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THE MEMPHIS DEPOT
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ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 579

Memphis Depot
Dunn Field

Feasibility Study

Defense Distribution Center (Memphis)

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U.S. Army Engineering and Support Center, Huntsville

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Acronyms and Abbreviations

ARAR	Applicable or relevant and appropriate requirement
BaP	Benzo(a)pyrene
BCT	BRAC Cleanup Team
BRA	Baseline risk assessment
BRAC	Base Realignment and Closure
BTEX	Benzene, toluene, ethyl benzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	Chemical of concern
COPC	Chemical of potential concern
CVOC	Chlorinated volatile organic compound
DCA	Dichloroethane
DCE	Dichloroethene
DCE	Dichloroethene
DDD	Dichlorodiphenyldichloroethane
DDE	1,1,1-Dichloro-2,2-bis(4-chlorophenyl)ethylene
DDMT	Defense Depot Memphis, Tennessee
DDT	Dichlorodiphenyltrichloroethane
DLA	Defense Logistics Agency
DNAPL	Dense non-aqueous phase liquid
EE/CA	Engineering Evaluation/Cost Analysis
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
°F	Degrees Fahrenheit
FFA	Federal Facilities Agreement
FR	*Federal Register*
FS	Feasibility Study
ft	Feet
FU	Functional unit
gpm	Gallons per minute
GRA	General Response Action
HHRA	Human Health Risk Assessment
HI	Hazard index
HRS	Hazard Ranking System
HTTD	High temperature thermal desorption
IC-LTM	Institutional Controls with Long-term Monitoring
IW	Inside worker
LDR	Land disposal restriction
LF	Linear feet
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter

MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
MDL	Maximum detection limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
msl	Mean sea level
MW	Monitoring well
NaOH	Sodium Hydroxide
NAPL	Non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable unit
OW	Outside worker
PAH	Polycyclic aromatic hydrocarbon
PRB	Permeable Reactive Barrier
PCA	Tetrachloroethane
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene
PCP	Pentachlorophenol
ppm	Parts per million
RAO	Remedial action objective
RBC	Risk-based concentration
RBCA	Risk-based Corrective Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial design
RE	Resident
RGO	Remedial goal option
RI/FS	Remedial investigation/feasibility study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SS	Surface soil
SVOC	Semivolatile organic compound
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane
1,1,2-TCA	1,1,2-Tetracholorethane
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TCE	Trichloroethene
TCLP	Toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environment and Conservation
TDS	Total dissolved solids
TM	Technical memorandum
TMV	Toxicity, mobility, or volume
TSCA	Toxic Substances Control Act

UIC	Underground injection control
USC	United States Code
VC	Vinyl chloride
VOC	Volatile organic compound
ZVI	Zero-Valent Iron

1.0 Introduction

The Memphis Depot (formerly known as the Defense Distribution Depot Memphis, Tennessee and referred to in this report as the Depot) is in southeastern Memphis, Tennessee (Figure 1-1). The Depot originated as a military facility in the early 1940s. Its initial mission and function was to provide stock control, materiel storage, and maintenance services for the U.S. Army (Memphis Depot Caretaker, 1998). The Depot was placed in 1995 on the list of Department of Defense (DoD) facilities to be closed under Base Realignment and Closure (BRAC). Storage and distribution of materiel for all U.S. military services and some civil agencies continued until the Depot closed in September 1997.

On October 14, 1992, the Depot was placed on the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA), bringing the facility within the Superfund program. As a result of its status as an NPL site, the Depot entered into a Federal Facilities Agreement (FFA) on March 6, 1995. The signatories to that agreement, the Defense Logistics Agency (DLA), EPA, and the Tennessee Department of Environment and Conservation (TDEC), agreed that investigating and remediating all applicable sites at the Depot would proceed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), i.e., Remedial Investigation/Feasibility Study (RI/ FS), proposed plan, Record of Decision (ROD), Remedial Design (RD), and Remedial Action (RA).

As part of the Depot's environmental cleanup program, an RI/FS is being conducted at Dunn Field. Surface and subsurface soil, sediment, intermittent surface water, and groundwater were investigated at Dunn Field, which is located adjacent to and north of the Depot's Main Installation (MI). The RI/FS process at Dunn Field will provide sufficient information regarding the environmental impacts from former hazardous materials disposal activities to identify appropriate cleanup alternatives.

1.1 Purpose of This Feasibility Study

This FS represents an important step in the evaluation of a CERCLA site and selection of a remedial action. To put this report in context, the following describes the CERCLA process used to evaluate the Depot and to select a remedy to resolve environmental contamination.

- Since 1995, a series of investigations have been conducted at Dunn Field to obtain samples of surface and subsurface soil, sediment, groundwater, and intermittent surface water to assess the nature of contamination that exists at Dunn Field, and to define the horizontal and vertical extent of contamination in each medium. The **Remedial Investigation (RI)** report (CH2M HILL, July 2002) summarizes and interprets the results of the investigations at Dunn Field.
- As part of the RI, a **Baseline Risk Assessment (BRA)** was prepared to assess the potential risks to human health and the environment represented by contaminants at the site. The BRA incorporates conservative assumptions regarding exposure of affected

individuals under various land use scenarios. The findings of the BRA are included in the RI report.

- This **Feasibility Study (FS)** develops and presents a range of remedial alternatives to address the contaminants identified in the RI and evaluates the probable performance of each alternative in comparison to a set of criteria established by the EPA. This FS is intended to present an unbiased and non-judgmental evaluation of the candidate remedial alternatives. In some cases, additional environmental data are collected or reassessed during the preparation of the FS in order to understand the applicability of a particular remedial technology, or to identify a better way to remediate a particular area of contamination.

- Following publication of the FS, the cognizant regulatory (EPA and TDEC) and lead agencies for the Depot (DLA) will evaluate the remedies presented in the FS. A **Proposed Plan** will then be prepared documenting the remedy(ies) proposed by those agencies and the rationale for the selection of the proposed remedy(ies). The Proposed Plan may "pick and choose" among the evaluated alternatives for various locations and media at Dunn Field. The Proposed Plan will be presented to the City of Memphis community and the public, who will be offered the opportunity to comment on the proposed remedy(ies).

- After public comments on the proposed remedy(ies) from the Proposed Plan are received, regulatory and lead agencies will take all comments into consideration, re-evaluate their selection of the proposed remedy(ies) for Dunn Field, and publish a **Record of Decision (ROD)** documenting the final remedy(ies) selected for Dunn Field. The Responsiveness Summary of the ROD includes all the public comments, as well as responses to each. The remedy(ies) documented in the ROD will then be implemented at Dunn Field through the RD and RA phases.

To facilitate the investigation of this relatively large and complex site, the Depot was divided into two areas: the Main Installation (MI) and Dunn Field. The MI RI/FS has been conducted and the final reports are part of the Administrative Record. The results are discussed in the *Memphis Depot Main Installation Remedial Investigation Report* (CH2M HILL, January 2000), *Memphis Depot Main Installation Groundwater Feasibility Study Report* (CH2M HILL, July 2000), *and Memphis Depot Main Installation Soil Feasibility Study Report* (CH2M HILL, July 2000). The *Memphis Depot Main Installation Proposed Plan* (CH2M HILL, July 2000) was presented to the public in August 2000 and the *Memphis Depot Main Installation Record of Decision* (CH2M HILL, September 2001) was completed and signed by DLA and TDEC in February 2001. EPA signed the MI ROD in September 2001. The *Memphis Depot Main Installation Remedial Design Workplan* (CH2M HILL, July 2002) has been approved by EPA and TDEC, and the RD is currently underway at the MI.

Dunn Field is a 64-acre rectangular area that joins the MI on the north, across Dunn Avenue, and has been designated Operable Unit (OU) 1. This *Dunn Field Feasibility Study* presents a range of remedial alternatives to address the nature and extent of contamination, and the risk present by the identified contaminants in the RI. This FS focuses on the Dunn Field area of the Depot. The report was prepared in accordance with published guidance for conducting an FS under CERCLA (EPA, 1988).

1.2 Report Organization

The FS report develops and evaluates a list of remedial action alternatives that could be implemented for soil and groundwater beneath the Dunn Field portion of the Depot.

This report contains eight sections and appendices. Since this FS addresses two matrices (soil and groundwater) under complex conditions, the detailed analysis was divided into three sections. The report is organized as follows:

- **Section 1** provides the purpose and scope of the document, background information about the Dunn Field, a summary of the nature and extent of contamination, fate and transport, the baseline risk assessment, and justification for use of a presumptive remedy at the site.
- **Section 2** presents the remedial action objectives (RAOs) for soil and groundwater, defines general response actions (GRAs), and describes the technologies that may be applicable to remediate soil and groundwater.
- **Section 3** combines applicable technologies into alternatives, and then evaluates and screens the alternatives according to the criteria of effectiveness, implementability, and cost.
- **Section 4** presents the approach for the detailed analysis process for alternatives that passed the screening steps in Section 3.
- **Section 5** presents a detailed analysis of the merits of the disposal sites alternatives that passed the screening steps in Section 3.
- **Section 6** presents a detailed analysis of the merits of the presumptive remedy for VOC-contaminated soil.
- **Section 7** presents a detailed analysis of the merits of the groundwater alternatives that passed the screening steps in Section 3.
- **Section 8** provides the references cited.
- **Appendix A** presents technical information from the Dunn Field RI Report (CH2M HILL, July 2002).
- **Appendix B** presents the EPA report documenting the results of an FS analysis for subsurface soils contaminated with VOCs. This report justifies the use of SVE as the presumptive remedy.
- **Appendix C** presents the Soil Vapor Extraction (SVE) Treatability Study Technical Memorandum.
- **Appendix D** presents cost estimates for remedial actions.
- **Appendix E** presents contaminant mass calculations for VOCs in soils.
- **Appendix F** presents piping and instrumentation diagram (P&ID) drawings for the SVE treatment system.

1.3 Site Background and History

1.3.1 Facility Description

The Depot, located in Memphis, Tennessee (Figure 1-1), consists of approximately 642 acres and includes the MI, which includes open storage areas, warehouses, military family housing, and outdoor recreational areas, and Dunn Field, which includes former mineral storage and former waste disposal areas. The major features of the Depot are shown in Figure 1-2. The Depot lies approximately 5 miles east of the Mississippi River and just northeast of the Interstate 240–Interstate 55 junction in the south-central portion of Memphis, approximately 4 miles southeast of the central business district and one mile northwest of Memphis International Airport (Figure 1-1). Airways Boulevard borders the MI portion of the Depot on the east and provides primary access to the MI. Dunn Avenue, Ball Road, and Perry Road serve as the northern, southern, and western boundaries of the MI, respectively.

Dunn Field, comprising 64 acres of undeveloped land, is immediately adjacent, across Dunn Avenue, to the north-northwest portion of the MI. Dunn Field is bounded by the Illinois Central Gulf Railroad and Person Avenue to the north, Hays Road to the east, and Dunn Avenue to the south. Dunn Field is partially bounded to the west by: (1) Kyle Street; (2) Memphis Light Gas and Water (MLGW) powerline corridor (which bisects Dunn Field); (3) undeveloped property; and (4) a commercial trucking facility (Figure 1-2).

For purposes of the completing the RI and BRA, Dunn Field was divided into three separate areas: Northeast Open Area, Disposal Area, and Stockpile Area (Figure 1-3). The original field sampling plans (FSPs) for the Dunn Field RI outlined the investigation of each specific site but, after review of geophysical survey and soil gas survey data, delineation of each site for a focussed investigation was deemed not practicable from the perspective of cost effective project management (*Final Field Sampling Plan for OU 1 Addendum [I]*, CH2M HILL, March 1999). The geophysical investigation and passive soil gas survey indicated that soil contamination and disposed items within Dunn Field did not, in all cases, correspond to boundaries of known or suspected burial sites. Over much of Dunn Field, the Final FSP Addendum for OU1 shifted the field investigation from the site-specific basis of the original FSPs to an approach that consolidated individual sites into areas of similar contamination. These areas are defined below and summarized in Table 1-1.

- <u>Northeast Open Area</u> - The Northeast Open Area (approximately 20 acres) consists of the grassy area with a number of interspersed mature trees in the northeast quadrant of Dunn Field containing Areas G and H identified in the OU 1 FSP Addendum [I] (see Figure 1-5). Table 1-2 describes the seven sites located within the Northeast Open Area. *The Memphis Depot Redevelopment Plan* (The Pathfinders, *et al.*, 1997) identified this area as future public open space for recreational purposes.
- <u>Disposal Area</u> - The Disposal Area (approximately 14 acres) consists of the pits and trenches in the northwestern quadrant of Dunn Field, and corresponds to Areas A through F identified in the OU 1 FSP Addendum [I] (see Figure 1-6). This area encompasses 25 sites, described in Table 1-2. Historical information concerning the location of the disposal sites is included in Dunn Field RI Report (CH2M, July 2002). The anticipated land use within this area is light industrial (The Pathfinders, *et al.*, 1997).

- Stockpile Area - The Stockpile Area (approximately 30 acres) encompasses the former bauxite and fluorspar storage and burial areas in the eastern and southwestern portions of Dunn Field (see Figure 1-7). Table 1-2 describes sites located in this area. The anticipated land use within this area is also light industrial (The Pathfinders, *et al.*, 1997).

Most of the Dunn Field surface is unpaved. Specifically, about two-thirds of the area is grassed, and the remaining area is covered with crushed rock and paved surfaces. Dunn Field was used for bulk mineral storage (bauxite and fluorspar) and waste disposal. Based on information obtained from Depot records and interviews with former Depot military personnel, ordnance and explosives (OE) and chemical warfare materiel (CWM) disposal occurred at Dunn Field, in addition to the hazardous and nonhazardous material disposal. OE and CWM disposal generally consisted of detonating or burning of such waste materials. A CWM removal action was conducted in 2000 and 2001.

1.3.2 Site History

The Depot originated in the early 1940s. Its initial mission was to provide stock control, storage, and maintenance services for the Army Engineer, Chemical, and Quartermaster Corps (Memphis Depot Caretaker, 1998). During World War II, the facility served as an internment center for 800 prisoners of war and performed supply missions for the Signal and Ordnance Corps. From 1963 until closure in September 1997, the facility served as a major field installation for the DLA for shipping and receiving a variety of materials (U.S. Army Toxic and Hazardous Materials Agency [USATHAMA], 1982).

The Depot received, warehoused, and distributed supplies common to all U.S. military services and some civil agencies located primarily in the southeastern United States, Puerto Rico, and Panama. Stocked items included food, clothing, electronic equipment, petroleum products, construction materials, and industrial, medical, and general supplies. Approximately 4 million line items were received and shipped by the Depot annually; total shipments amounted to about 107,000 tons of goods per year. In-stock inventory at the facility was worth more than $1 billion. The Depot employed approximately 1,486 civilians and 9 military personnel; its annual payroll was $41 million (Law Environmental, 1990a). The Depot was officially activated on January 26, 1942, as the Memphis General Depot. Since that time, the Depot mission and function has been related to the receipt, storage, and distribution of various commodities to the Armed Forces and civilian agencies, when required (USATHAMA, 1982).

Disposal activities at Dunn Field began in July 1946 when 29 mustard-filled German bomb casings were destroyed and buried (Sites 24-A and 24-B). Three railcars were identified as containing leaking munitions and were transferred to the Memphis General Depot for proper handling. A total of twenty-four 500-kilogram (kg) and five 250-kg bombs were destroyed (USACE, 1995). After draining and destruction operations were completed, all mustard-contaminated items (wood, clothing, etc.) were placed into the slurry pit and burned.

During the early to mid-1950s, Chemical Agent Identification Sets (CAIS) were allegedly disposed of and buried at Dunn Field at Site 1 in the Disposal Area portion of Dunn Field. The CAIS allegedly contained small glass ampoules of diluted mustard, lewisite (a vesicant chemical agent), chloropicrin, and phosgene, which were stored in sealed cylindrical metal containers (PIGS). CAIS stocks found to be leaking or broken during periodic inspection were reportedly buried at Dunn Field (USATHAMA, 1982). The damaged CAIS may have been broken up and neutralized with chlorinated lime; however, reports indicate that on at least five or six occasions the sets were placed into the pits intact (USACE, 1995).

The CWM disposal pits were located in the Disposal Area section of Dunn Field and the Stockpile Area portions of Dunn Field (Sites 24-A, and 24-B). According to information provided by USATHAMA (1982) and USACE (1995b), the remains of destroyed (burned or detonated) explosive ordnance (OE) were also buried in pits in the Disposal and Stockpile Areas . Reports indicate that the OE consisted of a 3.2-inch mortar round, smoke pots, chloroacetophenone (CN) canisters, and hand grenades (smoke) and "souvenir ordnance". A summary of the potential OE at Dunn Field is included as Appendix A-1. Section 1.3.4 presents additional information on the CWM removal action at Dunn Field.

In addition to that described above, other chemicals associated with the use of chemical agents such as Decontaminating Agent Non-Corrosive (DANC) were buried in Dunn Field. The decontaminant DANC disposed of at Dunn Field is an organic N-chloroamide compound in solution with 1,1,2,2-tetrachloroethane (1,1,2,2-PCA). DANC typically contained 90 percent to 95 percent 1,1,2,2-PCA (also known as acetylene tetrachloride). The Archives Search Report (USACE, 1995) indicates the "1947 burial of 32,636 lbs [pounds] of acetylene tetrachloride" at Dunn Field. A mixture similar to DANC formulations (S-210 suspension formulation) contained tetrachloroethene (or perchloroethylene, PCE). Use and disposal of unknown quantities of chlorinated lime, super tropical bleach (STB) and calcium hypochlorite (HTH) is documented at Dunn Field. Food stocks, paints/thinners, petroleum/oil/lubricants (POL), acids, herbicides, mixed chemicals, and medical waste were also reportedly destroyed or buried in pits and trenches at Dunn Field (USACE, 1995). These are the sources for the chlorinated volatile organic compounds (CVOCs) (solvents and their degradation products) found in the soil and groundwater in and beneath Dunn Field. The most frequently detected CVOCs include 1,1,2,2-PCA, trichloroethane (TCA), PCE, trichloroethene (TCE), several dichlorothenes (DCE), vinyl chloride, carbon tetrachloride and chloroform. Table 1-2 lists the sites at Dunn Field (OU-1), including the disposal sites.

1.3.3 Regulatory History

The Depot was issued a Resource Conservation and Recovery Act (RCRA) Part B permit (No. TN4 210-020-570) by EPA Region 4 and the TDEC on September 28, 1990. Subsequently, in accordance with Section 120(d)(2) of CERCLA, Title 42, Section 9620(d)(2) of CERCLA, and Title 42, Section 9620(d) (2) of the United States Code (USC), EPA prepared a final Hazard Ranking System (HRS) Scoring Package for the facility. Based on the final HRS score of 58.06, EPA added the Depot to the NPL by publication in the *Federal Register* (FR), 57 FR 47180 No. 199, on October 14, 1992.

As noted above, the Depot entered into a FFA on March 6, 1995. The signatories to that agreement, DLA, EPA, and TDEC, agreed that investigating all applicable sites would proceed under the CERCLA process for remediation.

In July 1995, the Depot was also placed on the BRAC list, indicating that the facility was to be closed and converted to potentially different ownership and uses. The BRAC Cleanup Team (BCT) was developed to implement BRAC requirements, which include identifying methods for expeditious property transfer and reuse. The BCT is comprised of a representative from EPA, TDEC and DLA (referred to as the BRAC Environmental Coordinator [BEC]). Therefore, in addition to meeting CERCLA requirements, environmental restoration at the facility must also comply with specific requirements for property transfer in accordance with Public Law 501-510 under Title XXIX, enacted in 1990.

1.3.4 Completed or Planned Remedial Actions

1.3.4.1 Interim Groundwater Remedial Action

In August 1995, an Interim Remedial Action (IRA) ROD was submitted for a groundwater removal action at Dunn Field (CH2M HILL, January 1996). The interim ROD provided the basis of design for the components associated with the IRA for Dunn Field. The interim ROD was finalized in January 1996 and was signed in April 1996. As presented in the document, the Dunn Field interim ROD remedial action objectives are "to incrementally remove contamination from the Fluvial Aquifer, to decrease risk by mitigating the spread of contamination towards the Allen Well field, and to create a hydraulic barrier to prevent contamination in the Fluvial Aquifer at Dunn Field from reaching the Allen Well Field." Contaminants identified as those of potential concern include VOCs and metals. The IRA was not intended as a permanent solution; however, it was intended to be compatible with the final remedy.

The final design for this IRA was completed by CH2M HILL in August 1997, and included the installation of seven groundwater extraction wells (RW-3 through RW-9), one pre-cast concrete building, an underground conveyance system, flow measurement and control systems, and associated civil, electrical, and instrumentation/controls work. The extraction system was constructed by OHM/International Technology (IT), under contract with USACE-Mobile District, from January 1998 through October 1998. The interim groundwater extraction system began operation in November 1998 and continues to operate as of the date of this report.

An updated final design of the groundwater interim remedial action was completed in January 2000 (CH2M HILL, January 2000), which included the addition of four extraction wells and associated electrical, mechanical, and instrumentation/controls components. Four new recovery wells (RW-1, RW-1A, RW-1B, and RW-2) were installed south of recovery well RW-03 by OHM/IT in late 1999 and early 2000. These wells were added due to the groundwater contamination detected in the southern portion of the Disposal Area and the northwest portion of the Stockpile Area. The expanded groundwater extraction system was constructed by Jacobs Engineering Group (Jacobs), under contract with USACE-Mobile District, from September 2000 through February 2001. The new extraction wells were brought on-line in the first quarter of 2001 and were fully functioning in June 2001.

Operation and maintenance (O&M) activities have been conducted since the system went online. The original O&M Plan (CH2M HILL, May 1998) for the groundwater extraction system outlined activities that would allow evaluation of the groundwater extraction system performance. The plan was amended in 1999, again in 2000, and a third time in August 2001. The performance activities that are conducted now (2002) include semi-annual sampling of groundwater at 26 specific monitoring wells and 11 recovery wells. Other activities are also included as part of the O&M of the system. For example, water levels are routinely measured on a biweekly basis from 53 monitoring wells on and surrounding Dunn Field and in another 17 wells on a monthly basis. In addition, total system effluent samples are collected (monthly from startup through 2000, and quarterly for 2001 and 2002) from the conveyance system for analyses prior to discharge to the City of Memphis POTW, per the Industrial Discharge Agreement between the Memphis Depot and the City of Memphis.

From system startup in 1998 through June 30, 2002, the system has pumped approximately 121,573,000 gallons of groundwater from the fluvial aquifer beneath Dunn Field and discharged to the POTW. Through June 30, 2002, an estimated total of 365 pounds of VOCs have been removed (Jacobs, July 2002).

As discussed in Section 14.5.3 of the Dunn Field RI Report (CH2M HILL, July 2002), the potentiometric surface of the fluvial aquifer in the area of the recovery wells suggest that groundwater is captured in the immediate vicinity of each recovery well. Recovery wells were installed at intervals, which would create a hydraulic barrier against contaminant migration offsite. Capture zones are not completely connected between RW-01 to RW-1A, RW-02 to RW-03, RW-03 to RW-04, RW-04 to RW-05, and RW-06 to RW-07; therefore, areas between these recovery wells could allow contaminates to pass through the recovery system.

According to the 1996 Interim ROD document, the principal goals of the IRA are to incrementally remove contaminants from the fluvial aquifer, to decrease risk by mitigating the spread of constituents toward the Allen Well Field, and to create a hydraulic barrier to prevent contamination in the fluvial aquifer at Dunn Field from reaching the Allen Well Field (approximately one-half mile west of Dunn Field). The document added that: "Although the IRA is not anticipated to achieve compliance with MCLs, it is consistent with the objective to protect the Memphis Sand Aquifer. Long-term operation of a groundwater removal system will help to achieve MCLs by incrementally removing contaminants."

The Five Year Review for Dunn Field (CH2M HILL, January 2003), which was triggered by the actual start of construction of the IRA in January 1998, concludes that while over 300 pounds of VOCs have been removed from groundwater by the IRA from 1998 to 2002, the extraction system does not provide complete control over groundwater flow and the spread of contaminant constituents in the fluvial aquifer from the western perimeter of Dunn Field. As a result contaminant levels have been increasing in a few monitoring wells downgradient and offsite of Dunn Field. Since the extraction system has not completely contained the spread of contaminants toward the Allen Well Field, the remedy does not fully satisfy the principal IRA goals. The only goal that is being met by the remedy is incremental removal of contaminants. However, because there is no current use of, nor plan to use, the shallow groundwater as a drinking water supply, and because local ordinances restrict installation of private wells, the IRA is considered protective in the short term.

It should be noted that Phase I and II of the interim groundwater remedy were implemented at Dunn Field from 1998 through 2001. The remedial investigation was completed in 2001 and the RI report was finalized in July 2002. Delineation of the western extent of the groundwater contamination in the fluvial aquifer was completed in 2001. Phase III of the interim remedy (offsite recovery wells) was not implemented. Based on new information developed subsequent to the 1996 ROD, both from the RI and from implementation of the 1996 Interim ROD, DLA, EPA, and TDEC agree that the offsite groundwater plume in the fluvial aquifer will be addressed in the final Proposed Plan and Record of Decision for Dunn Field in 2003. An explanation of significant differences to explain how the 1996 ROD was implemented in phases, and why it was not fully implemented, will be integrated into the final ROD. A fully protective remedy for all media will be selected in the final ROD for Dunn Field, which is expected to be completed and executed before the end of 2003.

1.3.4.2 CWM Removal Action

An Engineering Evaluation/Cost Analysis (EE/CA) was performed by Parsons Engineering Science (Parsons), under contract with USAESCH, in June 1999 to: (1) assess whether CWM contamination was migrating from the CWM disposal pits at Dunn Field; (2) analyze risk management alternatives; and (3) recommend feasible CWM remedial alternatives for contaminants found to be present.

A non-intrusive geophysical investigation was performed on the western half of Dunn Field between February and July 1998. The objective of the geophysical investigation was to delineate the former disposal pits/trenches so that they may be avoided during intrusive activities. Samples of soil and groundwater were then collected. No CWM-related compounds were detected in the background samples. Forty-three (43) soil samples and six groundwater samples were collected for CWM site characterization purposes. Most of the soil samples were obtained in the 0- to 15-foot depth interval of each boring. Three OE related compounds (2,4,6-trinitrotoluene, HMX and RDX) were detected or estimated in site surface soil samples. Two OE related compounds (2,4,6-trinitrotoluene and RDX) were detected or estimated in subsurface soil samples. Several metals were detected in both surface and subsurface samples. Based on the analytical results from the samples, no migration of CWM or breakdown products from the pits or trenches has occurred.

As part of the EE/CA document, a streamlined risk evaluation was conducted for the areas directly adjacent to suspected CWM burial pits, and included a human health risk assessment (HHRA) and an ecological preliminary risk evaluation. Potential exposure of both current and future human receptors to groundwater and soil at Dunn Field was evaluated in the HHRA. Chemicals of concern (COCs) identified from the HHRA included lead in surface soil; lead, chromium, and iron in mixed surface and subsurface soil (0 to 11 feet); and nitrobenzene, aluminum, iron, and manganese in groundwater. Based on the risk analysis and the fact that these COCs are not CWM-related, none were identified as COCs to be remediated at Dunn Field. Therefore, adverse effects to current and future human receptors resulting from exposure to site media are not expected to occur in the areas directly adjacent to the suspected CWM burial pits at the Dunn Field.

An ecological site characterization and soil screening were conducted at Dunn Field. Constituents in surface soil and mixed surface and subsurface soil exceeded existing regulatory criteria in some cases. According to the ecological site characterization, it is highly unlikely that wildlife populations would be sustained at Dunn Field or in the surrounding area. No significant impacts to ecological populations are expected from CWM or CWM breakdown products in the areas surrounding the trenches and pits associated with CWM at Dunn Field.

Although samples were not collected directly beneath or within the suspected CWM burial trenches/pits, the assumption was made that CWM may be present in these areas and, if so, would be toxic to human and ecological receptors. Based on current and anticipated future uses at the site, further assumptions were made that the wastes will result in an unacceptable risk if left in place and that removal actions are necessary to reduce or eliminate the potential CWM risk. Four alternatives were evaluated:

1. No action
2. Institutional controls
3. Capping
4. Excavation and removal of CWM

The selected alternative for the three identified areas of concern at Dunn Field was Alternative 4, excavation and removal of CWM.

UXB International, under contract with USAESCH, conducted remedial measures from mid-2000 to mid-2001 at Sites 1, 24-A, and 24-B to reduce or eliminate the potential CWM risk posed by these wastes. The CWM remedial actions at these sites are documented in the *Final Chemical Warfare Materiel Investigation/Removal Action Report*, dated December 2001, prepared by UXB International, Inc. The conclusions from this report are as follows:

- Site 1 - This site was suspected of containing CAIS containing small quantities of diluted agent and is located in the Disposal Area of Dunn Field. Historical documents suggested the CAIS might have been placed in PIGS (metal containment vessels exclusively used for CWM). Beginning in May 2000, the entire target area was excavated, but neither CAIS nor PIGS were recovered. However, 24 jars labeled as "HS" (sulfur mustard) were recovered, but they were tested to be free of CWM. No CWM or CWM contaminated soil was found within the investigation area of Site 1. In August 2000, the removal action was complete at Site 1.

- Site 24-A -This site is the confirmed burial location for 29 bomb casings that were used to transport mustard agent from Germany to the U.S. after World War II and is located in the Disposal Area of Dunn Field. The bomb casings were buried at this location after being drained into a neutralization pit. Beginning in August 2000, all 29 bomb casings were recovered at this site. No mustard or other CWM was discovered at this site; however, 900 cubic yards of soil contaminated with mustard degradation by-products were transported and disposed offsite. In November 2000, the removal action was complete at this site.

- Site 24-B -This site is the confirmed location of the neutralization pit for the contents of the 29 bomb casings and is located in the Stockpile Area of Dunn Field. Beginning in November 2000, 19 cubic yards of mustard contaminated soil and 14 cubic yards of soil contaminated with mustard degradation by-products were transported and disposed offsite. In March 2001, the removal action was complete at this site.

1.3.4.3 EE/CA for Site 60, Former Pistol Range

An EE/CA was performed by CH2M HILL in July 2002 to evaluate the recommended removal action for removing lead contaminated surface soil from the Site 60 - former Pistol Range in the Northeast Open Area on Dunn Field (Figure 1-4). This non-time critical early removal action will make the majority of the Northeast Open Area available for unrestricted future land use. Lead contamination in surface soil is the only chemical of concern (COC) identified for protection of human health under unrestricted land use at Site 60.

The aerial photograph review indicated that the range was constructed between 1953 and 1958. The time period that Site 60 was used for target practice is unknown, but the Installation Assessment Report (USATHMA, 1982) states that the "area was abandoned in the late 1970s and the building [Building 1184, Site 85] is currently being used for pesticide storage."

The maximum recorded lead concentration in surface soil at the Northeast Open Area is 2,100 mg/kg, with an estimated arithmetic mean of 196 mg/kg. The maximum concentration was detected in sample Location 6085D from Site 60. All concentrations for Site 60 and the entire Northeast Open Area except the maximum are below a residential exposure-based screening level of 400 mg/kg and an industrial worker exposure-based target concentration of 1,536 mg/kg (CH2M HILL, July 2002). The lead is likely associated with spent bullets in the firing range, as the elevated concentrations were limited to this area. The maximum observed lead levels in localized areas at the site could potentially pose health hazards for potentially exposed receptors because both screening levels have been exceeded.

Limited biased uncertainty for lead at the bullet stop area may exist due to the limited sampling of this area and random distribution of source, lead bullets. The single sample from this area may underestimate the importance of this area's contribution to lead exposure at this site. In addition, lead may be highest in surface soils in front (west) of the firing stand due to the spray from the pistols containing lead fragments abraded from the bullets as they are projected through the gun barrel. Lead would therefore be more widely dispersed in surface soil in this area.

On the basis of the screening evaluation, and consideration of future land use and accessibility, the following actions were deemed appropriate by the BCT:

- Removal of surface soil within the perimeter of Site 60.
- Demolition of the former pistol stand and associated building at Site 85.

Based on previous surface soil removal actions completed for Parcels 35 and 28 on the Main Installation (MI) of the Memphis Depot, as well as Building 949 on the MI, as stated in the September 2001 MI Record of Decision (ROD), the recommended removal action for Site 60 is excavation and offsite disposal. After reviewing these previous removal actions, this method was selected by the BCT as the most cost efficient and expeditious.

Prior to selection of excavation and offsite disposal as the method for removal at Site 60, it was evaluated in terms of effectiveness, implementability, and cost. The evaluation results revealed that the excavation and removal method was capable of meeting and exceeding these goals and objectives. The method has been used successfully during several previous surface soil removal actions with similar chemicals of concern at the Memphis Depot. An estimated 890 cubic yards or 1290 tons of surface soil would be excavated, transported and disposed offsite at an approved, permitted landfill as part of the non-time critical removal action at Site 60. The order of magnitude cost estimate for this removal action is $300,000.

The 30-day public comment period for the non-time critical removal action has been completed and the Action Memorandum for Site 60, including the Responsiveness Summary for all public comments received to date, was submitted as final on October 11, 2002. The removal action documented in the Action Memorandum is scheduled for implementation at Site 60 in early 2003.

1.3.5 Geology and Hydrology

The Dunn Field RI Report (CH2M HILL, July 2002) provides details regarding local geology and the occurrence of surface water and groundwater at the Depot. The following is a brief summary of these features.

1.3.5.1 Dunn Field Stratigraphy

The four uppermost stratigraphic units underlying Dunn Field are (in descending order):

- loess, including surface soil;
- fluvial deposits;
- Jackson Formation/Upper Claiborne Group (the Jackson [if present], Cockfield, and Cook Mountain Formations); and
- Memphis Sand.

Soil borings drilled at and near Dunn Field penetrate all formations down to and including the top of the Memphis Sand. The lithology for these units are described in Table 1-3. Appendix A-2 includes the lithologic cross-sections from the Dunn Field RI Report (CH2M HILL, July 2002) that depict the presence and subsurface thickness of the stratigraphic units across the area of Dunn Field.

Loess. Based on lithologic data from the drilling of soil borings and monitoring wells, the loess is continuous throughout the entire Dunn Field area. The Quaternary-aged loess consists of brown to reddish brown low-plasticity clayey silt (ML) or low-plasticity silty clay (CL). The loess deposits range from 10 feet thick at MW-55 (southwest of Dunn Field) to 36 feet thick at MW-74 (western boundary of Dunn Field) and are on average about 20 to 30 feet thick.

Fluvial Deposits. Fluvial deposits, which underlie the loess, were encountered at all drilling locations on and around Dunn Field. They are commonly underlain by a thick clay unit of the Jackson Formation/Upper Claiborne Group. The Quaternary- and possibly Pliocene-aged fluvial deposits are composed of two generalized layers that can be identified throughout the subsurface of the Dunn Field area. The upper layer is a silty, sandy clay that transitions to a clayey sand deposit. Within the Dunn Field boundaries, this layer ranges from about 3 feet thick at MW-56 (southwest corner of Dunn Field) to 20 feet thick at MW-58 (southwest corner of Dunn Field). The second unit, composed of layers of sand, sandy gravel, and gravelly sand, has an average thickness of approximately 40 feet underneath Dunn Field and along the eastern and western boundaries.

Jackson Formation/Upper Claiborne Group. The Late Eocene-aged Jackson Formation/Upper Claiborne Group consists primarily of clays, silts and sands. The upper clay unit of the Jackson Formation/Upper Claiborne Group is, based on boring log data, continuous underneath the Dunn Field boundary except for a gap that appears between monitoring wells MW-56 and MW-34 (and extends to the south, into the MI) at the southwestern boundary of Dunn Field. Offsite there are gaps in the clay the west (at MW-43) and northwest (at MW-40) of Dunn Field. These gaps are windows down to the upper part Jackson Formation/Upper Claiborne Group or the intermediate aquifer underlying the fluvial deposits. Where present, the maximum known thickness of this confining unit was 92 feet in MW-36.

Memphis Sand. According to Kingsbury and Parks (1993), the Early to Middle Eocene-aged Memphis Sand is composed primarily of thick-bedded, white to brown or gray, very fine-grained to gravelly, partly argillaceous and micaceous sand. Lignitic clay beds constitute only a small percentage of total thickness. The Memphis aquifer comprises the Memphis Sand. The Memphis Sand ranges from 500 to 890 feet in thickness, and the depth to the top of the Memphis aquifer in the area ranges from approximately 120 feet to 300 feet bgs. The City of Memphis obtains its drinking water from this aquifer. Local stratigraphic data from the Allen Well Field, located approximately 1 to 2 miles west of Dunn Field, were evaluated to characterize the stratigraphy of the Memphis Sand (Kingsbury and Parks, 1993). At well Sh:J-104, the top of the Memphis Sand is at an elevation 46 feet msl. MW-67 is the only monitoring well completed in the Memphis Sand associated with Dunn Field. Soil boring logs indicate approximately 80 feet of alternating silt and clay layers from 21 to 101 feet msl. Below the alternating silt and clay layers, a fine to medium grained, gray, sand occurs to the borehole termination depth of 0.5 feet msl.

1.3.5.2 Hydrology

There are no perennial flowing streams or creeks within the boundary of Dunn Field. Typically, surface drainage of Dunn Field occurs by overland flow via swales, ditches, concrete-lined channels, and a storm drainage system. Based on a generalized hydrogeologic cross section, groundwater elevations fall well below local stream base elevations in the vicinity of the Depot; therefore, the fluvial deposits do not appear to contribute to the stream base at this location.

There are three aquifers underlying Dunn Field and the local area, which correspond to the geologic units described previously. These aquifers are identified in descending order from ground surface to the Memphis Sand:

- Fluvial aquifer
- Intermediate aquifer
- Memphis aquifer

Fluvial Aquifer. The uppermost aquifer at Dunn Field is the unconfined fluvial aquifer, consisting of saturated sands and gravelly sands in the lower portion of the fluvial deposits. Recharge to this unit is primarily from the infiltration of rainfall (Graham and Parks, 1986). Discharge from the fluvial aquifer is generally directed toward underlying units in hydraulic communication with the fluvial deposits, or laterally into adjacent stream channels. The fluvial aquifer provides water for domestic and farm wells in rural areas (Kingsbury and Parks, 1993), but is not used as a drinking water source within the City of Memphis, including the area surrounding the Depot.

The low-permeability uppermost clay of the Jackson Formation/Upper Claiborne Group serves as the base of the fluvial aquifer at most locations. During the field work for the RI, six Shelby tube samples were collected from the top of the uppermost clay confining unit and were analyzed for triaxial permeability. These samples indicated the clay has very low permeability, with maximum, minimum, and average hydraulic conductivities of 2.5×10^{-7}, 1.2×10^{-8}, and 6.4×10^{-8} cm/sec, respectively. Therefore, the uppermost clay in the Jackson Formation/Upper Claiborne Group, where present, constitutes a hydraulic barrier to downward migration of groundwater in the overlying fluvial aquifer.

Continuous core obtained from wells drilled using the rotasonic method indicate perched groundwater also exists in the vadose zone of the fluvial aquifer deposits usually above small clay lenses or laminae. However, these perched water zones are isolated, are probably ephemeral , and are not considered part of the regional water table of the fluvial aquifer.

Saturated thickness of the fluvial aquifer is variable across Dunn Field and is controlled by the configuration of the uppermost clay in the Jackson Formation/Upper Claiborne Group. Maximum saturated thickness ranges between 10 and 20 feet above the clay surface in Dunn Field. Groundwater flow directions within the unconfined fluvial aquifer are depicted on Figure 1-8, based on measurements taken in November 2001. In general, the fluvial aquifer flows in a western direction, which follows the contours of the uppermost clay confining unit in the Jackson Formation/Upper Claiborne Group.

A potentiometric map displaying the water table surface of the fluvial aquifer (Figure 1-8) was developed for the Dunn Field RI Report (CH2M HILL, July 2002), based on January 2001 water levels. In general, the fluvial aquifer flows in a western direction, which follows the contours of the uppermost clay confining unit in the Jackson Formation/Upper Claiborne Group. However, cross-sections (see Appendix A-2) suggest the clay confining unit, in vicinity of MW-43 to STB-14 to MW-55, ending around MW-34 (west to east), creates a groundwater limited-flow boundary or area of "no significant saturated thickness" (NSST) (Figure 1-8). An area of NSST is defined as an area where the surface of the upper clay confining unit intersects and exceeds the surface of the fluvial aquifer. These conditions "pinch out" the fluvial aquifer and create unsaturated conditions above the clay confining unit. Monitoring wells 41, 55 and 56 are located on the northern side of the NSST boundary and have fluvial aquifer thickness' of 1.39, 2.12, and 2.62 feet, respectively, as measured on January 10, 2001. In areas where the fluvial aquifer is thin (<1 feet), the hydraulic head cannot sustain a measurable water table if a steep top-of-clay gradient occurs. Like the NSST zones, fluvial deposits in the vicinity of MW-34, MW-40, and MW-43 are not saturated. In these areas, soil borings have confirmed the absence of a clay unit directly below the fluvial deposits; this absence allows recharge water to vertically percolate into the lower aquifer(s). Where the fluvial aquifer is present, the potentiometric surface surrounding MW-34, MW-40 and MW-43 indicates groundwater flow directed toward these areas. However, localized NSST zones around these areas where the upper confining clay is present likely impedes groundwater flow into lower aquifers.

Aquifer tests conducted during August 1997 indicate the average hydraulic conductivities for the fluvial aquifer near Dunn Field is 6.1×10^{-3} (arithmetic mean) and 3.0×10^{-3} (geometric mean) cm/sec. Within the fluvial aquifer, groundwater flow velocities were calculated based upon data gathered from slug tests and aquifer pump tests. The range for groundwater velocity was estimated at 0.12 foot/day (4.2×10^{-5} cm/sec) to 1.69 feet/day (6.0×10^{-4} cm/sec) assuming the following parameters:

- Hydraulic gradient = ranges from 0.0017 foot/foot to 0.023 foot/foot along the western boundary of Dunn Field;
- Hydraulic conductivity = 22.11 feet/day (7.8 x 10^{-3} cm/sec) [(based on the average hydraulic conductivity for the fluvial aquifer reported in the *Final Groundwater Characterization Data Report* (CH2M HILL, 1997a)]; and
- Effective porosity = 0.3.

In 1992, a pump test was performed by Environmental Science and Engineering (ESE)(1994) in the northwestern portion of Dunn Field (MW-3) to measure hydrogeologic parameters needed for design of the Dunn Field groundwater extraction system. The average hydraulic conductivity value obtained via pump testing of the fluvial aquifer, 3.5x 10^{-2} cm/sec, is about an order of magnitude higher than the values obtained by slug testing.

As discussed in Appendix C, two samples collected from the fluvial deposits on Dunn Field in 2001 were analyzed for horizontal hydraulic conductivity. The results of one sample collected from 59 to 61 feet below land surface (bls) indicated a hydraulic conductivity of 2.8 x 10^{-4} cm/sec . The results of a second sample collected from 65 to 67 feet bls indicated a hydraulic conductivity of 7.1 x 10^{-4} cm/sec .

Intermediate Aquifer. The intermediate aquifer underlies the Memphis Depot and, based on soil borings installed during the RI investigation, this aquifer is separated from the fluvial aquifer by the clay confining unit; limited contact between the two aquifers occurs in areas near MW-34, -40, and -43 where the clay confining unit is absent. Based on the lithologic log of MW-67, the intermediate aquifer is composed of interbedded sand, silt, and clay.

Aquifer tests conducted during August 1997 indicate the hydraulic conductivity for the intermediate aquifer is similar to the fluvial aquifer with conductivities of 1.3x10^{-3} (MW-34) and 5.4x10^{-4} (MW-40) cm/sec. Away from the influence of recharge from the fluvial aquifer through areas where the clay directly underlying the fluvial deposits is absent, water level elevations in the intermediate aquifer are approximately 150 feet msl with a general westward flow toward the Allen Well Field.

Memphis Aquifer. The Memphis aquifer contains groundwater under strong artesian (confined) conditions and is a regionally significant source of potable water in the Memphis area. This hydrogeologic unit underlies Dunn Field at a depth of approximately 180 feet bgs, beneath the intermediate aquifer, and receives most of its recharge from an outcrop area, several miles east of Memphis. Some recharge is derived from overlying or hydraulically communicating units. Locally, extensive pumping has lowered water levels considerably. The top of the Memphis aquifer potentiometric surface at MW-67, the only well at the Depot that intersects the Memphis aquifer, is 151.6 feet msl. Flow in the unit is generally westward, toward the Allen Well Field, a major local pumping zone. VOC contamination within the fluvial aquifer at Dunn Field has not been detected within the Memphis aquifer at the Allen Well Field.

Groundwater Use. There are no public water supply wells within Dunn Field. A well survey conducted within a 2-mile radius of the Depot through the Environmental Data Resources, Inc. (EDR®) GeoCheck® Report (dated March 2002 and included as Appendix A-3 of the Dunn Field RI Report) determined that there are no private residential water wells within a

2-mile radius of Dunn Field. However there are several industrial production wells within 0.5 to 2 miles northwest, northeast and east of Dunn Field. In addition, groundwater from both the fluvial and intermediate aquifers meet the requirements of General Use Ground Water as defined by TDEC (1200-4-3-.07). This means that these aquifers could be used for water supply when the Depot is converted for reuse.

Approximately 1 mile west of the Dunn Field is the Allen Well Field, where 13 water-supply wells pump from the Memphis aquifer. This aquifer is the water source for the City of Memphis and most of Shelby County. Therefore, a factor in evaluating effectiveness of a remedial alternative is controlling migration of contaminants that might affect the quality of water produced by these public supply wells.

1.3.6 Nature and Extent of Contamination

The nature and extent of contamination was assessed for surface soils, subsurface soils, surface water, sediments, and groundwater across Dunn Field (CH2M HILL, July 2002). Nature and extent findings are summarized below by Area, with groundwater discussed independently.

1.3.6.1 Northeast Open Area

To facilitate the investigation of the Northeast Open Area, several historic Dunn Field sites were consolidated into "Locations" (Figure 1-5), as described in Table 1-4, taken from the *Final Field Sampling Plan for OU-1 Addendum* (CH2M HILL, 1999) and investigated as possible sources of contaminant releases to the environment.

To characterize the nature and extent of contamination within the Northeast Open Area, surface and subsurface soil samples were collected and analyzed for analyte groups that included volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and the Target Compound List/Target Analyte List (TCL/TAL) parameters (including organochlorine pesticides, herbicides, polychlorinated biphenyls [PCBs], and priority pollutant metals). Surface water and sediment samples were collected and analyzed for parameters included in the TCL/TAL. Appendix A-3 includes the figures from the Dunn Field RI Report (CH2M HILL, July 2002), which summarize the analytical results of surface and subsurface soil, sediment and surface water samples from the Northeast Open Area. Key findings and conclusions from the RI are as follows:

- VOCs were found in both surface and subsurface soil samples. In particular, PCE and TCE were detected at 3 to 5 feet bgs and/or 8 to 10 feet bgs at multiple locations. These VOC concentrations do not appear to be high enough to indicate a release from a definable source area. However, the VOC results confirm the PCE soil gas plume indicated by the passive soil gas survey and suggest that incidental surface waste disposal of chlorinated solvents may have occurred in the Northeast Open Area during the long period of operations at Dunn Field. VOCs detected along the western boundary of the Northeast Open Area may be associated with waste disposal operations in the adjacent Disposal Area.
- There is no indication that zinc or SVOCs have migrated from the XXCC-3 disposal area at Site 21.

- Lead was elevated at Site 60, the former pistol range.
- The distribution of pesticides across the Northeast Open Area is similar to that at the Main Installation, indicating widespread surficial pesticide application rather than releases from the temporary pesticide storage area, Site 85.
- Contaminant concentrations in samples of surface water and sediment coming onto Dunn Field at Site 50 are equivalent to or greater than concentrations in surface water and sediment leaving Dunn Field. Thus there is no evidence that Site 50 is contributing to offsite contamination.

1.3.6.2 Disposal Area

The Disposal Area contains 25 Dunn Field historical sites, identified in Table 1-2. To facilitate the RI, many of the above sites were combined into "Locations" (Figure 1-6) as described in Table 1-5, which was taken from the *Final Field Sampling Plan for OU-1 Addendum [I]* (CH2M HILL, March 1999). These locations were investigated as possible sources of contaminant releases to the environment.

To characterize the nature and extent of contaminants within the Disposal Area, surface and subsurface soil samples were collected and analyzed for VOCs, SVOCs, metals, and the TCL/TAL parameters. Surface water and sediment samples were collected and analyzed for parameters included in the TCL/TAL. Appendix A-4 includes the figures from the Dunn Field RI Report (CH2M HILL, July 2002), that summarize the analytical results of surface and subsurface soil, sediment and surface water samples from the Disposal Area. Key findings and conclusions from the RI are as follows:

- VOCs in soils at Dunn Field as represented by the 1999 and 2000 sampling results correlate well with the extent of VOCs in the subsurface suggested by the passive soil gas survey results. The apparent clustering of the higher VOC detections correlates well with the historical information indicating that the disposal pits and trenches were relatively small and separate. In addition, the TCE, PCE, and carbon tetrachloride plume centroid depths reflect the Disposal Area source areas as defined by the soil analytical results. The Site 10 disposal pit (Solid Waste Burial Site) in Location E appears to be the largest single, potential chlorinated VOC source of contamination to groundwater. In addition, as evidenced by soil samples collected in Location C, VOCs have been transported from near the base of the disposal trenches (8 to 10 feet bgs) to depths (83 feet bgs) immediately above the water table.
- Significant levels of the following chlorinated VOCs were detected in subsurface soils within the Disposal Area: 1,1,2,2-PCA, 1,1,2-TCA, 1,2-DCA, CCl4, chloroform, methylene chloride, PCE, TCE, 1,2-DCE and vinyl chloride. The contaminant mass calculations for the primary VOCs, TCE and 1,1,2,2-PCA (see Appendix E), indicate that there is approximately 456 pounds of TCE and 368 pounds of 1,1,2,2-PCA that needs to be treated and removed from the Disposal Area. This equates to approximately 713,400 cubic yards of soil in the Disposal Area.
- Based on comparison of soil sample analytical results to contaminants in groundwater underlying Dunn Field, there appears to be a complete migration pathway from surface soil/disposal area to subsurface soil and then to groundwater for CVOCs.

- Chromium and lead consistently exceed background concentrations in surface and subsurface soil and likely result from waste management operations at the Disposal Area. Arsenic, aluminum, copper, and zinc also exceed background concentrations in soil. Metals in both surface and subsurface soil are widely distributed or sporadic and mostly do not correlate with specific locations or sites.
- Pesticides were detected in surface and subsurface (8- to 10-foot bgs) samples across the Disposal Area. The distribution of concentrations is indicative of broadcast application to the surface rather than disposal operations.
- Concentrations of metals, pesticides, and PAHs in ephemeral surface water flow exceeded background. These chemicals also exceeded background in sediments in the northwest portion of the Disposal Area at Site 61. PAHs in sediment at Site 61 likely result from active offsite railroad tracks. Chemical concentrations in sediment from Location A–the Asphalt Pad–are almost all below background.

1.3.6.3 Stockpile Area

This section addresses the nature and extent of contamination within the Stockpile Area of Dunn Field (Figure 1-7). The Stockpile Area includes several historic Dunn Field sites (mineral stockpiles) identified in the *OU 1 Field Sampling Plan* (CH2M HILL, September 1995) and the *Screening Sites Field Sampling Plan* (CH2M HILL, September 1995), which were investigated as possible sources of contaminant releases to the environment. Appendix A-5 includes the figures from the Dunn Field RI Report (CH2M HILL, July 2002), that summarize the analytical results of surface and subsurface soil samples from the Stockpile Area. Key findings and conclusions from the RI are as follows:

- There is no indication that VOCs or SVOCs were disposed of at the Stockpile Area. The elevated concentrations of PAHs detected in surface soil samples appear to be related to former/existing railroad tracks and also asphalt roadways on this portion of Dunn Field.
- Elevated metals are primarily associated with ore storage and in general are close to background levels, including arsenic.
- The distribution of pesticides across the Stockpile Area is similar to that at the Main Installation, indicating widespread surficial pesticide application rather than releases.
- The alleged CC-2 burial trench is suspected as being located adjacent/near to Site 24-B in the west-south portion of the Stockpile Area. This area was not directly investigated during the RI field activities due to the CWM removal action, which was completed in 2001.

1.3.6.4 Disposal Sites

Based on information generated by the Archives Search Report, approximately 15 disposal sites are known to exist in the Disposal Area and one (a CC-2 disposal area) disposal site is known to exist in the Stockpile Area. These sites are described in Table 1-6. Information concerning the materials buried in each disposal site is based on historical information and the exact position of each site is unclear. Not all of these sites were directly investigated during the RI because of the potential for CWM, which was removed in 2000 and 2001. In 1993, the U. S. Army Engineer Waterways Experiment Station conducted a geophysical investigation of the Disposal Area and the western portion of Stockpile Area. Six areas were investigated to determine the location of buried trenches, pits, drums, and other sources that may be contributing to the contamination of the upper aquifer. The final technical report (GL-94-8) was published in March 1994. The report concluded that there are potential burial sites in five of the six areas surveyed.

Based on this data, CH2M HILL conducted field observations on August 18, 1995. The observations indicated many surface irregularities and depressions, suggesting possible burial sites in the northwest quadrant of Dunn Field (the Disposal Area). Many of the irregularities and depressions appeared to correspond with the mapped waste areas while others did not. Engineers from CH2M HILL revisited Dunn Field in October 1995, and mapped the irregularities and depressions noted during the visits. The results of the mapping confirm that many of the field-identified depressions and irregularities correspond well with previously mapped burial sites on Dunn Field, and there were some that did not. Three (3) figures generated from the mapping of the irregularities and depressions on the western portion of Dunn Field are included in Appendix A-6. In addition, Memphis General Depot Drawing No. 16.4D, Location of Materials Buried in Dunn Field, dated January 19, 1956 (last revised September 17, 1984), is also provided in Appendix A-5 as a historical source of information pertaining to the location of the disposal sites on the western portion of Dunn Field.

These 16 sites have been given priority level rankings by the Memphis Depot BCT and will be prioritized for removal during remedial activities at Dunn Field (see Table 1-2). This will likely involve a pre-design investigation, inclusive of intrusive activities, to determine the location and environmental condition of these 16 disposal sites, and the need for remedial action at each site. As discussed in Section 1.3.2 and presented in Appendix A-1, Dunn Field has been used in the past as a disposal area for OE. Procedures described in Engineer Pamphlet EP 75-1-2, *Unexploded Ordnance (UXO) Support During Hazardous, Toxic, and Radioactive Waste (HTRW) and Construction Activities,* (USACE, November 2000) will need to be followed during any activity involving intrusive measures. Based on a review of the available information there is a "low probability" that UXO will be encountered.

1.3.6.5 Groundwater

The nature and extent of contamination in groundwater underlying Dunn Field and areas to the west were assessed based on an evaluation of chemical data obtained from groundwater samples collected during 16 sampling events from January 1996 through February 2001. Groundwater samples were collected and analyzed during this time period for seven major types of contaminant parameters, including explosives, herbicides, metals (total), pesticides, PCBs, SVOCs, and VOCs. Groundwater samples were also analyzed for CWM breakdown products, including thiodiglycol, 1,4-oxathiane, and 1,4-dithiane. In addition, groundwater samples were collected and analyzed for various geochemical and geotechnical parameters, including tritium and gases, such as oxygen and hydrogen. Of all these parameters, VOCs, SVOCs, and total metals were the most frequently detected analytical constituents in groundwater samples. Appendix A-6 includes the figures from the Dunn Field RI Report (CH2M HILL, July 2002), which summarize the analytical results of groundwater samples for PCE, TCE, 1,2-DCE, 1,1-DCE, 1,1,2,2-PCA, 1,1,2-TCA, carbon tetrachloride and chloroform from 1996 through the beginning of 2001.

There appears to be three major VOC plumes in the groundwater underlying Dunn Field, a northern, a west-northwest plume, and west-southwest plume, with much mixing and intermingling of the plumes, as expected from influence by the active groundwater extraction system, natural groundwater flow, and degradation processes. All of the plumes have on- and offsite components.

