SECOND FIVE-YEAR REVIEW REPORT

FOR THE

HARDAGE-CRINER SUPERFUND SITE
CRINER, MCCLAIN COUNTY, OKLAHOMA

August 2007

PREPARED BY:

United States Environmental Protection Agency
Region 6
Dallas, Texas

SECOND FIVE-YEAR REVIEW REPORT
Hardage-Criner Superfund Site
EPA ID No. OKD000400093
Criner, McClain County, Oklahoma

This memorandum documents the United States Environmental Protection Agency's (EPA) performance, determinations, and approval of the Hardage-Criner Superfund Site (Site) second five-year review under Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Title 42 United States Code (U.S.C.), Section 9621(c), as provided in the attached Second Five-Year Review Report prepared by EA Engineering, Science, and Technology, Inc. (EA) on behalf of the EPA.

Summary of Second Five-Year Review Findings

The second five-year review for the Site was performed through a review of site documents and site-specific requirements; a site inspection performed on April 18, 2007; interviews with stakeholders; and a review of data collected at the Site during the second five-year review period.

All immediate threats at the Hardage-Criner Superfund Site, McClain County, Oklahoma have been addressed, and the remedy components determined by the Order of August 9, 1990, of the United States District Court for the Western District of Oklahoma (the Court) in United States v. Royal N. Hardage, et al, C.A. No. 86-1401-P (W.D. Oklahoma), as amended, (the Court Order) are expected to remain protective of human health and the environment. The Court Order, which was issued in response to a United States complaint under sections 106(a) and 107(a) of the CERCLA, 42 U.S.C. §§ 9606(a), 9607(a), specified remedial objectives for the Site without specifying cleanup goals for individual contaminated environmental media. The remedial objectives are to control the surface water pathway, preclude Site access and direct contact with the waste, control air emissions from the source areas, and preclude the use of affected groundwater. The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench Recovery System (V-Trench) must be maintained and operated indefinitely, but the Hardage Steering Committee (HSC) received permission from the Court in an agreed order with EPA in March 2005 to cease pumping the Southwest Wells Recovery System (SWWRS) and place it in a "stand-by mode" (USDC W.D. Oklahoma 2005), subject to data monitoring and other conditions. The institutional controls required by the Court Order dedicate the Site solely to the remedial activities ordered by the Court, as well as, control access and use of the Site itself and certain adjoining properties.

Actions Recommended

The recommended actions below address issues concerning data collection and performance monitoring of the Court selected remedy components. While these issues are not currently significant enough to call into question the protectiveness of the remedy, the performance monitoring data obtained by the Hardage Site Remedy Corporation (HSRC) and its contractors under the Site Performance Monitoring Plan (HSRC 2005a) will be needed to assess the future remedy protectiveness:

- **Northwest Borrow Area (NWBA) Groundwater Seeps** - Additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died; the PTP was designed to consist of three rows of trees and shrubs planted in parallel rows orientated perpendicular to groundwater flow and installed 55 to 95 feet upgradient of Seep-14. HSRC contractor Nationwide Environmental Services, Inc. (NES) could evaluate whether treated effluent from the Water Treatment Plant (WTP) could be diverted from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought

conditions. Additional piezometers should be installed downgradient of the south piezometer (SPZ) and Seep-14 to determine the extent of volatile organic compound (VOC) impacts to the NWBA; sampling and analysis should follow the same protocol established for the NWBA piezometers.

- **2007 Composite Cap Pest Control** - Several mounds of dirt (possibly due to ants) and small burrow holes were noted in and around the Cap, which were surficial in nature and showed no evidence of liner compromise. Pest control should be conducted to prevent possible compromise of the Cap.

- **Exterior Security Fence** - Maintenance of the perimeter security fence should be conducted to remove the small saplings and a large animal burrow hole near the NWBA.

- **Toxicity Criteria** - In the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene should be updated to coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) and the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - Treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors.

- **Institutional Control Boundary** - Domestic water well (No. 67437) should be a topic in future discussions in the Annual Remedial Status Reports and an annual check of the Oklahoma Water Resources Board database should be conducted to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy. Impacted groundwater is present in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary; therefore, a review of the institutional control boundary and legal description of the Site should be conducted to determine if adjustments are necessary.

- **North Criner Creek Alluvium Natural Attenuation** - In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) in the SWWRS should be evaluated. The tree roots growing into recovery wells of the SWWRS should be addressed as part of this evaluation.

- **2005 Revised Performance Monitoring Plan (PMP)** - The 2005 Revised Performance Monitoring Plan (HSRC 2005a) should be amended to incorporate potential changes to operation and maintenance associated with the V-Trench Passive Aeration System Pilot Study.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells should be collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent for comparative purposes; this protocol should also apply to the V-Trench Passive Aeration System Pilot Study approved by the Court in July 2007.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order in July 2007 will be operated and tested as a replacement for the WTP for a period of 24 months. Waste water quality and other parameters

will be monitored by HSRC, EPA, and ODEQ and a decision will be made within the six months following operation of the test (subject to Court approval) as to whether the aeration system should be permanent.

Determinations

All immediate threats at the Site have been addressed, and the Court selected remedy components are expected to remain protective of human health and the environment. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench must be maintained and operated indefinitely, but the HSRC has received permission from the Court to cease pumping the SWWRS and place it in a "stand-by mode" (USDC W.D. Oklahoma 2005). In July 2007, the Court approved implementation of a V-Trench Passive Aeration System Pilot Study to temporarily replace the WTP. The institutional controls ordered by the Court dedicate the Site solely to the remedial activities ordered by the Court and restrict access and use of the Site and certain adjoining properties.

I have determined that the remedy for the Hardage-Criner Superfund Site is protective of human health and the environment and that current human exposure is controlled and is thus protective, and will remain so provided the action items herein are addressed and corrective actions implemented.

Pamela Phillips, Acting — Sept 24, 2007

Samuel Coleman, P.E. — Date
Director
Superfund Division, Region 6
U.S. Environmental Protection Agency

CONCURRENCES:

SECOND FIVE-YEAR REVIEW REPORT
HARDAGE-CRINER SUPERFUND SITE
EPA ID No. LAD980879449

Michael G. Hebert Date: 9/10/07

Michael Hebert, U.S. EPA
Remedial Project Manager

James L. Turner Date: 9/17/07

James L. Turner, U.S. EPA
Superfund Branch, Office of Regional Counsel

Mark Peycke Date: 09/18/07

Mark Peycke, U.S. EPA
Chief, Superfund Branch, Office of Regional Counsel

H Parr Date: 09/19/2007

Buddy Parr, U.S. EPA
Team Leader, Louisiana/New Mexico/Oklahoma Team

Donald Williams Date: 9/19/07

Donald Williams, U.S. EPA
Deputy Associate Director, Remedial Branch

Donald Williams Date: 9/19/07

~~John Hepola,~~ U.S. EPA
Director, Remedial Branch

Pam Phillips Date: 9/24/07

Pam Phillips, U.S. EPA
Deputy Director, Superfund Division

CONTENTS

Attachments

LIST OF TABLES

LIST OF ACRONYMS

AGV	Active Gas Venting System
ARAR	Applicable or Relevant and Appropriate Requirement
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cap	Composite Cap
Court	U.S. District Court for the Western District of Oklahoma
Court Order	U.S. v. Royal N. Hardage, et al, C.A. No. 86-1401-P (W.D. Oklahoma)
DOJ	U.S. Department of Justice
EA	EA Engineering, Science, and Technology, Inc.
EPA	U.S. Environmental Protection Agency Region 6
FWA	Flow-weighted Average
gpm	Gallons Per Minute
HSC	Hardage Steering Committee
HSRC	Hardage Site Remediation Corporation
NAPL	Non-aqueous Phase Liquids
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NES	Nationwide Environmental Services, Inc.
NPL	National Priorities List
NWBA	Northwest Borrow Area
O&M	Operation and Maintenance
ODEQ	Oklahoma Department of Environmental Quality
OSDH	Oklahoma State Department of Health
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCOR	Preliminary Close Out Report
PDB	Passive Diffusion Bags
PLRS	Permanent Mounds Liquid Recovery System
PMP	Performance Monitoring Plan
ppb	Parts Per Billion
PRP	Potentially Responsible Party
PTP	Phytoremediation Test Plot
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
Site	Hardage-Criner Superfund Site
SWWRS	Southwest Wells Recovery System
SVOC	Semi-volatile Organic Compound
TOU	Thermal Oxidation Unit
ug/L	Micrograms Per Liter
U.S.C.	United States Code
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
V-Trench	V-Trench Recovery System
WTP	Water Treatment Plant
W.D.	Western District

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency Region 6 (EPA) has conducted the second five-year review of the remedial action (RA) implemented at the Hardage-Criner Superfund Site (Site) in McClain County, Oklahoma. The purpose of this second five-year review was to determine whether the selected remedy for the Site continues to protect human health and the environment.

This is the second five-year review for the Site, which has a review period from September 27, 2002 to September 27, 2007. The triggering action was the completion of the first five-year review on September 27, 2002. The second five-year review was conducted from February 28 through August 31, 2007, and its methods, findings, conclusions, and recommendations are documented in this report.

The Hardage-Criner Superfund Site, McClain County, Oklahoma, ("Hardage-Criner Site" or "the Site") is under the jurisdiction of the United States District Court of Western Oklahoma and operates under a 1990 Court Order and not under a traditional EPA Record of Decision. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedial objectives are to control the surface water pathway, preclude Site access and direct contact with the waste, control air emissions from the source areas, and preclude the use of affected groundwater. The Court Order remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The remedy components include a Composite Cap (Cap) over the former disposal area; a liquid recovery well system in the former disposal area; a hydraulic containment system composed of the V-Trench Recovery System (V-Trench) and Southwest Wells Recovery System (SWWRS) to prevent further migration of contaminated groundwater from the source areas; a Water Treatment Plant (WTP) for the recovered groundwater; natural attenuation for a portion of the contaminated groundwater; Northwest Borrow Area (NWBA) phytoremediation test plot (PTP); institutional controls on the property and groundwater usage; and a groundwater and surface water monitoring system.

The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench must be maintained and operated indefinitely, but the Hardage Steering Committee (HSC) and its remediation subsidiary the Hardage Site Remediation Corporation (HSRC) have received permission from the Court to cease pumping the SWWRS and place it in a “stand-by mode” (USDC W.D. Oklahoma 2005), in accordance with an agreed order with the EPA entered by the Court in March 2005. Further, the WTP, which handles waste water and leachate from the V-Trench

system, will be replaced by a passive aeration treatment system in a 24 month pilot test study approved by the Court in an order entered without opposition from either the EPA or Oklahoma Department of Environmental Quality (ODEQ) on July 16, 2007. After the 24 month study period, the HSC, EPA, and ODEQ will have 6 months to review and agree or disagree on the suitability of the passive aeration system as a permanent replacement for the WTP. The institutional controls ordered by the Court dedicate the Site itself solely to the remedial activities ordered by the Court, as well as, require the purchase of adjoining properties, the restriction of public access, and the recording of restrictive covenants controlling Site use.

The HSC commenced construction of the Court ordered remedy in November 1993 and completed construction in 1995. The EPA signed a Preliminary Close Out Report on September 30, 1997 to trigger the construction completion milestone. However, the trigger for this second five-year review was the completion of the first five-year review in 2002, which found that all immediate threats at the Site had been addressed, and the Court selected remedy components were expected to remain protective of human health and the environment, provided that action items enumerated in that report were addressed, as they subsequently were.

The second five-year review for the Site was performed through a review of historic site documents and site-specific requirements; a site inspection performed on April 18, 2007; interviews with stakeholders; and a review of data collected at the Site during the second five-year review period. Several documents were reviewed as part of this second five-year review, including those containing the following data: (1) groundwater, surface water, and air sampling summaries; (2) groundwater monitoring well water levels; (3) analytical sampling results; (4) inspection summaries; and (5) other ancillary data pertinent to the operation of remedial systems.

Responses to the site survey questionnaire were favorable. No complaints or concerns were noted. All returned surveys were included in Attachment 5 of this report.

Issues noted during this five-year review include the following:

- **NWBA Groundwater Seeps** - In its current condition, many of the trees and shrubs that were planted as part of the PTP have died due to insect infestation and/or drought. In addition, there are no PTP piezometers downgradient of the southern piezometer (SPZ) or Seep-14; therefore, the extent of volatile organic compounds (VOC) impacts in the NWBA is undefined.

- **2007 Composite Cap Pest Control** - The Cap was inspected during this five-year review for exposure of source materials and breaches in its layers, such as the vegetative cover or liner material. The Cap did not show any signs of breaches, leaks, tears, or other evidence that would suggest the integrity of the Cap or the vegetative cover is compromised. There were several mounds of dirt (possibly due to ants) and small burrow holes, which were surficial in nature and showed no evidence of liner compromise. A few minor areas of erosion were located on the east side of the Cap, but no erosional rills, channels, or gullies were noted.

- **Exterior Security Fence** - The exterior security fence was in excellent condition; however, there were some small saplings and a large animal burrow hole along the fence near the NWBA.

- **Toxicity Criteria** - Although there have been no changes to toxicity criteria for the VOCs evaluated in the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene do not coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) nor the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - The V-Trench Passive Aeration System is expected to create a wetland plant community in the water runoff retention basin, where biological communities will flourish with the continuous water supply (HSRC 2007a). However, the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment did not evaluate potential ecological risks to an aquatic environment, but only focused on terrestrial receptors (HSRC 2006a). Because a few treated water constituents (e.g., 1,1,2-trichloroethane) are not completely volatized in the aeration chamber, there is a potential for aquatic exposure in the water runoff retention basin.

- **Institutional Control Boundary** - In January 2002, a 160-foot domestic water well (No. 67437) was installed approximately 1,000 feet to the west of North Criner Creek, north of County Road 122. This domestic well was installed outside the institutional control area, but it was placed close enough to the institutional control boundary to warrant additional investigation as to its construction and use. At the time of this five-year review, there is no evidence that the new domestic well (No. 67437) is impacted by site-related constituents. Impacted groundwater is present in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

- **North Criner Creek Alluvium Natural Attenuation** - An evaluation of the constituent concentrations in the North Criner Creek alluvial groundwater monitoring wells indicates that the fringes of the VOC plume are undergoing natural attenuation, as indicated by a decreasing or neutral trend in MW-12S, MW-12M, AW-S03, and MW-28, but the center of the plume (i.e., near AW-A01) remains unaffected by natural attenuation processes. Also, tree roots were found to be growing into recovery wells of the SWWRS (HSRC 2007h), which has been placed in "stand-by mode" (USDC W.D. Oklahoma 2005); the SWWRS is located upgradient of the North Criner Creek alluvium groundwater monitoring wells and will be reactivated if required.

- **2005 Revised Performance Monitoring Plan (PMP)** - The 2005 Revised PMP (HSRC 2005a) does not include potential changes to operation and maintenance (O&M) associated with the V-Trench Passive Aeration System Pilot Study approved by the Court on July 16, 2007.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells are not collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court order in July 2007, will be operated and tested as a replacement for the WTP for a period of 24 months, followed by a six month evaluation period.

The following actions are recommended in response to these issues:

- **NWBA Groundwater Seeps** - Additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died; the PTP was designed to consist of three rows of trees and shrubs planted in parallel rows orientated perpendicular to groundwater flow and installed 55 to 95 feet upgradient of Seep-14. Nationwide Environmental Services, Inc. (NES) could evaluate whether some treated effluent from the WTP could be diverted from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought conditions. Additional piezometers should be installed downgradient of SPZ and Seep-14 to determine the extent of VOC impacts to the NWBA; sampling and analysis should follow the same protocol established for the NWBA piezometers.

- **2007 Composite Cap Pest Control** - There were several mounds of dirt (possibly due to ants) and small burrow holes in and around the Cap, which were surficial in nature and showed no evidence of liner compromise. Pest control should be conducted to prevent possible compromise of the Cap.

- **Exterior Security Fence** - Maintenance of the perimeter security fence should be conducted to remove the small saplings and a large animal burrow hole near the NWBA.

- **Toxicity Criteria** - In the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene should be updated to coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) and the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - Treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors.

- **Institutional Control Boundary** - Domestic water well (No. 67437) should be a topic in future discussions in the Annual Remedial Status Reports and an annual check of the Oklahoma Water Resources Board database should be conducted to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy. A review of the institutional control boundary and legal description of the Site should be conducted to determine if adjustments are necessary due to the presence of impacted groundwater in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

- **North Criner Creek Alluvium Natural Attenuation** - In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) in the SWWRS should be evaluated. The tree roots growing into recovery wells of the SWWRS should be addressed as part of this evaluation.

- **2005 Revised Performance Monitoring Plan** - The 2005 Revised PMP (HSRC 2005a) should be amended to incorporate potential changes to O&M associated with the V-Trench Passive Aeration System Pilot Study.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells should be collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent for comparative purposes; this protocol should also apply to the V-Trench Passive Aeration System Pilot Study.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order on July 16, 2007, will be operated and tested as a replacement for the WTP for a period of 24 months. Waste water quality and other technical parameters will be monitored by HSRC, EPA, and ODEQ during the 24 month test period. In the six months following operation of the pilot test, these parties will evaluate test results and determine, subject to Court approval, whether the aeration system should become a permanent replacement for the WTP.

All immediate threats at the Site have been addressed, and the Court selected remedy components are expected to remain protective of human health and the environment, subject to the conditions and recommendations outlined and discussed above.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site Name (from Waste LAN): Hardage-Criner Superfund Site

EPA ID (from Waste LAN): OKD000400093

Region: 6 | **State:** Oklahoma | **City/County:** Criner, McClain County

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:** September 30, 1997

Has site been put into reuse? ☐ YES ☒NO

REVIEW STATUS

Reviewing Agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency _____

Author Name: Mr. Michael Hebert

Author Title: Remedial Project Manager | **Author Affiliation:** EPA Region 6

Review Period:** February 28, 2007 to August 31, 2007

Date(s) of Site Inspection: April 18, 2007

Type of Review:
☒ Statutory
☐ Policy ☒ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

Review Number: ☐ 1 (first) ☒ 2 (second) ☐ 3 (third) ☐ Other (specify) _____

Triggering Action:
☐ Actual RA Onsite Construction at OU ☐ Actual RA Start
☐ Construction Completion ☒ Previous Five-Year Review Report
☐ Other (specify)_____

Triggering Action Date (from Waste LAN): September 27, 2002

Due Date (Five Years After Triggering Action Date): September 27, 2007

* "OU" refers to operable unit.

** The review period refers to the period during which the five-year review was conducted.

Five-Year Review Summary Form (Continued)

Issues noted during this five-year review include the following:

- **NWBA Groundwater Seeps** - Many of the trees and shrubs that were planted as part of the PTP have died due to insect infestation and/or drought. In addition, there are no PTP piezometers downgradient of SPZ or Seep-14 so the extent of VOC impacts in the NWBA is undefined.

- **2007 Composite Cap Pest Control** - There were several mounds of dirt (possibly due to ants) and small burrow holes, which were surficial in nature and showed no evidence of liner compromise. Also, a few minor areas of erosion were located on the east side of the Cap.

- **Exterior Security Fence** - There were some small saplings and a large animal burrow hole along the fence near the NWBA.

- **Toxicity Criteria** - Although there have been no changes to toxicity criteria for the VOCs evaluated in the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene do not coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) nor the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - The V-Trench Passive Aeration System is expected to create a wetland plant community in the water runoff retention basin, where biological communities will flourish with the continuous water supply (HSRC 2007a). However, the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment did not evaluate potential ecological risks to an aquatic environment, but only focused on terrestrial receptors (HSRC 2006a). Because a few treated water constituents (e.g., 1,1,2-trichloroethane) are not completely volatized in the aeration chamber, there is a potential for aquatic exposure in the water runoff retention basin.

- **Institutional Control Boundary** - In January 2002, a 160-foot domestic water well (No. 67437) was installed approximately 1000 feet to the west of North Criner Creek, north of County Road 122. This domestic well was installed outside the institutional control area, but it was placed close enough to the institutional control boundary to warrant additional investigation as to its construction and use. At the time of this five-year review, there is no evidence that the new domestic well (No. 67437) is impacted by site-related constituents. Impacted groundwater is present in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

Five-Year Review Summary Form (Continued)

- **North Criner Creek Alluvium Natural Attenuation** - Constituent concentrations in the North Criner Creek alluvial groundwater monitoring wells indicate that the fringes of the VOC plume are undergoing natural attenuation, as indicated by a decreasing or neutral trend in MW-12S, MW-12M, AW-S03, and MW-28, but the center of the plume (i.e., near AW-A01) remains unaffected by natural attenuation processes. Nevertheless, the plume has remained within the current monitoring well network with no significant expansion of the area of affected groundwater. Also, tree roots were found to be growing into recovery wells of the SWWRS (HSRC 2007h), which has been placed in "stand-by mode" (USDC W.D. Oklahoma 2005); the SWWRS is located upgradient of the North Criner Creek alluvium groundwater monitoring wells and will be reactivated if required.

