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THE MEMPHIS DEPOT
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ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 1012

PRELIMINARY CLOSE OUT REPORT

U.S. Defense Depot Memphis, Tennessee

EPA ID No. TN4210020570

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U.S. Environmental Protection Agency
Region 4

PRELIMINARY CLOSE OUT REPORT

Defense Depot Memphis, Tennessee

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
AOC	area of concern
AS-SVE	air sparging with soil vapor extraction
BCT	BRAC Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	chloroform
COCs	contaminants of concern
CT	carbon tetrachloride
CVOC	chlorinated volatile organic compound
CWM	Chemical Warfare Material
CY	cubic yards
DDMT	Defense Depot Memphis, Tennessee
DLA	Defense Logistics Agency
DRC	Depot Redevelopment Corporation
EBT	enhanced bioremediation treatment
EE/CA	engineering evaluation and cost analysis
e^2M	engineering-environmental Management, Inc
EISR	Early Implementation of Selected Remedy
ET&D	excavation, transportation and disposal
FCOR	Final Close-Out Report
FFA	Federal Facilities Agreement
FOSTs	findings of suitability to transfer
FSVE	Fluvial Soil Vapor Extraction
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendment
IRA	Interim Remedial Action
IRACR	Interim Remedial Action Completion Report
LTM	Long-Term Monitoring
LUC	Land Use Controls
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
MI	Main Installation
MNA	monitoring natural attenuation
MSCHD	Memphis Shelby County Health Department
MW	monitoring well

LIST OF ACRONYMS AND ABBREVIATIONS
(CONTINUED)

NPL	National Priorities List
O&M	Operations and Maintenance
OPS	Operating Properly and Successfully
OUs	operable units
PCE	tetrachloroethene
PCOR	Preliminary Close-Out Report
PCP	pentachlorophenol
PRB	permeable reactive barrier
PW	present worth
RA	Remedial Action
RA-C	Remedial Action Construction
RACR	Remedial Action Completion Report
RAO	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RG	Remediation Goal
RI	Remedial Investigation
ROD	Record of Decision
RW	recovery well
scfm	standard cubic feet per minute
SVE	Soil Vapor Extraction
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TSVE	Thermal Soil Vapor Extraction
USEPA	United States Environmental Protection Agency
VMP	vapor monitoring point
VOC	volatile organic compound
WMI	Waste Management Inc
ZVI	zero valent iron

1.0 INTRODUCTION

This Preliminary Close Out Report (PCOR) documents the completion of construction for the selected remedies at the U.S. Defense Depot Memphis, Tennessee (DDMT). The PCOR has been prepared in accordance with *Close Out Procedures for National Priorities List (NPL) Sites* (U.S. Environmental Protection Agency OSWER Directive 9320.2-09A-P, January 2000).

DDMT has four Operable Units (OUs) (OU 1 to OU 4). The selected remedies were described in two records of decision: the *Final Main Installation Record of Decision (ROD)* (CH2M HILL, 2001) includes OUs 2, 3, and 4; and the *Final Dunn Field Record of Decision* (CH2M HILL, 2004b) addresses OU 1. The selected remedy for Dunn Field was revised through the *Dunn Field Record of Decision Amendment* (e^2M, 2009a).

The final component of the selected remedies to be constructed was the AS-SVE system for Off Depot ground water treatment under Operable Unit 1, Dunn Field.. No further response actions are anticipated other than operation, maintenance, and monitoring of the existing remedies.

Interim or final remedial action completion reports have been approved for all actions except the Off Depot Ground Water remedial action (RA). These reports document that the remedies were constructed in accordance with the remedial designs (RDs) and describe the attainment or progress toward attainment of the remedial action objectives (RAOs).

The pre-final construction inspection for the Off Depot air sparging/soil vapor extraction (AS-SVE) system was held 29 October 2009 and a meeting summary submitted on 6 November. Representatives of the U.S. Environmental Protection Agency (USEPA), Tennessee Department of Environment and Conservation (TDEC), and Defense Logistics Agency (DLA) participated. The system was constructed in accordance with the Remedial Design. Not all system components were operational during the inspection and a punch list of action items was developed. Since that time the punch list has been completed and the system has begun full operations.

2.0 SUMMARY OF SITE CONDITIONS

2.1 SITE LOCATION AND DESCRIPTION

DDMT is located in southeastern Memphis, Tennessee. It was established in the early 1940s to provide stock control, material storage, and maintenance services for the U.S. Army. DDMT is located approximately five miles east of the Mississippi River, and just northeast of Interstate 240. The property covers approximately 642 acres and includes two components: the Main Installation (MI), which included open storage areas, warehouses, military family housing, and outdoor recreational areas; and Dunn Field, which included bulk mineral ore storage and waste disposal areas. In 1995, DDMT was placed on the list of Department of Defense facilities to be closed under Base Realignment and Closure (BRAC). Storage and distribution activities continued until DDMT closed in September 1997.