Nine persistent VOCs have been detected in groundwater during sampling events, including, 1,1,1,2-PCA, CCl_4, 1,1,2-TCA, chloroform, PCE, cis- and trans-1,2-DCE, total 1,2-DCE, and TCE. The plume along the northern boundary of the site appears to be composed of PCE, TCE, and 1,1-DCE. Since TCE and 1,1-DCE are both potential reductive dechlorination products of PCE, the contaminant plumes may be a result of the breakdown of PCE in the aquifer. However, since the TCE, and 1,1-DCE both appear in monitoring well MW-51 and piezometer PZ-02, which are upgradient to Dunn Field, there appears to be another source of these contaminants north to northeast of Dunn Field (see Section 1.3.6.6).

The west-northwest plume appears to be a mixture of PCE, TCE, 1,2-DCE, 1,1-DCE, 1,1,2,2-PCA, 1,1,2-TCA, CCl_4, and chloroform. Portions of this plume underlying Dunn Field appear to have a source within the Disposal Area or possibly offsite as well. Offsite portions of this plume trend to the west and northwest. The west-southwest plume that underlies Dunn Field is a mixture of several different contaminants and the source of these plumes appears to be located at the southern end of the Disposal Area of Dunn Field. The west-southwest plume is principally composed of 1,1,2,2-PCA, CCl_4, 1,1,2-TCA, and chloroform, but there are also portions of the plume made up of TCE, PCE, and 1,2-DCE.

The nature and extent of VOCs in groundwater have been impacted by the groundwater extraction system at Dunn Field to some extent. PCE, TCE, and 1,1,2,2-PCA concentrations in offsite monitoring wells near the northwest corner of the extraction system have dropped by factors of 7 to 10 from pre-extraction concentrations. This demonstrates significant reductions in offsite flux of VOCs in the northwest portion of Dunn Field. Although concentrations have decreased in the northwest portion, relatively high concentrations of TCE and 1,1,2,2-PCA were discovered in new wells installed near the west-central part of Dunn Field. These higher concentrations in downgradient monitoring wells indicate a significant portion of the west-central plumes are beyond the influence of the capture zone from the extraction system. Groundwater VOC monitoring data from April 2002 are included in this FS report for the first time. As previously stated, the Dunn Field RI Report summarized the analytical results of groundwater samples collected from 1996 through the beginning of 2001. Figures 1-9a through 1-9h summarize the results of the April 2002 groundwater samples for PCE, TCE, 1,2-DCE, 1,1-DCE, 1,1,2,2-PCA, 1,1,2-TCA, carbon tetrachloride and chloroform.

During the five RI sampling events (1996 through 1998), arsenic was detected in groundwater samples at concentrations above the laboratory method detection limits (MDLs) in 3, 15, 4, 1, and 2 samples, respectively. The second quarter 1997 sampling event was anomalously high since in the preceding first quarter 1996 (February) sampling event, arsenic was detected in only 3 samples. During the 1998 quarterly sampling events, exceedances were reported in samples collected from only three wells, MW-2 (perched), MW-3 and MW-13. Samples were collected from the onsite recovery wells in November 1999 and 2000, and arsenic was not detected above the MDL of 0.003 mg/L in 17 of 18 samples. Arsenic was detected at a concentration of 0.003 mg/L in the sample from RW-01 in November 2000. In addition, arsenic was analyzed in 33 samples collected from the groundwater extraction system effluent between October 1998 and April 2002. Of the 33 samples analyzed, none had arsenic concentrations that exceeded the MDL of 0.003 mg/L. Therefore, arsenic does not appear to be a groundwater contaminant in the fluvial aquifer at Dunn Field.

The SVOCs and pesticides detected in groundwater samples were attributed to sampling and analytical artifacts such as the introduction of plasticizers (e.g., bis-ethylhexyl phthalate) via the sampling and analysis process rather than to waste management practices at Dunn Field. In addition, their mobility through the soil column to groundwater is limited. Seven pesticides were detected in groundwater samples collected during the RI activities through 1998. These include alpha-chlordane, DDD, DDT, dieldrin, endrin ketone, gammachlordane, heptachlor epoxide. The most frequently detected pesticides were heptachlor epoxide and dieldrin. Among the 37 samples, the compound heptachlor epoxide was detected in 4 samples at concentrations ranging from 0.0000086 mg/L to 0.000014 mg/L. Dieldrin was also detected in 4 samples, ranging from 0.000036 to 0.000086 mg/L. The other five pesticides were detected not more than twice and never exceeded an estimated value of 0.00001 mg/L. All seven pesticides are associated with monitoring wells installed in 1998: MW-56, MW-57, MW-58, and MW-59. These wells were installed using hollow-stem auger methods rather than the rotosonic method used for many of the other wells installed at Dunn Field since 1997. Use of the auger method in unconsolidated materials may have introduced surface soils containing pesticides to the well completion interval. Since pesticides are ubiquitous in surface soil at Dunn Field and were not detected in other wells sampled during the RI, the pesticides detected in these wells most likely result from waste management operations or surficial application.

Thus the metals and other non-VOC organic chemicals such as pesticides and SVOCs are not considered COCs. The reason for this is: due to low frequency of their detection, low concentrations of detection near detection limits and their detection is possibly associated with turbidity in samples which may have been introduced as a sampling. Also based on the innate nature of these chemicals, they have low solubility, and subsurface soils above the aquifer do not have significant (above leachability based levels) levels of these chemicals. Thus metals and non-VOC chemicals are not selected as COCs and will not be addressed further in this FS.

1.3.6.6 Potential Sources of Offsite Groundwater Contamination

From 1996 to 2002, 1,1-DCE has been detected in groundwater samples above the MCL of 7 µg/L in monitoring wells and piezometers along the northern perimeter of Dunn Field and offsite to the north, northwest and northeast of Dunn Field. 1,1-DCE was found in northern perimeter wells MW-03, MW-07, MW-08, MW-10, and MW-29 at concentrations as high as 25 µg/L in October 1998. In particular, this compound was detected in offsite well MW-51 (which is located 200-feet side-gradient to the northern boundary of Dunn Field) and piezometer PZ-02 (which is located 700-feet upgradient from the northern boundary of Dunn Field), with the highest offsite concentration being recorded in a sample from PZ-02 at 170 µg/L in October 1998. TCE has also been detected in these wells at concentrations that exceed the MCL of 5 µg/L with the highest value of 24.4 µg/L detected in PZ-02 in April 2002. MW-65 was also sampled in April 2002 and no VOCs were detected. This well is located approximately 1,100 feet north-northeast of PZ-02. The offsite plume that enters Dunn Field along the northern boundary of the site primarily contains TCE and 1,1-DCE.

PCE and TCE are frequently detected contaminants of concern found in the soils on the Dunn Field; however, 1,1-DCE is not. Since the TCE and 1,1-DCE both appear in offsite monitoring well MW-51 and piezometer PZ-02, which are sidegradient and upgradient to Dunn Field, respectively, there appears to be an offsite source of these contaminants north to northeast of Dunn Field, unrelated to the source areas on Dunn Field. This apparent source is creating an offsite plume which migrating onsite and is further contributing to the VOC contamination in groundwater underlying Dunn Field. Consequently, any proposed remedial action for the groundwater underlying Dunn Field would likely need to consider this offsite plume as it enters the site unless otherwise addressed. This information is documented in the Technical Memorandum entitled *Potential Offsite Source of Groundwater Contamination, Northeast of Dunn Field* (CH2M HILL, June 2002).

1.3.7 Contaminant Fate and Transport

1.3.7.1 Physical and Chemical Properties of COPCs

Chemicals that are observed to occur frequently in the environmental media at Dunn Field are addressed below by their chemical group (VOCs, metals, etc.). The fate and transport of each of these groups are briefly summarized from Section 6 of the RI report (CH2M HILL, July 2002).

Volatile Organic Compounds

VOCs are characterized by relatively high vapor pressures, Henry's Law constants, and generally high solubility in water. They have a tendency to partition to the vapor phase (air) from either the sorbed (soil) or dissolved (aqueous) phases. Therefore, these chemicals could be released through volatilization from either VOC-contaminated soil or surface water. The range of K_{oc}, high solubility, and low K_{ow} values indicates that the CVOCs are mobile through soils and tend not to partition significantly from water to soil. These solvents may move through groundwater as dense nonaqueous phase liquids (DNAPLs) because CVOCs are denser than water. The most consistently detected VOC group of chemicals at concentrations above comparison criteria in the site media are CVOCs, such as TCE, PCE, 1,1,2,2-PCA, carbon tetrachloride and chloroform.

Release and transport mechanisms include vertical migration through unsaturated soils toward the water table. The presence of VOC plumes emanating from Dunn Field supports the conclusion that VOCs are being transported through the soil column to the fluvial aquifer. As CVOCs migrate vertically through soil, some mass are retained in the pore spaces and some may spread across layers of lower permeability. Specific lateral migration may occur if a zone of very low permeability is reached, in which case the nonaqueous phase liquid (NAPL) migrates laterally, depending in part on the contours of the surface of the layer.

If CVOCs are present as NAPL in soil, they can be continuing potential sources of CVOCs to groundwater. As a general rule, the potential presence of NAPL is indicated if concentrations in groundwater exceed 1 percent of the chemical's solubility limits. Based on the highest observed concentration of the detected solvents TCE and 1,1,2,2-PCA in groundwater, free-phase solvents may be present in Dunn Field groundwater; however, NAPL was not been detected during the RI and subsequent O&M groundwater sampling events.

Aerobic and anaerobic biodegradation are important transformation processes for chlorinated aliphatic compounds in natural water systems and soil. TCE would generally be expected to persist under aerobic or denitrifying conditions. Denitrifying conditions are indicated when nitrates are present in groundwater but no oxygen is detected. Smaller chlorinated compounds, such as DCE, are harder to degrade anaerobically but can be degraded more easily aerobically than the more highly chlorinated solvents such as TCE. The rate depends only on temperature and the residence time in groundwater can be estimated: half-lives ranging from less than one year (25 degrees Celsius [°C]) to over 5 years at cooler temperatures (Wiedemeier et al., 1995).

Semivolatile Organic Compounds

PAHs are common components of fuel oils and tar mixtures. PAHs have been detected extensively at the railroad operations across the Depot. Fuel use, vehicular and historical railroad traffic, asphalt roads, and pavement have contributed to non-point source releases of PAHs at the Depot. PAHs are relatively persistent and represent a broad class of compounds, ranging from low-molecular-weight components, such as naphthalene, to high-molecular-weight compounds such as dibenz(a,h)anthracene. Solubility, volatility, biodegradability, and toxicity vary widely across this class of compounds.

High-molecular-weight PAHs are more likely to be transported via particulate emissions, while low-molecular-weight PAHs have a greater tendency to volatilize. When PAHs are present in tar and oil waste mixtures, their behavior is determined largely by the mobility and behavior of the waste itself. Low-molecular-weight PAHs can migrate from spills and continuous releases of tars and oils, but as weathering occurs, the rate of release decreases. Higher-molecular-weight PAHs would persist in the vicinity of the original release.

Low-molecular-weight PAHs have higher water solubility and are more likely to be released into groundwater than higher-weight PAH compounds, which have an increased tendency for adsorption to soil or other organic matter. A primary fate and transport mechanism is migration of adsorbed PAHs with surface soils and sediment. Erosion of soil and movement of suspended sediments may result in migration of PAHs to surface water. However, because of the low solubility of adsorbed PAHs, they would not partition significantly to water.

Photolysis and biodegradation are two common attenuation mechanisms for PAH compounds. Although all PAHs transform in the presence of light, their rates are highly variable. Photolysis may reduce concentrations of these chemicals in surface soils, but is not relevant for subsurface soils. Biodegradation rates of PAHs in soils are also extremely variable across the chemical class.

Animals and microorganisms can metabolize PAHs to products that ultimately reach complete degradation. PAHs in soil may be assimilated by plants, degraded by soil microorganisms, or accumulated to relatively high levels in soils.

Metals

The potential release and migration of metals in the subsurface environment is a complex process. The migration of metals depends on factors such as the overall groundwater composition, pH, presence of dissolved organic matter that may complex with the metals, the valence state of the metal, and the cation-ion exchange capacity. Metals may be removed from the water phase through mechanisms such as precipitation and irreversible sorption (USEPA, December 1979). Because metals are not volatile, any emissions to ambient air would be in the form of particulate emissions.

Chemical distributions in both soil and water are more difficult to predict for metals than for organic compounds. A direct relationship between the measured total metal concentration in soil and the extractable aqueous concentration cannot be assumed. The metal may be fixed in the interior of the soil and unavailable for exchange or release to water, or exchangeable metal may be present at the surface of the particles. Published K_d values generally represent the potential relationship between water and exchangeable metal at the surface of the soil (USEPA, 1996c).

Metals detected well above background at Dunn Field include aluminum, arsenic, cadmium, chromium, and lead. Metals that typically have very low solubilities or are highly absorbed in soils include lead and trivalent chromium. For example, lead has a tendency to form low-solubility compounds with the major anions of natural water. Hydroxide, carbonate, sulfide, and sulfate may act as solubility controls to precipitate lead from water. Another important factor is lead's strong tendency to sorb to soils. A significant fraction of lead is insoluble lead, which may be associated with colloidal particles.

Arsenic is generally more mobile in groundwater than many other metals, but its behavior is complex. It can exist in multiple oxidation states that differ in solubility. The reduced form of arsenic (As^{+3}) is more mobile than the oxidized form (As^{+5}). The effect of solubility controls on arsenic concentrations cannot be evaluated with the information that currently exists (ATSDR, 1992). Adsorption of iron oxides or combination with sulfide may maintain low-level concentrations of arsenic. The adsorption of arsenic onto clays, iron oxides, and organic (humic) material is also an important transport pathway.

Pesticides

Dieldrin is the pesticide most present at Dunn Field, with relatively infrequent detection of DDT, DDE, and DDD in soil and sediment. These pesticides are no longer used at the facility.

In general, these chlorinated pesticides have low Henry's Law constants and are not expected to volatilize significantly. All of the detected organo-chlorine pesticides have lower solubility and higher K_{oc} values, indicating that these pesticides are more likely to sorb to soil and are less mobile in aqueous phases. The most likely migration pathways for pesticides are transport in particulate emissions and transport of sorbed materials in surface runoff.

Dieldrin is extremely nonpolar and, therefore, has a strong affinity for organic matter, such as animal fat, and sorbs tightly to soil particulates. It has low mobility through the soil column and moves at extremely low rates even under saturated soil conditions (greater than 270 years to move through 3 meters, [ATSDR, 1992]). Thus surface runoff and air-borne particulate emissions are the potential migration pathways for the chlorinated pesticides. Based on available BCFs, organo-chlorine compounds could bioconcentrate significantly.

1.3.7.2 Groundwater Conceptual Model

The conceptual site model (CSM) for groundwater at Dunn Field has a hydrogeological framework of three water-bearing units: the fluvial aquifer, the intermediate aquifer, and the Memphis aquifer. Logs of multiple test borings (see Appendix A-2) indicate that the vadose zone consists of about 30 feet of loess (silt), 10 feet of sandy clay/clayey sand, and up to 45 feet of sand, gravelly sand, and sandy gravel. The fluvial aquifer is locally 10 to 12 feet thick and occurs within gravelly sand lithologies below the vadose zone. Beneath the fluvial aquifer is a confining clay (approximately 70 to 95 feet thick) followed by the intermediate aquifer comprised of up to 50 feet of alternating sand and clay layers (each layer up to 20 feet thick). Approximately 75 to 100 feet of alternating sand, silt, and clay layers (each layer averages 5 feet thick) separate this aquifer from the underlying Memphis aquifer.

Movement of COCs begins with infiltration of rain through contaminated soil. The rainwater dissolves the chemicals and carries them vertically through the vadose zone into the fluvial aquifer (Figure 1-9). Within the fluvial aquifer, the dissolved COCs migrate in the direction of groundwater flow. Although there is a pervasive downward gradient, the clay layer that separates the fluvial aquifer from the underlying intermediate aquifer greatly slows the downward migration of the COCs. Wherever the clay is absent (i.e., areas near MW-34, -40 and -43), COCs may migrate downward through the "window" into the intermediate aquifer, and may ultimately reach the Memphis aquifer (Figure 1-8). Within the fluvial aquifer, the groundwater flows predominantly to the west/northwest shifting more north/northwest near MW-54 and MW-76 (Figure 1-8).

Below the intermediate aquifer is the Memphis aquifer. The log of MW-67 (total depth: 275 feet bgs) shows 80 feet of alternating clay/silt layers separating the intermediate aquifer from the Memphis aquifer. A "continuous" clay/silt unit in the area between Dunn Field and the Allen Well Field would be a substantial barrier to potential migration of dissolved COCs into the Memphis aquifer. However, if the unit is discontinuous, there is a possibility that dissolved COCs within the intermediate aquifer could migrate into the Memphis aquifer and then into municipal wells at the Allen Well Field. There is currently no evidence that COCs in the fluvial aquifer at Dunn Field have entered the Memphis aquifer. A "reasonable worst case scenario" assumes that COCs will migrate from the fluvial aquifer through the intermediate aquifer into the Memphis aquifer. Section 16 of the Dunn Field RI Report (CH2M HILL, July 2002) presents calculations of the potential transport of contaminants in the fluvial aquifer into the Memphis aquifer.

1.3.7.3 Natural Attenuation

Biological and chemical processes can degrade plumes of chlorinated solvents. MNA studies completed for the Depot in 1998 and 2000 concluded that although CVOCs at Dunn Field are undergoing reductive dechlorination, the process is limited and localized. As a result, TCE comprises the majority of the CVOC contamination throughout most of the plume.

The 2000 MNA dataset was also used to estimate the first-order biological rate constants. Two approaches - the normalization method and the Buscheck and Alcantar (1995) method - were used to calculate the first-order biological rate constant for a steady-state plume. A half life for TCE was calculated as 3.5 to 7.5 years using the normalization method and 3.4

years with the Buscheck and Alcantar method. Results for other parameters are presented in the RI report.

1.3.7.4 Potential Plume Migration

As described above in the CSM, downward leakage from the fluvial aquifer into the underlying intermediate aquifer may allow the offsite CVOC plumes to reach the Memphis aquifer; once within the Memphis aquifer, the CVOCs are expected to migrate toward the Allen Well Field. The Allen Well Field consists of 33 wells in the Memphis aquifer, each pumping approximately 1,000,000 gallons per day (MLGW, 1999).

To estimate the movement of COCs from the source area at Dunn Field to the Allen Well Field, calculations were performed using the BIOSCREEN (Air Force Center for Environmental Excellence [AFCEE], 1997) and BIOCHLOR (AFCEE, 2000) transport models. Assumptions used in model calculations were presented in the RI Report (CH2M HILL, July 2002). Two scenarios were used to model this pathway: (1) transport from source area to a breach in the confining clay below the fluvial aquifer near MW-40 and (2) transport from the breach to the Allen Well Field assuming the fluvial aquifer is connected directly to the Memphis aquifer. Using conservative estimates of natural attenuation rates, only PCE and 1,1-DCE reached the closest Allen Well Field pumping well above detection limits; however, concentrations were still below the EPA maximum contaminant levels (MCLs) of 5 and 7 µg/L, respectively. The models also estimated that maximum concentrations would not occur at the pumping well for at least 57 years for PCE and 82 years for 1,1-DCE after VOCs entered the Memphis aquifer. The model results strongly suggest the VOC contamination at Dunn Field will not affect the wells at Allen Well Field.

1.3.8 Summary of Baseline Risk Assessment

A baseline risk assessment (BRA), including an ecological risk assessment and human health risk assessment (HHRA), was conducted for each of the three areas of concern within Dunn Field and groundwater. Details of the BRA are presented in the Dunn Field RI Report (CH2M HILL, July 2002).

The BRA determined that the overall ecological risks are negligible for Dunn Field based on the weight of evidence indicating no contaminant-related toxicity, as well as poor quality habitat. The HHRA compared site- and contaminant-specific risk estimates with the acceptable health risks and hazard index (HI) levels. Acceptable risk levels (risks) for NPL sites range from 1 to 100 in 1 million excess lifetime cancer risks (ELCRs). The acceptable target HI is 1.0 for non-carcinogenic chemicals. Table 1-7 presents a summary of the risks and HIs for soil, based upon the three areas of concern, and groundwater at Dunn Field. This table also summarizes COPCs identified in the RI.

The following subsections summarize the BRA prepared for each Area and groundwater at Dunn Field.

1.3.8.1 Northeast Open Area

The potential risks to human health and ecological receptors from exposures to contaminants in impacted media in the Northeast Open Area were evaluated. The key findings from the risk analysis are as follows:

- Many COPCs for the Northeast Open Area, such as PAHs and metals, were also detected in background soils. Dieldrin was not used in the pistol range operations; however, it was applied as part of routine maintenance of the grassy areas, which are not directly related to the site operations within Dunn Field. Likewise, site-wide data statistical evaluations indicate that contaminants were similarly distributed in the background samples;
- The surface water COPCs were dieldrin and phenanthrene, both of which have low solubility, indicating they may be associated with suspended particulates;
- The risk evaluations under future land use conditions included potential exposures of maintenance, industrial, and utility workers within the Northeast Open Area based on activities observed to be applicable to the site. Offsite residential exposures to volatiles and dust from the site were also evaluated. None of these exposure scenarios resulted in risks above acceptable levels. Therefore, site-specific risk-based RGOs were not calculated for the site;
- The carcinogenic risks for industrial worker exposures to Sites 60/85 surface soil resulted in an estimated risk of 9×10^{-6} and a noncarcinogenic HI of 0.03. The carcinogenic risks are from dieldrin. The resulting risks are well within the acceptable limits for cancer risks of 1 to 100 in one million and an HI of 1.0. Thus, the overall Sites 60/85 surface soils do not pose a health threat to future industrial workers;
- The estimated cancer risk to future hypothetical onsite adult and child residents at Sites 60/85 was estimated at 7×10^{-5}, which is within the acceptable range of 10^{-6} to 10^{-4}. The estimated risk is due to dieldrin at EPC concentration of 2.54 mg/kg. The total noncarcinogenic health hazard was estimated to be an HI of 0.07 for an adult and an HI of 0.7 for a child, from dieldrin. Overall risks and HIs to future residents are well within acceptable limits for the Surrogate Site 60/85;
- Lead detected at sample Location 60/85 is reported at 2,100 mg/kg. This particular sample concentration is well above a residential screening concentration of 400 mg/kg, and is also above the Memphis Depot industrial worker target value of 1,536 mg/kg. However, the area average does not appear to be above these target levels. Lead-contaminated soil at Site 60 will be removed as part of a removal action at the site, allowing for recreational land use.
- Dieldrin and chromium were the only surface soil COPCs identified in the ecological risk assessment for the Northeast Open Area. Based on further refinement of the risk assumptions of dieldrin and chromium on the American robin as target receptor, along with the other site-specific characteristics and uncertainties, dieldrin and chromium will not be considered further as a COPCs at this site; and
- No further assessment of ecological risk associated with contaminants at the Northeast Open Area was found to be warranted.

1.3.8.2 The Disposal Area

The potential risks to human health and ecological receptors from exposures to contaminants in impacted media at the Disposal Area were evaluated. The key findings from the risk analysis are as follows (see the Disposal Area risks to human health summarized in Tables 1-8a and 1-8b):

- All of the chemicals were analyzed for their potential toxicity contribution to represent the combined effect of all site-related chemicals. Twenty-one (21) carcinogenic and 10 noncarcinogenic inorganic and organic chemicals were identified as COPCs at the Disposal Area;
- Combined risks from soil, sediment, and surface water exposure pathways for the maintenance worker resulted in a total ELCR of 4×10^{-6} and a total HI of 0.008. The cumulative surface media exposure is within acceptable limits;
- Exposures to ambient air VOCs from subsurface soils to future industrial workers in the area are estimated to be 2×10^{-5}, and the HI is at 0.3;
- The potential risks to a future industrial worker from potable use of site groundwater from the North plume is estimated to include an ELCR of 1×10^{-4} and an HI of 0.9 (mostly from inorganic chemicals). Contribution to indoor air presents negligible risks;
- Combined risks from soil, sediment, and surface water exposure pathways for the industrial worker resulted in a total ELCR of 4×10^{-5} and a total HI of 0.4. The cumulative surface media exposure is within acceptable limits, as stated above;
- The indoor air risk estimates for an industrial worker assumed to spend the workday indoors at Site E exceeded the acceptable HI of 1.0. This slight exceedance of the acceptable HI at Site E is predominantly due to total-1,2-dichloroethene;
- The risk estimates for inhalation of air originating from the Disposal Area subsurface groundwater to an onsite worker are well within acceptable limits (<1 in a million);
- The risk assessment for the Disposal Area included potential residential scenarios for a residential adult and child. The risks were found to be greater than an HI of 1.0 for surface soil and indoor air (soil to indoor air). Therefore, remediation efforts would be necessary to remove the risk prior to the Disposal Area being permitted for residential occupation.
- Results from the Site 61 surrogate study suggest that site arsenic, antimony, PAH, and CVOC levels render Site 61 unusable as a residential site under current contamination conditions. Both cancer risks and non-cancer hazards are unacceptable for indoor air exposures to a future onsite resident (adult/child). Thus, the landfilled areas are not suitable for housing under current conditions. In addition, the disposal sites are not suited for utility workers because of possible disturbance of buried wastes;
- RGOs were estimated for the subsurface soil in order to reduce indoor air VOC levels for future unlimited land use. These are presented in Table 1-9; and
- Given the poor quality of onsite habitat at the Disposal Area and the lack of surface soil COPCs, ecological impacts are expected to be negligible and are not expected to change in the foreseeable future.

1.3.8.3 The Stockpile Area

The potential risks to human health and ecological receptors from exposures to contaminants in impacted media at the Stockpile Area were also evaluated. The key findings from the risk analysis are as follows:

- The COPCs identified for the Stockpile Area included some inorganic chemicals, dieldrin, and PAHs. The inorganic chemicals could be from the minerals stored, or naturally occurring in soils. The PAHs and dieldrin were detected at concentrations similar to those detected elsewhere across the Depot and are not specific to the Stockpile Area. Dieldrin is likely from historical maintenance applications across the Depot. PAHs are thought to be associated with vehicle exhausts, asphalt pavements, and the railroad tracks. Inorganic chemicals are COPCs for subsurface soils, and no organic chemicals were identified as COPCs;
- No significant risks of adverse health impacts exist at the Stockpile Area for maintenance workers from exposure to surface soil;
- No significant risks of adverse health impacts exist at the Stockpile Area for future industrial/commercial workers from exposure to soil;
- The COPC selection for the surrogate site SSLFF indicated that surface soils at the site had aluminum and arsenic exceeding background levels and comparison criteria;
- SSLFF soils do not pose a health threat to future industrial workers outdoors;
- Analysis of SSLFF risk scenario results suggest that site arsenic levels are unacceptable to future hypothetical onsite adult and child residents; however, arsenic levels within this sample location are similar to those detected elsewhere within Shelby County;
- Based on a Weight of Evidence, as well as the poor quality of ecological habitat, current and future ecological impacts are probably negligible.

1.3.8.4 Disposal Sites

Sixteen burial sites were identified at the Disposal Area and in the Stockpile Area and given priority status (Tables 1-2 and 1-6), as described previously. These sites were not investigated during the RI because of unknown hazards and the potential for CWM at Dunn Field. However, they were given qualitative risk evaluations and remedial action objectives to accomplish any future investigation or removal activities.

The Baseline Risk Assessment included a qualitative evaluation of the risks associated with these sites:

- Buried containers of hazardous liquids could leak and discharge to the environment and impact groundwater and any selected groundwater remedy(s)
- Buried containerized hazardous liquids could be accessed through future intrusive activities and cause immediate injury to human health and release to the environment
- Buried hazardous solids/residuals that could leach contaminants to groundwater and/or cause immediate injury to human health if accessed through intrusive activities

1.3.8.5 Groundwater

Potential risks from future groundwater use within Dunn Field were estimated for two separate areas representing organic chemicals that occur as plumes: one plume underlying the Northeast Open Area (Northern Plume) and a second plume underlying the Disposal Area and portions of the Stockpile Area (Western Plume). This plume is further divided into two portions: the Northwest Plume and Southwest plume.

- Groundwater under the site, and offsite near the property boundary in downgradient locations, is contaminated in the shallow aquifer and is unfit for potable use.
- Overall, risks to a future industrial worker or hypothetical resident from exposure to maximum concentrations of onsite groundwater are above the acceptable range of 1 to 100 in a million (10^{-6} to 10^{-4}). Although there is no intent to use groundwater as potable water in the future, any plans for future use would have to be carefully evaluated.
- There are no unacceptable risks or hazards to future onsite workers or residents due to exposure of VOCs volatilizing from subsurface groundwater to indoor air.
- Since contamination has been detected in selected offsite wells, indoor air exposures are the most pertinent exposure pathway. Risks through this pathway to the offsite residents are well within the acceptable limits, presenting negligible risks and HI.
- Although there is no intent to use offsite groundwater as a potable water source, any plans for future use would have to be carefully evaluated. The groundwater contaminant plume, which has crossed the property boundary to the west of Dunn Field, could diminish in concentration with distance and time as a result of the extraction system currently in operation.

1.3.8.6 Summary of Conclusions from Baseline Risk Assessment

The baseline risk assessment conclusions for human health and ecological protection for Dunn Field are as follows:

- **Ecological receptors** are limited at this urban site. Any receptors present are not being threatened based on site contamination conditions and thus do not require protection.
- **Current exposures** from all media are limited to workers in the leased properties. The health risks are negligible to workers doing routine maintenance work such as mowing grass and moving stored materials across the site.
- **Future exposures** from all media to **workers** spending prolonged periods of time in indoors also do not present significant risks ("significant" is defined as risks in excess of 1 in 10,000 or a HI>1.0 for a worker), with the exception of Site E in the Disposal Area due to indoor air exceedances from VOC contaminated soils.
- **Future exposures** from sixteen disposal pits to **workers** presents a health risk due to possible disturbance of buried wastes.
- **Future exposures** from surface soils to **residents** presents a health risk in the Disposal Area, primarily from arsenic, antimony, PAHs, and CVOCs and in the Stockpile Area, due to arsenic. PAHs in sediment at Site 61 likely result from active offsite railroad

tracks. Arsenic is widely distributed and does not correlate with specific locations or sites. Arsenic levels within the SSLFF sample are similar to those detected elsewhere within Shelby County.

- **Future exposure** to the CVOCs in subsurface soil, if buildings were constructed for industrial or residential purposes, would present excessive risks. The highest levels of chlorinated VOCs were detected in soils at about 15-foot depths. These soils also present a threat by functioning as potential sources of continued leaching to groundwater and their impact on indoor air VOC levels.
- The **groundwater** in the fluvial aquifer under Dunn Field is not fit for use as drinking water. The contamination plume under the site extends beyond the site property boundary. The groundwater concentrations are above industrial and residential potable levels, as well as MCLs. There are no groundwater users within the site and none have been identified in the offsite areas.

1.3.9 Chemicals of Concern (COCs)

The COPCs identified in the RI were evaluated in the HHRA for exceedances above target risk criteria. The chemicals that exceeded those criteria (cumulative ELCRs greater than 1 x 10^{-4} and/or HIs greater than 1.0) and require remedial action for the protection of human health are identified as chemicals of concern (COCs) and are further evaluated in this FS. A summary of COCs for Dunn Field is presented in Table 1-10.

- No COCs were identified at the Northeast Open Area in surface media. Lead-contaminated surface soils at Site 60 will be remediated as a non-time critical and documented in a Source Removal Plan, making a majority of the land acceptable for unrestricted use.
- VOCs were identified as COCs in subsurface soil in the Disposal Area for industrial land use during the RI.
- No COCs were identified in the Stockpile Area for industrial land use.
- VOCs, dieldrin, arsenic, iron, and manganese were identified as COCs in onsite and offsite groundwater during the RI. Several rounds of additional monitoring data have been collected since the RI fieldwork. Most of the non-VOC organic and inorganic COCs previously identified were not detected at significant levels or do not have a high frequency of detection. Therefore, the dieldrin, arsenic, iron, and manganese are no longer identified as chemicals requiring further actions. Thus the current COCs are the CVOCs detected in multiple wells at relatively high frequency of detection (>5% FOD) and their degradation products.

1.3.10 Target Levels for Soil and Groundwater

1.3.10.1 Surface Soil

Site 60 had lead as COC from past use as pistol range. The lead has been removed as previously discussed in this section. There are no other COCs identified in surface soil therefore no target levels were developed for surface soil.

1.3.10.2 Subsurface Soil

The subsurface soils, primarily within Disposal Area of Dunn Field, have residual CVOC levels well above the soil-to-groundwater migration based screening levels, and potential vapor intrusion to indoor air under altered land use conditions. The extent of the subsurface soil contamination, that extends vertically to the groundwater in the underlying fluvial aquifer due to leaching over time from the burial pit wastes, affords very little dilution attenuation to the soil CVOCs.

The Exposure Model for Soil-Organic Fate and Transport (EMSOFT) (EPA, 1997) was used to calculate site-specific values of soil concentration that would be protective of groundwater at Dunn Field. The 1-dimensional screening model is based on the work described by Jury et al (1983, 1990) and incorporates volatilization, advective and diffusive transport, sorption, and decay. The model theory, verification, and validation are included in the EMSOFT User's Guide (EPA, 1997). Site-specific values were calculated for the Loess and fluvial deposits and are summarized in Table 1-11 (see Appendix C for the full discussion of the calculation of the site-specific soil cleanup values that would be protective of groundwater at Dunn Field).

1.3.10.3 Groundwater Target Levels

The groundwater in the fluvial aquifer underneath Dunn Field and to the west of Dunn Field has CVOCs above MCLs. In order to reduce the concentrations to levels that are protective of human health, both now and in the future, interim remedial actions have been implemented to date and additional remedial actions are planned for site groundwater. The planned actions aim to reduce the chlorinated solvent levels with time.

The groundwater at Dunn Field has been monitored for over 10 years and based on the data collected to date, most frequently detected chemicals are chlorinated solvents and their degradation products. The contamination plumes are observed to have 4 to 5 parent solvents, likely from past use and subsurface disposal during the former operations at Dunn Field. One possible offsite source, not related Depot operations, has also been previously identified during RI and subsequent investigations. The findings of the HHRA for the chlorinated solvents detected in the groundwater in the fluvial aquifer indicate that concentrations are high enough to make the water unfit for drinking either by industrial workers or residential receptors. The chemicals responsible for this predicted excess risk are mostly CVOCs. Though some organo-chlorine pesticides and metals were initially identified as COCs due to the relatively high toxicity, subsequent monitoring indicated a low frequency of detection of these chemicals in groundwater. Inorganic chemicals are likely associated with the turbidity in groundwater as discussed above. Thus the target groundwater levels are developed only for CVOCs which are the primary COCs, as these are the most frequently detected in widespread areas at relatively higher concentrations above MCLs.

Currently there is no exposure to the contaminated groundwater in the fluvial aquifer at Dunn Field. Thus the focus of this FS is to protect human health from potential future exposures as well as meeting the NCP guidance for protection against maximum beneficial uses of a potable aquifer.

For this FS and remedial action planning, the groundwater MCLs are ARARs for groundwater at Dunn Field, and where there is no MCL, a PRG/RBC can be used as the target level. Since multiple chlorinated solvents were detected in groundwater at the site and in the immediate downgradient area, targeting to meet the MCLs may not be adequately protective of a potentially exposed receptor due to the possibility of cumulative toxicity exceeding the upper-bound limit of the acceptable risk or HI. However, the cumulative risks are dependent on the total number of chemicals present and their individual concentration levels in the groundwater. Depending on the location of the contaminated groundwater underneath Dunn Field, the number of COCs and their levels differ significantly, thus developing a concentration value as a target is difficult and impractical. Therefore, following the EPA guidance for Superfund sites (EPA, 1991 *Full reference: Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions, OSWER Directive 9355.0-30, April 1991*) an upper-bound limit on target cumulative risk level of 1 in 10,000 (1 $X10^{-4}$) and an HI of 1.0 are selected as the **target remedial goals** for the individual plumes within and immediately downgradient of Dunn Field. Thus upon implementation of the remedial actions the residual risks will not exceed these target levels at the receptor points. The individual concentration of each COC within these plumes will be different from contaminated area to area; however, they will be within MCL levels and combined concentration levels will not exceed a cumulative upper-bound target risk of 1 in 10,000 (1 $X10^{-4}$) and HI of 1.0 in any given plume

A preliminary list of quantitative target risk based concentration levels were developed using the COCs, which are the CVOCs most frequently (>10% in 70+ samples) detected in all the rounds of sampling, including the latest data (see Table 1-12a). These calculated target concentrations assume that all the chemicals are present in each of the plumes, thus represents a conservative assumption for setting a target level. However, these levels will be revisited during the evaluation of remedial action groundwater monitoring to ensure target risk levels are met. Some of the individual chemical concentrations can be higher or lower depending on proportion of the cumulative risk each COC presents in that particular plume at that that time, while meeting target risk level.

Tables 1-12a and 1-12b present the COCs in groundwater and their respective target concentration levels based on cumulative target risk level of 1 in a million (10^{-6}) and 1 in 10,000 (10^{-4}). The proposed concentration levels in this target level table are likely to change, although target risk levels will remain the primary goal during ground water remediation. Any newer chemicals not identified as a COC in these tables will be added to the list if they are detected at a future time. These target levels (see Table 1-12b) are calculated by dividing the MCL with the concentration at a desired cumulative target risk level (similar to an RBC/PRG) from multiple chemical remains within the acceptable levels, while the target concentration remain below an MCL.

Target Concentration Level = MCL X Target Risk / Risk at MCL

Or

Target risk = Target MCL* 10-6 (TG for PRG)/PRG

Risks from individual target concentrations are added to obtain cumulative risk as included in Table 1-12b. As stated earlier, these individual chemical concentration levels will likely change with the number of chemicals present in a plume, while target risk level (e.g. 1×10^{-4}) will remain fixed.

1.4 Presumptive Remedy for Subsurface Soils

1.4.1 Introduction to the Presumptive Remedy Approach

Presumptive remedies are "preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation" (EPA, 1993). These technologies have been selected as the preferred remedy based on data analyses of similar types of sites conducted by EPA. Through this evaluation, it has been determined that certain remedies have been consistently selected as the appropriate remedy and other alternatives are typically screened out based on effectiveness, implementability, excessive costs, and the nine detailed criteria. The use of presumptive remedies are recommended by EPA because they allow the FS process to be streamlined by bypassing the technology identification and screening steps, potentially saving time and money.

The presumptive remedies for VOC-contaminated soils at CERCLA sites are soil vapor extraction (SVE), thermal desorption, and incineration. SVE is the preferred presumptive remedy. This selection is based on ROD and FS analyses conducted by the EPA. In the ROD analysis, 88 RODs were identified where VOCs were the driving force in the remedy selection to determine the frequency of technology selection. Of these, the three presumptive remedies were selected over 90 percent of the time. Further, SVE was chosen in over two-thirds of the RODs. The FS analysis was conducted on 21 VOC-contaminated soil/sludge sites in order to document the technology-screening step and identify the principal reasons for elimination of other technologies. The three presumptive remedies were selected the majority of the time.

The following reports document the FS and ROD analyses, and use of presumptive remedies for VOC-contaminated soils by EPA. They will be included as part of the administrative record as support for the selection of the presumptive remedy approach at Dunn Field.

- EPA. November 1991. *A Guide to Principal Threat and Low Level Threat Wastes.* Superfund Publication 9380.0-06FS.
- EPA. September 1993 *Presumptive Remedies: Policies and Procedures.* EPA Publication 540/F-93/047.
- EPA. September 1993. *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soils.* EPA Publication 540/F-93/048.
- EPA. August 1994. *Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soil.* EPA Publication 540/F-94/080.
- EPA. July 1996. *User's Guide to the VOCs in Soils Presumptive Remedy.* EPA Publication 540/F-96/008.

1.4.2 Determination to Use the Presumptive Remedy Approach for VOC-Contaminated Subsurface Soils

The following steps were taken in order to determine the feasibility of applying the presumptive remedy to subsurface soils at Dunn Field. Following these steps is not mandatory by the EPA but will hasten the clean-up process. They are presented to justify the selection of SVE as the proposed remedy for VOC-contaminated subsurface soils at Dunn Field. The SVE alternative will be described and analyzed in detail in Section 6.

1) *Are VOCs present in the Soil?*
   Yes. VOCs present within Dunn Field that are COCs include 1,1,2,2-PCA, 1,1,2-TCA, 1,2-DCA, carbon tetrachloride, chloroform, methylene chloride, PCE, total 1,2-DCE, TCE and vinyl chloride.

2) *Are non-VOC contaminants present that preclude the use of presumptive remedies?*
   No. However, select remedial actions will need to be conducted at the disposal sites prior to implementation of SVE.

3) *Initiate early community, state, and lead agency involvement.*
   TDEC, EPA and DLA have been involved since project initiation. The community has been informed of the SVE presumptive remedy approach. A presentation was made to the Restoration Advisory Board (RAB) in August 2001.

4) *Review advantages/limitations of the presumptive remedies.*
   Advantages and limitations for SVE, as presented in Table 3 of Appendix B, have been reviewed. In addition, the technology limiting factors are discussed in Appendix C.

5) *Conduct site characterization*
   The fieldwork for the Dunn Field RI was completed in 2001. The Dunn Field RI report was finalized in July 2002. In addition, a soil vapor extraction (SVE) pilot test was conducted in late 2001 and early 2002.

6) *Identify potential ARARs.*
   ARARs have been identified and presented in Section 2.

7) *Conduct time-critical removal action.*
   No time-critical removal actions are required.

8) *Is there a threat posed by the site?*
   Yes. Contaminated soil in the vadose zone poses a threat to human health and/or environment and acts as a source term for future groundwater contamination. A risk assessment for Dunn Field was conducted in the Dunn Field RI Report (CH2M HILL, July 2002).

9) *Proceed with technology assessment and review "Practical Considerations" section.*
   The "Practical Considerations" section was reviewed to ensure a comprehensive evaluation of alternatives.

10) *Does the Pilot/Treatability Study indicate that SVE is Feasible?*
   SVE is a process, which physically removes contaminants from vadose zone soils by inducing air flow through the soil. A pilot/treatability study was conducted during

January 2002 in a suspected source area on Dunn Field and provided information suggesting in-situ SVE as a presumptive remedy is acceptable. This information is provided in Appendix C.

11) *Is thermal desorption feasible?*
The vadose zone within Dunn Field extends to a depth of approximately 75 to 80 feet below ground surface and is contaminated throughout the entire soil column within each suspected source area. Thermal desorption is an ex-situ process that uses direct or indirect heat exchange to vaporize organic contaminants from the soil and thus requires soil excavation (EPA 1993). The quantities of soil for excavation and depth of contamination within the soil column would cause the process of thermal desorption to be infeasible.

12) *Is incineration feasible?*
Incineration like thermal desorption is also an ex-situ process and requires soil excavation. Therefore, incineration is also not feasible.

13) *Select remedy for remedial/removal action.*
Based on the selection criteria established by the EPA (1993), SVE is a feasible process for vadose zone soil remediation and is to be considered the presumptive remedy for Dunn Field subsurface soils with VOCs.

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Tables

TABLE 1-1
Dunn Field Area Descriptions
Rev. 0 Memphis Depot Dunn Field FS

	Name	Environmental Media Addressed	Anticipated Land Use	Description
1	Northeast Open Area	Surface and Subsurface Soil, Sediment, Surface Water	*The Memphis Depot Redevelopment Plan* (The Pathfinders et al , 1997) identified this area as future public open space for recreational purposes.	Approximately 20 acres of land located in the northeast quadrant of Dunn Field. This area is mostly grass covered, interspersed with lightly wooded areas, that contains Areas G and H identified in the OU1 FSP Addendum, as well as Site 21 (XXCC-3 Burial Site), Site 50 (Dunn Field Northeast Quadrant Drainage Ditch), and Site 60 (Pistol Range Impact Area and Bullet Stop). A former incinerator, which was located south of the former pistol range, was detected in the review of the 1957 and 1958 aerial photographs.
2	Disposal Area	Surface and Subsurface Soil, Sediment, Surface Water	The anticipated land use within this area is light industrial (The Pathfinders et al., 1997).	Approximately 14 acres of open land located in the northwest quadrant of Dunn Field. This area corresponds to Areas A through F identified in the OU 1 FSP Addendum. The past disposal methods within the Disposal Area were subsurface disposal of hazardous and non-hazardous materials, including CWM Site 1 (Mustard and Lewisite Training Set Burial Site) and 24-A (Former Bomb Casing Burial Site).
3	Stockpile Area	Surface and Subsurface Soil	As with the Disposal Area, the anticipated land use within this area is light industrial (The Pathfinders et al., 1997).	Approximately 30 acres of open land located in the southeastern and southwestern portions of Dunn Field; contained aboveground bauxite and fluorspar storage areas: Sites 62, 63, and 64. Past practices in this area were generally aboveground storage of mineral ores and other materials. Site 24-B, which is the chlorinated lime slurry pit used for the neutralization of the contents of the bomb casings buried in Site 24-A, is located in the southwestern corner of Dunn Field. The Archives Search Report (USACE, January 1995) states that a former flamethrower test area is located on the eastern half of Dunn Field in the northern portion of the Stockpile Area, and burial trench with 86,100 pounds of CC-2 (impregnite) in the southwest quadrant of Dunn Field.

Note: Groundwater data from the onsite (beneath the 3 areas referenced above) and offsite groundwater wells are also presented and discussed in this RI report.

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TABLE 1-2
List of Dunn Field (OU 1) Sites
Rev 1 Memphis Depot Dunn Field FS

INSTALLATION RESTORATION SITES NUMBER	DSERTS SITE NUMBER(a)	PRIORITY LEVEL(b)	SITE TYPE	SITE DESCRIPTION
Northeast Open Area				
19	19	C	SS	Former Tear Gas Canister Burn Site [(c)]
20	20	C	SS	Probable Asphalt Burial Site
21	21	C	SS	XXCC-3 Impregnite Burial Site (300,000 Pounds)
50	50	C	SS	Dunn Field Northeastern Quadrant Drainage Ditch
60	60	RA Planned[1]	SS	Pistol Range Impact Area/Bullet Stop
62	62	C	SS	Bauxite Storage
85	85	RA Planned[1]	RI	Old Pistol Range Building 1184/Temporary Pesticide Storage
Disposal Area				
1	1	Remediated[2]	CWM	Mustard and Lewisite Training Sets Burial Site (1955)
2	2	C	RI	Ammonia Hydroxide (7 Pounds) and Acetic Acid (1-Gallon) Burial Site (1955)
3	3	B	RI	Mixed Chemical Burial Site (Orthotouidine Dihydrochloride) (1955)
4	4	A	RI	POL Burial Site (13, 55-Gallon Drums of Oil, Grease and Paint)
4 1	90	A	RI	POL Burial Site (32, 55-Gallon Drums of Oil, Grease and Thinner)
5	5	C	RI	Methyl Bromide Burial Site A (3 Cubic Feet) (1955)
6	6	C	RI	40,037 Units of Eye Ointment Burial Site (1955)
7	7	A	RI	Nitric Acid Burial Site (1,700 Quart Bottles) (1954)
8	8	A	RI	Methyl Bromide Burial Site B (3,768 1-gallon cans) (1954)
9	9	C	RI	Ashes and Metal Burial Site (Burning Pit Refuse) (1955)
10	10	B	RI	Solid Waste Burial Site (Near MW-10) (Metal, Glass, Trash, etc)
11	11	B	RI	Trichloroacetic Acid Burial Site (1,433, 1-ounce Bottles) (1965)
12 & 12 1	12	B	RI	Sulfuric Acid and Hydrochloric Acid Burial (1967)
13	13	A	RI	Mixed Chemical Burial (Acid, 900 Pounds, Unnamed Solids, 8,100 Pounds)
14	14	C	RI	Municipal Waste Burial Site B (Near MW-12) (Food, Paper Products)
15	15	B	RI	Sodium Burial Sites (1968)
15 1	91	B	RI	Sodium Phosphate Burial (1968)
15 2	92	B	RI	14 Burial Pits Na2PO4, Sodium, Acid, Medical Supplies, and Chlorinated Lime
16	16	B	RI	Unknown Acid Burial Site (1969)
16 1	93	B	RI	Acid Burial Site
17	17	B	RI	Mixed Chemical Burial Site C (1969)
18	18	C	Proposed NFA	Plane Crash Residue
22	22	C	Proposed NFA	Hardware Burial Site (Nuts and Bolts)
23	23	C	Proposed NFA	Construction Debris and Food Burial Site
24-A	24	Remediated[2]	CWM	Bomb Casing Burial Site (29 Bomb Casings used to Transport Mustard Agent)
61	61	C	SS	Buried Drain Pipe
63	63	C	Proposed NFA	Aboveground Fluorspar Storage
64	64	C	Proposed NFA	Aboveground Bauxite Storage (1942 to 1972)
86	86	C	RI	Food Supplies
Stockpile Area [(d)]				
24-B	24	Remediated[2]	CWM	Neutralization Pit for the Contents of the 29 Bomb Casing used to Transport Mustard Agent
62	62	C	SS	Aboveground Bauxite Storage
63	63	C	Proposed NFA	Aboveground Fluorspar Storage
64	64	C	SS	Aboveground Bauxite Storage (1949 to 1972)
–	--	B	--	CC-2 Impregnite Burial Site (86,100 Pounds in 1947)

Notes

[1] See EE/CA and Action Memorandum for Site 60/85 Removal planned for early 2003

[2] CWM remedial actions at sites are documented in the Final Chemical Warfare Material Investigation/Removal Action Report, dated December 2001

SS	Screening Site
RI	Remedial Investigation
RA.	Remedial Action
NFA.	No Further Action
CWM	Chemical Warfare Material
Na2PO4	Sodium Phosphate
POL	Petroleum, Oil, and Lubricants
XXCC-3/CC-2	Stabilized/Unstabilized Impregnite for Impregnating Clothing Used to Protect Personnel against the Action of Vesicant-Type Chemical Agents

(a) Defense Site Environmental Restoration Tracking System (DoD Database)

(b) Priority levels were established for Installation Restoration Sites Number/DSERT Site Number Areas where remedial action will be required with some investigatory effort to determine extent of area Levels are as follows A - Highest Priority B - Medium Priority, C - Lowest Priority (no RA likely) Designation is based on described quantity of material potential hazard to human health and the environment, and form of material (solid or liquid)

(c) According to the available information, burning in this area dated back to the 1940s and included chloroacetophenone (CN) canisters, fuses, and smokes in addition to sanitary wastes Operations were conducted in pits and incorporated the weekly cleanup of residue and garbage in addition to material The ash was then allegedly buried in the north end of Dunn Field

(d) According to available information, USATHAMA (1982) Installation Assessment Site 31 is located in the southwest portion of Dunn Field This site was reportedly used for burning/disposal of smoke pots, CN (tear gas) grenades and souvenir ordnance, which included a 3.2 mortar round This area was covered by the bauxite storage pile (Site 64) Installation Site 31 was not designated as an IRP site or given a DSERTS site number

TABLE 1-3
Dunn Field Study Area Geologic Strata
Rev 1 Memphis Depot Dunn Field FS

System	Series	Group	Stratigraphic Unit	Thickness (feet)[b]	Lithology and Hydrologic Significance
Quaternary	Holocene and Pleistocene		Alluvium[a]	0 to 175	Sand, gravel, silt, and clay. Underlies the Mississippi Alluvial Plain and alluvial plains of streams in the Gulf Coastal Plain. Thickest beneath the alluvial plain, where commonly between 100 and 150 ft thick: generally less than 50 ft thick elsewhere. Provides water to domestic, farm, industrial, and irrigation wells in the Mississippi Alluvial Plain.
	Pleistocene		Loess	0 to 65	Silt, silty clay, and minor sand. Principal unit at the surface in upland areas of the Gulf Coastal Plain. Thickest on the bluffs that border the Mississippi Alluvial Plain; thinner eastward from the bluffs. Tends to retard downward movement of water, thus providing recharge to the fluvial deposits.
Quaternary And Tertiary (?)	Pleistocene and Pliocene (?)		Fluvial Deposits (terrace deposits)	0 to 100	Sand, gravel, minor clay, and ferruginous sandstone. Generally underlie the loess in upland areas, but are locally absent. Thickness varies greatly because of erosional surfaces at top and base. Provide water to many domestic and farm wells in rural areas
Tertiary		Claiborne	Jackson Formation and upper part of Claiborne Group; includes Cockfield and Cook Mountain Formations (Capping Clay)	0 to 360	Clay, silt, sand, and lignite. Because of similarities in lithology, the Jackson Formation and upper part of the Claiborne Group cannot be reliably subdivided based on available information. Most of the preserved sequence is the Cockfield and Cook Mountain formations undivided, but locally the Cockfield may be overlain by the Jackson Formation. Serves as the upper confining bed for the Memphis Sand.
	Eocene		Memphis Sand ("500-Foot" sand)	500 to 890	Sand, clay, and minor lignite. Thick body of sand with lenses of clay at various stratigraphic horizons and minor lignite Thickest in the southwestern part of the Memphis area, thinnest in the Northeastern part. Principal aquifer providing water for municipal and industrial supplies east of the Mississippi River; sole source of water for the City of Memphis.

TABLE 1-3
Dunn Field Study Area Geologic Strata
Rev 1 Memphis Depot Dunn Field FS

System	Series	Group	Stratigraphic Unit	Thickness (feet)[b]	Lithology and Hydrologic Significance
			Flour Island Formation	160 to 310	Clay, silt, sand, and lignite. Consists primarily of silty clays and sandy silts with lenses and interbeds of fine sand and lignites. Serves as the lower confining bed for the Memphis Sand and the upper confining bed for the Fort Pillow sand.
	Paleocene	Wilcox	Fort Pillow Formation ("1,400-Foot" Sand)	125 to 305	Sand with minor clay and lignite. Sand is fine to medium. Thickest in the southwestern part of the Memphis Area; thinnest in the northern and northeastern parts. Once the second principal aquifer supplying the City of Memphis; still used by an industry. Principal aquifer providing water for municipal and industrial supplies west of the Mississippi River.
			Old Breastworks Formation	180 to 350	Clay, silt, sand, and lignite. Consists primarily of silty clays and clayey silts with lenses and interbeds of fine sand and lignite. Serves as the lower confining bed for the Fort Pillow Sand, along with the underlying Porters Creek Clay and Clanton Formation of the Midway Group.

[a]Alluvium is shown here in the conventional position as the youngest stratigraphic unit Actually, it almost nowhere overlies the loess but may overlie any of the older stratigraphic units
[b]Note. this is the thickness of the unit--not the depth below grade
Source. Modified from Graham and Parks, 1986
? = Age not verified

TABLE 1-4
Site Consolidation and Rationale in Northeast Open Area
Rev 0 Memphis Depot Dunn Field FS

Consolidated Location ID	Historical Site Designation	Rationale for Consolidation
Location G-Asphalt Burial Site and Tear Gas Canister Burn Area	19, 20	PCE soil gas plume encompasses these sites and the incinerator disposal area identified by TEC aerial photographs. Low-level soil gas implies surface soil contamination. PCE contamination is west of Site 50 and may not be associated with the drainage ditch.
Location H-Perimeter TCE	50	TCE and PCE soil gas plume encompasses the end of the drainage ditch. Low-level soil gas implies possible surface soil contamination.
Sites not consolidated	21, 60, 62, 85	Sites are isolated and not associated with soil gas VOC detections or geophysical anomalies.

TABLE 1-5
Site Consolidation within the Disposal Area
Rev. 0 Memphis Depot Dunn Field FS

Consolidated Location ID	Historical Site Designation	Rationale for Consolidation and Sampling
Location A- Asphalt Pad	23, 24-A (CWM), 63	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches
Location B- Debris Site	22, 23	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches.
Location C- South Burial Site	12, 12.1, 14	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches.
Location D- North Burial Site	13, 15, 15.1, 15.2, 16, 16 1, 17	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches.
Location E- Site 10 Area	7, 8, 10	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches.
Location F- POL Waste Sites	1 (CWM), 2, 3, 4, 4.1, 5, 6, 9, 11, 18, 86	TCE, CCL4, 1,2-DCE, and PCE soil gas plume encompasses these sites. Soil gas survey implies VOCs in the disposal pits and trenches.
Site 61- Stormwater Culvert	61	Discharge area evaluated for the presence of contaminates associated with Dunn Field historical activities.

