levels for both landfills. Monitor wells in and around the caps were plugged for both landfill sites and not replaced after construction of the caps. Groundwater measurements since the capping are north of both sites and give little information about the caps. To better evaluate the effectiveness of the caps, monitor wells or piezometers could be installed within the capped area.

Table 6.4.3-2 Trichloroethylene Concentrations in Monitoring Wells Around Extraction System at Site 16

Monitoring Well No.	Sample Date Jun-95	Sample Date Oct-97	Sample Date Jan-98	Sample Date Jun-98
16WW12	1390	7500	5100	7100
16WW13	4820	12000	Not Sampled	Not Sampled
16WW14	38	53	82	45
16WW16	20900	25000	19000	15000
16WW22	Not Available	2700	4300	2000
16WW26	Not Available	95	270	32
16WW29	Not Available	59	66	25
16WW30	Not Available	36	9.3	11
16WW35	Not Available	1800	490	340
16WW36	Not Available	11000	8600	8900
16WW37	Not Available	1200	1500	1400
16WW38	Not Available	23	160	73

6.4.4 Site 16 Surface Water and Sediment Samples

Surface water and sediment samples for Site 16 were collected as a part of the RI program. This was done prior to or during the construction of the landfill cap as reported by Sverdrup, August 1999. They appear to have been only sampled once from information in the RI. The metals copper, lead, and zinc were above MSC in surface water samples. No contaminants were above the MSC in sediment samples.

Additional surface water and sediment sampling of Harrison Bayou has been carried out by the USACE on a quarterly schedule. TCE has been detected in surface water samples from Harrison Bayou at location HBW-1 since 1995. The location is 100 feet northeast of monitor well 16WW12 on Harrison Bayou. It can range between 282 ug/l to non-detect depending amount of flow in Harrison Bayou. The higher concentrations generally occur during late summer when flow can be very low. At the time of the highest detection, no detection was made at four downstream sample locations on Harrison Bayou.

6.5 Site Inspection

Representatives of the USACE Tulsa District, an independent consultant, and the operating contractor on the site carried out inspections at the Site on October 17 and 18, 2001. CES has the operating contract for the site. The purpose of the inspections was to assess the protectiveness of the early interim remedial actions at Site 18/24 and Site 12 & 16. This includes the groundwater treatment system, caps, fences, and signs.

No significant issues have been identified at any time regarding the groundwater treatment system, caps, fences, and signs. The groundwater treatment system was functioning well and had no major deficiencies.

Weather was clear and temperature in the mid 60's at the time of the site inspection. The ground was dry and the last rains were the week before when more than five inches fell.

The inspection team divided into two teams to look at Sites 18 & 24 and Sites 12 and 16 separately. Dawn Knight of USACE and Bill Corrigan of CES reviewed Site 18 and 24. They inspected the Burning Ground No. 3 (Site 18) and UEP (Site 24), including ICT's, monitor wells, fences, and signs. Discrepancies were noted in regard to signs, roads, and keeping fences clear of vegetation.

The same group inspected the GWTP and no major problems were encountered. Equipment at the plant has been maintained and is functioning as designed. Maintenance records are updated daily and provided to regulators in a monthly report. As indicated in the maintenance records, equipment at the plant has been periodically damaged due to lightning strikes so it is recommended that installation of lightning grounding system be considered. All compliance records at the GWTP are filed by date and sampling event. Records appear to be intact and are well organized. Each laboratory report is evaluated

according to USACE data validation guidelines. A data validation checklist is filled out and filed with each report. Daily flow, process changes, and onsite monitoring data is kept onsite and filed accordingly. A computer database of most information is maintained for electronic storage.

Cliff Murray of the USACE and Bill Sniffen of Sniffen Around, LLC inspected Sites 12 and 16. The caps on the landfills were a primary concern and are in good overall condition. Erosion was noted at the east/northeast edge of Site 12. Grass cover was thin in areas, but erosion has not resulted. Some of the monitor wells and piezometers needed maintenance. An operations and maintenance plan does not exist for the landfills caps specifically. However, on the whole the maintenance is being carried out without problems.

On October 18, 2001, the entire inspection team reviewed their findings and discussed any outstanding issues.

The site inspection checklist is included in this report as Appendix A.

6.6 Interview Summary

Interviews were conducted in person or by mail. The interview forms were distributed on September 17, 2001.

The following nine persons were interviewed either by mail or in person as a part of the five-year review:

Mr. William R. Corrigan III, the Plant Manager for the Groundwater Treatment Plant operated by Complete Environmental Service stated that the plant is well designed and has more capacity available. The FBR is working well but requires constant attention.

Mr. Roy Darville, a professor of biology at East Texas Baptist University states that the three projects are well done and performing as expected. He added that there is a positive effect on the community to know the cleanup is in-progress. He says the LHAAP TRC meetings have been informative to him.

Wes and Joann Hodges, owners of the Hodgepodge Cottages in Karnack, Texas did not have a direct knowledge of the sites, but did have confidence in Dwight Shellman's activities and found him to be a source of information.

Mr. H. L. (Bud) Jones of B. Jones Environmental feels that much progress has been made, but there needs to be some fine tuning in the Landfill 16 and BG 3/UEP (Site 18/24) Areas. Possibly additional remediation, such as insitu treatment may be required. The interim action has calmed down many of the community fears. There is still some community concern about leaving the source material at Site 16 Landfill. He suggested

that confirmation Site Characterization and Analysis Penetrometer System (SCAPS) data be collected at BG 3/UEP Area, similar to the work done at Landfill 16.

Mr. Cliff Murray, Environmental Engineer with the Tulsa District, U. S. Army Corps. Of Engineers, stated that things are going smoothly especially the maintenance of the sites. He also says the current operator at the site has done an outstanding job of maintaining records (operational and historical) of the site.

Mr. Jim Sher, Team Leader for the project for TNRRC states the organization of these areas and the work done at them has been well thought out. After years of investigation, progress is steadily increasing. He says the public is anxious to have the site turned over for public use and adds that there are many interested parties involved in this site, but all seem to be willing to work together.

Mr. William Sniffen, a consulting geologist stated that the landfill sites, burning ground, and the groundwater treatment plant are well managed and progress is being made on final solutions for all the sites. He added that the Army and regulatory community have worked hard to provide information on the sites to the public.

Mr. Bob Speight, the President of the Greater Caddo Lake Association and a resident of Karnack, Texas had a very good impression of the project. He added the site operations had a good effect on the community and were well run.

Mr. Chris Villarreal, Project Manager with the U. S. EPA, Region 6, stated that the project is very complex with multiple operable units. Considerable resources have been expended on this project over the years. Progress has been made in identifying and addressing contamination resulting from 50+ years of Army operations, however there is still a lot of work to be done.

The individual interview forms are included in this report as Appendix H.

7.0 TECHNICAL ASSESSMENT

7.1 Site 18/24 Technical Assessment

7.1.1 Question A: Is the remedy functioning as intended by the decision documents?

- **Remedial Action.** The Site 18/24 construction project was completed in August 1999. Some locations of contaminated source material were removed and treated from the old Burning Ground 3 Area, five thousand linear feet of ICT's were installed and the GWTP was built. The GWTP continues to operate. To date approximately 60 million gallons of contaminated water has been treated through the GWTP.

Groundwater elevation levels are monitored monthly at Site 18/24 and COCs are currently monitored semi-annually by sampling forty-seven selected monitor wells. Data from the sampling events is tabulated and monitor well trend charts are updated. Contaminant trend maps are generated semi-annually and groundwater contour maps are generated monthly. Contaminants have been monitored at the Site semi-annually since 1997 and quarterly between 1986 and 1994. Random sampling events have occurred at the site since 1976. Semi-annual sampling is intended to continue well beyond the next scheduled five-year review.

Contaminants are measured in ICT's semi-annually. Water removed from each ICT is measured daily. From this data, pounds of contaminants removed are calculated semi-annually. From April 1998 through December 2000, approximately 22,225 pounds of Methylene Chloride (MC) was removed from Site 18/24 and over 2100 pounds of TCE. In calendar year 2001, 170 pounds of perchlorate was removed from Site 18/24. Provided in Table 7.1.1-1 is a summary of contaminants removed at the site from 1998 through December 2001. Various other volatiles and byproducts were removed at lower quantities.

Review of documents, Applicable or Relevant and Appropriate Requirements (ARAR)'s, risk assumptions, and the results of the site inspection indicate that the remedy is functioning as intended by the ROD. The selected remedy to pump and treat groundwater continues to be effective in removing and controlling the groundwater gradient at the site. Large quantities of contaminants are being removed. As long as the water extraction system is operating, the contaminants should be contained.

Table 7.1.1-1 Contaminants Removed for Site 18/24 Apr.-98 to Dec.-01

Contaminants	Pounds Removed 1998	Pounds Removed 1999	Pounds Removed 2000	Pounds Removed 2001	Total Removed to Date
1, 1 Dichloroethene	0.00	0.00	0.17	14.24	14.41
1, 2 Dichloroethane	0.00	0.00	0.73	5.89	6.61
Acetone	0.00	192.54	227.93	0.92	421.39
Benzene	0.00	0.00	0.00	0.44	0.45
cis-1, 2- Dichloroethene	0.00	14.04	16.94	0.00	30.98
Toluene	0.00	0.00	0.00	0.44	0.44
trans-1,2- Dichloroethene	0.00	0.00	0.00	0.00	0.00
Trichloroethene	134.03	213.19	1168.32	1788.98	3304.51
Vinyl Chloride	0.00	0.00	5.34	8.57	13.91
1, 1, 2- Trichloroethane	0.00	0.00	0.01	0.53	0.54
1, 1- Dichloroethane	0.00	0.00	0.04	0.16	0.19
Chloroform	0.00	0.00	0.03	2.64	2.67
Methylene Chloride	2061.97	2042.18	14620.72	20584.32	39309.19
Tetrachloroethene	0.00	0.00	0.32	1.48	1.80
1, 2, 4-Trimethylbenzene	0.00	0.00	0.00	0.00	0.00
Carbon tetrachloride	0.00	0.00	0.00	0.20	0.20
Trichlorofluormethane	0.00	0.00	0.00	0.00	0.00
Dichlorodifluoromethane	0.00	0.00	0.00	0.00	0.00
Chloroethane	0.00	0.00	0.00	0.00	0.00
Carbon disulfide	0.00	0.00	0.00	0.00	0.00
Xylene	0.00	0.00	0.00	0.13	0.13
2-Butanone	0.00	0.00	0.00	0.00	0.00
Ethyl Benzene	0.00	0.00	0.00	0.80	0.80
1,1,1-Trichloroethane	0.00	0.00	0.00	0.33	0.33
Freon-113	* 0.00	* 0.00	* 0.00	* 679.70	* 679.70
Total Volatiles Removed Per Year	2195.99	2461.96	16040.55	23089.76	
Total Volatiles Removed to Date					43788.26
Total Perchlorate Removed to Date	0.00	0.00	102.59	2577.00	2679.59

* Freon-113 has not been monitored prior to 2001. The 679.70 pounds removed is based only on a few ICT's and one sampling event.

- **Implementation of Institutional Controls and Other Measures.** Access controls such as fencing and warning signs are in place. Security personnel regularly patrol the site daily. The property is under the jurisdiction of the Army, who has no plans on transferring the property. No deed records are in place for each site. Property owned by the federal government is not deeded.

- **HASP/Contingency Plan.** Both the Health and Safety Plan (HASP) and contingency plan are in place, are adequate to control risks, and are being properly implemented. Employee training is up to date. Hazwoper training occurs annually along with a simulated spill training exercise. First-Aid, CPR, and RCRA training occur annually. During the occurrence of a spill of contaminated groundwater during an extended freeze in January 2001, the contingency plan was implemented and functioned effectively.
- **System Operations O&M.** System operations are consistent with requirements.
- **Cost of Systems/O&M.** Total estimated remedial cost of the project is \$36,890,000. Current O&M exceeds the estimated \$400,000/year O&M costs in the ROD by approximately \$200,000/year. The original estimated O&M cost is exceeded partially due to the operation and maintenance of the FBR, which was not part of the original ROD. Other non-planned events have impacted the cost of operation of the GWTP such as weather events and emergency maintenance due to equipment failure. Costs of maintaining the extraction system at Site 16 has also been rolled into the contract for GWTP operations and therefore increases the costs associated with O&M of the GWTP.
- **Opportunities for Optimization.** Optimization of the remedial process has been an ongoing activity since the GWTP began operations in 1997.

Water levels and pump efficiency from each ICT are monitored and recorded on a monthly basis. Contaminant removal from Site 18/24 is quantified semi-annually for volatiles, perchlorate, and chloride. Water level probes are adjusted accordingly for maximum removal efficiency and for controlling groundwater contours.

Equipment at the wellfield and GWTP is maintained through a preventative maintenance program. All maintenance performed is recorded daily and summarized monthly and again in a yearly report. A spare parts inventory is kept onsite for long-lead time parts. Manufacturers technical guidance for all equipment is kept on file at the GWTP. Opportunities to improve the system are presented to the Army by the contractor on a quarterly basis and evaluated for cost and benefits.

The sampling program is evaluated at least yearly to ensure compliance and effective monitoring of the Site. Monitoring procedures were updated in 2001 to ensure collection of grab and composite samples from the GWTP. Some monitoring for specific constituents was reduced. Further improvements to the sampling are feasible during the next few years. Some reduction or change in

monitoring wells sampled is feasible. All data is filed at the GWTP and is also converted for electronic storage.

A GWTP and Wellfield Operations and Maintenance Plan has been developed which is comprised of all procedures, plans, and records for GWTP operation. The Plan is updated annually and distributed on a CD to the Army. Working copies are kept onsite at the GWTP.

The possibility of using treated water from the ground water treatment plant (GWTP) as injection water for Site 18/24 should be evaluated. Using the treated water in such a manner could provide the following benefits:

- Injecting the treated water within Site 18/24 could serve to mobilize contaminants (i.e., volatiles & perchlorate), thereby accelerating contaminant collection in the existing extraction system and subsequent treatment at the GWTP.
- The injected water could be amended with nutrients to enhance in-situ bioremediation of contaminants (i.e., Perchlorate).
- A current limiting factor for the GWTP discharge is the flow rate in Harrison Bayou which varies seasonally. Providing another place to send treated water would allow the GWTP to operate with less dependence on the flow in Harrison Bayou.
-
- **Early Indicators of Potential Remedy Failure.** No early indicators of potential remedy failure were noted in the review.

7.1.2 Question B: Are the assumptions used at the time of remedy selection still valid?

- **Changes in Standards and To Be Considered (TBC) Requirements.** ARAR's included in the ROD must still be met at this time. A list and review of ARAR's is included in Appendix C.

30 TAC Chapter 307 was revised and became effective on 17 August 2000. Although encompassing many changes, of applicable and relevant interest is the revision of toxic criteria to protect aquatic life. Changes to the ROD Table 2 discharge requirements for treated groundwater have been recently considered by the TNRCC. As a result of the review perchlorate effluent limitations have been reduced by the TNRCC.

30 TAC 106.533, (formerly Texas Air Control Board Standard Exemption No. 68 of 30 Texas Administrative Code (TAC) 116) concerns exemptions for waste processes and remediation facilities. The GWTP facility must meet emissions limitations and certain record keeping requirements. Effective 15 November 1996, all exemptions are included under 30 TAC Chapter 106.

- **Changes in Exposure Pathways.** The land at Site 18/24 is no longer used by any LHAAP Facility Contractor for open burning of propellant, explosives, or pyrotechnics. The land is still under the control of the Army and there have been no changes in exposure pathways due to changes in land use. The land surrounding the sites is controlled by the U. S. Army and may be transferred to the U. S. Fish and Wildlife Service.

No human health or ecological routes of exposure or receptors have changed or been newly identified.

- **Changes in Toxicity and Other Contaminant Characteristics.** Perchlorate has been identified in the groundwater at Site 18/24 and the GWTP has been modified to remove them. Effluent discharge guidelines for perchlorate and other COCs in the ROD have been reviewed and recently set by the TNRCC.

EPA set a provisional reference dose (RfD) level of 0.0009 mg/kg/day for perchlorate in 1998. Based on the RfD, TNRCC set the state risk levels for perchlorate in water to 33 ppb for residential and 92 ppb for industrial/commercial exposure. From more recent information, it appears that these levels will be lowered or both residential and industrial/commercial exposure. The maximum contaminant level for perchlorate is currently 22 ppb and subject to change. Perchlorate was added to the EPA's contaminant candidate list on 2 March 1998.

In addition to the constituents monitored in the ROD, the constituent Freon-113 has been detected in the groundwater at Site 18/24. The addition of this COC to the GWTP effluent table is recommended.

The ROD for the site addresses an interim remedy to mitigate potential risks associated with the shallow groundwater at the site and sets performance standards for the treated groundwater. As part of the RI/FS a risk assessment is being performed for the site. The final ROD will take into consideration the human health and ecological risk assessment for the site and toxicity and other contaminant characteristics.

- **Changes in Risk Assessment Methodologies.** Changes in risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the interim remedy.
- **Expected Progress Towards Meeting Remedial Action Objectives.** Since these are interim remedial actions, no objectives in terms of meeting set standards have been established. Progress has been good in controlling the groundwater migration at the site.

7.1.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

- Human health and ecological risks at the site have not been fully defined. However, a risk assessment is being performed as part of the RI/FS. All documents should include COCs that have not only been detected during the RI, but are present in sampling performed as part of O&M of the site. A final ROD after the RI/FS will later set remediation criteria as necessary.

7.2 Site 12 & 16 Technical Assessment

7.2.1 Question A: Is the remedy functioning as intended by the decision documents?

- **Remedial Action.** The caps, as agreed upon in the ROD, were built on Sites 12 and 16 officially completed on August 1999.

The study performed under the RI/FS at Site 16 of extracting contaminated groundwater is progressing. The selected remedy to pump and treat groundwater continues to be effective in removing COCs and seems to be controlling the groundwater gradient at the site. However, monitoring data is limited and/or not compiled does not confirm the effectiveness of the system.

Site wide groundwater elevation levels are not monitored regularly at Sites 12 and 16. Random groundwater sampling events have occurred since 1980.