2.2 REGULATORY STATUS

On 28 September 1990, USEPA Region 4 and TDEC issued DDMT a Resource Conservation and Recovery Act (RCRA) Part B permit for the storage of hazardous waste (No. TN 4210020570).

Subsequent to issuing the RCRA permit, USEPA proposed DDMT for listing on the NPL on 7 February 1992, based on an HRS score of 58.7. On 14 October 1992, USEPA added the Depot to the NPL (57 Federal Register 47180 No. 199). On 6 March 1995, USEPA, TDEC, and the DLA entered into a Federal Facilities Agreement (FFA) (USEPA, 1995) under CERCLA Section 120, and RCRA, Sections 3008(h) and 3004(u) and (v).

The FFA divided DDMT into four OUs: Dunn Field, OU 1; Southwest Quadrant MI, OU 2; Southeastern Watershed and Golf Course, OU 3; and North-Central Area MI, OU 4. The *Final Main Installation ROD* (CH2M HILL, 2001) includes OUs 2, 3, and 4. The *Dunn Field, Final ROD* (CH2M HILL, 2004b) addresses OU 1, the only known and documented waste burial area. Disposal records and interviews with facility personnel identified specific instances when some waste burials occurred on Dunn Field, with the earliest record of burial in 1946. Releases on the MI occurred as a result of occasional spills, improper storage, materials and equipment maintenance operations, and other modes incidental to facility operations over time.

2.3 MAIN INSTALLATION (OU-2, 3 AND 4)

Several investigations from 1989 to 2001 identified contamination in surface soil and ground water. Surface contamination requiring response consisted primarily of metals, polychlorinated biphenyls (PCB)s, semi-volatile organic compounds (SVOCs), and dieldrin, a pesticide. Ground water contamination requiring response is limited to CVOCs that exceed Safe Drinking Water Act MCLs, primarily PCE, trichloroethene (TCE), carbon tetrachloride (CT), and Chloroform (CF).

2.3.1 Prior Removal Activities

DLA implemented the following removal actions on the MI prior to the 2001 ROD.

- Approximately 602 cubic yards (CY) of surface and subsurface soil was removed from the pentachlorophenol (PCP) dip vat area (Building 737) because of elevated levels of PCP (began in 1986,completed in 1986, prior to NPL listing).
- Approximately 5,000 tons (3,700 CY) of surface soil in the Housing Area was removed because of the presence of dieldrin (began in June 1998; completed in October 1998). The Housing Area is an exception to the overall industrial land use for MI and soil clean-up levels were based on residential reuse.
- Approximately 530 tons (400 CY) of surface soil surrounding the cafeteria (Building 274) was removed because of elevated levels of PCBs (began in October 1998; completed in November 1998).
- Approximately 980 CY of surface and subsurface soil from near Buildings 1084, 1085, 1087, 1088, 1089 and 1090 was removed because of elevated levels of metals and polyaromatic hydrocarbons (began in May 2000; completed in August 2000).

2.3.2 Record of Decision

EPA approved the Main Installation ROD (MI ROD) on 6 September 2001. DLA implemented the remedy under the terms of the FFA. The RAOs for the MI ROD are:

- prevent ingestion of water contaminated with VOCs in excess of MCLs from potential future on-site wells;
- restore groundwater to levels at or less than MCLs; and prevent migration horizontally and vertically off-site of groundwater contaminants in excess of MCLs.
- prevent direct contact/ingestion of surface soils contaminated with lead in excess of industrial worker risk-based criteria (1,536 mg/kg)
- prevent direct contact/ingestion of surface soils contaminated with dieldrin and arsenic in excess of HHRA [risk-based] criteria for residents

The selected remedy presented in the MI ROD contained the following components:

- Excavation, transport and offsite disposal of lead contaminated surface soil near Building 949.
- Deed Restrictions and site controls, which include prevention of residential land use on the MI, except at the existing housing area; restriction on daycare facilities; production/consumptive use ground water controls for the fluvial aquifer and for drilling into deeper aquifers on the MI; and elimination of casual access through maintenance of a boundary fence around the golf course.
- Enhanced bioremediation of chlorinated volatile organic compounds (CVOCs) in the most contaminated part of the ground water plume.
- Long-term ground water monitoring to document changes in plume concentrations and to ensure contamination does not migrate offsite or to deeper aquifers (the Memphis aquifer, approximately 230-250 feet below ground surface, supplies the drinking water for Memphis).