- **2005 Revised Performance Monitoring Plan** - The 2005 Revised PMP (HSRC 2005a) does not include potential changes to O&M associated with the V-Trench Passive Aeration System Pilot Study approved by the Court on July 16, 2007.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells are not collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order in July 2007, will be operated and tested as a replacement for the WTP for a period of 24 months, followed by a six month evaluation period.

The following actions are recommended in response to these issues:

- **NWBA Groundwater Seeps** - Additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died; the PTP was designed to consist of three rows of trees and shrubs consisting planted in parallel rows orientated perpendicular to groundwater flow and installed 55 to 95 feet upgradient of Seep-14. Also, the possibility of diverting treated effluent from the WTP from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought conditions should be evaluated. Additional piezometers should be installed downgradient of SPZ and Seep-14 to determine the extent of VOC impacts to the NWBA; sampling and analysis should follow the same protocol established for the NWBA piezometers.

- **2007 Composite Cap Pest Control** - Pest control should be conducted to prevent possible compromise of the Cap.

- **Exterior Security Fence** - Maintenance of the perimeter security fence should be conducted to remove the small saplings and a large animal burrow hole near the NWBA.

Five-Year Review Summary Form (Continued)

- **Toxicity Criteria** - In the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene should be updated to coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) and the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - Treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors

- **Institutional Control Boundary -** Domestic water well (No. 67437) should be a topic in future discussions in the Annual Remedial Status Reports and an annual check of the Oklahoma Water Resources Board database should be conducted to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy. A review of the institutional control boundary and legal description of the Site should be conducted to determine if adjustments are necessary due to the presence of impacted groundwater in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

- **North Criner Creek Alluvium Natural Attenuation** - In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) in the SWWRS should be evaluated. The tree roots growing into recovery wells of the SWWRS should be addressed as part of this evaluation.

- **2005 Revised Performance Monitoring Plan** - The 2005 Revised PMP (HSRC 2005a) should be amended to incorporate potential changes to O&M associated with the V-Trench Passive Aeration System Pilot Study.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells should be collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent for comparative purposes; this protocol should also apply to the V-Trench Passive Aeration System Pilot Study.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order on July 16, 2007, will be operated and tested as a replacement for the WTP for a period of 24 months. Waste water quality and other technical parameters will be monitored by HSRC, EPA, and ODEQ during the 24 month test period. In the six months following operation of the pilot test, these parties will evaluate test results and determine, subject to Court approval, whether the aeration system should become a permanent replacement for the WTP.

Protectiveness Statement:

All immediate threats at the Site have been addressed, and the Court selected remedy components are expected to remain protective of human health and the environment. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench must be maintained and operated indefinitely, but the HSRC has received permission from the Court to cease pumping the SWWRS and place it in a "stand-by mode" (USDC W.D. Oklahoma 2005). The V-Trench Passive Aeration System Pilot Study has been approved by the Court as a temporary replacement for the WTP subject to review and evaluation. (USDC W.D. Oklahoma 2007). The institutional controls ordered by the Court dedicate the Site solely to the remedial activities ordered by the Court and restrict access and use of the Site and certain adjoining properties.

Long-Term Protectiveness:

The second five-year review found that the Court selected remedy components are expected to remain protective of human health and the environment.

1.0 INTRODUCTION

The U.S. Environmental Protection Agency Region 6 (EPA) has conducted a second five-year review of the remedial action (RA) implemented at the Hardage-Criner Superfund Site (Site), located in Criner, McClain County, Oklahoma, for the period between the completion of the first five-year review in September 2002 through September 2007. The purpose of a five-year review is to determine whether the remedy at a site remains protective of human health and the environment, and to document the methods, findings, and conclusions of the five-year review in a Five-Year Review Report. Five-Year Review Reports identify issues found during the review, if any, and make recommendations to address the issues. This Second Five-Year Review Report documents the results of the review for the Site, conducted in accordance with EPA guidance on five-year reviews.

The five-year review process is required by federal statute. The EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq. and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300 et seq. CERCLA Section 121(c), as amended, states the following:

> "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."

NCP Section 300.430(f) (4) (ii) states the following:

> "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."

The EPA five-year review guidance further states that a five-year review should be conducted as a matter of policy for the following types of actions:

- A pre-Superfund Amendments and Reauthorization Act (SARA) RA that leaves hazardous substances, pollutants, or contaminants onsite above levels that allow for unlimited use and unrestricted exposure.

- A pre- or post-SARA RA that, once completed, will not leave hazardous substances, pollutants, or contaminants onsite above levels that allow for unlimited use and unrestricted exposure but will require more than five years to complete.

- A removal-only site on the National Priorities List (NPL) where the removal action leaves hazardous substances, pollutants, or contaminants onsite above levels that allow for unlimited use and unrestricted exposure and no RA has or will be conducted.

Because hazardous substances, pollutants, or contaminants at the Site remain above levels that allow for unlimited use and unrestricted exposure, a five-year review is required.

This is the second five-year review for the Site, which has a review period from September 27, 2002 to September 27, 2007. The triggering action was the completion of the first five-year review on September 27, 2002. The second five-year review was conducted from February 28 through August 31, 2007, and its methods, findings, conclusions, and recommendations are documented in this report.

This report documents the five-year review for the Site by providing the following information: site chronology (Section 2.0), background information (Section 3.0), an overview of the RAs (Section 4.0), progress since the first five-year review (Section 5.0), the five-year review process (Section 6.0), technical assessment of the Site (Section 7.0), institutional controls (Section 8.0), issues (Section 9.0), recommendations and follow-up activities (Section 10.0), protectiveness statement (Section 11.0), and discussion of the next review (Section 12.0). Attachment 1 provides the site location map. Attachment 2 provides a site layout map. Attachment 3 provides a list of documents reviewed. Attachment 4 provides the site inspection checklist. Attachment 5 provides the interview records. Attachment 6 provides the site inspection photographs. Attachment 7 provides the correspondence since the first five-year review.

2.0 SITE CHRONOLOGY

A chronology of Site events for the Site is provided in Table 1. Additional historical information is available online at http://www.epa.gov/Arkansas/6sf/pdffiles/0600988.pdf (EPA 2007a).

TABLE 1

CHRONOLOGY OF SITE EVENTS
HARDAGE-CRINER SUPERFUND SITE

Date	Event
September 1972 - November 1980	Site operated as an Oklahoma Controlled Industrial Hazardous Waste Land Disposal Facility.
1978	State of Oklahoma filed complaints against the Site operator (i.e., Royal Hardage) for suspected lead contamination of the air around the Site.
September 1979	State of Oklahoma began proceedings to revoke the Site permit as a result of Royal Hardage's use of un-permitted pits, his failure to seal permeable lenses in the pits, his improper closure of pits, his failure to retain runoff, and his improper storage of wastes.
1979	Preliminary EPA investigations and inspections of the Site indicated poor waste management practices posing threats to public health and the environment.
September 1980	United States filed suit in United States v. Hardage (Hardage I) on behalf of the EPA against Royal Hardage seeking cleanup and closure of the Site. U.S. complaint alleged endangerment under Section 7003 of the RCRA, 42 United States Code Section 6973.
November 1980	Royal Hardage closed the Site prior to the effective date of the RCRA Subtitle C regulations.
1980 – 1986	EPA, RCRA, and CERCLA investigations and studies. Royal Hardage filed bankruptcy. Hardage I was dismissed in 1985 and U.S. filed CERCLA suit in Hardage II against 35 potentially responsible parties on June 25, 1986. United States v. Royal N. Hardage, et al., No. 86-1401-W (E.D. Oklahoma). EPA issued a CERCLA Record of Decision for remedial action on November 14, 1986, which it later withdrew.
1984	The EPA notified arranger and transporter companies that used the Site that they were CERCLA PRPs. The HSC was formed by the PRPs.
1986 – 1989	HSC site investigations and Hardage II case discovery. The EPA made second CERCLA remedy selection in late 1989 after 1986 remedy was not found compliant with RCRA land disposal restrictions. PRPs found liable in Hardage II, and the EPA entered $11 million de minimis settlement.
October 1989	HSC Recommended Comprehensive Site Remedy: Source Control and Management of Migration Preliminary Design Report. EPA issued second Record of Decision.
August 9, 1990	U.S. District Court rejected the EPA remedy and selected HSC Site remedy based on de novo review in Hardage II.
September 1990	HSC Site Remedial Design/Remedial Actions began.
May 2, 1991	U.S. District Court Supplemental Judgment and Order.
May 1993	Site Remedial Design completed.
August 31, 1993	Modifications to the remedy were identified in the Order Modifying Remedy Implementation: Mounds Liquids Recovery System and On Site Class-1 Non-Hazardous Injection Well.

TABLE 1

CHRONOLOGY OF SITE EVENTS
HARDAGE-CRINER SUPERFUND SITE

Date	Event
October 1993	Site remedial construction contract signed.
May 1994	Site V-Trench construction completed.
February 1995	Site Water Treatment Plant brought on-line.
September 1995	The Site remedial construction contractor finished its six-month shakedown and O&M started.
1995	Hardage Site Remedy Corporation contracted with Nationwide Environmental Services, Inc. for long-term O&M for the Site remedy.
September 1997	The EPA signed Hardage Site Preliminary Close Out Report.
September 13, 2001	Court approved Joint Stipulation Agreement and Order between HSC and EPA, which among other things, authorized modification of Site remedy to replace Class I injection well with an infiltration gallery.
September 2002	First Five Year Review Report for the Hardage-Criner Superfund Site completed.
January 2003	Hardage-Criner Superfund Site 2002 Annual Remedial Status Report completed.
January 2004	Hardage-Criner Superfund Site 2003 Annual Remedial Status Report completed.
January 2005	Hardage-Criner Superfund Site 2004 Annual Remedial Status Report completed.
March 9, 2005	U.S. District Court entered Joint Stipulation Agreement between HSC and EPA authorizing SWWRS to be placed in standby mode, subject to conditions.
June 2005	Safety, Health, and Emergency Response Plan completed.
August 2005	Revised Performance Monitoring Plan for Long-Term Operation of the Remedy Implementation.
December 2005	Southwest Wells “Stand-by” Flow-Weighted Average Sampling Results finalized.
January 2006	Hardage-Criner Superfund Site 2005 Annual Remedial Status Report completed.
May 2006	O&M Manual (Revision 2) completed.
December 2006	Screening Level Health and Ecological Risk Assessment completed. Hardage-Criner Superfund Site Proposed V-Trench Passive Aeration System Pilot Study completed.
January 2007	Hardage-Criner Superfund Site 2006 Annual Remedial Status Report completed.
May 2007	EPA approves HSC proposed plan for V-Trench Passive Aeration System Pilot Study, subject to notice to, or approval of, the Court.
July 16, 2007	On unopposed HSC motion, Court approves HSC plan for V-Trench Passive Aeration System Pilot Study as temporary replacement for Water Treatment Plant.

Notes:

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	U.S. Environmental Protection Agency Region 6
HSC	Hardage Steering Committee
O&M	Operation and Maintenance Manual
PRP	Potentially responsible party
RCRA	Resource Conservation and Recovery Act

3.0 BACKGROUND

This section discusses the Site's physical characteristics, land and resource use near the Site, history of site contamination, initial response to the Site, and the basis for the response.

3.1 PHYSICAL CHARACTERISTICS

The Site is located on State Highway 122, 3/4 mile west of Criner, Oklahoma and the intersection of State Highways 122 and 59 (Attachment 1). The Site is in McClain County, Oklahoma, approximately 30 miles south-southwest of Oklahoma City. The population within a one-mile radius of the Site is approximately 20 persons.

The Site covers approximately 160 acres and is bordered by open farmland. The topography of the area is flat to gently rolling hills. The principal disposal operations were conducted along a north-south trending ridge at the center of the property. Relief is about 100 feet from the ridge to the adjacent stream valley. The Site is bounded on the southwest by the North Criner Creek floodplain. North Criner Creek flows in a south-easterly direction past the Site, eventually discharging to the Canadian River. Runoff from the western side of the Site enters North Criner Creek and runoff from the eastern side drains into a series of three small farm ponds.

3.2 LAND AND RESOURCE USE

Historical land use surrounding the Site is primarily rural agricultural. Institutional controls restrict the Site and some adjoining property use surrounding the Site.

3.3 HISTORY OF CONTAMINATION

Royal N. Hardage owned and operated an industrial hazardous waste land disposal facility at the Site from September 1972 to November 1980. Initially, the facility was permitted by the Oklahoma State Department of Health (OSDH), but the permit was later revoked when the facility failed to meet newly imposed interim status standards promulgated by EPA under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 6925. During its operation, approximately 21 million gallons of waste were transported to the Site for storage or disposal. Wastes included acids, caustics, lead, cyanide, arsenic,

aromatic solvents, chlorinated solvents, pesticides, polychlorinated biphenyls, oil recycling waste, and other hazardous substances. Initially, liquid and sludge waste from drums or tank trucks was discharged into unlined pits. As the disposal pits filled, drums were piled into a Sludge Mound. Eventually, the Site contained waste impoundments, including a large unlined Main Pit, a series of smaller pits, a Sludge Mound, and a Barrel Mound.

3.4 INITIAL RESPONSE

In 1978, the State of Oklahoma filed complaints against the facility for suspected lead contamination of the air around the Site. In 1979, the OSDH began proceedings to revoke the facility's permit for utilizing unpermitted pits, failure to seal permeable lenses beneath the pits, improper closure of pits, failure to retain runoff, and improper storage of wastes at the Site. Subsequently, preliminary EPA investigations/inspections indicated poor waste management practices that posed a potential threat to public health and the environment. In September 1980, the U.S. Department of Justice (DOJ) filed suit in United States v. Hardage against Mr. Hardage on behalf of the EPA. The suit alleged imminent and substantial endangerment under Section 7003 of RCRA, 42 U.S.C. § 6973 and sought injunctive relief for Site cleanup and closure. The Site was closed in November 1980 and Royal Hardage filed bankruptcy in 1983. In 1984, potential responsible parties (PRPs) were notified of potential EPA CERCLA liability and the DOJ began legal action seeking to recover costs and impose an EPA CERCLA remedy. The original suit against Royal Hardage was dismissed by the Court in 1985 after the United States sought leave to amend the complaint. On June 25, 1986, the United States filed a suit for injunctive relief and recovery of response costs under sections 106(a) and 107(a) of CERCLA, 42 U.S.C. §§ 9606(a), 9607(a), against Royal Hardage and 35 arrangers and transporters. *United States v. Royal N. Hardage, et al.*, Civ. No. 86-1401-W (W.D. Oklahoma). Most of these defendants and numerous other Site PRPs were organized into the Hardage Steering Committee (HSC).

In November 1986, EPA selected a remedial action for the Site in a Record of Decision (ROD); however, EPA later withdrew the decision due to concerns about the impact of impending land disposal restrictions to be promulgated under the RCRA regulations at 40 C.F.R. 268. EPA issued a revised ROD in October 1989, but the Court found many problems with it based upon a *de novo* review at trial. After the trial, the CERCLA remedy was determined by the Court, and the Judge ordered implementation of most of the provisions of the HSC remedial design plan, rejecting the 1989 EPA CERCLA remedy as 'arbitrary and capricious'. Therefore, the Site is under the continuing jurisdiction of the U.S. District Court for the Western District of Oklahoma (Court) and operates under a Court Ordered remedy, not an EPA CERCLA

ROD. *See United States v. Royal N. Hardage*, 750 F.Supp. 1460 (USDC W.D. Oklahoma, 1990), *aff'd.* 982 F.2d 1436 (10th Cir., 1992), *cert. denied* 510 U.S. 913 (1993). The HSC later established the Hardage Site Remedy Corporation (HSRC) as its agent to manage Site remediation and response.

The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The HSRC completed construction of the court-ordered remedy in 1995. Periodic modifications have been made (i.e., concerning an infiltration gallery as replacement for a Class I injection well, the operation of the Southwest Wells Recovery System [SWWRS], and treated water disposal methods). The first Five-Year Review was completed on September 27, 2002.

3.5 BASIS FOR TAKING ACTION

During site operations, approximately 21 million gallons of industrial wastes including acidic, caustic and corrosive wastes, many classified as carcinogenic, were disposed on the Site. The principal source of contamination is estimated to be 278,000 cubic yards of sludges, waste drums, highly contaminated soils, and waste liquids contained in three waste disposal areas near the center of the property. Hazardous substances detected in the source area include: 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethene, tetrachloroethene, trichloroethene, lead, chromium, poly-chlorinated biphenyls, and toxaphane.

Hazardous substances from the source area have contaminated the groundwater present in Strata I, II, and III. Groundwater flows east toward the east farm ponds, and west-southwest toward the North Criner Creek alluvium. Strata IV and V consist of low permeability mudstones and silty mudstones that separates the shallow groundwater from saline water in Stratum VI.

4.0 REMEDIAL ACTIONS

This section discusses the selected remedy, remedy implementation, operation and maintenance (O&M) activities, and O&M costs.

4.1 SELECTED REMEDY

The Court selected remedial objectives for the Site remedy, but did not select specific numerical cleanup standards for attainment by the remedy. As noted in section 3.4 above, the Court rejected EPA's remedy

selected in a revised ROD and adopted most of the elements of a remedial design plan developed by the HSC in October 1989. The remedial objectives as described in the August 9, 1990 Judgment and Order (see Section VIII, Finding No. 12, page 55) included:

- Control of the surface water pathway;
- Preclusion of site access and direct contact with waste;
- Control of air emissions from source areas;
- Preclusion of the use of affected groundwater; and
- Provision for a contingent response to ensure continued maintenance of the quality of North Criner Creek.

The Court selected the following remedy components for the Site as described in the 1990 Judgment and Order (see Section VIII, Finding No. 16, pages 56-58). The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity.

- V-shaped, gravel-filled interceptor trench constructed at the base of Stratum III and top of Stratum IV to provide hydraulic control of the source areas by capture and removal of affected groundwater and non-aqueous phase liquids for subsequent treatment.
- Composite Cap (Cap) over source areas to prevent direct contact with wastes, to control surface water flow in source areas, to limit erosion of affected soils, to reduce infiltration of precipitation, and to provide passive gas collection and treatment.
- Permanent vertical liquid recovery wells in the Barrel Mound and the Main Pit to extract pumpable liquids for off-site treatment by incineration and disposal in order to protect the stability of the Barrel Mound and Main Pit and to reduce the volume of free liquids.
- Southwest interceptor wells to prevent migration of affected groundwater in the North Criner Creek alluvium.
- Water treatment system to treat groundwater collected from the trench and wells to standards applicable for discharge into North Criner Creek.
- Natural attenuation and, if necessary, control of migration of constituents presently found in the alluvial groundwater to effect cleanup of alluvial groundwater, and to prevent significant expansion of the area of affected groundwater.
- Institutional controls to limit public access to affected areas, to prohibit future withdrawal of affected groundwater, and to continue the public water supply to area residents.

- A groundwater and surface water monitoring system to monitor groundwater and surface water for continued effectiveness of the remedy.

4.2 REMEDY IMPLEMENTATION

As an agent for the Hardage Steering Committee, the HSRC is managing the implementation of the remedy for the Site. As noted above, the elements of the remedy are identified in the Court Order. HSRC let the construction contract on October 12, 1993, and physical construction of the remedy commenced in November 1993. The remedy was completed in February 1995 and the entire Remedy was in operation by May 1995. The construction contractor finished its initial six-month O&M contract on September 6, 1995. The EPA issued its Preliminary Close Out Report (PCOR) for the remedy on September 30, 1997. Implementation of the Site remedy components are as follows (see Attachment 2):

V-Trench Recovery System

The V-Trench Recovery System (V-Trench) consists of a gravel-filled groundwater interceptor trench 2,600-feet long constructed to the base of Stratum III and top of Stratum IV. The V-Trench has six recovery well sumps (designated TRS-2, 4, 6, 8, 10, and 12), seven instrumented in-trench piezometers (designated TPZ-li, 3i, 5i, 7i, 9i, 11i, and 13i), and 12 in-trench observation wells (designated TOW-1 through 12). Three instrumented piezometers (designated TPZ-14i, 16i, and 18i) and four non-instrumented piezometers (designated TPZ-20, 21, 22, and 23) are located down gradient of the trench. A monitoring well nest MW-21S and 21M is incorporated into the trench monitoring system.

The V-Trench wells provide hydraulic control by capture of affected groundwater. The performance criteria for demonstrating hydraulic capture by the V-Trench is for the water level within the trench piezometers (e.g., TPZ-3i) to be a minimum of 1-foot lower than the water level in the respective piezometer located 100 feet down gradient (e.g., TPZ-20). The trench piezometer well pairs (trench piezometer/down gradient piezometer) are li/14i, 3i/20, 5i/16i, 7i/21, 9i/22, lli/18i, and 13i/23. Captured groundwater is subsequently pumped to the Water Treatment Plant (WTP) for treatment. The pathway for direct contact with constituents in captured groundwater from the V-Trench is eliminated by the closed loop nature of the water treatment system.