The final RI/FS was complete for Site 16 in early 2002.

- **System Operations/O&M.** The caps seem to be functioning as designed and need only routine maintenance. The caps are maintained regularly and inspected quarterly in accordance with RCRA requirements. Neither site has a written O&M Plan for the maintenance on the caps.

The Site 16 groundwater extraction system is maintained by contract by the GWTP operator. Groundwater extracted is tallied monthly.

- **Cost of System Operations/O&M.** Cost of the remedial project through 1998 to cap the landfills was \$5,500,000. According to the LHAAP Installation Action Plan, the total estimated remaining remedial cost of the Site 12 project is \$1,012,000 and the Site 16 project is \$5,302,000.
- **Opportunities for Optimization.** The groundwater extraction system needs to be evaluated for effectiveness. Although samples have been taken from the extraction wells on a semi-annual basis since their installation, quarterly measurements of groundwater depths and COCs in surrounding monitor wells would be useful in evaluating the system and the caps. Since the extraction system was installed as a design measure, the final remedy for Site 16 will be determined following the Feasibility Study.
- **Early Indicators of Potential Remedy Failure.** Frequent problems with the pumps due to fouling at the Site 16 extraction system require a stringent maintenance schedule to remove and clean the pumps. However, with proper maintenance the pumps perform as designed.
- **Implementation of Institutional Controls and Other Measures.** Access controls such as fencing and warning signs are in place. Security personnel regularly patrol the site each day. The property is under the jurisdiction of the Army, who has no plans on transferring the property. Although no deed records are in place, this should be considered in the final ROD.
- **HASP/Contingency Plan.** Both the HASP and contingency plan are in place, are adequate to control risks, and are being properly implemented.

7.2.2 Question B: Are the assumptions used at the time of remedy selection still valid?

- **Changes in Standards and To Be Considered Requirements.** Since the caps have been constructed and maintained, the goal of minimizing long-term vertical infiltration of water through the landfills is being attained. Minimizing long-term vertical infiltration of water through the landfills will be dependent upon long-term maintenance of the landfill caps.

The requirement of the Early Interim Remedial Action to minimize contaminant transport through landfill Site 16 is only met by the continued operation of the eight vertical extraction wells installed as part of a treatability study after the installation of the landfill cap. Operation of the wells will continue until a final remedy is developed and in operation.

The RI/FS addresses toxicity and of the contaminants and the human health and ecological risk assessment. The final ROD for the site will determine the final remedy selection.

- **Changes in Exposure Pathways.** The land at Sites 12 and 16 are no longer used by a LHAAP Facility Contractor as landfills. The land is still under the control of the Army and there have been no changes in exposure pathways due to changes in land use. A fence and warning signs restrict access to the landfill. The land surrounding the sites is controlled by the U. S. Army and may be transferred to the U. S. Fish and Wildlife Service.

No human health or ecological routes of exposure or receptors have changed or been newly identified.

- **Changes in Toxicity and Other Contaminant Characteristics.** Perchlorate has been identified in the groundwater at Site 16 and groundwater extraction from the site is being treated at the GWTP. The GWTP has been modified to treat for perchlorate. The groundwater is being extracted and treated in the GWTP.

EPA set a provisional RfD level of 0.0009 mg/kg/day for perchlorate in 1998. Based on the RfD, TNRCC set the state risk levels for perchlorate in water to 33 ppb for residential and 92 ppb for industrial/commercial exposure. From more recent information, it appears that these levels will be lowered for both residential and industrial/commercial exposure. The maximum contaminant level for perchlorate is currently 22 ppb. Perchlorate was added to the EPA's contaminant candidate list on 2 March 1998.

As part of the RI/FS a risk assessment is being performed for the site, which takes into consideration the human health and ecological risks for the Site and toxicity and other contaminant characteristics.

The ROD for the site addresses an Early Interim Remedial Action and is designed to mitigate potential risks associated with the groundwater at the Site. The final ROD will address a permanent remedy for the site.

- **Changes in Risk Assessment Methodologies.** Changes in risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the remedy. The ROD is an Early Interim Remedial Action and not the final remedy.
- **Expected Progress Towards Meeting Remedial Action Objectives.** The objectives of the remedy are to perform the following 1) minimize long-term

vertical infiltration of water through the landfills; and 2) minimize contaminant transport.

Since the caps have been constructed and maintained, the goal of minimizing long-term vertical infiltration of water through the landfills is being attained. Minimizing long-term vertical infiltration of water through the landfills will be dependent upon long-term maintenance of the landfill caps. As stated in Section 6.5, “an operations and maintenance plan does not exist for the landfill caps specifically.” To help ensure long-term maintenance, a landfill cap operations and maintenance plan will be developed and implemented.

The requirement of the Early Interim Remedial Action to minimize contaminant transport through landfill Site 16 is only met by the continued operation of the eight vertical extraction wells installed as part of a treatability study after the installation of the landfill cap. Operation of the wells will continue until a final remedy is developed and in operation.

7.2.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

- A portion of the Site is within the 100-year floodplain. This does not effect operations now but should be considered when designing the remedy in the final ROD.
- Human health and ecological risks at the site have not been fully defined. However, a risk assessment is being performed as part of the RI/FS. A final ROD after the RI/FS will later set remediation criteria as necessary.
- The observance of perchlorate in the shallow ground water close to Harrison Bayou (i.e., Monitoring Well 16 WW12 with a detected perchlorate concentration of 2,430 µg/L) calls into question the protectiveness of the remedy. Not enough historical data for perchlorate or other known contaminants is available to establish contaminant trends in groundwater. Surface water has been monitored on a quarterly basis since 1995.

8.0 ISSUES

Several issues for Sites 18/24 and 12 & 16 were identified during the Site Inspection. The issues are provided in tables 8.0-1, 8.0-2, and 8.0-3.

Table 8.0-1 Issues for Site 18/24

Issue	Currently Affects Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
Eight vertical extraction wells required by ROD not installed.	No	No
Contracting groundwater plume due to pumping may allow reduction in number of monitoring wells sampled.	No	No
Growth in fence line around the Site.	No	No
Fencing around Site does not contain ICT's.	No	No
Lack of restricted access signs around the Site.	No	Yes
Roads in Site have potholes.	No	No
Slip flanges and bolts on pipe junctions at ICT wellheads deteriorating.	No	No
High frequency of repair of electronic equipment following lightning storms indicates need for lightning arrestors/lightning rods to prevent damage to sensitive equipment.	No	No
Metal precipitation process may not be required.	No	No
Control wires at Site at junction box are not protected.	No	No
Release of approximately 50,000 gallons of untreated groundwater in January 2001.	No	No
Contaminants in monitor well C-06.	No	No
Contamination at Northwest of Burning Ground outside ICT capture zone.	No	Yes
Monitor wells 18WW08 and 18WW17 not in perchlorate sampling of Site 18/24.	No	Yes
COC's detected in onsite monitoring should be included in subsequent documents.	No	Yes

Table 8.0-2 Issues for Sites 12

Issue	Currently Affects Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
Groundwater monitoring (chemical sampling and water levels) not conducted regularly or documented properly	No	Yes
Erosion on landfill cap near toe of cap	No	Yes
Need O&M Plan for Site	No	Yes
Non-source soils not protected by cap	No	Yes

Table 8.0-3 Issues for Sites 16

Issue	Currently Affects Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
Groundwater monitoring (chemical sampling and water levels) not conducted regularly or documented properly	No	Yes
Need O&M Plan for Site	No	Yes
Evaluate the hydrogeologic effectiveness of the groundwater extraction system	No	Yes
Groundwater model in RI/FS should provide modeling of perchlorate and possibly other contaminants	No	Yes
Steel covers off of housing at extraction wells	No	No

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations and follow-up actions are provided in table 9.0-1, 9.0-2, and 9.0-3.

Table 9.0-1 Recommendations for Site 18/24

Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Yes/No)	
					Current	Future
Eight extraction wells required by ROD not installed.	Evaluate need for wells and install or obtain release from State and EPA	USACE	State/EPA	11/30/02	No	Yes
Contracting groundwater plume due to pumping may allow for reduction in number of monitoring wells sampled	Review monitoring wells sampled and change as necessary	CES / USACE	State/EPA	11/30/02	No	No
Growth in fence line around the Site	Cut trees along fence line	CES	State/EPA	3/30/02	No	No
Fencing around Site does not contain ICT's	Determine applicability for fencing around ICT's	USACE	State/EPA	To Be Determined	No	No
Lack of restricted access signs around the Site	Place signs around site	CES / USACE	State/EPA	5/30/02	No	Yes
Roads in Site have potholes	Fill in potholes	CES	State/EPA	12/30/01	No	No
Slip flanges and bolts on pipe junctions at ICT wellheads deteriorating	Paint flanges and monitor for deterioration	CES	State/EPA	12/30/01	No	No
High frequency of repair of electronic equipment following lightning storms indicates need for lightning arrestors/lightning rods to prevent damage to sensitive equipment.	Perform cost analysis for installing lightning protection	USACE	State/EPA	12/30/01	No	No
Metal precipitation process may not be required	Review data and monitoring information	USACE	State/EPA	11/30/02	No	No
Control wires at Site at junction box are not protected	Protect wires at junctions	USACE	State/EPA	5/30/02	No	No
Release of approximately 50,000 gallons of untreated groundwater in January 2001	Review spill procedure and implement Freeze Protection Plan	USACE	State/EPA	11/30/01	No	No
Contaminants in monitor well C-06	Further investigation to determine if there is another source area.	USACE	State/EPA	11/30/02	No	No
Contamination at Northwest of Burning Ground outside of ICT capture zone.	Further study to determine if groundwater extraction from area is required.	USACE	State/EPA	11/30/02	No	Yes
Monitor wells 18WW08 and 18WW17 not in perchlorate sampling of Site 18/24	CES will include these wells in Site 18/24 sampling	CES	State/EPA	5/30/02	No	Yes
COC's detected in onsite monitoring not included in investigations.	Review analysis of ICT's and monitoring wells conducted by onsite GWTP contractor for COC's. Include new COC's in subsequent investigations as necessary.	USACE	State/EPA	8/30/02	No	Yes

Table 9.0-2 Recommendations for Site 12

Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Yes/No)	
					Current	Future
Groundwater monitoring not conducted regularly or documented properly	Monitor the wells on a regular basis and document in annual report.	USACE	State/EPA	11/30/02	No	Yes
Erosion on landfill near cap toe	Repair erosion	CES	USACE	2/30/02	No	Yes
Need Operation & Maintenance Plan for Site	Write and implement a O&M Plan for Site	USACE	State/EPA	8/30/02	No	Yes
Non source soils not protected by cap	Investigate and determine if action is necessary and include in final ROD.	USACE	State/EPA	11/30/02	No	Yes

Table 9.0-3 Recommendations for Site 16

Issue	Recommendations/Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Yes/No)	
					Current	Future
Groundwater monitoring not conducted regularly or documented properly	Monitor the wells on a regular basis and document in annual report.	USACE	State/EPA	5/30/02	No	Yes
Need Operation & Maintenance Plan for Site	Write and implement a O&M Plan for site	USACE	State/EPA	8/30/02	No	Yes
Evaluate the hydrogeologic effectiveness of the groundwater extraction system	Perform study to determine effectiveness of extraction system	USACE	State/EPA	11/30/02	No	Yes
Groundwater model in RF/FS should provide modeling of perchlorate and possibly other contaminants	Perform study to determine impact of other contaminants on environment	USACE	State/EPA	11/30/02	No	Yes
Steel covers off of housing at extraction wells.	Place covers on housing or replace with lighter covers more easily moved	CES / USACE	State/EPA	5/30/02	No	No

10.0 PROTECTIVENESS STATEMENT(S)

The protection of human health and the environment by the remedial actions at Site 18/24, Site 12, and Site 16 are discussed below. Both the Onsite Health and Safety Plan and the Contingency plan are in place and are adequate to control risks, and are properly implemented. These apply to all sites and substantially reduce the chance of exposure to contaminants even if the caps or extraction systems fail.

10.1 Sites 18 and 24

The Early Interim Remedial Action at Site 18/24 currently serves the purpose of protecting human health and the environment by controlling exposure pathways that could result in unacceptable risks. The migration of contaminants to wells screened in the intermediate and deeper groundwater zones has been stable and/or declining.

The removal action and operation of the ICT's and treatment of the water at the GWTP are protective of the environment and human health by greatly reducing the chance of contaminants leaving the site. As long as the ICT's and the GWTP are in operation, this will remain true. As an early interim action this was not intended to be final solution. Risk assessments for human health and the environment are being prepared for the site in accordance with the RI/FS.

10.2 Site 12

The Early Interim Remedial Action at Site 12 is expected to be protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

The early interim remedial action at Site 12 is expected to reduce the potential for vertical infiltration of water through the landfills and to minimize contaminant transport. The assessment of this five-year review found that the remedy was constructed in accordance with the requirements of the ROD for Site 12.

Although the cap is protective of the environment and human health by reducing the amount of water moving through the source material, the effectiveness of the cap needs to be further evaluated. Groundwater monitoring has not been conducted frequently enough to establish seasonal groundwater contours or contaminant trends. In addition, non-source area soil that contains contaminants is not protected by the cap from infiltration of water and may be a cause of concern.

The risk assessment for the site also needs to be completed. As an Early Interim Remedial Action, the cap was not intended to be final solution. However, pending the outcome of the risk assessment and groundwater monitoring, the cap may be the final solution.

10.3 Site 16

The remedial action at Site 16 is expected to be protective of human health and the environment by serving its intended purpose to reduce the potential for vertical infiltration of water through the landfill. With the addition of eight extraction wells as part of the accelerated RI/FS, the remedial action meets the objective to minimize contaminant transport. The removal action and operation of the eight extraction wells assist in protection of the environment and human health by greatly reducing the chance of contaminants leaving the site. For the remedial action to remain effective, the extraction wells will remain in operation. As an Early Interim Remedial Action this was not intended to be final solution. A Feasibility Study is still in progress.

Future remedies at Site 16 need to evaluate the following:

- The effectiveness of the cap needs to be evaluated through regular groundwater monitoring.
- Determine if additional monitoring wells and piezometers need to be installed between the landfill and Harrison Bayou.
- The Baseline Risk Assessment for Human Health states “Based on the results of the Site 16 baseline risk assessment, it appears that groundwater is the primary medium of concern at the site. The hypothetical future use of groundwater should be further evaluated by 1) identifying the effect of the current groundwater extraction system on groundwater concentrations relative to potential future sites uses: and 2) identifying the potential for contaminants identified in onsite groundwater to migrate off-site.”
- Site 16, needs additional ecological risk assessment work before a final decision can be made concerning the final remedy.

11.0 NEXT REVIEW

This Site requires ongoing five-year reviews. The next review will be conducted within 5 years of the completion of this five-year review report. The completion date is the date of the signature shown on the signature cover attached to the front of the report.

END OF REPORT
for
Five-Year Review

Longhorn Army Ammunition Plant
Karnack, Texas

Site 18/24 (Burning Ground 3)
Site 16 (Old Landfill)
Site 12 (Sanitary Landfill)

Appendix

- A. Five Year-Review Site Inspection Checklist**
- B. Documents Reviewed**
- C. Regulatory Review**
- D. Photographs**
- E. Site 18/24 Contaminant Contour Maps**
- F. Site 12 Groundwater Elevation Contour Maps**
- G. Site 16 Groundwater Elevation Contour Maps**
- H. Survey Forms**

APPENDIX A

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

Information may be completed by hand and attached to the five-year review report as supporting documentation of site status. "N/A" refers to "not applicable."

I. SITE INFORMATION	
Site Name: <u>Longhorn Army Ammunition Plant</u>	Date of Inspection: 10/17-18/01
Location and Region: Harrison County, Texas, Region 6	EPA ID: TX6213820529
Agency, office, or company leading the five-year review: Complete Environmental Service (Onsite Contractor) Corps of Engineers (Tulsa District)	Weather/temperature: Clear & Sunny/ 60 °F
Remedy Includes: (Check all that apply) <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Landfill cover/containment <input checked="" type="checkbox"/> Access controls <input checked="" type="checkbox"/> Institutional controls <input checked="" type="checkbox"/> Ground water pump and treatment <input type="checkbox"/> Surface water collection and treatment <input type="checkbox"/> Other 	
Attachments: <input type="checkbox"/> Inspection team roster attached <input checked="" type="checkbox"/> Site map attached	

II. INTERVIEWS (Check all that apply)		
1. O&M Site Manager		
<u>William Richard Corrigan</u>	<u>O&M Project Manager</u>	<u>10/17/01</u>
Name	Title	Date
Interviewed: <input type="checkbox"/> by mail <input checked="" type="checkbox"/> at office <input type="checkbox"/> by phone Phone no.		
Problems, suggestions: <input checked="" type="checkbox"/> Report attached		
2. O&M Staff		
<u>Scott Beesinger</u>	<u>Quality Control Manager</u>	<u>10/17/01</u>
<u>Lanita Burchfield</u>	<u>Office Administrator</u>	<u>10/17/01</u>
<u>Robert Owen</u>	<u>Plant Operator</u>	<u>10/17/01</u>
<u>William Corrigan II</u>	<u>Plant Operator/Maintenance</u>	<u>10/17/01</u>
Name	Title	Date
Interviewed: <input type="checkbox"/> by mail <input checked="" type="checkbox"/> at office <input type="checkbox"/> by phone Phone no.		
Problems, suggestions: <input checked="" type="checkbox"/> Report attached		

II. INTERVIEWS (continued)

3. Local regulatory authorities and response agencies (i.e.; State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency Texas Natural Resource Conservation Commission

Contact <u>Jim Sher</u>	<u>Team Leader</u>	<u>9/12/01</u>	<u>512-239-2444</u>
Name	Title	Date	Phone no.

Problems, suggestions: Report attached See survey

Agency U.S. Environmental Protection Agency – Region VI

Contact <u>Chris G. Villarreal</u>	<u>Remedial Project Manager</u>	<u>9/18/01</u>	<u>214-665-6758</u>
Name	Title	Date	Phone no.