The area of lead contamination in soil near Building 949 (approximately 300 CY) was excavated and disposed off-site after public comment on the proposed plan but prior to final execution of the ROD. The action was taken under DLA's removal authority under CERCLA Section 104 in order to accommodate more rapid economic redevelopment of the site. The action was documented in *Remediation Report, Removal Action at Building 949* (Jacobs Federal Programs, 2002) and noted in the ROD as a significant change from the Proposed Plan.

2.3.3 Remedial Actions

USEPA approved the *Main Installation Remedial Action Work Plan (RAWP)* (MACTEC, 2005b) on 12 September 2005. *The Interim Remedial Action Completion Report (IRACR) (HDR/E2M, 2010)* was approved on 23 March 2010.

The Enhanced Bioremediation Treatment (EBT) system was constructed from 1 May 2006 to 28 August 2006, in accordance with the approved RD and RAWP. EBT system construction included installation of injection wells and performance monitoring wells, construction of the lactate-storage and transfer facility, and construction of two trailer-mounted injection systems, The construction of the lactate storage and transfer facility and the trailer-mounted injection systems were reviewed using Quality Control checklists developed from the RAWP; no significant deviations were identified. Remedial project managers from DLA, USEPA and TDEC held the post-construction inspection on 28 September 2006. No outstanding items or deficiencies were noted during the inspection and no follow-up actions were required.

Sodium lactate was injected in all injection wells on a biweekly schedule during Year One (September 2006 through August 2007) and a monthly schedule during Year Two (September 2007 through February 2009). Changes to injection procedures were made based on field observations and measurements. Treatment performance was monitored quarterly through March 2009. Annual reports documented operations and monitoring results. CVOC concentrations for parent compounds (PCE, TCE, CT and CF) were reduced over 90 % in injection wells and over 80 % in monitoring wells at locations with baseline concentrations above 100 micrograms per liter (µg/L). Lactate injections have been discontinued. Long-term ground water monitoring will continue to track progress of the remedy toward achieving RAOs for ground water.

2.3.4 Land Use Controls and Redevelopment

The selected land use controls (LUCs) have been implemented in accordance with the Land Use Controls Implementation Plan (LUCIP), with the exception of deed restrictions on property that has not yet transferred. LUCs will remain in place until site contaminants have been reduced to levels that allow for unrestricted use and unlimited exposure (UU/UE). The U.S. Army is responsible for monitoring and enforcement of LUCs, either directly or by delegation. An annual inspection is conducted to ensure that the required LUCs remain effective and that land use restrictions are being achieved. The Notice of Land Use Restrictions for the Main Installation was recorded at the City of Memphis/Shelby County Register of Deeds on 26 January 2005, in accordance with Tennessee Law.

In March 2003, Department of the Army (DA) signed a Lease in Furtherance of Conveyance granting the Depot Redevelopment Corporation (DRC) exclusive interest in the MI to 2052. In

consultation with the BCT, the DRC upgraded water, sewer, and electrical utilities to bring them up to code. As of 1 November 2009, DRC has 29 subleases accounting for the reuse of about 4 million square feet of covered and uncovered facilities (85.7% of the area available on the MI) and the production of approximately 1,031 jobs. A total of 381 acres have transferred to Alpha Omega Veterans (housing), City of Memphis (golf course and police precinct) and the DRC (Memphis Depot Business Park). FOST 6, which will transfer the remainder of the MI, is scheduled for completion in 2010.

2.3.5 Long-Term Ground Water Monitoring

The long-term monitoring (LTM) system consists of wells that documented the performance of enhanced bioremediation in the treatment areas as well as wells outside the treatment area influence that document overall progress towards achieving the RAOs. Currently the wells are sampled semi-annually.

2.4 DUNN FIELD (OU-1)

2.4.1 Prior Removal and Remedial Activities

2.4.1.1 Interim Ground Water Remedial Action

USEPA approved the *Record of Decision for Interim Remedial Action of the Groundwater at Dunn Field (OU-1)* (CH2M HILL, 1996) on 1 May 1996. DLA implemented the remedy under the terms of the FFA. The objective of the remedy was hydraulic containment to: (1) prevent further contaminant plume migration; and (2) reduce contaminant mass in ground water. Phase 1 construction of the ground water extraction system with seven extraction wells was completed in October 1998 and began operation in November 1998. Phase II construction with five extraction wells to address ground water contamination in the southern portion of Dunn Field was completed in March 2001 and was in full operation in June 2001. The ground water was discharged to the city sewer system without treatment under Industrial Wastewater Discharge Agreement Permit # S-NN3-092 with the City of Memphis. As of 31 December 2008, the Interim Remedial Action (IRA) system had discharged 312,015,593 gallons of ground water to the sewer system and had removed approximately 918 pounds of total chlorinated volatile organic compounds (CVOCs). These include the same chemicals found on the MI, but resulted from a different release.