Composite Cap

The Cap is a multilayer cap placed over the Barrel Mound, Sludge Mound, and Main Pit. The Cap covers an area of 14 acres and prevents contact with affected materials. The Cap also functions to inhibit percolation of surface water through affected materials and prevent leaching of constituents to groundwater. The Cap has a surficial vegetative layer of grass that intercepts precipitation and releases water via evapotranspiration.

The surface water pathway is being controlled by the Cap and various onsite surface water control features. Surface water control features at the Site include topographic grading of the Cap to provide positive drainage off the Cap and from areas upgradient of groundwater recovery features to minimize infiltration and prevent unnecessary collection of excess groundwater. Other surface water control features include culverts, rip-rap-filled drainage channels, and a surface water detention pond. The detention pond was designed to collect surface water runoff and decrease the peak storm water discharge from a 50-year, 24-hour storm event. The pond is an earthen structure constructed with a 40-millimeter geomembrane liner covered with vegetated soil, a rip-rap centerline channel and spillway, and a corrugated metal pipe outlet. These features are passive structures that undergo periodic visual inspection and routine maintenance as needed.

Air emissions from waste beneath the Cap are controlled through the Active Gas Venting (AGV) system. The AGV system consists of eleven vents and a blower that collects gases and vapors that accumulate beneath the low permeability layer of the Cap. Collected gases and vapors are treated onsite using gas-phase activated carbon.

Permanent Mounds Liquid Recovery System

The Court approved HSC's preliminary remedy design for the mounds liquids extraction system assumed a well spacing of 50 feet with approximately 68 extraction wells planned for installation across the Main Pit and Barrel Mound source areas. The Court approved an interim measure to address the rise in liquid levels in the Barrel Mound area with a Mounds Liquid Recovery System consisting of 14 extraction wells, which became operational in December 1992. Initial operations over a 5-month period produced approximately 1,330,000 pounds of non-aqueous phase liquids (NAPL) that were sent off-site for thermal destruction. The system was shut-down during the start-up of construction in 1993.

Analysis of data collected from the interim MLRS operation indicated that 16 extraction wells instead of the planned 68 extraction wells could be used to remove all of the recoverable liquids from the Barrel Mound and Main Pit. This modification was approved by the EPA and the Oklahoma Department of Environmental Quality (ODEQ) and was approved by the Court in the amended Court Order dated August 31, 1993. On June 11, 1995, the Permanent Mounds Liquid Recovery System (PLRS) was placed into operation. The PLRS consists of 16 recovery wells (designated RW-1 through 16), 9 piezometers (designated MB-19, MB-20, MB-21, MB-23, MB-24, MB-25, MB-26, MB-27, MB-28), a toe-drain recovery sump, and the associated collection and storage system.

The Court Order required the removal of all pumpable liquids from the Barrel Mound and Main Pit. Data collected during the interim MLRS operation and other studies identified a 2 to 3 foot layer of viscous, tarry waste-sediment mixture at the bottom of the Barrel Mound and Main Pit source areas that was not pumpable. The 1993 amended Court Order specified that the bottom mass could be left in place and no further attempts shall be made to remove it.

The 1993 amendment also granted the flexibility for the HSC/HSRC to discontinue using the NAPL separator based on achieving the most cost effective operating scenario. In 2001, HSC/HSRC discontinued use of the separator.

Southwest Wells Recovery System

The SWWRS consists of a line of recovery wells and piezometers that is approximately 900 feet long and is designed to intercept affected groundwater above Stratum IV. Nineteen (19) recovery wells (designated SWWR-1 through SWWR-19) are installed along the alignment, along with three (3) instrumented in-line piezometers (designated SWPZ-3i, SWPZ-13i, and SWPZ-22i), and 15 non-instrumented in-line piezometers (designated SWPZ-1, SWPZ-2, SWPZ-7, SWPZ-8, SWPZ-9, SWPZ-10, SWPZ-11, SWPZ-12, SWPZ-17, SWPZ-18, SWPZ-19, SWPZ-20, SWPZ-21 SWPZ-26, and SWPZ-27) that are installed between each recovery well. Three instrumented piezometers (SWPZ-4i, SWPZ-14i, and SWPZ-23i) and four non-instrumented piezometers (SWPZ-24, SWPZ-25, SWPZ-28 and SWPZ-29) are located downgradient of the SWWRS piezometers SWPZ-3i, SWPZ-9, SWPZ-13i, SWPZ-19, and SWPZ-22i. The lines of Site piezometer pairs include (in-line piezometer/down-gradient piezometer): 3i/4i, 9/28,13i/14i, 19/29, and 22i/23i-24-25.

In March 2005, the HSRC received permission from the Court to cease pumping the SWWRS and place the SWWRS in a "stand-by mode" (USDC W.D. Oklahoma 2005). The "stand-by mode" means that none of the pumps or other SWWRS will be altered, removed, plugged, or abandoned, and that the SWWRS will be maintained in-place and ready for operation if reactivation is required. The present SWWRS consists of wells numbered SWWR-2 through SWWR-18. Recovery wells SWWR-1 and SWWR-19 have replaced off-end wells SWMW-1 and SWMW-2. Wells SWWR-1 and SWWR-19 will continue to serve as off-end monitoring wells to the SWWRS under this 2005 Revised Performance Monitoring Plan (PMP) (HSRC 2005a).

"Stand-by mode" allows the contaminated groundwater previously captured by the SWWRS to flow into the North Criner Creek alluvium and be treated by natural attenuation processes; natural attenuation is a remedy component that was established for the North Criner Creek alluvium by Court Order. Placing the SWWRS into stand-by status was deemed appropriate because of the decline in the volume and concentration of volatile organic compounds (VOC) contamination over nine years of SWWRS operation, as well as the anticipated continuing decline of such contamination based upon observed data and groundwater modeling (USDC W.D. Oklahoma 2005). The performance assessment criteria dictates that the SWWRS may be reactivated if semi-annual sampling indicates the flow-weighted average (FWA) total VOC concentration exceeds "action levels" set at 100 parts per billion (ppb) and 150 ppb, at which either the groundwater monitoring frequency will be changed, or the SWWRS may be reactivated as described in the 2005 Revised PMP (HSRC 2005a).

Water Treatment Plant

The WTP is designed to treat affected site groundwater prior to disposal. The Court Order prohibits mixing of groundwater recovered from the V-Trench and SWWRS before treatment, therefore, the remedy consists of two separate water treatment systems. After treatment, the two effluent streams are combined and discharged to the Infiltration Gallery for disposal (the Infiltration Gallery replaced the Class I Non-Hazardous Injection Well in October 2001 as approved by a Joint Stipulation, Agreement, and Order on September 13, 2001). When the SWWRS is in "stand-by mode", only treated water from the V-Trench is disposed in the Infiltration Gallery. On July 16, 2007, the Court approved an unopposed HSC motion that replaces the WTP with a V-Trench Passive Aeration System Pilot Study for a period of 24 months and a six month evaluation period. Waste water quality and other technical parameters will be

monitored by HSRC, EPA, and ODEQ during the 24 month test period. In the six months following operation of the pilot test, these parties will evaluate test results and determine, subject to Court approval, whether the aeration system should become a permanent replacement for the WTP; documents pertaining to the V-Trench Passive Aeration System Pilot Study are provided in Attachment 8.

Natural Attenuation of the Alluvial Aquifer

The remedy for the North Criner Creek alluvium calls for natural attenuation of constituents. To evaluate natural attenuation, twenty (20) monitoring wells were installed in the North Criner Creek alluvial groundwater located down-gradient of the Site source areas. Monitoring wells are grouped as Group I, Group II, or Group III according to the distance of the wells from the Site, with Group III (a.k.a., sentinel wells) being the furthest downgradient from the Site.

- Group I wells consist of: MW-12S, MW-12M, MW-13S, MW-13M, MW-28, MW-29S, MW-29M, MW- 30, AW-S03, and AW-A01.
- Group II wells consist of: MW-31, MW-32, MW-33, MW-34S and MW-34M

.

- Group III wells consist of: MW-35, MW-36, MW-37, MW-38, and MW-39.

The local groundwater gradient at the Site is primarily to the south-southwest. The majority of alluvial monitoring wells are located between source areas at the Site and North Criner Creek to monitor constituent migration, and all wells are within the Institutional Control Boundary to prevent unauthorized access to the wells.

North Criner Creek

The surface water monitoring system consists of four sampling stations along North Criner Creek. These are designated NCC-1, NCC-2, NCC-3 and NCC-4. The results of the surface water testing from North Criner Creek are compiled and reviewed to monitor the water quality of North Criner Creek for VOCs and ensure that there are no adverse effects resulting from the discharge of North Criner Creek alluvial groundwater to North Criner Creek. Water level measurements of North Criner Creek and the alluvial groundwater indicate a generally upward gradient near North Criner Creek resulting in the stream gaining water from the alluvial aquifer.

Institutional Controls

Site access and use is effectively controlled through the use of institutional and physical controls ordered by the Court. The Site itself is still owned by the Hardage family estate, but by virtue of the Court Order, the Site is dedicated to implementation and operation of the Site remedy. Property usage is controlled by restrictive covenants. Public and private access and use are strictly controlled by HSC. Only authorized personnel are allowed onsite. The primary physical manifestation of the institutional controls is the perimeter industrial security fence that surrounds the Site. The security fence is 9-feet high and consists of an 8-foot high chain link fabric and three strands of barbed wire supported by 45-degree extensions. The fence restricts access of both unauthorized persons and animals. Signs are posted at regular intervals along the security fence identifying the Site as a hazardous waste site and warning against unauthorized entry. A motorized gate at the main entrance prevents unauthorized entrance; it is operated by an intercom and keypad system. This allows ready access by the Site workers, while restricting access by others. The security fence surrounds approximately 160 acres of land consisting of the former disposal area, the WTP, office building, and other active control and monitoring systems. Site lighting is provided by floodlights that are operated by photocell detectors and hand switches. In addition, surrounding the security fence, perimeter fencing runs along the border of approximately 333 acres of land within the institutional control boundary. The institutional control boundary includes other properties adjoining the Site, which a Court Order required the HSC to acquire; these properties are subject to restrictive covenants governing uses. Installation of a public water supply to area residents has removed most nearby residents from domestic well water use as water is supplied through underground piping by McClain County Rural Water District 7.

In January 2002, a 160-foot domestic water well (No. 67437) was installed approximately 1,000 feet to the west of North Criner Creek, north of County Road 122, outside the institutional control area. The HSRC reports that the well is drilled in bedrock on an upland area and does not have any hydrologic connection to the alluvial aquifer of North Criner Creek or site-related constituents (HSRC 2007b). The new domestic well (No. 67437) is located almost directly west of the North Criner Creek alluvial monitoring well AW-S03 and the background wells (i.e., MW-29M, MW-29S, and MW-30), which are located on the east side of North Criner Creek; total VOC concentrations in well AW-S03 have been non-detect since 2002 and total VOC concentrations in the background wells have been non-detect since 1997. At the time of this five-year review, there is no evidence that the new domestic well (No. 67437) is

impacted by site-related constituents. However, impacted groundwater is present in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary

Because access to affected groundwater within the institutional control area has been prohibited, there is no longer an exposure pathway from constituents in groundwater to potential users. Property use within the institutional control boundary is restricted from future agricultural, commercial, or recreational use.

Class I Non-Hazardous Waste Injection Well

The August 31, 1993, amended Court Order modified the remedy, changing the disposal method for treated water from the WTP. The initial design, which had the treated water discharging into North Criner Creek, was changed to discharge into an onsite Class I non-hazardous Injection Well. The Injection Well is cased to 7,300 feet and is designed to inject treated water into four geological formations: the Permian Fortuna, Noble-Olson, Pennsylvanian Griffin, and Yule-Funk formations. These are brine formations, with greater than 10,000 parts per million total dissolved solids, containing non-potable water. The Injection Well operated from February 28, 1995, until October 30, 2001, when the Court approved HSC remedy modification to dispose WTP effluent via the Infiltration Gallery went into operation and the injection well was shut down.

Infiltration Gallery

In accordance with an agreed order of the Court dated September 13, 2001, an Infiltration Gallery was completed to dispose treated water from the WTP. On October 30, 2001, the Infiltration Gallery replaced the Injection Well for disposal of the treated water. The system was designed so that water from the WTP is pumped to the Injection Well equalization tank and then is conveyed through 1,000 feet of conveyance piping to five 100-foot long distribution pipes buried at a depth of 5 to 6 feet below ground surface (bgs). The gallery is designed to handle a flow rate of 25 gallons per minute (gpm) or 36,000 gallons per day.

4.3 OPERATION AND MAINTENANCE

HSRC contracted with NES for long-term O&M of the Site remedy. An updated 2005 Revised PMP (HSRC 2005a) describes the performance monitoring, which is conducted to evaluate the effectiveness of

the remedy and compliance with discharge limits. The 2005 Revised PMP supersedes the 1998 Revised PMP (HSRC 1998) and the original 1996 PMP (HSRC 1996).

Changes that are reflected in the 2005 Revised PMP (HSRC 2005a) are based on modifications to the Remedy, including:

- Placing the SWWRS into "stand-by mode" where pumping is discontinued and sampling is conducted using a "flow-weighted average";
- Construction of a passive Infiltration Gallery to dispose of treated water from the WTP because the Class I Injection Well is in "temporary abandonment mode";
- Construction of a phytoremediation test plot (PTP) in the Northwest Borrow Area (NWBA) to mitigate shallow groundwater upgradient of Seep-14; and
- Streamlining of remedy O&M activities.

The updated objectives of the 2005 Revised PMP (HSRC 2005a) include:

- Monitoring liquid levels and removing pumpable liquids via the PLRS;
- Monitoring the performance and verifying hydraulic capture of the V-Trench;
- Monitoring water quality performance of the SWWRS while in "stand-by mode";
- Monitoring performance and verifying hydraulic capture of the SWWRS when not in "stand-by mode";
- Monitoring operation and performance of the WTP and water quality of the WTP treated effluent;
- Monitoring the performance of the passive Infiltration Gallery while the Injection Well is in "temporary abandonment mode";
- Monitoring water levels and the natural attenuation of VOCs in North Criner Creek alluvial monitoring wells;
- Monitoring the water quality in North Criner Creek;
- Monitoring the performance of the Cap;
- Monitoring the water levels and quality of the NWBA Seep-14 and PTP;
- Monitoring the water quality of the NWBA surface water "county road" sampling station.

V-Trench Recovery System

The V-Trench wells provide hydraulic control by capture of affected groundwater. Captured groundwater is subsequently pumped to the WTP for treatment. The V-Trench recovery system produced: 4,394,970 gallons in 2002 (HSRC 2003b); 4,473,120 gallons in 2003 (HSRC 2004); 4,152,435 gallons in 2004 (HSRC 2005b); 4,961,232 gallons in 2005 (HSRC 2006c); 3,343,900 gallons in 2006 (HSRC 2007c); 750,400 gallons in the first quarter of 2007 (HSRC 2007d); and 62,787,100 gallons since operations began in 1995 (HSRC 2007d).

Water levels from the V-Trench recovery sumps, instrumented V-Trench piezometers, and instrumented downgradient V-Trench piezometers are recorded by a Programmable Logic Controller on a daily basis. Water levels from the non-instrumented observation wells and the non-instrumented downgradient V-Trench piezometers are measured manually using an electronic water level meter on a quarterly basis. The cumulative volume of liquids recovered from the V-Trench is recorded monthly by the Programmable Logic Controller. Annual groundwater samples of the recovery sumps and off-end wells (i.e., MW-21S and MW-21M) are collected annually and analyzed for VOCs.

The water quality data from the V-Trench recovery sumps is used to assess the quality of the groundwater being recovered at each recovery point and status of the remedial system. The water quality data for MW-21S and MW-21M is reviewed to ensure that capture of affected groundwater is achieved at the western limb of the trench alignment.

The objective of the piezometer monitoring is to demonstrate: a decrease in water levels as a result of V-Trench pumping, that inward flow gradients are maintained, and that performance standards are being met. The performance standard for the V-Trench states that hydraulic containment shall be demonstrated if the water level in each piezometer located midway between the recovery wells is at least one-foot lower than the simultaneous water level in the respective downgradient piezometer, which is located 100-foot downgradient of the in-trench piezometer.

As part of the V-Trench Passive Aeration System, the pumps in TRS-2, TRS-4, TRS-8, TRS-10, and TRS-12 were placed in “stand-by mode”, leaving only TRS-6 active (HSRC 2007e). It has been demonstrated that pumping groundwater from TRS-6 sustains hydraulic containment; when it is

necessary to place TRS-6 in "stand-by mode" (e.g., for maintenance), the remaining V-Trench recovery wells are reactivated to maintain hydraulic containment.

Composite Cap

The Cap is primarily a passive structure that prevents direct contact with waste at the main source areas and prevents erosion and migration of the entrained materials. The Cap is monitored to ensure that there is no settlement, erosion, or localized subsidence that may compromise the integrity of the Cap.

The Cap surface elevation was first surveyed during construction and 2-years after completion of Remedy commissioning, as described in the 1996 PMP (HSRC 1996). The first resurvey of the Cap was conducted in the third quarter of 1997. The second resurvey was conducted in 2002 (HSRC 2002a) and the third resurvey was conducted in 2007 (HSRC 2007g). The next scheduled survey is 2012 and every 5-years there after to coincide with the five-year reviews.

The results of resurveys are compared with the previous surveys to determine if there has been settlement, erosion, or localized subsidence. A difference of ±0.5-feet between the surveys will be regarded as severe enough to initiate the inspection and repair tasks described in the O&M Manual (HSRC 2006b).

The 2002 Cap survey indicated that except for two grid locations (i.e., grid location 2422 and 2437), all of the survey locations had an elevation change of less than 0.5-feet compared to the original as-built survey of the Cap (HSRC 2002a). These two grid locations were inspected in 2002, but no depressed areas could be identified; it is likely that these anomalies were due to minor differences in the positioning of the rod by field personnel during the survey. The 2007 survey of the Cap discovered nine points that indicate a change greater than 0.5-feet from the 2002 inspection. Most of these locations are on the northwest slope of the Cap, but there were no obvious indications of subsidence. A subsequent reinspection of the Cap by the surveyor concluded that these anomalies were due to minor differences in the positioning of the rod by field personnel during the survey (HSRC 2007i).

The Cap contains two mechanical systems: the AGV system and the Thermal Oxidation Unit (TOU), both of which function to control and treat vapors that originate from the capped source areas. Due to higher than expected operational efficiencies in the AGV carbon treatment units, operation of the TOU to treat

AGV off-gases has not been needed to date. Reported emissions from the AGV system are noted in the Annual Remedial Status Reports.

Permanent Mounds Liquid Recovery System

The Cap reduces infiltration and recharge to the mound liquids. Liquid levels are monitored manually from the top of the PLRS piezometer casing, using a multi-phase probe to distinguish between aqueous phase liquids and NAPL, on a quarterly basis. Liquid levels from the mounds piezometers are used to generate a liquid level elevation map to assess the effects of PLRS operation. Periodic adjustment of the depth of the recovery well intakes is necessary because of the rise in the sludge level in the wells.

The total volume of liquids pumped by the PLRS decreased from 90,000 gallons in 1995; to 9,390 gallons in 2001; to 7,098 gallons in 2002 (HSRC 2003b); to 6,520 gallons in 2003 (HSRC 2004); to 4,770 gallons in 2004 (HSRC 2005b); to 3,353 gallons in 2005 (HSRC 2006c); to 2,430 gallons in 2006 (HSRC 2007c); and approximately 1,135 gallons during the first quarter of 2007 (HSRC 2007d). The volume of liquids recovered from the PLRS recovery wells is measured during routine "loadout" events that are conducted approximately every 90 days for off-site disposal. Recovered liquids are incinerated off-site at the Clean Harbors facility in La Porte (formerly Deer Park), Texas. The volume of liquids recovered through the PLRS is reported in the quarterly and annual remedial status reports. Since start-up in 1992, the system has produced a cumulative volume of 430,700 gallons.

Southwest Wells Recovery System

The SWWRS produced: 2,832,490 gallons in 2002 (HSRC 2003b); 3,201,237 gallons in 2003 (HSRC 2004); 2,740,722 gallons in 2004 (HSRC 2005b); 1,700,375 gallons in 2005 (HSRC 2006c); 18,700 gallons of groundwater in 2006 (HSRC 2007c); and 25,279,100 gallons since operations began in 1995 (HSRC 2007c); because the SWWRS was placed into "stand-by mode" in June 2005 and ceased pumping, the volume of liquids produced in 2006 is from pumping the wells before the semi-annual sampling events.

Monitoring of the SWWRS, while in "stand-by mode", began in October 2005 and is conducted on a semi-annual basis; it is scheduled for two (2) years following cessation of SWWRS pumping, which occurred in June 2005. Monitoring is performed by sampling and analyzing southwest recovery wells

numbered SWWR-2 through SWWR-18 (a.k.a., the Monitoring System) for VOCs. The VOC concentration data from the Monitoring System is then used to compute a FWA total VOC concentration, which is calculated using analytical data and the SWWRS average flow contribution percentage (i.e., during the calendar years 2002 to 2004). Wells SWWR-1 and SWWR-19 are used in calculating the FWA total VOC concentration as per the Court Order (USDC W.D. Oklahoma 2005).