Problems, suggestions: Report attached See survey

4. Other interviews (optional): Report attached to Five-Year Review Report

1. Cliff Murray, Environmental Engineer, Corps of Engineers
2. Bob Speight, Vice President, Greater Caddo Lake Association
3. Wes & Joann Hodges, Local Business Owners
4. Roy Darville, Professor of Biology, East Texas Baptist University
5. Bill Sniffen, Geologist
6. H.L. (Bud) Jones

III. ONSITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. O&M Documents

- | | | | |
|---|---|--|------------------------------|
| <input checked="" type="checkbox"/> O&M manual | <input checked="" type="checkbox"/> Readily available | <input checked="" type="checkbox"/> Up to date | <input type="checkbox"/> N/A |
| <input checked="" type="checkbox"/> As-built drawings | <input checked="" type="checkbox"/> Readily available | <input checked="" type="checkbox"/> Up to date | <input type="checkbox"/> N/A |
| <input checked="" type="checkbox"/> Maintenance logs | <input checked="" type="checkbox"/> Readily available | <input checked="" type="checkbox"/> Up to date | <input type="checkbox"/> N/A |

Remarks: O&M manual kept at onsite, scheduled inspections up to date. All process monitoring logs, maintenance logs, calibration logs, air emissions reports, monthly reports, quarterly reports and annual reports available.

2. Site-Specific Health and Safety Plan

- | | | | |
|--|---|--|------------------------------|
| <input checked="" type="checkbox"/> Contingency plan/emergency response plan | <input checked="" type="checkbox"/> Readily available | <input checked="" type="checkbox"/> Up to date | <input type="checkbox"/> N/A |
|--|---|--|------------------------------|

Remarks: Reviewed annually.

III.2 ONSITE DOCUMENTS & RECORDS VERIFIED (continued)

3. O&M and OSHA Training Records Readily available Up to date N/A

Remarks: Confined Space and Hot Work Permits utilized. Training records for Hazwoper, CPR, and First-Aid training and RCRA training records onsite.

4. Permits and Service Agreements

- Air discharge permit Readily available Up to date N/A
- Effluent discharge Readily available Up to date N/A
- Waste disposal, POTW Readily available Up to date N/A
- Other permits Readily available Up to date N/A

Remarks: 1) Site operates by Standard Exemption for air emissions. Exemption requirements documented onsite. 2) Site has effluent limitations in ROD that it monitors by a testing plan listed in the "Groundwater Treatment Plant and Wellfields Sampling and Analysis Plan."

5. Gas Generation Records Readily available Up to date N/A

Remarks:

6. Settlement Monument Records Readily available Up to date N/A

Remarks:

7. Ground Water Monitoring Records Readily available Up to date N/A

Remarks:

8. Leachate Extraction Records Readily available Up to date N/A

Remarks:

9. Discharge Compliance Records

- Air Readily available Up to date N/A
- Water (effluent) Readily available Up to date N/A

Remarks: Discharge compliance records are available in the Monthly Reports and in the Quarterly Reports prepared by the onsite contractor. Analytical reports are filed onsite by event and date. Onsite air monitoring is verified by continuous emissions monitoring and hourly averages are printed and filed.

10. Daily Access/Security Logs Readily available Up to date N/A

Remarks: Access to the site controlled by Security. Entrance logs onto LHAAP available at LHAAP Security and access to Site 18/24 available at the Groundwater Treatment Plant.

IV. O&M COSTS

1. O&M Organization

- | | |
|---|---|
| <input type="checkbox"/> State in-house | <input type="checkbox"/> Contractor for State |
| <input type="checkbox"/> PRP in-house | <input type="checkbox"/> Contractor for PRP |
| <input checked="" type="checkbox"/> Other (Contractor for U.S. Army Corps of Engineers) | |

2. O&M Cost Records

- | | |
|--|--|
| <input checked="" type="checkbox"/> Readily available | <input checked="" type="checkbox"/> Up to date |
| <input checked="" type="checkbox"/> Funding mechanism/agreement in place | |
| Original O&M cost estimate <u>\$400,000 per year</u> | <input type="checkbox"/> Breakdown attached |

Total annual cost by year for review period, if available

(Groundwater Treatment Plant)

From <u>January 1997</u>	to <u>December 1997</u>	<u>\$ 907,721</u>	<input type="checkbox"/> Breakdown attached
Date	Date	Total cost	
From <u>January 1998</u>	to <u>December 1998</u>	<u>\$ 779,278</u>	<input type="checkbox"/> Breakdown attached
Date	Date	Total cost	
From <u>January 1999</u>	to <u>December 1999</u>	<u>\$ 1,007,209</u>	<input type="checkbox"/> Breakdown attached
Date	Date	Total cost	
From <u>January 2000</u>	to <u>December 2000</u>	<u>\$ 692,370</u>	<input type="checkbox"/> Breakdown attached
Date	Date	Total cost	
From <u>January 2001</u>	to <u>October 2001</u>	<u>\$ 580,066</u>	<input type="checkbox"/> Breakdown attached
Date	Date	Total cost	

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons:

1. Addition of carbon treatment units added about \$ 63,000 in 1998-1999.
2. Additional expense of \$ 12,000 in July 1999 due to Catox Blower failure.
3. Additional expense of \$ 20,722 in October 1999 due to lightning damage.
4. Additional expense \$ 7,000 in August 2001 due to lightning damage.
5. Additional expense of \$645,000 during CY 2000-2001 to install perchlorate treatment system. Ongoing operational expense of \$20,000 per year.

V. ACCESS AND INSTITUTIONAL CONTROLS Applicable N/A

A. Fencing

1. Fencing damaged Location shown on site map Gates secure N/A
Remarks: No damage evident other than vegetation growing within mesh. Trees growing near powerline ROW need to be trimmed or removed.

B. Other Access Restrictions

1. Signs and other security measures Location shown on site map N/A
Remarks: Warning signs posted properly around landfills. Restricted access warning signs need to be placed around Site 18/24. Fences in place and well maintained around each Site.

C. Institutional Controls

1. Implementation and enforcement
Site conditions imply ICs not properly implemented Yes No N/A
Site conditions imply ICs not being fully enforced Yes No N/A

Type of monitoring (e.g., self-reporting, drive by) Self reporting & security driveby/walkthrough
Frequency Three times/day
Responsible party/agency Department of Army Contractor
Contact

Name	Title	Date	Phone no.
Al Smith	Security Chief	11/01/01	318-459-5403

Reporting is up-to-date Yes No N/A
Reports are verified by the lead agency Yes No N/A

Specific requirements in deed or decision documents have been met Yes No N/A
Violations have been reported Yes No N/A
Other problems or suggestions: Report attached

2. Adequacy ICs are adequate ICs are inadequate N/A
Remarks: Property owned by federal government. Site is fenced and security staff is onsite 24 hours per day.

D. General

1. Vandalism/trespassing Location shown on site map No vandalism evident
Remarks: Lawn mower and ATV stolen from site in 1999. Security fence cut at GWTP for access. Fence repaired and theft reported to Harrison County authorities.

V.D.2 ACCESS AND INSTITUTIONAL CONTROLS (continued)	
2. Land use changes onsite	<input type="checkbox"/> N/A
Remarks: <u>Land will remain under federal/Army control.</u>	
3. Land use changes offsite	<input checked="" type="checkbox"/> N/A
Remarks:	

VI. GENERAL SITE CONDITIONS	
A. Roads	<input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A
1. Roads damaged	<input checked="" type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Roads adequate <input type="checkbox"/> N/A
Remarks: <u>Potholes roadway at Site 18/24 Area were noted during Site Inspection.</u>	
B. Other Site Conditions	
Remarks: <u>Site was in good condition during visit, but vegetation sparse and distressed in many areas due to lack of topsoil after construction of ICT's, etc..</u>	

VII. LANDFILL COVERS		<input checked="" type="checkbox"/> Applicable	<input type="checkbox"/> N/A
A. Landfill Surface			
1. Settlement (Low spots)	<input checked="" type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> Settlement not evident	
Areal extent	Depth		
Remarks: <u>Grass on landfill cover well maintained. Landfill undergoes quarterly inspection per RCRA requirements. Some minor erosion on Northeast location of Site 12. Under contract to be repaired.</u>			
2. Cracks	<input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> Cracking not evident	
Lengths	Widths	Depths	
Remarks:			
3. Erosion	<input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> Erosion not evident	
Areal extent	Depth		
Remarks:			

VII.A.3 LANDFILL COVERS (continued)		
4. Holes Areal extent Depth Remarks:	<input type="checkbox"/> Location shown on site map <input type="checkbox"/> Depth	<input checked="" type="checkbox"/> Holes not evident
5. Vegetative Cover <input type="checkbox"/> Trees/Shrubs (indicate size and locations on a diagram) Remarks: <u>Cover sparse and stressed in several locations where topsoil is thin. However, cover appears to be holding and not much erosion is evident.</u>	<input checked="" type="checkbox"/> Grass <input checked="" type="checkbox"/> Cover properly established	<input type="checkbox"/> No signs of stress
6. Alternative Cover (armored rock, concrete, etc.) Remarks: <u>Rip-rap on Site 16 constructed of concrete. The riprap is in good condition with no vegetation within.</u>	<input checked="" type="checkbox"/> N/A	
7. Bulges Areal extent Depth Remarks:	<input type="checkbox"/> Location shown on site map <input type="checkbox"/> Depth	<input checked="" type="checkbox"/> Bulges not evident
8. Wet Areas/Water Damage <input type="checkbox"/> Wet areas <input type="checkbox"/> Ponding <input type="checkbox"/> Seeps <input type="checkbox"/> Soft subgrade Remarks: <u>Area dry during inspection.</u>	<input type="checkbox"/> Location shown on site map <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> Wet areas/water damage not evident <input type="checkbox"/> Areal extent <input type="checkbox"/> Areal extent <input type="checkbox"/> Areal extent <input type="checkbox"/> Areal extent
9. Slope Instability Areal extent Remarks:	<input type="checkbox"/> Slides <input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> No evidence of slope instability
B. Benches Remarks:	<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Flows Bypass Bench Remarks:	<input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> N/A or okay

VII.B LANDFILL COVERS (continued)		
2. Bench Breached Remarks:	<input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> N/A or okay
3. Bench Overtopped Remarks:	<input type="checkbox"/> Location shown on site map	<input checked="" type="checkbox"/> N/A or okay
C. Letdown Channels <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A (Channel lined with erosion control mats & rip-rap that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		
1. Settlement Areal extent Remarks:	<input type="checkbox"/> Location shown on site map Depth	<input checked="" type="checkbox"/> No evidence of settlement
2. Material Degradation Material type Remarks:	<input type="checkbox"/> Location shown on site map Areal extent	<input checked="" type="checkbox"/> No evidence of degradation
3. Erosion Areal extent Remarks:	<input type="checkbox"/> Location shown on site map Depth	<input checked="" type="checkbox"/> No evidence of erosion
4. Undercutting Areal extent Remarks:	<input type="checkbox"/> Location shown on site map Depth	<input checked="" type="checkbox"/> No evidence of undercutting
5. Obstructions Type <input type="checkbox"/> Location shown on site map Areal extent Size Remarks:		<input checked="" type="checkbox"/> No obstructions
6. Excessive Vegetative Growth Type <input checked="" type="checkbox"/> No evidence of excessive growth <input type="checkbox"/> Vegetation in channels does not obstruct flow <input type="checkbox"/> Location shown on site map Areal extent Remarks: <u>Landfills cut twice yearly.</u>		

VII. LANDFILL COVERS (continued)			
D. Cover Penetrations		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Gas Vents	<input type="checkbox"/> Active <input type="checkbox"/> Passive		
<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled	<input checked="" type="checkbox"/> Good condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs Maintenance	<input checked="" type="checkbox"/> N/A
Remarks:			
2. Gas Monitoring Probes			
<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled	<input type="checkbox"/> Good condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs O&M	<input checked="" type="checkbox"/> N/A
Remarks:			
3. Monitoring Wells (within surface area of landfill)			
<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled	<input type="checkbox"/> Good condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs O&M	<input checked="" type="checkbox"/> N/A
Remarks:			
4. Leachate Extraction Wells			
<input type="checkbox"/> Properly secured/locked	<input checked="" type="checkbox"/> Functioning	<input checked="" type="checkbox"/> Routinely sampled	<input type="checkbox"/> Good condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs O&M	<input type="checkbox"/> N/A
Remarks:			
5. Settlement Monuments	<input type="checkbox"/> Located	<input type="checkbox"/> Routinely surveyed	<input checked="" type="checkbox"/> N/A
Remarks:			
E. Gas Collection and Treatment		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Gas Treatment Facilities			
<input type="checkbox"/> Flaring	<input type="checkbox"/> Thermal destruction	<input type="checkbox"/> Collection for reuse	
<input type="checkbox"/> Good condition		<input type="checkbox"/> Needs Maintenance	
Remarks:			
2. Gas Collection Wells, Manifolds, and Piping			
<input type="checkbox"/> Good condition		<input type="checkbox"/> Needs Maintenance	
Remarks:			
3. Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings)			
<input type="checkbox"/> Good condition		<input type="checkbox"/> Needs Maintenance	<input checked="" type="checkbox"/> N/A
Remarks:			

VII. LANDFILL COVERS (continued)			
F. Cover Drainage Layer		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Outlet Pipes Inspected		<input type="checkbox"/> Functioning	<input checked="" type="checkbox"/> N/A
Remarks:			
2. Outlet Rock Inspected		<input type="checkbox"/> Functioning	<input checked="" type="checkbox"/> N/A
Remarks:			
G. Detention/Sedimentation Ponds		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Siltation	Areal extent Siltation not evident	Depth	<input checked="" type="checkbox"/> N/A
Remarks:			
2. Erosion	Areal extent Erosion not evident	Depth	
Remarks:			
3. Outlet Works	<input type="checkbox"/> Functioning	<input checked="" type="checkbox"/> N/A	
Remarks:			
4. Dam	<input type="checkbox"/> Functioning	<input checked="" type="checkbox"/> N/A	
Remarks:			
H. Retaining Walls		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
1. Deformations	<input type="checkbox"/> Location shown on site map	<input type="checkbox"/> Deformation not evident	
	Horizontal displacement	Vertical displacement	
	Rotational displacement		
Remarks:			
2. Degradation	<input type="checkbox"/> Location shown on site map	<input type="checkbox"/> Degradation not evident	
Remarks:			

VII. LANDFILL COVERS (continued)		
I. Perimeter Ditches/Off-Site Discharge <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> N/A		
1. Siltation Areal extent Depth Remarks:	<input type="checkbox"/> Location shown on site map	<input type="checkbox"/> Siltation not evident
2. Vegetative Growth Areal extent Type Remarks:	<input type="checkbox"/> Location shown on site map <input type="checkbox"/> Vegetation does not impede flow	<input type="checkbox"/> N/A
3. Erosion Areal extent Depth Remarks:	<input type="checkbox"/> Location shown on site map	<input type="checkbox"/> Erosion not evident
4. Discharge Structure Remarks:	<input type="checkbox"/> Functioning	<input type="checkbox"/> N/A

VIII. VERTICAL BARRIER WALLS <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> N/A		
1. Settlement Areal extent Depth Remarks:	<input type="checkbox"/> Location shown on site map <input type="checkbox"/> Depth	<input type="checkbox"/> Settlement not evident
2. Performance Monitoring Frequency Head differential Remarks:	Type of monitoring <input type="checkbox"/> Performance not monitored	<input type="checkbox"/> Evidence of breaching

IX. GROUND WATER/SURFACE WATER REMEDIES <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A		
A. Ground Water Extraction Wells, Pumps, and Pipelines <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A		
1. Pumps, Wellhead Plumbing, and Electrical <input checked="" type="checkbox"/> Good condition <input checked="" type="checkbox"/> All required wells located <input type="checkbox"/> Needs Maintenance <input type="checkbox"/> N/A Remarks: <u>Slip flanges at wellheads warrant watching due to deterioration of carbon steel bolts.</u>		

IX. GROUND WATER/SURFACE WATER REMEDIES (continued)

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances

Good condition Needs Maintenance

Remarks:

3. Spare Parts and Equipment

Readily available Good condition Requires upgrade Needs to be provided

Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable N/A

1. Collection Structures, Pumps, and Electrical

Good condition Needs Maintenance

Remarks: Underground control wire at junction box in Site 18/24 exposed to weather.

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances

Good condition Needs Maintenance

Remarks:

3. Spare Parts and Equipment

Readily available Good condition Requires upgrade Needs to be provided

Remarks: Spare parts inventory is kept onsite. All manufacturer's literature is filed onsite and readily available. Spare parts and description of all parts ordered are kept on electronic file.

C. Treatment System Applicable N/A

1. Treatment Train (Check components that apply)

Metals removal Oil/water separation Bioremediation

Air stripping Carbon adsorbers

Filters Sand

Additive (e.g., chelation agent, flocculent) Cationic Polymer

Others

Good condition Needs Maintenance

Sampling ports properly marked and functional

Sampling/maintenance log displayed and up to date

Equipment properly identified

Quantity of ground water treated annually

Quantity of surface water treated annually

Remarks: All construction and process control drawings of GWTP onsite.