TABLE 1-6
Burial Pit Descriptions and History
Rev. 0 Memphis Depot Dunn Field FS

IRP Site Number	Site Description and History
Disposal Area	
3	This site is estimated to be approximately 30 feet long and 10 feet wide. It reportedly contains about 3,000 quarts of various chemicals, plus 5 cubic feet of orthotoludine dihydrochloride buried in 1955. As a result, toxicity potential is unknown based on the description of "various chemicals".
4	This site is a trench containing approximately 13 drums of oil, grease, and paint thinner that were disposed of in the mid-1950's These materials are considered to be both potentially toxic and highly mobile. Since the drums were placed 50 years ago, they may have corroded and may no longer be intact.
4.1	This site is similar to Site 4, except that it contains approximately 32 drums of oil, grease, or thinners that were disposed of in the mid-1950's. These materials are considered to be both potentially toxic and highly mobile. Since the drums were placed 50 years ago, they may have corroded and may no longer be intact.
7	This site is a trench containing approximately 1,700 quart bottles of nitric acid from 1954. Nitric acid is considered to have low toxicity, but could cause a low pH in the area, or mobilize metals, or both.
8	This site is an excavation containing approximately 3,768 cans of methyl bromide (bromomethane) from 1954. The hazard is similar to that of Site 5, but the quantity is significantly greater and that makes this a higher priority site. The disposal excavation is estimated to be approximately 45 feet by 45 feet at the surface and the reported burial depth is 7 feet. (It should noted, that no bromomethane was detected in the surface soil or subsurface soil on Dunn Field where tested during the RI [>250 samples]. Bromomethane was detected in 5 monitoring wells [MW-13, -69, -70, -76 & -77] in 2001 at low estimated concentrations ranging from 0.2J ug/L to 0.6J ug/L. No bromomethane was detected in the recovery wells. Bromomethane was not detected in groundwater samples prior to 2001 [a total of >500 groundwater samples]. There is no federal or state drinking water standard for bromomethane in groundwater.)
10	This a solid waste burial site approximately 100 feet long and 50 feet wide containing metal, cans, ash, broken glass, and other similar material last used in 1955 Information indicates the waste was located in a zone from 3.5 to 10 feet below the ground surface Materials descriptions suggest that the burial site contains little organic matter. The site is not expected to contain hazardous materials, but the actual contents of the buried material is unknown.
11	This site is an excavation containing 11 gallons of the herbicide trichlororacetic acid in 1,433 1-ounce bottles buried in 1965 This is a reportedly unstable chemical, with a transient influence on pH and with low toxicity.
12/12.1	These sites consists of 3 trenches containing a total of 30 pallets of sulfuric and hydrochloric acid buried in 1967. These below-grade materials are not expected to be extremely toxic, but could affect the pH in the local area and cause metals to become more mobile.
13	This site contains approximately 32 cubic yards of mixed chemicals, acid and detergents, plus approximately 8,100 pounds of solids. The area is estimated at approximately 35 feet wide by 50 feet long, approximately 8 feet deep.
15/15.1/ 15.2	These sites comprise an area approximately 100 feet long and 20 feet wide containing 14 discrete trenches with sodium salt, sodium phosphate, chlorinated lime, acid wastes, and various medical supplies buried in 1968. The disposal area is estimated at approximately 8 feet deep. Sodium salts and lime materials are typically not considered to be hazardous materials, however, the contents are not clearly identified.

TABLE 1-6
Burial Pit Descriptions and History
Rev. 0 Memphis Depot Dunn Field FS

IRP Site Number	Site Description and History
16/16.1	These site are disposal areas containing unknown acid materials. Records indicate disposal of just one pallet of an unknown acid. Depending upon the quantity, this acid could adversely affect the local pH and groundwater.
17	This site is a 20-foot by 30-foot area containing an unknown quantity of herbicides, medical supplies, and cleaning compounds buried in . The depth of the disposal trench is estimated at 8 feet.
Stockpile Area	
-	This site is documented as containing 86,100 pounds of CC-2 (impregnite) buried in a 6- to 8-foot deep, 8-foot wide, and 40-foot long trench in the west-southwest portion of the Stockpile Area.

IRP Installation Restoration Site

TABLE 1-7
Risk Assessment Summary for Dunn Field
Rev 1 Memphis Depot Dunn Field FS

Exposure Receptors	Total ELCR	Total HI	Above Target ELCR 1x10^{-4} or HI 1	COPCs[a]
Northeast Open Area				
Maintenance Worker	6E-07	0 004	No	N/A
Industnal Worker[b]	5E-05	0.04	No	As, dieldrin, 1,1,2,2-PCA, 1,1-DCE, 1,2-DCA, chloroform, CCl4, PCE, TCE
Utility Worker	7E-07	0 005	No	N/A
Recreational Adult	2E-06	0 01	No	dieldrin
Recreational Child	2E-06	0.1	No	dieldrin
Recreational Youth	1E-06	0 02	No	N/A
Offsite Residential	3E-08	0 00002	No	N/A
Northeast Open Area - Sites 60/85				
Industrial Worker[b]	3E-03	5	**Yes**	As, dieldrin, 1,1,2,2-PCA, 1,1-DCE, chloroform, CCl4, PCE, TCE
Residential Adult[b]	1E-02	15	**Yes**	As, dieldrin, heptachlor epoxide, 1,1,2,2-PCA, 1,1-DCE, 1,2-DCA, chloroform, CCl4, PCE, TCE
Residential Child[b]	N/A	35 1	**Yes**	As, dieldrin, 1,1,2,2-PCA, 1,1-DCE, 1,2-DCA, chloroform, CCl4, PCE, TCE
Disposal Area				
Maintenance Worker	4E-06	0 008	No	PAHs
Industrial Worker	6E-05	0 3	No	As, PAHs, dieldrin, 1,1,2,2-Tetrachloroethane, VCl, TCE
Utility Worker	8E-07	0 002	No	N/A
Offsite Residential	4E-06	0 02	No	1,1,2,2-Tetrachloroethane
Disposal Area - Site 61LE				
Industrial Worker	8E-05	0.3	No	As, BaP, TCE, 1,1,2,2-Tetrachloroethane,VCl
Utility Worker	6E-06	0 01	No	TCE, 1,1,2,2-Tetrachloroethane,VCl
Residential Adult	3E-04	2	**Yes**	PAHs, As, Sb, TCE, 1,1,2,2-Tetrachloroethane,VCl
Residential Child	N/A	14	**Yes**	PAHS, Antimony, Arsenic
Offsite Residential	9E-07	0 005	No	N/A
Stockpile Area				
Maintenance Worker	1E-06	0 009	No	Arsenic*, benzo(a)pyrene*
Industrial Worker	7E-06	0 05	No	Arsenic, benzo(a)pyrene
Utility Worker	4E-07	0 005	No	N/A
Stockpile Area - SSLFF Soil				
Industrial Worker	8 E-06	0 06	No	Arsenic
Residential Adult	6 E-05	0.2	No	Arsenic
Residential Child	N/A	2	**Yes**	Arsenic
Groundwater - Onsite Plumes				
<u>North Plume</u>				
Industrial Worker	1 E-04	0 88	No	As, dieldrin, PCA1122, DCA12, DCE11, CCl4, PCE, Chloroform, TCE
Residential Adult	5 E-04	2 5	**Yes**	As, dieldrin, PCA1122, TCA112, DCE11, DCA12, Bromodichloromethane, CCl4, Chloroform, PCE, TCE
Residential Child	N/A	5 7	**Yes**	TCE, Manganese

TABLE 1-7
Risk Assessment Summary for Dunn Field
Rev. 1 Memphis Depot Dunn Field FS

Exposure Receptors	Total ELCR	Total HI	Above Target ELCR 1x10^{-4} or HI 1	COPCs[a]
Northwest Plume				
Industrial Worker	3 E-03	5 3	Yes	As, PCA1122, TCA112, DCE11, DCA12, DCP12, Benzene, CCl4, Chloroform, PCE, TCE, VC
Residential Adult	1 E-02	15	Yes	As, PCA1122, TCA112, DCE11, DCA12, DCP12, Benzene, CCl4, Chloroform, PCE, TCE, VC
Residential Child	N/A	34	Yes	TCE
Southwest Plume				
Industrial Worker	3 E-04	1 6	Yes	As, PCA1122, TCA112, CCl4, Chloroform, PCE, TCE
Residential Adult	1 E-03	4 6	Yes	As, PCA1122, TCA112, Bromodichloromethane, CCl4, Chloroform, PCE, TCE
Residential Child	N/A	11	Yes	CCl4, Chloroform, TCE
Groundwater - Offsite Plumes				
MW30				
Residential Adult	5 E-05	0 81	No	As
Residential Child	N/A	1.9	Yes	As
MW31				
Residential Adult	8 E-04	3.1	Yes	Chlorinated solvents
Residential Child	N/A	7 2	Yes	Chlorinated solvents
MW32				
Residential Adult	2.E-03	5	Yes	Chlorinated solvents
Residential Child	N/A	12	Yes	Chlorinated solvents
MW33				
Residential Adult	2.E-04	1 4	Yes	Chlorinated solvents
Residential Child	N/A	3 2	Yes	Chlorinated solvents
MW40				
Residential Adult	3 E-05	0 35	No	1,1-Dichloroethene
Residential Child	N/A	0 83	No	
MW44				
Residential Adult	2.E-04	2 2	Yes	As, Chlorinated solvents
Residential Child	N/A	5 2	Yes	As, Fe, Chlorinated solvents
MW54				
Residential Adult	1.E-04	1 2	Yes	Chlorinated solvents
Residential Child	N/A	2 8	Yes	Chlorinated solvents
MW51				
Residential Adult	2.E-04	0 42	Yes	Chlorinated solvents
Residential Child	N/A	0 97	No	As, Chlorinated solvents
MW71				
Residential Adult	2 E-03	5	Yes	Chlorinated solvents
Residential Child	N/A	12	Yes	Chlorinated solvents
MW76/77				
Residential Adult	1 E-02	9 3	Yes	Chlorinated solvents
Residential Child	N/A	22	Yes	Chlorinated solvents
MW79				
Residential Adult	5 E-04	0 36	Yes	Chlorinated solvents
Residential Child	N/A	0 83	No	Chlorinated solvents

TABLE 1-7
Risk Assessment Summary for Dunn Field
Rev 1 Memphis Depot Dunn Field FS

Exposure Receptors	Total ELCR	Total HI	Above Target ELCR $1x10^{-4}$ or HI 1	COPCs[a]

[a] COPCs are the chemicals contributing to risks at or above 1 in a million, and/or to HI at or above 1.0.

[b] Risk calculations include risk from groundwater media through ingestion, dermal, and inhalation exposure routes.

ELCR = Estimated Lifetime Cancer Risk
HI = Hazard Indices
COPCs= Chemicals of Potential Concern
As = Arsenic
CCl4 = Carbon Tetrachloride
PAHs = Polyaromatic hydrocarbons
PCE = Tetrachloroethane
TCE = Trichloroethene
1,1-DCE = 1,1-Dichloroethene
1,2-DCE = 1,2-Dichloroethane
1,1,2,2-PCA = 1,1,2,2-Tetrachloroethane

Table 1-8a
Summary of Risks and Hazards at Disposal Area
Rev 1 Memphis Depot Dunn Field FS

Exposure Route/Receptors	Ingestion	Dermal	Inhalation	Total ELCR	Ingestion	Dermal	Inhalation	Total HI	COPCs
Industrial Worker									
Surface Water	6 E-09	8 E-06	N/A	**8E-06**	0 0007	0 0004	N/A	**0.001**	PAHs
Sediment	3 E-06	1 E-06	N/A	**5E-06**	0 005	0 0005	N/A	**0.005**	BaP
Surface Soil	7 E-06	2 E-06	2 E-07	**9E-06**	0 05	0 006	0 0002	**0.06**	Arsenic, BaP, dieldrin
Soil Column - Ambient Air	N/A	N/A	3 E-05	**4E-05**	N/A	N/A	0 2	**0.3**	1,1,2,2-Tetrachloroethane, Vinyl chloride, TCE
Total Risks & Hazards (combined from all pathways) [1]				***6E-05***				***0.3***	***As, PAHs, dieldrin, 1,1,2,2-Tetrachloroethane, VCl, TCE***
Soil Column - Indoor Air	N/A	N/A	8 E-04	**8E-04**	N/A	N/A	4	**4**	1,1,2,2-Tetrachloroethane,1,1,2-TCA, TCE, VCl, CCl4
Maintenance Worker									
Surface Water	2.E-09	2.E-06	N/A	**2E-06**	0.0002	0 00009	N/A	**0.0003**	PAHs
Sediment	8 E-07	3 E-07	N/A	**1E-06**	0 001	0 0001	N/A	**0.001**	N/A
Surface Soil	7.E-07	4 E-07	2 E-08	**1E-06**	0 005	0 001	0 00003	**0.006**	N/A
Total Risks & Hazards (combined from all pathways)				***4E-06***				***0.008***	***PAHs***
Utility Worker									
Soil Column	4 E-07	3 E-07	5 E-08	**8E-07**	0 004	0 001	0 002	**0.007**	N/A
Soil Column - Ambient Air	N/A	N/A	3 E-08	**8E-07**	N/A	N/A	0 0002	**0.005**	N/A
Total Risks & Hazards (combined from all pathways)				***8E-07***				***0.002***	***N/A***
Offsite Residential									
Soil Column - Ambient Air	N/A	N/A	4 E-06	**4E-06**	N/A	N/A	0 02	**0.02**	1,1,2,2-Tetrachloroethane
Total Risks & Hazards (combined from all pathways)				***4E-06***				***0.02***	***1,1,2,2-Tetrachloroethane***

Note
1 = Industrial Worker Soil Column risks (6E-06) were not included in Total Risks & Hazards because they were less than Surface Soil risks (9E-06)
Indoor Air is also not included in this summary

Where:
- As Arsenic
- BaP Benzo(a)pyrene
- CCl4 Carbon tetrachloride
- PAHs Polyaromatic hydrocarbons
- 1,1,2-TCA 1,1,2-Trichloroethane
- TCE Trichloroethane
- VCl Vinyl chloride

Table 1-8b

Summary of Risks and Hazards from all Media at Disposal Area Surrogate Site 61LE1

Rev 1 Memphis Depot Dunn Field FS

Exposure Route/Receptors	Carcinogenic Risks				Noncarcinogenic Hazard Index				COPCs
	Ingestion	Dermal	Inhalation	Total ELCR	Ingestion	Dermal	Inhalation	Total HI	
Industrial Worker (Outdoor) [2]									
Surface Media									
Surface Soil	2 E-05	9 E-06	4 E-08	3E-05	0 5	0 04	NA	0 6	PAH, AS, SB
Groundwater									
North Plume (Avg VOCs)	8 E-05	3 E-08	3 E-05	1E-04	0 84	7 01E-04	0 040	0 88	AS, PCA, DCA12, DCE11, CTCL, PCE, TCLME, TCE
Total Risks & Hazards (all media & with ambient air)				***1E-04***				***1.4***	*AS, SB, PAH, PCA, TCE, DCA12, DCE11, CTCL, PCE, TCLME*
Industrial Worker (Indoor) [1]									
Indoor Air									
Soil-to-Indoor Air			7 E-05	7 E-05			5 0	5 0	PCA, TCE, VC, TOT12DCE
Groundwater (Potable Use)									
North Plume (Avg VOCs)	8 E-05	3 E-08	3 E-05	1E-04	0 84	7 01E-04	0 040	0 88	AS, PCA, DCA12, DCE11, CTCL, PCE, TCLME, TCE
Total Risks & Hazards (combined from all pathways)				**2E-04**				**6**	*AS, PCA, DCA12, DCE11, CTCL, PCE, TCLME, TCE, VC, TOT12DCE*
Utility Worker									
Surface Media									
Surface Soil	2 E-06	3 E-06	4 E-09	5E-06	0 05	0 01	0	0 06	AS, BaP
Total Risks & Hazards (all media & with ambient air)				***2E-06***				***0 01***	*AS, BaP*
Residential Child (Onsite)									
Surface Media									
Surface Soil	N/A	N/A	N/A	NA	13	0 2	NA	14	PAH, AS, SB
Groundwater									
North Plume (Avg VOCs)	NA	NA	N/A	NA	5 5	0 011	0.26	5 7	
Indoor Air									
Soil-to-Indoor Air	NA	NA	N/A	NA			75	75	TOT12DCE
Total Risks & Hazards (combined from all pathways)				***NA***				***94***	*PAH, AS, SB, TOT12DCE*
Residential Adult (Onsite)									
Surface Media									
Surface Soil	2 E-04	6 E-06	2 E-08	2E-04	1	0 02	NA	1	PAH, AS, SB
Groundwater									
North Plume (Ave VOCs)	4 E-04	4 E-07	1 E-04	5E-04	2 3	0 0073	0 11	2 5	AS, PCA, DCA12, DCE11, CTCL, PCE, TCLME, TCE
Indoor Air									
Soil-to-Indoor Air			5 E-04	5E-04			21	21	PCA, 112TCA, PCE, TCE, VC, TOT12DCE
Total Risks & Hazards (with average ambient air)				***1E-03***				***25***	*PAH, AS, SB, PCA, TCE, DCA12, DCE11, CTCL, PCE, TCLME, TOT12DCE, 112TCA, VC*

Note

1 = Indoor air risks from subsurface volatilization from soils is found in Table 11-18A

2 = Worker is assumed to spend all time outdoors

COPCs are the chemicals contributing to risks at or above 1 in a million, and/or to HI at or above 1 0

Where

As	Arsenic	TCLME	Chloroform
BaP	Benzo(a)pyrene	TOT12DCE	Total-1,2-Dichloroethene
CTCL	Carbon tetrachloride	VC	Vinyl Chloride
12DCA	1,2-Dichloroethane	11DCE	1,1-Dichloroethene
PAH	Polyaromatic hydrocarbons	PCE	Tetrachloroethene
SB	Antimony		
112TCA	1,1,2-Trichloroethane		
TCE	Trichloroethane		

Table 1-9
Remedial Goal Options for Disposal Area Subsurface Soils
Rev 1 Memphis Depot Dunn Field FS

Chemical	Carcinogenic Effects						Noncarcinogenic Effects					
	Industrial worker			Residential Adult			Industrial worker			Residential Adult		
	TR = 1E-06	TR = 1E-05	TR = 1E-04	TR = 1E-06	TR = 1E-05	TR = 1E-04	THI =0 1	THI =1	THI =10	THI =0 1	THI =1	THI =10
Pesticides												
Dieldrin	0 271	2 71	27 1	0 035	0 350	3 50	7 7	77	773	2 8	28	280
Metals												
Arsenic	3 40	34 046	340	0 405	4 047	40 472	55	549	5487	20	197	1971
Semivolatiles												
Benzo(a)anthracene	5 16	51 6	516	0 714	7 14	71 4						
Benzo(a)pyrene	0 468	4 68	46 8	0 068	0 676	6 76						
Benzo(b)fluoranthene	5 16	51 6	516	0 714	7 14	71 4						
Carbazole	233	2327	23272	29 0	290	2903						
Chrysene	516	5162	51625	71 4	714	7136						
Dibenz(a,h)anthracene	0 516	5 16	51 6	0 071	0 714	7 14						
Indeno(1,2,3-c,d)pyrene	5 16	51 6	516	0 714	7 14	71 4						
Volatiles												
1,1,2,2-Tetrachloroethane	1 07	10 7	107	0 420	4 20	42 0						
1,1,2-Trichloroethane	1 82	18 2	182	0 752	7 52	75 2	802	8017	80169	287	2866	28664
1,2-Dichloroethane	0 682	6 82	68 2	0 287	2 87	28 7	3 1	31	313	2 5	25	245
Carbon tetrachloride	0 623	6 23	62 3	0 260	2 60	26 0	0 67	6 7	67	0 52	5 2	52
Tetrachloroethene	17 2	172	1720	5 14	51 4	514	222	2222	22216	154	1537	15366
Trichloroethene	8 55	85 5	855	3 54	35 4	354	1108	11077	110770	398	3978	39783
Vinyl chloride	0 043	0 432	4 32	0 018	0 180	1 80						

Note. All units are mg/kg

Formulas

Age-adjusted Carcinogenic calculation (ADULT only)

RBC = <u>TR x ATc</u>
(mg/kg) EF x (A+B+C)

Where·
Ac = (SFo x IRing_adj x FI x CF)
Bc = (SFd x SA_adj x AF x ABS x CF)
Cc = (SFi x IRinh_adj x ((1/VF)+(1/PEF)))

Carcinogenic calculation (INDUSTRIAL WORKER only)

RBC = <u>TR x BW x ATc</u>
(mg/kg) ED x (A+B+C)

Where·
Ac = (SFo x IRing x FI x CF)
Bc = (SFd x SA x AF x ABS x CF)
Cc = (SFi x IRinh x ((1/VF)+(1/PEF)))

Noncarcinogenic calculation (ALL RECEPTORS)

RBC = <u>THI x BW x ATnc</u>
(mg/kg) EF x ED x (A+B+C)

An = ((1/RfDo) x IRing x FI x CF)
Bn = ((1/RfDd) x SA x AF x ABS x CF)
Cn = ((1/RfDi) x IRinh x ((1/VF)+(1/PEF)))

Note

RBC	Risk Based Concentration	EF	Exposure Frequency	RfDo	Reference Dose-oral
TR	Target Risk	FI	Fraction Ingested	SA	Skin Surface Area
ABS	Absorbance Factor	IRING	Intake Rate-Ingestion	SA_adj	Skin Surface Area, Age-adjusted
AF	Soil-to-Skin Adherence Factor	IRing_adj	Intake Rate-Ingestion, Age-adjusted	SFd	Slope Factor-dermal
ATc	Averaging Time-Carcinogens	IRinh	Intake Rate-Inhalation	SFi	Slope Factor-ingestion
ATnc	Averaging Time-Noncarcinogens	IRinh_adj	Intake Rate-Inhalation, Age-adjusted	SFo	Slope Factor-oral
BW	Weight	PEF	Particulate Emmision Factor	THI	Target Hazard Index
CF	Conversion Factor	RfDd	Reference Dose-dermal	VF	Volatilization Factor
ED	Exposure Duration	RfDi	Reference Dose-Inhalation		

Table 1-10
Selection of COCs from COPCs Identified During Risk Assessment for Various Functional Units and Surrogate Sites at Dunn Field
Rev 0 Memphis Depot Dunn Field FS

Functional Unit	COPCs	Max. Lead (Pb) Conc. (mg/kg)	Above target $>10^{-4}$, >1.0 - Maintenance	Above target $>10^{-4}$, >1.0 - Industrial	Above target $>10^{-4}$, >1.0 - Onsite Residential	Above target $>10^{-4}$, >1.0- Offsite Residential	Above target $>10^{-4}$, >1.0 - Recreational	Is Lead Above Ind Target?	COCs* Industrial Worker	Comment	COCs Residential Scenario	Comment
Surface and Subsurface Soil												
Northeast Open Area	Dieldrin, Lead	2100	NO	NO	NA	NO	NO	YES	Lead	Lead in surface soil is above industrial health protective level of 1536 mg/kg. The cumulative risks were less than 10^{-4} level to an industrial worker. Therefore no other COCs identified.	NA	NA
Surrogate Site 6085	Dieldrin, Lead	2100	NA	NO	NO	NA	NA	YES	Lead		Lead	The EE/CA for the Site 60 identified a removal action for the lead in surface soil.
Disposal Area	Arsenic, CVOCs, Dieldrin, PAHs	1020	NO	YES	NA	NO	NA	NO	CVOCs	Subsurface CVOCs could be an acceptable risk if site is built over with new office buildings.	NA	NA
Surrogate Site 61LE	Antimony Arsenic, CVOCs, Dieldrin, PAHs	211	NA	YES	YES	NO	NA	NO	CVOCs		PAHs, Antimony, Arsenic, CVOCs	The cumulative risks were greater than 10^{-4} and 1.0 levels to a hypothetical resident at the surrogate site. Therefore, residential COCs are identified.
Stockpile Area	Arsenic, Benzo(a)pyrene (a PAH)	Below background	NO	NO	NA	NA	NA	NO	None	None of the chemicals exceeded the acceptable risk criteria for workers	NA	NA
Surrogate Site SSLFF	Arsenic	Below background	NA	NO	YES	NA	NA	NO	None		Arsenic	The cumulative risks were greater than 1.0 levels to a hypothetical resident at the surrogate site due to arsenic. The arsenic levels within this surrogate sites are similar to those detected elsewhere within Shelby County, as reported in the Background Sampling Program Report (CH2M HILL, May 1998). Thus the observed risks are similar to those from background.
Groundwater Plumes (Average Concentration) - Onsite & Offsite												
North Plume (Onsite)	Arsenic, Dieldrin, CVOCs, Manganese	–	NA	NO	YES	NA	NA	–	None	None of the chemicals exceeded the acceptable risk criteria for workers	Arsenic, Dieldrin, CVOCs, Manganese	The risks are from the ingestion, dermal contact and inhalation of groundwater from the fluvial aquifer. Currently, there are no residential users of the groundwater from the fluvial aquifer
Northwest Plume (Onsite)	Arsenic, Benzene, CVOCs	–	NA	YES	YES	NA	NA	–	Arsenic, Benzene, CVOCs	The risk are from the ingestion, dermal contact and inhalation of groundwater from the fluvial aquifer. Currently, there are no residential users of the groundwater from the fluvial aquifer	Arsenic, Benzene, CVOCs	
Southwest Plume (Onsite)	Arsenic, CVOCs	–	NA	YES	YES	NA	NA	–	Arsenic, CVOCs		Arsenic, CVOCs	
Offsite Plume	Arsenic, CVOCs, Iron	–	NA	NA	NA	YES	NA	–	NA	NA	Arsenic, CVOCs, Iron	The risks are from the ingestion, dermal contact and inhalation of groundwater from the fluvial aquifer. Currently, there are no residential users of the groundwater from the fluvial aquifer. The risks from groundwater to indoor air are acceptable

Note:
Target Values estimated for lead are 1,536 mg/kg for industrial worker and 400 mg/kg for a residential child health protection
CVOCs = chlorinated volatile organic compounds
NA = not analyzed

579 56

Table 1-11
Summary of Site Specific SSLs to be Protective of Groundwater
Rev 1 Memphis Depot Dunn Field FS

							Generic SSL Calculated from EPA Guidance[c, e]		Site-Specific Calculated SSLs to be Protective of Groundwater	
Parameter	Protective Groundwater Criteria[a] (mg/L)	Target Soil Leachate Concentration[b] (mg/L)	Disposal Area Concentrations (mg/kg) Max	Mean	Detects	% Detects	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)
Carbon Tetrachloride	0 005	0 0305	6 8	0 52	16/155	10%	0 0476	0 0164	0 2150	0 1086
Chloroform	0 079	0 4819	14	0 94	37/154	24%	0 2267	0 0603	0 9170	0 4860
Dichloroethane, 1,2-	0 005	0 0305	0 046	0 016	5/155	3%	0 0091	0 0023	0 0329	0 0189
Dichloroethene, 1,1	0 007	0 0427	0 06	0 014	8/155	5%	0 0312	0 0160	0 1500	0 0764
Dichloroethene, cis-1,2-	0 070	0 4270	0 132	0 013	40/49	82%	0 1890	0 0534	0 7550	0 4040
Dichloroethene,1,2-trans-	0 100	0 6100	0 044	0 0054	22/49	76%	0 3608	0 1202	1 5200	0 7910
Methylene chloride	0 005	0 0305	0 039	0 0071	20/155	13%	0 0081	0 0025	0 0305	0 0169
Tetrachloroethane, 1,1,2,2-	0 0005	0 0031	160	6 18	56/155	36%	0 0025	0 0004	0 0112	0 0066
Tetrachloroethene	0 005	0 0305	4 4	0 16	56/155	36%	0 0415	0 0120	0 1806	0 0920
Trichloroethane, 1,1,2-	0 005	0 0305	2 2	0 18	25/155	16%	0 0161	0 0033	0 0627	0 0355
Trichloroethene	0 005	0 0305	460	7 89	92/155	59%	0 0424	0 0098	0 1820	0 0932
Vinyl chloride	0 002	0 0122	7 0	0 64	15/155	10%	0 0055	0 0042	0 0294	0 0150

[a] Protective groundwater criteria assumed to be MCL for all compounds except 1,1,2,2-Tetrachloroethane, in which the laboratory reporting limit was used The MCL for Chloroform is 99% of the MCL for Total Trihalomethanes, which is 0 08 mg/L, based on Dunn Field groundwater concentration

[b] Target Soil Leachate Concentration = protective groundwater criteria times a DAF of 6 1

[c] SSL Calculated from Equation 10 in SSL Guidance (EPA, 1996)

[d] Soil Vapor concentration is in equilibrium with EMSOFT calculated SSL

[e] Does not account for thickness of layers or that Loess exists on top of Fluvial Deposits

SSL = Soil Screening Level
MCL = Maximum Contaminant Level
DAF = Dilution Attenuation Factor

Table 1-12a

Selection of COCs for Groundwater at Dunn Field - Most Frequently Detected Chemicals and Exceedence of MCLs/PRGs

Rev 1 Memphis Depot Dunn Field FS

Chemical of Concern	Units	Maximum Contaminant Level (MCL)-Primary Drinking Water Standard	Risk/HI at MCL	USEPA Region 9 PRGs-Tap Water (October 1, 2002)	Risk/HI at RBCs	Average Conc.	All-time Max Conc.	Frequency of Detections	Risk/HI at Average	Risk/HI at Max
Carbon Tetrachloride	ug/L	5	2 9E-05	0 17	1.0E-06	17 7	44.4	21%	1 0E-04	2 6E-04
Chloroform	ug/L	80	1 3E-05	6 2	1 0E-06	117	857	33%	1 9E-05	1 4E-04
1,1-Dichloroethene**	ug/L	7	0.02	340	NC, HI=1 0	23 3	39 5	15%	0 07	0 1
Trans 1,2-Dichloroethene	ug/L	100	0.83	120	NC, HI=1.0	8.2	54 0	26%	0 07	0 5
Cis 1,2-Dichloroethene	ug/L	70	1 1	61	NC, HI=1.0	28 8	250	25%	0.47	4 1
1,1,2,2-Tetrachloroethane	ug/L	NA	NA	0 055	1 0E-06	2000	33000	26%	3 6E-02	6 0E-01
Tetrachloroethene	ug/L	5	7.6E-06	0 66	1 0E-06	19 5	120	29%	3 0E-05	1 8E-04
1,1,2-Trichloroethane	ug/L	5	2.6E-05	0 19	1.0E-06	4 2	9.5	8%	2 2E-05	5 0E-05
Trichloroethene***	ug/L	5	8 9E-06	0 56	1 0E-06	254	3170	55%	4 5E-04	5 7E-03
Total Risk/HI			**8.5E-05**		**6.0E-06**				**3.7E-02**	**6.1E-01**

ug/L = micrograms per liter

DL = Detection Limit

TCL = Target Compound List

BDL = Below Detection Limit

MCL = Maximum Contaminant Level - Primary Drinking Water Standards

RBCs = Risk Based Contaminants

NS = no standard NP = not performed

NA = not available

** - 1,1-dichlorethene has recently been reclassified by EPA as a non-carcinogen, however existing MCL is based on previous assumption that it is a carcinogen EPA is likely to revise this MCL

*** - For Trichloroethene, a slope factor of 0 02 $(mg/kg\text{-}day)^{-1}$ from the range of 0 02 to 0 4 $(mg/kg\text{-}day)^{-1}$

Table 1-12b
Target Risk Based Concentration Levels for COCs Detected in Groundwater at Dunn Field
Rev 1 Memphis Depot Dunn Field FS

		Maximum Contaminant Level (MCL)-Primary Drinking Water Standard	Risk/HI at MCL	USEPA Region 9 PRGs-Tap Water (October 1, 2002)	Risk/HI at RBCs	Target Concentrations at 10^{-6} target risk levels and Target HI=1.0			Target Concentrations at 10^{-4} target risk levels and Target HI=1.0			
						Target MCL	Risk at Target	HI at Target	Target MCL	Risk at Target	HI at Target	Target Organ
Chemical of Concern	Units											
Carbon Tetrachloride	ug/L	5	2 9E-05	0 17	1 0E-06	**0 03**	2 0E-07	NA	**3 0**	1 8E-05	NA	
Chloroform	ug/L	80	1 3E-05	6 2	1 0E-06	**0.62**	1 0E-07	NA	**12**	2 0E-06	NA	
1,1-Dichloroethene**	ug/L	7	0 02	340	NC, HI=1 0	**112 2**	NA	0 33	**7/340****	NA	**1.00**	Liver
Trans 1,2-Dichloroethene	ug/L	100	0 83	120	NC, HI=1 0	**39 6**	NA	0 33	**50**	NA	**0 42**	Blood
Cis 1,2-Dichloroethene	ug/L	70	1 1	61	NC, HI=1 0	**20 1**	NA	0 33	**35**	NA	**0 57**	Blood
1,1,2,2-Tetrachloroethane	ug/L	NA	NA	0 055	1 0E-06	**0.011**	2 0E-07	NA	**2.20**	4 0E-05	NA	
Tetrachloroethene	ug/L	5	7 6E-06	0 66	1 0E-06	**0 132**	2 0E-07	NA	**2 5**	3 8E-06	NA	
1,1,2-Trichloroethane	ug/L	5	2 6E-05	0 19	1 0E-06	**0 019**	1 0E-07	NA	**1 9**	1 0E-05	NA	
Trichloroethene***	ug/L	5	8 9E-06	0 56	1 0E-06	**0 1120**	2 0E-07	NA	**5 0**	8 9E-06	NA	
Total Risk/HI			**8.5E-05**		**6.0E-06**		**1.0E-06**	**0.99**		**8.2E-05**	**<=1**	

ug/L = micrograms per liter
DL = Detection Limit
TCL = Target Compound List
BDL = Below Detection Limit
MCL = Maximum Contaminant Level - Primary Drinking Water Standards
RBCs = Risk Based Contaminants
NS = no standard NP = not performed
NA = not available
** - 1,1-dichlorethene has recently been reclassified by EPA as a non-carcinogen, however, existing MCL is based on previous assumption that it is a carcinogen EPA is likely to revise this MCL
*** - For Trichloroethene, a slope factor of 0 02 $(mg/kg\text{-}day)^{-1}$ from the range of 0 02 to 0 4 $(mg/kg\text{-}day)^{-1}$

Figures

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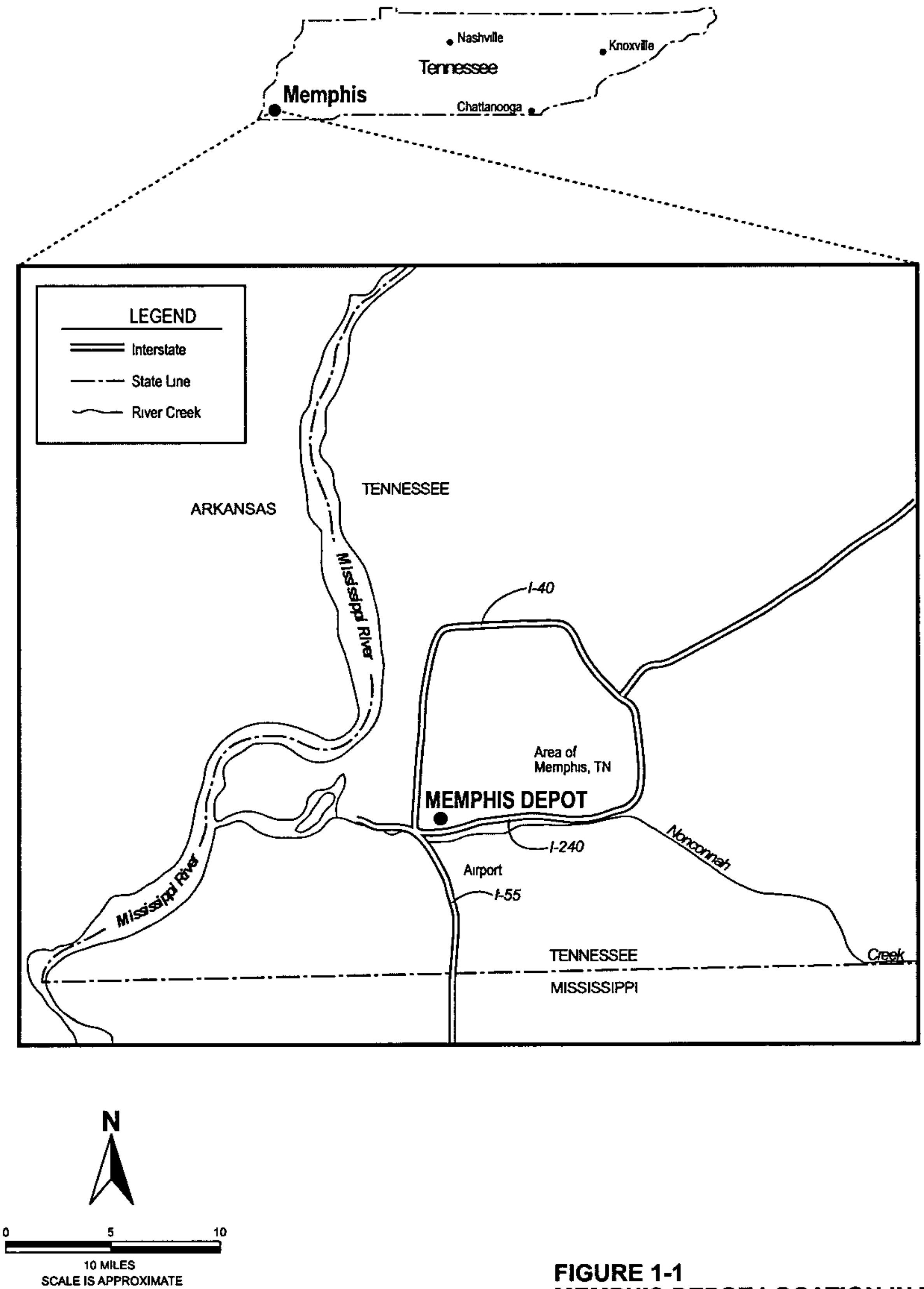

FIGURE 1-1
MEMPHIS DEPOT LOCATION IN THE MEMPHIS METROPOLITAN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD FS

E082002008ATL \ Dunn128 FH8

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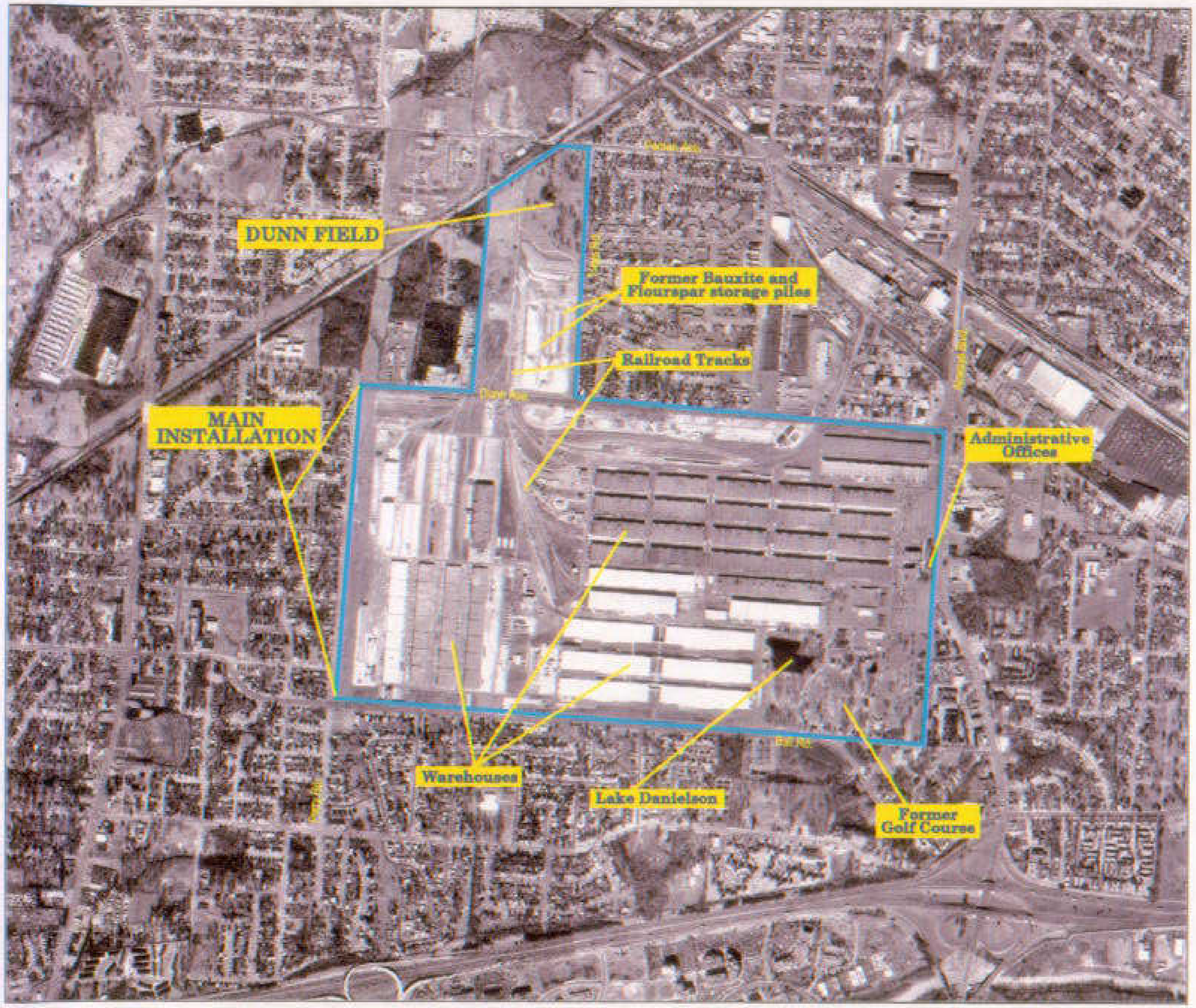

FIGURE 1-2
MAJOR FEATURES OF THE DEPOT (Aerial Photo Date: 1997)
Rev. 0 MEMPHIS DEPOT DUNN FIELD FS

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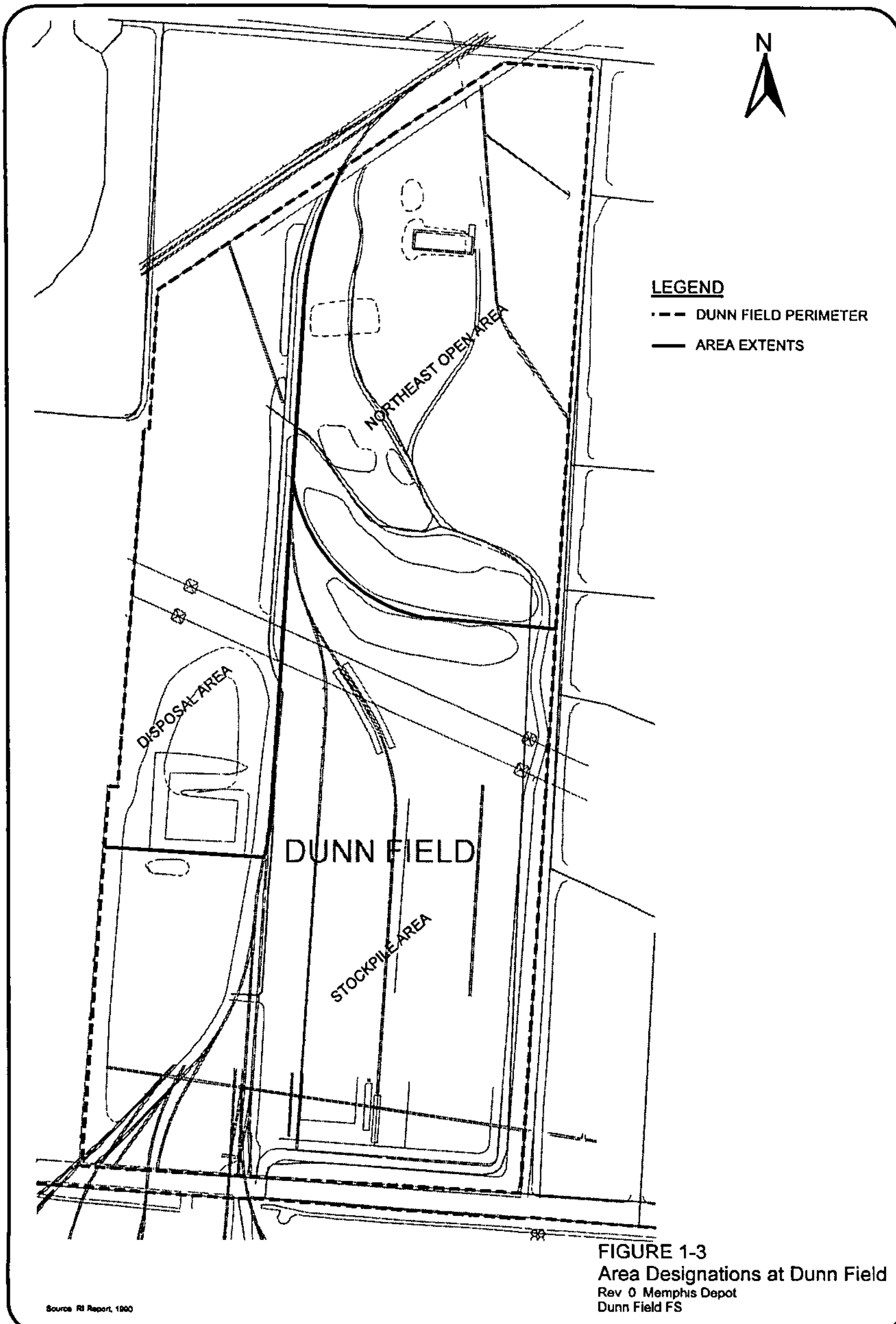

FIGURE 1-3
Area Designations at Dunn Field
Rev 0 Memphis Depot
Dunn Field FS

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ATL/CAD1/PROJECTS/148071 DDMT/DunnField FS 2002/8071DFRI01-1-3.dgn

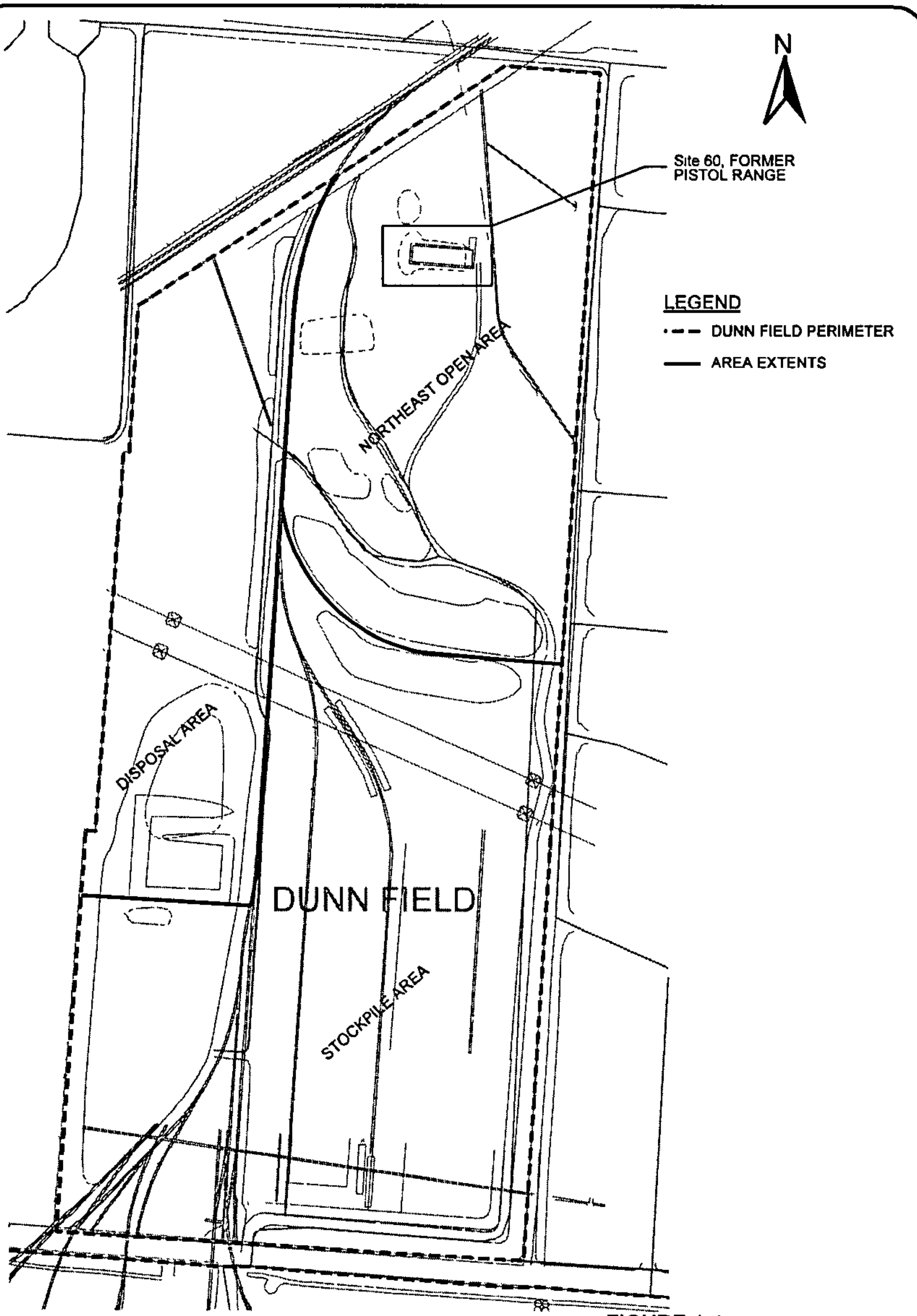

FIGURE 1-4
Site 60, Former Pistol Range
Rev 0 Memphis Depot Dunn Field FS

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ATL/CAD1/PROJECTS/148071 DDMT/Dunn Field FS 2002/FIGURE 1-4

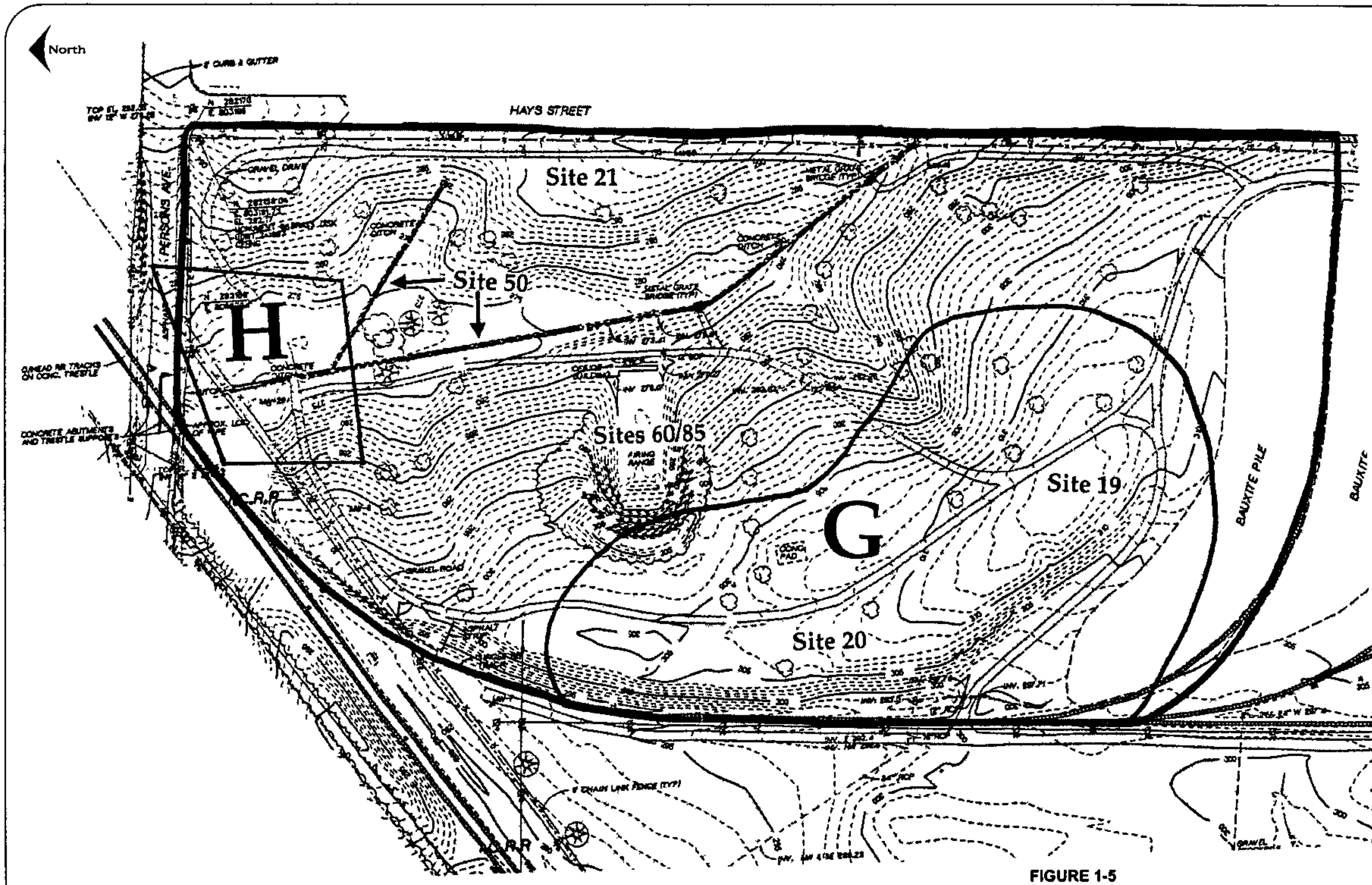

FIGURE 1-5
NORTHEAST OPEN AREA OF DUNN FIELD TOPOGRAPHY, CONSOLIDATIONS LOCATIONS G AND H, AND HISTORICAL SITES 10, 20, 21, 50, 60 & 85
REV 0 MEMPHIS DEPOT DUNN FIELD FS