CVOC concentrations in IRA system effluent decreased significantly following start-up of the Fluvial SVE system in July 2007. CVOCs in recovery wells (RWs) and monitoring wells (MWs) at the north end of Dunn Field did not exceed 50 µg/L for any single CVOC in April 2008. RW-5 through RW-9 were shut down on 9 June 2008. CVOC concentrations in October 2008 ground water samples continued to decrease and the remaining six wells (RW-1, RW-1A, RW-1B, RW-2, RW-3, and RW-4) were shut down on 23 January 2009. O&M activities for this action have ended. The extraction system is slated for abandonment.

2.4.1.2 Chemical Warfare Materiel Removal Action

Following completion of an engineering evaluation and cost analysis (EE/CA), a non-time critical removal action was conducted to reduce or eliminate the potential risk posed by chemical warfare material (CWM) wastes at Sites 1, 24-A, and 24-B. The removal action began on 31 March 2000 and was completed on 16 May 2001, and was documented in the *Final Chemical Warfare Materiel Investigation/Removal Action Report* (UXB, 2001). Approximately 914 CY of soil contaminated with mustard degradation by-products, and 19 CY of mustard-contaminated soil were excavated, transported, and disposed offsite. Twenty-nine bomb casings were recovered from Site 24-A.

2.4.1.3 Soil Removal Action at Site 60, Former Pistol Range

A non-time critical removal action to address lead contaminated surface soil at Site 60, a former pistol range in the Northeast Open Area, started on 27 January 2003 and was completed on 10 March 2003, pursuant to an EE/CA completed in July 2002. Approximately 930 CY of lead contaminated surface soil was excavated, transported, and disposed offsite at an approved, permitted landfill.

2.4.2 Record of Decision

EPA approved the *Memphis Depot Dunn Field ROD* (CH2M HILL, 2004b) on 12 April 2004. The selected remedy addresses surface soil, material within disposal sites and associated soil, and CVOCs in subsurface soil and ground water. In addition, this final OU-1 ROD discussed and incorporated the 1996 interim OU-1 ROD that is discussed above. DLA implemented the remedy under the terms of the FFA. The RAOs identified in the Dunn Field ROD are:

- Limit use of the surface soil in the Disposal Area to activities consistent with Light Industrial use and prevent residential use through land use controls;
- Prevent groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids;
- Prevent unacceptable risk of direct contact with buried hazardous liquid and/or solids due to intrusive activities during future land use or site development;
- Prevent direct inhalation of indoor air vapors from subsurface soils in excess of industrial worker criteria;
- Reduce or eliminate further impacts to the shallow fluvial aquifer from the VOCs in the subsurface soil;
- Prevent human exposure to contaminated groundwater (i.e., exceeding protective target levels);
- Prevent further offsite migration of VOCs in groundwater in excess of protective target levels; and
- Remediate fluvial aquifer groundwater to drinking water quality to be protective of the deeper Memphis aquifer (see Section 2.7.3 for groundwater remediation goals).

The major components of the selected remedy are:

- Excavation, transportation, and disposal (ET&D) of soil and material contained within disposal sites based upon results from a pre-design investigation
- Soil vapor extraction (SVE) to reduce VOC concentrations in subsurface soils to levels that are protective of the intended land use and ground water
- Injection of zero valent iron (ZVI) within Dunn Field to treat CVOCs in the most contaminated part of the ground water plume
- Installation of a permeable reactive barrier (PRB) to remediate CVOCs within the off-site areas of the ground water plume
- Monitored natural attenuation (MNA) down-gradient of the PRB and LTM of ground water to document changes in plume concentrations, detect potential plume migration to off-site areas or into deeper aquifers, and track progress toward remediation goals (RGs).
- Implementation of LUCs, which consist of the following institutional controls: Deed and/or lease restrictions; Notice of Land Use Restrictions; City of Memphis/Shelby County zoning restrictions and the MSCHD ground water well restrictions.

2.4.3 2009 ROD Amendment

Information gathered after approval of the Dunn Field ROD led to seven changes to components of the selected remedy. USEPA approved the *Dunn Field ROD Amendment* (e^2M, 2009a) on 19 March 2009.

One change was fundamental:

- Use of AS-SVE to treat the Off Depot ground water plume instead of a PRB.

Five changes were significant:

- revision to criteria for extent of the AS-SVE system and clarification of the treatment objective for AS-SVE;
- reduction in the areal extent of subsurface soils requiring treatment;
- use of TSVE by in-situ thermal desorption (ISTD) in the shallow subsurface soils (loess) on Dunn Field instead of conventional SVE.
- clarifying that ZVI injections in ground water under the treatment areas would be implemented based on total CVOC concentrations above 1,000 µg/L on completion of TSVE; and
- use of ET&D in two areas with shallow impacts (a small area of VOC-impacted subsurface soils and an area of buried crushed drums not previously identified).