IX. C GROUND WATER/SURFACE WATER REMEDIES (continued)	
2. Electrical Enclosures and Panels (Properly rated and functional)	<input type="checkbox"/> N/A <input checked="" type="checkbox"/> Good condition <input type="checkbox"/> Needs Maintenance
Remarks:	
3. Tanks, Vaults, Storage Vessels	<input type="checkbox"/> N/A <input checked="" type="checkbox"/> Good condition <input checked="" type="checkbox"/> Proper secondary containment <input type="checkbox"/> Needs Maintenance
Remarks:	
4. Discharge Structure and Appurtenances	<input type="checkbox"/> N/A <input checked="" type="checkbox"/> Good condition <input type="checkbox"/> Needs Maintenance
Remarks: Some brush around discharge structure.	
5. Treatment Building(s)	<input type="checkbox"/> N/A <input checked="" type="checkbox"/> Good condition (esp. roof and doorways) <input type="checkbox"/> Needs repair
<input checked="" type="checkbox"/> Chemicals and equipment properly stored	
Remarks: <u>Most chemical storage in large tanks within containment area. Only chemical storage outside containment area is polymer in 55-gallon drums or dry chemical (urea) in equipment shed.</u>	
6. Monitoring Wells (Pump and treatment remedy)	<input checked="" type="checkbox"/> Properly secured/locked <input checked="" type="checkbox"/> Functioning <input checked="" type="checkbox"/> Routinely sampled <input checked="" type="checkbox"/> Good condition
<input checked="" type="checkbox"/> All required wells located <input type="checkbox"/> Needs Maintenance <input type="checkbox"/> N/A	
Remarks: <u>Monitor well inspected when sampled twice yearly. Inspection records onsite. Repairs made to wells twice yearly when inspection is completed.</u>	
D. Monitoring Data	
1. Monitoring Data	<input checked="" type="checkbox"/> Is routinely sampled on time <input checked="" type="checkbox"/> Is of acceptable quality
1. Monitoring Data Suggests	<input checked="" type="checkbox"/> Groundwater plume is effectively contained <input checked="" type="checkbox"/> Contaminant concentrations are declining.
D. Monitored Natural Attenuation	
1. Monitoring Wells (Natural attenuation remedy)	<input type="checkbox"/> Properly secured/locked <input type="checkbox"/> Functioning <input type="checkbox"/> Routinely sampled <input type="checkbox"/> Good condition
<input type="checkbox"/> All required wells located <input type="checkbox"/> Needs Maintenance <input checked="" type="checkbox"/> N/A	
Remarks:	

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

At Site 18/24 the interim remedies have been implemented as designed. The treatment of soil reduced the amount source material. The extraction system contains and reduces the groundwater contamination. Hydraulic control has been accomplished as evidenced by the piezometric surface map showing zones of depression. Contaminant concentrations appear to have decreased in wells at the perimeter of the impacted areas. Issues that need to be addressed do not compromise the overall effectiveness of the action.

Landfill Site 12 the interim remedies have been implemented as designed. The cap should reduce the amount of leaching of the contaminants out of the landfill. The issues that need to be addressed do not compromise the overall effectiveness of the landfill cap.

Landfill Site 16 the interim remedies have been implemented as designed. The cap should reduce the amount of leaching of the contaminants out of the landfill. The extraction system contains and reduces the groundwater contamination. The issues that need to be addressed do not compromise the overall effectiveness of the extraction system and the cap.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O& M have been carried out in an efficient manner. Operations and maintenance consists of plant maintenance and repairs, compliance monitoring, maintain spare parts inventory, grounds maintenance, and maintenance of all extraction systems. Employees are well trained and attend at least one training class per year. Maintenance and operations procedures are in place and well documented. Changes have been made when they were required.

Regular monitoring of landfills should be implemented to compare concentrations of contaminants over time to determine if reduction of infiltration reduces concentrations downgradient of landfill.

XI. OVERALL OBSERVATIONS (continued)

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

There was nothing in the document review, site visit, or interviews that would suggest that the protectiveness of the remedy has been compromised. Costs of plant operations & maintenance have escalated due to implementation of a fluidized bed reactor process.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

1. Groundwater monitoring needs to be carried out on a regular basis and summarized in report for Sites 12 and 16.
2. The groundwater extraction systems for sites 16 and 18/24 need to be evaluated to make sure they have the maximum effectiveness.
3. A reduction in monitoring well sampling at Site 18/24 could be reduced as the plume retracts.
4. The metal precipitation process at the GWTP may not be required.

APPENDIX B

DOCUMENTS REVIEWED

Dow Environmental, Final General Work Plan, Interim Remedial Action, Burning Ground No. 3, Longhorn Army Ammunition Plant, Karnack, TX, December 28, 1995.

Complete Environmental Service, Onsite Remediation System Operations Plan for Groundwater Treatment Plant and Wellfields, Longhorn Army Ammunition Plant, Karnack, TX, June 2000.

Jacobs Engineering Group, Inc. Draft Final Feasibility Study for Site 16, Longhorn Army Ammunition Plant, Karnack, TX, December 2001.

Jacobs Engineering Group, Inc. Final Baseline Risk Assessment: A Supplement to the Remedial Investigation report, Site 16 Landfill RI/FS, Longhorn Army Ammunition Plant, Karnack, TX, June 2001.

Jacobs Engineering Group, Inc. Final Ecological Risk Assessment, A Supplement to the Remedial Investigation report, Site 16 Landfill, Longhorn Army Ammunition Plant, Karnack, TX, October 2001.

Jacobs Engineering Group, Inc. Final Remedial Investigation, Group 2 Sites, Longhorn Army Ammunition Plant, Karnack, TX, April 2001.

Jacobs Engineering Group, Inc. Second Quarter Data Summary Report for the Perchlorate Investigation, Longhorn Army Ammunition Plant, Karnack, TX, March 2001.

OHM Remediation Services Corporation, Final Construction Completion Report, Interim Remedial Action, Landfill 12 and 16 Cap Construction, Longhorn Army Ammunition Plant, Karnack, TX, December 1998.

Sverdrup Environmental, Inc., Final Work Plan for the Site 16-Old Landfill Groundwater-Control System, Longhorn Army Ammunition Plant, Karnack, TX, January 1996.

Sverdrup Environmental, Inc., Draft Remedial Investigation Report, Site 16 Landfill Remedial Investigation and Feasibility Study, Longhorn Army Ammunition Plant, Karnack, TX, August 1999.

U.S. Environmental Protection Agency. EPA Superfund Record of Decision: Longhorn Army Ammunition Plant, (Burning Ground 3), Karnack, TX, 12 May 1995.

U.S. Environmental Protection Agency. EPA Superfund Record of Decision: Longhorn Army Ammunition Plant, (The LHAAP 12 and 16 Landfills), Karnack, TX, 12 September 1995.

U.S. Environmental Protection Agency. Comprehensive Five-Year Review Guidance, Office of Emergency and Remedial Response, Washington, D. C., June 2001

U.S. Environmental Protection Agency Region 6 and the U.S. Department of the Army and the State of Texas. Federal Facility Agreement under CERCLA Section 120, Longhorn Army Ammunition Plant, Karnack, TX, September 1991.

U.S. Army Industrial Operations Command. Installation Action Plan for Longhorn Army Ammunition Plant, March 2000.

APPENDIX C

REGULATORY REVIEW

The Record of Decision's (ROD) for Sites 18/24 and for Sites 12 & 16 identified many specific ARAR's pertaining to each site. Types of ARAR's applicable to the sites include Chemical Specific ARAR's, Action Specific ARAR's, and Location Specific ARARs. ARAR's applicable for each Site are listed and discussed in Tables C-1 and C-2. A description of the ARAR review areas are described below.

ROD ACTION-SPECIFIC REQUIREMENTS

Action-specific ARARs are usually technology or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, very different requirements can come into play. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved.

ROD CHEMICAL-SPECIFIC ARARs

Chemical-specific ARARs are health or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. If more than one chemical-specific ARAR exists for a chemical of concern (COC), the most stringent level would be identified as an ARAR for the remedial action.

ROD LOCATION-SPECIFIC ARARs

Location-specific ARARs are restrictions on remedial activities solely based on the location of the remedial activity. Some examples of locations that might prompt a location-specific ARAR include wetlands, sensitive ecosystems or habitats, flood plains, and areas of historical significance.

TO BE CONSIDERED REQUIREMENTS (TBCs)

Many Federal and State environmental and public health agencies develop criteria, advisories, guidance, and proposed standards that are not legally enforceable but contain information that would be helpful in carrying out, or in determining the level of protectiveness of, selected remedies. "To be considered" (TBCs) are environmental policies or proposals that are not ARARs, but to address site-specific concerns and may be used in determining the cleanup levels necessary for protection of human health and the environment. TBCs are meant to complement the use of ARARs, not to compete with or replace them. No TBC's were identified in the ROD's for Site 18/24 or for Site 12 & 16.

The following conclusions support the determination that the Early Interim Remedial Action at the site is expected to be protective of human health and the environment until the final ROD.

Table C-1 Site 18/24

Medium/ Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Soil/RCRA	Federal – 40 CFR 268.44 Treatability Variance Procedures for the thermal desorption treatment of soils and source material	Relevant and Appropriate	40 CFR 268.44 requires the treatment level range that will be established throughout the Treatability Variance for the treatment technologies is a 90 to a 99.9 percent reduction in the concentration of the contaminants upon the completion of the treatment process.	Remediation technology attains treatment levels of contaminants to 99.9% reduction in contaminants prior to land disposal.
Groundwater/ CWA	State – 30 TAC Chapter 307 and 30 TAC Chapter 319 Subchapter B	Applicable, Relevant and Appropriate	30 TAC Chapter 307 establishes the minimum requirements by the State to maintain the quality of water in the state consistent with public health and enjoyment, propagation and protection of terrestrial and aquatic life, etc. 30 TAC Chapter 307 was revised and became effective on 17 August 2000. Although encompassing many changes, of applicable and relevant interest is the revision of toxic criteria to protect aquatic life.	Remediation of contaminated groundwater will reduce ongoing discharges of contaminants to groundwater. Treated effluent discharged will meet the requirements of the State Antidegradation policy. Treatment levels are established in Table 2 of the ROD.
Solid Waste/RCRA	Federal – 40 CFR Part 261 Hazardous Waste Identification and Listing	Applicable, Relevant and Appropriate	40 CFR Part 261 establishes the guidelines to identify wastes subject to regulation and those excluded.	Treatment residuals will be managed in accordance with hazardous waste identification rules. 40 CFR Part 261 allows for some exclusions under 40 CFR Part 273 for universal waste.
Water/CWA	Federal – 40 CFR Part 125 Establishes criteria and standards for the effluent limitations	Applicable, Relevant and Appropriate	40 CFR Part 125 establishes the basis for water discharges to a surface body of water for protection of human health and the environment.	Treatment of the groundwater effectively meets the requirements of the Federal NPDES Program The State program effectively meets the requirements of the federal program.
Water/CWA	State – 30 TAC 308 Establishes criteria and standards for the effluent limitations. 40 CFR 125 adopted by reference.	Applicable, Relevant and Appropriate	30 TAC 308 establishes the basis for water discharges to a surface body of water for protection of human health and the environment. 30 TAC 308 adopts 40 CFR 125 by reference.	Treatment of the groundwater effectively meets the requirements of the State TPDES Program

Air/CAA	State – 30 TAC Chapter 106.262 References to Standard Exemptions and Exemptions from Permitting	Applicable, Relevant and Appropriate	30 TAC 106.262, (formerly TACB Standard Exemption No. 188 of 30 TAC 116) concerning emissions and distance exemptions for physical or operational changes to certain types of facilities.	Treatment of the contaminated water at the GWTP generates a solvent laded airstream (SLA) that is treated in a thermal catalytic oxidizer. The air emissions are monitored continuously with a Continuous Emissions Monitor (CEM). The GWTP emission are not permitted but are operated under a standard exemption. The selected remedy meets the applicable sections of the Rule concerning the emissions limitation of 5 tons/year requirement and distance to offsite receptor requirements of the Rule. This rule is applicable because soil thermal desorption and groundwater treatment by air stripping and catalytic oxidation are part of the remedy.
Air/CAA	State – 30 TAC Chapter 106.533 References to Standard Exemptions and Exemptions from Permitting	Applicable, Relevant and Appropriate	30 TAC 106.533, (formerly TACB Standard Exemption No. 68 of 30 TAC 116) concerns exemptions for waste processes and remediation facilities. Facility must meet emissions limitations and certain record keeping requirements. Effective 15 November 1996, all exemptions are included under 30 TAC Chapter 106.	The selected remedy meets the applicable sections of the Rule concerning total emissions of TPH are not to exceed one pound/hour. This rule is applicable because soil thermal desorption and groundwater treatment by air stripping and catalytic oxidation are part of the remedy.
Air/OSHA	Federal - 29 CFR 1910 Occupational Safety and Health	Applicable, Relevant and Appropriate	29 CFR 1910 establishes standards for occupational health and safety.	Action levels for volatile and semi-volatile air contaminants will be established for implementation during onsite remedial activities. Action levels will be established for hearing protection and respiratory protection during onsite remedial activities. Furthermore, an onsite training program and mandatory health and safety standards will be enforced during the remedial activities

Floodplains/ RCRA	Federal - 40 CFR 264.18 Location Standards	Applicable, Relevant and Appropriate	This regulation identifies geological features that a proposed location for a RCRA hazardous waste treatment and/or disposal facility must avoid. One of the three specific features applies to the site: Floodplain – A facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or any hazardous waste by a 100-year flood unless the owner or operator can demonstrate to the Regional Administrator that he can meet the criteria established under this subpart, which exempts him from the requirement.	RCRA requirements for the location of a treatment, storage, or disposal facility in a flood plain were noted to apply in the 1995 ROD because part of the Burning Ground is within a 100-year floodplain.
Water/CWA	State – 30 TAC Chapter 350 Ground Water Restoration.	Applicable, Relevant and Appropriate	30 TAC Chapter 350 concerning the Texas Risk Reduction Program (TRRP) became effective on 23 September 1999 and replaced 30 TAC 335 Subchapter S. The purpose of the TRRP is to develop a consistent and reasonable risk based corrective action program. The rule allows for a choice of three levels of cleanup values, each with a different level of effort. The new rule utilizes different exposure factors that the 30 TAC 335 Subchapter S Risk Reduction Standards that it replaced. The TRRP rule establishes Protective Concentration Levels determined by land use, groundwater classification, and receptors lieu of specific cleanup levels	The State of Texas Groundwater Rules were cited in the 1995 ROD as a location-specific ARAR. It is applicable because the site's underlying ground water is affected. This rule requires ground water to be monitored and restored, if feasible. Ground water has not yet been restored at the site, as remediation is still underway.
Historic Sites/NHPA	Federal – 36 CFR 800 National Historic Preservation Act of 1966, archeological concerns.	Applicable, Relevant and Appropriate	A location-specific ARAR, this Act establishes procedures to preserve historical and archeological data that could be destroyed through terrain alteration as a result of federal construction projects or federally licensed activities or programs	The selected remedy should not disturb areas that have not previously been disturbed. No archeological concerns have been discovered at the site.

Table C-1 Site 12 & 16

Medium/ Authority	ARAR	Status	Requirement Synopsis	Action to be taken to Attain ARAR
Water/CWA	Federal – 40 CFR Part 125 Establishes criteria and standards for the effluent limitations	Applicable, Relevant and Appropriate	40 CFR Part 125 establishes the basis for water discharges to a surface body of water for protection of human health and the environment.	Minimizing infiltration of the groundwater into the landfills reduces contaminant transport.
Groundwater/ CWA	State – 30 TAC Chapter 307	Applicable, Relevant and Appropriate	30 TAC Chapter 307 establishes the minimum requirements by the State to maintain the quality of water in the state consistent with public health and enjoyment, propagation and protection of terrestrial and aquatic life, etc. 30 TAC Chapter 307 was revised and became effective on 17 August 2000. Although encompassing many changes, of applicable and relevant interest is the revision of toxic criteria to protect aquatic life.	Minimizing infiltration of the groundwater into the landfills reduces contaminant transport to surface water bodies and will meet the requirements of the State Anti-degradation policy.
Workplace/ OSHA	Federal - 29 CFR 1910 Occupational Safety and Health	Applicable, Relevant and Appropriate	29 CFR 1910 establishes standards for occupational health and safety.	Action levels for volatile and semi-volatile air contaminants will be established for implementation during onsite remedial activities. Action levels will be established for hearing protection and respiratory protection during onsite remedial activities. Furthermore, an onsite training program and mandatory health and safety standards will be enforced during the remedial activities
Wetland/ CWA	Federal - 40 CFR Parts 133 and 230 and 33 CFR Parts 320-330	Applicable, Relevant and Appropriate	40 CFR Parts 133 and 230 and 33 CFR Parts 320-330 prohibit the discharge of dredged or fill material into wetlands unless those actions comply with the substantive requirements which are identified under these regulations.	Discharges to wetlands around the site will comply with these requirements.

Landfill/ RCRA	State - 30 TAC 335.112, 335.118, 335.119, and 335.174	Applicable, Relevant and Appropriate	30 TAC 335.112 adopts 40 CFR 265 by reference. These regulations establish general facility standards, preparedness and prevention, contingency plan and emergency procedures, manifest system, groundwater monitoring, and closure and post-closure care.	Remedial activities will comply with all provisions of this regulation with the exception of the financial standards. Federal facilities are exempt from financial standards.
Landfill/ RCRA	Federal - 40 CFR 264.228 and 264.310 Concerning closure and post-closure care	Applicable, Relevant and Appropriate	Action-specific guidelines for areas which may be capped as set forth in 40 CFR 264 include the following: (1) conduct and maintain post-closure care for 30 years; (2) maintain the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover; (3) maintain and operate a leachate collection system unless leachate is deemed to be no longer a threat to human health and the environment; (4) monitor ground water and adequately maintain the ground water recovery system; (5) develop a written post-closure plan that includes a description of monitoring and maintenance, and the name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and (6) document a description of the planned uses of the property during the post-closure period. When the site is prepared to enter the O&M period, an O&M plan will outline the type and frequency of monitoring and maintenance activities to be performed at the site.	Remedial activities will comply with all provisions of this regulation with the exception of the financial standards. Federal facilities are exempt from financial standards.

Floodplains/ RCRA	Federal - 40 CFR 264.18 Location Standards	Applicable, Relevant and Appropriate	This regulation identifies geological features that a proposed location for a RCRA hazardous waste treatment and/or disposal facility must avoid. One of the three specific features applies to the site: Floodplain – A facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or any hazardous waste by a 100-year flood unless the owner or operator can demonstrate to the Regional Administrator that he can meet the criteria established under this subpart, which exempts him from the requirement.	RCRA requirements for the location of a treatment, storage, or disposal facility in a flood plain were noted to apply in the 1995 ROD because part of the Burning Ground is within a 100-year floodplain.
Historic Sites/NHPA	Federal - 36 CFR 800 National Historic Preservation Act of 1966, archeological concerns.	Applicable, Relevant and Appropriate	A location-specific ARAR, this Act establishes procedures to preserve historical and archeological data that could be destroyed through terrain alteration as a result of federal construction projects or federally licensed activities or programs	The selected remedy should not disturb areas that have not previously been disturbed. No archeological concerns have been discovered at the site.