The performance assessment criteria dictates that the SWWRS may be reactivated if semi-annual sampling indicates the FWA total VOC concentration exceeds "action levels" set at 100 and 150 ppb, at which either the groundwater monitoring frequency will be changed, or the SWWRS may be reactivated as described in the 2005 Revised PMP (HSRC 2005a).

Water Treatment Plant

The WTP treats affected groundwater captured by the V-Trench and SWWRS (when not in "stand-by mode"). The WTP treated approximately: 7,425,484 gallons in 2002 (HSRC 2003b); 7,685,280 gallons in 2003 (HSRC 2004); 6,803,104 gallons in 2004 (HSRC 2005b); 6,435,367 gallons in 2005 (HSRC 2006c); 3,104,500 gallons in 2006 (HSRC 2007c); 666,400 gallons in the first quarter of 2007 (HSRC 2007d); and over 88,026,300 gallons since operations began (HSRC 2007d). The decrease in volume is attributed to the SWWRS being placed in "stand-by mode" and allowing the groundwater to naturally attenuate rather than be processed through the WTP.

V-Trench and SWWRS (when operating) influent samples are collected quarterly and analyzed for VOCs; the WTP effluent is sampled monthly and analyzed for total VOCs. During operation of the Infiltration Gallery, inorganic field parameters (i.e., pH, total dissolved solids, specific conductance, and temperature) are measured monthly. Inorganic laboratory parameters previously collected during operation of the Injection Well (i.e., dissolved oxygen, sulfide, sulfate, chloride, specific gravity, total suspended solids, bicarbonate, carbonate, and alkalinity) will only be collected if the Injection Well is reactivated. Annual samples of WTP effluent, which are collected in October, are analyzed for total VOCs, semi-volatile organic compounds (SVOC), pesticides, herbicides, poly-chlorinated biphenyls, and inorganics in accordance with the 2005 Revised PMP (HSRC 2005a).

The V-Trench and SWWRS influent constituent concentrations require treatment to comply with numerical standards for discharge to the Infiltration Gallery. Influent results from the V-Trench and

SWWRS (when not in "stand-by" mode) are compiled, entered into the data management system, and used to evaluate operation of the WTP. The WTP routinely operates to remove all organic constituents to non- detect levels. Results of the WTP effluent testing are compared to the discharge limits to ensure that the WTP effluent is meeting all discharge limits. The WTP numerical discharge standards, as specified by the ODEQ, are presented in the 2005 Revised PMP (HSRC 2005a).

As previously noted, based upon a Court Order of July 16, 2007, the WTP will be replaced by the V-Trench Passive Aeration System in a pilot study of 24 months duration, followed by up to six months of evaluation. While this system is expected to produce effluent treatment results that favorably compare with the WTP, it will be closely monitored during the pilot test phase. The Court will have a further opportunity to review this system's performance following completion of the test period.

Natural Attenuation of Alluvial Aquifer

The Group I monitoring wells includes two wells that are located on the west side of North Criner Creek (i.e., MW-13S and MW-13M) and five wells that have been impacted by VOCs during this five-year review period (i.e., MW-12S, MW-12M, MW-28, AW-A01, and AW-S03). Water levels and water quality data (i.e., VOCs) are collected annually from the Group I monitoring wells. The same protocol is followed for the Group II monitoring wells, which are located downgradient of the alluvial groundwater plume. Downgradient Group III (a.k.a., sentinel wells), which have been unimpacted by VOCs since start-up in 1995, are scheduled to be sampled every 5-years, beginning in October 2007; if VOCs are detected in any Group II monitoring wells, the sampling frequency of the Group III monitoring wells will be changed from every 5-years to annually, beginning with the year that VOCs are detected in the upgradient wells. Of the three upgradient alluvial monitoring wells (i.e., background), MW-29S and MW-29M are scheduled to be dropped from the sampling program, but MW-30 is scheduled to be sampled annually for VOCs. Annual groundwater sampling will be conducted in October using passive diffusion bags ("PDBs"), per EPA and Court approval received in 2003; prior to 2003, alluvial groundwater samples were collected using dedicated bailers.

North Criner Creek

The surface water monitoring system consists of four sampling stations (i.e., NCC-1, NCC-2, NCC-3 and NCC-4) along North Criner Creek. Surface water sampling stations NCC-2 and NCC-4 (stations closest

to the Site) are sampled quarterly for VOCs during low flow, when there is sufficient water available from sample collection locations. Stations NCC-1 (furthest down gradient station) and NCC-3 (furthest up-gradient station) are sampled annually for VOCs in the fall (typically October), during low stream flow conditions. The samples are collected when the flow in the creek is less than 1-cubic feet per second, when possible. A U.S. Geological Survey (USGS) gauging station (No. 07328180), located immediately up-gradient of NCC-4, is used to measure stream flow in North Criner Creek.

Institutional Controls

Inspection of all requirements of the institutional controls indicate they are functioning as designed, and all necessary O&M is being performed.

Class I Non-Hazardous Waste Injection Well

Monitoring of the Injection Well was performed for operational purposes and to meet the reporting requirements of Oklahoma Administrative Code Title 252 Chapter 650, Underground Injection Control regulations, as described in the O&M Manual (HSRC 2006b). When in operation, monthly reports were submitted to the ODEQ reporting injection volume, injection pressure, annulus pressure, injection rate, and analytical results for the treated water from the WTP and monthly sampling from monitoring well MW-34M; quarterly reports were submitted to the ODEQ providing injectivity plots. Since October 2001, the Injection Well has been in a "stand-by mode" while the treated water is diverted into the Infiltration Gallery.

Infiltration Gallery

The Infiltration Gallery was completed to dispose treated water from the WTP. Although the Infiltration Gallery is designed to routinely accept up to 25 gpm, the typical influx from the WTP is 13 to 15 gpm when both the V-Trench and SWWRS waste streams are active. With the SWWRS in "stand-by mode", the inflow to the Infiltration Gallery is estimated at 8 to 10 gpm. The Infiltration Gallery received all of the water from the WTP, which included 3,115,300 gallons in 2006 (HSRC 2007c) and 666,400 gallons in the first quarter of 2007 (HSRC 2007d). Once the V-trench Passive Aeration Pilot Study commences, then the Infiltration Gallery will be placed on inactive status.

The monitoring of water levels is used to assess the ability of the Infiltration Gallery to accept treated water from the WTP. Piezometer water levels are plotted on time series charts and the results are reported on a quarterly basis. The water quality of the Infiltration Gallery influent is tested indirectly by monthly sampling the WTP effluent for VOCs. The WTP effluent (i.e., Infiltration Gallery influent) is treated to non-detect levels for all organic constituents by air stripping followed by a carbon polish.

Northwest Borrow Area

During construction of the Cap, soils were obtained from onsite borrow areas located northwest and west of the Site to provide materials for construction. Excavation of soil resulted in the creation of a borrow pit, referred to as the NWBA, covering an area of approximately 11 acres, and extending from a few feet to up to 30-feet below the original topographic surface. The NWBA is located between the Site security fence and the Site boundary, but within the overall institutional control boundary designated in the Court Ordered remedy. Following heavy precipitation, groundwater seepage was observed in the east slope of the NWBA. Two seeps were subsequently sampled for chemical analysis. Water samples collected from one seep contained 27 VOCs and six SVOCs; the source of the constituents appears to be the past operations.

An investigation was subsequently conducted to determine the extent of affected groundwater in the NWBA. Results indicated that geologic Stratum I (the shallowest geologic unit at the Site) along the northern boundary of the Site had been affected by historical waste disposal activities at the North Pond Area and/or the West Pond Area. Groundwater in Stratum I flows predominantly to the south toward the V-Trench recovery system. The portion of Stratum I groundwater flow that emerges as seeps in the NWBA is not captured or treated by the present remedy components under the Court Order. The seeps are present during periods of heavy precipitation, and are estimated to flow for approximately 71 days per year along a smaller confined area of the NWBA. The highest total VOCs detected in the seep was 5,340 micrograms per liter (ug/L) in well Seep-14. The resultant surface water flows accumulates in the low areas with overflow into drainage areas that eventually discharge to North Criner Creek. Fate and transport analysis indicated constituents would primarily volatilize from the water prior to reaching other surface water bodies that might support aquatic life. The seeps are often dry during the summer months.

Summary information and risk assessment concerning the NWBA are available in the 5-Year risk Assessment for the NWBA prepared in February 2003 (HSRC 2003a). The risk assessment concluded

that there was no unacceptable risk to humans or ecological receptors and that only monitoring of the seep was appropriate for the NWBA.

While a comprehensive risk assessment of Seep-14 showed that no unacceptable risk to human health or the environment existed at Seep-14 and no remedial action was needed, the HSRC chose anyway to test the PTP because it is a passive system that requires only minimal effort to maintain, and if successful, could reduce or eliminate Seep-14. Regulatory approval by the ODEQ was verbally granted to the HSRC to install the PTP.

The PTP was installed in March 2000. The primary objective of the PTP is to use all of the groundwater via plant evapotranspiration before it reaches Seep-14. The PTP was designed to consist of three rows of trees and shrubs consisting of hybrid poplar, locust, hackberry and cottonwood planted in parallel rows orientated perpendicular to groundwater flow and installed 55 to 95 feet upgradient of Seep-14. The rows were designed to span the entire area of the seeps and the distance between the rows is designed to be wide enough to address migration of groundwater during winter months when the trees are dormant. The effectiveness of the PTP depends on the growth rate of the trees and the concurrent decline in the observed water flowing from the seeps. Many of the trees and shrubs that were planted as part of the PTP have died due to insect infestation and/or drought.

While not an official component of the Site remedy required by the Court Order, routine monitoring and reporting of seep water quality is conducted as part of the Site O&M surface water and groundwater monitoring program. Three Stratum I piezometers are installed in the PTP in locations designated North (NPZ), South (SPZ), and East (EPZ). Water levels in the three PTP piezometers and Seep-14 are measured manually on a monthly basis if sufficient water is available. Water quality samples for analysis of total VOCs are collected from Seep-14, the County Road surface water station, and the PTP piezometers on a quarterly basis if sufficient water is present.

Performance of the NWBA PTP is determined qualitatively using water levels and changes in VOC content over time. If successful, the VOC content of Seep-14 should decrease with time as the PTP root system removes water from Stratum I by evapotranspiration and facilitates microbial VOC degradation in the root zone. Water levels in Seep-14 should decrease with time as well.

V-Trench Passive Aeration System

In February 2002, a V-Trench Passive Aeration System pilot test was initiated. It is not an official component of the Site remedy required by the Court Order, but was initiated to evaluate a more energy efficient, passive, gravity-flow aeration system to treat the groundwater collected from the V-Trench (HSRC 2007e). The objective of the pilot test was to determine whether a passive, gravity flow air stripping process, tied to an equilibration/polishing basin, could be used to achieve the same level of VOC removal as the current mechanical air-stripping system. At full-scale, the energy savings from this alternative air stripper technology will accumulate for decades.

The basic configuration of the V-Trench Passive Aeration System studied during the pilot tests consisted of the following (HSRC 2007e):

- The pumps in TRS-2, TRS-4, TRS-8, TRS-10, and TRS-12 were placed in "stand-by mode";
- V-Trench groundwater was pumped from TRS-6 to obtain a composite of the overall V-Trench water;
- A 1,000-gallon polyethylene surge tank received the untreated V-Trench groundwater;
- A 24-inch diameter passive aeration chamber approximately 400-feet long constructed of black corrugated high-density polyethylene pipe (with a ventilation fan located at the approximate mid-point of the aeration chamber to increase air flow) installed at a 2% to 5% grade on the ground surface and anchored using rebar stakes to prevent movement;
- A 1,000-gallon polyethylene tank at the end of the aeration chamber received the treated V-Trench groundwater;
- Sampling ports at various locations were used to obtain samples of the water in the aeration chamber and a temperature probe monitored the temperature inside the aeration chamber; and
- An equilibrium/polishing basin was added to increase the residence time for VOC removal.

As the pilot tests were conducted, additional VOC removal components were added and deleted to the basic aeration chamber system to evaluate whether or not VOC removal efficiency could be improved (HSRC 2007e). The pilot tests were conducted using the long-term average flow rate from the V-Trench recovery sumps of 10 gpm. Water quality samples were collected and analyzed for VOCs to evaluate the efficacy of the pilot test. The V-Trench Passive Aeration System was approved by the Court on July 16,

2007 for a 24 month temporary pilot study to be followed by an evaluation period of up to six months (see Attachment 8).

4.4 OPERATION AND MAINTENANCE COST

NES provided approximate associated costs for the Site O&M activities since the last five-year review (HSRC 2007f). The costs include the following:

- Annual O&M of the remedy components
- Agency oversight
- Annual USGS fee for maintaining the gauging station on North Criner Creek

Table 2 provides the approximate costs for the years stated.

TABLE 2

ANNUAL OPERATION AND MAINTENANCE COSTS
HARDAGE-CRINER SUPERFUND SITE

Year	Total Cost Rounded to Nearest $1,000
2002	$412,000
2003	$394,000
2004	$488,000
2005	$454,000
2006	$383,000

5.0 PROGRESS SINCE THE FIRST FIVE-YEAR REVIEW

The purpose of this second five-year review was to determine whether the selected remedy for the Site continues to protect human health and the environment. This review was conducted from February to June 2007, and its findings and conclusions are documented in this report. The first five-year review of the RA was signed on September 27, 2002; this established the second five-year review period of September 27, 2002 to September 27, 2007. The scheduled date for the third five-year report is September 2012; however, the final commitment date is five years from the signature date of this second report.

5.1 PROTECTIVENESS STATEMENT FROM FIRST FIVE-YEAR REVIEW

The First Five-Year Review Report (EPA 2002) concluded that all immediate threats at the Site have been addressed, and the Court selected remedy components were expected to remain protective of human health and the environment. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedy components form the basis of the waste containment remedy at the Site and must be monitored in perpetuity. The institutional controls ordered by the Court dedicate the Site solely to the remedial activities ordered by the Court and restrict access and use of the Site and certain adjoining properties.

5.2 FIRST FIVE-YEAR REVIEW RECOMMENDATIONS AND FOLLOW-UP ACTIONS

The First Five-Year Review Report (EPA 2002) recommended the following follow-up actions:

- Determine if changes in the pumping rates can be used to achieve the performance standard for hydraulic containment in the SWWRS. The performance standard for evaluating hydraulic containment in the SWWRS is for the pumping wells to maintain at least a 0.1 foot water level in the inline piezometers lower than the down-gradient piezometer. A review of the water level data for the SWWRS piezometers indicates that while the performance standard has been generally met, there are areas where the performance standard has not been continuously met. This issue has been noted in the Annual Remedial Status Reports for 2001, 1999, and 1998.

  In an effort to better demonstrate that this performance standard is being maintained by the SWWRS, the piezometer well pairs that are instrumented should also be plotted on a chart comparing the annual record of water levels for each well. The non-instrumented piezometers that are monitored on a quarterly basis should also be plotted on a chart comparing the water levels to the instrumented piezometer. The use of charts would be in addition to the data tables currently found in the annual reports.

  This issue is also related to a proposal submitted by NES on behalf of the HSRC to discontinue pumping in the SWWRS.

- Determine why the performance standard for monitoring hydraulic containment has not been continuously met in the V-Trench piezometers. The performance criteria for demonstrating hydraulic capture by the V-Trench is for the water level within the trench piezometer to be a minimum of 1-foot lower than the water level in the respective piezometer located 100 feet down gradient. A review of the water level data for the SWWRS piezometers indicates that while the performance standard has been generally met, there are areas where the performance standard has not been continuously met. This issue was not identified in the Annual Remedial Status Report (e.g., TPZ well pairs 5i/16i in the 2001 and1999 annual reports and lli/18i in the 2001 and 2000 annual reports).

- Repair the damaged piezometers and implement the quarterly collection of fluid levels from the

PLRS piezometers, and the generation of a liquid level elevation map to assess the effects of PLRS operation.

The presence of a viscous, tarry waste-sediment mixture has plugged the screens in the piezometers or has caused casing failure in all or most of the piezometers. The viscous, tarry mixture at the bottom of the Barrel Mound and Main Pit area also reduces the effectiveness of the vertical recovery wells. During the October 2001 EPA inspection of four PLRS recovery wells, the depth to the bottom sludge was variable at each well location. NES is not currently recording the measured depth to the top of the sludge, or base of the well casing if no sludge is present, or the top of the liquid level within the well. This information could be used to adjust the depth of the pump intake to better recover the pumpable liquids. During the maintenance activities on the PLRS recovery wells, NES should collect this information and adjust the pump intakes for each well. Also, the information for each of the 16 PLRS recovery wells (e.g., construction information, pump intake, sludge and liquid levels, etc.) should be presented in a graphic display or table format for inclusion in the Annual Remedial Status Report. This information will provide an easily referenced source prior to any inspection by the EPA and/or the ODEQ during PLRS maintenance activities.

- Evaluate alternative sample collection methods for VOCs from groundwater monitoring wells. The EPA developed recommendations for the groundwater sampling following oversight of the annual performance monitoring groundwater sampling event conducted by NES in June 2002. The recommendations were provided in a letter dated August 30, 2002, to NES responsible for implementing the groundwater monitoring program at the Site. Revisions to the sampling and analysis plan should be provided to the EPA and the ODEQ for review prior to amending the PMP for Long-Term Operation of the Remedy Implementation.

- Resubmit the proposed risk assessment for the NWBA groundwater seeps incorporating the updated VOC concentration profile and the updated cancer slope factor and toxicity data for 1,1-dichloroethene. Update the VOC data relative to exposure concentrations and risk levels calculated for the NWBA groundwater seeps. Currently, the monthly sample data is totaled for all VOCs and then compared with the total VOCs used in the risk assessment calculations. A more effective determination of any change in the risk to human health and the environment can be performed through a comparison of the individual VOCs utilized to calculate risk rather than a comparison with the total VOC concentration.

- Provide an assessment of the PTP and reduction in the NWBA groundwater seeps in the annual report. The effectiveness of the phytoremediation effort should be considered against the reduction in flow from the seeps within the NWBA.

- Update the 1998 PMP for Long-Term Operation of the Remedy for the Site. This recommended action should be completed by the HSRC upon resolution of the above issues.

- Provide a written report to the EPA of the results of the scheduled 2002 inspection of the Site Cap.

5.3 STATUS OF RECOMMENDED ACTIONS

This section describes the current status of implementation of the recommendations included in the first five-year review (HSRC 2002b) as follows:

- In March 2005, the HSRC received permission from the Court to cease pumping the SWWRS and place the SWWRS in a "stand-by mode" (USDC W.D. Oklahoma 2005). The "stand-by mode" means that none of the pumps or other SWWRS will be altered, removed, plugged, or abandoned, and that the SWWRS will be maintained in-place and ready for operation if reactivation is required. "Stand-by mode" allows the contaminated groundwater previously captured by the SWWRS to flow into the North Criner Creek alluvium and be treated by natural attenuation processes; natural attenuation is a remedy component that was established for the North Criner Creek alluvium by Court Order. Placing the SWWRS into stand-by status was deemed appropriate because of the decline in the volume and concentration of VOC contamination over nine years of SWWRS operation, as well as the anticipated continuing decline of such contamination based upon observed data and groundwater modeling (USDC W.D. Oklahoma 2005).

- V-Trench hydrographs for piezometer profiles indicate that the hydraulic head of each downgradient piezometer is at least 1-foot higher than the corresponding upgradient piezometer. In fact, pumping has achieved draw-downs ranging from approximately 10 to 25 feet within the V-Trench during the second five-year review period with a few exceptions. On occasion, electrical power failures, plugging piezometer air lines, or leaking piezometer air lines resulted in an apparent spike in water levels that appeared to represent loss of hydraulic containment; however, no loss of hydraulic containment occurred, servicing was performed, and the equipment was put back on line. Therefore, the V-Trench performance standard for hydraulic containment has been met.

- Liquid levels from the mounds piezometers are used to generate a liquid level elevation map on a quarterly basis to assess the effects of PLRS operation. Significant changes to liquid levels are then reported. In addition, adjustments to the pump intakes are made based on well specific information (e.g., the depth to the top of the sludge). Maintenance and repairs to damaged piezometers or other components of the PLRS are conducted only after several issues arise; this is because there are significant worker health and safety considerations.

- Monitoring wells are sampled annually for total VOCs using passive diffusion bags ("PDBs"), per EPA and Court approval received in 2003. Prior to 2003 alluvial groundwater samples were collected using dedicated bailers.

- An updated risk assessment for the NWBA was completed in February 2003 (HSRC 2003a), which incorporated the updated VOC concentration profile and the updated cancer slope factor for 1,2-dichloroethene. This risk assessment incorporated chemical-specific toxicity criteria instead of comparisons with total VOC concentrations to determine chemical specific risks to potential human health receptors.

- The PTP monitoring data, evaluation of total VOC concentrations from the NWBA, and effectiveness of the field test are being submitted to the Court, EPA, and ODEQ in the Annual Remedial Status Reports.

- HSRC contracted with Nationwide Environmental Services, Inc. (NES) for long-term O&M of the Site remedy.