The final change was minor:

- re-order sequence of RA components so that ZVI injections in ground water on Dunn Field will occur after implementation of the subsurface soil remedies.

2.4.4 Disposal Sites Remedial Action

In accordance with the *ROD* and the *Dunn Field Disposal Sites RAWP Addendum 1* (MACTEC, 2006a), soil and debris (primarily drums and glass bottles) from Disposal Sites 3, 4.1, 10, 13, and 31 were excavated and transported for offsite disposal.

The Disposal Sites RA was performed during two separate mobilizations. During the first mobilization from 14 March 2005 through 7 May 2005, Disposal Sites 4.1, 13, 31, and the majority of Disposal Site 10 were completed. Disposal Site 3 and the remaining materials from Disposal Site 10 were completed during the second mobilization from 27 February through 8 March 2006. A total of 4,051 tons (approximately 2,700 CY) of non-hazardous materials from Disposal Sites 3, 4.1, 10, 13, and 31 were transported off-site and disposed of at the BFI South Shelby County Landfill. A total of 351 tons (approximately 234 CY) of hazardous materials from Disposal Site 3 was disposed at the Clean Harbors Lambton Secure Landfill in Canada. Confirmation sampling demonstrated that the RAOs outlined in the ROD for these sites were achieved. USEPA approved the *Dunn Field Disposal Site RA Completion Report* (MACTEC, 2006b) on 25 August 2006.

2.4.5 Early Implementation of Selected Remedy

Ground water monitoring after the ROD identified higher CVOC concentrations down-gradient of the planned PRB location than was found during the RI. An early application of the ZVI injection element of the remedy was performed to reduce contaminant mass in ground water there in order to ensure that contamination in that portion of the plume which was slated for MNA was not unduly extensive or high in concentration.

A total of 192,500 pounds of ZVI was injected in 14 borings between 18 November 2004 and 8 January 2005, following procedures in the approved *EISR Work Plan* (MACTEC, 2004b). The *EISR Interim Remedial Action Completion Report* (MACTEC, 2005a), documenting results of this action, was approved by USEPA on 22 September 2005.

Subsequent to this action the BCT determined that, based on new site conditions, a PRB was not the best approach to ground water treatment due to the need to relocate the focus of ground water treatment further down-gradient.

2.4.6 Source Areas Remedial Action

The *Memphis Depot Dunn Field Source Areas Final RD* (Dunn Field RD) (CH2M HILL, 2007) was approved by USEPA on 20 March 2007 and by TDEC on 23 March 2007. The action was phased in two parts: installation and operation of the deeper, standard SVE system in fluvial sands and gravels (FSVE), followed by installation and operation of the Thermal SVE (TSVE) in the clay-rich upper 30 feet of soil.

The *Dunn Field Source Areas Loess/Ground water RAWP, Rev.1* (Loess/Ground water RAWP) (e^2M, 2007b), including the remaining components of the Source Areas remedy (ZVI injection in

ground water and TSVE and ET&D in the loess), received final approval by USEPA on 5 June 2008 and by TDEC on 7 July 2008.

2.4.6.1 Fluvial SVE

The *Dunn Field Source Areas Fluvial Soil Vapor Extraction RAWP, Rev.1* (e^2M, 2007a) was approved by USEPA on 3 July 2007. Construction of the FSVE system began on 15 May 2007 and was completed in July 2007. System components included seven SVE wells with individual conveyance piping to the control building; ten vapor monitoring points 15 to 80 feet from an associated SVE well; and a control building/treatment compound.

DLA, USEPA, TDEC inspected the remedy following construction on 8 August, 2007. The inspection included a discussion of construction activities and field deviations from the RD or RAWP, and physical inspection of the FSVE system. No outstanding items or deficiencies were noted and no follow-up actions were required.

System operations and monitoring results are described in annual reports. During the first year of operation from system start-up through July 2008, the system operated 94 % of the time and removed 2,800 pounds of VOCs. During the second year of operation through July 2009, the system operated 97 % of the time and removed 1,200 pounds of VOCs.

CVOC concentrations in ground water began to decrease significantly soon after FSVE operations began, indicating that capture zones of the SVE wells encompass the contaminated areas. The reduction in ground water concentrations also indicates the ground water plumes resulted from continuing vertical migration of CVOCs from the vadose zone and that there is not a continuing source of contamination, such as pockets of free product, below the water table.

2.4.6.2 ET&D

The excavation at TA-1F was performed due to the presence of CF above remediation goals (RGs). All contaminated material was removed and confirmation samples showed that the TA1-F action had achieved soil cleanup levels.