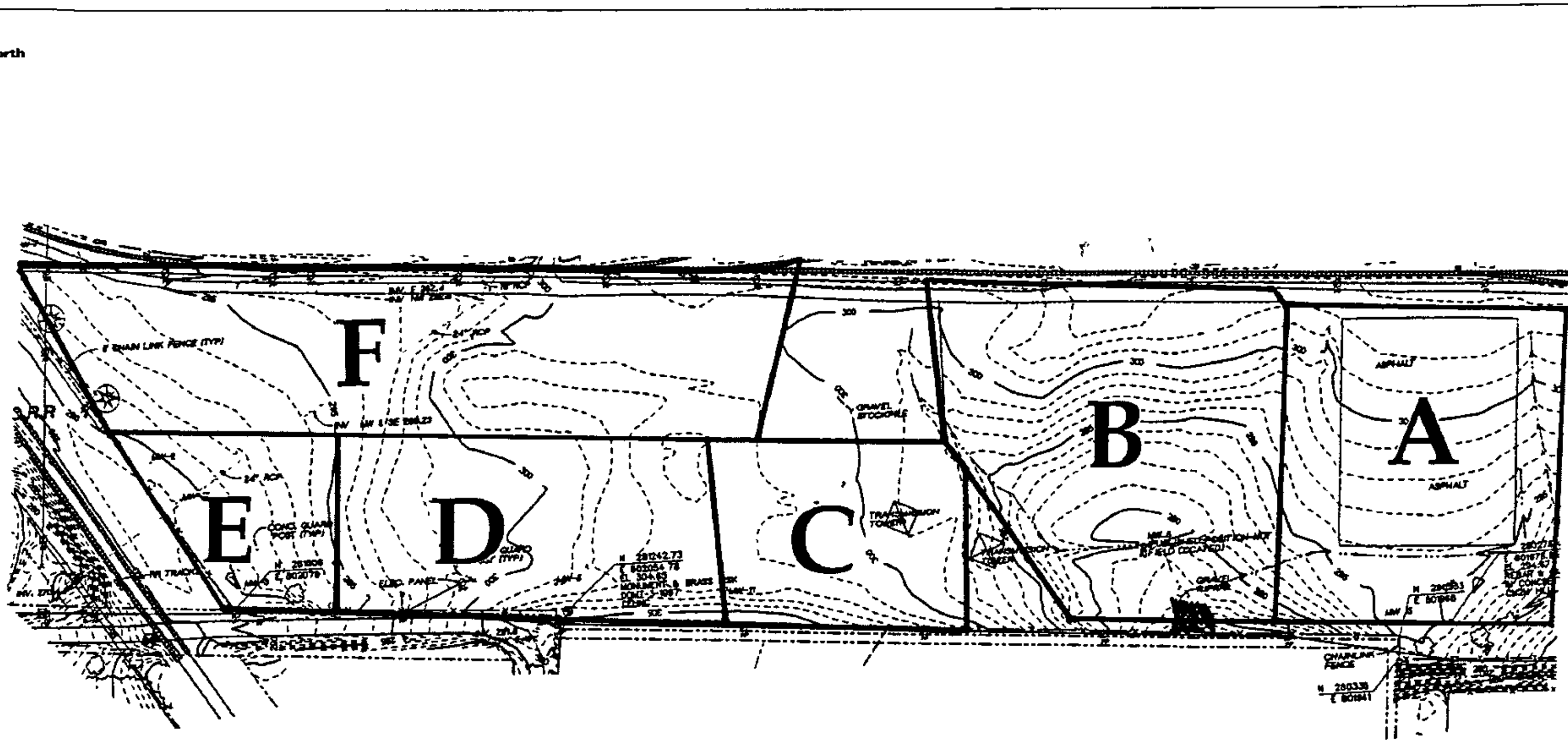

FIGURE 1-6
DUNN FIELD DISPOSAL AREA
CONSOLIDATED LOCATION MAP
REV 0 MEMPHIS DEPOT DUNN FIELD FS

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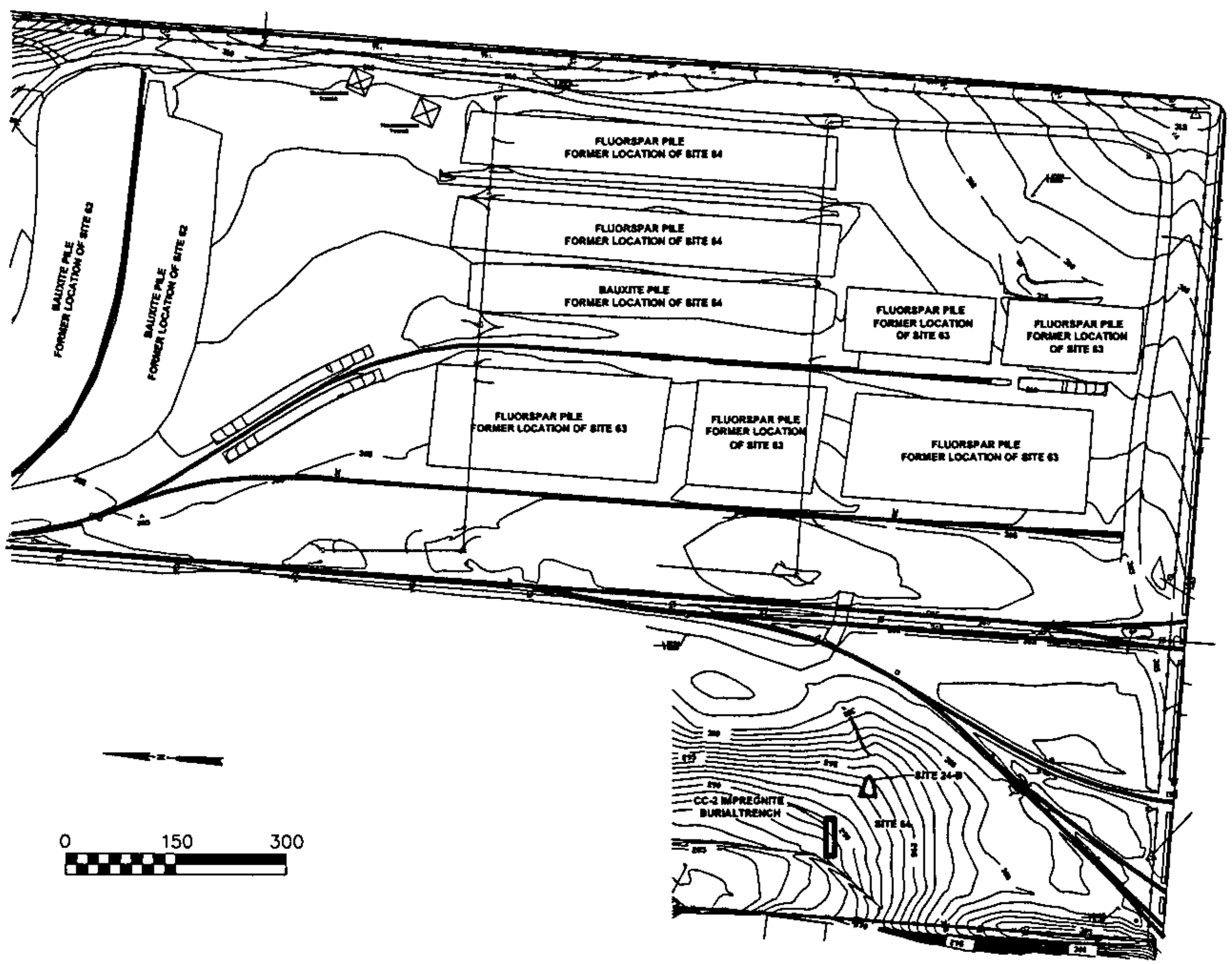

FIGURE 1-7
DUNN FIELD STOCKPILE AREA TOPOGRAPHY AND LOCATIONS OF FORMER MINERAL STOCKPILES
REV 0 MEMPHIS DEPOT DUNN FIELD FS

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ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD FS 2002

Well ID	Water Level Elevation (feet MSL)
MW03	221.08
MW04	224.84
MW06	224.00
MW07	226.71
MW08	226.86
MW09	226.43
MW10	223.13
MW11	222.69
MW12	224.11
MW13	224.81
MW14	227.22
MW15	224.46
MW16	241.44
MW18	175.20
MW19	200.92
MW20	199.30
MW21	189.86
MW22	200.33
MW23	189.57
MW24	180.82
MW26	205.05
MW27	DRY
MW28	223.86
MW29	233.02
MW30	228.56
MW31	218.34
MW32	221.47
MW33	224.13
MW34	196.89
MW35	223.34
MW36	191.83
MW37	181.12
MW38	189.27
MW39	191.69
MW40	171.06
MW41	217.86
MW42	217.70
MW43	182.79
MW44	212.97
MW45	226.66
MW46	222.50
MW47	223.86
MW48	230.86
MW50	213.31
MW51	224.82
MW52	197.23
MW53	220.87
MW54	213.80
MW55	221.06
MW56	223.51
MW57	224.87
MW58	226.29
MW59	223.82
MW60	224.18
MW61	224.73
MW62	186.71
MW63	197.48

Well ID	Water Level Elevation (feet MSL)
MW64	196.83
MW65	262.68
MW67	151.59
MW68	221.79
MW69	222.44
MW70	223.38
MW71	222.43
MW72	206.01
MW73	223.47
MW74	223.36
MW75	222.50
MW76	217.34
MW77	222.43
MW78	228.11
MW79	212.93
MW80	212.84
MW81	184.57
MW82	181.50
MW83	187.48
MW84	228.48
MW85	204.16
MW86	208.08
MW87	223.73
MW88	224.17
MW89	183.57
MW90	183.94
MW91	223.73
MW92	207.93
MW93	191.83
MW94	189.57
MW95	228.82
MW96	206.00
MW97	196.19
MW98	192.43
MW99	196.73
MW100	196.21
MW101	198.36
MW102	200.68
MW103	221.02
MW104	222.73
MW107	190.49
MW108	189.88
F201	202.74
F202	241.91
F203	191.47
F204	202.96
F205	196.64
F206	229.03
F207	205.74
F208	204.86
RW04	223.38
RW06	230.82
RW08	219.34
RW09	221.89
SS105	DRY
SS106	DRY

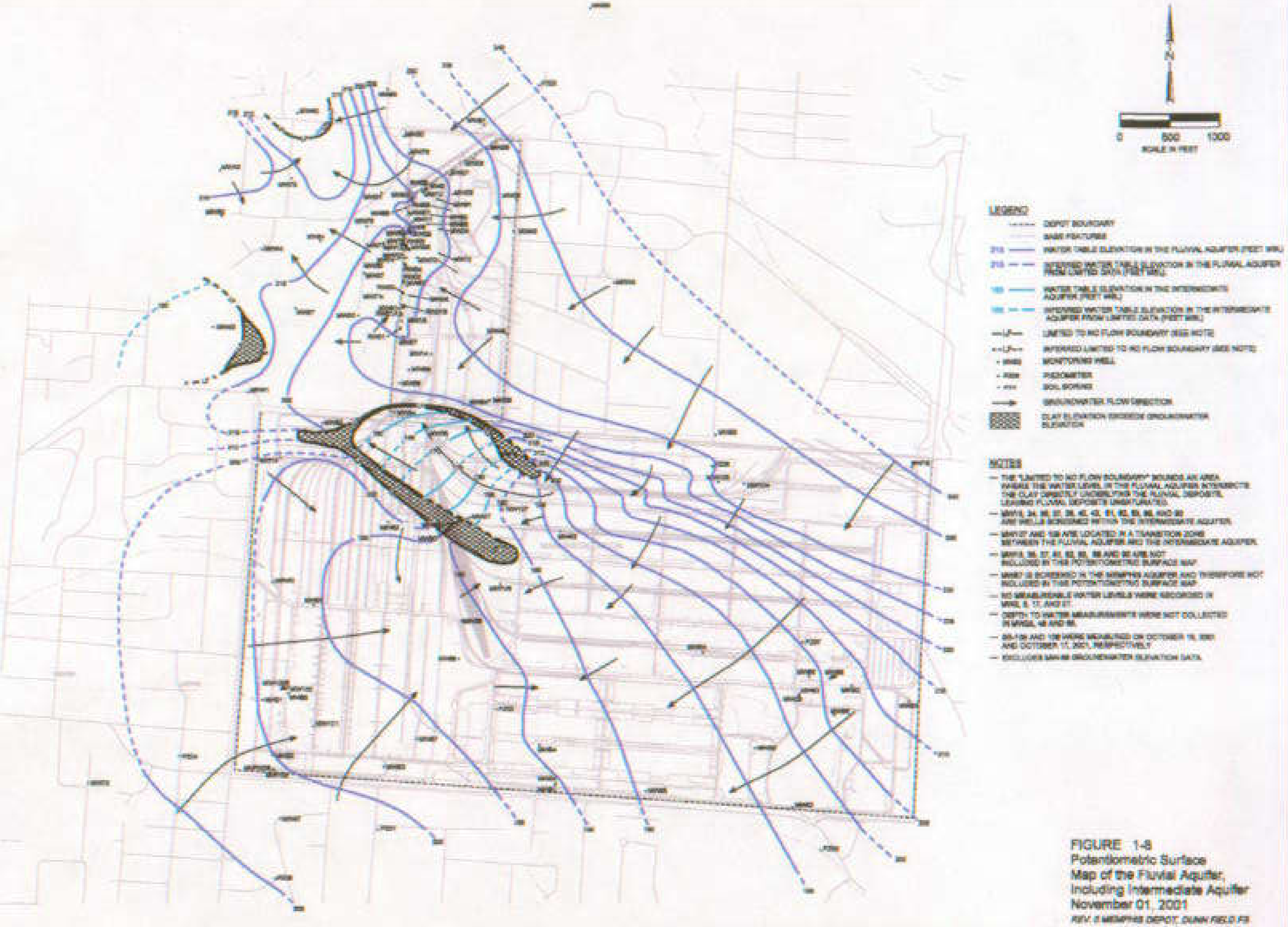

FIGURE 1-8
Potentiometric Surface
Map of the Fluvial Aquifer,
Including Intermediate Aquifer
November 01, 2001

REV. 0 MEMPHIS DEPOT, DUNN FIELD FS

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FIGURE 1-9a
Groundwater Tetrachloroethene (PCE) Concentrations
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

FIGURE 1-9b
Groundwater Trichloroethene (TCE) Concentrations
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

FIGURE 1-9c
Groundwater 1,2 - Dichloroethene (Total) (1,2 - DCE) Concentrations

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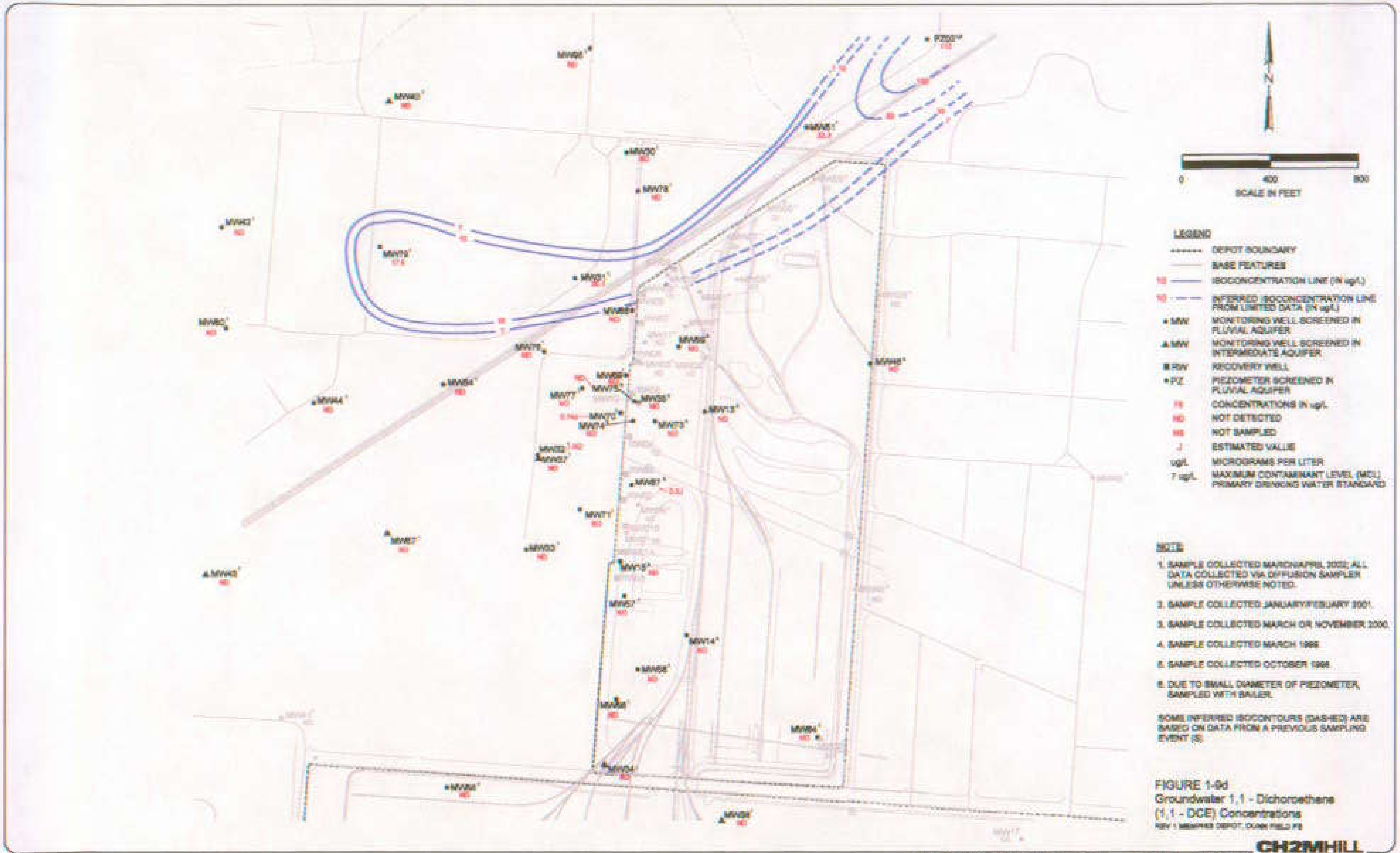

FIGURE 1-9d
Groundwater 1,1 - Dichloroethene (1,1 - DCE) Concentrations

FIGURE 1-9a
Groundwater 1,1,2,2 - Tetrachloroethane (1,1,2,2 - PCA) Concentrations

FIGURE1-9f
Groundwater 1,1,2 - Trichloroethane (1,1,2 - TCA) Concentrations

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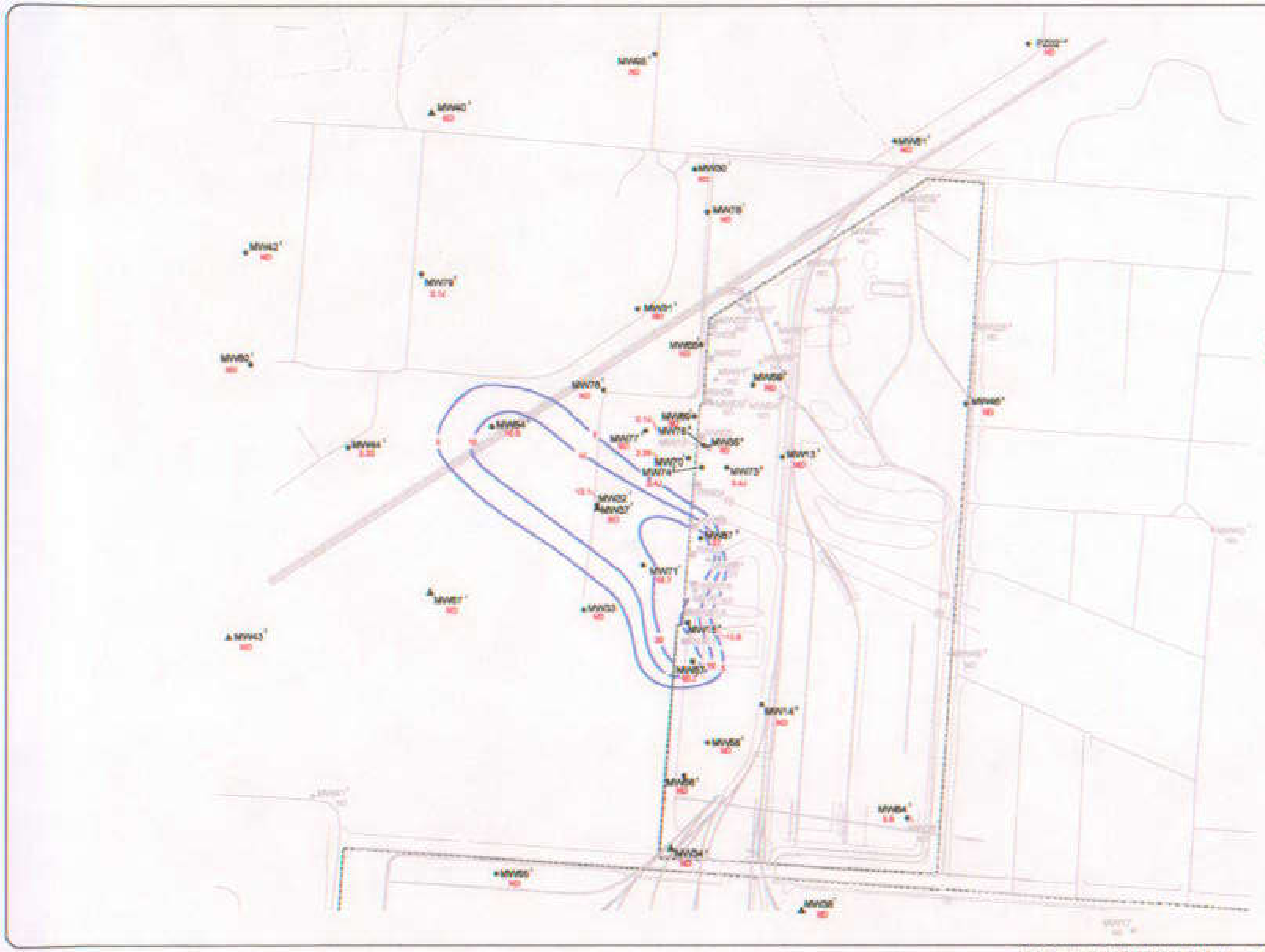

N

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- MW MONITORING WELL SCREENED IN INTERMEDIATE AQUIFER
- RW RECOVERY WELL
- PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- 79 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- NS NOT SAMPLED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

1. SAMPLE COLLECTED MARCH/APRIL 2002; ALL DATA COLLECTED VIA DIFFUSION SAMPLER UNLESS OTHERWISE NOTED.
2. SAMPLE COLLECTED JANUARY/FEBUARY 2001.
3. SAMPLE COLLECTED MARCH OR NOVEMBER 2000.
4. SAMPLE COLLECTED MARCH 1999.
5. SAMPLE COLLECTED OCTOBER 1998.
6. DUE TO SMALL DIAMETER OF PIEZOMETER, SAMPLED WITH BAILER.

SOME INFERRED ISOCONTOURS (DASHED) ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT (8).

FIGURE 1-9g
Groundwater Carbon Tetrachloride (CT) Concentrations
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

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ATL/CAD/PROJECTS/148871 CONT/DUNNFIELD 2003 06-FEB-2003

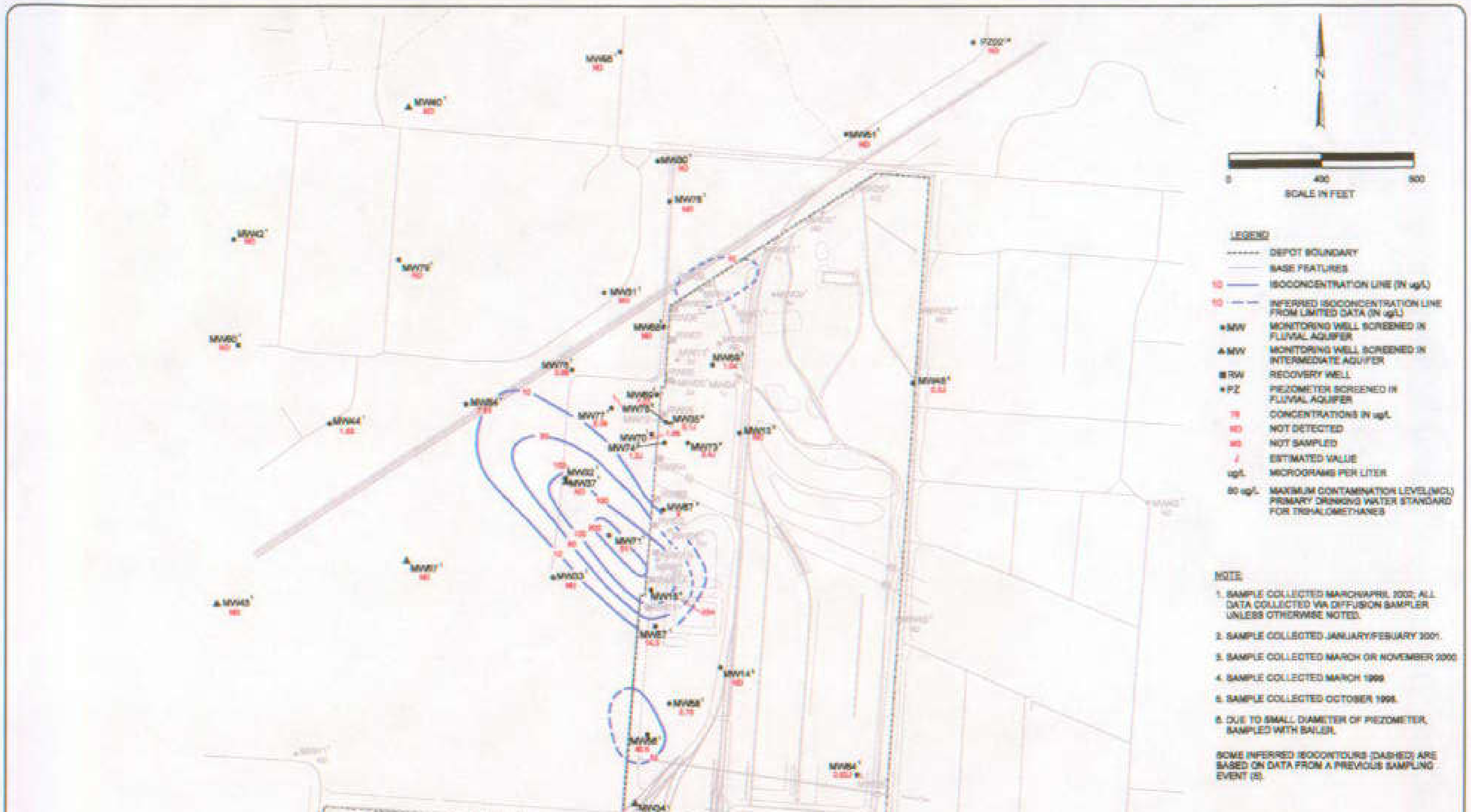

FIGURE 1-9h
Groundwater Chloroform (CF) Concentrations
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

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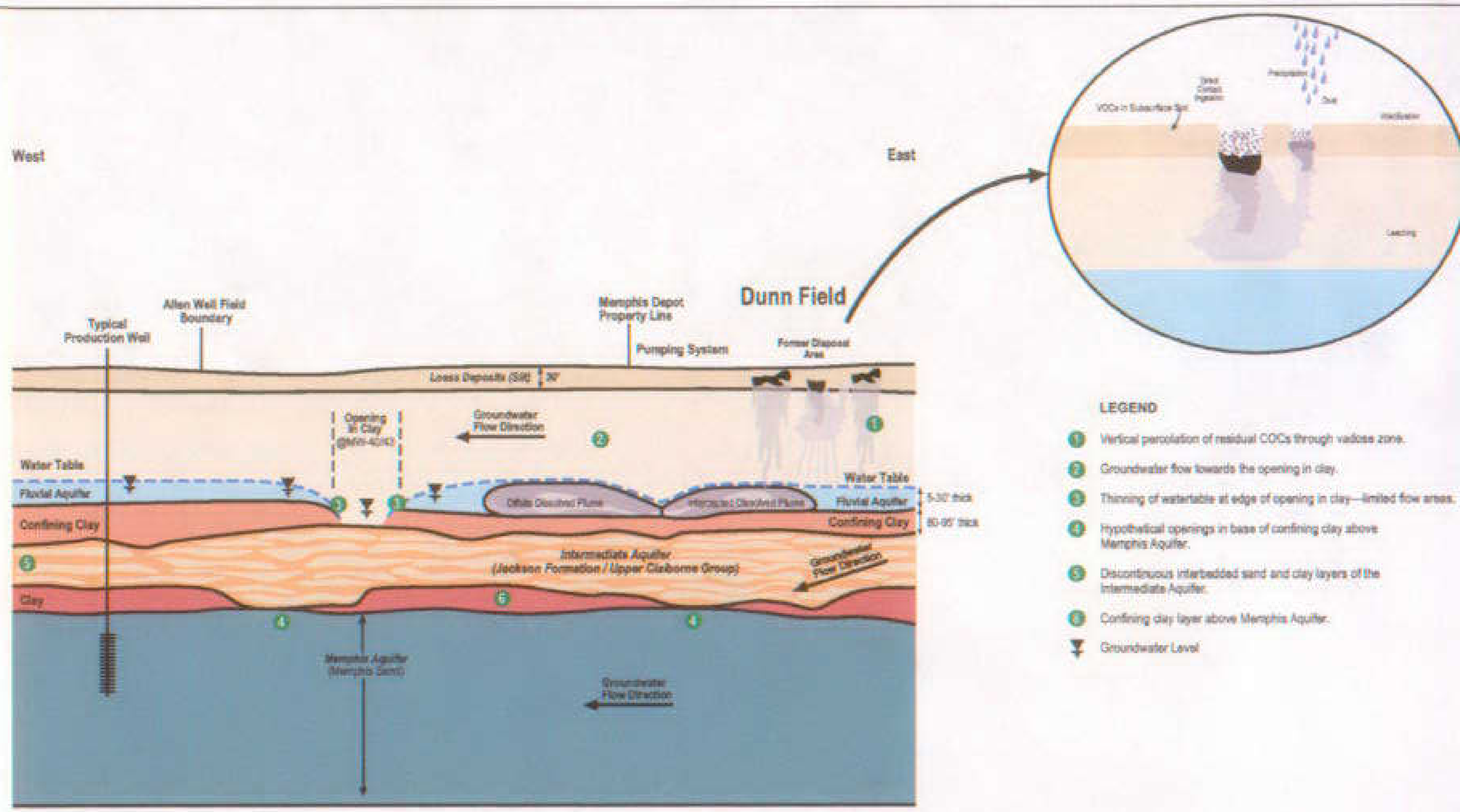

FIGURE 1-10
MOST CONSERVATIVE CONCEPTUAL MODEL
OF CONTAMINANT MIGRATION FROM DUNN FIELD
REV. 1 MEMPHIS DEPOT DUNN FIELD FS

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2.0 Identification and Screening of Technologies

This section describes the initial steps in development of potential remedial alternatives at Dunn Field by developing a list of applicable or relevant and appropriate requirements (ARARs) and defining remedial action objectives (RAOs). From this, technologies are identified and screened to meet the objectives. The screening process involves identifying general response actions, remedial technologies, and processes for implementing the technologies. This section concludes with a summary table of remedial technologies that are evaluated in more detail in Sections 3 through 7.

2.1 ARARs

Section 121(d)(2) of CERCLA, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), requires that remedial actions attain (or waive) the levels or standards of control for hazardous substances, pollutants, and contaminants specified by the ARARs of Federal and more stringent state environmental laws. The identification of ARARs for remedial actions typically begins after the site characterization (during the RI) and may continue through the remedial design phase. The processes for preliminary identification of ARARs, as well as the definition of the types of ARARs, are discussed in the following subsections.

2.1.1 Definition of ARARs

A requirement under environmental laws may be either "applicable" or "relevant and appropriate" to a remedial action, but not both. ARARs must be identified on a site-specific basis in a two-part analysis: (1) determine whether a given requirement is applicable; and (2) if the requirement is not applicable, determine whether it is nevertheless relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state environmental or facility siting laws that "specifically address a hazardous substance, pollutant, contaminant, remedial action, location, other circumstance found at a CERCLA site" (see 40 CFR 300.5 and 55 FR 8814). In other words, applicable requirements are legal and jurisdictional requirements that would apply directly to the action, even if the action were not taken pursuant to CERCLA.

Relevant and appropriate requirements are those cleanup standards that "...address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (see 40 CFR 300.5 and 55 FR 8817). Determining whether a requirement is relevant and appropriate requires the use of discretion and judgement, unlike determining whether a requirement is applicable. A requirement may be "relevant" because it addresses situations similar to those at the site, but may not be "appropriate" because it is not well suited to the specific site conditions. Once a requirement is determined to both relevant and appropriate, the requirement must be addressed as though it was applicable.

If no ARAR exists for a CERCLA site or existing ARARs are inadequate to protect human health and the environment, other non-promulgated criteria, advisories, guidance, or proposed standards issued by Federal or state governments may need *to be considered* (TBC). 40 CFR 300.400(g)(3) states that TBC standards are not potential ARARs because they are neither promulgated nor enforceable and their identification is not mandatory. However, TBC standards may be used in conjunction with ARARs to achieve an acceptable level of risk. Human health-based cleanup levels or RGOs, as discussed below, are below examples of TBC standards.

Section 121 of CERCLA and 40 CFR 300.430(f)(1)(ui)(c) allows for ARARs to be waived under the following circumstances:

- The remedial action selected is an interim measure and will become a part of a total remedial action that will attain the ARAR upon completion of all activities
- Compliance with the ARAR will result in greater risk to human health and the environment than the alternative option chosen
- Compliance with the ARAR is technically impracticable from an engineerng perspective
- The remedial action selected will attain a standard performance that is equivalent to that required under the ARAR through the use of another method or approach
- The ARAR is a state requirement that has not been consistently applied in similar circumstances for other remedial actions
- Compliance with the ARAR would not provide a balance between the need for protection of public health and the environment and the availability of funds to respond to other sites presenting a threat to the public or environment (for fund-financed cleanups only)

2.1.2 Types of ARARs

The following are the three primary types of ARARs:

- **Chemical-specific** - health- or risk-based restrictions that result in the establishment of numerical values that would meet the National Contingency Plan (NCP) threshold criterion of overall protection of human health and the environment
- **Action-specific** - technology- or activity-based requirements or limitations on actions taken with respect to a hazardous substance that are triggered by a particular remedial activity
- **Location-specific** - requirements that must be addressed during remedial activities because the activities occur in "special" locations. Location-specific ARARs include activities on and near wetlands and floodplains, archeological and natural resources, historical landmarks, critical habitats of endangered or threatened species, existing land use controls, etc.

2.1.3 Chemical-specific ARARs

The chemical-specific ARARs for Dunn Field are as follows:

- There are no chemical-specific ARARs for the soils. Therefore, chemical-specific RGOs developed in the risk analysis are used for the remedial alternatives analysis.

- Maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs) are relevant and appropriate as cleanup levels for groundwater that is a current or potential source of drinking water. The fluvial aquifer beneath Dunn Field is not used as a source of potable water at the Depot and the surrounding; however, the underlying Memphis aquifer is a source of potable water for the City of Memphis. 40 CFR 300.430 of the NCP states that MCLGs (established under the Safe Drinking Water Act [SDWA] at 40 CFR 141) above zero, shall be attained if relevant and appropriate to the circumstances of the release. Where the MCLG for a contaminant has been set at zero, the MCL for that contaminant shall be attained. TDEC's MCLGs and MCLs are listed at Tennessee Rule 1200-5-1.06 and are identical to the federal MCLGs and MCLs.

- Federal secondary MCLs are non-enforceable goals for drinking water established by EPA under the SDWA. Secondary MCLs pertain to contaminants that affect such qualities as taste, color, odor, and corrosivity. Secondary MCLs are listed in 40 CFR 143 and Tennessee Rule 1200-5-1.12. These secondary MCLs are to be considered (TBC) in the evaluation of technologies. This means that technologies that meet MCLs or MCLGs but cause an exceedance of secondary MCLs would not score (rank) as high as equally-effective technologies that do not cause an exceedance of secondary MCLs.

- There are no natural surface water bodies within the Depot or in the vicinity. Therefore, the surface water ARARs were included in the risk assessment for comparison purposes, but were not included as ARARs for screening of alternatives due to the lack of risks indicated during the risk assessment.

- Sediments do not have ARARs.

2.1.4 Action-specific ARARs

The action-specific ARARs at the Depot are as follows:

- On-site remedial actions that involve land-disturbing activities are required to comply only with the substantive requirements of the NPDES stormwater permit program (e.g., BMPs to minimize the discharge of pollutants from the site) and not the administrative requirements (e.g., submittal of a Notice of Intent, a Storm Water Pollution Prevention Plan, and Notice of Termination). The Phase II rule was published on December 8, 1999, and addresses construction activities disturbing greater than 1 acre and less than 5 acres of land. The effective date of the rule is February 7, 2000; however, operators of small construction activities (less than 5 acres) are not required to obtain permit coverage until March 10, 2003. Remedial actions at Dunn Field may disturb 5 acres or more of land and may need to comply with the substantive requirements of the NPDES Phase I stormwater permit program as implemented by TDEC under its General Permit (Stormwater Discharge from Construction Activities, No. TNR10-0000).

- The capping of hazardous materials that may be left in place in sufficient concentrations would require compliance with relevant RCRA Subtitle C landfill closure requirements at 40 CFR 264.310(a). Subtitle C landfill closures require post-closure care and maintenance for at least 30 years. Also, RCRA landfill post-closure requirements at 40 CFR 264.116 and 264.119 (TDEC Rule 1200-1-11.06(7)(g) and (j), respectively requires preparation of a survey plat "indicating the locations and dimensions of landfill cells or other hazardous waste units with respect to permanently surveyed benchmarks" and should be submitted to the local zoning authority and EPA. Under 40 CFR 264.119, one must include a notation on the deed of the facility property (or some other instrument which is normally examined during a title search) that will notify potential purchaser that land has been used to manage hazardous waste and its use is restricted. Only the substantive aspects that are deemed both "relevant and appropriate" (R&A) would apply.

- The excavation, on-site ex situ solidification, or placement of soil that contains RCRA-restricted waste may trigger the RCRA land disposal restrictions (LDRs). Generators of contaminated soil that is subject to the LDR regulations may elect to meet either the generic treatment standards for hazardous wastes in 40 CFR 268.40, or the alternative treatment standards for contaminated soil in 40 CFR 268.49. The alternative LDR soil standards require treatment to reduce concentrations of hazardous constituents in the soil either by 90 percent or by enough so that the hazardous constituent concentrations are less than or equal to 10 times the Universal Treatment Standards (UTS) (identified in 40 CFR 268.48), whichever is greater. To determine if the soils are to be disposed of in a hazardous or solid waste landfill, a toxicity characteristic leaching procedure (TCLP) test is conducted on representative soil samples. This will determine if a waste is characterized as hazardous per (40 CFR 261 C). The excavation and off-site disposal of soil and debris that contain RCRA hazardous waste must comply with transporter regulations under 40 CFR 263. A transporter under Subtitle C is defined as any person engaged in off-site transportation of hazardous waste within the United States. Such transportation requires a manifest under 40 CFR 262.

- Emissions to air during on-site treatment may require compliance with the substantive requirements of the Tennessee Air Quality Act and the federal Clean Air Act as the City of Memphis is in a non-attainment zone. This includes requirements for monitoring and control of the release of volatile organics to the atmosphere, the control of fugitive dust emissions, and compliance with ambient air quality standards. These requirements are outlined in Tennessee Rule 1200-3.

- Discharge of groundwater to the POTW must meet City of Memphis industrial discharge standards that limit contaminant levels in liquids accepted at the POTW. Wastewater generated by pumping groundwater or other remedial processes must meet the limits or be pre-treated prior to discharge.

- The Ground Water Quality Control Board for Shelby County, Tennessee, has promulgated *Rules and Regulations of Wells in Shelby County*. These regulations govern the location, design, installation, use, modification, repair, and abandonment of all types of wells; for example, monitoring, injection, recovery, and vapor extraction wells. These requirements are more stringent than corresponding federal and state rules. The substantive requirements of these regulations may be considered ARARs.

- For well installations at a CERCLA site, the substantive requirements of a well construction permits must be adhered to, even though no permit is required. Information on permit applications for monitoring and injection wells are obtained from the Memphis and Shelby County Health Department and TDEC Division of Water Supply. According to Tennessee Rule 1200-4-6, monitoring and injection wells at Dunn Field would be classified as Class V (shallow, non-hazardous) wells. Substantive requirements of an underground injection control (UIC) Class V permit application for injection wells must also be adhered to, although no permit is required.

2.1.5 Location-specific ARARs

A search for possible location-specific ARARs applicable to the Depot was conducted by Law Environmental (1990). No federal, state, or local natural resources were found to be near the site (less than ½ mile).

- Currently, Dunn Field is zoned as Light Industrial (I-L). The principal uses permitted are manufacturing, wholesaling, or warehousing. According to Section 24 of the Memphis and Shelby County zoning regulation, single family or multi-family residential uses are prohibited.
- Institutional controls are required Tennessee Rule 1200-1-13.08(10) whenever the remedial action does not fully address the hazardous substances which pose a risk to human health or the environment. This includes requirements for deed restrictions and future transfer of property. Transfers of contaminated federal property are subject to CERCLA Section 120(h)(3) requirements. The property disposal agent shall incorporate a "Notice of Land Use Restrictions" to ensure that the above land use restrictions are incorporated into the deeds transferring the property. This Notice of Land Use Restrictions shall be prepared and recorded in accordance with T.C.A. Section 68-212-225. It must: (1) include a legal description of the site that would be sufficient as a description of the property in an instrument of conveyance; (2) identify the location and dimensions of the areas of potential environmental concern with respect to surveyed, permanent benchmarks. Where a site encompasses more than one parcel or tract of land, a composite map or plat showing all parcels or tracts may be recorded; (3) identify generally the type, location, and quantity of regulated hazardous substances and regulated substances known to exist on the site; and (4) identify specific restrictions on the current or future use of the site.
- Under the *Rules and Regulations of Wells in Shelby County*, described above, water wells are defined as wells developed for the primary purpose of producing a supply of water regardless of the intended use of the water supply. The rules prohibit water wells within a half-mile of the designated boundaries of a listed federal or state CERCLA site or RCRA corrective action site, unless the owner can demonstrate that movement of contaminated groundwater or materials into adjoining aquifers will not be enhanced by the well. Similar location restrictions are not specified for any other type of well (e.g., monitoring, injection, and recovery). In addition, these rules allow the Memphis and Shelby County Health Departments to reject a permit application for a proposed well if the well will be harmful or potentially harmful to the water resources of Shelby County. Specific criteria for the determination of harm or potential harm are not identified in the rules.

2.2 Remedial Action Objectives (RAOs)

RAOs are medium-specific goals that the remedial actions are expected to accomplish to protect human health and the environment; they are used to help identify the feasible alternatives. RAOs express both a contaminant level and exposure route.

The Dunn Field BRA (CH2M HILL, July 2002) identified contaminants in surface and subsurface soils (also referred to as buried waste), disposal sites, and soil-to-indoor air that pose unacceptable risks to industrial workers and potential on-site residents (if Dunn Field is re-developed). These risks are identified as RGOs, chemical specific criteria based on calculated risk (see Table 1-7).

RAOs guide formulation and evaluation of remedial alternatives. The development of RAOs takes into consideration RGOs (permissible exposures), COCs, and clean-up concentrations associated with the RGOs.

The following RAOs have been developed for surface soil at Dunn Field:

- For the residential scenario in the Northeast Open Area, removal of surface soils contaminated with lead to residential levels;
- For the residential scenario in the Disposal Area, enact institutional controls, excavate, or contain to prevent exposure to COCs.

The lead contaminated surface soils in the Northeast Open Area, specifically those within Site 60 (Former Pistol Range) that are above residential risk-based levels, are to be removed as part of a non-time-critical removal action in early 2003 (as documented in the Site 60 EE/CA [CH2M HILL, July 2002]) and will no longer be considered in the FS.

The following RAOs have been developed for subsurface soil (buried waste) at Dunn Field:

- Prevent subsurface disturbance of buried wastes by workers.
- Prevent exposure through direct contact with the top 10 feet of the soil column where COCs exceed health-protective concentrations.

The following RAOs have been developed for the disposal sites at Dunn Field:

- Eliminate potential for groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids;
- Eliminate future unacceptable risk of direct contact with buried hazardous liquid and/or solids due to intrusive activities during future land use or site development.

The following RAOs have been developed for soil-to-indoor air contaminated with chlorinated VOCs at Dunn Field:

- Prevent direct inhalation of indoor air vapors from subsurface soils in excess of industrial worker and residential risk-based criteria.

The BRA also identified contaminants in groundwater that could pose unacceptable risk to possible receptors (CH2M HILL, July 2002). Contaminants in the fluvial aquifer may migrate further offsite or into deeper aquifers, posing a threat to water supplies. Based on analysis of the contaminants present, both onsite and offsite potential receptors, and permissible exposure levels, the following RAOs have been developed for groundwater at Dunn Field:

- Prevent use of impacted groundwater as a potable source;
- Prevent further offsite migration of VOCs in groundwater in excess of MCLs; and

- Remediate fluvial aquifer groundwater to drinking water standards (MCLs) to be protective of the deeper Memphis aquifer.

Table 2-1 summarizes RAOs for surface and subsurface soils, disposal sites, soil-to-indoor air, and groundwater.

2.3 General Response Actions

General Response Actions (GRAs) describe remedial activities that potentially satisfy the RAOs and goals, either independently or in combination with other GRAs. GRAs to be considered for surface and subsurface soils and the disposal sites at Dunn Field include the following:

- No action
- Institutional controls
- Containment
- Treatment
- Removal
- Disposal (Off-site)

GRAs to be considered for groundwater located onsite and offsite of Dunn Field include the following:

- No action
- Institutional controls
- Containment
- Treatment
- Removal
- Disposal (Offsite)
- Monitoring

Table 2-2 summarizes the GRAs and their approach to meeting remedial goals. Often there are several technologies that may be applied to each GRA. These technologies are discussed and screened for potential effectiveness in the following sections.

2.4 Identification and Screening of Technology Types and Process Options

The proposed treatment technology for subsurface soil remediation of VOCs is the presumptive remedy, soil vapor extraction (SVE). This is an in-situ physical treatment technology in which a vacuum is applied through extraction wells to create a pressure or concentration gradient. Gas phase volatiles are induced to diffuse through soils to the extraction wells. Additional enhancements of the technology may include a temporary soil cap or seal and thermal heating of soil. In addition, a system to handle and treat system off-gasses will likely be required. By definition of a presumptive remedy, this technology has already been screened against other alternatives for these contaminants and matrix, and selected as the preferred remedy. This technology screening process is documented in the *Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soil*, (EPA, 1994) and provided as Appendix B. Therefore, the no action and SVE treatment options for VOCs contained in soil and soil-to-indoor air will be carried forward into Sections 3 and 6 of this FS.

Potentially applicable technologies and process options for remediation of surface and subsurface soil associated with disposal sites are identified and described in Table 2-3. Potentially applicable technologies and process options for groundwater remediation are identified and described in Table 2-4. As part of the initial screening process, certain technologies and/or process options are identified as clearly inappropriate for the physical features of the site and/or the chemical characteristics of the contaminant matrix. These inappropriate technologies are shaded in Tables 2-3 and 2-4 and are not evaluated further.

2.4.1 Evaluation and Selection of Representative Technologies

Technologies and process options retained after preliminary screening are further evaluated on the basis of their relative effectiveness, difficulty to implement, and cost. These factors are evaluated as follows:

- The relative effectiveness of a technology is judged on the basis of its estimated capability to meet one or more of the RAOs, its estimated protectiveness of human health and the environment during operation, and its estimated reliability to function considering the contaminants and site conditions;
- The difficulty in implementing a technology considers both the technical and administrative aspects of construction and operation; and
- The cost evaluation focuses on relative capital (initial) and operation and maintenance (O&M) costs. Detailed cost analyses are not performed at this level of screening.

Table 2-5 presents the secondary screening of technologies and process options for surface and subsurface soil and disposal sites. Table 2-6 presents the secondary screening of technologies and process options for groundwater. Technologies and/or process options that were rejected on the basis of effectiveness, implementability, or cost are shaded in the table and were not evaluated further.

2.4.2 Selection of Representative Process Options

Technologies and process options that were retained after the secondary screening were further evaluated, relative to other process options within the technology type, to identify one representative option for use in the developing alternatives. Effectiveness was the primary consideration for the process option assessment. Process options considered to be similarly effective were further evaluated on the basis of relative implementability and relative cost, resulting in the selection of the best process option for the technology.

Similarly, effective process options within various technologies were also evaluated to select the best representative process option. Identifying a representative process option for each technology was not intended to limit the process options that could be used in remedial design, but to provide a basis for evaluating a manageable number of remedial alternatives.

In some cases, multiple process options were retained because of their ability to complement other technologies. For example, institutional control process options were retained because they would most likely be used during the implementation of potential remedial alternatives.

Table 2-7 presents the selection of representative process options for surface and subsurface soils and disposal sites. Table 2-8 presents the selection of representative process options for groundwater.

2.5 Summary

Table 2-9 summarizes the GRAs and associated process options for surface and subsurface soil and disposal site contamination and groundwater retained after the screening process. These process options are used to develop remedial alternatives in Section 3.

Tables

Table 2-1
Remedial Action Objectives - Disposal Area
Rev 0 Memphis Depot Dunn Field FS

Media	Land Use	Remedial Action Objectives (from RI)	General Response Actions
Surface Soil	Maintenance Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Industrial Worker (Outdoor)	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Residential Adult*	Risks exceed acceptable range of 1 in 10,000 to one million, and hazard index (HI) is greater than 1 0, for ingestion, dermal and inhalation exposures combined	Institutional Controls Excavation Containment/In-situ Treatment
	Residential Child*	Hazard index (HI) is greater than 1 0, for ingestion, dermal and inhalation exposures combined	Institutional Controls Excavation Containment/In-situ Treatment
Soil Column (Ambient Air)	Utility Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Industrial Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Residential Adult*	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Offsite Resident	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
Subsurface Soil	Utility Worker	Buried wastes may present a physical or chemical hazard to workers during intrusive activities which would disturb subsurface soil such as excavation, trenching, drilling, etc	Institutional Controls to prevent subsurface disturbance of buried wastes Excavation Containment/In-situ Treatment
Indoor Air (Soil-to-Indoor Air)	Industrial worker	Risks exceed acceptable range of 1 in 10,000 to one million, and hazard index (HI) is greater than 1 0, for inhalation exposures due to chlorinated VOCs in some localized locations across the Disposal Area	Institutional Controls for localized contaminants Excavation Containment/In-situ Treatment
	Utility Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Residential Adult*	Risks exceed acceptable range of 1 in 10,000 to one million, and hazard index (HI) is greater than 1 0, for inhalation exposures due to chlorinated VOCs in some localized locations across the Disposal Area	Institutional Controls for localized contaminants Excavation Containment/In-situ Treatment
Sediment & Surface Water	Maintenance Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Industrial Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
Disposal Sites	All potential onsite users	Unknown buried waste that could contain hazardous materials that pose an unacceptable risk to groundwater and land occupants Location of the disposal sites and potential chemical constituents are unknown and will be confirmed in the field through a pre-design investigation	Eliminate potential for groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids; and, eliminate future unacceptable risk of direct contact with buried hazardous liquid and/or solids due to intrusive activities during future land use or site development

Table 2-1
Remedial Action Objectives for the Northeast Open Area
Rev 0 Memphis Depot Dunn Field FS

Media	Land Use	Remedial Action Objectives (from RI)	General Response Actions
Surface Soil	Maintenance Worker	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for ingestion, dermal and inhalation exposures combined	No Action*
	Industrial Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1.0, for ingestion, dermal and inhalation exposures combined	No Action*
	Recreational Adult	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action*
	Recreational Youth	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action*
	Recreational Child	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action*
	Residential Adult**	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined. Lead concentrations are elevated in localized areas	Removal of contaminated soils to residential levels
	Residential Child**	Hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined. Lead concentrations are elevated in localized areas	Removal of contaminated soils to residential levels
Soil Column (Soil-to-Indoor Air)	Industrial worker	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for ingestion, dermal and inhalation exposures combined	No Action
	Utility worker	Risks are below 1 in a million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Offsite Resident	Risks are below 1 in a million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
Sediment & Surface Water	Maintenance Worker	Risks are below 1 in a million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Industrial Worker	Risks are below 1 in a million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Recreational Adult	Risks are below 1 in a million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Recreational Child	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for ingestion, dermal and inhalation exposures combined	No Action
	Recreational Youth	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for ingestion, dermal and inhalation exposures combined	No Action

*The maximum lead concentration detected at 2,100 mg/kg will be removed per the EE/CA (CH2M HILL, July 2002)
**Risks and hazards evaluated for the Surrogate Site

Table 2-1
Remedial Action Objectives - Stockpile Area
Rev 0 Memphis Depot Dunn Field FS

Media	Land Use	Remedial Action Objectives (from RI)	General Response Actions
Surface Soil	Maintenance Worker	Risks within acceptable range of 1 in 10,000 to one million and hazard index (HI) is less than 1 0, for ingestion dermal and inhalation exposures combined	No Action
	Industrial Worker	Risks within acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Residential Adult*	Risks within acceptable range of 1 in 10 000 to one million, and hazard index (HI) is less than 1 0 for ingestion dermal and inhalation exposures combined	No Action
	Residential Child*	Hazard index (HI) is greater than 1 0, for ingestion, dermal and inhalation exposures combined HI is primarily associated with Arsenic in soils which is similar to background concentrations (max = 26 mg/kg)	No Action
Soil Column	Utility Worker	Risks are below acceptable range of 1 in 10 000 to one million and hazard index (HI) is less than 1 0, for ingestion, dermal and inhalation exposures combined	No Action
	Industrial Worker	Risks are below acceptable range of 1 in 10,000 to one million, and hazard index (HI) is less than 1 0 for ingestion dermal and inhalation exposures combined	No Action
Disposal Site (CC-2 Site)	All potential onsite users	Potential burial of CC-2 impregnite in the southwest quadrant of Dunn Field Location of the disposal site and potential chemical constituents are unknown and will be confirmed in the field through a pre-design investigation	Eliminate potential for groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids, and, eliminate future unacceptable risk of direct contact with buried hazardous liquid and/or solids due to intrusive activities during future land use or site development.

*Risks and hazards evaluated for the Surrogate Site

Table 2-1
Remedial Action Objectives for Groundwater
Rev. 0 Memphis Depot Dunn Field FS

Media	Land Use	Remedial Action Objectives (from RI)	General Response Actions
Groundwater (Onsite) (All areas)	Industrial worker	Risks exceed acceptable range of 1 in 10,000 to one million and HI exceeds 1.0 primarily due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
	Residential Adult	Risks exceed acceptable range of 1 in 10,000 to one million and HI exceeds 1.0 primarily due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
	Residential Child	HI exceeds 1.0 due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
Indoor Air (Onsite) (Groundwater-to-Indoor Air)	Industrial worker	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action
	Residential Adult	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action
	Residential Child	HI is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action
Groundwater (Offsite)	Industrial worker	Risks exceed acceptable range of 1 in 10,000 to one million and HI exceeds 1.0 due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
	Residential Adult	Risks exceed acceptable range of 1 in 10,000 to one million and HI exceeds 1.0 due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
	Residential Child	HI exceeds 1.0 due to presence of chlorinated VOCs	Prevent use of groundwater for potable use/prevent offsite migration/remediate groundwater to drinking water standards
Indoor Air (Offsite) (Groundwater-to-Indoor Air)	Industrial worker	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action
	Residential Adult	Risks are below 1 in a million, and hazard index (HI) is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action
	Residential Child	HI is less than 1.0, for inhalation exposures from VOCs migrating to indoor air	No Action

TABLE 2-2
General Response Actions and Typical Goals Met
Rev. 0 Memphis Depot Dunn Field FS

Medium	General Response Action	Remedial Goals Met
Disposal Sites and Associated Subsurface Soils	No Action	Relies on natural attenuation to reduce contaminant concentrations without performing any other measures.
	Institutional Controls	Reduces the likelihood of direct contact with or ingestion or inhalation of contaminated soil.
	Containment	Minimizes the exposure to contaminated soil. Confines contamination for possible removal or treatment and reduces mobility of contamination.
	Removal	Prevents direct contact with or ingestion or inhalation of contaminated soil or sediment. Eliminates chance of release of contaminants to groundwater.
	Treatment	Reduces mobility, toxicity, or volume of contaminated media.
	Disposal	Minimizes the likelihood of exposure to contaminants by placing them in a controlled environment.
Groundwater	No Action	Relies on natural attenuation to reduce contaminant concentrations without performing any other measures.
	Institutional Controls	Relies on natural attenuation to reduce contaminant concentrations but reduces the likelihood of direct contact with or ingestion of contaminated groundwater.
	Monitoring	Relies on natural attenuation to reduce contaminant concentrations but reduces the likelihood of undetected contamination or unanticipated migration In addition, the monitoring data can be used to assess the effectiveness of natural attenuation processes.
	Containment	Actively reduces or prevents release of contaminants from soil to groundwater. Minimizes the migration of contaminants in the groundwater.
	Removal	Minimizes or prevents the migration of contaminants in the groundwater to receptors and removes contaminants from the saturated zone.
	Treatment	Reduces the mobility, toxicity, or volume of contaminated groundwater.
	Disposal	Minimizes the likelihood of exposure to contaminants by extracting them from groundwater and placing them in a controlled environment.