- An updated 2005 Revised PMP (HSRC 2005a) describes the performance monitoring, which is conducted to evaluate the effectiveness of the Remedy and compliance with discharge limits. The 2005 Revised PMP (HSRC 2005a) supersedes the January 1998 Revised PMP (HSRC 1998) and the original 1996 PMP (HSRC 1996).

- A written report of the 2002 Cap inspection has been provided to the EPA (HSRC 2002a).

6.0 FIVE-YEAR REVIEW PROCESS

This section presents the process and findings of the second five-year review. Specifically, this section presents the findings of surveys, a site inspection, an applicable or relevant and appropriate requirements (ARARs) review, and a data review.

6.1 ADMINISTRATIVE COMPONENTS

The second five-year review team was lead by Mr. Michael Hebert of the EPA (Remedial Project Manager) with participation from Mr. Hal Cantwell, the ODEQ project manager. Mr. Doug McReynolds and Ms. April Ballweg, representatives from EA Engineering, Science, and Technology, Inc. (EA), assisted in the review process.

In April 2007, the review team established the review schedule, which included the following components:

- Community Involvement
- Site Inspection
- Local Interviews
- ARAR Review
- Data Review
- Five-Year Review Report Development and Review

6.2 COMMUNITY INVOLVEMENT

Upon signature, the Second Five-Year Review Report will be placed in the information repositories for the Site; the ODEQ office in Oklahoma City, Oklahoma; and the EPA Region 6 office in Dallas, Texas. A notice will then be published in the local newspaper to summarize the findings of the review and announce the availability of the report at the information repositories.

6.3 DOCUMENT REVIEW

This second five-year review for the Site included a review of relevant site documents, including Court Orders, annual remedial status reports, risk assessments, pilot test reports, and other ancillary documents. The complete list of documents reviewed during this second five-year review is provided in Attachment 3.

6.4 DATA REVIEW

A review of the Annual Remedial Status Reports through the first quarter of 2007 indicates that the 2005 Revised PMP (HSRC 2005a) is being followed and the remedial action objectives are being met. The following sections discuss the 2002 through 2006 data associated with the Site.

6.4.1 GROUNDWATER MONITORING DATA REVIEW

The following water quality monitoring was performed in 2002 (HSRC 2003c); 2003 (HSRC 2004); 2004 (HSRC 2005c); 2005 (HSRC 2006c); 2006 (HSRC 2007c); and in the first quarter of 2007 (HSRC 2007d).

V-Trench Recovery System

Quarterly water quality samples were collected from the V-Trench recovery system influent for analysis of total VOCs; annual forth quarter total VOC concentrations are provided for a year-over-year comparison (see Table 3).

TABLE 3

V-TRENCH RECOVERY SYSTEM INFLUENT TOTAL VOC CONCENTRATIONS
HARDAGE-CRINER SUPERFUND SITE

Sample Date	Total VOC (ug/L)
12-27-2002	539
12-18-2003	278
12-17-2004	804
12-16-2005	233
12-18-2006	245
03-14-2007	311

Annual water quality samples were collected from the six V-Trench recovery wells in October 2006 for analysis of total VOCs (see Table 4). The average total VOCs in 2006 (434 ug/L) was lower than the 2005 average (760 ug/L); all individual recovery well concentrations were lower in 2006 than the year prior, with the exception of TRS-2.

TABLE 4

V-TRENCH RECOVERY WELLS TOTAL VOC CONCENTRATIONS
HARDAGE-CRINER SUPERFUND SITE

Well ID	2006 Total VOC (ug/L)	2005 Total VOC (ug/L)
TRS-2	507	484
TRS-4	1,293	2,068
TRS-6	433	1,016
TRS-8	143	215
TRS-10	168	510
TRS-12	60	267
Yearly Average	**434**	**760**

Southwest Wells Recovery System

Semi-annual water quality samples were collected from 17 of the 19 Southwest Recovery Wells (SWWR-2 through SWWR-18) on May 9, 2006, and November 14, 2006, and analyzed for total VOCs. The performance assessment criteria dictates that the SWWRS may be reactivated if semi-annual sampling indicates the FWA total VOC concentration exceeds “action levels” set at 100 and 150 ppb, at which either the groundwater monitoring frequency will be changed, or the SWWRS may be reactivated as described in the 2005 Revised PMP (HSRC 2005a). The FWA total VOC concentration was: 35.13 ppb on November 1, 2005 (HSRC 2006c), which was the first FWA result from the March 9, 2005 Court

Order [USDC W.D. Oklahoma 2005]); 35.2 ppb on May 9, 2006 (HSRC 2007c); and 31.8 ppb on November 14, 2006 (HSRC 2007c). Since the semi-annual water quality samples contained total VOC concentrations less than 100 ppb, there was no change in the SWWRS status (i.e., it remained inactive).

Water Treatment Plant and Infiltration Gallery

No VOCs were detected in the monthly WTP effluent water quality samples nor were SVOCs, pesticides, or PCBs detected in the annual water quality sampling from 2002 through 2006 (HSRC 2003, 2004, 2005, 2006, and 2007c). Treated effluent from the WTP continued to be discharged to the Infiltration Gallery.

Northwest Borrow Area

Quarterly water quality samples were collected from the Seep-14 in May and October 2006, with total VOC concentrations of 1,502 and 801 ug/L respectively (HSRC 2007c). In February 2007, the concentration of total VOCs in water at Seep-14 was 1,857 ug/L (HSRC 2007d). Although this concentration is a bit higher than in results from 2006, it is considered to be within the normal range of variability associated with sampling and is less than the maximum concentration of total VOCs reported at Seep-14 (i.e., 5,340 ug/L in December 1995).

Annual spring total VOC concentrations at Seep-14 are provided for a year-over-year comparison: 1,567 ug/L in March 2002 (HSRC 2003b); 4,607 ug/L in March 2003 (HSRC 2004); 2,094 ug/L in March 2004 (HSRC 2005b); 3,420 ug/L in March 2005 (HSRC 2006c); and 1,502 ug/L in May 2006 (HSRC 2007c).

Quarterly water quality samples collected in February 2007 from the three PTP piezometers (SPZ, EPZ, and NPZ) and analyzed for total VOCs were 111 ug/L, non-detect, and 1,036 ug/L respectively (HSRC 2007c). The total VOC concentration trend in these piezometers indicates a neutral trend for SPZ, a downward trend for EPZ, and an upward trend for NPZ. It should be noted that there are no PTP piezometers downgradient of SPZ or Seep-14 so the extent of VOC impacts in the NWBA is undefined.

North Criner Creek

Collection of quarterly and annual surface water quality samples from North Criner Creek was unsuccessful for most of 2006 due to insufficient water for sample collection. In March 2006, Quarterly

surface water samples were collected from locations NCC-2 and NCC-4; no VOCs were detected (HSRC 2007c). In March 2007, quarterly surface water samples were collected from the same locations once again and the results were also negative for VOCs (HSRC 2007d). With the exception of a single estimated value of 3.6 ug/L of trichloroethylene at NCC-1 in September 1998, there have not been any positive indications of VOCs in surface water from North Criner Creek since the start of the remedy in 1995. The absence of constituents in North Criner Creek is supporting evidence that natural attenuation is occurring in the North Criner Creek alluvium.

Natural Attenuation of Alluvial Aquifer

Annual sampling results indicate that only five of the alluvial monitoring wells have been impacted by VOCs during this five-year review period; all are Group I wells (i.e., MW-12S, MW-12M, MW-28, AW-A01, and AW-S03). The remaining Group 1 monitoring wells located on the west side of North Criner Creek and upgradient of the alluvial groundwater plume (i.e., background) have been unimpacted by VOCs during this five-year review period. All of the Group II and Group III monitoring wells are located downgradient of the alluvial groundwater plume and have been unimpacted by VOCs during this five-year review period. The approximate travel time from the Group II wells to the sentinel wells is approximately 5 years according to the 2005 Revised PMP (HSRC 2005a).

Regular groundwater monitoring of VOCs in the alluvial aquifer indicate a general downward trend. Of the five alluvial monitoring wells that have been impacted by VOCs during this five-year review period, three (i.e., MW-12S, MW-12M, and AW-S03) indicate a downward trend; one (i.e., MW-28) trends neutral; and one (i.e., AW-A01) indicates an upward trend (see Table 5).

Monitoring of the alluvial aquifer is conducted to measure the natural attenuation of the alluvial groundwater and verify that there is no significant expansion of the affected groundwater. In the EPA guidance document "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (OSWER Directive No. 9200.4-17P, April 21, 1999), the following four indicators are used for evaluating the performance of a natural attenuation remedy: 1) demonstrate that natural attenuation is occurring according to expectations; 2) detect changes in environmental conditions that may reduce the efficacy of the natural attenuation processes; 3) identify any potentially toxic or mobile transformation products; and 4) verify that the plume is not expanding either downgradient, laterally, or vertically.

Cleanup of the alluvial aquifer through natural attenuation is measured through the VOC concentration trends for the alluvial aquifer monitoring wells. Of the 20 monitoring wells installed in the alluvial aquifer, 15 remain non-detect for VOCs. However, of the remaining 5 wells, 4 wells have demonstrated a declining or neutral trend for total VOC concentrations during this five-year review period. There is a concern regarding the absence of a declining concentration trend for VOCs detected in monitoring well AW-A01, which is located at the downgradient extent of alluvial aquifer contamination. Since 2002, VOC concentrations have fluctuated with no persistent downward trend to indicate either a shrinking or stable plume boundary (see Table 5). However, monitoring data collected from the next line of downgradient monitoring wells (MW-33, MW-34M, MW-34S, MW-31, and MW-32) have remained non-detect for VOCs, suggesting the contamination measured in well AW-A01 is discharging into North Criner Creek.

Environmental conditions that may affect the efficacy of the natural attenuation remedy component remain unchanged. Groundwater flow in the alluvial aquifer continues to discharge into the North Criner Creek based on water level measurements for well clusters reported in the annual reports. In addition, the North Criner Creek water samples have remained non-detect for any potentially toxic or mobile transformation products from the VOCs detected in the groundwater. Verification that significant plume expansion is not occurring in the alluvial aquifer is one of the measurements for the natural attenuation remedy component. Lines of monitoring wells provide information on the size and concentration of the contaminant plume in the alluvial aquifer. An evaluation of the constituent concentrations in the wells indicates that the fringes of the plume are undergoing natural attenuation, as indicated by a decreasing or neutral trend in MW-12S, MW-12M, AW-S03, and MW-28, but the center of the plume (i.e., near AW-A01) remains unaffected by natural attenuation processes. Nevertheless, the plume has remained within the current monitoring well network with no significant expansion of the area of affected groundwater.

TABLE 5

NORTH CRINER CREEK ALLUVIAL GROUNDWATER MONITORING RESULTS
HARDAGE-CRINER SUPERFUND SITE

Monitoring Well	Analytical Results Total VOCs (ug/l)				
	2002	2003	2004	2005	2006
MW-12S	0	7.3	6.4	0	0
MW-12M	206	146	152	139	84
MW-28	18	37	48	40	30
AW-A01	109	131	182	163	148
AW-S03	21	0	0	0	0

6.4.2 GROUNDWATER LEVEL MONITORING REVIEW

The following groundwater level monitoring was conducted in 2002 (HSRC 2003c); 2003 (HSRC 2004); 2004 (HSRC 2005c); 2005 (HSRC 2006c); 2006 (HSRC 2007c); and in the first quarter of 2007 (HSRC 2007d)

V-Trench Recovery System

V-Trench groundwater levels are measured on a daily basis using automated instrumented piezometers, and quarterly, using a standard manual water level meter. The objective of the piezometer monitoring is to demonstrate a decrease in water levels as a result of V-Trench pumping, that inward flow gradients are maintained, and that the performance standards are being met. The performance standard for the V-Trench states that hydraulic containment shall be demonstrated if the water level in each piezometer located midway between the recovery wells is at least one-foot lower than the simultaneous water level in the downgradient piezometer.

V-Trench hydrographs for piezometer profiles indicate that the hydraulic head of each downgradient piezometer is at least 1-foot higher than the corresponding upgradient piezometer. In fact, pumping has achieved draw-downs ranging from approximately 10 to 25 feet within the V-Trench during the second five-year review period with a few exceptions (HSRC 2007c, d). On occasion, electrical power failures, plugged piezometer air lines, or leaking piezometer air lines resulted in an apparent spike in water levels

that appeared to represent loss of hydraulic containment; however, no loss of hydraulic containment occurred, servicing was performed, and the equipment was put back on line.

During 2006, only TRS-6 was actively pumped the majority of the time to route affected groundwater to the WTP, while the other five TRS pumping wells were idle, except during maintenance on TRS-6. Even with five of the six pumping wells idle, the drawdown in the V-Trench induced by TRS-6 was more than sufficient to meet the Court-ordered performance standard requirements of 1-foot head difference. Therefore, the V-Trench performance standard for hydraulic containment has been met.

Southwest Wells Recovery System

The SWWRS was placed into "stand-by mode" in 2005, per Court Order (USDC W.D. Oklahoma, 2005). The collection or reporting of water level data is not required in "stand-by mode" so water levels have been allowed to rise.

Infiltration Gallery

Monthly water level measurements of the three Infiltration Gallery piezometers (PZ-1, PZ-2, and PZ-3) indicate that water levels have flattened and remained stable since the initiation of the Infiltration Gallery (HSRC 2007c, d). Water levels spike temporarily when measurable precipitation events are recorded, but soon return to the baseline indicating the Infiltration Gallery is performing as designed.

Permanent Mounds Liquid Recovery System

The PLRS liquid levels have been fairly level during this five-year review period with some minor deviations (HSRC 2007c, d). Occasionally, a liquid level could not be obtained for MB-28; this is likely due to a kink in the casing, which prevents the liquid measurement probe from passing down the casing.

Northwest Borrow Area

Monthly water levels were measured in the NWBA PTP piezometers (NPZ, SPZ, and EPZ) and Seep-14 to assess the effects of the PTP on groundwater levels in Stratum I (HSRC 2007c). The plotted data show that the shallow piezometers respond rapidly to precipitation events as shown by the rapid upward spikes

in water levels; they became “dry” almost as quickly. The piezometers were dry during most of 2004 through 2006, which led to significant loss of the PTP trees and shrubs.

Natural Attenuation of Alluvial Aquifer

Quarterly water levels in North Criner Creek alluvial groundwater wells were measured during this five-year review period. Water level measurements from nested monitoring wells MW-29S and MW-29M indicate a downward vertical gradient. Water level measurements from nested monitoring wells MW-12S and MW-12M, MW-13S and MW-13M, and MW-34S and MW-34M generally indicate an upward vertical gradient. During 2006, water levels in the alluvial wells declined, with the exception of the 4th quarter, as the Site continued to receive below normal precipitation.

6.5 ARAR REVIEW

The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. There have been no changes in the exposure assumptions or physical conditions of the Site that would affect the protectiveness of the Court Order remedy.

Changes in Standards and “To Be Considered"

The Court Order selected the remedial objectives for the Site remedy but did not select specific numerical cleanup standards for attainment by the remedy other than for the operation of the SWWRS. The Court in selecting the remedy did not identify specific standards or ARARs that the remedy must comply with during operations. However, the HSRC has complied with ARARs for operating the remedy. The following ARARs are listed for specific components of the operating remedy.

- Air emissions at the Site are regulated by federal and state laws. The federal regulations are the Clean Air Act, 29 U.S.C. 7408 7413, the National Emission Standards for Hazardous Air Pollutants, 40 C.F.R. 61, and the National Emission Standards for Hazardous Air Pollutants for Source Categories, 40 C.F.R. 63. The Oklahoma regulation is OAC 252:100-41. The Oklahoma statute regarding hazardous air emissions adopts the federal standards, while the Oklahoma statute regarding toxic air emissions contains regulations in addition to the federal standards. Routine on-site analysis of effluent vapors from the AGV indicates the Site is in compliance with all federal and state air regulations. AGV activated carbon treatment units effectively remove constituents from the influent gases and vapors. When positive readings occur during routine analysis, this indicates a potential constituent breakthrough. The carbon units are then replaced and a new sample is analyzed.

- The Injection Well received discharges of the treated water from the WTP from 1995 to 2001 and was operated in compliance with 40 C.F.R. 146 and OAC 252:652. The Injection Well is operated and maintained according to Site manuals as well as the federal and state regulations.

- The regulations regarding water discharges and quality are the Federal Water Pollution Control Act, 33 U.S.C. Section 1342, the federal Safe Drinking Water Act, 40C.F.R. 141, the state regulations found at OAS 252:605, and the discharge limits for North Criner Creek.

- Hazardous substances stored at the Site are those removed from the source areas beneath the Cap by the PLRS. The hazardous materials recovered by the PLRS are collected and shipped off-site to an RCRA regulated incineration facility (Safety-Kleen, La Porte, Texas). All off-site shipments of waste are tracked using required manifest records.

As part of a second five-year review, ARARs were reviewed to determine if any newly promulgated or modified requirements of federal and state environmental laws have significantly changed the protectiveness of the remedies implemented at the Site since the last five-year review was conducted. No newly promulgated or modified ARARs were found during this review that would change the protectiveness of the remedies implemented at the Site.

Although not an ARAR, performance assessment criteria and "action levels" were established for the SWWRS. The SWWRS was placed in a "stand-by mode" (USDC W.D. Oklahoma 2005), which allows the contaminated groundwater previously captured by the SWWRS to flow into the North Criner Creek alluvium and be treated by natural attenuation processes; natural attenuation is a Remedy component that was established for the North Criner Creek alluvium by Court Order. The performance assessment criteria dictates that the SWWRS may be reactivated if semi-annual sampling indicates the FWA total VOC concentration exceeds "action levels" set at 100 ppb and 150 ppb, at which either the groundwater monitoring frequency will be changed, or the SWWRS may be reactivated as described in the 2005 Revised PMP (HSRC 2005a).

The first five-year review was performed by the EPA on September 27, 2002, in which no changes in ARARs were identified. The EPA will continue to monitor this Site and any future changes in ARARs will be reported in the next five-year review.

6.6 SITE INSPECTION

A site inspection was conducted on April 18, 2007, to assess the condition of the Site and the measures employed to protect human health and the environment from the contaminants still present at the Site.

Attendees included: (1) Michael Hebert of the EPA; (2) Hal Cantwell of the ODEQ; (3) Amy Brittain of the ODEQ; (4) Ben Costello of NES; (5) Brian LaFlamme of NES; (6) George Davis of NES; (7) Doug McReynolds of EA; and (8) April Ballweg of EA. The site inspection checklist is included in Attachment 4. Site survey forms are provided in Attachment 5. A photographic log of the inspection is included in Attachment 6.

No evidence of contamination was visible at the Site. The Site's general appearance was excellent and well maintained. Equipment associated with remedial systems appeared to be in good working order and well serviced. The inspection team investigated the Site within the boundary of the fence, as well as the area immediately adjacent to the Site. In addition, the team observed/inspected a representative subset (e.g., V-Trench recovery well TRS-10) of all major remedial system components.

The Cap was inspected during this five-year review for exposure of source materials and breaches in its layers, such as the vegetative cover or liner material. The Cap did not show any signs of breaches, leaks, tears, or other evidence that would suggest the integrity of the Cap or the vegetative cover is compromised. There were several mounds of dirt (possibly due to ants) and small burrow holes, which were surficial in nature and showed no evidence of liner compromise. A few minor areas of erosion were located on the east side of the Cap, but no erosional rills, channels, or gullies were noted.

The exterior security fence was in excellent condition; however, there were some small saplings and a large animal burrow hole along the fence near the NWBA. Many of the trees and shrubs that were planted as part of the PTP have died due to insect infestation and/or drought.

6.7 SITE INTERVIEWS

In accordance with the community involvement requirements of the five-year review process, key individuals to be surveyed were identified by the EPA. Completed survey forms for the following individuals are included in Attachment 5:

- Hal Cantwell, ODEQ
- Ben Costello and Brian LaFlamme, NES

No continuing or unresolved issues were discovered during the interview process.

7.0 TECHNICAL ASSESSMENT

The conclusions presented in this section support the determination that the selected remedy for the Site is currently protective of human health and the environment. EPA Guidance indicates that to assess the protectiveness of a remedy, three questions (Questions A, B, and C) shall be answered.

7.1 QUESTION A: IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS?

- **RA performance**— The review of documents, monitoring data, and the results of the site inspection indicates that the remedy components are generally functioning as intended by the Court Order. The Cap over the Main Pit and Barrel Mound prevents direct contact with the contaminants, controls surface water flow in source areas, limits erosion of affected soils, and reduces infiltration of precipitation. A separate vapor recovery system was installed within the Cap, which controls emissions produced from the Main Pit and Barrel Mound. Pumpable liquids are still being removed from the Main Pit and Barrel Mound areas. The V-Trench provides general, nearly continuous, hydraulic containment of the groundwater contaminant plume originating from the Main Pit and Barrel Mound, and the water is treated through the operating WTP. For the remaining groundwater contamination unaffected by the groundwater containment system, monitoring data indicates that natural attenuation is reducing contaminant concentrations in the alluvial aquifer. The Site security fence and institutional controls prevent contact with contaminants present in the groundwater or in the seeps in the NWBA.