APPENDIX D
PHOTOGRAPHS



**Site 18/24 Groundwater Treatment Plant
(From Northwest)**



**Site 18/24 Groundwater Treatment Plant
(From Southwest)**



View of Fluidized Bed Reactor at Groundwater Treatment Plant



**Entrance to Site 18/24
(UEP Cap is at right in picture)**



Interceptor Collection Trench Wellhead



Interceptor Collection Trenches 12-D and 12-E



Unlined Evaporation Pond Cap



View across Site 18/24 from West



GWTP Outfall at Harrison Bayou



**Flange from ICT into Dual Containment Pipe
(Some deterioration of carbon steel flange at ground level)**



Trees in fence at on east site of Site 18/24



Trees in Electrical ROW at Site 18/24



Entrance to Site 12 Landfill



Erosion along fence at Site 12



Site 16 Landfill



Site 16 Extraction Well System



Site 16 Extraction Wells



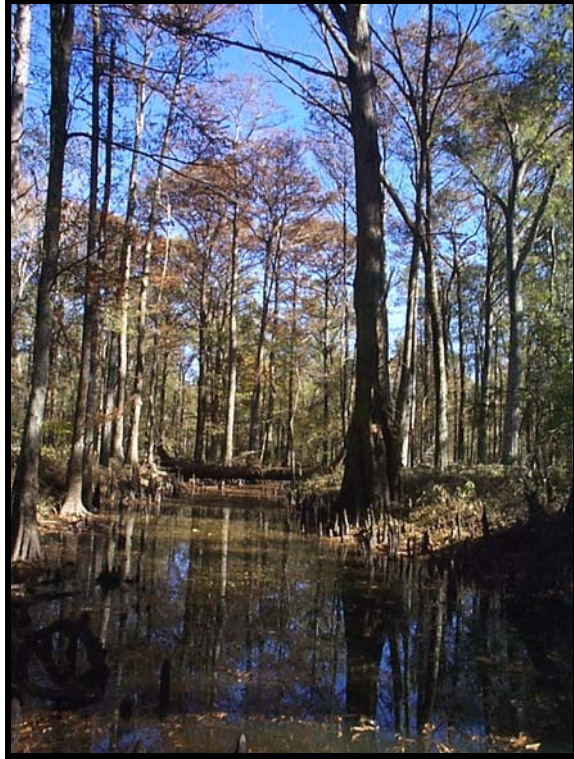
60,000 gallon holding tank at Site 16



Riprap for erosion control on slope of Site 16

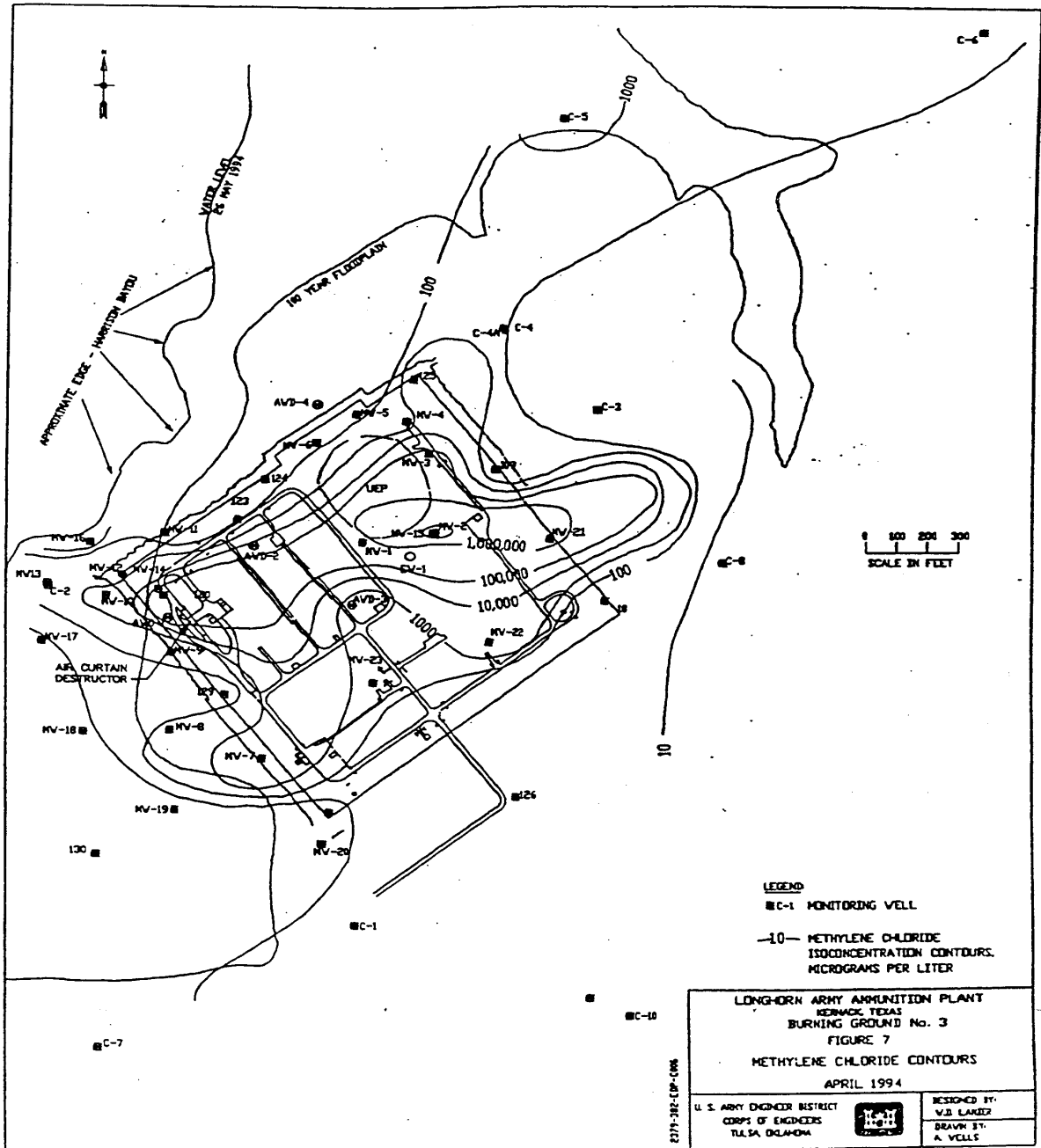


Minor erosion on Site 16 cap

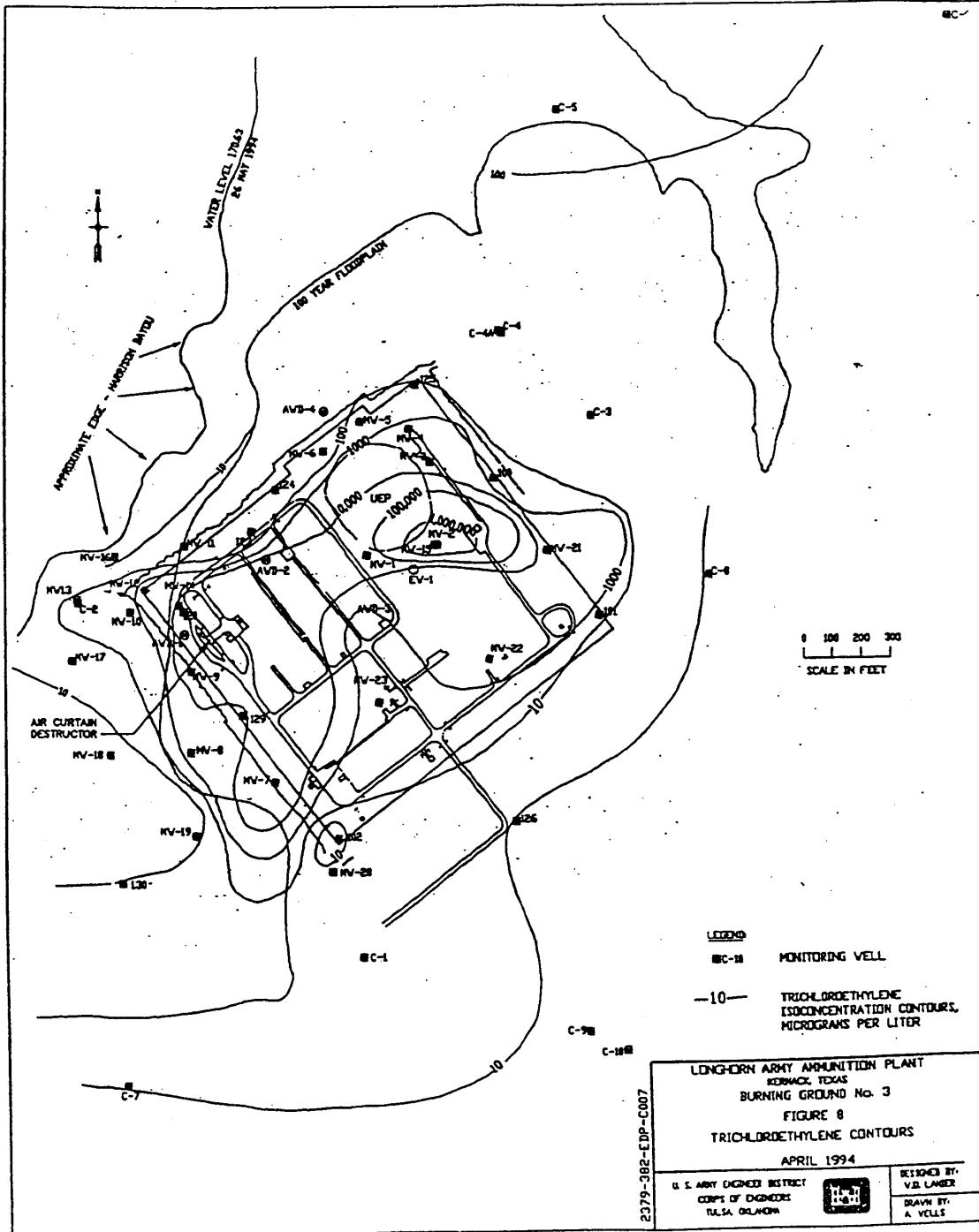


Harrison Bayou near Site 16

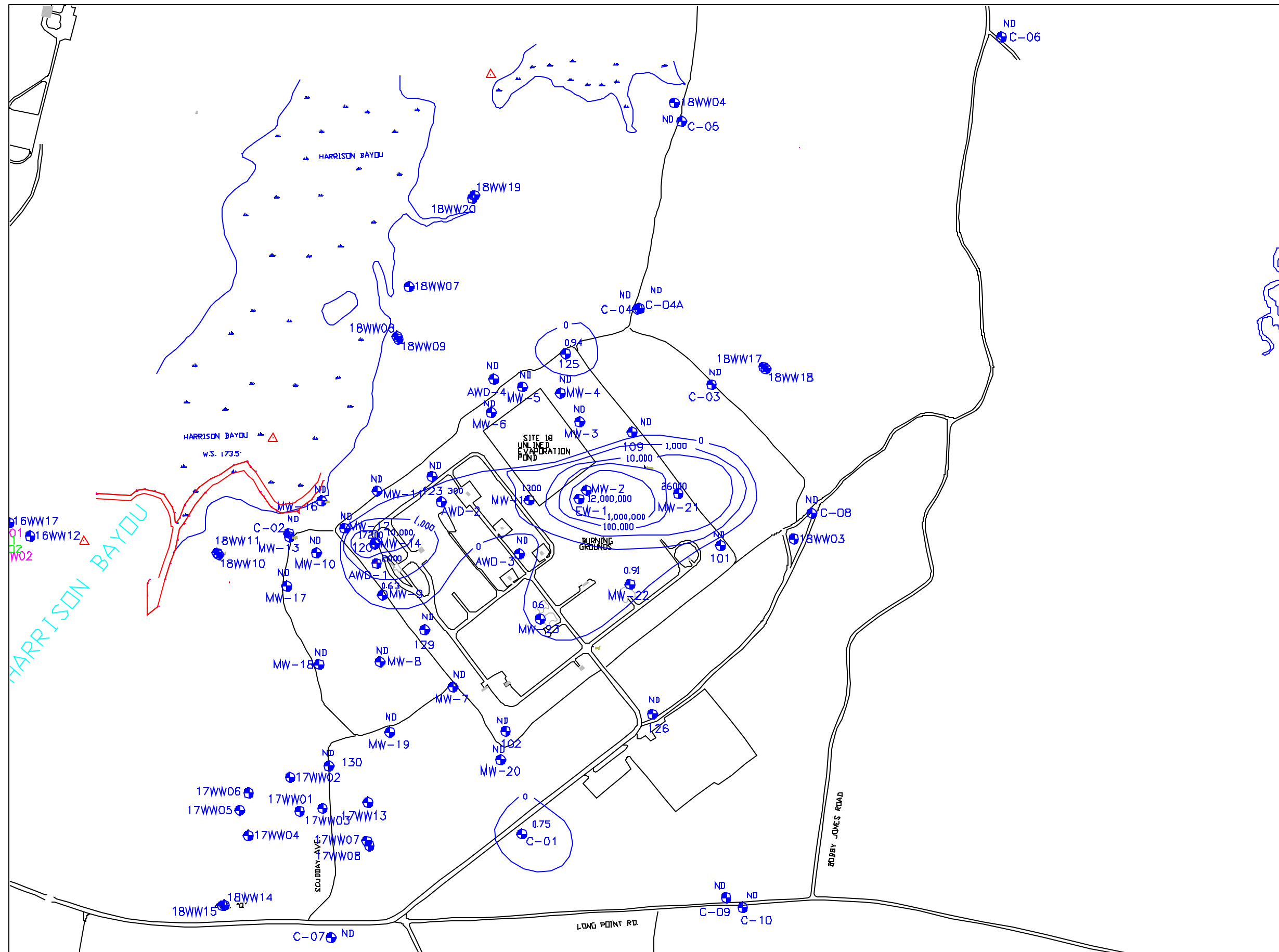
APPENDIX E
CONTAMINANT CONTOUR MAPS



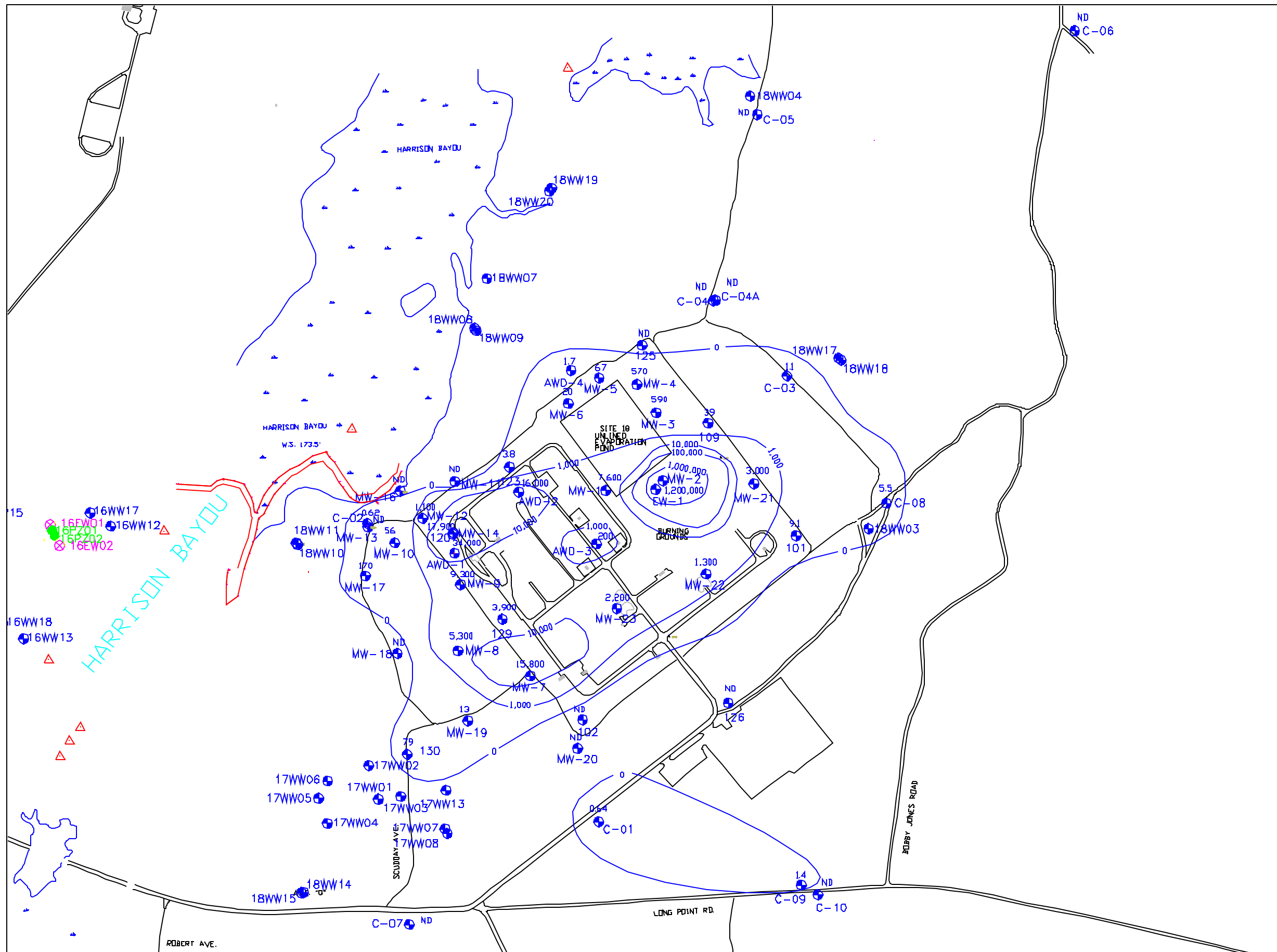
Site 18/24 Methylene Chloride Contour Map from 1995 ROD