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Table 2-3

Primary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Primary Screening Comments	Pass Primary Screen?
No Action	None	None	No further actions to address contaminated soils	Retained per CERCLA	Yes
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to restrict property use Property transfer documents will include use restrictions	Transfer documents will include use restrictions	Yes
		Signage	Installation of signs demarcating restricted areas and providing information regarding hazards within the area	Provide information to potential users	Yes
		Fences	Security fences installed around potentially contaminated areas to limit access Fences will be installed and maintained in accordance with the Memphis Depot Redevelopment Plan	Limit access to planned users	Yes
Containment	Capping	Native Soil	Uncontaminated native soil placed over contaminated areas	Native soil with erosion control, applicable for soil burial pits to prevent direct contact.	Yes
		Clay Cap	Compacted clay placed over contaminated area Clay should be covered by at least a foot of silty sand or sandy soil to maintain the integrity of the clay cap	Native soil with erosion control, applicable for soil burial pits to prevent direct contact.	Yes
		Synthetic Membranes	Synthetic membrane placed over prepared soil or geotextile surface that is over a contaminated area The membrane is seamed by a variety of methods The membrane must be compatible with the wastes present.	Native soil with erosion control, applicable for soil burial pits to prevent direct contact.	Yes
		Asphalt or Concrete Cap	Paving grade asphalt or concrete placed over prepared contaminated area Fill settlement must be evaluated in considering a concrete cap design	Light industrial with concrete or asphalt is compatible with existing use	Yes
		Multilayered Cap	Cap may be composed of natural soils, soil admixtures, clay, synthetic membranes, spray-on asphalts, asphalt concrete, or Portland cement concrete and placed over contaminated areas If properly designed, will meet RCRA requirements	Applicable to soil burial pits	Yes
		Chemical Sealant/Stabilizers	Water-dispersible emulsions and/or resins placed over contaminated areas to form a crust that reduces water and wind or dust erosion. Most are nontoxic to plants and animals. Temporary cover only.	Effects are temporary only.	No
	Vertical Barriers	Soil-Bentonite Slurry Wall	Trench around contaminated area excavated and filled with a bentonite slurry. Trench backfilled with a soil-bentonite mix.	Mobility not an issue. Groundwater wells will be used to monitor possible future leachate.	No
		Cement-Bentonite Slurry Wall	Trench around contaminated area excavated and filled with a cement bentonite water slurry. Cement sets and forms the wall.		No
		Vibrating Beam Barrier Installation	Vibratory force used to advance steel beam into ground: injection of a relatively thin wall of cement or bentonite as beam is withdrawn.		No
		Sheet Piling	Steel sheet piling driven along contamination boundaries.		No
		Permeability Reduction Agents	Cement chemical grout or organic polymer injected into the soil matrix to reduce permeability. Experimental process option.		No
		Ground Freezing (CRYOCELL process)	Conventional ground freezing technology is used to form a flow-impervious, removable, and fully monitored ice barrier that circumscribes the contaminant source in-situ.		No
	Horizontal Barriers	Block Displacement	Controlled injection of slurry in notched injection holes produces a horizontal barrier beneath contamination. Experimental process option.		No
		Grout Injection	Grout pressure-injected at depth through closely spaced drilled holes.		No

Table 2-3

Primary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Primary Screening Comments	Pass Primary Screen?
Containment (continued)	Horizontal Barriers (continued)	Ground Freezing	Similar to vertical barriers by ground freezing. Experimental process option	Mobility not an issue. Groundwater wells will be used to monitor possible future leachate.	No
		Liners	Liners placed to restrict vertical flow can be constructed of the same materials considered for cap construction.		No
	Surface Controls	Grading	Reshaping of topography to manage surface water infiltration and runoff to control erosion.	Applicable to completion of cap or excavation options for soil burial pits	Yes
		Revegetation	A systematic revegetation plan includes selection of a suitable plant species, seedbed preparation, seeding/planting, mulching and/or chemical stabilization, fertilization, and maintenance	Cap maintenance option	Yes
		Erosion Control	Natural or man-made materials used to prevent erosion and subsequent exposure to contaminated soils	Cap maintenance option.	Yes
		Diversion and Collection Systems	Diversion and collection structures installed upslope or at perimeter of the site to control drainage of stormwater runoff System can also be implemented to collect contaminated surface water from excavations for remediation	Cap maintenance option.	Yes
	Dust and Vapor Suppression	Water	Water sprayed over area of concern to prevent dust generation.	May be required during excavation of soils or placement of cap.	Yes
		Organic Agents/Polymers/Foams	Organic agents/polymers/foams sprayed over area of concern to prevent dust/vapor generation		Yes
		Membranes/Tarps	Membranes or tarps are spread over area of concern to prevent dust/vapor generation		Yes
		Hygroscopic Agents	Hygroscopic salts absorb moisture into the soil in which they are mixed		Yes
Removal	Excavation	Excavation	Excavation of contaminated solids can use ordinary construction equipment backhoes, bulldozers, and front-end loaders(s)	Applicable to soil burial pits	Yes
Treatment	In-situ Biological Treatment	Aerobic Cometabolic Bioremediation	Injection of water containing inducers and electron acceptors (oxygen) to enhance aerobic biodegradation Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade chlorinated VOCs (fortuitous cometabolism).	Not applicable to site contamination.	No
		Anaerobic Bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.		No
		Phytoremediation	Use of plants and their associated rhizospheric mocroorganisms to remove, degrade, or contain chemical contaminants in soil.		No
		Bioremediation Enhancements	Use of various process options (thermal, physical, and/or biochemical) to optimize in-situ anaerobic or aerobic biodegradation		No
		Bioventing	Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.		No
	In-situ Physical-Chemical Treatment	Pneumatic Fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize contaminant travel time via diffusion Complements vapor and fluid extraction technologies.	Not applicable to site contamination.	No

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Table 2-3

Primary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Primary Screening Comments	Pass Primary Screen?
Treatment (continued)	In-situ Physical-Chemical Treatment (continued)	Hydraulic Fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize contaminant travel time via diffusion. Complements vapor or fluid extraction technologies.	Not applicable to site contamination.	No
		In-Situ Soil Mixing	Use of large-diameter augers to physically disturb the subsurface, with the introduction of hot air, steam, peroxide, or other fluids to promote contaminant removal during the mixing process. Complements vapor extraction or in-situ chemical oxidation technologies.	Not applicable to site contamination.	No
		Electrokinetic Treatment	Creation of electrical fields through application of low-voltage DC power to subsurface electrodes that affect contaminant transport through electromigration and/or electro-osmosis. Complements vapor extraction technologies.	Not applicable to site contamination.	No
		Soil Vapor Extraction (SVE)	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to diffuse through soil to extraction wells Includes a system for handling off-gases	Not applicable as a primary remedial option for the disposal sites, however, SVE will be used as a presumptive remedy for VOCs in the suburface soil around/beneath the disposal sites	Yes
		Solidification/Stabilization (S/S)	Solidification agents physically bind contaminants within a stabilized mass Stabilizing agents react with contaminants to reduce their mobility Auger/caisson systems and injector head systems are used to apply S/S agents to in-situ soils	Solidification applicable to associated subsurface soils Stabilization would not apply to most site contaminants	Yes
		LASAGNA™ Process	Electro-osmosis is used to mobilize contaminants to installed in-situ treatment zones, where contaminants are removed by adsorption, stabilization, or chemical degradation.	Not applicable to site contamination.	No
		Surfactant/Cosolvent Flushing	Delivery of a solution that enhances the transport of the targeted contaminants by physical displacement, solubilization, desorption, with subsequent recovery of both the solution and target contaminants.	Not applicable to site contamination.	No
		In-Situ Chemical Oxidation	Aqueous injection of an oxidizing agent (peroxide/iron, permanganate, or ozone) to promote abiotic in-situ oxidation of chlorinated organic compounds.	Not applicable to site contamination.	No
	In-situ Thermal Treatment	Six-Phase Soil Heating	The introduction of polyphase AC electricity to a specially-configured array of subsurface electrodes that promotes in-situ generation of steam to vaporize target contaminants. Complements vapor extraction applications.	Not applicable to site contamination.	No
		Radio Frequency Heating	The introduction of radio frequency energy to heat the subsurface and vaporize target contaminants. Complements vapor extraction applications.		No
		Electrical Resistance Heating	The introduction of electrical energy to heat the subsurface and vaporize target contaminants. Complements vapor extraction applications.		No
		Steam Heating	The introduction of steam to heat the subsurface and vaporize target contaminants. Complements vapor and liquid extraction applications.		No
		Dynamic Underground Stripping (DUS)	A combination of in-situ steam injection, electrical resistance heating and fluid extraction to enhance contaminant removal from the subsurface. Contaminants are volatilized, driven to centrally-located extraction wells, removed to surface, and treated.		No
		Vitrification	Electrodes are used to melt contaminated soils at high temperature to form a glass and crystalline structure with very low leaching characteristics.		No

Table 2-3

Primary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Primary Screening Comments	Pass Primary Screen?
Treatment (continued)	Other In-situ Treatment	Natural Attenuation	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels	Not applicable to site contamination	No
	Ex-situ Biological Treatment	Aerobic Cometabolic Bioremediation	Bioreactor combining contaminants, inducers and electron acceptor (oxygen) to enhance aerobic biodegradation. Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade chlorinated VOCs (fortuitous cometabolism)	Not applicable to site contamination.	No
		Anaerobic Bioremediation	Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.		No
	Ex-situ Physical/Chemical Treatment	Chemical Oxidation	Chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. Reducing/oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Not applicable to site contamination	No
		Reductive Dehalogenation: Based-Catalyzed (BCD)	Contaminated soil is screened, processed with a crusher and pug mill, and mixed with NaOH and catalysts. The mixture is heated in a rotary reactor to dehalogenate and partially volatilize the contaminants.	Not applicable to site contamination.	No
		Reductive Dehalogenation: Glycolate	Used for halogenated aromatic compounds. Soils and an alkaline polyethylene glycol (APEG) reagent are mixed and heated in a treatment vessel, causing polyethylene glycol to replace halogens and render the compounds nonhazardous.	Not applicable to site contamination.	No
		Soil Washing	Contaminants sorbed onto fine soil particles and separated from bulk soil in an aqueous-based system. Wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals	Not applicable to site contamination.	No
		Soil Vapor Extraction	Vacuum is applied to a network of aboveground piping to promote volatilization of organics from the excavated media. Includes a system for handling off-gases	Not applicable to site contamination.	No
		Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization)	Solidification applicable to associated subsurface soils. Stabilization would not apply to most site contaminants.	Yes
		Solvent Extraction	Soil and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed in a separator, where the contaminants and solvent are separated for treatment and further use.	Not applicable to site contamination	No
	Ex-situ Thermal Treatment	Thermal Desorption	Soils are heated to target temperatures (up to 1000 F) to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Not applicable to site contamination.	No
		Incineration	Soils are heated to very high temperatures 1,600 - 2,200 F (871-1,204 C) to combust organic constituents in the presence of oxygen.		No
		Open Burn/Open Detonation	Open burn: explosives/munitions are destroyed by self-sustained combustion, which is ignited by an external source. Open detonation: detonatable explosives/munitions are destroyed by a detonation.		No
Treatment (continued)	Ex-situ Thermal Treatment (continued)	Pyrolysis	Chemical decomposition is induced in organic materials by heat in the absence of oxygen. Organic materials are transformed into gaseous components and a solid residue (coke) containing fixed carbon and ash.	Not applicable to site contamination.	No
		Vitrification	Contaminated soils are melted at high temperature to form a glass and crystalline structure with very low leaching characteristics		No

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Table 2-3

Primary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Primary Screening Comments	Pass Primary Screen?
Disposal	Land Application	Land Application	Solid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized.	Not applicable to site contaminants.	No
	Landfill	Hazardous Waste Landfill	Solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill	Applicable for soil disposal pits with identified hazardous wastes, in conjunction with removal	Yes
		Non-Hazardous Waste Landfill	Solid nonhazardous wastes are permanently disposed of in a non-hazardous RCRA-permitted landfill	Applicable for soil disposal pits with identified non-hazardous wastes, in conjunction with removal TCLP analysis required	Yes

TABLE 2-4

Primary Screening of Remedial Technologies and Process Options for Groundwater Contaminants Chlorinated VOCs

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Comments	Pass Initial Screen?
No Action	None	None	No further actions to address contaminated groundwater Natural attenuation occurs	Retained per CERCLA.	Yes
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to restrict property use and well installation. Relies on natural attenuation to reduce VOC plume.	Dunn Field currently zoned Light Industrial	Yes
		Fences	Security fences installed around potentially contaminated areas to limit access.	Not applicable to groundwater contamination.	No
		Permits	Regulations promulgated to require a permit for groundwater removal activities Relies on natural attenuation to reduce VOC plume	Dunn Field currently zoned Light Industrial. Shelby Co. imposes permit restrictions on wells near Superfund sites	Yes
	Alternative Drinking Water Source	Cisterns or Tanks	Drinking water is dispensed to users from a central point.	Not needed for contamination in the fluvial aquifer, as it is not used as a source of potable water. Not needed for potable water supplied from the Allen Well Field	No
		Bottled Water	Drinking water is obtained from a commercial vendor.		No
		Deeper or Upgradient Wells	Wells are installed deep or upgradient if these areas are isolated from contamination.		No
		Relocation of Intake	Intake is relocated to an uncontaminated area.		No
		Municipal Water Supply	Additional water sources are established.		No
Containment	Capping	Native Soil	Uncontaminated native soil placed over contaminated areas. Relies on natural attenuation to reduce VOC plume.	Chlorinated VOCs have been identified in subsurface soils at Dunn Field and may serve as source areas for groundwater contamination. A presumptive remedy will address this soil contamination. A temporary cap may be required during remedial activities. A cap will not mitigate VOCs in groundwater and is therefore not practical for groundwater contamination at the site	No
		Clay Cap	Compacted clay placed over contaminated area. Clay should be covered by at least a foot of silty sand or sandy soil to maintain the integrity of the clay cap.		No
		Synthetic Membranes	Synthetic membrane placed over prepared soil or geotextile surface that is over a contaminated area. The membrane is seamed by a variety of methods. The membrane must be compatible with the wastes present.		No
		Asphalt or Concrete Cap	Paving grade asphalt or concrete placed over prepared contaminated area. Fill settlement must be evaluated in considering a concrete cap design.		No
		Multilayered Cap	Cap may be composed of natural soils, soil admixtures, clay synthetic membranes, spray-on asphalts, asphalt concrete, or Portland cement concrete and placed over contaminated areas. If properly designed, will meet RCRA requirements		No
		Chemical Sealant/Stabilizers	Water-dispersible emulsions and/or resins placed over contaminated areas to form a crust that reduces water and wind or dust erosion. Most are nontoxic to plants and animals. Temporary cover only.		No
	Vertical Barriers	Soil-Bentonite Slurry Wall	Trench around contaminated area excavated and filled with a bentonite slurry. Trench backfilled with a soil-bentonite mix. Relies on biodegradation to reduce VOC plume inside barrier.	Depth to water considered too deep to install a physical barrier via trenching. Installation is possible through wells or injection points; however, there is no treatment involved for the VOCs in groundwater	No
		Cement-Bentonite Slurry Wall	Trench around contaminated area excavated and filled with a cement bentonite water slurry Cement sets and forms the wall. Relies on biodegradation to reduce VOC plume inside barrier		No
		Vibrating Beam Barrier Installation	Vibratory force used to advance steel beam into ground injection of a relatively thin wall of cement or bentonite as beam is withdrawn Relies on biodegradation to reduce VOC plume inside barrier		No
		Grout Curtains	Grout is pressure-injected along contamination boundaries in a regular overlapping pattern of drilled holes. Relies on biodegradation to reduce VOC plume inside barrier		No
		Sheet Piling	Steel sheet piling driven along contamination boundaries. Relies on biodegradation to reduce VOC plume inside barrier		No

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TABLE 2-4

Primary Screening of Remedial Technologies and Process Options for Groundwater Contaminants· Chlorinated VOCs

Rev 1 Memphis Depot Dunn Field FS

Containment (continued)	Vertical Barriers (continued)	Permeability Reduction Agents	Cement chemical grout or organic polymer injected into the soil matrix to reduce permeability. Experimenta process option. Relies on biodegradation to reduce VOC plume inside barrier.		No
		Ground Freezing (CRYOCELL process)	Conventional ground freezing technology is used to form a flow-impervious, removable, and fully monitored ice barrier that circumscribes the contaminant source in-situ. Relies on biodegradation to reduce VOC plume inside barrier.		No
	Horizontal Barriers	Block Displacement	Controlled injection of slurry in notched injection holes produces a horizontal barrier beneath contamination. Experimental process option.	Depth to water considered too deep to install a physical barrier via trenching. Installation is possible through wells or injection points; however, there is no treatment involved for the VOCs in groundwater.	No
		Grout Injection	Grout pressure injected at depth through closely spaced drilled holes. Relies on biodegradation to reduce VOC plume inside barrier.		No
		Ground Freezing	Similar to vertical barriers by ground freezing. Experimental process option. Relies on biodegradation to reduce VOC plume inside barrier.		No
		Liners	Liners placed to restrict vertical flow can be constructed of the same materials considered for cap construction. Relies on biodegradation to reduce VOC plume inside barrier.		No
Removal	Groundwater Extraction	Conventional Pump/Treat/Discharge	Conventional groundwater extraction involves pumping in vertical wells Other extraction devices include vacuum enhanced recovery, jet-pumping systems etc. Extracted groundwater may be discharged to POTW, or treated as required and then discharged, or treated and re-injected	Applicable for VOC groundwater treatment. Current Dunn Field pump and treat does experience dewatering problems	Yes
		Horizontal Wells	Horizontal well configuration for increasing production rate from low permeability sites, or to access areas inaccessible with vertical well technology.	Depth to water is too deep for practical installation of horizontal wells	No
		One-pass Trenching	Groundwater collection technique to increase production rate from low permeability areas.	Depth to water is too deep for practical installation of trenches.	No
		Drains	Underground gravel-filled trenches generally equipped with tile or perforated pipe are installed to collect contaminated groundwater and leachate.	Depth to water is too deep for practical installation of drains.	No
Treatment	In-situ Biological Treatment	Aerobic Cometabolic Bioremediation	Injection of water containing inducers and electron acceptors (oxygen) to enhance aerobic biodegradation. Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade chlorinated VOCs (fortuitous cometabolism).	Anaerobic conditions are most effective for TCE and PCE to degrade via natural attenuation	No
		Enhanced Bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination	Applicable for chlorinated VOC groundwater treatment.	Yes
		Phytoremediation	Use of plants and their associated rhizospheric microorganisms to remove, degrade, or contain chemical contaminants in groundwater.	Depth to water is too deep for phytoremediation to be effective.	No
	In-situ Physical-Chemical Treatment	Pneumatic Fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize contaminant travel time via diffusion Complements vapor or fluid extraction technologies	Applicable as a delivery component for another technology	Yes
		Hydraulic Fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize contaminant travel time via diffusion Complements vapor or fluid extraction technologies	Applicable as a delivery component for another technology	Yes
		Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization SVE is typically required to collect and treat VOC vapors	Applicable for chlorinated VOC groundwater treatment.	Yes
		Electrokinetic Treatment	Creation of electrical fields to aid in contaminant transport. Can be used to extract contaminants, immobilize them in-situ, or deliver chemical reactants or bioremediation enhancements.	Groundwater too deep for practical application.	No
		Dual Phase Extraction	Application of a high power vacuum system to simultaneously remove soil vapors, groundwater, and other liquid (e.g., NAPL) from low permeability or heterogeneous subsurface environments.	Not applicable to site conditions.	No
		Treatment Walls	Permeable treatment walls are installed across the flow path of a contaminant plume As groundwater moves through the treatment wall, contaminants are removed in the treatment zones by physical, chemical and/or biological processes	Groundwater is too deep for walls installed through trenching, but a series of wells or injection points will be considered	Yes

TABLE 2-4

Primary Screening of Remedial Technologies and Process Options for Groundwater Contaminants. Chlorinated VOCs

Rev 1 Memphis Depot Dunn Field FS

Treatment (continued)	In-situ Physical-Chemical Treatment (continued)	In-situ Air Stripping (Circulating Cells, Vacuum Vapor Extraction)	Groundwater is aerated and lifted within a well bore, re-infiltrates a different stratum of the formation, and creates groundwater circulation. VOCs in groundwater are transferred to vapor phase and removed from well.	Depth to water is very deep to raise water and may not be practical.	No
		Surfactant/Cosolvent Flushing	Delivery of a solution that enhances the transport of the targeted contaminants by physical displacement, solubilization, desorption, with subsequent recovery of both the solution and target contaminants.	Applicable for groundwater treatment of chlorinated VOCs with high concentrations.	Yes
		In-Situ Chemical Oxidation	Aqueous injection of oxidizing agents (peroxide/iron, permanganate, or ozone) to promote abiotic in-situ oxidation of chlorinated organic compounds	Applicable for groundwater treatment of chlorinated VOCs with high concentrations.	Yes
		In-Situ Chemical Reduction	Aqueous injection of reducing agents (zero-valent iron) to promote abiotic in-situ reduction of chlorinated organic compounds	Applicable for chlorinated VOC groundwater treatment.	Yes
	In-situ Thermal Treatment	Hot Water or Steam Flushing/Stripping	Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and treated	Applicable for chlorinated VOC groundwater treatment.	Yes
		Dynamic Underground Stripping (DUS)	A combination of in-situ steam injection, electrical resistance heating, and fluid extraction enhances contaminant removal from the subsurface. Contaminants are volatilized, driven to centrally-located extraction wells, removed to surface, and treated.	Applicable for chlorinated VOC groundwater treatment.	Yes
		Hydrous Pyrolysis/ Oxidation (HPO)	Steam (and possibly oxygen) is injected to subsurface. Injection is halted, and steam condenses, allowing displaced groundwater to return to heated zone. Groundwater mixes with steam and oxygen, destroying contaminants in-situ by chemical oxidation	Not readily available or proven	No
	Other In-situ Treatment	Natural Attenuation	Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels.	However, due to the high DO content as documented in the 2000 MNA study, reductive dechlorination by anaerobic biodegradation will not be retained as the primary component of any ground water alternatives, but will be appropriate as a final polishing step to be attempted in relatively low concentration areas of the plumes where more active treatment is not cost-effective.	Yes
	Ex-situ Biological Treatment	Aerobic Cometabolic Bioremediation	Bioreactor combining contaminants, inducers, and electron acceptors (oxygen) to enhance aerobic biodegradation. Inducers serve as carbon sources that activate aerobic enzyme systems known to degrade chlorinated VOCs (fortuitous cometabolism).	Anaerobic conditions are most effective for the chlorinated VOCs to degrade via natural attenuation	No
		Anaerobic Bioremediation	Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Applicable for chlorinated VOC groundwater treatment.	Yes
	Ex-situ Physical/Chemical Treatment	Chemical Oxidation	Oxidizing agents are used to destroy organic contaminants in an ex-situ reactor. Potential oxidizing agents are UV radiation, ozone, and/or hydrogen peroxide/ferrous iron, or permanganate	Applicable for chlorinated VOC groundwater treatment.	Yes
		Chemical Reduction	Reducing agents (zero-valent iron) are used to destroy organic contaminants in an ex-situ reactor	Applicable for chlorinated VOC groundwater treatment.	Yes
		Air Stripping	Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Emissions from the air stripping system need to be monitored and may need to be treated to conform with federal (Clean Air Act) and local air emission monitoring requirements.	Applicable for chlorinated VOC groundwater treatment.	Yes
		Filtration	Solid particles are isolated by running a fluid stream through a porous medium. The driving force is either gravity or a pressure differential across the filtration medium	Not applicable to VOCs.	No
		Ion Exchange	Ions from the aqueous phase are removed by exchange with innocuous ions on the exchange medium.	Not applicable to VOCs.	No
		Liquid-Phase Carbon Adsorption	Groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required. Wastes produced from the saturated carbon need to be properly managed.	Applicable for chlorinated VOC groundwater treatment.	Yes
		Precipitation	Dissolved contaminants are transformed into an insoluble solid, facilitating the contaminants' subsequent removal from the liquid phase by sedimentation or filtration. Usually includes pH adjustment, addition of a chemical precipitant, and flocculation	Not applicable to VOCs.	No
	Ex-situ Thermal Treatment	Incineration	Recovered free product heated to very high temperatures to combust organic contaminants in the presence of oxygen.	Free product has not been observed at this site	No

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TABLE 2-4

Primary Screening of Remedial Technologies and Process Options for Groundwater Contaminants Chlorinated VOCs

Rev 1 Memphis Depot Dunn Field FS

Disposal	Land Application	Land Application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized	Applicable for chlorinated VOC groundwater treatment.	Yes
	Wastewater Discharge	POTW	Wastewater is discharged to a POTW for treatment. Must comply with City of Memphis effluent standards	Applicable for chlorinated VOC groundwater treatment.	Yes
		Surface Waters	Wastewater is discharged to surface receiving streams Must comply with NPDES permit standards and sampling requirements	Applicable for chlorinated VOC groundwater treatment	Yes
		Reinjection	Treated groundwater is reinjected into on-site wells Federal and state regulations are very restrictive	Applicable for chlorinated VOC groundwater treatment.	Yes
		Deep Well Injection	Wastewater is injected into Class I wells. Federal and state regulations are very restrictive.	Not desirable to inject aqueous waste into potential drinking water aquifers.	No
		Evaporation Ponds	Surface impoundments are used to contain treated or untreated wastewater or groundwater until it evaporates.	Limited seasonal use.	No
Monitoring	Monitoring	Monitoring	Short- and/or long-term monitoring is implemented to record site conditions and contamination and groundwater levels	Applicable for chlorinated VOC groundwater treatment.	Yes

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Table 2-5

Secondary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Secondary Screening Comments	Pass Secondary Screen?
No Action	None	None	No further actions to address contaminated soils.	Retained per CERCLA.	Yes
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to restrict property use Property transfer documents will include use restrictions	Transfer documents will include use restrictions.	Yes
		Signage	Installation of signs demarcating restricted areas and providing information regarding hazards within the area	Provide information to potential users	Yes
		Fences	Security fences installed around potentially contaminated areas to limit access Fences will be installed and maintained in accordance with the Memphis Depot Redevelopment Plan	Limit access to planned users.	Yes
Containment	Capping	Native Soil	Uncontaminated native soil placed over contaminated areas	Would not comply if RCRA Subtitle C landfill cap required and would not prevent percolation of rainwater through the disposal areas.	No
		Clay Cap	Compacted clay placed over contaminated area. Clay should be covered by at least a foot of silty sand or sandy soil to maintain the integrity of the clay cap	Would provide protection from percolation of rainwater through disposal sites May be compatible with SVE presumptive remedy due to low permeability materials	Yes
		Synthetic Membranes	Synthetic membrane placed over prepared soil or geotextile surface that is over a contaminated area The membrane is seamed by a variety of methods The membrane must be compatible with the wastes present.	Would have to be of low permeability to provide protectiveness.	Yes
		Asphalt or Concrete Cap	Paving grade asphalt or concrete placed over prepared contaminated area. Fill settlement must be evaluated in considering a concrete cap design	Asphalt cap would be compatible with SVE presumptive remedy, however concrete cap may not. May not be appropriate for future land use in all areas	Yes
		Multilayered Cap	Cap may be composed of natural soils, soil admixtures, clay, synthetic membranes, spray-on asphalts, asphalt concrete, or Portland cement concrete and placed over contaminated areas If properly designed, will meet RCRA requirements	See the comments above, as they apply to this combination of technology types.	Yes
	Surface Controls	Grading	Reshaping of topography to manage surface water infiltration and runoff to control erosion.	Support other technologies	Yes
		Revegetatation	A systematic revegetation plan includes selection of a suitable plant species, seedbed preparation, seeding/planting, mulching and/or chemical stabilization, fertilization, and maintenance		Yes
		Erosion Control	Natural or man-made materials used to prevent erosion and subsequent exposure to contaminated soils		Yes
		Diversion and Collection Systems	Diversion and collection structures installed upslope or at perimeter of the site to control drainage of stormwater runoff System can also be implemented to collect contaminated surface water from excavations for remediation		Yes
	Dust and Vapor Suppression	Water	Water sprayed over area of concern to prevent dust generation	May be required during excavation of soils or placement of cap	Yes
		Organic Agents/Polymers/Foams	Organic agents/polymers/foams sprayed over area of concern to prevent dust/vapor generation	May be required during excavation of soils or placement of cap	Yes
		Membranes/Tarps	Membranes or tarps are spread over area of concern to prevent dust/vapor generation.	More expensive than water application	No
		Hygroscopic Agents	Hygroscopic salts absorb moisture into the soil in which they are mixed	More expensive than water application.	No

Table 2-5

Secondary Screening of Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils

Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Secondary Screening Comments	Pass Secondary Screen?
Removal	Excavation	Excavation	Excavation of contaminated solids can use ordinary construction equipment backhoes, bulldozers, and front-end loaders(s)	Applicable to soil, buried waste, and disposal sites	Yes
Treatment	In-situ Physical-Chemical Treatment	Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization)	Solidification applicable to contaminated subsurface soils associated with disposal pits Stabilization would not apply to most site contaminants	Yes
		Soil Vapor Extraction (SVE)	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. Includes a system for handling off-gases.	Not applicable as a primary remedial option for the disposal sites; however, SVE will be used as a presumptive remedy for VOCs in the subsurface soil around/beneath the disposal sites. Therefore, SVE will not be carried forward for the disposal sites, but is retained as a presumptive remedy for subsurface soil.	No
	Ex-situ Physical/Chemical Treatment	Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization)	Solidification applicable to contaminated subsurface soils associated with disposal pits Stabilization would not apply to most site contaminants	Yes
Disposal	Landfill	Hazardous Waste Landfill	Solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill	Applicable for soil disposal pits with identified hazardous wastes, in conjunction with removal	Yes
		Non-Hazardous Waste Landfill	Solid nonhazardous wastes are permanently disposed of in a non-hazardous RCRA-permitted landfill	Applicable for soil disposal pits with identified non-hazardous wastes, in conjunction with removal TCLP analysis required	Yes

TABLE 2-6
Secondary Screening of Remedial Technologies and Process Options for Groundwater
Rev 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions	Secondary Screening Comments	Pass Secondary Screen?
No Action	None	None	No further actions to address contaminated groundwater Natural attenuation occurs	Retained per CERCLA.	Yes
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to restrict well installation. Relies on natural attenuation to reduce VOC plume	Dunn Field is zoned Light Industrial Shelby Co places restrictions on permits for wells near Superfund sites	Yes
		Permits	Regulations promulgated to require a permit for groundwater removal activities Relies on natural attenuation to reduce VOC plume	Dunn Field is zoned Light Industrial. Shelby Co places restrictions on permits for wells near Superfund sites	Yes
Removal	Groundwater Extraction	Conventional Pump/Treat/Discharge	Conventional groundwater extraction involves pumping in vertical wells Other extraction devices include vacuum enhanced recovery, jet-pumping systems, etc. Extracted groundwater may be discharged to a sanitary sewer or treated as required and then discharged or treated and re-injected	Applicable for chlorinated VOC groundwater treatment.	Yes
Treatment	In-situ Biological Treatment	Enhanced Bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination	Applicable for chlorinated VOC groundwater treatment.	Yes
	In-situ Physical-Chemical Treatment	Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization. SVE is typically required to collect and treat VOC vapors	Applicable for chlorinated VOC groundwater treatment.	Yes
		Pneumatic Fracturing	High-pressure injection of air to create self-propped subsurface fracture patterns that minimize contaminant travel time via diffusion Complements vapor or fluid extraction technologies	Applicable as a delivery component for another technology	Yes
		Hydraulic Fracturing	High-pressure injection of fluids, followed by granular slurry, to create subsurface fracture patterns that minimize contaminant travel time via diffusion Complements vapor or fluid extraction technologies	Applicable as a delivery component for another technology	Yes
		Treatment Walls	Permeable treatment units are installed across the flow path of a contaminant plume As groundwater moves through the treatment wall, contaminants are removed in the treatment zones by physical, chemical, and/or biological processes	Applicable for chlorinated VOC groundwater treatment.	Yes
		Surfactant/Cosolvent Flushing	Delivery of a solution that enhances the transport of the targeted contaminants by physical displacement, solubilization, desorption with subsequent recovery of both the solution and target contaminants.	Recovery of solutions and contaminants may be difficult with depth of water table. Not as easily implemented as other in-situ techoologies	No
		In-Situ Chemical Oxidation	Aqueous Injection of oxidizing agents (peroxide/iron, permanganate or ozone) to promote abiotic in-situ oxidation of chlorinated organic compounds.	Applicable for groundwater treatment of chlorinated VOCs with high concentrations	Yes
		In-Situ Chemical Reduction	Aqueous injection of reducing agents (zero-valent iron) to promote in-situ reduction of chlorinated organic compounds	The zero-valent iron is delivered via wells or injected through soil borings	Yes
	In-situ Thermal Treatment	Hot Water or Steam Flushing/Stripping	Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone, where they are removed by vacuum extraction and treated.	More expensive than other treatment actions.	No
		Dynamic Underground Stripping (DUS)	A combination of in-situ steam injection electrical resistance heating and fluid extraction to enhance contaminant removal from the subsurface. Contaminants are volatilized, driven to centrally located extraction wells, removed to surface, and treated.	More expensive than other treatment actions.	No
	Ex-situ Biological Treatment	Anaerobic Bioremediation	Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.	Applicable for chlorinated VOC groundwater treatment. Ex-situ treatment may be required if remedial option requires additional groundwater to be discharged to POTW	Yes
	Ex-situ Physical/Chemical Treatment	Chemical Oxidation	Oxidizing agents are used to destroy organic contaminants in an ex-situ reactor. Potential oxidizing agents are UV radiation, ozone, and/or hydrogen peroxide/ferrous iron, or permanganate	More expensive than other treatment actions	No
		Chemical Reduction	Reducing agents (zero-valent iron) are used to destroy organic contaminants in an ex-situ reactor.	More expensive than other treatment actions.	No
		Air Stripping	Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air Aeration methods include packed towers, diffused aeration tray aeration, and spray aeration Emissions from the air stripping system need to be monitored and may need to be treated to conform with federal (Clean Air Act) and local air emission monitoring requirements	Applicable for chlorinated VOC groundwater treatment. Ex-situ treatment may be required if remedial option requires additional groundwater to be discharged to POTW	Yes
		Liquid-Phase Carbon Adsorption	Groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb Periodic replacement or regeneration of saturated carbon is required Wastes produced from the saturated carbon need to be properly managed	Applicable for chlorinated VOC groundwater treatment. Ex-situ treatment may be required if remedial option requires additional groundwater to be discharged to POTW	Yes
Disposal	Land Application	Land Application	Liquid wastes that are primarily organic are incorporated into the upper soil horizon so they can be degraded, transformed, or immobilized	Not as effective as other disposal actions	No
	Wastewater Discharge	POTW	Aqueous streams are discharged to a POTW for treatment. Must comply with City of Memphis effluent standards	Applicable for VOC groundwater treatment. Will require a permit with the City of Memphis	Yes
		Surface Waters	Aqueous streams are discharged to surface receiving streams. Must comply with NPDES permit standards and sampling requirements.	Groundwater concentrations are most likely above acceptable discharge limits to surface waters. Ex-situ treatment would be required. NPDES permit and compliance monitoring are required.	No

TABLE 2-6
Secondary Screening of Remedial Technologies and Process Options for Groundwater
Rev 1 Memphis Depot Dunn Field FS

Disposal (Continued)		Reinjection	Treated groundwater or surface water is reinjected into on-site wells.	Federal and state permit requirements for reinjection are very restrictive. The Memphis aquifer is a source of potable water	No
Monitoring	Monitoring	Monitoring	Short-and/or long-term monitoring is implemented to record site conditions and contamination levels	Applicable to most potential remedial alternatives	Yes

TABLE 2-7
Final Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils
Rev. 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions
No Action	None	None	Retained per CERCLA No further actions to address contaminated soils.
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to restrict property use
		Signage	Delineate restricted areas around potentially hazardous areas.
		Fences	Security fences installed around potentially contaminated areas to limit access
Containment	Capping	Clay Cap	Compacted clay placed over contaminated area. Clay should be covered by at least a foot of silty sand or sandy soil to maintain the integrity of the clay cap.
		Synthetic Membranes	Synthetic membrane placed over prepared soil or geotextile surface that is over a contaminated area The membrane is seamed by a variety of methods The membrane must be compatible with the wastes present.
		Asphalt or Concrete Cap	Paving grade asphalt or concrete placed over prepared contaminated area. Fill settlement must be evaluated in considering a concrete cap design
		Multilayered Cap	Cap may be composed of natural soils, soil admixtures, clay, synthetic membranes, spray-on asphalts, asphalt concrete, or Portland cement concrete and placed over contaminated areas If properly designed, will meet RCRA requirements.
	Surface Controls	Grading	Reshaping of topography to manage surface water infiltration and runoff to control erosion
		Revegetatation	A systematic revegetation plan includes selection of a suitable plant species, seedbed preparation, seeding/planting, mulching and/or chemical stabilization, fertilization, and maintenance
		Erosion Control	Natural or man-made materials used to prevent erosion and subsequent exposure to contaminated soils
		Diversion and Collection Systems	Diversion and collection structures installed upslope or at perimeter of the site to control drainage of stormwater runoff System can also be implemented to collect contaminated surface water from excavations for remediation.
	Dust and Vapor Suppression	Water	Water sprayed over area of concern to prevent dust generation
		Organic Agents/ Polymers/ Foams	Organic agents/polymers/foams sprayed over area of concern to prevent dust/vapor generation

TABLE 2-7
Final Remedial Technologies and Process Options for Disposal Sites (Various Compounds) and Associated Subsurface Soils
Rev. 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions
Removal	Excavation	Excavation	Excavation of contaminated solids/containers can use ordinary construction equipment excavators, and front-end loaders(s).
Treatment	In-situ Physical-Chemical Treatment	Solidification/Stabilization	Solidification agents physically bind contaminants within a stabilized mass Stabilizing agents react with contaminants to reduce their mobility. Auger/caisson systems and injector head systems are used to apply S/S agents to in-situ soils
	Ex-situ Physical/Chemical Treatment	Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification) , or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization)
Disposal	Landfill	Hazardous Waste Landfill	Solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill
		Non-Hazardous Waste Landfill	Solid nonhazardous wastes are permanently disposed of in a non-hazardous RCRA-permitted landfill

TABLE 2-8
Final Remedial Technologies and Process Options for Groundwater
Rev. 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions
No Action	None	None	Retained per CERCLA. No further actions to address contaminated groundwater. Natural attenuation occurs.
Institutional Controls	Access and Use Restrictions	Deed Restrictions	Deed restrictions issued for property within potentially contaminated areas to prohibit well installation. Relies on natural attenuation to reduce VOC plume
		Permits	Regulations promulgated to require a permit for wells to extract groundwater. Relies on natural attenuation to reduce VOC plume.
Removal	Groundwater Extraction	Conventional Pump/Treat	Conventional groundwater extraction involves pumping in vertical wells. Other extraction devices include vacuum enhanced recovery, jet-pumping systems, etc. Extracted groundwater may be discharged to a sanitary sewer, or treated as required and then discharged.
Treatment	In-situ Biological Treatment	Enhanced Bioremediation	Subsurface delivery of electron donors within the target zone to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.
	In-situ Physical/Chemical Treatment	Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization.
		Treatment Walls	Permeable treatment walls are installed across the flow path of a contaminant plume. As groundwater moves through the treatment wall, contaminants are removed in the treatment zones by physical, chemical, and/or biological processes.
		In-Situ Chemical Reduction	Aqueous injection of reducing agents (zero-valent iron) to promote in-situ reduction of chlorinated organic compounds.
		In-Situ Chemical Oxidation	Aqueous injection of oxidizing agents (peroxide/iron, permanganate, or ozone) to promote abiotic in-situ oxidation of chlorinated organic compounds
	Ex-situ Biological Treatment	Anaerobic Bioremediation	Bioreactor containing contaminants and electron donors to stimulate anaerobic biodegradation of chlorinated compounds by reductive dechlorination.
Treatment Continued	Ex-situ Physical/Chemical Treatment	Air Stripping	Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Emissions from the air stripping system need to be monitored and may need to be treated to conform with federal (Clean Air Act) and local air emission monitoring requirements.
		Liquid-Phase Carbon Adsorption	Groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb

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TABLE 2-8
Final Remedial Technologies and Process Options for Groundwater
Rev. 1 Memphis Depot Dunn Field FS

General Response Actions	Remedial Technology Types	Process Options	Descriptions
			Periodic replacement or regeneration of saturated carbon is required. Wastes produced from the saturated carbon need to be properly managed
Disposal	Wastewater Discharge	POTW	Wastewater is discharged to a POTW for treatment. Must comply with City of Memphis effluent standards. A permit with the City of Memphis is required.
Monitoring	Monitoring	Monitoring	Short-and/or long-term monitoring is implemented to record site conditions and contamination levels.

TABLE 2-9
Screening Summary of GRAs and Process Options Retained for Alternative Development
Rev. 1 Memphis Depot Dunn Field FS

Medium	General Response Action	Remedial Technology Type	Process Option
Disposal Sites and Associated Subsurface Soil	No Action	None	None
	Institutional Controls	Access and Use Restrictions	Deed Restrictions
			Signage
			Fences
	Containment	Capping	Clay Cap
			Synthetic Membranes
			Asphalt or Concrete Cap
			Multilayered Cap
		Surface Controls	Grading
			Revegetatation
			Erosion Control
			Diversion and Collection Systems
		Dust and Vapor Suppression	Water
			Organic Agents/Polymers/Foams
	Removal	Excavation	Excavation
	Treatment	In-situ Physical/Chemical Treatment	Solidification/Stabilization
		Ex-situ Physical/Chemical Treatment	Solidification/Stabilization
	Disposal	Landfill	Hazardous Waste Landfill
			Non-Hazardous Waste Landfill
Groundwater	No Action	None	None
	Institutional Controls	Access and Use Restrictions	Deed Restrictions
			Permits
	Removal	Groundwater Extraction	Conventional Pump/Treat/Discharge
	Treatment	In-situ Biological Treatment	Enhanced Bioremediation
		In-situ Physical/Chemical Treatment	Air Sparging
			Pneumatic Fracturing
			Hydraulic Fracturing
			Treatment Walls
			In-Situ Chemical Reduction
			In-Situ Chemical Oxidation
		Ex-situ Biological Treatment	Anaerobic Bioremediation
		Ex-situ Physical/Chemical Treatment	Air Stripping
			Liquid-Phase Carbon Adsorption
	Disposal	Wastewater Discharge	POTW
	Monitoring	Monitoring	Monitoring

3.0 Development and Screening of Alternatives

This section develops preliminary and potential remedial alternatives for surface and subsurface soils, disposal sites and groundwater at Dunn Field. The primary objective of alternative development and screening is to produce an appropriate range of contaminant management options that will be analyzed more fully in the detailed analysis phase of this FS (Sections 4 through 7).

As described in Section 2, the proposed treatment technology for subsurface soil remediation of VOCs at Dunn Field is the presumptive remedy, soil vapor extraction (SVE). However, there may be other contaminants in the subsurface that require remediation. For example, the 16 disposal sites identified in the Disposal Area at Dunn Field may contain hazardous materials, including potentially containerized hazardous materials. Some of the soil associated with these sites may have become contaminated through rupture or leakage through incompetence of containers and/or contact with buried waste. Since potential contaminants in the disposal sites and surrounding soil may not be able to be remediated using SVE, they will be addressed separately from the VOC-contaminated subsurface soils.

VOCs have been detected in groundwater monitoring wells located within the site boundaries of Dunn Field, as well as offsite to the west and northeast of Dunn Field. Remedial alternatives presented as acceptable for treatment of onsite groundwater contamination, however, are not necessarily feasible for treatment of offsite groundwater contamination with respect to land accessibility and public acceptance. Therefore, groundwater remedial alternatives are addressed in the FS in terms of onsite and offsite, allowing for selection of different remedial strategies for onsite versus offsite groundwater contaminants, within the same remedial alternative.

Remedial alternatives are developed and screened on their ability to achieve RAOs. Initial screening is based on relative effectiveness, implementability, and cost. The three steps of the process include:

1. Create an initial list of preliminary alternatives and define them using applicable technologies (Section 3.1);
2. Screen the preliminary alternatives for redundancy to develop a smaller list of potential alternatives (Section 3.2); and
3. Screen the potential alternatives for effectiveness, implementability, and cost to develop a smaller list of final alternatives that are carried forward for detailed evaluation in Sections 4 through 7.

3.1 Development of Preliminary Alternatives

For CERCLA actions, the range of alternatives should include the following:

- A no action alternative;
- One or more alternatives that involve containment with little or no treatment; and

- A range of alternatives in which treatment addresses the principal threat and eliminates or minimizes the need for long-term management (EPA, 1988).

Section 121(b) of CERCLA identifies the following statutory preferences when developing and evaluating remedial alternatives:

- Remedial actions involving treatment that permanently and significantly reduce the toxicity, mobility, or volume of the COCs are preferred;
- Offsite transport and disposal of COCs without treatment is considered the least favorable remedial action when practical treatment technologies are available; and
- Remedial actions that use permanent solutions, alternative treatment technologies, or resource recovery technologies are to be assessed.

The evaluation in Section 2 generated a list of preliminary remedial technologies for further consideration. The technologies passing the preliminary screening were then assembled into the remedial action alternatives shown in Tables 3-1 and 3-2. Since the presumptive remedy was selected for VOC-contaminated subsurface soils and soil-to-indoor air, preliminary screening is not required; the no action and SVE alternatives are carried forward.

For this FS, only a limited number of alternatives representing reasonable and practical remedial approaches were listed. These preliminary remedial alternatives are not intended to preclude consideration of other remedial alternatives that may be suitable. Rather, the listed alternatives are proposed as those most applicable, based on site conditions and recent remediation experience. During the process of remedy selection and implementation, new information may indicate other technologies are better than those evaluated below.

Descriptions of alternatives for disposal sites and associated subsurface soil, VOC-contaminated subsurface soil and soil-to-indoor air, and groundwater are presented in the following subsections.

3.1.1 Description of Remedial Alternatives – Disposal Sites and Associated Subsurface Soil

3.1.1.1 Alternative 1 – No Action

A no action alternative is required under CERCLA for comparison to active remedies.

3.1.1.2 Alternative 2 – Institutional Controls

Alternative 2 will leave residual waste and associated contaminated soil in place, but will involve deed restrictions limiting the use of the property or portions of the property. This alternative includes signage to document the areas and potential hazards within, regulation of intrusive activities during which potential receptors could encounter COCs, maintenance of access barriers to limit entry into contaminated areas, and periodic inspection for soil disturbance or migration of COCs. Some biodegradation and chemical reactions with subsurface materials will be expected to occur naturally over time.

3.1.1.3 Alternative 3 – Soil Containment with Institutional Controls

Alternative 3 involves the placement of a protective cover or cap over contaminated soil and residual waste to act as a physical barrier against direct contact to workers or residents and water percolation. Natural clean soil consisting of low-permeability (clay) and high-permeability (sand) soil, asphalt, concrete or other material such as flexible geomembrane liner from offsite will be placed over contaminated areas. Surface controls such as stormwater control and vegetative cover will be necessary to prevent erosion damage to a soil cover. This alternative will require deed restrictions limiting the use of the property or portions of the property, regulation of intrusive activities during which potential receptors can encounter COCs, maintenance of access barriers to limit entry into contaminated areas, signage to warn visitors to the site that these areas exist, and periodic inspection for cover disturbance.

3.1.1.4 Alternative 4 – In-situ Soil Treatment with Institutional Controls

Alternative 4 includes in-situ treatment for subsurface wastes/soils by solidification. Solidification treatment physically binds constituents within a stabilized mass. These treatments typically utilize auger/caisson and injector head systems to apply stabilizing agents to in-situ contaminated soil and vapor controls. Some form of institutional controls will be necessary to limit site use during implementation.

3.1.1.5 Alternative 5 – Ex-situ Soil Treatment with Institutional Controls

Alternative 5 includes ex-situ treatment for subsurface wastes/soils by solidification. Solidification treatment physically binds constituents within a stabilized mass. Ex-situ treatment assumes removal of residual waste and contaminated soil by excavation and then utilizes processes such as emulsified asphalt, pozzolan/Portland cement, or vitrification/molten glass to immobilize or contain the harmful constituents. Some form of institutional controls will be necessary to limit site use during implementation. Under CERCLA, material can be replaced on site.

3.1.1.6 Alternative 6 – Excavation, Transportation, and Offsite Disposal

Alternative 6 includes excavation of buried waste and/or contaminated soil, and transportation and permanent offsite disposal in a RCRA-permitted landfill as an industrial waste or hazardous waste, depending on levels of contamination and landfill requirements. Some offsite pretreatment processes might be required to meet land disposal restrictions. Excavated areas will be filled with clean imported soil.

3.1.2 Description of Remedial Alternatives – VOC-Contaminated Subsurface Soil and Soil-to-Indoor Air

3.1.2.1 Alternative 1 – No Action

A no action alternative is required under CERCLA for comparison to active remedies.

3.1.2.2 Alternative 2 – Presumptive Remedy (Soil Vapor Extraction System)

Alternative 2 combines institutional controls with SVE as the presumptive remedy for Dunn Field. A discussion of presumptive remedy approach and justification for its use at Dunn Field is presented in Section 1.

For this alternative, air flow will be induced through contaminated soil by applying vacuum through vapor extraction wells and thus, creating a pressure gradient in the vapor phase within the vadose zone (unsaturated soil zone above the water table) of the targeted soil. As the soil vapor migrates through the soil pores toward the extraction vents, VOCs will be volatilized and transported out of subsurface. The extracted soil vapor may or may not need treatment before release to the atmosphere depending on the COC, its concentration, and the system flow rate. SVE may be implemented without any enhancements or in conjunction with technologies that enhance permeability or vapor transport.

Site controls will be in place to limit access during implementation. Further, process controls will be implemented to minimize fugitive emissions and releases of contaminants above the acceptable levels.

3.1.3 Description of Remedial Alternatives – Groundwater

3.1.3.1 Alternative 1 – No Action

A no action alternative is required under CERCLA for comparison to active remedies.

3.1.3.2 Alternative 2 – Zero-Valent Iron (ZVI) Injection, Enhanced Bioremediation and Enhanced Extraction, and MNA with Institutional Controls

Alternative 2 combines ZVI injection, enhanced bioremediation while enhancing the existing groundwater extraction system positioned along the western boundary of Dunn Field. MNA and institutional controls are also included as part of the remedy.

ZVI injection is intended to remove chlorinated organic contaminants by chemical reduction utilizing zero-valent iron injected into the source areas on Dunn Field to promote abiotic reduction. A reactive slurry containing colloidal-sized ZVI is delivered to the saturated subsurface zone. The colloidal iron particles become imbedded throughout the subsurface matrix within the radius of influence of the injection point, where the iron particles react with dissolved-phase CVOCs in the saturated environment. The ZVI will be delivered into the fluvial aquifer source areas by various mixing or injecting methods. The ZVI is the bulk reducing agent in these systems. However, corrosion of iron metal yields ferrous iron and hydrogen, both of which are possible reducing agents relative to contaminants such as chlorinated solvents. A bench-scale treatability test and field pilot study will assist design of the total number of ZVI injection points and the ZVI admixture required for the site.

The existing extraction system reduces further offsite plume migration by creating a hydrological barrier along the western side of Dunn Field. For this alternative, additional extraction wells will be added to the existing system to decrease the possibility of contaminated groundwater traveling offsite and placing recovery wells offsite in the areas of highest VOC concentrations. If system effluent concentrations fail to comply with effluent discharge standards established via a permit with the City of Memphis, onsite treatment will be required (as a contingency).

Enhanced bioremediation will reduce contaminant levels in those parts of the plumes outside the influence of the enhanced extraction system. This remediation method involves adding nutrients, microbes, and/or chemicals that accelerate in-situ anaerobic biodegradation processes. The injection of microorganisms into the subsurface is considered an experimental technology, while the injection of nutrients has been shown to be effective. This alternative will consider only injection of nutrients, such as vegetable oil and sodium lactate, to enhance bioremediation. Long-term groundwater monitoring will be needed to record site conditions and contamination levels and to monitor the progress of the enhanced bioremediation. Additional injections may be necessary as part of the enhanced bioremediation process.

Institutional controls, such as deed restrictions to prohibit installation of production or consumptive use wells within Dunn Field, will protect future workers and residents from contact with the contaminants in groundwater. The Memphis-Shelby County ordinance that controls wells near CERCLA sites will prohibit new wells near Dunn Field. Prohibitions on groundwater development on and near Dunn Field will be necessary to protect potential receptors. MNA will be used as a final polishing step in low concentration areas of the plumes where more active treatment is not cost-effective. Groundwater monitoring will be needed to check for potential migration of plumes and degradation of contaminants. If plume degradation appears to be limited, contingencies for more active remedial measures will be evaluated.

3.1.3.3 Alternative 3 – Zero-Valent Iron (ZVI) Injection, Permeable Reactive Barrier, and MNA with Institutional Controls

Alternative 3 combines ZVI source area injection as a more aggressive method of remediating the most contaminated portions of the groundwater plume with a more passive remedial method, an offsite permeable reactive barrier (PRB). The alternative also includes MNA and institutional controls. ZVI, MNA, and institutional controls are the same as those indicated in Alternative 2.

A permeable reactive barrier (PRB) is a passive in situ treatment zone of reactive material, usually granular zero-valent iron, that degrades or immobilizes contaminants as ground water flows through it. A permeable treatment wall will be installed offsite as a permanent unit across the flow path of the contaminant plumes. Natural gradients transport contaminants through strategically placed treatment media. The permeable treatment wall consists of zero-valent iron granules or other iron bearing minerals for the treatment of CVOCs. As the iron is oxidized, a chlorine atom is removed from the CVOC by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The iron granules are dissolved by the process, but the metal disappears so slowly that the remediation barriers can be expected to remain effective for many years, possibly even decades. These degradation barriers will facilitate reactions that break down contaminants in the plume into harmless byproducts. Based on the depth to water in the fluvial aquifer, potential installation methods include jetting and vertical hydrofracturing. The applicability of PRBs to the site will be demonstrated with the use of bench-scale testing of zero-valent iron with site groundwater and site COCs.

3.1.3.4 Alternative 4 – Air Sparging with SVE, PRB, and MNA with Institutional Controls

Alternative 4 combines a method that volatilizes the VOCs in groundwater (air sparging) and removes the vapors (soil vapor extraction, or SVE). In addition, an offsite PRB will be used to remediate downgradient portions of the plume. MNA and institutional controls will also be used to monitor groundwater contaminant levels and prevent groundwater use. PRB, MNA, and institutional controls are the same as those indicated in Alternative 3.

Alternative 4 involves injecting air via wells into the contamination source areas of the fluvial aquifer. This technology removes contaminants from the groundwater through volatilization into the injected air stream. VOCs removed from the groundwater will move upwards into the vadose zone (unsaturated soil zone) and ultimately towards the SVE system. Lines of sparge wells will be located within each source area and corresponding contaminant plume. The treatment will immediately effect concentrations within the zone of influence of the sparge wells and ultimately reduce levels of VOCs downgradient of the sparge wells. VOC concentrations downgradient of the sparge wells will also be reduced by the PRB.

The number and placement of sparge wells will have to be determined from pilot testing at the site. Results of the pilot test will also indicate the release rate of VOCs into the soil and further aid in the development of the presumptive remedy for subsurface soil. The discharge of VOCs from the aquifer will be captured by an extension of the SVE system outside of the Dunn Field perimeter. The SVE lines will be set within the vadose zone above the fluvial aquifer to immediately pull the vapors from the air sparging system.

3.1.3.5 Alternative 5 – In-situ Chemical Oxidation, PRB, and MNA with Institutional Controls

Alternative 5 combines in-situ chemical oxidation (ISCO) as a source area groundwater treatment on and offsite (along the west boundary of Dunn Field), with a PRB for the offsite contamination. In addition, MNA and institutional controls will also be used to monitor groundwater contaminant levels and groundwater use. PRB, MNA, and institutional controls are the same as those indicated in Alternatives 3 and 4.

ISCO involves the aqueous injection of oxidizing agents (hydrogen peroxide/iron, permanganate, or ozone) to promote abiotic in-situ oxidation of chlorinated organic compounds into harmless end products. The oxidizing agents are injected into the fluvial aquifer through boreholes using an injector process. Chemical oxidation is driven by the formation of a free hydroxyl radical (OH), which is extremely powerful oxidizer. A bench-scale treatability study and field pilot study will assist design of the total number of ISCO boreholes/injectors required for the site, and the type of oxidizing agent.

3.1.3.6 Summary of Active Groundwater Remedial Alternatives

The table below summarizes the effectiveness of the active groundwater remediation technologies, described as Alternatives 2 through 5 above, on the CVOCs in the groundwater on Dunn Field. As indicated in the table, not every active remedial technology is 100% effective in treating all of the CVOCs.