- **Cost of system and O&M**—O&M costs for fiscal years 2002 through 2006 were an average of approximately $426,200. Current O&M activities (as described in Section 4.3) appear sufficient to maintain the effectiveness of the current remedy.

- **Opportunities for optimization**— NES is responsible for long-term O&M of the Court Order remedy components and they have continued to identify areas for system optimization. The Infiltration Gallery replaced the Injection Well for disposal of treated water from the WTP. Also, the SWWRS was placed in "stand-by mode", which allows the contaminated groundwater previously captured by the SWWRS to flow into the North Criner Creek alluvium and be treated by natural attenuation processes; natural attenuation is a Remedy component that was established for the North Criner Creek alluvium by Court Order. In February 2002, a V-Trench Passive Aeration System pilot test was initiated to evaluate a passive, gravity flow air stripping process, and tied to an equilibration/polishing basin that could be used to treat the groundwater collected from the V-Trench. As part of the V-Trench Passive Aeration System, the pumps in TRS-2, TRS-4, TRS-8, TRS-10, and TRS-12 were placed in "stand-by mode", leaving only TRS-6 active. This passive aeration system has now been approved by the Court for a formal 24 month pilot study. The EPA will continue to work with the HSRC and NES on opportunities for system optimization.

- **Early indicators of potential issues**—There is no indication of remedy failure.

- **Implementation of institutional controls and other measures** – The institutional controls are in place and limit public access to affected areas, prohibit future withdrawal of affected groundwater, and continue to supply public water to area residents. Institutional control requirements ordered by the Court include perimeter fencing, security fencing with an electronic

gate, warning signs, and access restrictions and land use restrictions recorded in restrictive covenants. Connection of the public water supply to area residents has removed these residents from all well water supplies. No activities were observed that would have violated the institutional controls.

7.2 QUESTION B: ARE THE ASSUMPTIONS USED AT THE TIME OF REMEDY SELECTION STILL VALID?

- **Changes in exposure pathways**— Institutional controls require prevention of public access to the affected area, prohibition of withdrawal of affected groundwater, and supply of potable water to area residents. As such, there are no current exposure pathways except for the on-site workers and trespassers. These two exposure pathways were used to develop a human health risk assessment for the seeps in the NWBA located outside the Site security fence, but within the institutional control boundary and perimeter fence line. No ecological targets were identified during the ecological screening risk assessment. In addition, a screening level human health and ecological risk assessment was conducted for the V-Trench Passive Aeration System pilot test. The screening level risk assessment concluded that there is no unacceptable risk human health or ecological receptors at the Site. However, the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment did not evaluate potential ecological risks to an aquatic environment, but only focused on terrestrial receptors (HSRC 2006a). Because a few treated water constituents (e.g., 1,1,2-trichloroethane) are not completely volatized in the aeration chamber, there is a potential for aquatic exposure in the water runoff retention basin. Therefore, treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors.

- **Changes in standards, newly promulgated standards, and to-be-considered**— The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. There have been no changes in the exposure assumptions or physical conditions of the Site that would affect the protectiveness of the Court Order remedy. The Court in selecting the remedy did not specify specific standards or ARARs that the remedy must comply with during operations; however, HSRC has complied with those ARARs for operating the remedy.

  Although not an ARAR, performance assessment criteria and "action levels" were established for the SWWRS. The SWWRS was placed in a "stand-by mode" (USDC W.D. Oklahoma 2005), which allows the contaminated groundwater previously captured by the SWWRS to flow into the North Criner Creek alluvium and be treated by natural attenuation processes; natural attenuation is a remedy component that was established for the North Criner Creek alluvium by Court Order. The performance assessment criteria dictates that the SWWRS may be reactivated if semi-annual sampling indicates the FWA total VOC concentration exceeds "action levels" set at 100 ppb and 150 ppb, at which either the groundwater monitoring frequency will be changed, or the SWWRS may be reactivated as described in the 2005 Revised PMP (HSRC 2005a).

- **Changes in toxicity and other contaminant characteristics**—Although there have been no changes to toxicity criteria for the VOCs evaluated in the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene do not coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) nor the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a). The 5-Year Risk Assessment (HSRC 2003a) should be updated accordingly.

- **Changes in land use**—There have been no changes in land use that bear on the protectiveness of the selected remedy.

- **New contaminants and/or contaminant sources**—There have been no new contaminants or contaminant sources identified at the Site.

- **Expected progress toward meeting RA Objectives**— The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedial objectives are to control the surface water pathway, preclude Site access and direct contact with the waste, control air emissions from the source areas, and preclude the use of affected groundwater. The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench must be maintained and operated indefinitely, but the HSRC has received permission from the Court to cease pumping the SWWRS and place it in a "stand-by mode" (USDC W.D. Oklahoma 2005). The institutional controls required by the Court Order dedicate the Site solely to the remedial activities ordered by the Court, as well as, control access and use of the Site itself and certain adjoining properties. There have been no changes in the exposure assumptions or physical conditions of the Site that would affect the protectiveness of the Court Order remedy.

7.3 QUESTION C: HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY?

The type of other information that might call into question the protectiveness of the remedy includes potential future land use changes in the vicinity of the Site or other unexpected changes in site conditions or exposure pathways. All groundwater and surface samples analyzed for the Site were consistent with the extent of contamination and the remedial objectives identified in the 1990 Court remedy with the exception of the seeps in the NWBA. At this time, there is no other information that calls into question the current protectiveness of the remedy required by the Court Order.

7.4 TECHNICAL ASSESSMENT SUMMARY

The review of documents, monitoring data, and the results of the site inspection indicates that the remedy components are generally functioning as intended by the Court Order. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. There have been no changes in the exposure assumptions or physical conditions of the site that would affect the protectiveness of the Court Order remedy. The Court in selecting the remedy did not specify specific standards or ARARs that the remedy must comply with during operations; however, the HSRC has complied with those ARARs for operating the remedy.

The institutional controls are in place and limit public access to affected areas, prohibit future withdrawal of affected groundwater, and continue to provide public water supply to area residents, so no activities were observed that violate the institutional controls.

A screening level human health and ecological risk assessment was conducted for the V-Trench Passive Aeration System pilot test. The screening level risk assessment concluded that there is no unacceptable risk to human health or ecological receptors at the Site. However, the EPA is evaluating the risk assessment and will provide a separate written response to the risk assessment and the supporting data.

Although there have been no changes to toxicity criteria for the VOCs evaluated in the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene do not coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) nor the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a). The 5-Year Risk Assessment (HSRC 2003a) should be updated accordingly.

There is no other information that calls into question the protectiveness of the remedy.

8.0 INSTITUTIONAL CONTROLS

Institutional Controls are generally defined as non-engineered instruments such as administrative and legal tools that do not involve construction or physically changing the Site and that help minimize the potential for human exposure to contamination and/or protect the integrity of a remedy by limiting land and/or resource use (EPA 2005). Institutional controls can be used for many reasons including restriction of Site use, modifying behavior, and providing information to individuals (EPA 2000). Institutional controls may include easements, covenants, restrictions or other conditions on deeds, and/or groundwater and/or land use restriction documents (EPA 2001). The following sections describe the institutional controls implemented at the Site, the potential effect of future land use plans on institutional controls, and any plans for changes to site contamination status.

8.1 TYPES OF INSTITUTIONAL CONTROLS IN PLACE AT THE SITE

Institutional controls are in place and limit public access to affected areas, prohibit future withdrawal of affected groundwater, and continue to provide public water supply to area residents. Institutional control requirements ordered by the Court include access restrictions and land use restrictions as recorded in restrictive covenants and in Court Orders (USDC W.D. Oklahoma, 1991; see Attachment 9). Physical controls implemented in accordance with the Court Order include perimeter fencing, security fencing with an electronic gate, and warning signs. Installation of a public water supply to area residents has removed these residents from all well water supplies. No activities were observed that would have violated either the institutional or physical controls.

8.2 EFFECT OF FUTURE LAND USE PLANS ON INSTITUTIONAL CONTOLS

No future land uses have been established or are anticipated for the Site that would require an adjustment to the institutional controls currently being implemented.

8.3 PLANS FOR CHANGES TO SITE CONTAMINATION STATUS

No changes to the status of the contamination at the Site are anticipated.

9.0 ISSUES

This section describes issues associated with the Site that were identified during the second five-year review:

- **NWBA Groundwater Seeps** - In its current condition, many of the trees and shrubs that were planted as part of the PTP have died due to insect infestation and/or drought. In addition, there are no PTP piezometers downgradient of the SPZ or Seep-14; therefore, the extent of VOC impacts in the NWBA is undefined.

- **2007 Composite Cap Pest Control** - The Cap was inspected during this five-year review for exposure of source materials and breaches in its layers, such as the vegetative cover or liner material. The Cap did not show any signs of breaches, leaks, tears, or other evidence that would suggest the integrity of the Cap or the vegetative cover is compromised. There were several mounds of dirt (possibly due to ants) and small burrow holes, which were surficial in nature and showed no evidence of liner compromise. A few minor areas of erosion were located on the east side of the Cap, but no erosional rills, channels, or gullies were noted.

- **Exterior Security Fence** - The exterior security fence was in excellent condition; however, there were some small saplings and a large animal burrow hole along the fence near the NWBA.

- **Toxicity Criteria** - Although there have been no changes to toxicity criteria for the VOCs evaluated in the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene do not coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) nor the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - The V-Trench Passive Aeration System is expected to create a wetland plant community in the water runoff retention basin, where biological communities will flourish with the continuous water supply (HSRC 2007a). However, the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment did not evaluate potential ecological risks to an aquatic environment, but only focused on terrestrial receptors (HSRC 2006a). Because a few treated water constituents (e.g., 1,1,2-trichloroethane) are not completely volatized in the aeration chamber, which will now be in place for a formal pilot study and evaluation period of about 30 months, there is a potential for aquatic exposure in the water runoff retention basin.

- **Institutional Control Boundary** - In January 2002, a 160-foot domestic water well (No. 67437) was installed approximately 1,000 feet to the west of North Criner Creek, north of County Road 122. This domestic well was installed outside the institutional control area, but it was placed close enough to the institutional control boundary to warrant additional investigation as to its construction and use. At the time of this five-year review, there is no evidence that the new domestic well (No. 67437) is impacted by site-related constituents. Impacted groundwater is present in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

- **North Criner Creek Alluvium Natural Attenuation** - An evaluation of the constituent concentrations in the North Criner Creek alluvial groundwater monitoring wells indicates that the fringes of the VOC plume are undergoing natural attenuation, as indicated by a decreasing or neutral trend in MW-12S, MW-12M, AW-S03, and MW-28, but the center of the plume (i.e., near AW-A01) remains unaffected by natural attenuation processes. Also, tree roots were found to be growing into recovery wells of the SWWRS (HSRC 2007h), which has been placed in "stand-by mode" (USDC W.D. Oklahoma 2005); the SWWRS is located upgradient of the North Criner Creek alluvium groundwater monitoring wells and will be reactivated if required.

- **2005 Revised Performance Monitoring Plan** - The 2005 Revised PMP (HSRC 2005a) does not include potential changes to O&M associated with the V-Trench Passive Aeration System Pilot Study.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells are not collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order in July 2007, will be operated and tested as a replacement for the WTP for a period of 24 months, followed by a six month evaluation period.

Table 6 summarizes the issues for the Site.

TABLE 6

ISSUES IDENTIFIED
HARDAGE-CRINER SUPERFUND SITE

Issue	Affects Current or Future Remedy Protectiveness (Yes/No)
NWBA Groundwater Seeps	No
2007 Composite Pest Control	No
Exterior Security Fence	No
Toxicity Criteria	No
Aquatic Receptors	No
Institutional Control Boundary	No
North Criner Creek Alluvium Natural Attenuation	No
2005 Revised Performance Monitoring Plan	No
Annual Water Quality Sample Collection	No
V-Trench Passive Aeration System Pilot Study	No

10.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

This section describes the recommendations and follow-up actions associated with the Site that were identified during the second five-year review:

- **NWBA Groundwater Seeps** - Additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died; the PTP was designed to consist of three rows of trees and shrubs planted in parallel rows orientated perpendicular to groundwater flow and installed 55 to 95 feet upgradient of Seep-14. Also, the possibility of diverting treated effluent from the WTP from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought conditions should be evaluated. Additional piezometers should be installed downgradient of SPZ and Seep-14 to determine the extent of VOC impacts to the NWBA; sampling and analysis should follow the same protocol established for the NWBA piezometers.

- **2007 Composite Cap Pest Control** - There were several mounds of dirt (possibly due to ants) and small burrow holes in and around the Cap, which were surficial in nature and showed no evidence of liner compromise. Pest control should be conducted to prevent possible compromise of the Cap.

- **Exterior Security Fence** - Maintenance of the perimeter security fence should be conducted to remove the small saplings and a large animal burrow hole near the NWBA.

- **Toxicity Criteria** - In the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene should be updated to coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) and the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).

- **Aquatic Receptors** - Treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors.

- **Institutional Control Boundary** - Domestic water well (No. 67437) should be a topic in future discussions in the Annual Remedial Status Reports and an annual check of the Oklahoma Water Resources Board database should be conducted to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy. A review of the institutional control boundary and legal description of the Site should be conducted to determine if adjustments are necessary due to the presence of impacted groundwater in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.

- **North Criner Creek Alluvium Natural Attenuation** - In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) in the SWWRS should be evaluated. The tree roots growing into recovery wells of the SWWRS should be addressed as part of this evaluation.

- **2005 Revised Performance Monitoring Plan** - The 2005 Revised PMP (HSRC 2005a) should be amended to incorporate potential changes to O&M associated with the V-Trench Passive Aeration System Pilot Study.

- **Annual Water Quality Sample Collection** - Annual water quality samples from the six V-Trench recovery wells should be collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent for comparative purposes; this protocol should also apply to the V-Trench Passive Aeration System Pilot Study.

- **V-Trench Passive Aeration System Pilot Study** - The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order on July 16, 2007, will be operated and tested as a replacement for the WTP for a period of 24 months. Waste water quality and other technical parameters will be monitored by HSRC, EPA, and ODEQ during the 24 month test period. In the six months following operation of the pilot test, these parties will evaluate test results and determine, subject to Court approval, whether the aeration system should become a permanent replacement for the WTP.

Table 7 summarizes the recommendations and follow-up actions for the Site.

TABLE 7

RECOMMENDATIONS AND FOLLOW-UP ACTIONS
HARDAGE-CRINER SUPERFUND SITE

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affect Long-Term Remedy Protectiveness (Yes/No)
NWBA Groundwater Seeps	Additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died Evaluate whether treated effluent from the WTP could be diverted from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought conditions. Additional piezometers should be installed downgradient of SPZ and Seep-14 to determine the extent of VOC impacts to the NWBA; sampling and analysis should follow the protocol established for the NWBA piezometers.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
2007 Composite Cap Pest Control	Pest control should be conducted to prevent possible compromise of the Cap.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
Exterior Security Fence	Maintenance of the perimeter security fence should be conducted to remove the small saplings and a large animal burrow hole near the NWBA.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
Toxicity Criteria	In the 5-Year Risk Assessment (HSRC 2003a), noncancer reference doses for 1,2-dichloroethene; 1,1,1-trichloroethane; and trichloroethene and cancer slope factors for tetrachloroethene and trichloroethene should be updated to coincide with the preferred hierarchy found in the EPA Region 6 Human Health Medium-Specific Screening Levels (EPA 2004) and the hierarchy demonstrated in the Proposed V-Trench Passive Aeration System Screening Level Health and Ecological Risk Assessment (HSRC 2006a).	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affect Long-Term Remedy Protectiveness (Yes/No)
Aquatic Receptors	Treated water constituents that are detected in the aeration chamber effluent should be evaluated for potential unacceptable ecological risk to aquatic receptors	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
Institutional Control Boundary	Domestic water well (No. 67437) should be a topic in future discussions in the Annual Remedial Status Reports and an annual check of the Oklahoma Water Resources Board database should be conducted to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy. A review of the institutional control boundary and legal description of the Site should be conducted to determine if adjustments are necessary due to the presence of impacted groundwater in monitoring wells MW-12M and AW-A01, which are in close proximity to the institutional control boundary.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
North Criner Creek Alluvium Natural Attenuation	In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) in the SWWRS should be evaluated. The tree roots growing into recovery wells of the SWWRS should be addressed as part of this evaluation.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
2005 Revised Performance Monitoring Plan	The 2005 Revised PMP (HSRC 2005a) should be amended to incorporate potential changes to O&M associated with the V-Trench Passive Aeration System.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No
Annual Water Quality Sample Collection	Annual Water Quality Sample Collection - Annual water quality samples from the six V-Trench recovery wells should be collected at the same time as the quarterly water quality samples for the V-Trench recovery system influent for comparative purposes; this protocol should also apply to the V-Trench Passive Aeration System, if implemented.	HSRC	ODEQ/EPA	Within 1 year of submittal of this report	No

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affect Long-Term Remedy Protectiveness (Yes/No)
V-Trench Passive Aeration System Pilot Study	The pilot test system that was outlined in an unopposed HSC motion and approved by Court Order on July 16, 2007, will be operated and tested as a replacement for the WTP for a period of 24 months. Waste water quality and other technical parameters will be monitored by HSRC, EPA, and ODEQ during the 24 month test period. In the six months following operation of the pilot test, these parties will evaluate test results and determine, subject to Court approval, whether the aeration system should become a permanent replacement for the WTP.	HSRC	ODEQ/EPA	30 months following approval of the Court Order on July 16, 2007	No

11.0 PROTECTIVENESS STATEMENT

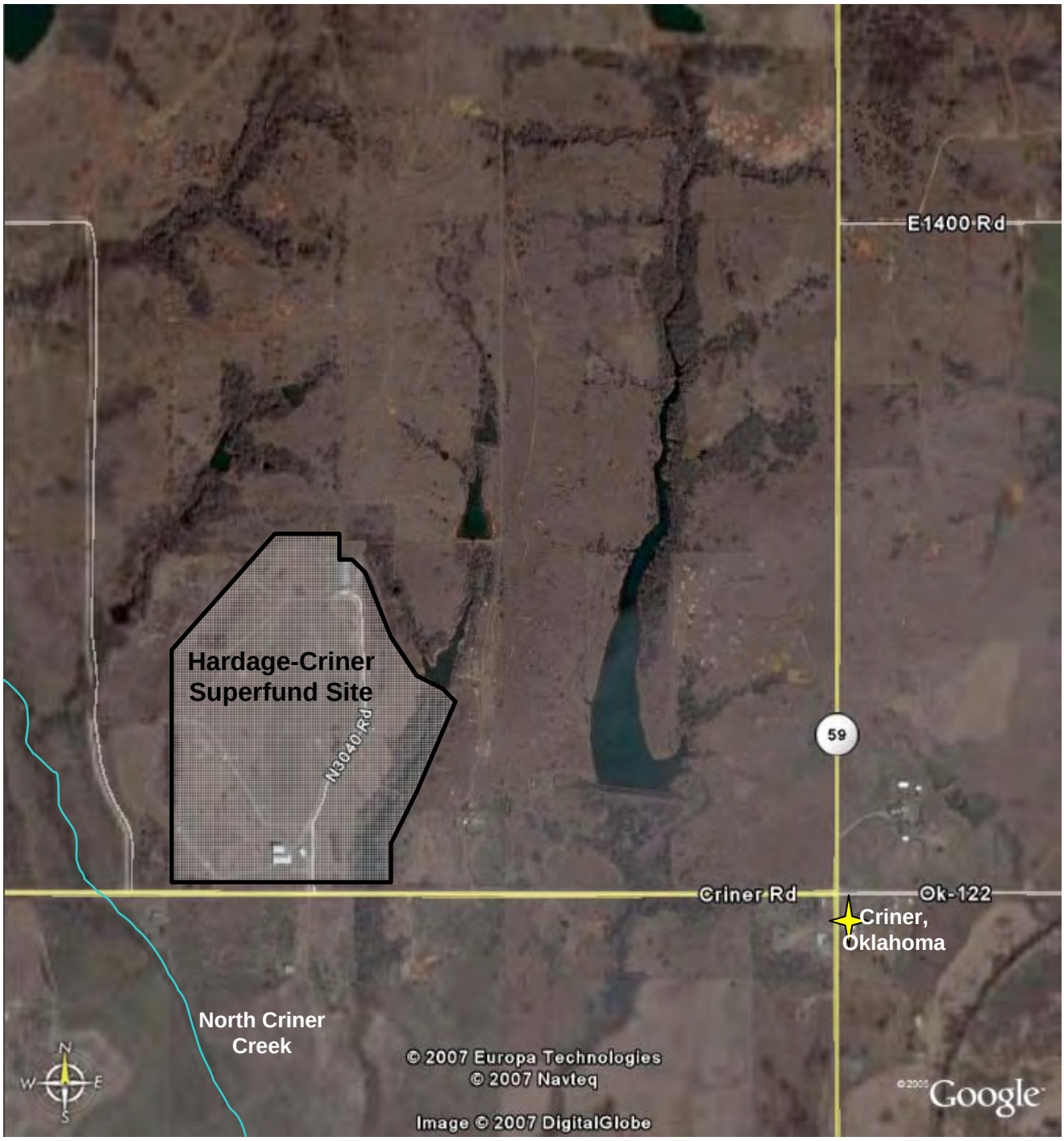
All immediate threats at the Site have been addressed, and the Court selected remedy components are expected to remain protective of human health and the environment. The Court Order specified remedial objectives for the Site without specifying cleanup goals for individual media. The remedy components form the basis of a waste containment remedy at the Site and must be monitored in perpetuity. The V-Trench must be maintained and operated indefinitely, but the HSRC has received permission from the Court to cease pumping the SWWRS and place it in a "stand-by mode" (USDC W.D. Oklahoma 2005). In July 2007, the Court approved implementation of a V-Trench Passive Aeration System Pilot Study to temporarily replace the WTP. The institutional controls ordered by the Court dedicate the Site solely to the remedial activities ordered by the Court and restrict access and use of the Site and certain adjoining properties.