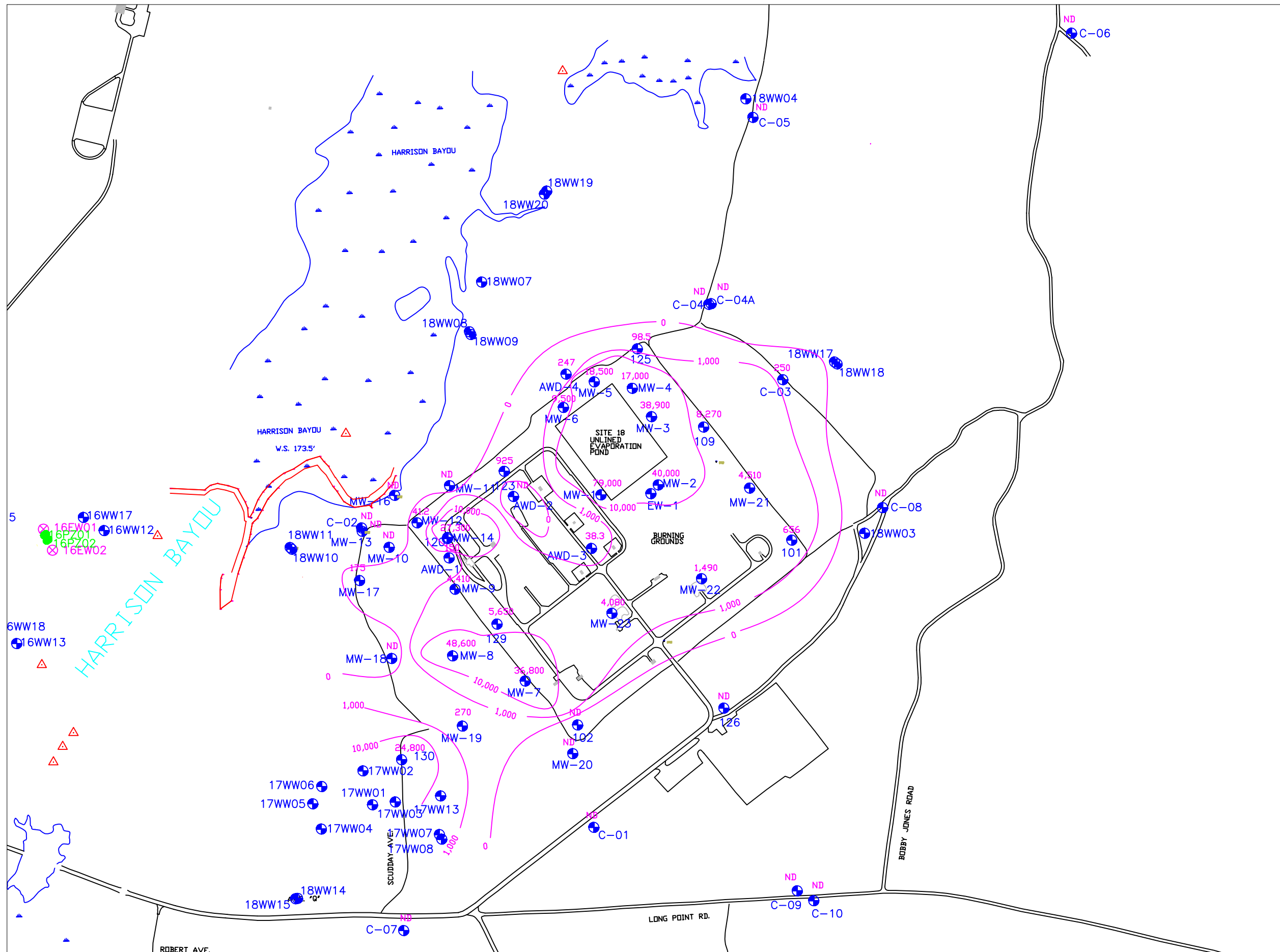
Site 18/24 Trichloroethene Contour Map from 1995 ROD



Complete Environmental Service
 Longhorn AAP Sites 18 & 24
 Methylene Chloride Contours, ug/L
 DATE: April 2001



Complete Environmental Service
 Longhorn AAP Sites 18 & 24
 Trichloroethene Contours, ug/L
 DATE: April 2001

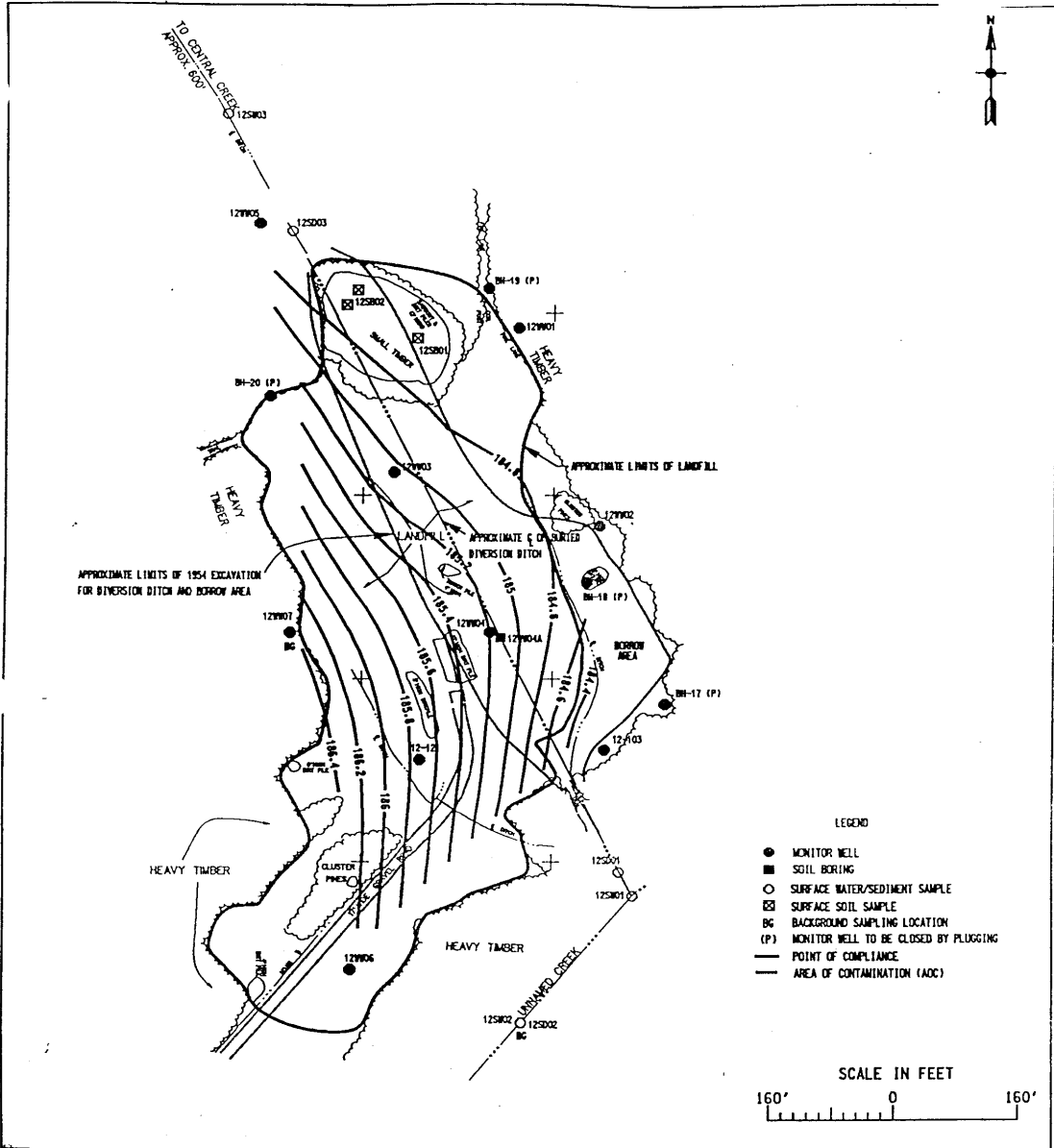



Complete Environmental Service
Longhorn AAP Sites 18 & 24
Perchlorate Contours, ug/L
DATE: April 2001

APPENDIX F

SITE 12 GROUNDWATER ELEVATION CONTOUR MAPS

015690




 US Army Corps
 of Engineers
 Tulsa District

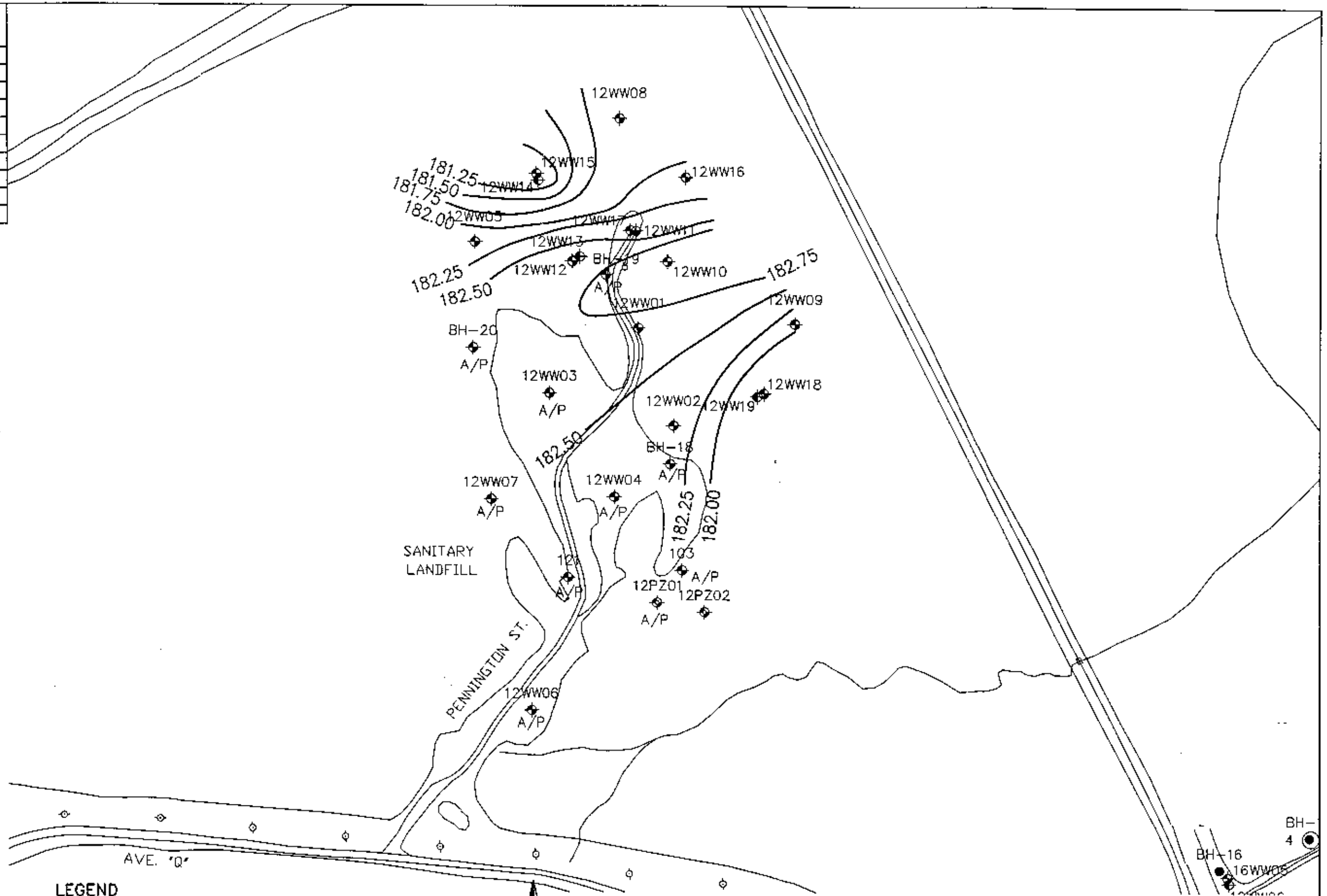
SHALLOW GROUNDWATER CONTOUR MAP
 FOR LHAAP 12

LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

FIGURE
 NUMBER
 6

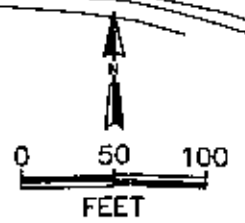
Site 12 Shallow Groundwater Contour Map from 1995 ROD

Well ID	Water Surface Elevation (ft)
12WW01	182.62
12WW02	182.42
12WW05	182.12
12WW08	181.91
12WW11	183.00
12WW12	182.69
12WW15	181.13
12WW16	182.01
12WW17	182.27
12WW18	181.79



LEGEND

- SHALLOW MONITORING WELL
- INTERMEDIATE MONITORING WELL
- POTENTIOMETRIC SURFACE CONTOUR
- PIEZOMETER
- DEEP MONITORING WELL
- ABANDONED AND PLUGGED



US Army Corps of Engineers

 Texas District

OWN:	CSR	DES.:
CHKD:	BKB	APPD:
DATE:	10/11/99	REV.:

SITE 12 SHALLOW POTENTIOMETRIC SURFACE (8/98)
GROUP 2 REMEDIAL INVESTIGATION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

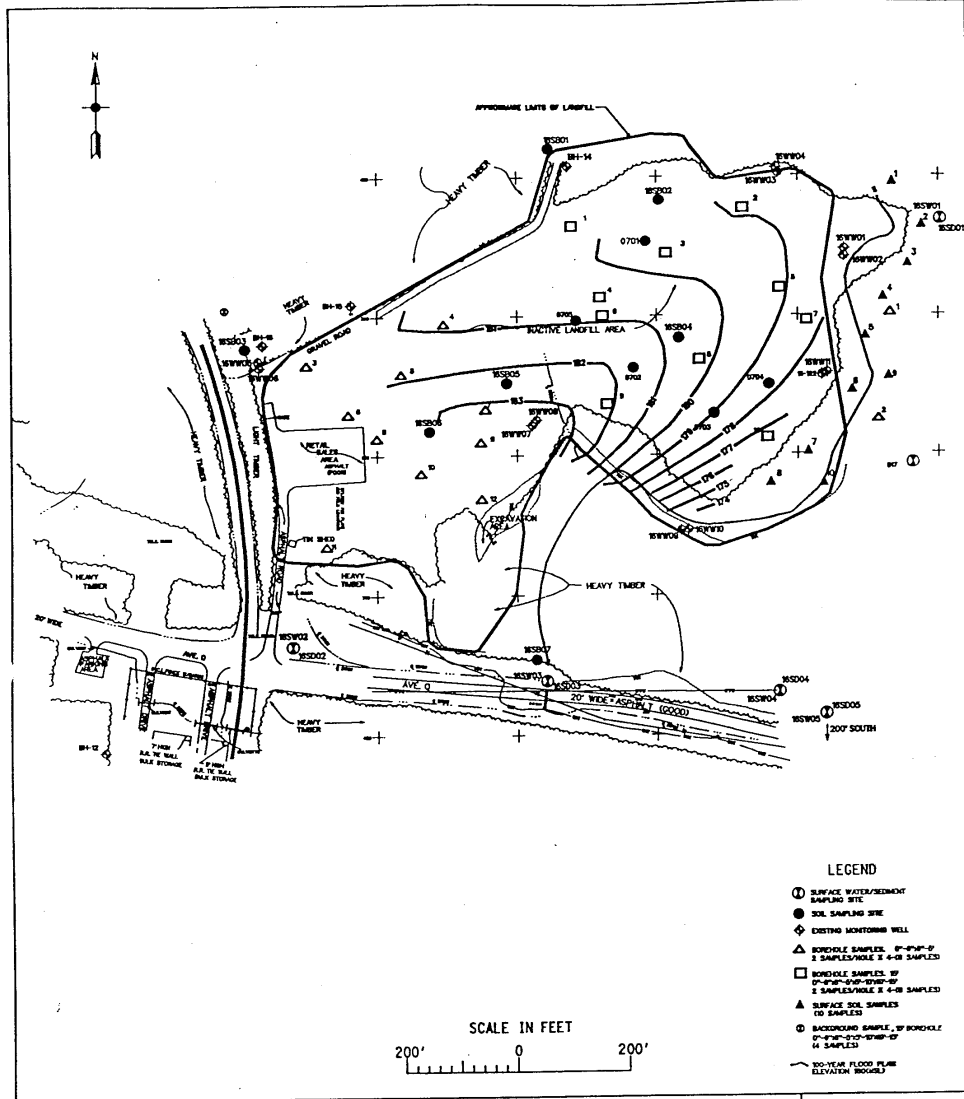
PROJECT NO.:	000187
FIGURE NO.:	3-7

A LOT MORE INFORMATION IS ON THE FILE - PLEASE CONSULT THE APPROPRIATE DATA FILES TO OBTAIN THE COMPLETE DATA SET.