The excavation at TA-3 was performed to remove crushed buried drums containing petroleum hydrocarbons. The initial excavation from 27 October 2007 to 8 January 2008 removed all of the observed crushed drums and associated debris. Additional grid soil sampling was performed in February 2009, following demobilization of the TSVE system, and the areas requiring additional excavation to meet the cleanup standards were delineated. The final excavation at TA-3 was performed 11 May to 12 June 2009. A total of 7,200 CY of soil, drums and debris were excavated and disposed during the two mobilizations. The confirmation samples showed that the TA-3 action had achieved soil cleanup levels.

2.4.6.3 Thermal SVE

TSVE treatment was performed in four areas with a total area of about 1.25 acres and a treatment interval of approximately 5 to 30 feet bgs. Construction of the TSVE system began in 15 December 2007 and was completed in May 2008.

The system operated continuously from 27 May 2008 until the heaters were shut down in the final treatment area on 20 November, 2008, for a total of 177 heating days. Approximately 12,500 pounds of CVOCs were removed during treatment, consistent with the RD estimate of 9,000 to 14,000 pounds. The confirmation samples showed that the action had achieved soil cleanup levels.

2.4.6.4 ZVI Injections

ZVI injections were not required because ground water objectives for the Source Areas remedy were achieved by the subsurface soil remedies. This was documented in the Dunn Field ROD Amendment.

2.5.6.5 Interim Remedial Action Completion Report

USEPA approved the *Source Areas Interim Remedial Action Completion Report, Rev. 1* (HDR|e^{2}M, 2009a) on 2 November 2009. The report is considered interim because the fluvial SVE system will continue to operate until soil RGs are achieved, at which time a final RACR will be generated to supplement the IRACR

2.4.7 Off Depot Ground Water Remedial Action

USEPA approved the *Dunn Field Off Depot Groundwater Remedial Action Work Plan* (e^{2}M, 2009b) on 18 March 2009. Construction of the AS-SVE system began on 17 June 2009 and was completed in October 2009 in accordance with the RD and the Construction Quality Assurance Plan. This is the final remedial construction planned at the site.

The pre-final construction inspection and meeting was held on 29 October 2009. Summary tables describing and figures with planned and as-built locations were reviewed, along with completed construction inspection forms from the Construction Quality Assurance Plan. USEPA, TDC, and DLA visited the system compound to inspect the equipment and discuss system operations. The AS-SVE system was constructed in accordance with the RD. Not all system components were operational during the inspection and a list of action items was developed. The punch list items have since been addressed and the system is fully operational and functional.

2.4.8 Land Use Controls and Redevelopment

The Dunn Field LUCIP was included in the Off Depot RD. The LUCs have been implemented, with the exception of deed restrictions which will occur upon property transfer. LUCs will remain in place until site contaminants have been reduced to levels that allow for UU/UE. The

U.S. Army is responsible for monitoring and enforcement of LUCs, either directly or by delegation. An annual inspection is conducted to ensure that the required LUCs remain effective and that land use restrictions are being achieved.

The Notice of Land Use Restrictions for Dunn Field was recorded at the City of Memphis/Shelby County Register of Deeds on 11 June 2009, pursuant to Tennessee Law.

The eastern side of Dunn Field containing approximately 41 acres was transferred through a public sale on 24 October 2007. The property had been identified for unrestricted re-use in the Dunn Field ROD. A finding of suitability to transfer (FOST) for the remainder of Dunn Field was approved on 1 March 2010

3.0 DEMONSTRATION OF REMEDIAL ACTION QUALITY CONTROL

RA construction (RA-C) activities were performed in accordance with the Construction Quality Assurance Plans that are included as appendices in the RAWPs. The RA contractor held pre-construction meetings with the BCT to review roles and responsibilities, RA plans and specific expectations of BCT members.

Remedial Action	BCT Pre-Construction Meeting
Main Installation	20 April 2006
Dunn Field Disposal Sites	3 March 2005
Fluvial SVE	18 April 2007
Loess-Ground water	11 October 2007
Off Depot Ground water	22 April 2009

Pre-construction meetings or discussions were held with key prime and subcontractors to review required documentation and to go over the project plans and schedules. RA contractor field staff observed site activities to confirm compliance with project plans and to prepare field documentation. TDEC and USEPA conducted field oversight at appropriate times during construction activities. Installation of AS and SVE wells, ground water monitoring and injection wells and VMPs at the proper location and depth were verified through field measurements, installation summaries and location surveys by a Tennessee-registered land surveyor. Inspections of the AS-SVE and FSVE systems were made at the manufacturing facility as each system neared completion and following delivery. Inspections of the TSVE system were made prior to system start-up based on checklists in the contractor work plan.