Contaminant	Air Sparging	PRB or ZVI	Enhanced Anaerobic Bioremediation	Chemical Oxidation
Tetrachloroethene (PCE)	✓	✓	✓	✓
Trichloroethene (TCE)	✓	✓	✓	✓
Cis 1,2-Dichloroethene (DCE)	✓	✓	✓[3]	✓
Trans 1,2-Dichloroethene (DCE)	✓	✓	✓[3]	✓
1,1-Dichloroethene (DCE)	✓	✓	✓[3]	✓
Vinyl Chloride	✓	✓	✓[4]	✓
1,1,2,2-Tetrachloroethane (PCA)	✓[1]	✓	✓	--[2]
1,1,2-Trichloroethane (TCA)	✓[1]	✓	✓	--[2]

Contaminant	Air Sparging	PRB or ZVI	Enhanced Anaerobic Bioremediation	Chemical Oxidation
Carbon Tetrachloride	✓	✓	✓	–[2]
Chloroform	✓	✓	✓[5]	–[2]

PRB = Permeable Reactive Barrier (granular iron)
ZVI = Zero-Valent Iron
[1] = These VOCs have a relatively low Henry's Law constant and therefore will be more difficult to strip/sparge from the groundwater
[2] = Chemical oxidation (via peroxide/iron, permanganate, or ozone) is effective in the chemical destruction of unsaturated aliphatic compounds or alkenes Saturated aliphatic compounds or alkanes are resistant to chemical oxidation
[3] = Reductive dechlorination of the Dichloroethenes is slower and requires sulfate-reducing and methanogenic conditions.
[4] = Reductive dechlorination of Vinyl Chloride is slower and requires sulfate-reducing and methanogenic conditions, degrades more rapidly under aerobic conditions.
[5] = Chloroform may degrade slowly under anaerobic conditions or may degrade through cometabolism

References
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3.2 Screening of Preliminary Alternatives

In this section, the initial list of preliminary alternatives, presented in Tables 3-1 and 3-2, is screened for redundancy and elimination of similar technologies. The following table and discussion documents this initial screening process and presents the list of potential alternatives for more detailed screening.

Alternative	Retained for Further Evaluation	Eliminated from Consideration	Key Screening Comments
Disposal Sites and Associated Subsurface Soil			
1	✓		Keep per CERCLA
2	✓		Controls are viable
3	✓		Cover/capping is viable
4		✓	Not viable for the heterogeneous wastes and potential unknowns
5	✓		Viable and includes treatment
6	✓		Permanent Removal
VOC-Contaminated Subsurface Soil and Soil-to-Indoor Air			
1	✓		Keep per CERCLA
2	✓		Presumptive remedy, includes treatment

Alternative	Retained for Further Evaluation	Eliminated from Consideration	Key Screening Comments
*Groundwater**			
1	✓		Keep per CERCLA
2	✓		Viable and includes treatment
3	✓		Viable and includes treatment
4	✓		Viable and includes treatment
5		✓	Does not treat pnmary chlonnated volatile alkanes (such as 1,1,2,2-PCA)

3.2.1 Preliminary Alternatives for Disposal Sites and Associated Soil

Five of the six preliminary alternatives for disposal pits and associated soil are retained for further screening as potential alternatives.

Alternative 1, No Action, is retained per CERCLA requirements.

Alternative 2, Institutional Controls, and *Alternative 3, Soil Containment,* are both viable and are therefore retained.

Alternative 4, In-situ Treatment, satisfies the CERCLA preference for treatment; however, it not viable for disposal sites where there are heterogeneous wastes and potential unknowns, such as those reported in the disposal pits. Therefore, this alternative is not retained.

Alternative 5, Ex-situ Treatment, satisfies the CERCLA preference for treatment and is retained.

Alternative 6, Excavation, Transport, and Offsite Disposal, is retained as the alternative that permanently removes the waste from the site by transferring it to an approved offsite disposal facility.

3.2.2 Preliminary Alternatives for VOC-Contaminated Subsurface Soil and Soil-to-Indoor Air

Since a presumptive remedy has been selected for subsurface soils, both alternatives will be carried through to Sections 4 and 6. *Alternative 1, No Action,* is retained per CERCLA requirements. *Alternative 2, SVE,* is the presumptive remedy and satisfies the CERCLA preference for treatment.

3.2.3 Preliminary Alternatives for Groundwater

Four of the five preliminary alternatives for groundwater are retained for further screening as potential alternatives.

Alternative 1, No Action, is retained per CERCLA requirements.

Alternatives 2 through 4 are retained. All alternatives are in-situ technologies that satisfy the CERCLA preference for treatment. Institutional controls will be implemented during all alternatives. *Alternative 5* is not retained due to fact that the chlorinated alkanes (such as 1,1,2,2-PCA) are resistant to chemical oxidation.

3.3 Screening of Potential Alternatives

3.3.1 Screening Criteria

This section defines each of the screening criteria used for this phase of the screening process — relative effectiveness, implementability, and cost. Potential alternatives with the most favorable composite appraisal of effectiveness, implementability, and cost are carried forward as final alternatives for detailed analysis in Sections 4 through 7. Alternatives that are considered effective and implementable are not eliminated on the basis of cost alone.

3.3.1.1 Effectiveness

Effectiveness is the degree to which an alternative safeguards human health by reducing potential human exposure to contaminated media, and protects the environment by preventing further transport of the constituents. Alternatives that meet this criterion are considered effective; alternatives that are relatively less effective or not effective are eliminated from further consideration.

3.3.1.2 Implementability

Implementability refers to the technical and administrative feasibility of implementing the option.

Technical feasibility refers to the ability of process options to be constructed and reliably operated, and to meet technology-specific regulations until a remedial action is complete; the term also includes operations and maintenance (O&M), replacement, and monitoring of technical components after the remedial action is complete, if such monitoring is required.

Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for, and availability of, specific equipment and technical specialists. Options that are technically or administratively difficult may be eliminated from further consideration.

3.3.1.3 Cost

Cost refers to the present worth of construction and long-term O&M costs. At this stage of analysis, costs are discussed qualitatively. Detailed cost analyses for the final alternatives remaining after screening appear in Sections 4 through 7.

3.3.2 Screening of Remedial Alternatives – All Media Associated with Dunn Field

3.3.2.1 Alternative 1 – No Action

Description

Alternative 1 will leave buried receptacles, contaminated soil and groundwater in place. Receptacles containing contaminant compounds buried in subsurface soils will be expected to remain competent. Natural processes, such as neutralization and attenuation, are expected to occur with the potential to reduce contaminant concentrations over time. However, the concentrations will not be monitored and the degree to which natural processes are occurring will be unknown. No deed restrictions on future use within Dunn Field takes place under this alternative.

Evaluation

No action does not guarantee any reduction in the TMV of any contamination at the site. Under Alternative 1, the potential pathways continue to exist, and the COCs in soil and groundwater may migrate. Since there is no action to limit potential exposure, the no action alternative is not considered viable. However, it will be retained as an alternative, as required by CERCLA.

Effectiveness

The no action alternative relies entirely on natural attenuation processes to remediate associated soil and groundwater, contaminant receptacles to remain competent, and on existing land use controls to prevent residential land use. Contamination in associated soil and groundwater will not likely be remediated under these conditions. Contaminant receptacles may not remain intact, leaching into surrounding soils and underlying groundwater. The effectiveness of this alternative is unpredictable.

Implementability

Implementability is not a consideration since nothing is implemented.

Cost

Alternative 1 has no associated costs.

3.3.3 Screening of Remedial Alternatives – Disposal Sites and Associated Subsurface Soil

3.3.3.1 Alternative 2 – Institutional Controls

Description

Alternative 2 will leave buried receptacles and contaminated soil in place, but will involve deed restrictions limiting the use/sale of the property or portions of the property; regulation of intrusive activities and signage to indicate hazards potential receptors could encounter; maintenance of access barriers to limit entry into contaminated areas; and periodic inspection for soil disturbance or migration of COCs. Receptacles containing contaminant compounds buried in subsurface soils will be expected to remain competent. Some biodegradation and chemical reactions with subsurface materials may occur naturally over time.

Evaluation

Institutional controls do not guarantee any reduction in the TMV of any contamination at the site. Under Alternative 2, the potential pathways continue to exist, and the COCs in soil could migrate and further impact groundwater in the fluvial aquifer. However, institutional controls will be used to prevent access to these pathways.

Effectiveness

Alternative 2 relies entirely on natural attenuation processes to remediate associated subsurface soil and on contaminant receptacles to remain competent. Contamination in associated soil and buried materials may not be remediated under these conditions. Contaminant receptacles may not remain intact, leaching into surrounding soils and the underlying groundwater. Protectiveness depends on preventing access to the site constituents. Long-term protectiveness is uncertain.

Implementability

Institutional controls involve legal documents such as deed restrictions, and long term custodial care. These services are not difficult to obtain but long-term care is not always reliable. Community acceptance may be difficult to obtain compared to remedies that are more active.

Cost

Costs for the institutional controls alternative are relatively low. Some ongoing maintenance costs are associated with periodic site inspections and remedy evaluations to verify access limitations and continued remedy effectiveness.

3.3.3.2 Alternative 3 – Soil Containment

Description

The containment alternative involves the placement of a protective cover or cap over contaminated soil and residual waste to act as a physical barrier against direct contact to workers or residents and water percolation. Natural clean soil consisting of low-permeability (clay) and high-permeability (sand) soil, asphalt, concrete or other material such as flexible geomembrane liner from offsite will be placed over contaminated areas. Surface controls such as stormwater control and vegetative cover will be necessary to prevent erosion damage to a soil cover. This alternative will require deed restrictions limiting the use of the property or portions of the property, regulation of intrusive activities during which potential receptors can encounter COCs, maintenance of access barriers to limit entry into contaminated areas, signage to warn visitors to the site that these areas exist, and periodic inspection for cover disturbance.

Evaluation

With Alternative 3, associated subsurface contamination at the site is expected to attenuate over time. However, the materials buried in the disposal sites will persist and will not attenuate. The soil cover or pavement provides a barrier, preventing direct exposure to contamination. It does not guarantee any reduction in the toxicity or volume of contamination, but would reduce its mobility somewhat. Reports of containerized liquid waste in the disposal sites suggest that over time, even if a containment/cap were installed, the containers may become compromised and release liquids to the environment regardless of any infiltration protection from the containment. Also, some of the disposal sites may contain waste that would be amenable to a containment alternative.

Effectiveness

The containment alternative protects human health by preventing direct contact with the disposal site. Soil containment relies primarily on a physical barrier preventing exposure to disposal material and any associated contaminated soil. Natural attenuation processes may remediate some associated contamination at the site, but the time required for constituents to attenuate below target levels is difficult to predict. Buried wastes could still pose a risk to the underlying groundwater.

Implementability

Institutional controls involve legal instruments such as deed restrictions and long-term custodial care. These services are not difficult to obtain, but long-term care is not always reliable.

Material from off-site is used for the soil cover or pavement. Dust control would be considered, and surface controls are necessary to prevent erosion damage to a soil cover. Routine O&M is required to maintain integrity of the cover, as well as periodic site inspections and cover evaluations to verify access limitations and continued remedy effectiveness.

Cost

Costs for soil containment are moderately low. They include excavation, hauling, and placement of soil or paving on top of contaminated soil. Costs may range from $5 to $50 per ton of cover material. Some ongoing maintenance costs are associated with site inspection and maintenance of cover material.

3.3.3.3 Alternative 5 – Ex-situ Soil Treatment with Institutional Controls

Description

Alternative 5 includes institutional controls, as described in Section 3.3.2.2, and provides ex-situ treatment of contaminated subsurface soils associated with buried receptacles, after the excavation of soil and receptacles. Like alternative 3, the contaminated soil is physically treated to bind constituents within a solidified mass. Once contaminated soil is excavated, it is treated in a pug mill, rotating drum mixer, or other slurry mixing apparatus with emulsified asphalt, pozzolan/Portland cement, or vitrification/molten glass to immobilize or contain the harmful constituents. Under CERCLA, material can be replaced on site; however, the locations available for placement of soil may be limited due to treatment. Therefore, ex-situ soil treatment may also be used to comply with disposal requirements for offsite disposal facilities. Excavated sites, containing contaminant compounds, will be disposed of at an appropriate offsite disposal facility. Institutional controls will be used to limit site access during implementation of the technology.

Evaluation

Ex-situ soil treatment reduces the mobility of contaminated subsurface soils due to treatment. There will be no guarantee of any reduction in the toxicity or volume of contamination at the site. Excavated soil from all burial pits could be placed in one location, decreasing area exposed to potential pathways. Receptacles will be disposed of, removing any potential future source.

Effectiveness

This alternative effectively safeguards human health through treatment of contaminated soil. This alternative relies on the physical/chemical treatment process of solidification to immobilize site contaminants. This alternative may take several months to become effective.

Implementability

All contaminated soil and buried receptacles are excavated. Implementation requires the use of onsite heavy equipment, an offsite landfill facility that can be used for disposal of receptacles, and transportation to the facility. The treatment process can result in solidified material that may affect future use of the site. Some processes within this treatment may result in significant increase in volume. All soil could be re-located to one central area, reducing the number of areas on site requiring institutional controls; however, more trucks will be required for transport of soil. Site supervision will be required during treatment and institutional controls will need to be obtained.

Substantive requirements of the NPDES permit must be addressed with this alternative. These include control of sediment runoff in stormwater during the removal/remedial actions, and may include collecting stormwater samples to verify if any contamination is migrating offsite during these actions. In addition, dust control may be warranted if the material in the sites adheres to soil. Additionally, the site must be reasonably returned to its pre-action status by replacing sod and performing other landscaping as necessary. Offsite soil will need to be brought onsite to re-grade excavated soil. Dust or vapor control may be required.

Cost

Costs for Alternative 5 are moderate to moderately high and depend on initial and target concentrations, quantity of soil treated, depth of contamination, soil characteristics, amount of debris, characteristics of any residual, site preparation, equipment needs, methods for excavation and transportation. Excavation and hauling costs may range from $5 to $50 per ton, with the lower end of that range corresponding to a large amount of soil that does not have to be transported a long distance. Typical costs for ex-situ solidification on excavated soil are generally the same as Alternative 3, with a mobilization cost of $10,000 to $20,000 and an operating cost of $90 to $290 per cubic yard.

Costs for preventing sediment runoff, monitoring stormwater runoff, and post-action landscaping vary with the size of the site, and the type of action. Stormwater runoff costs are assumed to be minimal, by using passive controls such as hay bales and silt screens. Costs for post-action landscaping also vary with pre-vegetation and the size of the site, but are assumed to average $5,000 per acre.

3.3.3.4 Alternative 6 – Excavation, Transportation, and Offsite Disposal

Description

Alternative 6 includes excavation of contaminated soil and buried receptacles, transportation and, permanent offsite disposal in a RCRA-permitted landfill as an industrial waste or hazardous waste, depending on levels of contamination and landfill requirements. Some pretreatment processes might be required to meet land disposal restrictions. Excavated areas will be graded with clean soil brought from offsite.

Evaluation

Excavation, transport, and offsite removal removes contaminated soil, reducing the possibility for COC migration or exposure.

Effectiveness

This alternative effectively safeguards human health through removal, and controlled disposal of contaminated soil and buried receptacles. This alternative relies on excavation to remove contamination at the site. The duration of this alternative depends on the quantity of soil, the number of loaders and trucks operating, and the availability of adequate containers to transport contaminated soil to a disposal facility. This alternative may take several months to implement.

Implementability

Implementation requires the use of onsite heavy equipment, an offsite landfill facility that can be used for soil disposal, transportation to the facility, and containers for contaminated soil. Confirmation sampling is required after excavation.

Substantive requirements of the NPDES permit must be addressed with this alternative. These include control of sediment runoff in stormwater during the removal/remedial actions, and may include collecting stormwater samples to verify if any contamination is migrating offsite during these actions. Additionally, the site must be reasonably returned to its pre-action status by replacing sod and performing other landscaping as necessary. Offsite soil will need to be brought onsite to re-grade excavated soil. Dust or vapor control may be required.

Cost

Costs for alternative 6 can be moderate to high, and are dependent on the nature of the hazardous materials, methods used for excavation, transportation costs, and costs for disposal at the particular type of RCRA-permitted facility. Typically costs for hazardous waste landfill transportation and disposal range from $270 to $800 per ton. The costs for non-hazardous waste landfill transportation and disposal range from $25 to $150 per ton. The lower end of the range corresponds to soil contaminated with less hazardous materials, an effective method of excavation, and a nearby disposal facility.

Costs for preventing dust control, sediment runoff, monitoring stormwater runoff, and post-action landscaping vary with the size of the site, and the type of action. Stormwater runoff costs are assumed to be minimal, by using passive controls such as hay bales and silt screens. Costs for post-action landscaping also vary with pre-vegetation and the size of the site, but are assumed to average $5,000 per acre.

3.3.4 Screening of Remedial Alternatives – VOC-Contaminated Subsurface Soil and Soil-to-Indoor Air

As described in Section 1.6, Dunn Field VOC-contaminated subsurface soils and, therefore, soil-to-indoor air meet the criteria required to apply the presumptive remedy, SVE. This alternative has already been screened against several other alternatives for these contaminants and matrix (EPA, 1994) and recommended as the preferred remedy. This screening of technologies is presented in Appendix B. As stated in the document, *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with VOCs in Soils* (EPA, 1993), no additional preliminary screening is required in this FS.

3.3.5 Screening of Remedial Alternatives – Groundwater

3.3.5.1 Alternative 2 – ZVI Injection, Enhanced Bioremediation and Enhanced Extraction and MNA with Institutional Controls

Description

Alternative 2 combines ZVI injection and enhanced bioremediation while enhancing the existing groundwater extraction system positioned along the western boundary of Dunn Field.

In addition, MNA with institutional controls will be implemented. In this alternative, ZVI is used to aggressively remediate the more contaminated portions of the fluvial aquifer while the existing groundwater extraction system is retained and enhanced to further remove the contaminants. Also, nutrients are injected into the fluvial aquifer to enhance biodegradation of the contaminants in a down-gradient position.

The potential for groundwater contact and use is restricted by institutional controls until active treatment reduces contaminant concentrations to acceptable levels. Groundwater monitoring is conducted until after MCLs are achieved. Monitoring is also required to measure plume reduction and/or migration. Contingency plans will be evaluated if site contaminants migrate towards deeper aquifers (see Figure 7-2 for the location of the potential contingency areas). Additional extraction wells will be added to the existing system to enhance the ability of the system to control offsite migration. Treatment of contaminated groundwater will occur at the POTW. If system effluent concentrations fail to comply with effluent discharge standards, onsite treatment, such as an air stripper and/or activated carbon or bioreactor, may be implemented (as a contingency).

Evaluation

Alternative 2 reduces contamination in groundwater by physical and in-situ biological treatment and extraction. This alternative includes institutional controls to restrict use of groundwater in the fluvial aquifer during remediation. Long-term groundwater monitoring measures the rate of biodegradation, system effectiveness, and defines migration of contaminant plumes, if any.

Effectiveness

This alternative effectively safeguards human health through treatment of contaminated groundwater. ZVI injection will act to speed up the treatment of the contamination.Enhanced bioremediation has been implemented at many hazardous waste sites and is considered an effective technology. However, multiple injections of biological amendments may be required to reach remedial goals. In addition, treatment may not work as effectively at sites with very high VOC concentrations, where a continuing source is indicated. However, the ZVI injection should alleviate this problem. Since the time required to degrade the contaminants below MCLs is difficult to predict, protectiveness relies on long-term monitoring and on institutional controls to prevent access to the groundwater until remediation is complete.

Implementability

Bench-scale and pilot testing is required to confirm well spacing and injection rates of the ZVI. Surface and subsurface heterogeneity may increase the difficulty of injecting amendments into contaminated areas and adequate injection equipment is required to reach appropriate treatment depth. Additional extraction wells and the enhanced bioremediation injection wells will be installed using the rotosonic drilling method and the substantive requirements of permits will be complied with. The alternative generates relatively little waste and requires minimal surface structures during operation; however, access to areas off of the Memphis Depot facility (west of Dunn Field) will be required. The extraction system effluent concentrations need to comply with discharge standards, as established by the City of Memphis. Institutional controls will need to be implemented.

Cost

Costs for Alternative 3 are likely to be high to very high, due primarily to injection of materials and maintenance of the existing extraction system. Costs include injection of biological amendments, installation of injection wells or boreholes, equipment, mobilization, and long-term groundwater monitoring, installation of additional extraction wells, and operation and maintenance of the current extraction system. Typically, the costs for enhanced in-situ bioremediation can cost between $1 and $25 per pound of contaminant removed, depending on the depth to injection and lateral extent of the plume. If discharge from the extraction system needs to be treated, costs will also include onsite treatment.

3.3.5.2 Alternative 3 – ZVI Injection, PRB with MNA and Institutional Controls

Description

Alternative 3 combines ZVI injection as described in Alternative 2 with installation of a PRB. In addition, MNA with institutional controls will be implemented. In this alternative, an oxidizing agent (ZVI) is injected into the fluvial aquifer to promote anaerobic degradation of chlorinated organic compounds. The current groundwater extraction system is not retained as part of this alternative and will be decommissioned.

A permeable reactive barrier (PRB) will be installed west of Dunn Field (down gradient) to treat contaminated groundwater that has migrated offsite. A PRB is a passive in situ treatment zone of reactive material, usually granular zero-valent iron that degrades or immobilizes contaminants as ground water flows through it. A permeable treatment wall will be installed offsite as a permanent unit across the flow path of the contaminant plumes. Natural gradients transport contaminants through strategically placed treatment media. The permeable treatment wall consists of zero-valent iron granules or other iron bearing minerals for the treatment of CVOCs. The applicability of PRBs to the site will be demonstrated with the use of bench-scale testing of zero-valent iron with site groundwater and site COCs.

Evaluation

Alternative 3 reduces contamination in groundwater by in-situ chemical treatment. Institutional controls will restrict use of groundwater in the fluvial aquifer during remediation. Long-term groundwater monitoring measures the rate of contaminant reduction, and also indicates if site contaminants are migrating towards deeper aquifers. Contingency plans will be evaluated if site contaminants migrate towards deeper aquifers (see Figure 7-3 for the location of the potential contingency areas).

Effectiveness

This alternative effectively safeguards human health through treatment of contaminated groundwater.ZVI source area treatment of groundwater is an emerging technology and has been implemented at several sites. The effectiveness of treatment may be impeded by site porosity and the radius of influence of the injected colloidal ZVI. PRBs are also a recent treatment method but have been used successfully at many locations. Until remediation is complete, protectiveness relies on institutional controls to prevent access to groundwater.

Implementability

Pilot or bench-scale testing is required to determine applicability of treatment to site conditions, confirm injection point spacing, and quantities. Additional requirements to define implementability will be developed during testing.

Due to the depth of the groundwater, the ZVI source area treatment and reactive barrier wall will be installed as a series of injection points. Access to areas off of the Memphis Depot facility (west of Dunn Field) will be required. The alternative generates relatively little waste and requires minimal surface structures during operation.

Cost

Costs for Alternative 3 can be moderately high, depending on the amount of iron to inject and injection points required. However, due to its relatively rapid effectiveness, it may be more cost-effective than other alternatives requiring a longer remediation time. Costs include injection point installation, colloidal iron (ZVI), mobilization of equipment and personnel, and long-term monitoring.

3.3.5.3 Alternative 4 – Air Sparging with SVE, PRB with MNA and Institutional Controls;

Description

Alternative 4 combines MNA and institutional controls and air sparging and SVE along the western boundary of Dunn Field. In addition, a PRB will be installed along the western offsite boundary of Dunn Field. Air sparging is a proven in-situ technology that injects air into the groundwater aquifer. This technology removes contaminants from the groundwater through volatilization into the injected air stream. Volatilized contaminants removed from the groundwater move into the vadose zone and are recovered by a SVE system (which will be installed as part of the presumptive remedy for subsurface soils). The current groundwater extraction system is not retained as part of this alternative and will be decommissioned. Contingency plans will be evaluated if site contaminants migrate towards deeper aquifers (see Figure 7-4 for the location of the potential contingency areas). The installation of the PRB is the same as described in Section 3.3.5.2.

Evaluation

Alternative 4 reduces contamination in groundwater by in-situ physical treatment. Air sparging is expected to remove VOCs from groundwater in the treatment zone at a high rate. Calculations using Henry's Law (assuming chemical equilibrium) indicate that sparging 200 parts per billion (ppb) of PCE produces a vapor concentration of about 31 parts per million by volume (ppmV), or about 215 mg/L, in the soil zone. Similar calculations suggest that sparging 85 ppb of TCE produces a vapor concentration of about 6 ppmV, or about 32 mg/L, in the soil zone. Vapors will be removed from the soil by the SVE system.

This alternative includes institutional controls to restrict use of groundwater in the fluvial aquifer during remediation. Long-term groundwater monitoring measures the rate of biodegradation, system effectiveness, and also warns if site contaminants are migrating into deeper aquifers.

Effectiveness
This alternative effectively safeguards human health through treatment of contaminated groundwater. Air sparging has been shown to be effective at removing VOCs from groundwater in relatively homogeneous aquifers. However, air channeling can be a significant concern. This occurs because the air bubbles form preferential pathways in the aquifer as they migrate to the surface. The effects of channeling can be minimized by pulsing the airflow into the well. Air sparging can take years to be effective. Because the time required to degrade the contaminants below MCLs is difficult to predict, protectiveness relies on monitoring and on institutional controls to prevent access to the groundwater until remediation is complete. Additional remedial measures, including the installation of a PRB should reduce the number of years to remediate groundwater.

Implementability
Pilot testing is needed to determine the configuration of sparge wells, release rates of VOCs, and airflow rates. Wells and blowers (air pumps) are relatively easy to install and operate. Bench-scale testing is also necessary for installation of PRBs to determine spacing of injection points. Access to areas off of the Memphis Depot facility (west of Dunn Field) will be required.Aboveground equipment and piping are required to implement this technology and some equipment maintenance is required. The depth to groundwater and the relatively thin saturated thickness of the fluvial aquifer could cause a limited radius of influence and increase the number of injection wells.

Injection borings for the PRBs will be installed using the rotosonic drilling method and the required permits will be obtained. The alternative generates relatively little waste and requires minimal surface structures during operation.

Cost
Costs for Alternative 4 are moderately high to high, depending on the period of operation. Costs for air sparging may range from $150,000 to $350,000 per acre and are dependent on number of sparge points, installation of blowers and piping, short-term monitoring, and O&M labor. The cost efficiency of the treatment decreases as contaminant concentrations in the plume decrease over time. If discharge from extraction system needs to be treated, costs will also include onsite treatment.

3.4 Summary of Alternatives Screening

The relative merits of the potential alternatives were compared and screened on the basis of effectiveness, implementability, and cost. This screening produced a final list of alternatives for detailed analysis in Sections 4 through 7.

The "No Action" alternative (Alternative 1) is retained for all media on Dunn Field as required per CERCLA.

The final alternatives retained for disposal sites and associated subsurface soils are as follows:

- Alternative 3: Soil Containment with Institutional Controls;
- Alternative 5: Ex-situ Soil Treatment with Institutional Controls; and
- Alternative 6: Excavation, Transportation, and Offsite Disposal with Institutional Controls.

The final alternatives retained for VOC-contaminated subsurface soils and soil-to-indoor air are as follows:

- Alternative 2: SVE (presumptive remedy).

The final alternatives retained for groundwater are as follows:

- Alternative 2: ZVI Injection, Enhanced Bioremediation and Enhanced Extraction and MNA with Institutional Controls;
- Alternative 3: ZVI Injection, PRB with MNA and Institutional Controls;
- Alternative 4: Air Sparging with SVE, PRB with MNA and Institutional Controls.

Tables

TABLE 3-1

Summary of Preliminary Disposal Site and Subsurface Soil Remedial Alternatives

Rev. 1 Memphis Depot Dunn Field FS

			Preliminary Alternatives			
			1	3	5	6
Medium	General Response Action	Technology Type	No Action	Containment (Capping) with IC	Ex-situ Soil Treatment with IC	Soil Excavation and Off-site Disposal with IC
Disposal Sites & Subsurface Soil	No Action	None	•			
	Institutional Controls	Access and Use Restrictions		•	•	•
	Containment	Capping		•		
		Surface Controls		•	•	•
		Dust and Vapor Suppression		•	•	•
	Removal	Excavation			•	○
	Treatment	Ex-situ Physical-Chemical			•	
	Disposal	Landfill			•	•

IC Institutional Controls

TABLE 3-2
Summary of Preliminary Groundwater Remedial Alternatives
Rev. 1 Memphis Depot Dunn Field FS

			Preliminary Alternatives			
			1	2	3	4
Medium	General Response Action	Technology Type	No Action	Zero Valent Iron (ZVI) Injection; Enhanced Bioremediation; Enhanced Extraction; MNA and IC	ZVI Injection; Permeable Reactive Barrier (PRB); MNA and IC	Air Sparging with SVE; PRB; MNA and IC
Groundwater	No Action	None	o			
	Institutional Controls	Access and Use Restrictions		o	o	o
	Removal	Groundwater Extraction		o		
	Treatment	In-situ Biological		o		
		In-situ Physical/Chemical		o	o	o
		Ex-situ Biological		o[1]		
		Ex-situ Physical/Chemical		o[1]		
	Disposal	Wastewater Discharge to POTW		o		
	Monitoring	Monitoring during Implementation		o	o	o

1 Contingency Treatment
IC Institutional Controls

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4.0 Approach to the Detailed Analysis Process

4.1 Approach

The information presented in Sections 5 through 7 is designed to aid stakeholders in the evaluation and, ultimately, in the selection of remedial actions for soils and groundwater at Dunn Field. The detailed analysis follows the development and screening of alternatives presented in the previous section, and precedes the actual selection of alternatives with the Proposed Plan. The alternatives selected in the Proposed Plan will be open for public comment prior to selection of a remedy in the ROD.

The alternatives retained for detailed analysis from Section 3 are described and evaluated in Section 5 through 7. The components of this evaluation include the following:

- Further definition of each alternative, including site-specific application and associated performance requirements;
- A summary evaluation of each alternative comparing its performance to the nine criteria prescribed by EPA pursuant to CERCLA (42 of the U.S. Code [U.S.C.] Sections 9601 through 9675); and
- A summary analysis of the alternatives with respect to each other.

The evaluation criteria and a detailed description of each alternative are provided followed by a detailed evaluation of the alternatives. Finally, alternatives are compared to each other.

4.2 Evaluation Criteria

Pursuant to CERCLA and the NCP (40 CFR 300), a range of remedial action alternatives was developed and included in Section 3. Remedial actions must meet the following statutory requirements:

- Protect human health and the environment;
- Comply with ARARs or define criteria for invoking a waiver;
- Be cost-effective;
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element or explain why this is not attainable.

Since these requirements must be specifically addressed in the ROD, the alternatives are evaluated to show how remedial actions support these requirements. An alternative will not necessarily fulfill all requirements.

There are also statutory (CERCLA 121(b)(1)(A)) considerations that address long-term effectiveness of an action, including:

- Long-term uncertainties associated with land disposal;
- Goals, objectives, and requirements of the Solid Waste Disposal Act;
- Persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate;
- Short- and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;
- Potential for future remedial action costs if the alternative were to fail; and
- Potential threat to human health and the environment associated with excavation, transportation, and re-disposal, or containment.

EPA has developed nine evaluation criteria that address these statutory requirements and additional technical and policy considerations that are important for a CERCLA remedial action. The nine criteria are grouped into three categories: threshold, balancing, and modifying.

4.2.1 Threshold Criteria

Threshold criteria must be met or complied with by the selected remedial action. These criteria include the following.

4.2.1.1 Overall Protectiveness (Criterion 1)

Under this criterion, each alternative is evaluated to determine its ability to reduce risk to human health and the environment. The evaluation is also used to assess whether the alternative poses unacceptable short-term or cross-media impacts. For each alternative, the evaluation includes the following determinations:

- How is the source of contamination to be reduced or controlled;
- How are the site-related risks to human health and the environment to be reduced; and
- How are target levels attained.

4.1.1.2 Compliance with ARARs (Criterion 2)

Remedial actions must comply with the requirements, criteria, standards, and limitations under federal or more stringent state and local environmental laws that are legally applicable, or relevant and appropriate, to the hazardous substances or circumstances at a site. Regulations considered during this FS include the following:

- RCRA - Applicable to the generation, transportation, storage, treatment, and disposal of hazardous waste during remedial action;
- SDWA - Applicable to the concentration of contaminants present in groundwater used for potable water supply, and local groundwater and wellhead protection requirements;

- Drinking Water Standards (MCLs) applicable to the concentration of contaminants present in groundwater used for potable use;
- Clean Water Act - Applicable to NPDES permitting and discharge monitoring requirements;
- Clean Air Act - Applicable to local air quality requirements;
- *Rules and Regulations of Wells in Memphis-Shelby County* established by the Ground Water Quality Control Board for Memphis-Shelby County, Tennessee - Applicable to the location, design, installation, use, modification, repair, and abandonment of all types of wells;
- *Rules and Regulations of Wells in Shelby County*, described above, prohibit water wells within a half-mile of the designated boundaries of a listed federal or state CERCLA site or RCRA corrective action site;
- State of Tennessee Rule 1200-4-6 - Applicable to underground injection control (UIC) permit with the Division of Water Supply, and injection well permits;
- State of Tennessee Rule 1200-3 - Applicable to emissions to air during on-site treatment and the substantive requirements of the Tennessee Air Quality Act, as the City of Memphis is in a non-attainment zone;
- State of Tennessee Rule 1200-1-13.08(10) – Applicable to recording Notice of Land Use Restrictions in deeds transferring property whenever the remedial action does not fully address the hazardous substances which pose a risk to human health or the environment;
- State of Tennessee Rule 1200-1-11.06(7)(g) and (j) - Applicable to the preparation of a survey plat "indicating the locations and dimensions of landfill cells or other hazardous waste units with respect to permanently surveyed benchmarks" and should be submitted to the local zoning authority and EPA.
- Stormwater Discharge from Construction Activities, No. TNR10-0000 – Applicable to remedial actions that disturb 5 acres or more of land and need to comply with the substantive requirements of the NPDES Phase I stormwater permit program as implemented by TDEC under its General Permit;
- City of Memphis, Public Works - Permits applicable to industrial effluent discharging to a POTW.
- Existing land use controls – Currently, Dunn Field is zoned as Light Industrial (I-L). The principal uses permitted are manufacturing, wholesaling, or warehousing.

4.2.2 Balancing Criteria

Balancing criteria are the five criteria used to determine the acceptability of a remedial action. These criteria provide a way to assess which alternative best achieves the remedial objectives while balancing technical and cost considerations. The balancing criteria are included in the following paragraphs.

4.2.2.1 Long-term Effectiveness and Permanence (Criterion 3)

Long-term effectiveness and permanence are measured by how much risk remains after the remedy is completed. Alternatives providing the highest degree of long-term effectiveness and permanence are those that leave little or no waste at the site, make long-term maintenance and monitoring unnecessary, and minimize the need for institutional controls. The evaluation of long-term effectiveness includes consideration of the following factors:

- The magnitude of the risk to human and environmental receptors posed by untreated waste or treatment residues after active remedial activities;
- The type, degree, and adequacy of long-term management required for untreated waste or treatment residues after active remedial activities;
- The long-term reliability of engineering and/or institutional actions to provide continued protection from untreated waste or treatment residues; and
- The potential need for replacement of the action and the continuing need for repairs to maintain the performance of the remedy.

4.2.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment (Criterion 4)

The statutory preference is a remedial action that employs treatment to reduce the toxicity, mobility, or volume (TMV) of hazardous substances. Criterion 4 addresses the anticipated performance of technologies to reduce TMV of hazardous substances. Alternatives that do not include treatment technologies are not considered to reduce TMV. This criterion considers the following:

- The treatment process(es);
- The amount of hazardous substances that will be treated or destroyed;
- The degree of expected reduction in TMV through treatment, including how the treatment addresses the principal risk(s);
- The degree to which the treatment will be irreversible; and
- The type and quantity of residuals that will remain following treatment.

4.2.2.3 Short-term Effectiveness (Criterion 5)

This criterion considers the short-term effects of an alternative on human health and the environment. Short-term effectiveness is measured by:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential adverse impacts on workers during implementation, and the effectiveness and reliability of protective measures;
- Potential for adverse environmental impacts during implementation, and the effectiveness and reliability of mitigation measures; and
- Estimated duration of implementation needed to achieve the remedial objectives.

4.2.2.4 Implementability (Criterion 6)

Implementability deals with the difficulties of constructing and operating an alternative, and the availability of materials and services required. The following factors are considered:

- Ability to construct and operate;
- Ease of doing more action, if needed;
- Ability to monitor effectiveness;
- Ability to obtain approvals and coordinate with other agencies;
- Availability of services and capacities;
- Availability of necessary equipment, specialists, and materials; and
- Availability of technologies.

4.2.2.5 Cost (Criterion 7)

Preliminary cost estimates were developed for each remedial alternative. These cost estimates are used to compare the alternatives, not to bid the work. These estimates were made from available information, i.e., they have an expected accuracy of -30 percent to +50 percent for the scope of action described for each alternative. The estimates are divided into capital costs and O&M costs, and are based on information provided by vendors, regulators, and experience on similar projects. The present worth of the capital cost and 30 years of O&M are included. Details of these cost estimates are included in Appendix D. Significant uncertainties that may affect cost are discussed with each alternative.

4.2.3 Modifying Criteria

State and community acceptance of a proposed remedial action is an important element in the decision to select and to implement. Concerns of state regulators and the local community must be addressed during the selection process and are generally termed "modifying criteria."

4.2.3.1 State Acceptance (Criterion 8)

The State of Tennessee (TDEC) will have the opportunity to review and comment on all stages of the Dunn Field cleanup process. TDEC comments become part of the Administrative Record and are considered in selection of the preferred remedy.

4.2.3.2 Community Acceptance (Criterion 9)

Potential community concerns are used to evaluate each remedy in this FS. Consistent with the NCP, public comments will be solicited on the preferred alternative presented in the Proposed Plan. These public comments are factored into the decision to select a final remedy.

5.0 Detailed Analysis of Disposal Sites and Associated Soil Alternatives

5.1 Definition of Disposal Sites and Associated Soil Alternatives

The EPA guidance for conducting an RI/FS (EPA, 1988) recommends that each alternative be defined in sufficient detail to apply the evaluation criteria and to determine order-of-magnitude costs. The definition may include preliminary design calculations and drawings, as well as address the limitations, assumptions, and uncertainties about each alternative. However, the definition step is not a remedial design. Complete details of how an alternative will be implemented are not necessary (or required by CERCLA) for the comparative analyses performed. The quantitative data given as part of the description of an alternative are estimates based on conceptual design and professional experience. They are for the purpose of estimating costs to an accuracy of +50% to -30%, per EPA guidance on FS cost estimates.

In the detailed analyses presented in this section, alternatives were defined with respect to future land use and respective disposal sites. Based on information generated by the Archives Search Report, approximately 15 disposal sites are known to exist in the Disposal Area and one (a CC-2 disposal area) disposal site is known to exist in the Stockpile Area (Table 1-6). These 16 sites have been identified by the BCT as having a priority ranking for remedial action. The anticipated land use for these areas is industrial. The various COCs associated with the disposal sites are summarized in Table 5-1. While the alternatives discussed in this section may be effective at remediating contaminants contained within the disposal sites and associated subsurface soils to industrial use standards, remedial action for subsurface soils contaminated with VOCs (Section 6) will be required prior to the Disposal Area being acceptable for industrial use and to be protective of groundwater. The disposal sites and associated soil alternatives retained from Section 3 are defined in the following sections.

The following RAOs that have been developed for the disposal sites at Dunn Field are as follows:

- Eliminate potential for groundwater impacts from a release of buried containerized hazardous liquids and the leaching of contaminants from buried hazardous solids;
- Eliminate future unacceptable risk of direct contact with buried hazardous liquid and/or solids due to intrusive activities during future land use or site development.

5.1.1 Alternative 1 – No Action

This alternative includes no active remedial activities, but is required by CERCLA to be retained as a baseline for comparison.

5.1.2 Alternative 3 – Soil Containment with Institutional Controls

The soil containment alternative involves the placement of a protective cover or cap over contaminated soil and residual waste to act as a physical barrier against direct contact to workers or residents and water percolation. Natural clean soil consisting of low-permeability (clay) and high-permeability (sand) soil, asphalt, concrete or other material such as flexible geomembrane liner from offsite will be placed over contaminated areas. Surface controls such as stormwater control and vegetative cover will be necessary to prevent erosion damage to a soil cover. This alternative will require deed restrictions limiting the use of the property or portions of the property, regulation of intrusive activities during which potential receptors can encounter COCs, maintenance of access barriers to limit entry into contaminated areas, signage to warn visitors to the site that these areas exist, and periodic inspection for cover disturbance.

This alternative includes constructing a protective cover or containment of soil or pavement over contaminated disposal sites with deed restrictions preventing disturbance of the cover and preventing residential landuse. Disposal sites and any associated contaminated subsurface soils would be left in place, and a 2-ft thick cover would be installed over them. In addition, deed restrictions preventing future disturbance of the cover would be provided. These restrictions would be coordinated with the Depot reuse implementation plans, and would be included in all deeds and leases. Location of the disposal sites would be required in the deed language. Figure 5-1 depicts the various disposal areas that this alternative would address the disposal sites.

Containment will be applied to individual soil areas within the Disposal Area that require remedial action to obtain the RAOs. Table 5-1 summarizes the characteristics of these disposal sites. For purposes of the costing in this FS, it has been assumed that only 12 of the sites (or 10,215 square feet) presented in Table 5-1 will require future remedial efforts.

Preliminary design components will include the following:

- Deed restrictions will prevent future residential land use and intrusive activities within the covered/contained areas. These restrictions will be coordinated with the Depot reuse implementation plans, and will be included in all deeds and leases. A fence with signage will be required.
- Annual inspections and reports by the DoD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The remedy will require less than 1 year to achieve remedial goals.
- Areas identified with buried receptacles and subsurface soils contaminated with concentrations exceeding the RGOs will be treated. The extent of the disposal sites and associated subsurface soils as well as the contaminant concentration will be refined prior to the Dunn Field Remedial Design. The following information was developed within the Dunn Field RI (CH2M HILL, July 2002) regarding the areas of the pits:

  "In 1993, the U. S. Army Engineer Waterways Experiment Station conducted a geophysical investigation of the western portion of Dunn Field. Six areas were investigated to determine the location of buried trenches, pits, drums, and other sources that may be contributing to the contamination of the upper aquifer. The final technical report (GL-94-8) was published in March 1994. The report concluded that there are potential burial sites in five of the six areas surveyed. Based on this data, CH2M HILL conducted field observations on August 18, 1995. The observations indicated many surface irregularities and depressions, suggesting possible burial sites in the northwest quadrant of Dunn Field (the Disposal Area). Many of the irregularities and depressions appeared to correspond with the mapped waste areas while others did not. Engineers from CH2M HILL revisited Dunn Field in October 1995, and mapped the irregularities and depressions noted during the visits. The results of the mapping confirm that many of the field-identified depressions and irregularities correspond well with previously mapped burial sites on Dunn Field, and there were some that did not. Three (3) figures generated from the mapping of the irregularities and depressions on the western portion of Dunn Field are included in Appendix A-6."

- Fugitive dust or vapor emissions and stormwater runoff controls will be required during remedial activities.
- Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.

5.1.3 Alternative 5 – Ex-situ Soil Treatment with Institutional Controls

This alternative includes excavation of each disposal site and associated contaminated subsurface soils, treatment of contaminated subsurface soils through solidification, and institutional controls prohibiting future residential use. This alternative will immobilize contaminants in associated subsurface soils and remove any potential source in the buried receptacles. The excavated receptacles will be disposed of in an appropriate disposal facility. Implementation of this alternative will be fully protective for industrial use by eliminating risk of exposure to subsurface soil areas with contaminants exceeding levels acceptable for industrial workers. Deed restrictions will be required to prevent industrial use during implementation of the remedy.

Treatment will be applied to individual soil areas within the Disposal Area that exceed levels acceptable for industrial land use. Table 5-1 summarizes the characteristics of these disposal sites. For purposes of the costing in this FS, it has been assumed that only 12 of the sites presented in Table 5-1 will require future remedial efforts.

Preliminary design components will include the following:

- Buried receptacles and associated contaminated soil will be excavated in areas where contaminated subsurface soils exceed industrial RGOs (Figure 5-1) to depth of disposal sites. This varies with each disposal sites but is 10 feet below land surface on average. Confirmation sampling will be required to verify contaminant areas have been removed.
- Contaminated soil will be treated with a mixture that will solidify the soil, immobilizing contaminants. Treated soil will be left onsite to the greatest extent possible. Some hazardous debris (assume 50 tons) will be removed for offsite treatment and disposal.
- Temporary restrictions are afforded by CERCLA to restrict site access during implementation of the technology. Permanent deed restrictions will prevent future residential land use. These permanent restrictions will be coordinated with the Depot reuse implementation plans, and will be included in all deeds and leases.

- Annual inspections and reports by the DoD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The remedy will require less than 1 year to achieve remedial goals.
- Deed restrictions will be enforced to prevent residential land use.
- Areas identified with buried receptacles and subsurface soils contaminated with concentrations exceeding the RGOs will be excavated and treated. As described in Section 5.1.2, the extent of the disposal sites and associated subsurface soils as well as the contaminant concentration will be refined prior to the Dunn Field Remedial Design.
- Contaminated soils will be excavated to depth of each disposal site, on average 10 feet, and replaced with compacted clean (as determined by analytical testing) backfill, obtained from offsite.
- Approximately 3,900 cubic yards of contaminated subsurface soil will be treated with chemical process (emulsified asphalt, pozzolan/Portland cement, or vitrification/molten glass) to solidify soils. Treated soils will be left on site to greatest extent possible.
- Excavated containers and compounds could require special handling, treatment and disposal at a RCRA hazardous waste facility (assume 50 tons); however, disposal characterization samples will be analyzed prior to disposal.
- Trucks will be required to transport clean backfill onsite and transport excavated receptacles offsite.
- Fugitive dust emissions and stormwater runoff controls will be required during remedial activities.
- Excavation confirmation sampling and analyses will be required to confirm that RGOs were met.
- Site restoration will be required following treatment to restore the site to acceptable conditions.
- Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.

5.1.4 Alternative 6 – Excavation, Transportation, and Offsite Disposal

This alternative includes the excavation, transportation, and offsite disposal of contaminated buried receptacles and associated contaminated subsurface soil. Implementation of this alternative will be fully protective for industrial use by eliminating risk of exposure to areas with concentrations exceeding industrial levels.

Excavation and offsite disposal will be applied to individual soil areas within the Disposal Area that exceed levels acceptable for industrial land use. Table 5-1 summarizes characteristics of the disposal sites. For purposes of the costing in this FS, it has been assumed that only 12 of the sites presented in Table 5-1 will require future remedial efforts.

Preliminary design components will include the following:

- Buried receptacles and associated contaminated soil will be excavated in areas where contaminated subsurface soils exceed industrial RGOs (Figure 5-1) to 1 foot below the depth of each disposal site. This varies with each disposal site but is 10 feet below land surface on average. Confirmation sampling will be required to verify contaminant areas have been removed.
- Excavation, transportation, and off-site disposal will require temporary controls that will limit the use of the Depot during implementation. These restrictions will be coordinated with the Depot reuse implementation plans.
- Annual inspections and reports by the DOD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The remedy will require less than 1 year to achieve remedial goals.
- Deed restrictions will be enforced to prevent residential land use.
- Areas identified with buried receptacles and subsurface soils contaminated with concentrations exceeding the RGOs will be treated. As described in Section 5.1.2, the extent of the disposal sites and associated subsurface soils as well as the contaminant concentration will be refined within the Dunn Field Remedial Design.
- Approximately 3,900 cubic yards of contaminated subsurface soil and debris will require treatment.
- Contaminated soils will be excavated to 1 foot below depth of each disposal site, on average 10 feet, and replaced with compacted, clean (as determined by analytical testing) backfill, obtained from offsite.
- Excavated subsurface soil and containers holding chemicals could require special handling, pretreatment and disposal at a RCRA Subtitle C hazardous waste landfill or other acceptable disposal facility; however, disposal characterization samples will be analyzed prior to disposal. If the compounds were determined to be non-hazardous, they could be disposed of at a local Subtitle D landfill.
- Trucks will be required to transport clean backfill onsite and transport excavated receptacles offsite. Some excavated material may have to be overpacked.
- Fugitive dust emissions or vapors and stormwater runoff controls will be required during remedial activities.
- Excavation confirmation sampling and analyses will be required to confirm that RGOs were met.
- Site restoration will be required following treatment to restore the site to acceptable conditions.

- Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.

5.2 Detailed Analysis of Disposal Sites and Associated Soil Alternatives

The following detailed analyses compare the alternatives to the nine EPA criteria. The analyses are presented in the following narrative and in a summary table (Table 5-2) following this section.

5.2.1 Alternative 1 – No Action

The no action alternative will not be protective of human health for disposal sites and associated contaminated subsurface soil under industrial land use. The alternative provides no control of exposure to the contaminated soil for industrial workers or controls to prevent industrial use. Further, although existing land use restrictions (see Section 4.2.1) currently prohibit residential development at the Depot, the existing restrictions could be removed or altered at some time in the future. The no action alternative does not add any protective layer of institutional controls prohibiting residential development.

There are no ARARs that apply to the no action alternative for subsurface soils. Long-term effectiveness will not be acceptable for this alternative. It includes no controls for exposure and no long-term management measures. All current and future potential risks will remain under this alternative to industrial workers. This alternative provides no reduction in toxicity, mobility, or volume of the contaminated soil through treatment. Short-term effectiveness will not apply since nothing is being implemented; there will be no additional risks posed to the community, remediation workers, or the environment. Further, there are no implementability concerns or costs posed by this remedy since no action will be taken. This alternative is not likely to be accepted by the regulatory agencies or the community. However, it is retained and presented for detailed evaluation as required by CERCLA.

5.2.2 Alternative 3 – Soil Containment with Institutional Controls

The containment alternative is protective of human health and the environment by preventing residential and industrial worker exposure to contaminated soil/waste. ARARs do not apply to cover installation since actions would not involve the disposal of waste. Controls that would be required include deed restrictions and fencing. These controls would complement the existing zoning and land use controls prohibiting residential use in the Disposal Area.

For this alternative to remain effective over the long term, the cover would require careful maintenance of landscaping and controls that would help prevent industrial worker or residential intrusion below the cover. Because contamination remains on-site, a review would be conducted at least every 5 years to ensure that the remedy continues to provide adequate protection of human health and the environment in accordance with CERCLA 121(c). This alternative leaves all wastes in place and unknown waste receptacles/containers could leak and create a threat to groundwater.

This alternative provides no reduction in toxicity, mobility, or volume of the contaminated soil through treatment. The cover reduces the mobility of contaminants by physical containment.

Site engineering controls would be required to minimize fugitive dust and stormwater releases during site preparation and installation of the cover. The cover and controls would be completed in less than 1 year.

The containment alternative is easily implemented and monitored. No special techniques, materials, equipment, or skills are required. Soils are available locally for cover. The containment action could be enhanced by enlarging the cover if more contamination were discovered.

In the short-term, there is no increase in risk to the community or to workers due to implementation of this alternative because there are no site activities that will affect exposure. Controls and restrictions will take an estimated 6 months to implement. Institutional controls are easy to implement and require no special equipment or materials. The action could be enhanced by extending the areas of control and adding fencing.

The 30-year present worth cost is estimated to be $616,000, with a capital cost of $304,000, with an annual O&M cost of $20,000 to control areas exceeding industrial RGOs. This alternative is not like to be accepted by the state regulators and the community since long-term effectiveness is marginal, the alternative is not protective of groundwater, and ongoing monitoring and maintenance of the soil containment is required.

5.2.3 Alternative 5 – Ex-situ Soil Treatment with Institutional Controls

Ex-situ soil remediation is protective of human health and the environment by treating contaminated subsurface soil and removing buried receptacles that can not be treated onsite. Treatment and removal reduce exposures to levels that are acceptable to industrial land use. This remedy will comply with ARARs, in particular fugitive dust and stormwater controls, and RCRA land disposal restrictions. Deed restrictions will prohibit future residential use.

Alternative 5 will be effective and permanent because the treatment immobilizes contaminants in subsurface soils and excavation and offsite disposal of buried receptacles (that can not be treated onsite) removes any potential future source. No monitoring or management beyond the completion period will be required. Solidification is irreversible by fixing contaminants in the soil matrix so it will not be ingested or inhaled. This alternative meets the statutory preference for using treatment as a principal element.

For the short-term, site engineering controls will be required to minimize fugitive dust and stormwater releases during site preparation, treatment activities, and transport of soil and containers. Site workers might be required to wear dermal and respiratory protection to minimize the likelihood of exposure during intrusive activities. Temporary controls will be required to prevent exposure or disturbance to contaminated soil during the treatment period. Excavation and ex-situ soil treatment are reasonably easy to implement and proven technologies. The treatment actions could be enhanced by enlarging the treatment areas if more contamination were discovered. Compliance with RCRA land disposal restrictions could result in additional treatment, resulting in an increase in difficulty in implementing this remedy.

The 30-year present worth cost is estimated to be $2,129,000, with a capital cost of $2,069,000, and an annual O&M cost of $4,000. The capital cost is primarily excavations and onsite treatment of subsurface soil/wastes, and excavation, transport, and disposal costs for buried receptacles that can not be treated onsite. The annual O&M cost is primarily for continued monitoring of compliance with institutional controls. Since contamination remains on-site, a review will be conducted at least every 5 years. This alternative is likely to be accepted by the state and the community because it affords protection after a moderate time for cleanup and removes buried receptacles from the site.

5.2.4 Alternative 6 – Excavation, Transportation, and Offsite Disposal with Institutional Controls

Excavation, transportation, and off-site disposal is protective of human health and the environment by removing contaminated soil and buried receptacles. Removing contaminants reduces industrial worker exposure to levels that are acceptable.

This remedy will comply with ARARs, in particular fugitive dust, vapor, and stormwater controls and RCRA land disposal restrictions. Sites 3, 7, 10, 11, 15, and 15.1 do not likely contain compounds that are listed hazardous wastes and are not likely to exceed TCLP criteria; therefore, they are not considered RCRA hazardous wastes at this time. Sites 4.1, 8, 12, 12.1, and 15.2 likely contain compounds that are listed as hazardous wastes. Sites 4, 13, 16, 16.1, and 17 contain a mixture of compounds, whose characteristics are not completely defined and testing is required prior to disposal. Site descriptions and COCs are described in Table 5.1

Contaminated subsurface soil will be disposed of at the appropriate land disposal facility. They will be tested prior to disposal and if they exceed TCLP criteria, they will be disposed of as a hazardous waste. Upon excavation, compounds still contained in receptacles will either be saved for recovery and recycling or disposed of in an appropriate and approved waste disposal facility. Hazardous compounds will go to an approved RCRA treatment and/or disposal facility.

This alternative remains effective after completion because contaminated soil is removed. Removal is reliable and permanent. No monitoring or management beyond the implementation period will be required. A 5-year review will be required, as some waste will remain onsite. This alternative provides no reduction in TMV of the contaminated soil through treatment. Disposal in an offsite landfill reduces the mobility of contaminants by physical containment.

For the short-term, site engineering controls will be required to minimize fugitive dust and stormwater releases during site preparation, treatment activities, and transport of soil and containers. Site workers might be required to wear dermal and respiratory protection to minimize the likelihood of exposure during intrusive activities. Temporary controls will be required to prevent exposure to contaminated soil during the excavation period. This alternative is easily implemented and monitored. No special techniques, materials, equipment, or skills are required. Native soil is available locally for backfill. Offsite transportation may require special controls on trucking operations. The removal action could be enhanced by enlarging the excavated area if more contamination were discovered.

The 30-year present worth cost is estimated to be $1,772,000, with a capital cost of $1,715,000, and an annual O&M cost of $3800 to cover areas exceeding industrial RGOs. The annual O&M cost is primarily for continued monitoring of compliance with institutional controls. This alternative is likely to be accepted by the state and the community because it affords protection after a moderate time for cleanup and removes contaminated subsurface soil and buried receptacles from the site.

5.3 Comparative Analysis of Disposal sites and Associated Soil Alternatives

The alternatives are compared to each other using the nine EPA criteria. A description of this comparison is included in the following paragraphs. This section concludes with a summary of the comparative analysis.

5.3.1 Overall Protection of Human Health and the Environment

All alternatives are considered protective of human health and the environment. The no action alternative is not protective of human health and the environment, which is a threshold criteria; therefore, it will not be carried forward for discussion under the remaining criteria.

5.3.2 Compliance with ARARs

All alternatives are expected to meet ARARs at the completion of implementation.

5.3.3 Long-term Effectiveness and Permanence

Alternatives 5 and 6 are expected to be effective and permanent at the completion of implementation through treatment or removal for offsite disposal. Alternative 3 (Soil Containment) is effective and permanent through the covering of the disposal sites and associated subsurface soil with a low permeability cap which will prevent rainwater percolation and intrusive access. However, unknown receptacles/containers could leak and create threat to groundwater.