APPENDIX G

SITE 16 GROUNDWATER ELEVATION CONTOUR MAPS

015697



US Army Corps
of Engineers
Tulsa District

SHALLOW GROUNDWATER CONTOUR MAP
FOR LHAAP 16

LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

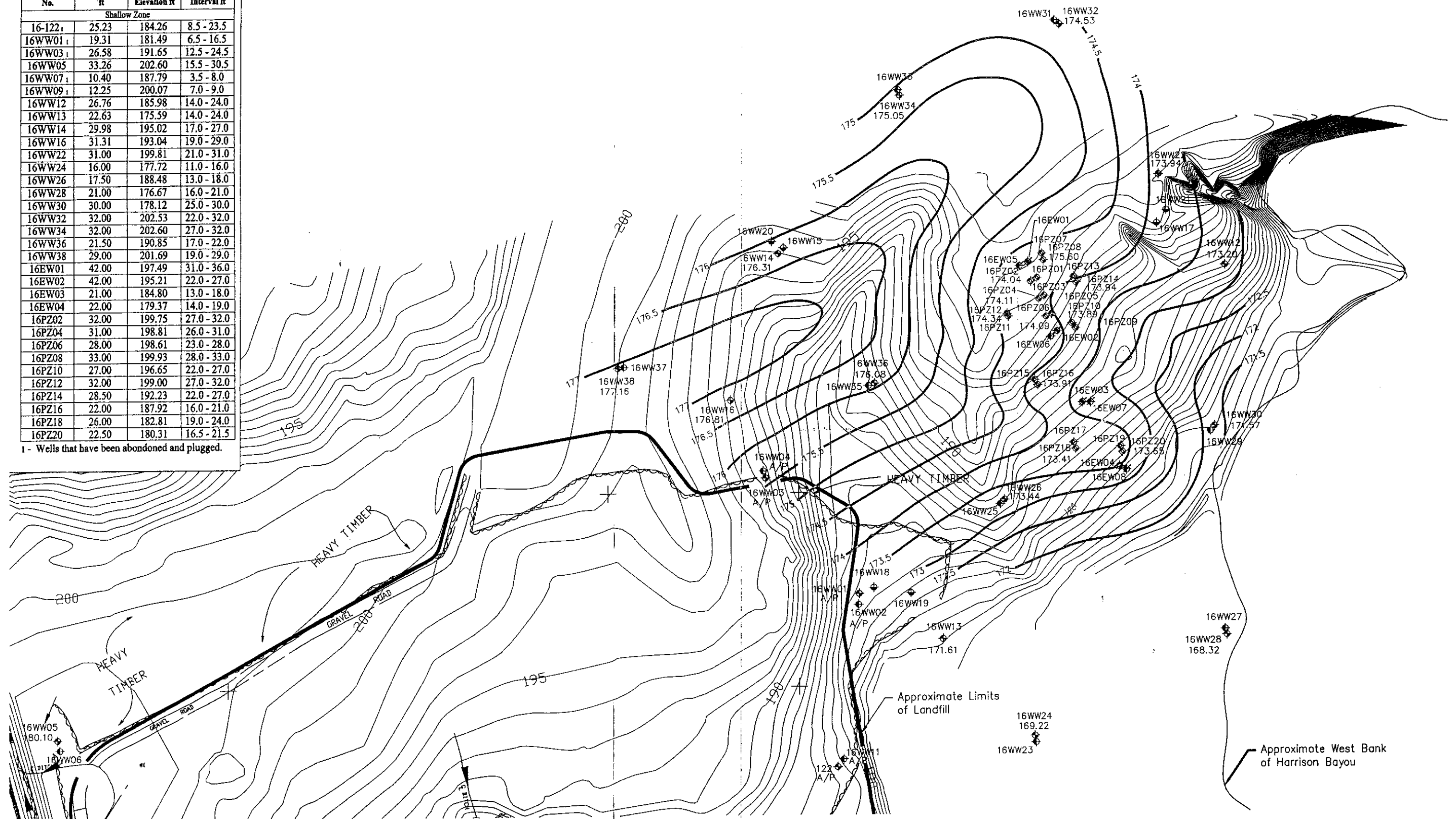
FIGURE
NUMBER

7

Site 16 Shallow Groundwater Contour Map from 1995 ROD

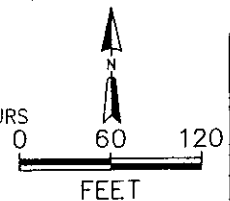
Well Identification No.	Total Depth of Well ft	Ground Surface Elevation ft	Depth of Screen Interval ft
Shallow Zone			
16-122	25.23	184.26	8.5 - 23.5
16WW01	19.31	181.49	6.5 - 16.5
16WW03	26.58	191.65	12.5 - 24.5
16WW05	33.26	202.60	15.5 - 30.5
16WW07	10.40	187.79	3.5 - 8.0
16WW09	12.25	200.07	7.0 - 9.0
16WW12	26.76	185.98	14.0 - 24.0
16WW13	22.63	175.59	14.0 - 24.0
16WW14	29.98	195.02	17.0 - 27.0
16WW16	31.31	193.04	19.0 - 29.0
16WW22	31.00	199.81	21.0 - 31.0
16WW24	16.00	177.72	11.0 - 16.0
16WW26	17.50	188.48	13.0 - 18.0
16WW28	21.00	176.67	16.0 - 21.0
16WW30	30.00	178.12	25.0 - 30.0
16WW32	32.00	202.53	22.0 - 32.0
16WW34	32.00	202.60	27.0 - 32.0
16WW36	21.50	190.85	17.0 - 22.0
16WW38	29.00	201.69	19.0 - 29.0
16EW01	42.00	197.49	31.0 - 36.0
16EW02	42.00	195.21	22.0 - 27.0
16EW03	21.00	184.80	13.0 - 18.0
16EW04	22.00	179.37	14.0 - 19.0
16PZ02	32.00	199.75	27.0 - 32.0
16PZ04	31.00	198.81	26.0 - 31.0
16PZ06	28.00	198.61	23.0 - 28.0
16PZ08	33.00	199.93	28.0 - 33.0
16PZ10	27.00	196.65	22.0 - 27.0
16PZ12	32.00	199.00	27.0 - 32.0
16PZ14	28.50	192.23	22.0 - 27.0
16PZ16	22.00	187.92	16.0 - 21.0
16PZ18	26.00	182.81	19.0 - 24.0
16PZ20	22.50	180.31	16.5 - 21.5

1 - Wells that have been abandoned and plugged.



LEGEND

- ◆ SHALLOW MONITORING WELL
- ◆ INTERMEDIATE MONITORING WELL
- ◆ UPPER DEEP ZONE MW
- ◆ LOWER DEEP ZONE MW
- ◆ SHALLOW EXTRACTION WELL
- ◆ INTERMEDIATE EXTRACTION WELL
- ◆ SHALLOW PIEZOMETER
- ◆ INTERMEDIATE PIEZOMETER
- A/P ABANDONED AND PLUGGED
- PIEZOMETRIC SURFACE CONTOURS

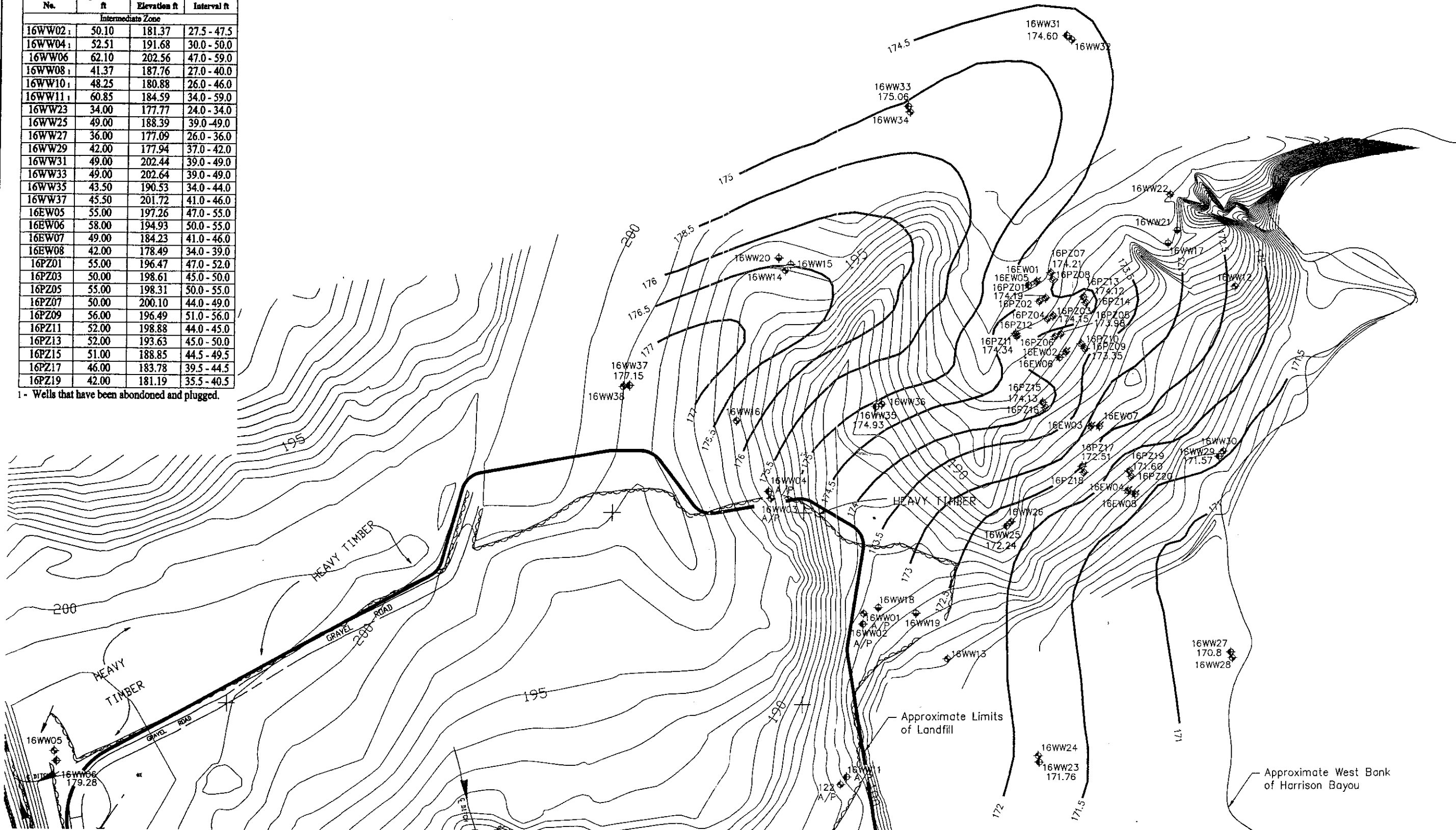


SHALLOW ZONE PIEZOMETRIC SURFACE MAP - 10-20-97
SITE 16 REMEDIAL INVESTIGATION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

OWN: BSM	DES:	PROJECT NO.: 000187
CHKD: PTS	APPD:	FIGURE NO.: 3-3
DATE: FEB 99	REV.:	

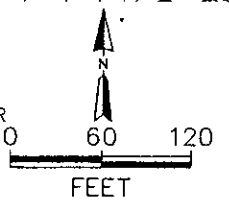
Well Identification No.	Total Depth of Well ft	Ground Surface Elevation ft	Depth of Screen Interval ft
Intermediate Zone			
16WW02	50.10	181.37	27.5 - 47.5
16WW04	52.51	191.68	30.0 - 50.0
16WW06	62.10	202.56	47.0 - 59.0
16WW08	41.37	187.76	27.0 - 40.0
16WW10	48.25	180.88	26.0 - 46.0
16WW11	60.85	184.59	34.0 - 59.0
16WW23	34.00	177.77	24.0 - 34.0
16WW25	49.00	188.39	39.0 - 49.0
16WW27	36.00	177.09	26.0 - 36.0
16WW29	42.00	177.94	37.0 - 42.0
16WW31	49.00	202.44	39.0 - 49.0
16WW33	49.00	202.64	39.0 - 49.0
16WW35	43.50	190.53	34.0 - 44.0
16WW37	45.50	201.72	41.0 - 46.0
16EW05	55.00	197.26	47.0 - 55.0
16EW06	58.00	194.93	50.0 - 55.0
16EW07	49.00	184.23	41.0 - 46.0
16EW08	42.00	178.49	34.0 - 39.0
16PZ01	55.00	196.47	47.0 - 52.0
16PZ03	50.00	198.61	45.0 - 50.0
16PZ05	55.00	198.31	50.0 - 55.0
16PZ07	50.00	200.10	44.0 - 49.0
16PZ09	56.00	196.49	51.0 - 56.0
16PZ11	52.00	198.88	44.0 - 45.0
16PZ13	52.00	193.63	45.0 - 50.0
16PZ15	51.00	188.85	44.5 - 49.5
16PZ17	46.00	183.78	39.5 - 44.5
16PZ19	42.00	181.19	35.5 - 40.5

1 - Wells that have been abandoned and plugged.



LEGEND

- ◆ SHALLOW MONITORING WELL
- ◆ INTERMEDIATE MONITORING WELL
- ◆ UPPER DEEP ZONE MW
- ◆ LOWER DEEP ZONE MW
- ◆ SHALLOW EXTRACTION WELL
- ◆ INTERMEDIATE EXTRACTION WELL
- ◆ SHALLOW PIEZOMETER
- ◆ INTERMEDIATE PIEZOMETER
- A/P ABANDONED AND PLUGGED
- PIEZOMETRIC SURFACE CONTOUR



US Army Corps of Engineers
Tulsa District

Sverdrup
ENVIRONMENTAL

PROJECT NO.:	DWN:	DES.:
000187	BSM	
	CHKD:	APPD:
	PTS	
	DATE:	REV.:
	FEB 99	

INTERMEDIATE ZONE PIEZOMETRIC SURFACE MAP - 10-20-97

SITE 16 REMEDIAL INVESTIGATION

LONGHORN ARMY AMMUNITION PLANT

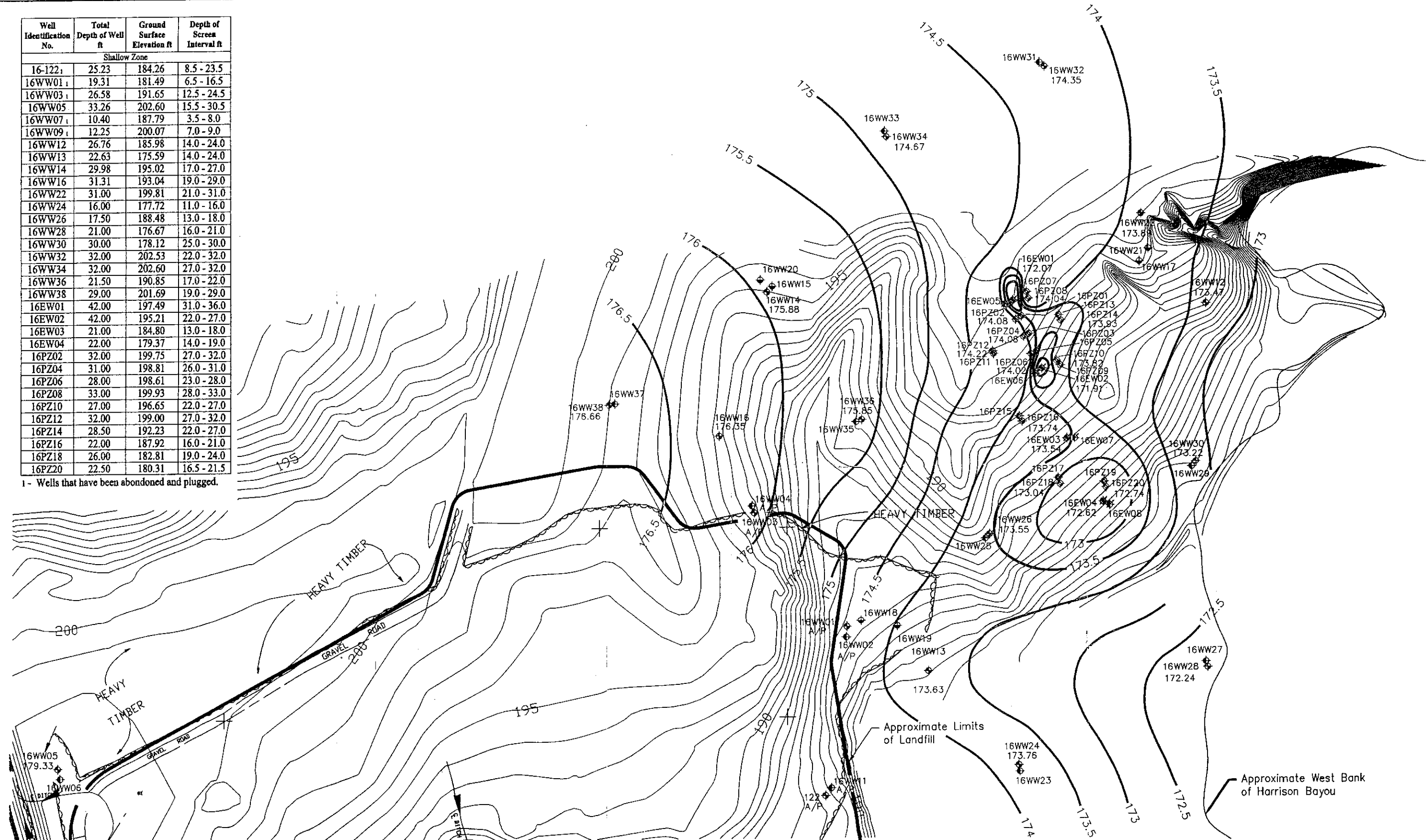
KARNACK, TEXAS

FIGURE NO.:

3-5

Well Identification No.	Total Depth of Well ft	Ground Surface Elevation ft	Depth of Screen Interval ft
Shallow Zone			
16-122 ₁	25.23	184.26	8.5 - 23.5
16WW01 ₁	19.31	181.49	6.5 - 16.5
16WW03 ₁	26.58	191.65	12.5 - 24.5
16WW05 ₁	33.26	202.60	15.5 - 30.5
16WW07 ₁	10.40	187.79	3.5 - 8.0
16WW09 ₁	12.25	200.07	7.0 - 9.0
16WW12 ₁	26.76	185.98	14.0 - 24.0
16WW13 ₁	22.63	175.59	14.0 - 24.0
16WW14 ₁	29.98	195.02	17.0 - 27.0
16WW16 ₁	31.31	193.04	19.0 - 29.0
16WW22 ₁	31.00	199.81	21.0 - 31.0
16WW24 ₁	16.00	177.72	11.0 - 16.0
16WW26 ₁	17.50	188.48	13.0 - 18.0
16WW28 ₁	21.00	176.67	16.0 - 21.0
16WW30 ₁	30.00	178.12	25.0 - 30.0
16WW32 ₁	32.00	202.53	22.0 - 32.0
16WW34 ₁	32.00	202.60	27.0 - 32.0
16WW36 ₁	21.50	190.85	17.0 - 22.0
16WW38 ₁	29.00	201.69	19.0 - 29.0
16EW01 ₁	42.00	197.49	31.0 - 36.0
16EW02 ₁	42.00	195.21	22.0 - 27.0
16EW03 ₁	21.00	184.80	13.0 - 18.0
16EW04 ₁	22.00	179.37	14.0 - 19.0
16PZ02 ₁	32.00	199.75	27.0 - 32.0
16PZ04 ₁	31.00	198.81	26.0 - 31.0
16PZ06 ₁	28.00	198.61	23.0 - 28.0
16PZ08 ₁	33.00	199.93	28.0 - 33.0
16PZ10 ₁	27.00	196.65	22.0 - 27.0
16PZ12 ₁	32.00	199.00	27.0 - 32.0
16PZ14 ₁	28.50	192.23	22.0 - 27.0
16PZ16 ₁	22.00	187.92	16.0 - 21.0
16PZ18 ₁	26.00	182.81	19.0 - 24.0
16PZ20 ₁	22.50	180.31	16.5 - 21.5

1 - Wells that have been abandoned and plugged.