12.0 NEXT REVIEW

The Site requires ongoing five-year reviews. The next review will be conducted within the next five years, but no later than September 2012.

Attachment 1

Site Location Map



SOURCE: GOOGLE EARTH 2007

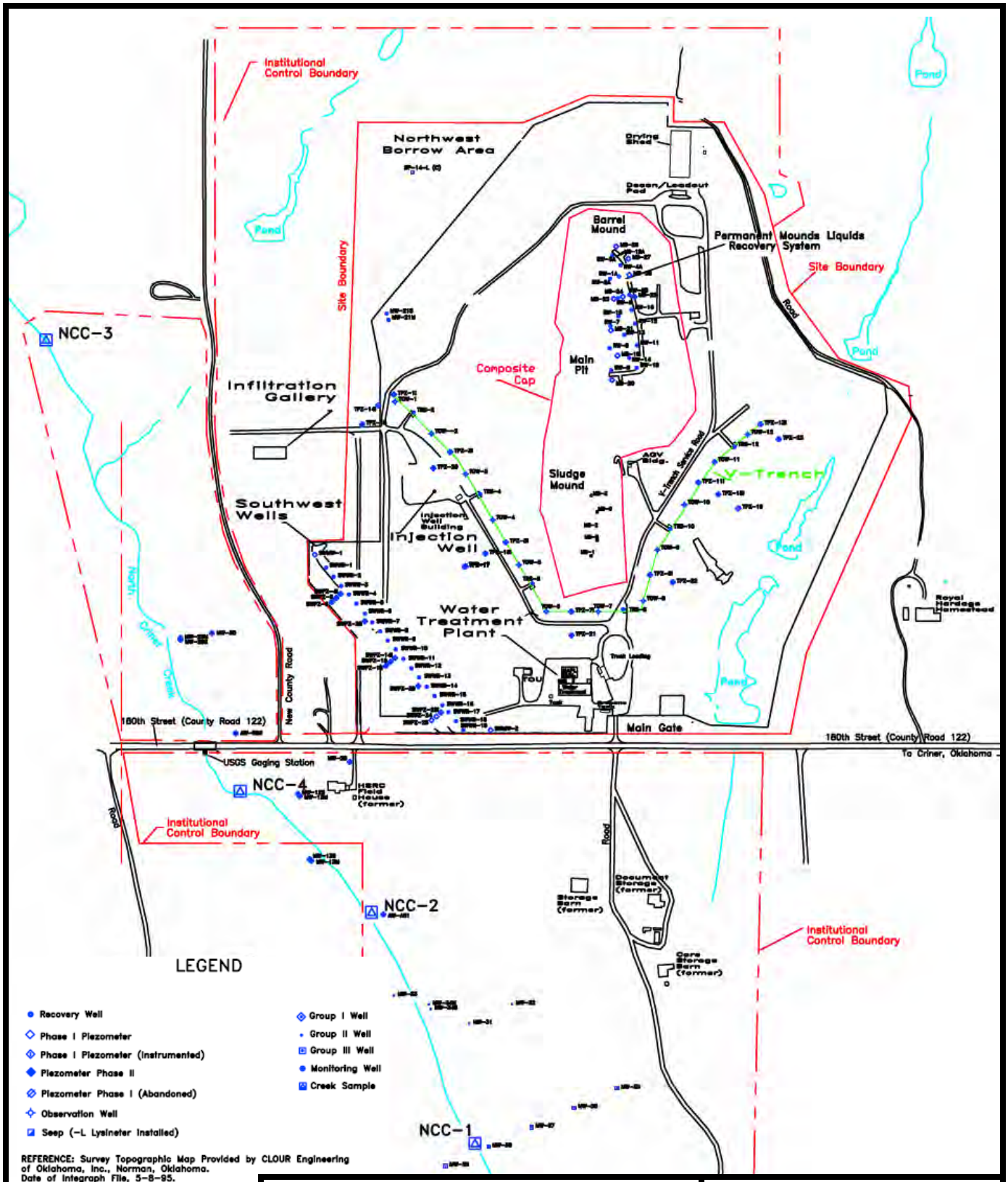
HARDAGE-CRINER SUPERFUND SITE

CRINER, MCCLAIN COUNTY, OKLAHOMA

SITE LOCATION MAP

Attachment 2

Site Map



HARDAGE-CRINER SUPERFUND SITE

CRINER, MCCLAIN COUNTY, OKLAHOMA

SITE MAP

Attachment 3

Documents Reviewed

DOCUMENTS REVIEWED

Hardage Steering Committee. 1989. Recommended Comprehensive Site Remedy: Source Control and Management of Migration. Preliminary Design Report. October 12.

Hardage Site Remedy Corporation (HSRC). 1996. Performance Monitoring Plan for Long-Term Operation of the Remedy Implementation.

HSRC. 1997. Investigation Report and Risk Assessment, Northwest Borrow Area, November.

HSRC. 1998. Revised Performance Monitoring Plan for Long-Term Operation of the Remedy Implementation. January.

HSRC. 2001. Evaluation of the Southwest Wells and Alluvial Natural Attenuation. March.

HSRC. 2002a. Hardage Site RCRA Cap Subsidence Survey. Criner, Oklahoma. September 26.

HSRC. 2002b. Hardage Site Remedy Corporation's Response to U.S. EPA Region 6 Five Year Review Report for the Hardage-Criner Superfund Site. Criner, Oklahoma. November 18.

HSRC. 2003a. 5-Year Risk Assessment. Hardage-Criner Superfund Site. Northwest Borrow Area, Criner, Oklahoma. February.

HSRC. 2003b. Hardage-Criner Superfund Site 2002 Annual Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. January.

HSRC. 2004. Hardage-Criner Superfund Site 2003 Annual Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. January.

HSRC. 2005a. Revised Performance Monitoring Plan for Long-Term Operation of the Remedy Implementation. Hardage-Criner Superfund Site. Criner, Oklahoma. August.

HSRC. 2005b. Hardage-Criner Superfund Site 2004 Annual Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. January.

HSRC. 2005c. Safety, Health, and Emergency Response Plan. Hardage-Criner Superfund Site. Criner, Oklahoma. June.

HSRC. 2005d. Southwest Wells "Stand-by" Flow-Weighted Average Sampling Results, November 2005. December.

HSRC. 2006a. Screening Level Health and Ecological Risk Assessment. Hardage Superfund Site Proposed V-Trench Passive Aeration System. Criner, Oklahoma. December.

HSRC. 2006b. Operation and Maintenance Manual (Revision 2). Hardage-Criner Superfund Site. Criner, Oklahoma. May.

HSRC. 2006c. Hardage-Criner Superfund Site 2005 Annual Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. January.

HSRC. 2007a. Hardage-Criner Superfund Site - Response to EPA Comments on the V-Trench Passive Aeration Pilot Study Report. Criner, Oklahoma. April 20.

HSRC. 2007b. Hardage-Criner Superfund Site - Response to May 7, 2007 E-mail on Groundwater Wells. Criner, Oklahoma. May 17.

HSRC. 2007c. Hardage-Criner Superfund Site 2006 Annual Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. January.

HSRC. 2007d. Hardage-Criner Superfund Site – First Quarter 2007 Remedial Status Report. Prepared for the United States District Court for the Western District of Oklahoma, the United States Environmental Protection Agency, Region VI, and the Oklahoma Department of Environmental Quality. May 4.

HSRC. 2007e. Hardage-Criner Superfund Site – V-Trench Passive Aeration System – Field Pilot Tests.

HSRC. 2007f. Hardage-Criner Superfund Site – Follow-up to April 18, 2007, 5-Year Review Meeting. Criner, Oklahoma. May 4.

HSRC. 2007g. Hardage Superfund Site 2007 5-Year RCRA Composite Cap Subsidence Survey. Criner, Oklahoma. June 19.

HSRC. 2007h. 5-Year Down Hole Videos of the Southwest Wells Recovery System and V-Trench Recovery Wells. Criner, Oklahoma. June 8.

HSRC. 2007i. Hardage Superfund Site 2007 5-Year RCRA Composite Cap Subsidence Survey. Criner, Oklahoma. August 9.

International Technology, Corporation (IT). 1993a. Sampling and Analysis Plan, Construction and Operation, Remedy Implementation. Hardage-Criner Superfund Site. May.

IT. 1993b. Quality Assurance Plan, Construction Phase, Remedy Implementation. Hardage-Criner Superfund Site. June 15.

U. S. District Court for the Western District of Oklahoma. (USDC W.D. Oklahoma). 1990. Court Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-P (W.D. Oklahoma). Judgment and Order. August 9.

USDC W.D. Oklahoma. 1991. Court Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-W (W.D. Oklahoma). Supplemental Judgment and Order. May 2.

USDC W.D. Oklahoma. 2001. Court Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-W (W.D. Oklahoma). Joint Stipulation Agreement. September 13.

USDC W.D. Oklahoma. 2005. Court Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-W (W.D. Oklahoma). Joint Stipulation Agreement. March 9.

USDC W.D. Oklahoma. 2007. Temporary Modification of Remedy - Court Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-W (W.D. Oklahoma). July 16.

USDC W.D. Oklahoma. 2007. HSC Parties' Unopposed Motion and Brief to Temporarily Modify Remedy Order, United States v. Royal Hardage, et al, C.A. No. 86-1401-W (W.D. Oklahoma). July 16.

U. S. Environmental Protection Agency (EPA). 1986. Hardage Criner Superfund Site Record of Decision – OU 01. Criner, Oklahoma. November 14.

EPA. 1989. Hardage-Criner Superfund Site Record of Decision – OU 02. Criner, Oklahoma. November 22.

EPA. 1990. "CERCLA Compliance with the CWA and SDWA." Office of Solid Waste and Emergency Response. 9234.2-06/FS. February.

EPA. 1997. Preliminary Close Out Report, Hardage-Criner Superfund Site. Criner, Oklahoma. September.

EPA. 2000. Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups." EPA 540-F-00-005. September 2000.

EPA. 2001. "Comprehensive Five-Year Review Guidance." EPA 540-R-01-007. June 2001.

EPA. 2002. First Five-Year Review Report for the Hardage-Criner Superfund Site. McClain County, Oklahoma. September.

EPA. 2004. "EPA Region 6 Human Health Medium-Specific Screening Levels." December. On-line address: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm

EPA. 2005. "Institutional Controls: A Citizen's Guide to Understanding Institutional Controls at Superfund, Brownfields, Federal Facilities, Underground Storage Tank, and Resource Conservation and Recovery Act Cleanups." EPA-540-R-04-003. February.

EPA. 2007a. Hardage-Criner (McClain County) Oklahoma Current Status. EPA Region 6. March. On-line address: http://www.epa.gov/Arkansas/6sf/pdffiles/0600988.pdf

EPA. 2007b. Letter from Mike Hebert (EPA Region 6) to Brian LaFlamme (Nationwide Environmental Services, Inc.). V-Trench Passive Aeration Study Field Pilot Tests Approval. May 15.

Attachment 4

Site Inspection Checklist

FIVE-YEAR REVIEW SITE VISIT CHECKLIST

I. SITE INFORMATION

Site Name: Hardage-Criner Superfund Site	**Date of Inspection:** April 18, 2007
Location and Region: McClain County, Oklahoma	**EPA ID:** OKD000400093
Agency leading the five-year review: EPA Region 6	**Weather/temperature:** Sunny, 70°F

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump-and-treatment
- ☐ Surface water collection and treatment
- ☒ Other-Leachate collection and treatment

Attachments: ☒ Inspection team roster attached ☒ Site map attached to report

II. INTERVIEWS (Check all that apply)

1. O&M Site Manager Ben Costello (Name) Project Manager/NES (Title) 4/18/2007 (Date)

Interviewed: ☐ by mail ☒ at site ☐ by phone Phone no. 918-746-7977
Problems, suggestions: ☒ Report attached Survey form attached to report

2. O&M Staff Brian LaFlamme (Name) Facility Manager/NES (Title) 4/18/07 (Date)

Interviewed: ☐ by mail ☒ at office ☐ by phone Phone no. 303-232-2134
Problems, suggestions: ☒ Report attached

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 ODEQ

Contact Hal Cantwell (Name) Project Manager (Title) 4/18/2007 (Date) 405-702-5139 (Phone no.)

Problems, suggestions: ☒ Report attached Survey form attached to report

Agency N/A

Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)

Problems, suggestions: ☐ Report attached _____

4. Other interviews (optional): ☐ Report attached _____

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

1. O&M Documents

☒ O&M manual (long term monitoring plan)	☒ Readily available	☒ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
☒ Maintenance logs (current and cumulative monitoring reports)	☒ Readily available	☒ Up to date	☐ N/A

Remarks:

2. Site-Specific Health and Safety Plan	☒ Readily available	☒ Up to date	☐ N/A
☒ Contingency plan/emergency response plan	☒ Readily available	☒ Up to date	☐ N/A

Remarks: Site-specific health and safety plan was not reviewed

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

Remarks:

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:

5. Gas Generation Records	☐ Readily available	☐ Up to date	☒ N/A
6. Settlement Monument Records	☒ Readily available	☒ Up to date	☐ N/A
7. Groundwater Monitoring Records	☒ Readily available	☒ Up to date	☐ N/A
8. Leachate Extraction Records	☒ Readily available	☒ Up to date	☐ N/A

9. Discharge Compliance Records

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

Remarks:

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

Remarks:

IV. O&M COSTS

1. O&M Organization

☐ State in-house ☐ Contractor for State ☐ PRP in-house

☒ Contractor for PRP ☐ Other _____

2. O&M Cost Records

☒ Readily available ☒ Up to date ☐ Funding mechanism/agreement in place

☐ Original O&M cost estimate ☐ Breakdown attached

Total annual cost by year for review period, if available

Date	Date	Total Cost		
From 2002	to 2002	$412, 000	- ☐	Breakdown attached
From 2003	to 2003	$394,000	- ☐	Breakdown attached
From 2004	to 2004	$488,000	- ☐	Breakdown attached
From 2005	to 2005	$454,000	- ☐	Breakdown attached
From 2006	to 2006	$383,000	- ☐	Breakdown attached

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

No

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing damaged ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: The security fence is 9-feet high and consists of an 8-foot high chain-link fabric and three strands of barbed-wire supported by 45-degree extensions. The fence restricts access of both unauthorized persons and animals. A motorized gate at the main entrance prevents unauthorized entrance; it is operated by an intercom and keypad system. This allows ready access by the Site workers, while restricting access by others. The security fence surrounds approximately 160 acres of land consisting of the former disposal area, the WTP, office building, and other active control and monitoring systems. In addition, surrounding the security fence, perimeter fencing runs along the border of approximately 333 acres of land within the institutional control boundary.

B. Other Access Restrictions

1. Signs and other security measures ☐ Location shown on site map ☐ N/A

Remarks: Signs are posted at regular intervals along the security fence identifying the site as a hazardous waste site and warning against unauthorized entry. Site lighting is provided by floodlights that are operated by photocell detectors and hand switches.

C. Institutional Controls

1. Implementation and enforcement

Site conditions imply institutional controls not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply institutional controls not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by) Onsite personnel enforce the institutional controls during normal work hours.

Frequency Daily

Responsible party/agency HSRC/NES

Contact Ben Costello (Name) Project Manager/NES (Title) 6/15/06 (Date) 918-746-7977 (Phone no.)

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

The Oklahoma Water Resources Board database should be reviewed to ensure that no additional water wells have been installed that may impinge on the protectiveness of the institutional controls and the remedy.

2. Adequacy ☒ Institutional controls are adequate ☐ Institutional controls are inadequate ☐ N/A

Remarks:

D. General

1. Vandalism/trespassing ☐ Location shown on site map ☒ No vandalism evident

Remarks:

2. Land use changes onsite ☒ N/A

Remarks: The Court Order precludes the change of future land use.

3. Land use changes offsite ☐ N/A

Remarks: The land use is predominantly agricultural, which is unlikely to change in the future.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

Remarks: The roads were in excellent condition.

B. Other Site Conditions ☒ Applicable ☐ N/A

Remarks: The site's general appearance was excellent and well maintained. Equipment associated with remedial systems appeared to be in good working order and well serviced.

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots) ☐ Location shown on site map ☒ Settlement not evident

Areal extent Depth

Remarks: _____

2. Cracks ☐ Location shown on site map ☒ Cracking not evident
Lengths _____ Widths _____ Depths _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☒ Substantial erosion not evident
Areal extent _____ Depth _____
Remarks: A few minor areas of erosion were located on the east side of the Cap, but no erosional rills, channels, or gullies were noted.

4. Holes ☒ Holes evident ☐ Holes not evident
Areal extent _____ Depth _____
Remarks: There were several mounds of dirt (possibly due to ants) and small burrow holes, which were surficial in nature and showed no evidence of liner compromise.

5. Vegetative Cover ☒ Grass ☒ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram) (None)
Remarks: _____

6. Alternative Cover (armored rock, concrete, etc.) ☐ N/A
Remarks: Surface water relief channels were noted with rip-rap and armored as necessary.

7. Bulges ☐ Location shown on site map ☒ Bulges not evident
Areal extent _____ Depth _____
Remarks: _____

8. Wet Areas/Water Damage ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	☐ Areal extent _____
☐ Ponding	☐ Location shown on site map	☐ Areal extent _____
☐ Seeps	☐ Location shown on site map	☐ Areal extent _____
☐ Soft subgrade	☐ Location shown on site map	☐ Areal extent _____

Remarks: _____

9. Slope Instability ☐ Slides ☐ Location shown on site map
☒ No evidence of slope instability Areal extent _____
Remarks: _____

B. Benches ☐ Applicable ☒ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. Flows Bypass Bench ☐ Location shown on site map ☒ N/A or okay
Remarks: _____

2. Bench Breached ☐ Location shown on site map ☒ N/A or okay
Remarks: _____

3. Bench Overtopped ☐ Location shown on site map ☒ N/A or okay
Remarks: _____

C. Letdown Channels ☐ Applicable ☒ N/A

1. Settlement ☐ Location shown on site map ☒ No evidence of settlement
Areal extent _____ Depth _____
Remarks: _____

2. Material Degradation ☐ Location shown on site map ☒ No evidence of degradation
Material type _____ Areal extent _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☒ No evidence of erosion
Areal extent _____ Depth _____
Remarks: _____

4. Undercutting ☐ Location shown on site map ☒ No evidence of undercutting
Areal extent _____ Depth _____
Remarks: _____

5. Obstructions Type _____
☒ No obstructions ☐ Location shown on site map
Areal extent _____ Size _____
Remarks: _____

6. Excessive Vegetative Growth Type _____
☒ No evidence of excessive growth ☒ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent _____
Remarks: _____

D. Cover Penetrations ☒ Applicable ☐ N/A

1. Gas Vents ☒ Active ☐ Passive
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks: _____

2. Gas Monitoring Probes
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks: _____

3. Monitoring Wells (within surface area of landfill)
☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
Remarks: _____

4. Leachate Extraction Wells
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks: _____

5. Settlement Monuments ☐ Located ☒ Routinely surveyed ☐ N/A
Remarks: _____

E. Gas Collection and Treatment ☒ Applicable ☐ N/A

1. Gas Treatment Facilities
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☒ Good condition ☐ Needs O&M
Remarks: _____

2. Gas Collection Wells, Manifolds, and Piping ☒ Good condition ☐ Needs O&M
Remarks: _____

3. Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings)
☒ Good condition ☐ Needs O&M ☐ N/A

Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. Outlet Pipes Inspected ☐ Functioning ☒ N/A
Remarks: _____

2. Outlet Rock Inspected ☐ Functioning ☒ N/A
Remarks: _____

G. Detention/Sedimentation Ponds ☒ Applicable ☐ N/A

1. Siltation Areal extent _____ Size _____
☐ N/A ☒ Siltation not evident
Remarks: _____

2. Erosion Areal extent _____ Depth _____
☒ Erosion not evident
Remarks: _____

3. Outlet Works ☐ Functioning ☒ N/A
Remarks: _____

4. Dam ☐ Functioning ☒ N/A
Remarks: _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. Deformations ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____
Remarks: _____

2. Degradation ☐ Location shown on site map ☐ Degradation not evident
Remarks: _____

I. Perimeter Ditches/Off-Site Discharge ☒ Applicable ☐ N/A

1. Siltation ☐ Location shown on site map ☒ Siltation not evident
Areal extent _____ Depth _____
Remarks: _____

2. Vegetative Growth ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent _____ Type _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☒ Erosion not evident
Areal extent _____ Depth _____
Remarks: _____

4. Discharge Structure ☐ Functioning ☒ N/A
Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. Settlement ☐ Location shown on site map ☐ Settlement not evident
Areal extent _____ Depth _____
Remarks: _____

2. Performance Monitoring Type of monitoring _____

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY		
Site Name: Hardage-Criner Superfund Site	**EPA ID No.:** OKD000400093	
Location: Criner, McClain County, Oklahoma	**Date:**	
Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** Hebert.Michael@epamail.epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Doug McReynolds	**Title:** Project Manager	**Organization:** EA Engineering
Telephone No.: (972) 459-5046 **E-Mail:** dmcreynolds@eaest.com	**Street Address:** 405 S. Highway 121, Building C, Suite 100 **City, State, Zip:** Lewisville, Texas 75067	
Individual Contacted:		
Name: Hal Cantwell	**Title:** ODEQ	**Organization:** ODEQ
Telephone No.: 405-702-5139 **E-Mail Address:** Hal.Cantwell@deq.state.ok.us	**Street Address:** 707 North Robinson; P.O. Box 1677 **City, State, Zip:** Oklahoma City, OK 73101-1677	

☐ Performance not monitored Frequency _____ ☐ Evidence of breaching
Head differential _____
Remarks: _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical
☒ Good condition ☒ All required wells located ☐ Needs O&M ☐ N/A
Remarks: _____

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances
☒ Good condition ☐ Needs O&M
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 O&M
Remarks: _____

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances
☐ Good condition ☐ Needs O&M
Remarks: _____

3. Spare Parts and Equipment
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks: _____

C. Treatment System ☒ Applicable ☐ N/A

1. Treatment Train (Check components that apply)

☐ Metals removal ☒ Oil/water separation ☐ Bioremediation
☒ Air stripping ☒ Carbon absorbers
☐ Filters _____
☒ Additive (e.g., chelation agent, flocculent) pH management
☐ Others _____
☒ Good condition ☐ Needs O&M
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☒ Quantity of groundwater treated annually (see below)
☐ Quantity of surface water treated annually _____

Remarks: Approximately 3,104,500 gallons of groundwater were treated in 2006 (HSRC 2007c); approximately 666,400 gallons were treated in the first quarter of 2007; and over 88,026,300 gallons of groundwater have been treated since operations began (HSRC 2007d).