5.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 5 (Ex-situ Soil Treatment) is the only action that satisfies the statutory preference for treatment as a principal element. Ex-situ solidification of subsurface soils/waste are used to reduce the mobility of contaminants to residual levels acceptable to industrial land use. Although Alternatives 3 (Soil Containment) and 6 (Excavation, Transportation and Offsite Disposal) reduces the mobility of chemicals, the reduction is not achieved through treatment. Treatment may be required at the disposal facility prior to the final disposition of the waste materials.

5.3.5 Short-term Effectiveness

Alternative 3 (Soil Containment) has the greatest short-term effectiveness because it presents the least risk to workers, community, and the environment, and is the quickest way to short-term protection (6 months). This alternative does require some engineering controls during placement of the cap material. Alternatives 5 (Ex-situ Soil Treatment) and 6 (Excavation, Transportation and Off-site Disposal) require significant engineering controls during remedial activities to minimize impacts from fugitive dust and vapor emissions, and stormwater runoff. These alternatives pose greater risk to workers and the community through the excavation of buried waste materials. All alternatives should take less than 1 year to implement. Alternatives

5 (to a lesser degree) and 6 may also cause traffic impacts due to offsite hauling of excavated material and the hauling of backfill material onsite.

5.3.6 Implementability

All alternatives are considered technically feasible and can be implemented with available labor, materials, and equipment. Additional remedial actions can be readily implemented if more effectiveness becomes necessary with all three alternatives. Alternative 3 (Soil Containment) is considered the simplest to implement; however, long-term monitoring and maintenance will be required for the capped areas. Alternative 5 (Ex-site Soil Treatment) is most difficult to implement because of the treatment processes and time required. Care will need to be taken to avoid damage/release from excavated buried containers during implementation of Alternatives 5 (Ex-site Soil Treatment) and 6 (Excavation, Transportation and Off-site Disposal).

5.3.7 Cost

Present worth costs are summarized in the following list.

Alternative	Capital Cost	O&M Cost	Present Worth
1-No Action	$0	$0	$0
3-Soil Containment	$304,000	$312,000	$616,000
5-Ex-situ Treatment	$2,069,000	$60,000	$2,129,000
6-Excavation, Transport, and Offsite Disposal	$1,715,000	$57,000	$1,772,000

There are no costs associated with Alternative 1 (No Action). With present worth cost of $616,000, Alternative 3 (Soil Containment), is the least expensive of the active alternatives. Alternative 6 (Excavation, Transportation, and Offsite Disposal) with a present worth cost of $1,772,000 is more expensive than Alternative 3 , but less expensive that Alternative 5 (Ex-situ Treatment) at $2,129,000.

5.3.8 State Acceptance

State acceptance is likely for all alternatives except soil containment since waste materials are left in-place and there is a potential long-term threat to groundwater quality.

5.3.9 Community Acceptance

The community is not likely to accept the soil containment with institutional controls alternative because the contaminants and contents of the disposal sites are left in place and untreated. The community is likely to accept the ex-situ treatment and excavation, transportation, and offsite disposal alternatives. Ongoing community involvement activities will be an important element of remedy implementation.

5.3.10 Summary

The comparative analysis of alternatives is summarized as follows.

Evaluation Criteria	1 No Action	3 Soil Containment with ICs	5 Ex-situ Treatment with ICs	6 Excavation, Transport, and Offsite Disposal with ICs
Protective of Human Health and Environ.	No	Yes	Yes	Yes
Complies with ARARs	N/A	Yes	Yes	Yes
Effective and Permanent	N/A	Yes	Yes	Yes
Reduces TMV	N/A	No	Yes	No
Short-term Effectiveness	N/A	Acceptable	Acceptable	Acceptable
Implementable	N/A	Yes	Yes	Yes
Cost	$0	$0.62 million	$2.13 million	$1.77 million
State Acceptance	Unlikely	Unlikely	Likely	Likely
Community Acceptance	Unlikely	Unlikely	Likely	Likely

Tables

TABLE 5-1
Assumptions for the Disposal Sites and Subsurface Soil Areas Requiring Remediation
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IRP Site Number	Site Description	COCs	RCRA Hazardous Waste	Area of Remediation (ft^2)
3	Mixed Chemical Burial Site	Orthotouidine Dihydrochloride	No	300
4	POL Burial Site	Oil, grease, paint	ND[a]	200
4.1	POL Burial Site	Oil, grease, thinner	Yes	400
7	Nitric Acid Burial Site	Nitric acid	No[b]	150
8	Methyl Bromide Burial Site B	Methyl bromide	Yes	2025
10	Solid Waste Burial Site (Near MW-10)	Metal, glass, trash	No	5000
11	Trichloroacetic Acid Burial Site	Trichloroacetic acid	No[b]	<50
12/12.1	Sulfuric Acid and Hydrochloric Acid Burial	Sulfuric Acid, Hydrochloric Acid	Yes	475
13	Mixed Chemical Burial	Acid, unnamed solids	ND[a]	1750
15	Sodium Burial Sites	Sodium	No[b]	
15.1	Sodium Phosphate Burial	Sodium phosphate	No	2000
15.2	14 Burial Pits	Sodium phosphate, sodium, acid, medical supplies, chlorinated lime	Yes	
16	Unknown Acid Burial Site	Acid	ND[a]	250
16.1	Acid Burial Site	Acid	ND[a]	100
17	Mixed Chemical Burial Site C	Mixed chemical	ND[a]	600
--	CC-2 Impregnite Site	CC-2 Impregnite	ND[a]	320
Total Area				13,620

IRP Installation Restoration Site

[a] Exact constituents undetermined. TCLP testing will need to be performed to determine appropriate land disposal facility.

[b] Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements.

TABLE 5-2
Summary of Detailed Analysis of Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 3 Soil Containment	Alternative 5 Ex-situ Soil Treatment	Alternative 6 Excavation, Transportation, and Off-site Disposal
	This alternative includes the containment (capping) of buried receptacles and associated contaminated soil, deed restrictions and site controls (fencing and signage) preventing intrusive use in areas containing disposal sites and associated subsurface soil. Future residential use in the Disposal Area is prevented by the use of institutional controls.	***This alternative includes excavation of buried receptacles and associated contaminated soil and the ex-situ solidification of associated subsurface soil (a total area of 10,215 ft²) at the Disposal Area, and institutional controls prohibiting industrial use during implementation of the remedial action Future residential use in the Disposal Area is prevented by the use of institutional controls. Assume that 3900 cubic yards of soil will require treatment.***	***This alternative includes the excavation and offsite transportation and disposal of buried receptacles and associated contaminated soil (a total of 10,215 ft²) at the Disposal Area for industrial use Future residential use in the Disposal Area is prevented by the use of institutional controls Assume that 3900 cubic yards of soil will require excavation and disposal***
OVERALL PROTECTIVENESS			
Human Health Protection **(Direct Contact/Soil Ingestion)**	This alternative does protect human health for industrial use and does protect against intrusive activities However, the buried waste could continue to pose a risk to groundwater resources Institutional controls (deed restrictions) will also prohibit residential use	This alternative does provide protection of human health for industrial use by treatment and removal Excavation of buried receptacles removes future risk Solidification of contaminated subsurface soil associated with disposal sites decreases direct contact risk and soil ingestion risk to levels acceptable for industrial use Institutional controls preventing industrial use in the area of concern until the remedial action is complete are necessary to maintain protection of human health	This alternative does protect human health for industrial use Excavation, transportation, and off-site disposal at a permitted, controlled landfill removes direct contact risk and soil ingestion risk of contaminated subsurface soil and potential future risk from compounds contained in buried receptacles
Environmental Protection	The buried waste is capped in-place, but could continue to pose a risk to groundwater resources and therefore is marginally protective of the environment	The buried waste will not continue to pose a risk to groundwater resources and therefore is protective of the environment	The buried waste will not continue to pose a risk to groundwater resources and therefore is protective of the environment
COMPLIANCE WITH ARARs			
Chemical-Specific ARARs	There are no chemical-specific ARARs for subsurface soil	See Alternative 3.	See Alternative 3
Location-Specific ARARs	Institutional controls are required Tennessee Rule 1200-1-13 08(10) whenever the remedial action does not fully address the hazardous substances which pose a risk to human health or the environment. This includes requirements for deed restrictions and future transfer of property Transfers of contaminated federal property are subject to CERCLA Section 120(h)(3) requirements Deed restrictions precluding industrial use in the areas where contaminants are above RGOs in the subsurface soil or future residential use across the Disposal Area reinforce add a layer of protectiveness over and above the existing land use controls Currently, Dunn Field is zoned as Light Industrial (I-L) The principal uses permitted are manufacturing, wholesaling, or warehousing According to Section 24 of the Memphis and Shelby County zoning regulation, single family or multi-family residential uses are prohibited	Institutional controls are required Tennessee Rule 1200-1-13 08(10) whenever the remedial action does not fully address the hazardous substances which pose a risk to human health or the environment. This includes requirements for deed restrictions and future transfer of property. Transfers of contaminated federal property are subject to CERCLA Section 120(h)(3) requirements Deed restrictions precluding industrial use in the areas where contaminants are above RGOs in the subsurface soil or future residential use across the Disposal Area reinforce add a layer of protectiveness over and above the existing land use controls Currently, Dunn Field is zoned as Light Industrial (I-L). The principal uses permitted are manufacturing, wholesaling, or warehousing According to Section 24 of the Memphis and Shelby County zoning regulation, single family or multi-family residential uses are prohibited	Deed restrictions precluding industrial use in the areas where contaminants are above RGOs in the subsurface soil or future residential use across the Disposal Area reinforce add a layer of protectiveness over and above the existing land use controls Currently, Dunn Field is zoned as Light Industrial (I-L) The principal uses permitted are manufacturing, wholesaling, or warehousing According to Section 24 of the Memphis and Shelby County zoning regulation, single family or multi-family residential uses are prohibited
Action-Specific ARARs	The capping of hazardous materials that may be left in place in sufficient concentrations would require compliance with relevant RCRA Subtitle C landfill closure requirements at 40 CFR 264 310(a) Subtitle C landfill closures require post-closure care and maintenance for at least 30 years Also, RCRA landfill post-closure requirements at 40 CFR 264 116 and 264 119 (TDEC Rule 1200-1-11 06(7)(g) and (j),	The excavation, on-site ex situ solidification, or placement of soil that contains RCRA-restricted waste may trigger the RCRA land disposal restrictions (LDRs) Generators of contaminated soil that is subject to the LDR regulations may elect to meet either the generic treatment standards for hazardous wastes in 40 CFR 268 40, or the alternative treatment standards for contaminated soil in 40 CFR 268 49 The alternative LDR soil standards require treatment to reduce	Generators of contaminated soil that is subject to the LDR regulations may elect to meet either the generic treatment standards for hazardous wastes in 40 CFR 268 40, or the alternative treatment standards for contaminated soil in 40 CFR 268 49 The alternative LDR soil standards require treatment to reduce concentrations of hazardous constituents in the soil either by 90 percent or by enough so that the hazardous constituent concentrations are less than or equal to 10 times the

TABLE 5-2
Summary of Detailed Analysis of Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 3 Soil Containment	Alternative 5 Ex-situ Soil Treatment	Alternative 6 Excavation, Transportation, and Off-site Disposal
	respectively requires preparation of a survey plat "indicating the locations and dimensions of landfill cells or other hazardous waste units with respect to permanently surveyed benchmarks" and should be submitted to the local zoning authority and EPA. Under 40 CFR 264 119, one must include a notation on the deed of the facility property (or some other instrument which is normally examined during a title search) that will notify potential purchaser that land has been used to manage hazardous waste and its use is restricted Only the substantive aspects that are deemed both "relevant and appropriate" (R&A) would apply	concentrations of hazardous constituents in the soil either by 90 percent or by enough so that the hazardous constituent concentrations are less than or equal to 10 times the Universal Treatment Standards (UTS) (identified in 40 CFR 268 48), whichever is greater To determine if the soils are to be disposed of in a hazardous or solid waste landfill, a toxicity characteristic leaching procedure (TCLP) test is conducted on representative soil samples This will determine if a waste is characterized as hazardous per (40 CFR 261 C) The excavation and off-site disposal of soil and debris that contain RCRA hazardous waste must comply with transporter regulations under 40 CFR 263 A transporter under Subtitle C is defined as any person engaged in off-site transportation of hazardous waste within the United States Such transportation requires a manifest under 40 CFR 262 Compliance with Tennessee Rule 1200-3-1 on fugitive dust emissions during remedial activities will be required NPDES compliance of stormwater in contact with contaminated soil during remediation activities could be required	Universal Treatment Standards (UTS) (identified in 40 CFR 268 48), whichever is greater To determine if the soils are to be disposed of in a hazardous or solid waste landfill, a toxicity characteristic leaching procedure (TCLP) test is conducted on representative soil samples. This will determine if a waste is characterized as hazardous per (40 CFR 261 C). The excavation and off-site disposal of soil and debris that contain RCRA hazardous waste must comply with transporter regulations under 40 CFR 263 A transporter under Subtitle C is defined as any person engaged in off-site transportation of hazardous waste within the United States Such transportation requires a manifest under 40 CFR 262 Compliance with Tennessee Rule 1200-3-1 on fugitive dust emissions during excavation, transportation, and backfilling operation will be required NPDES compliance of stormwater in contact with contaminated soil during construction activities could be required
Other Criteria and Guidance	This alternative is compliant with industrial risk-based criteria if controls are implemented that limit intrusive use of areas of the capped disposal sites and associated subsurface soils	By solidification of contaminated soil associated with disposal sites, the site will meet RAOs for industrial use Imported soil for backfill will be confirmed clean by laboratory testing prior to placement on-site	By removing buried receptacles and associated contaminated soil and disposing off-site, the site will meet RAOs for industrial use Imported soil for backfill will be confirmed clean by laboratory testing prior to placement on-site
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk **(Direct Contact/Soil Ingestion)**	The source will not be removed, however, unacceptable risk for industrial use will be prevented through containment and institutional controls	Industrial use risk at the site from contaminated surface soil is reduced to acceptable levels by treatment that immobilizes contaminated soils associated with disposal sites and removed buried receptacles containing wastes	Industrial use risk at site from contaminated surface soil is eliminated because buried receptacles containing wastes and contaminated subsurface soil will be removed from the site
Adequacy and Reliability of Controls	This alternative controls contamination in subsurface soil by containment. Reliability is high for industrial use	This alternative controls contamination in subsurface soil by immobilizing contaminants through solidification and removing buried receptacles Reliability is very high for industrial use Solidification is a known, proven technology for the fixation of contaminated soil Therefore, no management beyond the remedial implementation period is required	Excavation, transportation, and off-site disposal effectively removes buried receptacles and soil contaminated above levels acceptable for industrial use Reliability is very high for industrial use No site management beyond the remedial implementation period is required The reliability of a permitted offsite disposal facility is high
Need for 5-Year Review	Review will be required to ensure that institutional controls are still in place for the adequate protection of human health and the environment for future users of the site	Buried receptacle will be removed and contaminated surface soil will be effectively solidified 5-Year review will be required	5-Year review will be required due to some wastes left in-place and implementation of land use controls
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT			
Treatment Process Used	This alternative does not include active treatment of contaminated subsurface soil	Solidification is used to treat contaminated subsurface soil associated with disposal sites	This alternative does not include active treatment of contaminated subsurface soil *(There may be offsite treatment to meet LDRs and the disposal facility)*
Amount Destroyed or Treated	No soil contaminants are treated or destroyed under this alternative	Approximately 3900 excavated cubic yards of contaminated subsurface soil associated with disposal sites will be solidified	Approximately 3900 cubic yards of soil will be excavated and disposed offsite
Reduction of Toxicity, Mobility, or Volume	There is no reduction in toxicity, mobility, or volume through	Solidification of contaminated subsurface soil associated with disposal	There is no reduction in toxicity, mobility, or volume through treatment

TABLE 5-2
Summary of Detailed Analysis of Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 3 Soil Containment	Alternative 5 Ex-situ Soil Treatment	Alternative 6 Excavation, Transportation, and Off-site Disposal
	treatment under this alternative	sites will reduce the mobility of contaminants to residual levels acceptable for future industrial use	under this alternative *(There may be offsite treatment to meet LDRs and the disposal facility)*
Irreversible Treatment	There is no irreversible treatment under this alternative	The solidification process is effectively irreversible.	There is no irreversible treatment under this alternative *(There may be offsite treatment to meet LDRs and the disposal facility)*
Type and Quantity of Residuals Remaining After Treatment	There is no treatment, therefore, no residuals are generated in this alternative	Solidified soil associated with disposal sites will remain on-site Approximately 5850 cubic yards of solidified soil and waste will remain on-site	There is no treatment, therefore, no residuals are generated in this alternative *(There may be offsite treatment to meet LDRs and the disposal facility)*
Statutory Preference for Treatment	This alternative does not satisfy the statutory preference for treatment	This alternative satisfies the statutory preference for treatment	This alternative does not satisfy the statutory preference for treatment *(There may be offsite treatment to meet LDRs and the disposal facility)*
SHORT-TERM EFFECTIVENESS			
Community Protection	The risk to the community is not increased by remedy implementation	A temporary increase in fugitive dust emissions and stormwater runoff during implementation will be managed by engineering controls The transportation of buried receptacles and clean backfill through the community may require special controls such as restrictions on truck routing and hours of operation	A temporary increase in fugitive dust emissions and stormwater runoff during implementation will be managed by engineering controls The transportation of excavated soil and clean backfill through the community may require special controls such as restrictions on truck routing and hours of operation
Worker Protection	Workers will be protected during placement of the cap material	Engineering controls and protective personnel equipment will be required for workers during construction	Engineering controls and protective personnel equipment will be required for workers during construction
Environmental Impacts	Engineering controls will be required to protect the environment during construction	Engineering controls will be required to protect the environment during construction	Engineering controls will be required to protect the environment during construction
Time Until Action Is Complete	Soil containment, deed restrictions and site controls will be implemented within 6 months	Remedial activities (excavation of buried receptacles and subsurface soils, transport of receptacles, treatment of subsurface soils) will be completed within 1 year	Subsurface soil and buried receptacles will be excavated and transported from the site within 1 year allowing industrial use after implementation
IMPLEMENTABILITY			
Ability to Construct and Operate	Covers/caps are easily constructed and maintained	This alternative is reasonably easy to construct and operate, allowing future industrial use Solidification is a known, proven technology Excavation, transportation, and disposal are easily implemented Caution will need to be taken during the excavation to not damage buried receptacles	Excavation, transportation, and disposal are easily implemented Caution will need to be taken during the excavation to not damage buried receptacles
Ease of Doing More Action If Needed	It would be easy to extend the limits of the covered areas if needed	The volume of treated soil could be increased and the technology could be modified For example, the solidification mixture could be altered This alternative could also be combined with other remedial technologies	It will be easy to extend the limits of remedial areas, or to add treatment.
Ability to Monitor Effectiveness	Annual monitoring will be necessary to ensure that the covers are not disturbed	Confirmation sampling and lab analyses are an integral part of the remedial action	See Alternative 5

TABLE 5-2
Summary of Detailed Analysis of Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 3 Soil Containment	Alternative 5 Ex-situ Soil Treatment	Alternative 6 Excavation, Transportation, and Off-site Disposal
Ability to Obtain Approvals and Coordinate with Other Agencies	This alternative will require deed restrictions to prevent residential use across the Disposal Area Long-term coordination with Shelby County-City of Memphis is necessary to maintain existing land use controls to provide layers of protectiveness with the deed restrictions	See Alternative 3.	See Alternative 3
Availability of Services and Capacities	Services are readily available to construct and maintain covers.	Implementation services for the technology are readily available in the commercial market. Services are readily available for excavation, transportation, and off-site disposal.	Services are readily available for excavation, transportation, and off-site disposal
Availability of Necessary Equipment, Specialists, and Materials	Equipment and materials are readily available to construct and maintain covers.	Equipment and most materials are readily available for solidification of contaminated subsurface soil and excavation, transportation, and offsite disposal There are a number of solidification amendments available in the commercial market. The capacity of local landfills may be limited	Equipment and materials are readily available for excavation, transportation, and offsite disposal The capacity of local landfills may be limited
Availability of Technologies	Soil Containment technology is readily available	The treatment and excavation, transportation, and disposal technologies are readily available, allowing industrial use	The excavation, transportation, and disposal technologies are readily available, allowing industrial use
COST			
Capital Cost	$304,000	$2,069,000	$1,715,000
Present Worth O&M Cost	$312,000	$60,000	$57,000
Total Cost	$616,000	$2,129,000	$1,772,000
STATE ACCEPTANCE	Soil containment will not likely be acceptable to state regulators since long-term effectiveness is marginal and wastes are left in-place	Ex-situ treatment will likely be acceptable to state regulators, allowing industrial use since all onsite soil will be treated to meet industrial use criteria and buried receptacles will be removed and disposed offsite	Excavation, transportation, and offsite disposal will likely be acceptable to state regulators, allowing industrial use since all onsite soil exceeding industrial use criteria and buried receptacles will be removed The soil will be disposed of in a permitted off-site location
COMMUNITY ACCEPTANCE	Soil containment will not likely be acceptable to the community since contaminants are left in place and untreated	Ex-situ treatment will likely be acceptable to the community, allowing industrial use, since all onsite soil will be treated to meet industrial use criteria and buried receptacles will be removed and disposed offsite	Excavation, transportation, and offsite disposal may be acceptable to the community, allowing industrial use since all onsite soil exceeding industrial use criteria and buried receptacles will be removed The soil will be disposed of in a permitted off-site location

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Figures

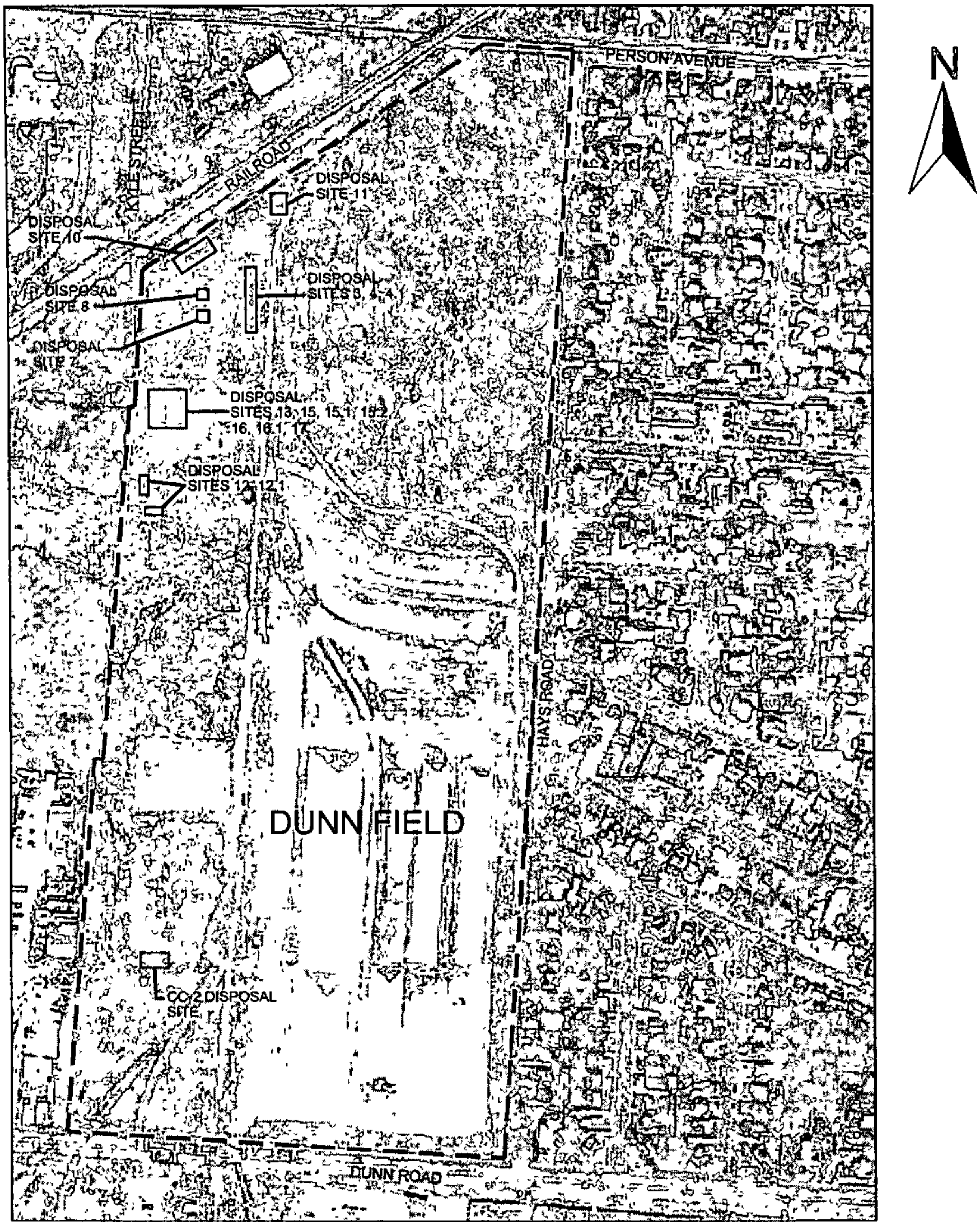

FIGURE 5.1
DISPOSAL SITE TREATMENT AREAS
REV. 0 MEMPHIS DEPOT
DUNN FIELD FS

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD FS 2002

CH2MHILL

6.0 Detailed Analysis of VOC-Contaminated Soils and Soil-to-Indoor Air

6.1 Definition of Onsite Remedial Alternatives – VOCs in Soil and Soil-to-Indoor Air

The EPA guidance for conducting an RI/FS (EPA, 1988) recommends that each alternative be defined in sufficient detail to apply the evaluation criteria and to determine order-of-magnitude costs. The definition may include preliminary design calculations and drawings, as well as address the limitations, assumptions, and uncertainties about each alternative. However, the definition step is not a remedial design. The quantitative data given as part of the description of an alternative are estimates based on conceptual design and professional experience. They are for the purpose of estimating costs to an accuracy of +50% to -30%, per EPA guidance on FS cost estimates. Complete details of how an alternative will be implemented are not necessary (or required by CERCLA) for the comparative analyses performed. In the detailed analyses presented in this section, alternatives were defined with respect to future land use and respective COCs. VOC-contaminated soils and soil-to-indoor air are located within the Disposal Area of Dunn Field. The intended land use for this area is industrial. While the alternatives discussed in this section may be effective at remediating VOC-contaminated soils and soil-to-indoor air to industrial use standards, remedial action for disposal sites and associated soils (Section 5) and groundwater (Section 7) contaminated with VOCs will be required for the Disposal Area to be acceptable for industrial land use.

The proposed alternative for soils contaminated with VOCs and soil-to-indoor air is the presumptive remedy, SVE. This alternative has been retained, along with the no action from Section 3. These alternatives are defined below.

6.1.1 Alternative 1 – No Action

A no action alternative is required under CERCLA for comparison to active remedies.

6.1.2 Alternative 2 – Soil Vapor Extraction

In this alternative, air flow will be induced through contaminated soil by applying a vacuum, using vapor extraction wells, to create a pressure gradient in the vapor phase within the unsaturated zone of the targeted soil. As the soil vapor migrates though the soil pores toward the extraction vents, VOCs will be volatilized, transported out of subsurface soil, and collected aboveground. Two preliminary SVE remediation systems for Dunn Field have been designed for cost estimation: Alternative 2a refers to a vertical SVE system and Alternative 2b refers to a horizontal and vertical SVE system. Both designs are based on contaminant mass calculations from soil analytical data and the December 2001/January 2002 Dunn Field SVE pilot test data (Appendix C).

This alternative also includes institutional controls, which included deed (including lease) restrictions, in addition to the existing land use controls, limiting the future use by the Depot.

Deed restrictions will prevent residential land use where surface and subsurface soils pose an unacceptable risk. Restrictions and controls will be coordinated with the Depot reuse implementation plans, and will be included in all deeds and leases. Under this alternative, controls will have to be inspected periodically for effectiveness.

Preliminary design components for a vertical or horizontal SVE system at Dunn Field are described below:

- The vertical SVE system will include 57 vertical, 4-inch diameter wells installed in the loess to a depth of approximately 25 ft bls and 24 vertical, 4-inch diameter wells installed in the fluvial deposits to a depth of approximately 70 ft bls. Piping will connect the SVE wells and be placed horizontally in 3-ft deep trenches. Figures 6-1 and 6-2 depict the proposed layout of the vertical SVE system in the loess and fluvial deposits, respectively.
- The horizontal SVE system includes 3 horizontal, 6-inch diameter wells with a total length of 2,325 ft (each well ranging in length from 705 to 840 ft) at a depth of 15-20 ft bls installed in the loess and 2 horizontal, 6-inch diameter wells with a total length of 1,550 ft (each well ranging in length from 705 to 840 ft) at a depth of 50-55 ft bls installed in the fluvial deposits. In addition, 34 vertical, 4-inch diameter wells will be installed in the loess and fluvial deposits to a depth as described in Alternative 2a to cover treatment areas outside the horizontal zone of influence. Piping will connect the SVE wells and be placed horizontally in 3-ft deep trenches. Figures 6-3 and 6-4 depict the proposed layout of the horizontal and vertical SVE system in the loess and fluvial deposits, respectively.
- A soil vacuum and vapor monitoring system will be installed within the network of SVE wells to monitor full-scale soil vapor extraction. Each soil monitoring point cluster will be constructed with 4, 1-inch diameter monitoring points. Two soil monitoring points will be installed to depths in the upper and lower portion of the loess (above the fluvial deposits) and two soil monitoring points will be installed to depths in the upper and lower portion of the fluvial deposits (below the loess and above the fluvial aquifer).
- A temporary cap measuring approximately 360,000 ft^2 will be placed over the SVE treatment area consisting of a 20-mm liner and gravel cover. The site will be cleared and graded prior to its placement.
- An equipment storage building will be set up with all electrical controls, vacuum pumps, and off-gas collection and treatment units. Off-gasses (extracted volatile organic compounds) and hydrochloric acid (HCL) (produced through the oxidation of chlorinated hydrocarbons) emissions released to the atmosphere will be treated by a chlorinated catalytic oxidizer and a scrubber, with sodium hydroxide (NaOH). Piping and instrumentation diagram (P&ID) drawings for the off-gas or vapor treatment system are presented as Appendix F. Electricity will be hooked up to the building prior to startup.
- Permanent deed restrictions will prohibit residential use of the Disposal Area.
- SVE treatment system operation and maintenance will be performed regularly. The remedy assumes full-time, onsite oversight during the operational life of the remedy.
- Annual summaries of monitoring data will be produced to document the site conditions and progress of the remedy. EPA and TDEC reviews of the remedy are required at 5-year intervals for Dunn Field (OU-1).

The assumptions used in developing the cost estimate for this alternative were as follows:

- For a vertical SVE system, 81 SVE wells will be installed using rotosonic-drilling methods. Ten thousand feet of 4-inch, SDR 11, HDPE piping will be used. Three 25-horsepower (HP) multiphase extraction (MPE) systems for wells constructed in the loess and one 15-HP regenerative system for wells constructed in the fluvial deposits will be utilized.
- For a horizontal SVE system, 5 SVE wells will be installed using a horizontal drilling methods and 34 SVE wells will be installed using rotosonic-drilling methods. Four thousand five hundred (4,500) feet of 4-inch, SDR 11, HDPE piping will be used. One 75-HP MPE system for wells constructed in the loess and one 15-HP regenerative system for wells constructed in the fluvial deposits will be utilized.
- One chlorinated catalytic oxidizer, one scrubber, and 66,600 gallons of sodium hydroxide will be used to treat-off gasses and hydrochloric acid emissions released to the atmosphere from the SVE system.
- The remedy will require 3 to 4 years to achieve remedial target goals. This estimated cleanup time is based on the results of the SVE pilot test (see Appendix C) and the average mass removal rate for the individual CVOCs that was obtained from the pilot test for the loess and fluvial deposits. Total contaminant mass calculations for VOCs (PCE, TCE and 1,1,2,2-PCA) in soils are presented in Appendix E. The development of measures to signal completion of the SVE remedy, which should be implemented as part of the design process, are presented in the *Evaluation of Soil Vapor Extraction Treatability Study*, included in Appendix C. This includes calculated soil screening level (SSL) protective of groundwater in the fluvial aquifer for contamination in the loess and the fluvial deposits. In addition, soil vapor concentrations in equilibrium with both SSLs (loess and fluvial) were developed for each COC. The measures also include use of the SVE Termination or Optimization Process (STOP) developed by the Air Force Center for Environmental Excellence (AFCEE) in the June 2001 *Final Guidance on Soil Vapor Extraction Optimization*. The STOP process is part of an SVE closure plan in the case where the system has been fully optimized yet continuing operations requires tradeoff between monetary expenditures and uncertain environmental benefits. The decision to continue with SVE will be based on scientific, economic, and engineering judgement included in the STOP process. Part of the decision to discontinue operation of the SVE system includes a determination that contaminant removal rates have stabilized and approached asymptotic levels, following one or more temporary shutdown period. A STOP decision tree that will be implemented into the design of the SVE presumptive remedy for Dunn Field is also included in Appendix C. At this time, EPA believes that ultimate cleanup for purposes of determining that the remedy is complete must be demonstrated by direct measurements of subsurface soil. Soil vapor may be used as a surrogate for the purpose of optimizing the system operations and indicating when confirmation sampling should be initiated.
- Areas identified with subsurface soils with VOC concentrations exceeding the RGOs will be treated. Eighty (80) additional soil samples will be collected during soil monitoring point installation (4 samples from 20 borings) to confirm the extent of vadose VOCs identified in the RI, or allow adjustments to be made as necessary.
- The pilot test has already been performed, which has adequately defined design parameters for the treatment system.

- A network of soil monitoring points will be installed to various depths as part of the SVE monitoring system.
- The SVE treatment areas will be covered by a 360,000-ft^2 cap of 20-mm liner covered with gravel. The cap will be keyed into the existing wells at the site and will be turned-down and keyed into trenches along the edge of the treatment zones. The site will be graded to direct stormwater runoff to the existing stormwater system on the western half of Dunn Field.
- System startup will last for 14 days.
- Off-gas monitoring, SVE performance air monitoring, and system O&M will be performed regularly. Air samples, collected from the scrubber, for VOCs and HCl will be collected daily for three days and then weekly for 4 weeks during the system startup. Afterwards, samples will be collected monthly till completion of treatment. O&M of the SVE system and air monitoring will be conducted during air sampling events.
- Wastewater effluent from the remediation system will be collected and analyzed monthly in accordance with the industrial discharge agreement between the City of Memphis and the Depot in order to monitor industrial discharge levels and system performance.
- Soil vapor confirmation sampling will be conducted to determine the end of treatment. Actual soil confirmation samples should be collected when the treatment endpoint has been reached. The Jury et al. (1983) model was used to evaluate the potential migration of contaminants of concern in the subsurface at Dunn Field (see Appendix C). The model takes into consideration aqueous and vapor phase conditions at the site. CH2M HILL used a version of the Jury model to develop soil vapor screening values that are protective of groundwater quality at Dunn Field for both the loess and fluvial deposits. To perform the screening level calculations, the leachate concentration, or dissolved contaminant water concentration, at the water table depth was set at the applicable groundwater criteria level (MCL, RBC, or the minimum laboratory reporting limit). Since the model only reads data in the form of sorbed soil concentrations, the leachate concentration was converted to an equilibrium target soil concentration. The model was then run using a trial and error method for each COC to determine the maximum soil concentration at the source that would be required to achieve the target soil and leachate concentrations at the water table. Once the maximum sorbed soil concentration at the source was determined, the equilibrium soil vapor concentration was calculated. This soil vapor concentration corresponds to the maximum concentrations of COCs that could remain in the vadose zone without posing a threat to groundwater quality, assuming no dilution. If dilution is to be incorporated, a DAF factor is also calculated. A summary of the results is presented in Appendix C. These vapor-phase concentrations represent screening level indicators that will serve as a benchmark of site-specific cleanup criteria for COCs in soil at Dunn Field, and for initiating a phased approach of remedy optimization and determination of the point in which the SVE system at the site could be: (1) temporarily shut down to perform equilibrium/rebound tests; or (2) permanently shutdown. Final cleanup confirmation will be determined through direct measurement of the soils through standard soil sample collection and analyses.
- An annual evaluation of treatment applicability and effectiveness will be performed until treatment is complete. Annual monitoring reports will document the site status.

- Upon completion of the remedy, the system will be decommissioned and all wells will be abandoned. Site restoration will be required to restore the site to acceptable conditions.
- Periodic 5-year reviews by regulators will be required for Dunn Field (OU-1).

6.2 Detailed and Comparative Analysis of Onsite Remedial Alternatives – Subsurface Soil and Soil-to-Indoor Air

A detailed analyses of the SVE alternative to the EPA criteria is presented in Appendix B of Appendix B. It should be noted the no action alternative is not protective of human health or the environment for VOC soil contamination. The following site-specific analysis of the costs, and state and community acceptance is presented below.

6.2.1 Cost

Present worth costs are summarized in the following list (details of the cost estimates are provided in Appendix D).

Alternative	Capital Cost	Present Worth O&M Cost	Total Present Worth
1 – No Action	$0	$0	$0
2 –SVE System	$3,183,000	$1,228,000	$4,410,000

6.2.2 State Acceptance

State acceptance is unlikely for no action because it will not reduce the risks to groundwater and industrial workers. State acceptance of the presumptive remedy, SVE, is likely.

6.2.3 Community Acceptance

Community acceptance is unlikely for no action because it will leave contaminated soils in place without treatment, and because it will not reduce the risks to groundwater and human health. Community acceptance of SVE is likely because the life of the remedy is shorter and involves treatment.

6.2.4 Summary

The comparative analysis of alternatives is summarized as follows.

	Remedial Alternative	
Evaluation Criteria	1 No Action	2 SVE System
Protective of Human Health and Environment	No	Yes
Complies with ARARs	N/A	Yes
Effective and Permanent	N/A	Yes
Reduces TMV	N/A	Yes
Short-term Effectiveness	N/A	Acceptable
Implementable	N/A	Yes
Cost	$0	$4,410,000
State Acceptance	Unlikely	Likely
Community Acceptance	Unlikely	Likely

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Figures

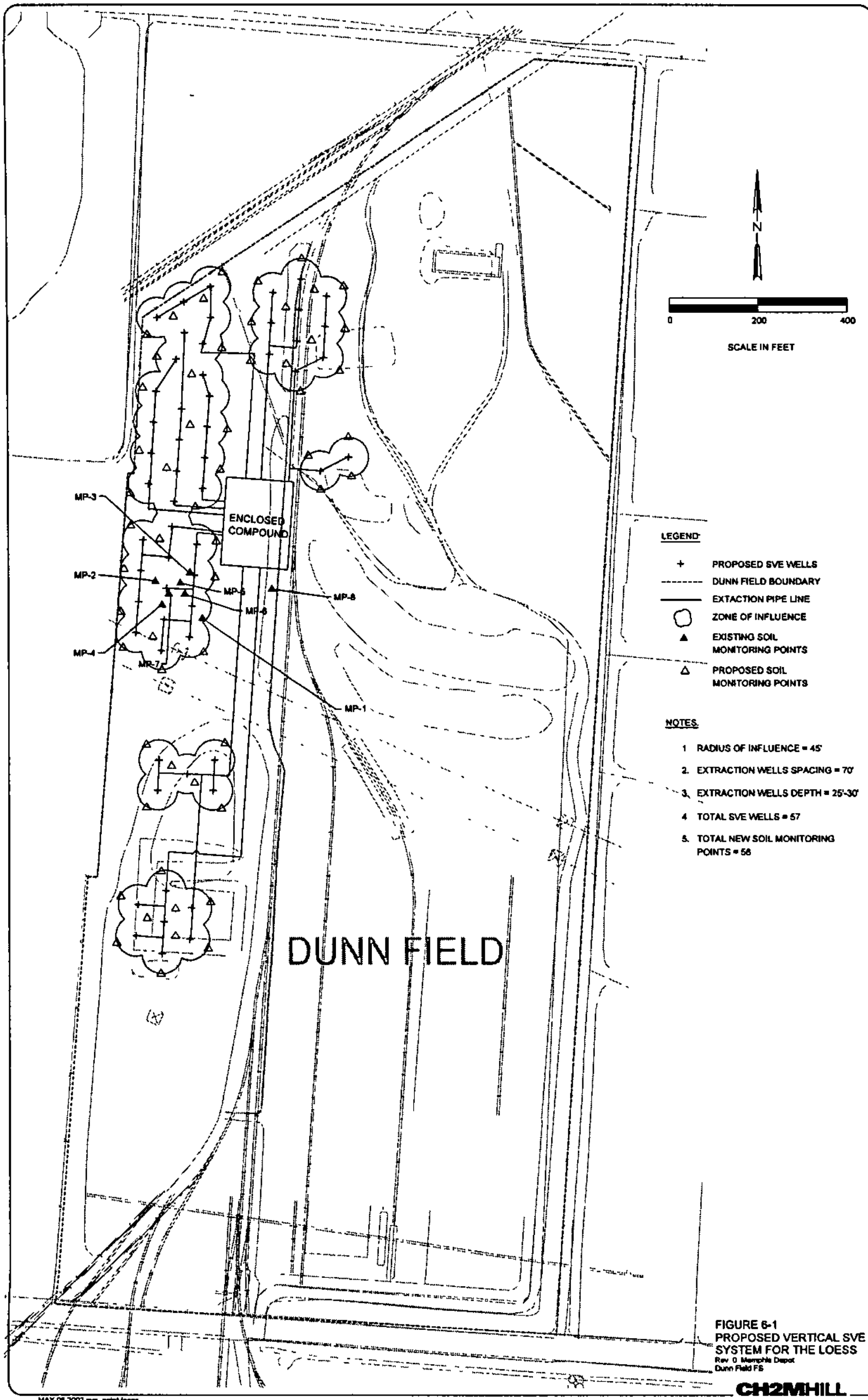

FIGURE 6-1
PROPOSED VERTICAL SVE SYSTEM FOR THE LOESS
Rev 0 Memphis Depot
Dunn Field FS

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ATL/CAD1/PROJECTS/146071 DDMT

MAY 08 2002 sve_point-loess

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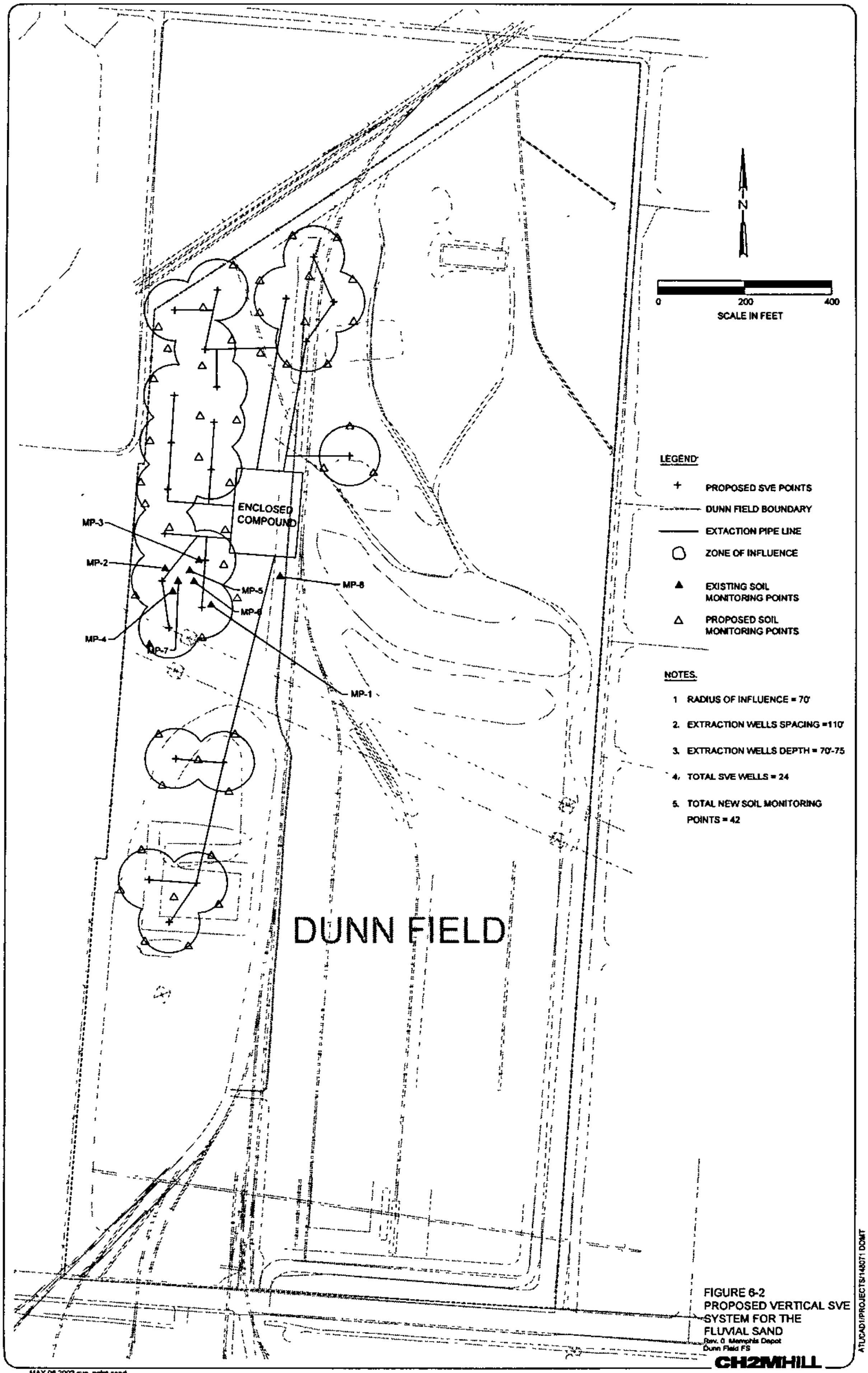

FIGURE 6-2
PROPOSED VERTICAL SVE SYSTEM FOR THE FLUVIAL SAND
Rev. 0 Memphis Depot
Dunn Field FS

CH2MHILL

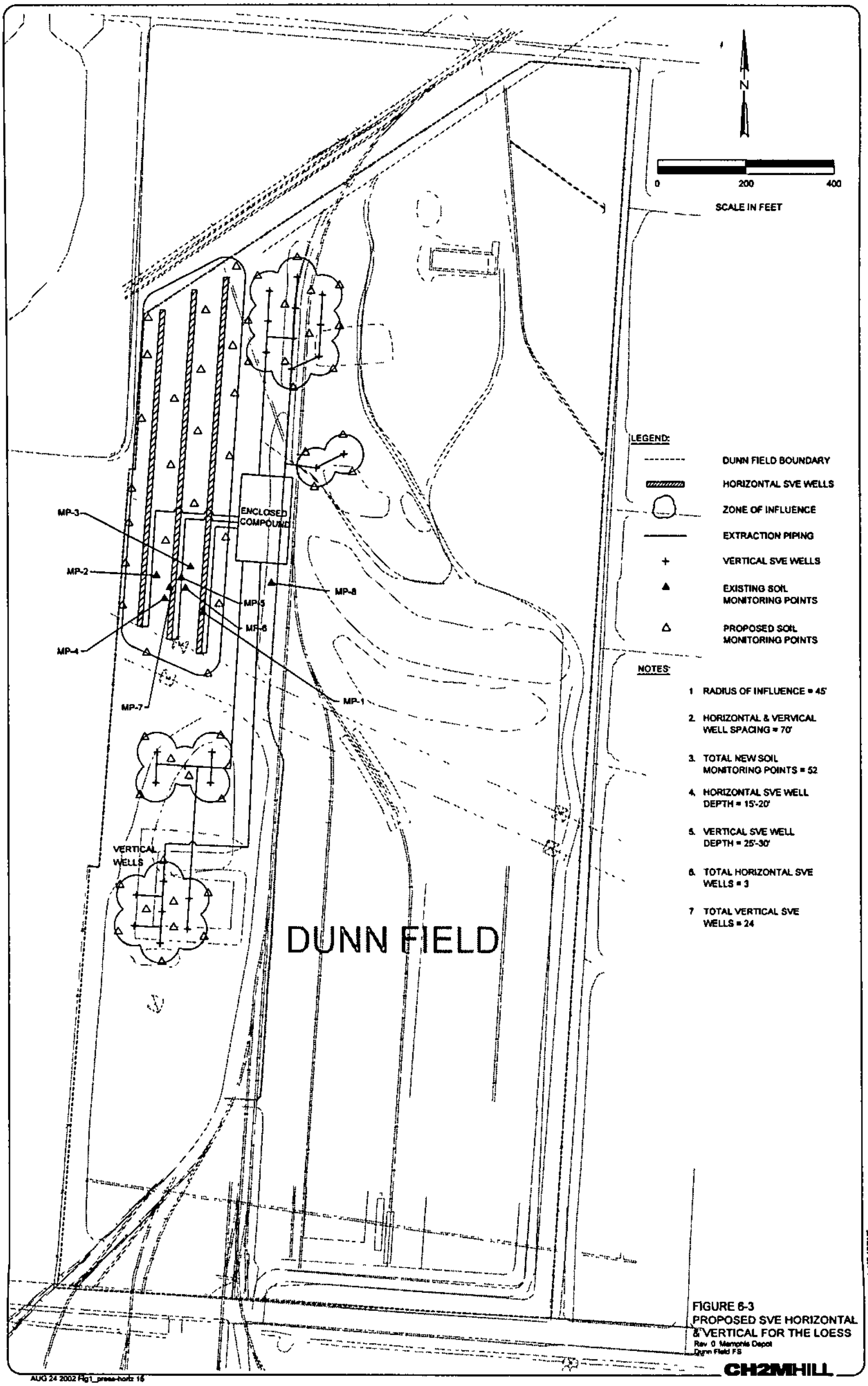

FIGURE 6-3
PROPOSED SVE HORIZONTAL & VERTICAL FOR THE LOESS
Rev. 0 Memphis Depot
Dunn Field FS

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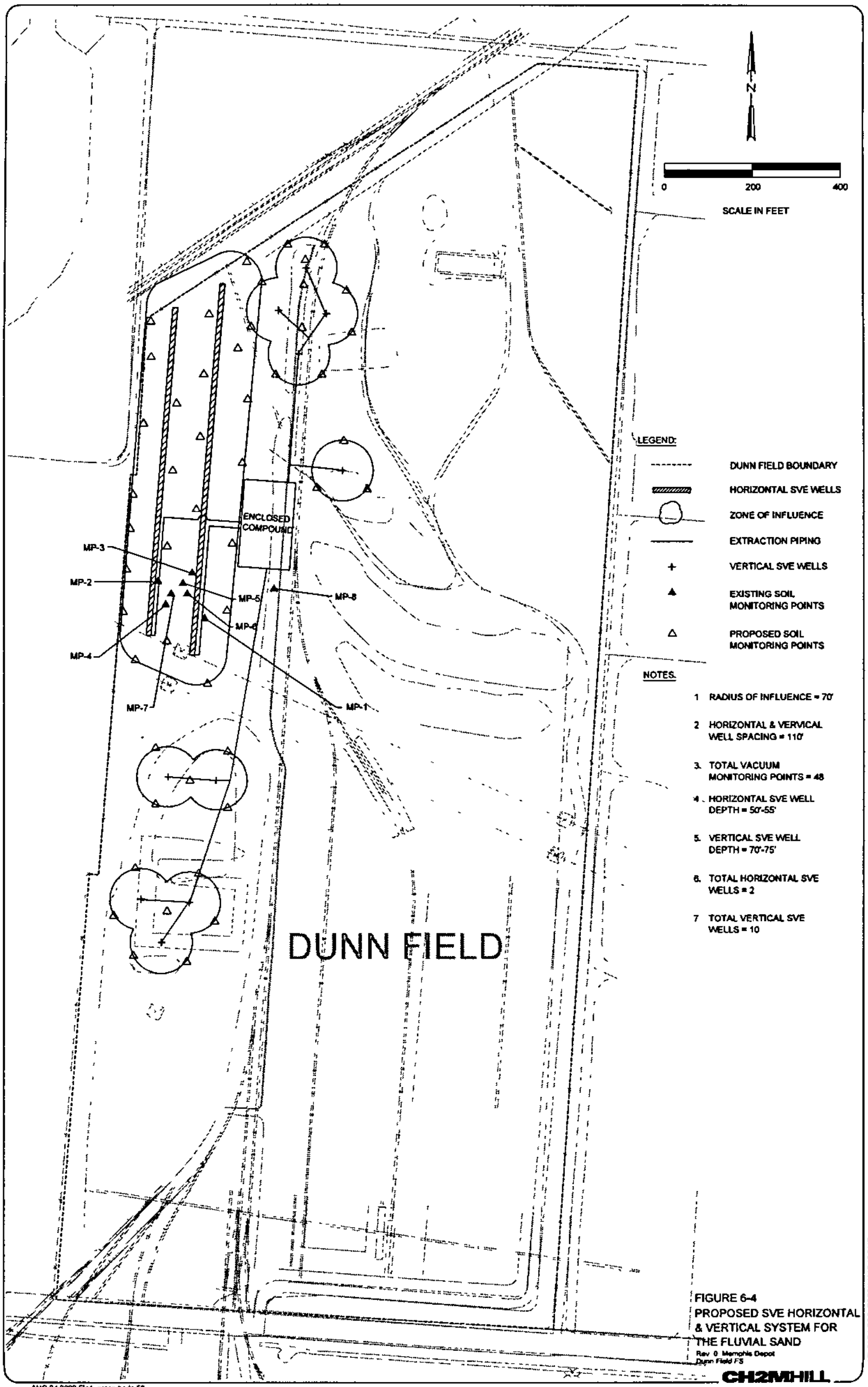

FIGURE 6-4
PROPOSED SVE HORIZONTAL & VERTICAL SYSTEM FOR THE FLUVIAL SAND

7.0 Detailed Analysis of Groundwater Alternatives

7.1 Definition of Remedial Alternatives – Groundwater

The EPA guidance for conducting an RI/FS (EPA, 1988) recommends that each alternative be defined in sufficient detail to apply the evaluation criteria and to determine order-of-magnitude costs. The definition may include preliminary design calculations and drawings, as well as address the limitations, assumptions, and uncertainties about each alternative. However, the definition step is not a remedial design. Complete details of how an alternative will be implemented are not necessary (or required by CERCLA) for the comparative analyses performed. The quantitative data given as part of the description of an alternative are estimates based on conceptual design and professional experience. They are for the purpose of estimating costs to an accuracy of +50% to -30%, per EPA guidance on FS cost estimates.

As presented in Section 3, the groundwater alternatives retained for further development are defined in the following sections. A composite map of the groundwater VOC plumes is presented as Figure 7-1.

The BRA identified contaminants in groundwater that could pose unacceptable risk to possible receptors (CH2M HILL, July 2002). Contaminants in the fluvial aquifer may migrate further offsite or into deeper aquifers, posing a threat to water supplies. Based on analysis of the contaminants present, both onsite and offsite potential receptors, and permissible exposure levels, the following RAOs have been developed for groundwater at Dunn Field:

- Prevent use of impacted groundwater as a potable source;
- Prevent further offsite migration of VOCs in groundwater in excess of MCLs; and
- Remediate fluvial aquifer groundwater to drinking water standards (MCLs) to be protective of the deeper Memphis aquifer. This RAO means that the site shall be cleaned up until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard.

7.1.1 Alternative 1 – No Action

This alternative includes no active remedial activities, but is required by CERCLA to be retained as a baseline for comparison.

7.1.2 Alternative 2 – Zero-Valent Iron Injection for Source Areas, Groundwater Extraction Enhancement, and Enhanced Bioremediation (with MNA and Institutional Controls)

The principle active groundwater treatment methods within this alternative include onsite ZVI injection, enhancement of the existing groundwater extraction system, and enhancement of bioremediation processes within the fluvial aquifer downgradient of Dunn Field. The ZVI injection will be used to treat source areas in the aquifer underlying Dunn Field only. The existing groundwater extraction system will be used to control further migration of contaminant plumes offsite (Figure 7-2), but will be supplemented with additional extraction wells. Since the extraction system will be introducing additional contaminant levels into the current system, the water may exceed current permit City of Memphis limits. For this reason, an air stripping system or activated carbon canisters may need to be introduced into the system near the edge of Dunn Field prior to release into the municipal lines. This is considered a contingency cost.