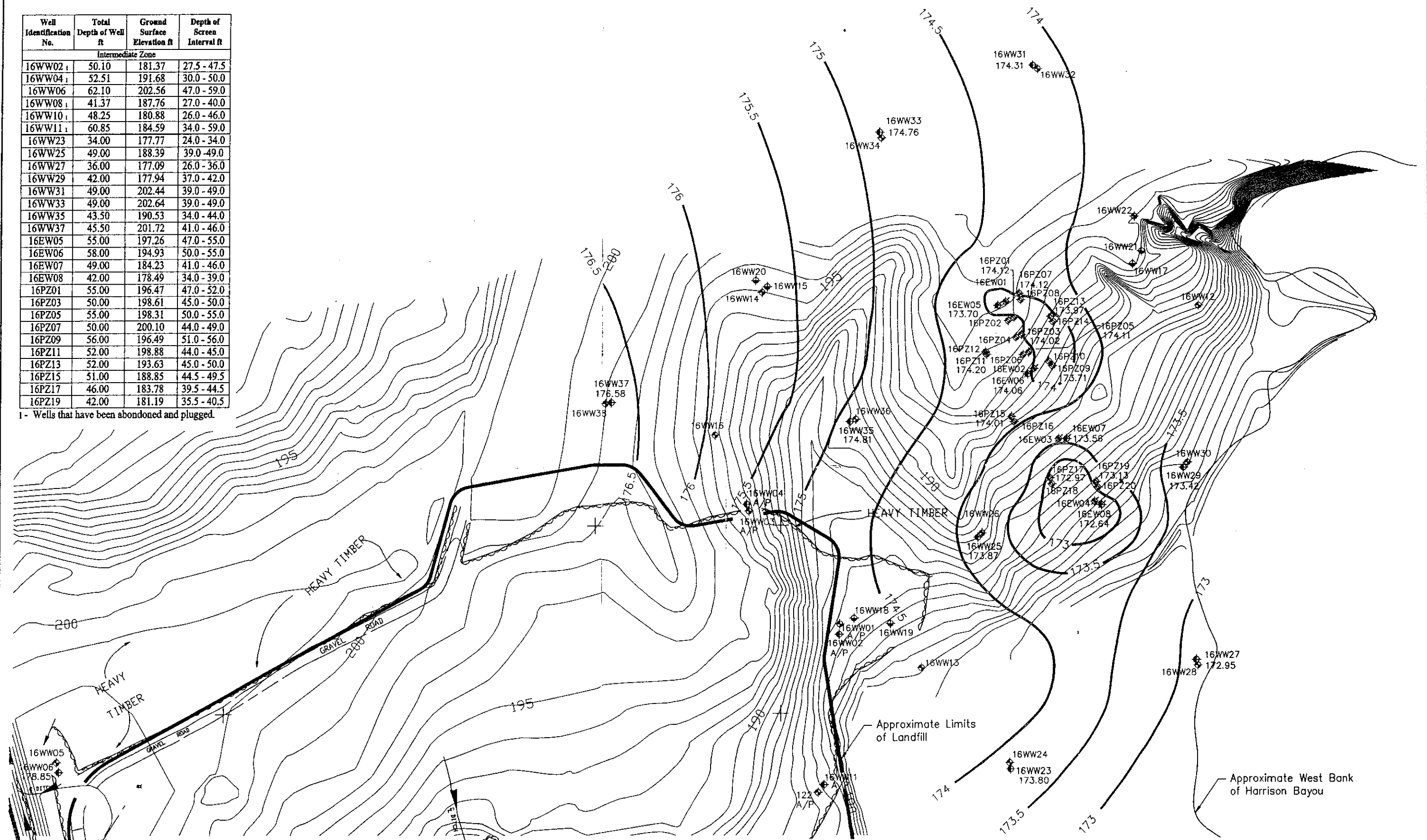
LEGEND

● SHALLOW MONITORING WELL	● SHALLOW PIEZOMETER
● INTERMEDIATE MONITORING WELL	● INTERMEDIATE PIEZOMETER
● UPPER DEEP ZONE MW	● A/P ABANDONED AND PLUGGED
● LOWER DEEP ZONE MW	— PIEZOMETRIC SURFACE CONTOUR
● SHALLOW EXTRACTION WELL	
● INTERMEDIATE EXTRACTION WELL	

<p>Sverdrup ENVIRONMENTAL</p>	PROJECT NO.:	DWN:	DES.:	<p>SHALLOW ZONE PIEZOMETRIC SURFACE MAP - 10-28-98</p> <p>SITE 16 REMEDIAL INVESTIGATION</p> <p>LONGHORN ARMY AMMUNITION PLANT</p> <p>KARNACK, TEXAS</p>	<p>FIGURE NO.:</p> <p>3-4</p>
	000187	BSM			
		PTS	APPD:		
		DATE:	REV.:		
		FEB 99			

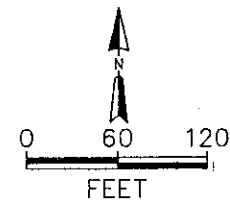
Well Identification No.	Total Depth of Well ft	Ground Surface Elevation ft	Depth of Screen Interval ft
Intermediate Zone			
16WW02	50.10	181.37	27.5 - 47.5
16WW04	52.51	191.68	30.0 - 50.0
16WW06	62.10	202.56	47.0 - 59.0
16WW08	41.37	187.76	27.0 - 40.0
16WW10	48.25	180.88	26.0 - 46.0
16WW11	60.85	184.59	34.0 - 59.0
16WW23	34.00	177.77	24.0 - 34.0
16WW25	49.00	188.39	39.0 - 49.0
16WW27	36.00	177.09	26.0 - 36.0
16WW29	42.00	177.94	37.0 - 42.0
16WW31	49.00	202.44	39.0 - 49.0
16WW33	49.00	202.64	39.0 - 49.0
16WW35	43.50	190.53	34.0 - 44.0
16WW37	45.50	201.72	41.0 - 46.0
16EW05	55.00	197.26	47.0 - 55.0
16EW06	58.00	194.93	50.0 - 55.0
16EW07	49.00	184.23	41.0 - 46.0
16EW08	42.00	178.49	34.0 - 39.0
16PZ01	55.00	196.47	47.0 - 52.0
16PZ03	50.00	198.61	45.0 - 50.0
16PZ05	55.00	198.31	50.0 - 55.0
16PZ07	50.00	200.10	44.0 - 49.0
16PZ09	56.00	196.49	51.0 - 56.0
16PZ11	52.00	198.88	44.0 - 45.0
16PZ13	52.00	193.63	45.0 - 50.0
16PZ15	51.00	188.85	44.5 - 49.5
16PZ17	46.00	183.78	39.5 - 44.5
16PZ19	42.00	181.19	35.5 - 40.5

1 - Wells that have been abandoned and plugged.



LEGEND

- ◆ SHALLOW MONITORING WELL
- ◆ INTERMEDIATE MONITORING WELL
- ◆ UPPER DEEP ZONE MW
- ◆ LOWER DEEP ZONE MW
- ◆ SHALLOW EXTRACTION WELL
- ◆ INTERMEDIATE EXTRACTION WELL
- ◆ SHALLOW PIEZOMETER
- ◆ INTERMEDIATE PIEZOMETER
- A/P ABANDONED AND PLUGGED
- PIEZOMETRIC SURFACE CONTOUR



US Army Corps of Engineers
Tulsa District
Sverdrup
ENVIRONMENTAL

PROJECT NO.:	DWN:	DES.:
000187	BSM	
	CHKD:	APPD.:
	PTS	
	DATE:	REV.:
	FEB 99	

INTERMEDIATE ZONE PIEZOMETRIC SURFACE MAP - 10-28-98
SITE 18 REMEDIAL INVESTIGATION
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FIGURE NO.:
3-6

APPENDIX H
SURVEY FORMS

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Bob Speight

Title: President, Vice President

Organization: Greater Caddo
Lake Association

Telephone No.: (903) 679-3145

E-mail Address:

Street Address: 1727 Dorough Rd

City, State, Zip: Karnack, TX 75661

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | | |
|---|-----|--------------------------|
| 1. Are you familiar with the following: | yes | no |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
2. What is your impression of the project (general sentiment)?
Very good.
3. What effect have site operations had on the surrounding community?
Good.
4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
You cannot please everyone.
5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing,
or emergency responses from local authorities? If so, please give details. No.
6. Do you feel well informed about the site's activities and progress?
Yes.
7. Do you have any comments, suggestions, or recommendations regarding the site's management
or operation? Very good.

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Wes and Joann Hodges

Title: Owners

Organization: Hodgepodge
Cottages

Telephone No.: (903) 789-3901

E-mail Address:
Joann@hodgepodgecottages.com

Street Address: 724 Cypress Dr.

City, State, Zip: Karnack, TX 75661

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | yes | no |
|---|--------------------------|----|
| 1. Are you familiar with the following: | | |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | <input type="checkbox"/> | x |
| b. Site 16 Landfill Cap (Old Landfill) | <input type="checkbox"/> | x |
| c. Site 12 Landfill Cap (Sanitary Landfill) | <input type="checkbox"/> | x |
| 2. What is your impression of the project (general sentiment)?
None. | | |
| 3. What effect have site operations had on the surrounding community?
Not aware of any. | | |
| 4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
We agree with Dwight Shellman and his recommendations and follow-up. | | |
| 5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing,
or emergency responses from local authorities? If so, please give details.
No. | | |
| 6. Do you feel well informed about the site's activities and progress?
Yes, through Dwight Shellman. | | |
| 7. Do you have any comments, suggestions, or recommendations regarding the site's management
or operation?
No. | | |

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Bud Jones

Title:

Organization:

Telephone No.:

E-mail Address:

Street Address:

City, State, Zip:

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | yes | no |
|---|-----|--------------------------|
| 1. Are you familiar with the following: | x | <input type="checkbox"/> |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
| 2. What is your impression of the project (general sentiment)?
I feel that much progress has been made, but there needs to be some time-timing in the Landfill 16/B63/UEP Areas, and possibly some sort of remediation, possibly in sites. | | |
| 3. What effect have site operations had on the surrounding community?
In general, I feel that they have calmed some of the fears originally existing among some of the local citizens. | | |
| 4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
General concern about the effectiveness of the Landfill 16 cap. Some feel that the contaminants in the Landfill 16 should have been removed prior to placement of the cap. Others feel that some sort of site remediation should be implemented. | | |
| 5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.
No. | | |
| 6. Do you feel well informed about the site's activities and progress?
Yes. | | |
| 7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
Feel that confirmation SCAPS data should be collected at B63/UEP Area, similar to that of Landfill 16. | | |

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Roy Darville

Title: Professor of Biology

Organization: East Texas
Baptist University

Telephone No.: (903) 935-7963 x3182

E-mail Address: rdarville@etbu.edu

Street Address: 1209 N. Grove St.

City, State, Zip: Marshall, TX 75670

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | yes | no |
|---|-----|--------------------------|
| 1. Are you familiar with the following: | | |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
| 2. What is your impression of the project (general sentiment)?
It appears the three projects are well done and performing as expected | | |
| 3. What effect have site operations had on the surrounding community?
No effects except perhaps a positive one to know the cleanup un in-progress. | | |
| 4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
No. | | |
| 5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing,
or emergency responses from local authorities? If so, please give details.
No. | | |
| 6. Do you feel well informed about the site's activities and progress?
Yes, through attendance at the LHAAP TRC meetings. | | |
| 7. Do you have any comments, suggestions, or recommendations regarding the site's management
or operation?
No. | | |

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Robert Speight Jr.

Title:

Organization:

Telephone No.: (903) 679-3875

E-mail Address:

Street Address: 2757 Blairs Landing Rd.

City, State, Zip: Karnack, TX 75661

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | | |
|---|-----|--------------------------|
| 1. Are you familiar with the following: | yes | no |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
| 2. What is your impression of the project (general sentiment)?
CES is doing a very good job. | | |
| 3. What effect have site operations had on the surrounding community?
Very little impact on community. | | |
| 4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
No. | | |
| 5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing,
or emergency responses from local authorities? If so, please give details.
No. | | |
| 6. Do you feel well informed about the site's activities and progress?
Yes. | | |
| 7. Do you have any comments, suggestions, or recommendations regarding the site's management
or operation?
Not at this time. | | |

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Jim Sher

Title: P.E., Team Leader, PM

Organization: TNRCC

Telephone No.: (512) 239-2444

E-mail Address: Jsher@TNRCC.State.TX.US

Street Address: 12100 Park 35 Circle Building D

City, State, Zip: Austin, TX 78753

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

1. Are you familiar with the following:

	yes	no
a. Site 18/24 Burning Grounds and Groundwater Treatment Plant (Groundwater from Burning Grounds and Landfill 16)	x	<input type="checkbox"/>
b. Site 16 Landfill Cap (Old Landfill)	x	<input type="checkbox"/>
c. Site 12 Landfill Cap (Sanitary Landfill)	x	<input type="checkbox"/>

2. What is your impression of the project (general sentiment)?
This is a large site with many areas of concern. The organization of these areas and the work done at them has been well thought out. After many years of investigation, progress is steadily increasing.

3. What effect have site operations had on the surrounding community?
Remedial activities have had little impact on the community. However, with the site being inactive for many years the community is in support of the site becoming a wildlife refuge.

4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
No. However, the community is anxious to have the site turned over for public use.

5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.
Local fire departments responded to a fire in one of the buildings on site.

6. Do you feel well informed about the site's activities and progress?
Yes. Monthly meetings with schedules provided, as well as e-mails keep everyone up to date.

7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
There are many interested parties involved in this site, but all seem to be willing to work together.

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Cliff Murray

Title: Environmental Engineer

Organization: Tulsa District,
USACE

Telephone No.: (918) 669-7573

E-mail Address: Cliff.Murray@usace.army.mil

Street Address: 1645 S 101 E Ave

City, State, Zip: Tulsa, OK 74128

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | yes | no |
|--|-----|--------------------------|
| 1. Are you familiar with the following: | yes | no |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
| 2. What is your impression of the project (general sentiment)?
Things are going smoothly especially the maintenance of the affected sites. | | |
| 3. What effect have site operations had on the surrounding community?
Employment of worker, both temporary (installation of caps, trenches, and treatment plant) as well as long-term employment of personnel at the Groundwater Treatment Plant. | | |
| 4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
No. | | |
| 5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing,
or emergency responses from local authorities? If so, please give details.
A four-wheeled recreation vehicle and lawn mower were stolen from the treatment plant approximately 2 years ago. The items were replaced by the operator at the time (Radian). | | |
| 6. Do you feel well informed about the site's activities and progress?
Yes. | | |
| 7. Do you have any comments, suggestions, or recommendations regarding the site's management
or operation?
The current operator at the site has done an outstanding job of maintaining records (operational and historical) of the site. | | |

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661

LONGHORN ARMY AMMUNITION PLANT, SUPERFUND SURVEY

Site Name: Longhorn Army Ammunition Plant, Superfund Site

Subject: 5-Year Review Background Information Survey

Date: 17 September 2001

Contact Made By:

Name: William R. Corrigan

Title: Groundwater Treatment
Plant Manager

Organization: Complete
Environmental Service

Telephone No.: (903) 679-3448

E-Mail Address: ces@shreve.net

Street Address: P.O. Box 170

City, State, Zip: Karnack, TX 75661

Individual Contacted:

Name: Chris G. Villarreal

Title: Remedial Project Manager

Organization: U.S.
Environmental Protection Agency-
Region 6

Telephone No.: (214) 665-6758

E-mail Address: villarreal.chris@epa.gov

Street Address: 1445 Ross Avenue

City, State, Zip: Dallas, TX 75202-2733

Survey Questions:

Please direct questions or comments regarding this survey to William R. Corrigan (at the address listed above).

- | | | |
|---|-----|--------------------------|
| 1. Are you familiar with the following: | yes | no |
| a. Site 18/24 Burning Grounds and Groundwater Treatment Plant
(Groundwater from Burning Grounds and Landfill 16) | x | <input type="checkbox"/> |
| b. Site 16 Landfill Cap (Old Landfill) | x | <input type="checkbox"/> |
| c. Site 12 Landfill Cap (Sanitary Landfill) | x | <input type="checkbox"/> |
2. What is your impression of the project (general sentiment)?
The project is very complex with multiple operable units. Considerable resources have been expended on this project over the years. Progress has been made in identifying and addressing contamination resulting from 50+ years of Army operations, however, there is still a lot of work to be done.
3. What effect have site operations had on the surrounding community?
The ending of Army operations at the facility and subsequent loss of jobs undoubtedly had a negative effect on the local economy. However, the establishment of a formal process to establish the Caddo Lake national Wildlife Refuge has the potential to bring new income to the local community. Local people and organizations have expressed support for the refuge.
4. Are you aware of any community concerns regarding the site or its operation and administration?
If so, please give details.
No.
5. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.
There have been two fires at the Longhorn Army Ammunition Plant within the last year or so. Local fire departments were contacted to respond. Additionally, 189,000 gallons of effluent were released at the Site 18/24 Groundwater Treatment Plant (GWTP) in January 2001. Of the 189,000 gallons, approximately 50,000 gallons spilled over the GWTP containment onto surrounding soils.
6. Do you feel well informed about the site's activities and progress?
Yes.
7. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
A new U.S. Army Corps of Engineer's contractor management team was recently put in place. The new contractor team appears to be very competent and I am looking forward to making significant progress on the Site 16 and the Group 2 and 4 sites this next year.

Please mail responses to William R. Corrigan at Complete Environmental Service, P.O. Box 170, Karnack, TX 75661