2. Electrical Enclosures and Panels (Properly rated and functional)

☐ N/A ☒ Good condition ☐ Needs O&M

Remarks: _____

3. Tanks, Vaults, Storage Vessels

☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs O&M

Remarks: _____

4. Discharge Structure and Appurtenances

☐ N/A ☒ Good condition ☐ Needs O&M

Remarks: _____

5. Treatment Building(s)

☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☒ Chemicals and equipment properly stored

Remarks: _____

6. Monitoring Wells (Pump-and-treatment remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs O&M ☐ N/A

Remarks: _____

D. Monitored Natural Attenuation ☒ Applicable ☐ N/A

1. Monitoring Wells (Natural attenuation remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks: _____

X. OTHER REMEDIES

If there are remedies applied at the site that 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.).

None

B. Adequacy of O&M

Current O&M activities are adequate; however, see opportunities for optimization below.

C. Early Indicators of Potential Remedy Failure

There are no early indicators of potential remedy failure.

D. Opportunities for Optimization

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

Although not part of the Court Ordered remedy, additional drought resistant trees or shrubs should be planted in the Phytoremediation Test Plot (PTP) to replace those that have died. Also, the possibility of diverting treated effluent from the WTP from the Infiltration Gallery to the PTP to help establish the trees and shrubs and ensure their survivability during drought conditions should be evaluated.

In order to enhance the natural attenuation of VOCs in alluvial groundwater near AW-A01 and possibly reduce future monitoring costs for the North Criner Creek alluvial groundwater, natural attenuation enhancement (e.g., adding nutrients) should be evaluated. Tree roots growing into the recovery wells of the SWWRS should be considered in this evaluation.

INSPECTION TEAM ROSTER

Name	Organization	Title
Michael Hebert	U.S. EPA Region 6	Remedial Project Manager
Hal Cantwell	ODEQ	Project Manager
Amy Brittain	ODEQ	Hydrologist
Ben Costello	NES	Contractor to HSRC
Brian LaFlamme	NES	Contractor to HSRC
George Davis	NES	Contractor to HSRC
Doug McReynolds	EA Engineering	Contractor to the EPA
April Ballweg	EA Engineering	Contractor to the EPA

Attachment 5

Interview Records

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY		
Site Name: Hardage-Criner Superfund Site	**EPA ID No.:** OKD000400093	
Location: Criner, McClain County, Oklahoma	**Date:**	
Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** Hebert.Michael@epamail.epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Doug McReynolds	**Title:** Project Manager	**Organization:** EA Engineering
Telephone No.: (972) 459-5046 **E-Mail:** dmcreynolds@eaest.com	**Street Address:** 405 S. Highway 121, Building C, Suite 100 **City, State, Zip:** Lewisville, Texas 75067	
Individual Contacted:		
Name: Ben Costello	**Title:** Project Mgr.	**Organization:** NES, Inc.
Telephone No.: 918-746-7977 **E-Mail Address:** bcostello@nationwideenv.com	**Street Address:** 2151 East 31st Street **City, State, Zip:** Tulsa, OK 74105	

Survey Questions

Should you choose to respond, please return your survey form to Doug McReynolds at EA Engineering via email or postal service by April 13, 2007.

1. What is your general impression of the work conducted at the site since the first Five-Year Review period (since September 2002)?

   O&M of the remedial action at the Site has been conducted in accordance with the Court Order in an efficient manner and all necessary reports have been filed in a timely manner. During the last 5-year interval, the Site-related VOC concentrations in the Stratum III groundwater captured by the SWWRS remedy component were reduced to the point that the HSRC was permitted to place the SWWRS in "stand-by mode". The Court established flow-weighted average (FWA) VOC concentration limits of 100 ppb and 150 ppb that trigger additional sampling and monitoring. Recent sampling events in 2005 and 2006 reported FWA VOC concentrations of approximately 35 ppb that are well below the Court limits.

   Placing the SWWRS in standby-by mode is yet another incremental operational change that the HSRC has implemented at the Site to improve upon the original remedy. For example, substituting the Infiltration Gallery for the Injection Well has reduced energy costs yet still kept to the original concept of discharging treated water on site; leaving the "bottom mass" in the Barrel Mound and Main Pit area reduced the exposure of on-site personnel to health and safety risks; and shutdown of the NAPL separation facility and incinerating all recovered liquids as NAPLs has reduced energy costs in operating the facility. In yet another proposed modification of the remedy, the HSRC has submitted a detailed plan for achieving significant energy savings utilizing a passive air stripping system to treat groundwater recovered by the V-Trench remedy component. This modification is based on rising energy costs and energy conservation initiatives sponsored by the EPA in response to Presidential Executive Order (E.O. 13123) Greening the Government Through Efficient Energy Management.

   As anticipated, each year the permanent mound liquids recovery system (PLRS) recovers less pumpable liquids than the year before. The HSRC continues to conduct quarterly load outs of the recovered mounds liquids.

   The monitoring data indicates that the phytoremediation test plot has been successful at lowering the shallow groundwater levels in the vicinity of Seep-14 and appears to be reducing the Site related VOC concentrations in the shallow groundwater in the vicinity of Seep-14. There are preliminary indications that the phytoremediation test in the Stratum I interceptor trench at the northeast end of the V-Trench may be exerting an influence on the groundwater entering the northeast portion of the V-Trench.

2. What effect have site operations had on the surrounding community since the first Five-Year Review?

   There have been no negative effects of Site operations on the surrounding community. The HSRC has been very proactive to insure that on-going Site operations have no negative effects on the surrounding community. The HSRC has been working diligently with the various potential first responders in the vicinity of the Site that might, in case of a Site-related emergency, be called upon to enter the Site. A series of first-responder briefings were held with several local fire departments in 2006 to

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY (continued)	
Site Name: Hardage-Criner Superfund Site	**EPA ID No.:** OKD000400093
Location: Criner, McClain County, Oklahoma	**Date:**

Survey Questions (Cont.)

provide the updated Safety, Health, and Emergency Response Plan. The HSRC has voluntarily prepared first responder information notebooks and distributed them to each local fire department and police force and installed first responder information boxes at each entrance to the Site. The first responder information boxes are equipped with all relevant Site-related maps and annotated photographs, health and safety information and HSRC emergency contact information.

To continue a fostering of goodwill with the community, a donation of surplus materials (9 rolls of filter fabric) was made to McClain County in 2004. The HSRC also recognizes the need to be a good neighbor to the adjacent landowners. So when Mr. Whitehead requested access through HSRC property to his land on the east side of North Criner Creek, an easement was successfully negotiated in 2004.

3. In the past five years, are you aware of any community concerns regarding the site or its operation and administration? If so, please provide details.

   The HSRC has not been contacted by anyone regarding any concerns with the Site O&M. Additionally, the on-Site personnel have had no indirect (coffee-shop talk so to speak) evidence of community concerns with the O&M at the Site.

4. Are you aware of any events, incidents, or activities at the Site in the past five years such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details.

   The Site has experienced no events, incidents or activities, such as vandalism, trespassing or emergency responses from local authorities, in the last 5-years.

5. Do you feel well informed about the Site's activities and progress?

   Yes

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

   No

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY		
Site Name: Hardage-Criner Superfund Site	**EPA ID No.:** OKD000400093	
Location: Criner, McClain County, Oklahoma	**Date:**	
Contact Made By:		
Name: Michael Hebert	**Title:** Remedial Project Manager	**Organization:** U.S. EPA
Telephone No.: (214) 665-8315 **E-Mail:** Hebert.Michael@epamail.epa.gov	**Street Address:** 1455 Ross Avenue, Suite 1200 **City, State, Zip:** Dallas, Texas 75202	
Name: Doug McReynolds	**Title:** Project Manager	**Organization:** EA Engineering
Telephone No.: (972) 459-5046 **E-Mail:** dmcreynolds@eaest.com	**Street Address:** 405 S. Highway 121, Building C, Suite 100 **City, State, Zip:** Lewisville, Texas 75067	
Individual Contacted:		
Name: Brian LaFlamme	**Title:** Fac. Mgr.	**Organization:** NES, Inc.
Telephone No.: 303-232-2134 **E-Mail Address:** BLaFlamme@nationwideenv.com	**Street Address:** 4251 Kipling Street, Suite 440 **City, State, Zip:** Wheat Ridge, CO 80033	

Survey Questions

Should you choose to respond, please return your survey form to Doug McReynolds at EA Engineering via email or postal service by April 13, 2007.

1. What is your general impression of the work conducted at the Site since the first Five-Year Review period (since September 2002)?

   O&M of the remedial action at the Site has been conducted in accordance with the Court Order in an efficient manner and all necessary reports have been filed in a timely manner. During the last 5-year interval, the Site-related VOC concentrations in the Stratum III groundwater captured by the SWWRS remedy component were reduced to the point that the HSRC was permitted to place the SWWRS in "stand-by mode". The Court established flow-weighted average (FWA) VOC concentration limits of 100 ppb and 150 ppb that trigger additional sampling and monitoring. Recent sampling events in 2005 and 2006 reported FWA VOC concentrations of approximately 35 ppb that are well below the Court limits.

   Placing the SWWRS in standby-by mode is yet another incremental operational change that the HSRC has implemented at the Site to improve upon the original remedy. For example, substituting the Infiltration Gallery for the Injection Well has reduced energy costs yet still kept to the original concept of discharging treated water on site; leaving the "bottom mass" in the Barrel Mound and Main Pit area reduced the exposure of on-site personnel to health and safety risks; and shutdown of the NAPL separation facility and incinerating all recovered liquids as NAPLs has reduced energy costs in operating the facility. In yet another proposed modification of the remedy, the HSRC has submitted a detailed plan for achieving significant energy savings utilizing a passive air stripping system to treat groundwater recovered by the V-Trench remedy component. This modification is based on rising energy costs and energy conservation initiatives sponsored by the EPA in response to Presidential Executive Order (E.O. 13123) Greening the Government Through Efficient Energy Management.

   As anticipated, each year the permanent mound liquids recovery system (PLRS) recovers less pumpable liquids than the year before. The HSRC continues to conduct quarterly load outs of the recovered mounds liquids.

   The monitoring data indicates that the phytoremediation test plot has been successful at lowering the shallow groundwater levels in the vicinity of Seep-14 and appears to be reducing the Site related VOC concentrations in the shallow groundwater in the vicinity of Seep-14. There are preliminary indications that the phytoremediation test in the Stratum I interceptor trench at the northeast end of the V-Trench may be exerting an influence on the groundwater entering the northeast portion of the V-Trench.

2. What effect have Site operations had on the surrounding community since the first Five-Year Review?

   There have been no negative effects of Site operations on the surrounding community. The HSRC has been very proactive to insure that on-going Site operations have no negative effects on the surrounding community. The HSRC has been working diligently with the various potential first responders in the vicinity of the Site that might, in case of a Site-related emergency, be called upon to enter the Site. A series of first-responder briefings were held with several local fire departments in 2006 to

SUPERFUND FIVE-YEAR REVIEW SITE SURVEY (continued)	
Site Name: Hardage-Criner Superfund Site	**EPA ID No.:** OKD000400093
Location: Criner, McClain County, Oklahoma	**Date:**

Survey Questions (Cont.)

provide the updated Safety, Health, and Emergency Response Plan. The HSRC has voluntarily prepared first responder information notebooks and distributed them to each local fire department and police force and installed first responder information boxes at each entrance to the Site. The first responder information boxes are equipped with all relevant Site-related maps and annotated photographs, health and safety information and HSRC emergency contact information.

To continue a fostering of goodwill with the community, a donation of surplus materials (9 rolls of filter fabric) was made to McClain County in 2004. The HSRC also recognizes the need to be a good neighbor to the adjacent landowners. So when Mr. Whitehead requested access through HSRC property to his land on the east side of North Criner Creek, an easement was successfully negotiated in 2004.

3. In the past five years, are you aware of any community concerns regarding the Site or its operation and administration? If so, please provide details.

   The HSRC has not been contacted by anyone regarding any concerns with the Site O&M. Additionally, the on-Site personnel have had no indirect (coffee-shop talk so to speak) evidence of community concerns with the O&M at the Site.

4. Are you aware of any events, incidents, or activities at the Site in the past five years such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details.

   The Site has experienced no events, incidents or activities, such as vandalism, trespassing or emergency responses from local authorities, in the last 5-years.

5. Do you feel well informed about the Site's activities and progress?

   Yes

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

   No

Survey Questions

Should you choose to respond, please return your survey form to Doug McReynolds at EA Engineering via email or postal service by April 13, 2007.

1. What is your general impression of the work conducted at the Site since the first Five-Year Review period (since September 2002)?

   Very postitive.

2. What effect have Site operations had on the surrounding community since the first Five-Year Review?

   Little to none.

3. In the past five years, are you aware of any community concerns regarding the Site or its operation and administration? If so, please provide details.

   Some general information inquiries about the site related to real estate transactions in the area.

4. Are you aware of any events, incidents, or activities at the Site in the past five years such as vandalism, trespassing, or emergency responses from local authorities? If so, please provide details.

   No.

5. Do you feel well informed about the Site's activities and progress?

   Yes.

6. Do you have any comments, suggestions, or recommendations regarding the Site's management or operation?

   Maintain current high standards and quality.

Attachment 6

Site Inspection Photographs

Photograph No. 1 Site: Hardage-Criner Superfund Site
Description: Entrance gate to site with warning signs Date: April 18, 2007

Photograph No. 2 Site: Hardage-Criner Superfund Site
Description: Truck load-out with secondary containment Date: April 18, 2007

Photograph No. 3 Site: Hardage-Criner Superfund Site
Description: V-Trench recovery well (TRS-10) Date: April 18, 2007

Photograph No. 4 Site: Hardage-Criner Superfund Site
Description: Control instruments within TRS-10 housing unit Date: April 18, 2007

Photograph No. 5 Site: Hardage-Criner Superfund Site
Description: Sump area for TRS-10 housing unit Date: April 18, 2007

Photograph No. 6 Site: Hardage-Criner Superfund Site
Description: PMRS vapor recovery system Date: April 18, 2007

Photograph No. 7 Site: Hardage-Criner Superfund Site
Description: PMRS vapor recovery system Date: April 18, 2007

Photograph No. 8 Site: Hardage-Criner Superfund Site
Description: PMRS vapor recovery system Date: April 18, 2007

Photograph No. 9 Site: Hardage-Criner Superfund Site
Description: PMRS well Date: April 18, 2007

Photograph No. 10 Site: Hardage-Criner Superfund Site
Description: PLRS Date: April 18, 2007

Photograph No. 11 Site: Hardage-Criner Superfund Site
Description: Drying Shed Date: April 18, 2007

Photograph No. 12 Site: Hardage-Criner Superfund Site
Description: Storage at Drying Shed Date: April 18, 2007

Photograph No. 13 Site: Hardage-Criner Superfund Site
Description: Vapor recovery system at Drying Shed Date: April 18, 2007

Photograph No. 14 Site: Hardage-Criner Superfund Site
Description: Fire suppression system at Drying Shed Date: April 18, 2007

Photograph No. 15 Site: Hardage-Criner Superfund Site
Description: Drying Shed with storage tanks Date: April 18, 2007

Photograph No. 16 Site: Hardage-Criner Superfund Site
Description: Drying Shed with foam fire suppressor Date: April 18, 2007

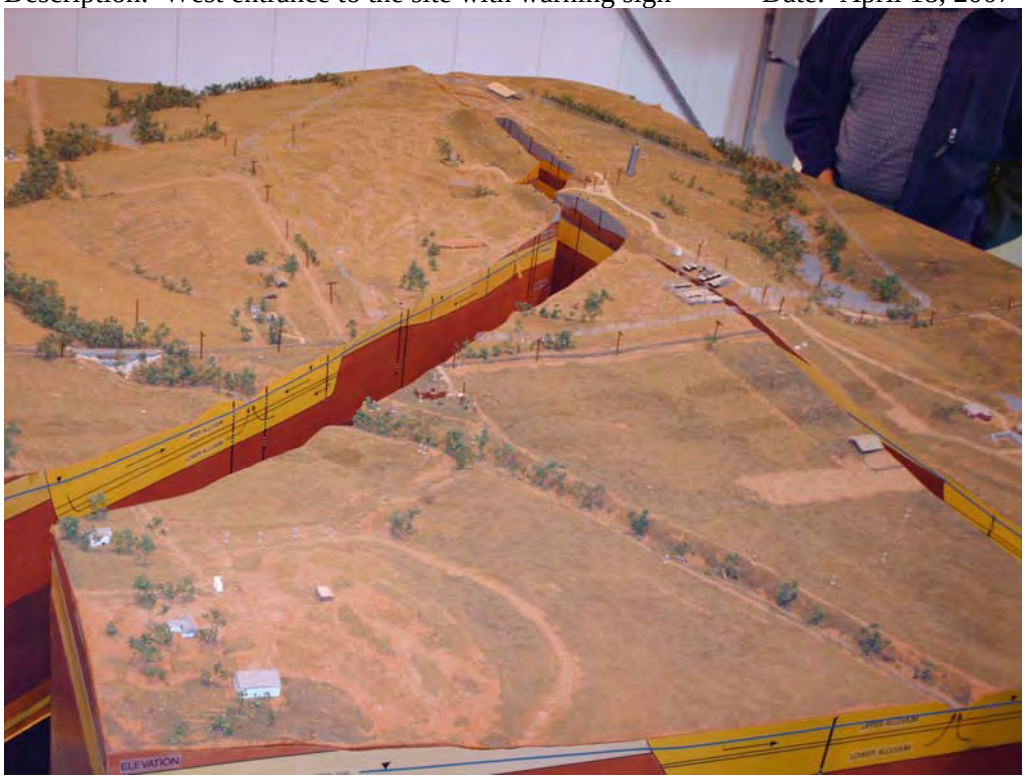
Photograph No. 17 Site: Hardage-Criner Superfund Site
Description: TOU Date: April 18, 2007

Photograph No. 18 Site: Hardage-Criner Superfund Site
Description: TOU and SWWRS Date: April 18, 2007

Photograph No. 19 Site: Hardage-Criner Superfund Site
Description: SWWRS Date: April 18, 2007

Photograph No. 20 Site: Hardage-Criner Superfund Site
Description: V-Trench Passive Aeration Pilot System Date: April 18, 2007

Photograph No. 21 Site: Hardage-Criner Superfund Site
Description: West entrance to the site with warning sign Date: April 18, 2007



Photograph No. 22 Site: Hardage-Criner Superfund Site
Description: Scaled model of the Site prior to remedy Date: April 18, 2007