Post-construction inspections were performed by the BCT prior to or shortly after system operations were begun for longer term remedial actions (MI EBT, Dunn Field FSVE and Off Depot AS-SVE). The inspections were performed to determine whether RA-C was complete and consistent with the plans. Each inspection included a discussion of construction activities and deviations from the RAWP, and a physical inspection of the system.

Remedial Action	BCT Post-Construction Inspection
Main Installation	28 September 2006
Fluvial SVE	8 August 2007
Off Depot Ground water	28 September 2006

No action items for the MI EBT or Dunn Field FSVE systems were identified during these site inspections. Action items were identified for the Off Depot AS-SVE system.

Final inspection of the Disposal Sites excavation and Loess/Ground Water RAs was not required as they were short-term, discrete actions with achievement of RAOs documented by confirmation sampling results. A USEPA representative was on-site during the initial excavation and confirmation sampling at TA-1F on 7 November 2007. A review of TSVE operations and observation of construction activities at Dunn Field was conducted with DLA, USEPA and TDEC on 3 April 2007. Other informal site inspections by USEPA and TDEC were made during BCT meetings in Memphis.

Complete documentation that the Dunn Field and MI RAs were performed in accordance with the ROD and RDs are provided in the remedial action completion reports (RACRs), with the exception of the final action that just completed construction and for which a RACR is scheduled in FY11. USEPA has approved the Main Installation IRACR, the Disposal Sites Final RACR and the Source Areas IRACR.

Documentation for the Off Depot Ground Water RA pre-final inspection was provided in the inspection summary dated 6 November 2009.

4.0 ACTIVITIES REQUIRED FOR SITE COMPLETION

The following activities will be completed according to the following schedule:

Sitewide

Task	Estimated Completion	Responsible Organization
Conduct LUC Inspections and report	Annual – Indefinite	Army/DoD
Ground Water LTM OUs 1-4	Annual report	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2013	Army/DoD
Complete O&M of AS/SVE system, OU-1	1/31/2015	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2018	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2023	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2028	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2033	Army/DoD
Five Year Review (OUs 1 through 4)	1/23/2038	Army/DoD
Complete Ground Water LTM, OUs 1-4	09/30/2040	Army/DoD
Prepare Site-wide FCOR	03/31/2041	Army/DoD
Approve Site-wide FCOR	12/31/2041	EPA
Delete Site from NPL	06/30/2042	EPA

5.0 SUMMARY OF REMEDIATION COSTS

5.1 MAIN INSTALLATION

The cost estimate for the selected ground water remedy in the MI ROD was developed in 2000. The total present worth (PW) costs include annual operating costs adjusted by a 5 % interest rate. The initial costs from the ROD were adjusted to reflect an annual 3 % increase for inflation over six years to account for the RA start in 2006.

The actual RA construction and operations costs include estimated installation costs for the three new deep monitoring wells and estimated LTM costs through 2016 to complete the 10 year monitoring period from the ROD; the PW costs were adjusted based on a 5 % interest rate for Years 3 through 10.

Main Installation	Capital Costs	Annual Operations	Annual Operations PW Cost	Total PW Cost
ROD Estimate (2000)				
EBT & LTM	$627,600	$320,600	$1,153,490	$1,781,090
Adjusted ROD Estimate (2006)				
EBT & LTM	$749,354	$382,796	$1,377,267	$2,126,622
Actual Costs and Estimated Capital and Operations Costs				
EBT & LTM	$4,626,651	$145,641	$884,147	$5,510,798

5.2 DUNN FIELD

5.2.1 Disposal Sites

The cost estimate for the Disposal Sites RA in the MI ROD was developed in 2000. There were no operating costs. The ROD estimates were adjusted to reflect an annual 3 % increase for inflation over four years to account for the RA start in 2004.

Disposal Sites	Capital Costs	Annual Operations	Annual Operations PW Cost	Total PW Cost
ROD Estimate (2004)				
ET&D	$1,536,900	$0	$0	$1,729,795
Actual Costs				
ET&D	$1,026,378	$0	$0	$1,026,378

The actual costs, from the Disposal Sites RACR, were 60% of the adjusted ROD estimate.

5.2.2 Off Depot ZVI Injection

As discussed above, this activity responded to contamination identified after the ROD using an element of the selected remedy. Therefore the ROD did not contain a cost estimate for this activity. The BCT judged that the work was within the scope of the ROD, and the additional estimated costs did not warrant a formal ESD. This decision was captured in a Memorandum to file jointly signed by the BCT members.

Activity	Cost	Comment
Project Management and Planning	$ 100,491	Site visit, work plans, coordination, management
Mobilization	$ 75,236	Mobilization, de-mobilization, and site restoration
ZVI Injections	$ 968,343	ZVI, shipping, nitrogen, Ferox^{SM} injections, drilling services, oversight
ZVI Injection Subtotal	**$ 1,144,070**	
Monitoring Wells	$ 128,360	Drilling services, oversight, and soil sample analysis
Ground water Sampling and Analysis	$ 192,616	Baseline and post-injection, sampling and laboratory analysis, DQE
Reporting	$ 82,304	
Total	**$ 1,547,351**	

5.2.3 Source Areas

The estimated costs in the ROD, developed in 2003, provided costs for SVE in subsurface soil and for ZVI injection and PRB installation in ground water. The subsurface soil remedy capital costs included construction and operations for one year and total PW costs for annual operating costs over three years adjusted by a 5 % interest rate. The ground water remedy capital costs included ZVI injection and PRB installation, and operating costs included ground water monitoring for years 2 through 15. The ZVI injection costs shown below include a pro rata share of the contingency for capital costs and project management; no ground water monitoring costs

are included since LTM will be conducted as part of the Off Depot Ground Water RA. The in adjusted costs reflect an annual 3 % increase for inflation over five years (2003 to 2008).

Source Areas	Capital Costs	Annual Operations	Annual Operations PW Cost	Total PW Cost
ROD Estimate (2003)				
SVE	$3,184,000	$451,000	$1,228,000	$4,411,000
ZVI Injection	$5,053,012	$0	$0	$5,053,012
Total	$8,227,012	$451,000	$1,228,000	$9,464,012
Adjusted ROD Estimate (2008)				
SVE	$3,690,256	$522,709	$1,416,477	$5,106,733
ZVI Injection	$5,856,441	$0	$0	$5,856,441
Total	$9,546,697	$522,709	$1,416,477	$10,963,174

The actual costs summarized below include construction and operations of the FSVE system, the TSVE system and ET&D of two areas. The FSVE system is in the third year of operations, therefore actual costs are only available for construction and Year 1 and 2 operations. The operating costs for Year 1 were used as operating costs for the planned period of operations (Years 2 through 5); the PW costs were adjusted based on a 5 % interest rate for Years 3 through 5. ZVI injections were not necessary and those costs will not be incurred.

Source Areas	Capital Costs	Annual Operations	Annual Operations PW Cost	Total PW Cost
Actual Capital Costs and Estimated Operations				
Subsurface Soil	$6,787,810	$170,000	$630,700	$7,418,510
ZVI Injection	$0	$0	$0	$0
Total	$6,787,810	$170,000	$630,700	$7,418,510

The actual total PW cost for the subsurface soil remedy is 145 % of the adjusted ROD estimate due to the increased cost for TSVE and ET&D in the loess as opposed to use of conventional SVE. The reduced operations cost reflect the operations in the fluvial sands only. The actual costs include five years of operations for the FSVE while the ROD included only four years of

operations. The actual total PW cost for the Source Areas remedy is 68% of the adjusted ROD estimate due to omission of ZVI injections.

5.2.4 Off Depot Ground Water

Estimated costs from the ROD for the original remedy for Off Depot ground water are not adjusted for inflation since 2003, but were adjusted to omit ZVI injections since that component was included in the Source Areas RA. Costs for the amended remedy for were taken from the Off Depot RD. The annual operations cost for the amended remedy includes 30 years of ground water monitoring while the ROD estimated 15 years of monitoring.

Off Depot Ground Water	**Capital Cost**	**O&M Cost**	**Present Worth**
ROD Estimate (2003) - Original Remedy			
PRB and MNA	$2,686,946	$1,067,400	$3,754,346
Adjusted ROD Estimate (2008) - Amended Remedy			
AS-SVE and MNA	$2,549,069	$2,369,658	$4,918,727
Actual Contract Costs and Estimated Operations			
AS-SVE and MNA	$2,753,812	$2,369,658	$4,918,727

The actual costs include the contracted costs for construction and Year 1 operations and the RD estimated O&M costs. The contract costs are 8% above the estimated capital cost.

6.0 FIVE YEAR REVIEWS

Hazardous substances will remain at the site above levels that allow for unrestricted use and unlimited exposure after completion of the remedial action. Under CERCLA section 121, and as provided in the current guidance on 5-year reviews: OSWER Directive 9355.7-03B-P *Comprehensive Five-Year Review Guidance,* June 2001, the Army/DoD must conduct a statutory five-year review.

DDMT has undergone two such reviews to date, dating from the start of the interim remedial action for Dunn Field in January 1998. The first review was conducted in 2003, and the second in 2008. Because the final remedies for both the MI and Dunn Field include land use controls in perpetuity, the period in which five-year reviews will be needed is indefinite. The next five year review is scheduled to be completed in January 2013.

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