Enhanced bioremediation will be used to treat portions of the plume away from the perimeter of the other methods in this alternative. Monitored natural attenuation will be implemented as a polishing step to the active groundwater treatment methods. Groundwater monitoring will occur throughout this alternative and will take place to document changes in plume concentrations, and to detect any potential plume migration into deeper aquifers, and until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard.

With active groundwater source area remediation within Dunn Field (injection of ZVI in the source areas) and along the west side of Dunn Field (groundwater extraction), and a downgradient enhancement of bioremediation with MNA as a polishing step, a conservative assumption was made that the alternatives will greatly increase the contaminant reduction/degradation rate within the fluvial aquifer, and the duration of the remedial action was assumed to be 15 years. This also takes into account that subsurface soil remediation is occurring concurrently and the mass transfer from soil to groundwater has been abated on Dunn Field.

The principal uncertainty of this alternative is the potential movement of the plume. More active remedial measures may be needed to control the plume during the life of the action. The scope and cost of more active measures cannot be predicted.

Preliminary components of this alternative include the following:

- Institutional controls (deed restrictions) will prohibit installation and use of production and consumptive use wells during the operational life of the remedy. The deed restrictions will also guarantee access to all monitoring wells for the life of the remedy. These restrictions might be removed at the completion of the remedy.
- Zero-valent iron (ZVI) will be injected into the fluvial aquifer underlying Dunn Field suspected of acting as a source for continued downgradient groundwater contamination. In this alternative, the ZVI source area treatment will be used on Dunn Field only.
- The existing groundwater extraction system will be supplemented with 10 additional extraction wells along the current line and will have two additional lines added to the current piping. The current system is described in Section 1. The new lines will serve five new extraction wells (Figure 7-2). An air stripping system could be placed into the distal end of the discharge line prior to emptying into the municipal lines as a contingency action to the alternative. The air stripping system would be used to bring the effluent contaminant levels down to within limits set by the current City of Memphis discharge permit.
- Enhanced bioremediation via nutrient injection into the fluvial aquifer will be conducted via approximately 100 borings or injection wells. A treatment zone will be established in a

downgradient position across the plume to capture and reduce contaminants at those portions not effected by the other treatment methods in this alternative(Figure 7-2). Nutrient re-injection will occur at intervals determined by monitoring results.

- Monitoring of approximately 43 groundwater wells for definition of the effectiveness of the groundwater remedies and natural attentuation processes will take place quarterly for 1 year and semiannually for the next 9 years. Thereafter, monitoring will be conducted annually for five years or until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard.
  - Wells inside the most contaminated parts of the plumes to measure the effectiveness of the active treatment measures.
  - Boundary wells to detect potential migration of the plume further offsite to the west-northwest, upgradient or downgradient. Water samples will be analyzed for VOCs.
  - Sentinel wells to detect potential migration of the plume into the deeper intermediate aquifer or the Memphis aquifer.

  Field parameters, such as water level, pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen, will be measured during sample collection.
- Monitoring of groundwater extraction system effluent, will take place quarterly.
- Annual summaries of monitoring data will be produced to document site conditions and progress of the remedy.
- Annual inspections and reports by the DoD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence. Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.
- Groundwater monitoring will continue until data indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard. The sampling schedule will therefore be subject to change due to observed trends and variability.
- Contingency provisions will ensure that if groundwater contamination exceeds MCLs at the sentinel wells, more active measures for plume control will be implemented. Potential remedial contingency areas are shown on Figure 7-2.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The active treatment portion of the remedy will occur over the first 15 years.
- ZVI injection will occur in source areas present in the fluvial aquifer underlying Dunn Field only. Each injection zone will include injection points to the bottom of the fluvial aquifer.
- A bench-scale test and a 3-month pilot study will be completed to determine design parameters of the ZVI injection, such as injection amounts, depth, and zone of influence. The pilot study will include installation of 4 injection borings and 4 new monitoring wells.

- Ten new extraction wells will be installed, for a total of 21 wells included in the extraction system.
- The effluent from the additional extraction wells is expected to result in exceedance of permit requirements, therefore, groundwater pumped by the extraction system will be treated using air stripping or activated carbon canisters before discharge to POTW.
- Four samples (discharge effluent and QC samples) will be collected quarterly each year to monitor the groundwater extraction system. Water samples will be analyzed for VOCs.
- A fee will be paid to the local POTW for groundwater discharged into the sewer line; annual discharge volume will be approximately 53 million gallons per year.
- O&M activities for the groundwater extraction system will be performed monthly for the life of the alternative. Monitoring well maintenance (cleaning, wellhead repairs) will be performed as needed during groundwater sampling events. O&M activities for the enhanced bioremediation system will be performed bi-monthly.
- 100 injection points will be installed by conventional drilling techniques at 40-foot spacing. Approximately 3,171,000 pounds of nutrients will be re-injected into the aquifer twice.
- Clearing and grubbing of the areas surrounding the additional groundwater extraction system lines will be necessary. Property access, lease or purchase will be required for offsite remedial actions.
- Deed restrictions are the only institutional controls to be imposed to prevent the installation of wells for production or consumptive groundwater use.
- Fifteen new monitoring wells will be installed and a total of 43 wells will be included in the monitoring program.
- Groundwater monitoring will occur quarterly for the first year, semiannually for 9 years and once every year for 5 years. Water samples will be analyzed for VOCs and degradation parameters. Field parameters will be measured during sample collection. Monitoring may be discontinued once the cleanup levels have been achieved and maintained for three consecutive sampling periods.
- All monitoring and extraction wells will be plugged and abandoned per Memphis-Shelby County requirements at the completion of the remedy.
- Annual monitoring reports will document the site status. These reports will include a potentiometric surface map, a plume map, summary tables of detected parameters, interpretative text, and an appendix that contains the laboratory data and field forms.

7.1.3 Alternative 3 - Zero-Valent Iron (ZVI) Injection for Source Areas, Installation of a Permeable Reactive Barrier (PRB) with MNA and Institutional Controls

The principle, active groundwater treatment methods within this alternative include onsite ZVI injection, installation of an offsite PRB containing ZVI. The ZVI injection will be used to treat source areas in the aquifer underlying Dunn Field and the area west of Dunn Field (Figure 7-3). The PRB will treat and prevent further migration of contaminants in the relatively higher level zones of the plume, specifically offsite portions of the plume. Untreated parts of the plume will degrade under natural attenuation processes (as described in Alternative 2).

The rate of groundwater moving from monitoring well MW-71 (the western edge of the ZVI source are treatment) to MW-54 (near the planned location of the PRB) (a distance of 850 linear feet) was estimated by the average seepage velocity. The average seepage velocity between these wells was 0.4 feet/day, or 154.6 feet/year. The travel was calculated to be 5.5 years.

With active groundwater source area remediation within Dunn Field (injection of ZVI in the source areas both on and off of Dunn Field) and the installation of a PRB with MNA as a polishing step, a conservative assumption was made that the alternatives will greatly increase the contaminant reduction/degradation rate within the fluvial aquifer, and the duration of the remedial action was assumed to be 15 years. This also takes into account that subsurface soil remediation is occurring concurrently and the mass transfer from soil to groundwater has been abated on Dunn Field.

The principal uncertainties of this alternative are the rate of degradation achieved using the PRB and bioenhancement materials and the treatment zone of influence. More bioenhancement injection points or more frequent application of the electron donors may be needed to treat the plume during the life of the action. The scope and cost of the actual application cannot be predicted without pilot test data.

Preliminary components of this alternative include the following:

- Institutional controls (deed restrictions) will prohibit installation and use of production and consumptive use wells during the operational life of the remedy. The deed restrictions will also guarantee access to all monitoring wells for the life of the remedy. These restrictions might be removed at the completion of the remedy.
- ZVI will be injected into areas of the fluvial aquifer underlying Dunn Field suspected of acting as a source for continued downgradient groundwater contamination. The ZVI will be used on Dunn Field and along the western boundary of Dunn Field.
- A PRB will be placed offsite, across the flowpath of the groundwater plumes to prevent further migration of relatively high groundwater contaminant concentration (Figure 7-3). The PRB will consist of three lines of a number of injection points designed to ensure complete coverage across the plume and adequate residence time within the wall for the chemical reduction of the CVOCs.
- Monitoring of approximately 43 groundwater wells for definition of the effectiveness of the groundwater remedies and natural attenuation processes will take place quarterly for 1 year and semiannually for the next 9 years. Thereafter, monitoring will be conducted annually for five years or until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard.
  - Wells inside the most contaminated parts of the plumes to measure the effectiveness of the active treatment measures.
  - Boundary wells to detect potential migration of the plume further offsite to the west-northwest, upgradient or downgradient. Water samples will be analyzed for VOCs.

- Sentinel wells to detect potential migration of the plume into the deeper intermediate aquifer or the Memphis aquifer.

Field parameters, such as water level, pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen, will be measured during sample collection.

- Annual summaries of monitoring data will be produced to document site conditions and progress of the remedy. Annual inspections and reports by the DoD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence. Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.
- Groundwater monitoring will continue until data indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard. The sampling schedule will therefore be subject to change due to observed trends and variability.
- Contingency provisions will ensure that if groundwater contamination exceeds MCLs at the sentinel wells, more active measures for plume control will be implemented. Potential remedial contingency areas are shown on Figure 7-3.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The active treatment portion of the remedy will occur over the first 15 years.
- ZVI injection will occur in source areas present in the fluvial aquifer underlying Dunn Field only. Each injection zone will include injection points to the bottom of the fluvial aquifer.
- A 3-month pilot study will be completed to determine design parameters of the ZVI injection, such as injection amounts, depth, and zone of influence. The pilot study will include installation of 4 injection borings and 4 new monitoring wells.
- Approximately 1050 feet of injection points will be installed as part of the PRB construction. The locations will be set within three lines per each treatment area.
- A bench-scale study will be completed to determine design parameters of the PRB injection lines, such as amount of ZVI needed, depth, and zone of influence.
- Deed restrictions are the only institutional controls to be imposed to prevent the installation of wells for production or consumptive groundwater use.
- Clearing and grubbing of the areas surrounding the areas of the planned PRB and offsite ZVI injections will be necessary. Property lease or purchase may also be required.
- Fifteen new monitoring wells will be installed and a total of 43 wells will be included in the groundwater monitoring program.
- Groundwater monitoring will occur quarterly for the first year, semiannually for 9 years and once every year for 5 years. Water samples will be analyzed for VOCs and degradation parameters. Field parameters will be measured during sample collection. Monitoring may be discontinued once the cleanup levels have been achieved and maintained for three consecutive sampling periods.

- The existing groundwater extraction system will be "moth-balled" during the life of the remedies in this alternative and will be dismantled at the end of the remedy. The system will not be dismantled immediately because of potential use in the future to assist with the aquifer remediation.
- All monitoring and extraction wells and injection borings will be plugged and abandoned per Memphis-Shelby County requirements at the completion of the remedy.
- Annual monitoring reports will document the site status. These reports will include a potentiometric surface map, a plume map, summary tables of detected parameters, interpretative text, and an appendix that contains the laboratory data and field forms.

7.1.4 Alternative 4 - Air Sparging with SVE for Source Areas Installation of a Permeable Reactive Barrier (PRB) with MNA and Institutional Controls

This alternative treats groundwater through volatilization in the most contaminated parts of the plume both on- and offsite by injecting air (Figure 7-4). Volatilized contaminants will be recovered by the SVE system, installed as part of the presumptive remedy for subsurface soils. Additional lines for the SVE will be installed in the offsite portions of the plume. The remedy is expected to remove contaminants from the most contaminated parts of the plume. In addition to the air sparging activities, a PRB will be constructed downgradient of Dunn Field, across the flow path of the contaminant plumes.

Untreated parts of the plume will degrade under natural attenuation processes. Therefore, this alternative must also include institutional controls and groundwater monitoring similar to Alternative 3.

With active groundwater source area remediation within and west of Dunn Field (via air sparging with SVE) and the installation of a PRB with MNA as a polishing step, a conservative assumption was made that the alternatives will greatly increase the contaminant reduction/degradation rate within the fluvial aquifer, and the duration of the remedial action was assumed to be 15 years. This also takes into account that subsurface soil remediation is occurring concurrently and the mass transfer from soil to groundwater has been abated on Dunn Field.

The principal uncertainties of this alternative is the effective zone of influence of the air sparging array and the areas that are capable of being bio-remediated. More sparge points and higher capacity blowers may be needed to treat the plume during the life of the action. More bioenhancement injection points or more frequent application of the electron donors may be needed to treat the plume during the life of the action. The scope and cost of the actual applications cannot be predicted without pilot test data.

Preliminary design components will include the following:

- Air sparging of the fluvial aquifer will be conducted via approximately 364 sparge wells. Treatment zones will be established in the most contaminated parts of the plume on- and offsite of Dunn Field (Figure 7-4). Approximately six 20-psi and 300-SCFM positive displacement (PD) type blowers or compressors will be required. A 1-week pilot test will be required to determine injection rates, spacing, and zone of influence.

- A remediation compound/trailer will be set up with all electrical equipment, generators, and off-gas collection and treatment units. The compound will be set up adjacent to an available power source.
- Start up and testing of air sparging system will take approximately 2 months.
- Deed restrictions will prohibit the installation and use of production and consumptive use wells during the operational life of the remedy. The deed restrictions will also guarantee access to all monitoring wells for the life of the remedy. These restrictions might be removed at the completion of the remedy.
- A PRB will be placed offsite, across the flowpath of the groundwater plumes to prevent further migration of relatively high groundwater contaminant concentration (Figure 7-4). The PRB will consist of three lines of a number of injection points designed to ensure complete coverage across the plume and adequate residence time within the wall for the chemical reduction of the CVOCs.
- Monitoring of approximately 43 groundwater wells for definition of the effectiveness of the groundwater remedies and natural attenuation processes will take place quarterly for 1 year and semiannually for the next 9 years. Thereafter, monitoring will be conducted annually for five years or until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard.
  - Wells inside the most contaminated parts of the plumes to measure the effectiveness of the active treatment measures.
  - Boundary wells to detect potential migration of the plume further offsite to the west-northwest, upgradient or downgradient. Water samples will be analyzed for VOCs.
  - Sentinel wells to detect potential migration of the plume into the deeper intermediate aquifer or the Memphis aquifer.
  - Field parameters, such as water level, pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen, will be measured during sample collection.
- Annual inspections and reports by the DoD will document the site status to ensure that uses incompatible with the deed restrictions do not take place, with reporting for regulatory concurrence. Periodic 5-year reviews performed by the DoD, with concurrence by the regulators, will also be required.
- Groundwater monitoring will occur quarterly for the first year, semiannually for 9 years and once every year for 5 years. Water samples will be analyzed for VOCs and degradation parameters. Field parameters will be measured during sample collection. Monitoring may be discontinued once the cleanup levels have been achieved and maintained for three consecutive sampling periods.
- Contingency provisions will ensure that if groundwater contamination exceeds MCLs at the sentinel wells, more active measures for plume control will be implemented. Potential remedial contingency areas are shown on Figure 7-4.
- If levels exceeded permit requirements, groundwater pumped by extraction system will be treated using air stripping or activated carbon canisters before discharge to POTW.

The assumptions used in developing the cost estimate for this alternative were as follows:

- The remedy will require 15 years to achieve remedial goals.
- Fifteen new monitoring wells will be installed, and a total of 43 wells will be included in the monitoring program.
- A 1-week pilot study will be completed to determine design parameters, such as injection rates, sparge cycle times, and zone of influence. During this test, five air sparge wells and one air sparging system will be installed. All pilot test wells will be 2-inch diameter PVC wells installed into the fluvial aquifer. Groundwater samples will be collected prior and post to pilot test startup from 8 monitoring wells.
- An additional 364 air sparge wells will be installed at 30-foot spacing by rotosonic drilling for the full-scale system. Eight claw-type blowers or compressors, instrument controls, and in-ground piping will deliver air.
- Groundwater monitoring will occur quarterly for the first year, semiannually for 9 years and once every year for 5 years. Water samples will be analyzed for VOCs and degradation parameters. Field parameters will be measured during sample collection. Monitoring may be discontinued once the cleanup levels have been achieved and maintained for three consecutive sampling periods.
- Deed restrictions are the only institutional controls to be imposed to prevent the installation of wells for production or consumptive groundwater use.
- The existing groundwater extraction system will be "moth-balled" during the life of the remedies in this alternative and will be dismantled at the end of the remedy. The system will not be dismantled immediately because of potential use in the future to assist with the aquifer remediation.
- Air sparge wells, monitoring wells, and extraction wells will be plugged and abandoned per TDEC requirements at the completion of the remedy.
- Annual monitoring reports will document the site status. These reports will include a potentiometric surface map, a plume map, summary tables of detected parameters, interpretative text, and an appendix that contains the laboratory data and field forms.

7.2 Analysis of Remedial Alternatives – Groundwater

The following detailed analyses compare the alternatives to the nine EPA criteria. The analyses are presented in the following narrative and in a summary table (Table 7-1) following this section.

7.2.2 Alternative 1 – No Action

The no action alternative will not be protective of human health and will be not be evaluated further.

7.2.3 Alternative 2 – Zero-Valent Iron Injection for Source Areas, Groundwater Extraction Enhancement, and Enhanced Bioremediation (with MNA and Institutional Controls)

Alternative 3 is considered protective of human health and the environment because groundwater will be aggressively treated to MCLs in the areas of highest contaminant concentration, thereby reducing the risk to human health and the environment in a short time period. Contaminated groundwater migrating offsite will be removed and treated by an enhanced groundwater extraction system. In addition, contaminated groundwater on- and offsite not effected by the ZVI source are injection or the groundwater extraction system will be treated with enhanced bioremediation methods to reduce contaminant levels. In addition, MNA will be employed to ensure that outer areas of the plume are degrading as a result of treatment of groundwater or via natural processes. Groundwater monitoring conducted during the remedy will indicate if contaminant plumes are degrading as expected and to define if the plumes are migrating into deeper aquifers, and until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard. A contingency plan for more aggressive plume control will be developed if an unacceptable risk is indicated. This alternative also includes institutional controls to prohibit use of groundwater until MCLs are met. This remedy will comply with ARARs, and is considered effective and permanent. A review of the alternative will be conducted every 5 years.

This alternative employs aggressive methods to accelerate the degradation of the most contaminated, on-and offsite parts of the plume. In addition, methods will be used to stimulate and monitor natural biodegradation processes to remediate other portions of the plume. Use of these methods will reduce the plume to acceptable levels. The expected duration of this alternative, 10 years, is also acceptable, with no risk to workers, the community, or the environment during the remedy lifetime. This alternative is technically feasible and could be implemented with commercially available labor, materials, and equipment, however, pilot tests are needed to determine specifications and, ultimately, applicability.

The present worth cost is estimated to be $14,828,000, with a capital cost of $10,506,000, and an annual O&M cost of $4,322,000. The capital cost is primarily for additional extraction wells, purchase and injection of ZVI, purchase and injection of nutrients, injection wells for the enhanced bioremediation remedy, monitoring well installation, and establishing controls. The annual O&M cost is primarily for extraction system maintenance, groundwater monitoring, and nutrient re-injection. This alternative is likely to be accepted by the state and the community because it affords protection after a moderate time for cleanup.

7.2.4 Alternative 3 – Zero-Valent Iron Injection for Source Areas, Installation of a Passive Reactive Barrier (PRB) with MNA and Institutional Controls

Alternative 3 reduces the risk to human health and the environment because groundwater will be aggressively treated to MCLs using ZVI injections. Contaminated groundwater migrating offsite will be treated by the PRB. In addition, portions of the contaminant plume outside of the influence of the ZVI injection and the PRB will be treated with enhanced bioremediation. This alternative also includes institutional controls to prohibit development of groundwater until MCLs are met, as well as groundwater monitoring for providing information on the plume degradation via mechanical and natural means, and until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard. The groundwater data will also indicate plume configuration. This remedy will comply with ARARs, and is considered effective and permanent. A review of the alternative will be conducted every 5 years.

The alternative employs ZVI injection as a treatment technology of the most contaminated parts of the plume, and treatment of the remaining areas of contaminated groundwater through installation a PRB and enhanced bioremediation. Reduction in the total mass and concentration of the plume will be acceptable through this alternative. The expected duration of this alternative, 10 years, is also acceptable, with no risk to workers, the community, or the environment during the remedy lifetime. The alternative is technically feasible although pilot tests are needed to determine specifications and, ultimately, applicability. The alternative can be implemented with commercially available labor, materials, and equipment.

The present worth cost is estimated to be $8,807,000, with a capital cost of $7,827,000, and an annual O&M cost of $981,000. The capital cost is primarily for purchase and injection of ZVI, installation of a PRB, establishing controls, installation of monitoring wells, and site supervision. The annual O&M cost is primarily for groundwater monitoring for 15 years. This alternative is likely to be accepted by the state and the community because it affords protection after a short time for cleanup.

7.2.5 Alternative 4 – Air Sparging with SVE for Source Areas and Installation of a Passive Reactive Barrier (PRB) (with MNA and Institutional Controls)

This alternative employs air sparging techniques combined with the presumptive remedy SVE to treat and remove contaminants from the groundwater. The air sparging methods will be employed for the most contaminated, on-and offsite areas of the plume. The SVE system designed for onsite soil contamination will be extended to offsite areas to assist the air sparging of the groundwater. Contaminated groundwater that has migrated offsite will be treated by a PRB (using ZVI). This alternative also includes groundwater monitoring to define natural bioremediation processes occurring at outer areas of the plume and institutional controls to prohibit use of groundwater until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard. This remedy will comply with ARARs, and is considered effective and permanent. A review of the alternative will be conducted every 5 years.

The alternative employs techniques to aggressively treat contaminated groundwater, thus reduction in TMV of the plume through treatment is acceptable. This alternative is considered effective in the short-term because adequate controls can be employed to protect workers and the community from vapors during implementation. The expected duration of this remedy, 15 years, is also acceptable. The alternative is technically feasible although a pilot test is needed to determine its effectiveness. The alternative can be implemented with available labor, materials, and equipment.

The present worth cost is estimated to be $8,753,00, with a capital cost of $7,195,00, and an annual O&M cost of $1,949,000. The capital cost is primarily for construction of the air sparging system and well installation, PRB installation, establishing controls, monitoring well installation, and site supervision. The cost of this remedy could increase significantly if pilot tests indicate a more extensive network of sparge wells is needed to achieve treatment or that additional ZVI is needed within the PRB. This alternative is likely to be accepted by the state and the community because it affords protection after a moderate time for cleanup.

7.3 Comparative Analysis of Remedial Alternatives – Groundwater

The alternatives are compared to each other using the nine EPA criteria. A description of this comparison is included in the following paragraphs. This section concludes with a summary of the comparative analysis.

7.3.1 Overall Protection of Human Health and the Environment

All alternatives, except no action, are considered protective of human health and the environment. Alternatives 2, 3 and 4 provide protection through active remediation of the groundwater in the fluvial aquifer, both on and off Dunn Field, and provide protection for the deeper, underlying Memphis aquifer. All three alternatives also include institutional controls to prevent the use of the groundwater in the fluvial aquifer during remediation.

7.3.2 Compliance with ARARs

All alternatives except no action are expected to meet ARARs at the completion of implementation. Each of the three active alternatives employ active remediation of the source areas on and off of Dunn Field, and provide treatment of the offsite plume through installation of PRB (using ZVI) (Alternatives 3 and 4) or through enhanced bioremediation (Alternative 2). MNA is used in all three active alternatives as a 'polishing' step for the diffuse contaminants beyond the areas of active in-situ remediation. Based on know groundwater flow velocities and attenuation data, all three active alternatives are expected to be in compliance with ARARs with 15 years.

7.3.3 Long-term Effectiveness and Permanence

All alternatives except no action are expected to be effective and permanent at the completion of implementation. The enhanced bioremediation portion of Alternative 2 may require additional injection of chemicals/nutrients, as they are consumed in the biodegradation process. The ZVI injected into the source areas or as part of the PRB has been shown to last for up to two decades without replacement.

7.3.4 Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment

All alternatives except no action are expected to reduce the toxicity, mobility and volume for the CVOCs through treatment at the completion of implementation. Alternative 2 relies on in-situ chemical reduction (using ZVI) and enhanced bioremediation for treatment. The groundwater extraction component of the remedy does not use treatment, but does reduce volume of contaminants. Alternative 3 relies primarily on in-situ chemical reduction (using ZVI injection for the source area and a PRB for the downgradient, offsite plumes) for treatment. Alternative 4 uses volatilization (through air sparging) and in-situ chemical reduction (using a PRB for the downgradient, offsite plumes) for treatment. Vapors generated from air sparge system and collected through the SVE system are treated aboveground prior to release to the atmosphere.

7.3.5 Short-term Effectiveness

Alternatives 2 through 4 require some engineering controls during installation of treatment to protect the environment and safety controls to protect workers. Air sparging will require engineering controls (an associated SVE system) for fugitive VOC emissions during treatment. Alternative 1 has no short-term impacts because nothing is implemented.

7.3.6 Implementability

All alternatives are considered technically feasible and can be implemented with available labor, materials, and equipment. All of the active remedies require offsite access for remedial actions, which can pose implementability concerns. The depth to groundwater creates delivery obstacles for installation of a PRB and for ZVI source area injection. Depth to water and limited saturated thickness presents technical implementability issues concerning radius of influence for air sparging and groundwater extraction. With respect to the use of ZVI source area treatment and ZVI in a PRB, the degree to which complete dechlorination can be achieved is important for understanding the viability and implementability of the alternatives which rely on in-situ chemical reduction. In-situ delivery of the ZVI to the subsurface and the resultant contact time between the CVOC and the ZVI are important implementability issues. Alternatives 2 through 4 will all require pilot testing to determine an effective design for implementation.

7.3.7 Cost

Present worth costs are summarized in the following list.

Alternative	Capital Cost	Present Worth O&M Cost	Total Present Worth
1 – No Action	$0	$0	$0
2 – ZVI/Enhanced GE / Enhanced Bio/MNA/IC	$10,506,00	$4,322,000	$14,828,000
3 – ZVI/PRB/MNA/IC	$7,827,000	$981,000	$8,807,000
4 – Air Sparging/PRB/MNA/IC	$7,195,000	$1,949,000	$8,753,000

IC Institutional controls
ZVI Zero-Valent Iron (as a source area treatment)
GE Groundwater extraction
PRB Permeable reactive barrier (using ZVI [granular iron])
MNA Monitored Natural Attenuation

There are no costs associated with Alternative 1 (No Action). Alternatives 3 and 4 are the least expensive of the treatment alternatives at approximately $8.8 million each. Alternative 2 is the most expensive at $14.8 million. Details of the cost estimates are provided in Appendix D.

7.3.8 State Acceptance

State acceptance is likely for all active alternatives.

7.3.9 Community Acceptance

Community acceptance of all, faster-acting alternatives, such as the alternatives presented herein, is likely. Ongoing community involvement activities will be an important element of remedy implementation.

7.4 Summary

The comparative analysis of alternatives is summarized as follows.

Evaluation Criteria	1 No Action	2 ZVI / Enhanced Groundwater Extraction / Enhanced Bioremediation/ MNA / IC	3 ZVI / PRB / MNA / IC	4 Air Sparging / PRB / MNA / IC
Protective of Human Health and Environ.	No	Yes	Yes	Yes
Complies with ARARs	N/A	Yes	Yes	Yes
Effective and Permanent	N/A	Yes	Yes	Yes
Reduces TMV	N/A	Yes	Yes	Yes
Short-term Effectiveness	N/A	Acceptable	Acceptable	Acceptable
Implementable	N/A	Yes	Yes	Yes
Cost	$0	$14.8 million	$8.8 million	$8 8 million
State Acceptance	Unlikely	Likely	Likely	Likely
Community Acceptance	Unlikely	Likely	Likely	Likely

Tables

TABLE 7-1
Summary of Detailed Analysis of Groundwater Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 2 Zero Valent Iron (ZVI); Enhanced GW Extraction; Enhanced Bioremediation, MNA and IC	Alternative 3 ZVI, Permeable Reactive Barriers (PRBs), MNA and IC	Alternative 4 Air Sparging with SVE, PRB, MNA and IC
	This alternative includes *(1) ZVI source area injection into the fluvial aquifer beneath Dunn Field to enhance the degradation of contaminants,* *(2) the enhanced extraction and discharge of groundwater from the fluvial aquifer at western boundary of site to the City of Memphis POTW,* *(3) injection of nutrients into the fluvial aquifer to enhance the natural biodegradation processes,* *(4) institutional controls preventing use of the groundwater beneath the site, and* *(5) monitored natural attenuation for groundwater.*	*This alternative include.* *(1) ZVI source area injection into the fluvial aquifer beneath Dunn Field and the area west of Dunn Field to enhance the degradation of contaminants,* *(2) installation of a PRB to chemically reduce contaminants via granular iron (ZVI),* *(3) institutional controls preventing use of the groundwater beneath the site, and* *(4) monitored natural attenuation for groundwater*	*This alternative includes* *(1) air sparging of the fluvial aquifer to volatilize VOCs combined with SVE as an extension to the sparging area,* *(2) installation of a PRB to chemically reduce contaminants via granular iron (ZVI),* *(3) institutional controls preventing use of the groundwater beneath the site,* *(4) monitored natural attenuation for groundwater*
OVERALL PROTECTIVENESS			
Human Health Protection **(Groundwater Ingestion for Existing Users)**	This alternative remediation methods to remediate groundwater, in addition to institutional controls to prevent use of the groundwater	See Alternative 3	See Alternative 3
(Groundwater Ingestion for Future Users)	This alternative reduces risk by aggressively treating the more contaminated areas of the groundwater contaminant plume with ZVI source area treatment In addition, other portions of the plume will be treated by enhancing the biodegradation of VOCs It also extracts contaminated groundwater from the western boundary of the site This alternative also uses deed restrictions to prevent groundwater use on the Depot, and allows natural attenuation to reduce the concentrations of VOCs in groundwater to MCLs downgradient of the treatment zone A contingency plan for more aggressive treatment of the VOCs will be developed and implemented if an unacceptable risk were indicated	This alternative reduces risk by aggressively treating the more contaminated areas of the groundwater contaminant plume with ZVI In addition, other portions of the plume will be treated by a flow through PRB This alternative also uses deed restrictions to prevent groundwater use on the Depot, and allows natural attenuation to reduce the concentrations of VOCs in groundwater downgradient of the treatment zone A contingency plan for more aggressive treatment of the VOCs will be developed and implemented if an unacceptable risk were indicated	This alternative reduces risk by volatilizing the VOCs from the most contaminated parts of the plumes through air sparging In addition, other portions of the plume will be treated by a flow through PRB This alternative also uses deed restrictions to prevent groundwater use on the Depot, and allows natural attenuation to reduce the concentrations of VOCs in groundwater to MCLs downgradient of the treatment zone A contingency plan for more aggressive treatment of the VOCs will be developed and implemented if an unacceptable risk were indicated
Environmental Protection	This alternative monitors groundwater quality and has a contingency plan to ensure that no further environmental degradation occurs.	This alternative monitors groundwater quality and has a contingency plan to ensure that no further environmental degradation occurs	This alternative monitors groundwater quality and has a contingency plan to ensure that no further environmental degradation occurs
COMPLIANCE WITH ARARs			
Chemical-Specific ARARs	Will comply with MCLs at the completion of implementation	Will comply with MCLs at the completion of implementation	Will comply with MCLs at the completion of implementation
Location-Specific ARARs	Memphis-Shelby County Health Department, Water Quality Branch, prevents the installation of water wells within 0 5 mile of the designated boundaries of a listed federal CERCLA site This restriction is not considered permanent. Deed restrictions will prohibit groundwater use within the Depot during the action These restrictions will not be removed until the remedial action is complete	See Alternative 3	See Alternative 3

TABLE 7-1
Summary of Detailed Analysis of Groundwater Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 2 Zero Valent Iron (ZVI), Enhanced GW Extraction, Enhanced Bioremediation; MNA and IC	Alternative 3 ZVI; Permeable Reactive Barriers (PRBs), MNA and IC	Alternative 4 Air Sparging with SVE; PRB, MNA and IC
Action-Specific ARARs	Must comply with (1) substantive requirements of the underground injection rules of TDEC and Memphis-Shelby County, (2) substantive requirements of the Memphis-Shelby County regulations for the installation of extraction and monitoring wells, and (3) RCRA for the disposal of the wastes generated during well installation and groundwater monitoring	Must comply with (1) substantive requirements of the underground injection rules of TDEC and Memphis-Shelby County, (2) substantive requirements of the Memphis-Shelby County regulations for the installation of extraction and monitoring wells, and (3) RCRA for the disposal of the wastes generated during well installation and groundwater monitoring	Must comply with (1) substantive requirements of the Memphis-Shelby County rules for the installation of extraction and monitoring wells, (2) substantive requirements of the Memphis-Shelby County regulations for the installation of extraction, injection, and monitoring wells, (3) Clean Air Act and Tennessee Rule 1200-3-1 for VOC emissions to the air during treatment, and (4) RCRA for the disposal of the waste generated during well installation and groundwater monitoring
Other Criteria and Guidance	Chemical-specific ARARs for groundwater use (MCLs) will be met at completion of the remedial action	Chemical-specific ARARs for groundwater use (MCLs) will be met at completion of the remedial action	Chemical-specific ARARs for groundwater use (MCLs) will be met at completion of the remedial action
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk **(Groundwater Ingestion for Existing Users)**	Risks are reduced by treatment of groundwater in the most contaminated parts of the plume and downgradient of western boundary of site Deed restrictions prevent exposure to contaminants during treatment until degradation is complete Monitoring will assess the reduction of the VOC plumes, and will indicate if the plumes begin to migrate into deeper aquifers	See Alternative 3	See Alternative 3
(Groundwater Ingestion for Future Users)	Risks are reduced by treatment of groundwater in the more contaminated parts of the plume and downgradient of western boundary of site Deed restrictions prevent exposure to contaminants during implementation. The site shall be cleaned up until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard A contingency plan for more aggressive treatment of groundwater contaminants will be implemented if unacceptable risks were indicated during monitoring.	See Alternative 3	See Alternative 3.
Adequacy and Reliability of Controls	ZVI injection will treat the more contaminated areas of the plume and is adequate for the intended use Enhanced biodegradation and groundwater extraction and discharge to the City of Memphis POTW are adequate and reliable treatment alternatives. Monitoring and enforcement of deed restrictions are required during implementation (approximately 15 years)	ZVI injection will treat the more contaminated areas of the plume and is adequate for the intended use A PRB is adequate and reliable treatment alternatives for downgradient portions of the plume Monitoring and enforcement of deed restrictions are required during implementation (approximately 15 years).	Air sparging with SVE is a proven technology combination and is adequate and reliable treatment alternatives A PRB is adequate and reliable treatment alternatives for downgradient portions of the plume Monitoring and enforcement of deed restrictions are required during implementation (approximately 15 years).
Need for 5-Year Review	Review will be required to ensure that deed restrictions are being enforced and that plume reduction is occurring Review will also ensure that adequate plume controls are in place if unacceptable risks were indicated during monitoring	Review will be required to ensure that deed restrictions are being enforced and that plume reduction is occurring Review will also ensure that adequate plume controls are in place if unacceptable risks were indicated during monitoring	Review will be required to ensure that deed restrictions are being enforced and that plume reduction is occurring Review will also ensure that adequate plume controls are in place if unacceptable risks were indicated during monitoring
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT			
Treatment Process Used	ZVI injection and enhanced groundwater extraction occurs within the most contaminated parts of the plume Enhanced bioremediation methods will be used to treat other portions of the plume Natural attenuation occurs in other areas	ZVI injection occurs within the most contaminated parts of the plume A PRB method will be used to treat other portions of the plume Natural attenuation occurs in other areas	In-situ volatilization of VOCs occurs within the most contaminated parts of the plume A PRB method will be used to treat other portions of the plume Natural attenuation occurs in other areas
Amount Destroyed or Treated	Contamination will be treated until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard	Contamination will be treated until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard	Contamination will be treated until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard
Reduction of Toxicity, Mobility, or Volume	This alternative will reduce volume and toxicity of contaminated groundwater through active treatment. Mobility is reduced through groundwater extraction.	This alternative will reduce volume and toxicity of contaminated groundwater through active treatment.	See Alternative 4

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TABLE 7-1
Summary of Detailed Analysis of Groundwater Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 2 Zero Valent Iron (ZVI), Enhanced GW Extraction, Enhanced Bioremediation, MNA and IC	Alternative 3 ZVI, Permeable Reactive Barriers (PRBs), MNA and IC	Alternative 4 Air Sparging with SVE, PRB; MNA and IC
Irreversible Treatment	In-situ chemical reduction, biodegradation and extraction are irreversible	In-situ chemical reduction and biodegradation are irreversible	Volatilization, in-situ chemical reduction and biodegradation are irreversible
Type and Quantity of Residuals Remaining After Treatment	Residuals include biodegradation products chloride salts, methane, ethane, and ethene Organic products are also biodegradable	Residuals include biodegradation products chloride salts, methane, ethane, and ethene Organic products are also biodegradable	Biodegradation products chloride salts, methane, ethane, and ethene Organic products are also biodegradable Volatile vapors are treated before release to the atmosphere
Statutory Preference for Treatment	This alternative satisfies the statutory preference for treatment	This alternative satisfies the statutory preference for treatment	This alternative satisfies the statutory preference for treatment
SHORT-TERM EFFECTIVENESS			
Community Protection	Risk to the community is not increased by implementation, although risks to unauthorized groundwater users, and the potential migration of plumes into deeper aquifers do remain These risks are reduced by deed restrictions and monitoring Physical controls may be required around treatment area, in particular during installation processes in offsite areas	Risk to the community is not increased by implementation, although risks to unauthorized groundwater users, and the potential migration of plumes into deeper aquifers do remain These risks are reduced by deed restrictions and monitoring Physical controls may be required around treatment area, in particular during installation processes in offsite areas	Risk to the community is not increased by air sparging and SVE A pilot study will determine whether air emissions will require vapor treatment before discharging to the atmosphere Risks to unauthorized groundwater users and the potential migration of plumes into deeper aquifers do remain. These risks are reduced by deed restrictions and monitoring Physical controls may be required around treatment area, in particular during installation processes in offsite areas
Worker Protection	Workers will be protected during drilling, ZVI injection, nutrient injection, and monitoring activities by specific health and safety procedures, and personal protective equipment	Workers will be protected during drilling, ZVI injection, and monitoring activities by specific health and safety procedures and personal protective equipment	Workers will be protected during drilling, ZVI injection, system O&M, and monitoring activities by specific health and safety procedures, and personal protective equipment. Fugitive VOC emissions will be managed by engineering controls, if required, preventing impacts to workers
Environmental Impacts	The environment will be protected through the use of engineering controls during well installation, nutrient injection, groundwater monitoring, and disposal of generated waste	The environment will be protected through the use of engineering controls during well installation, ZVI injection, groundwater monitoring, and disposal of generated waste	The environment will be protected through the use of engineering controls during well installation, air sparging operations, ZVI injection, groundwater monitoring, and disposal of generated waste Fugitive VOC emissions will be managed by engineering controls, if required, to prevent environmental impacts
Time Until Action Is Complete	Deed restrictions will be implemented within 6 months to prohibit groundwater use during implementation A 3-month pilot study of ZVI injection processes will be required Enhanced biodegradation will begin to be effective within a few days of treatment, and will be complete in approximately 15 years Additional groundwater extraction wells will be installed within 6 months The enhanced groundwater extraction system will be run until there was no longer a threat of offsite migration	Deed restrictions will be implemented within 6 months to prohibit groundwater use during implementation A 3-month pilot study of ZVI injection processes will be required A PRB bench-scale study will also be conducted In-situ chemical reduction will begin to be effective within a few days of treatment, and the remedy will be complete in approximately 15 years	Deed restrictions will be implemented within 6 months to prohibit groundwater use during implementation A 1-week pilot study will be required In-situ chemical reduction will begin to be effective within a few days of treatment, and the remedy will be complete in approximately 15 years
IMPLEMENTABILITY			
Ability to Construct and Operate	The groundwater monitoring system is simple to construct and operate Approximately 15 new monitoring wells will be installed 43 wells will be monitored until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard The delivery of ZVI to the source areas will present challenges based on the depth to groundwater Approximately ten new extraction wells will be installed Enhanced groundwater extraction system requires constant O&M	The groundwater monitoring system is simple to construct and operate Approximately 15 new monitoring wells will be installed 43 wells will be monitored until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard The delivery of ZVI to the source areas and in a PRB will present challenges based on the depth to groundwater and offsite access In addition, a nutrient injection system will be simple to construct Approximately 100 injection points will be installed O&M of	The groundwater monitoring system is simple to construct and operate Approximately 15 new monitoring wells will be installed 43 wells will be monitored until the sampling program indicates with reasonable confidence that the concentrations of the contaminants at the entire site are less than the cleanup standard The 364 air sparge points will be drilled using available technologies SVE is a common remediation technology and is simple to install The delivery of ZVI in a PRB will present challenges based on the depth to groundwater and offsite access

TABLE 7-1
Summary of Detailed Analysis of Groundwater Alternatives
Rev 1 Memphis Depot Dunn Field FS

Evaluation Criteria	Alternative 2 Zero Valent Iron (ZVI); Enhanced GW Extraction; Enhanced Bioremediation; MNA and IC	Alternative 3 ZVI, Permeable Reactive Barriers (PRBs); MNA and IC	Alternative 4 Air Sparging with SVE, PRB; MNA and IC
	In addition, a nutrient injection system will be simple to construct. Approximately 100 injection points will be installed O&M of treatment system will be conducted for 15 years Offsite access will be required for this remedial alternative	treatment system will be conducted for 15 years Offsite access will be required for this remedial alternative	O&M of treatment system will be conducted for 15 years Offsite access will be required for this remedial alternative
Ease of Doing More Action if Needed	It will be easy to add nutrient injection wells or extraction wells, if required, to improve treatment. Additional ZVI can be added, if required, to improve treatment. If additional remedial action becomes necessary, preferred technology will depend on plume extent. Contingent actions will include a revised remedial design.	Additional ZVI can be added, if required, to improve treatment. Contingent actions will include a revised remedial design.	Capture and treatment of vapors to meet air emissions standards is easy to implement, if required It will be easy to add sparge wells, if required to improve plume control Additional ZVI can be added, if required, to improve treatment. Contingent actions will include a revised remedial design.
Ability to Monitor Effectiveness	Plume will be monitored to determine effectiveness of treatment process Monitoring will give indication of potential exposure before it occurs.	Plume will be monitored to determine effectiveness of treatment process Monitoring will give indication of potential exposure before it occurs	Plume will be monitored to determine effectiveness of treatment process. Monitoring will give indication of potential exposure before it occurs
Ability to Obtain Approvals and Coordinate with Other Agencies	Underground injection of nutrients will require compliance with substantive requirements of TDEC and Memphis-Shelby County Due to an increase in groundwater extraction and discharge, approval from the City of Memphis will be required prior to discharge to POTW	Underground injection of iron and PRB construction will require compliance with substantive requirements of TDEC and Memphis-Shelby County regulations	See Alternative 3 Approval from TDEC may be required for fugitive VOC emissions
Availability of Services and Capacities	Services required for groundwater monitoring and establishing deed restrictions are readily available Services are readily available to install wells and to inject nutrients and ZVI	Services required for groundwater monitoring and establishing deed restrictions are readily available Services are readily available to install wells and to inject ZVI and construct PRBs.	Services required for groundwater monitoring and establishing deed restrictions are readily available Services are readily available to install sparge and extraction wells and blowers Services are readily available to install wells
Availability of Necessary Equipment, Specialists, and Materials	No special equipment or specialists are required under this alternative, required groundwater monitoring equipment and well materials are readily available Equipment and materials are readily available to construct and maintain the ZVI injection areas and enhanced biodegradation, and enhanced groundwater extraction treatment processes	No special equipment or specialists are required under this alternative, required groundwater monitoring equipment and well materials are readily available Equipment and materials are readily available to construct the ZVI injection areas and a PRB	No special equipment or specialists are required under this alternative, required groundwater monitoring equipment and well materials are readily available Equipment and materials are readily available to construct and maintain air sparging systems and a PRB
Availability of Technologies	Enhanced biodegradation and enhanced groundwater extraction technologies are readily available ZVI source technologies are readily available	ZVI source area treatment and PRB technologies are readily available	Air sparging (and SVE) and PRB technologies are readily available
COST			
Capital Cost	$10,506,000	$7,827,000	$7,195,000
Present Worth O&M Cost	$4,322,000	$981,000	$1,949,000
Total Cost	$14,828,000	$8,807,000	$8,753,000
STATE ACCEPTANCE	This alternative is likely to be acceptable to state regulators	This alternative is likely to be acceptable to state regulators	This alternative is likely to be acceptable to state regulators
COMMUNITY ACCEPTANCE	This alternative is likely to be acceptable to community	This alternative is likely to be acceptable to community	This alternative is likely to be acceptable to community

Costs are expressed as order-of-magnitude estimates

The basis for the cost estimates is included in Appendix D of this FS

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Figures

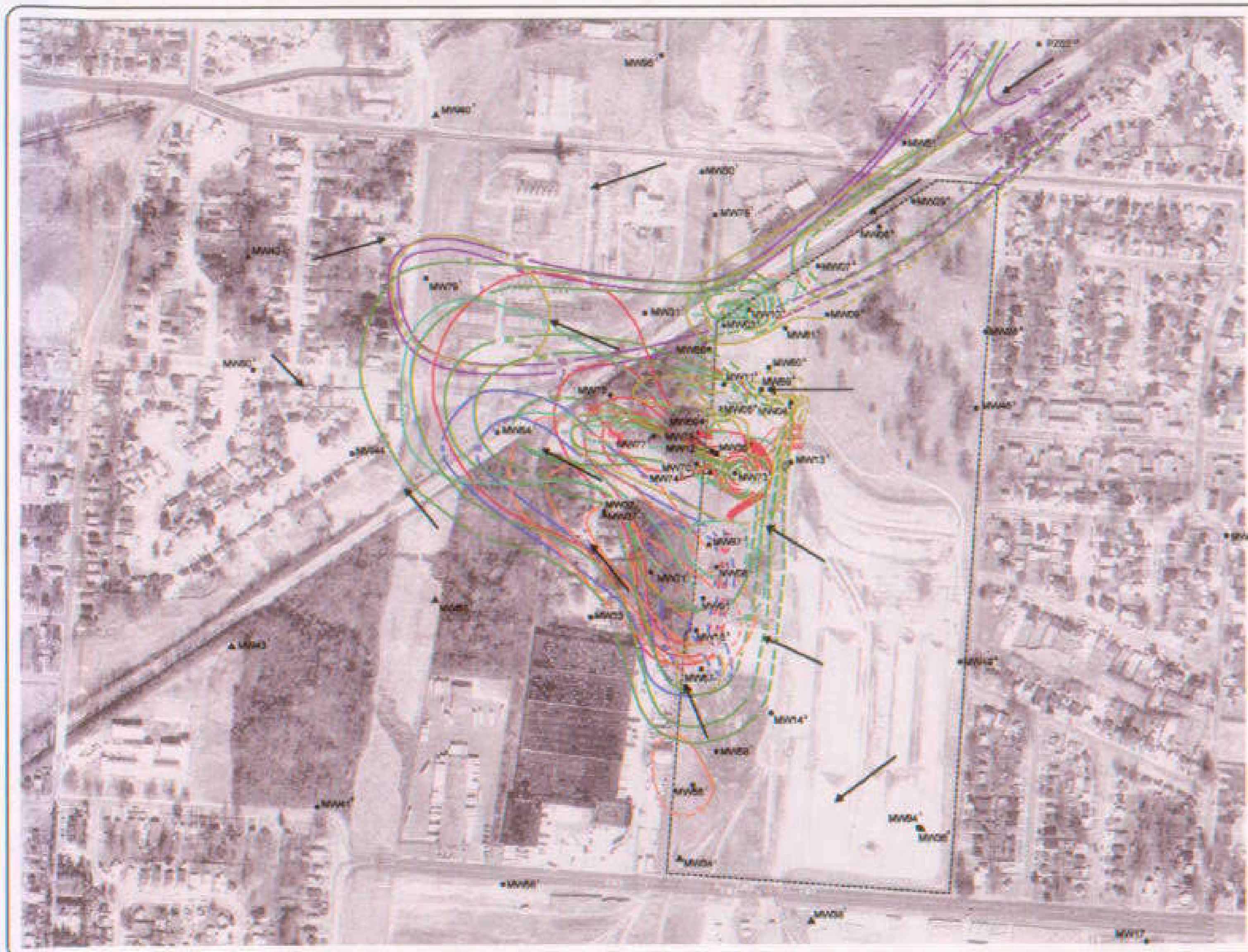

FIGURE 7-1
VOC COMPOSITE PLUME MAP
OF THE FLUVIAL AQUIFER
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

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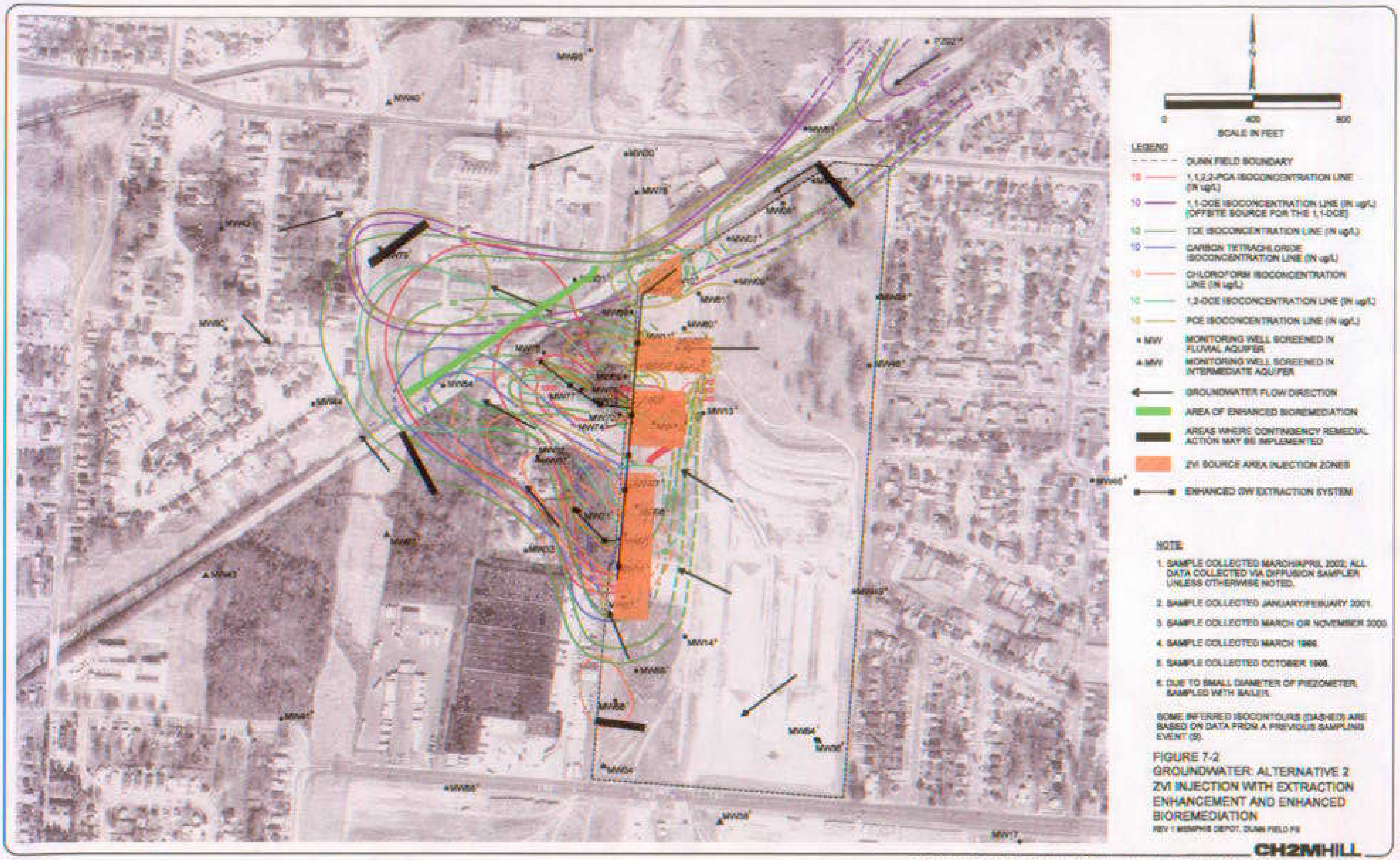
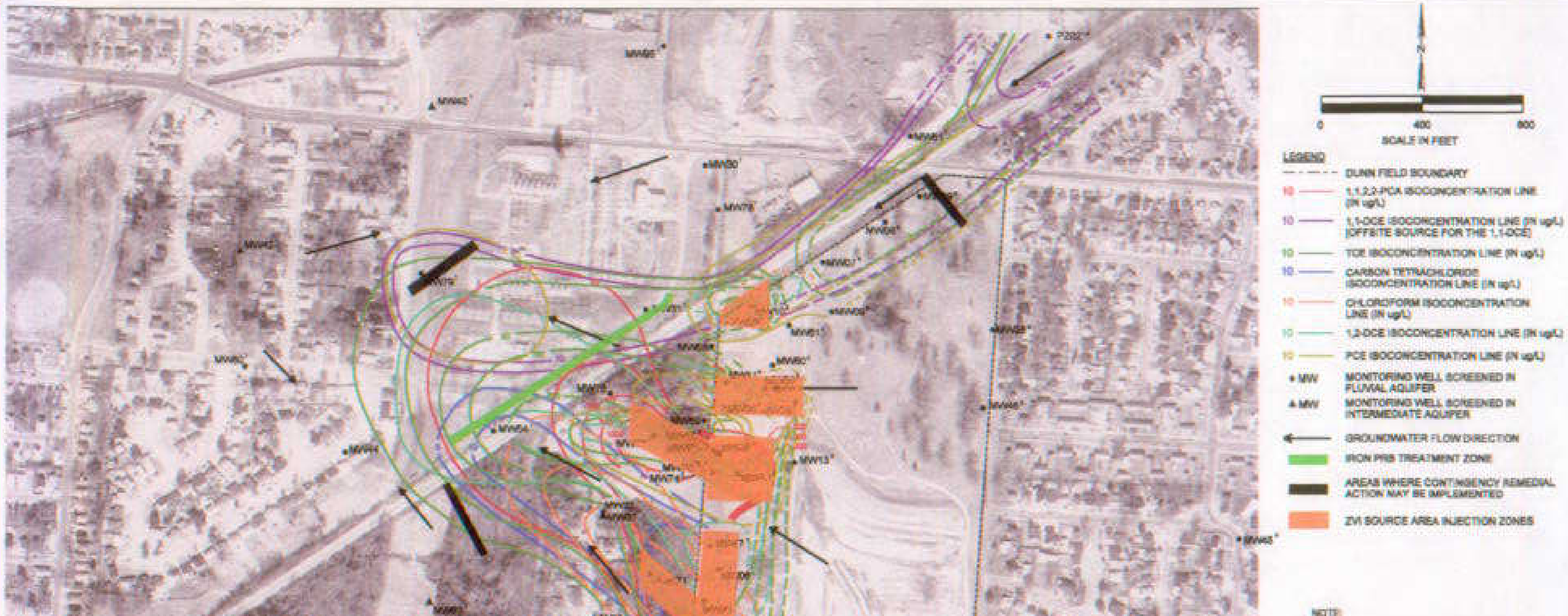


FIGURE 7-2
GROUNDWATER: ALTERNATIVE 2
ZVI INJECTION WITH EXTRACTION ENHANCEMENT AND ENHANCED BIOREMEDIATION
REV 1 MEMPHIS DEPOT, DUNN FIELD FS



NOTE:

1. SAMPLE COLLECTED MARCH/APRIL 2002; ALL DATA COLLECTED VIA DIFFUSION SAMPLER UNLESS OTHERWISE NOTED.
2. SAMPLE COLLECTED JANUARY/FEBUARY 2001.
3. SAMPLE COLLECTED MARCH OR NOVEMBER 2000.
4. SAMPLE COLLECTED MARCH 1999.
5. SAMPLE COLLECTED OCTOBER 1998.
6. DUE TO SMALL DIAMETER OF PIEZOMETER, SAMPLED WITH BAILER.

SOME INFERRED ISOCONTOURS (DASHED) ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT (3).

FIGURE 7-3
GROUNDWATER: ALTERNATIVE 3
ZVI INJECTION AND IRON PRB
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

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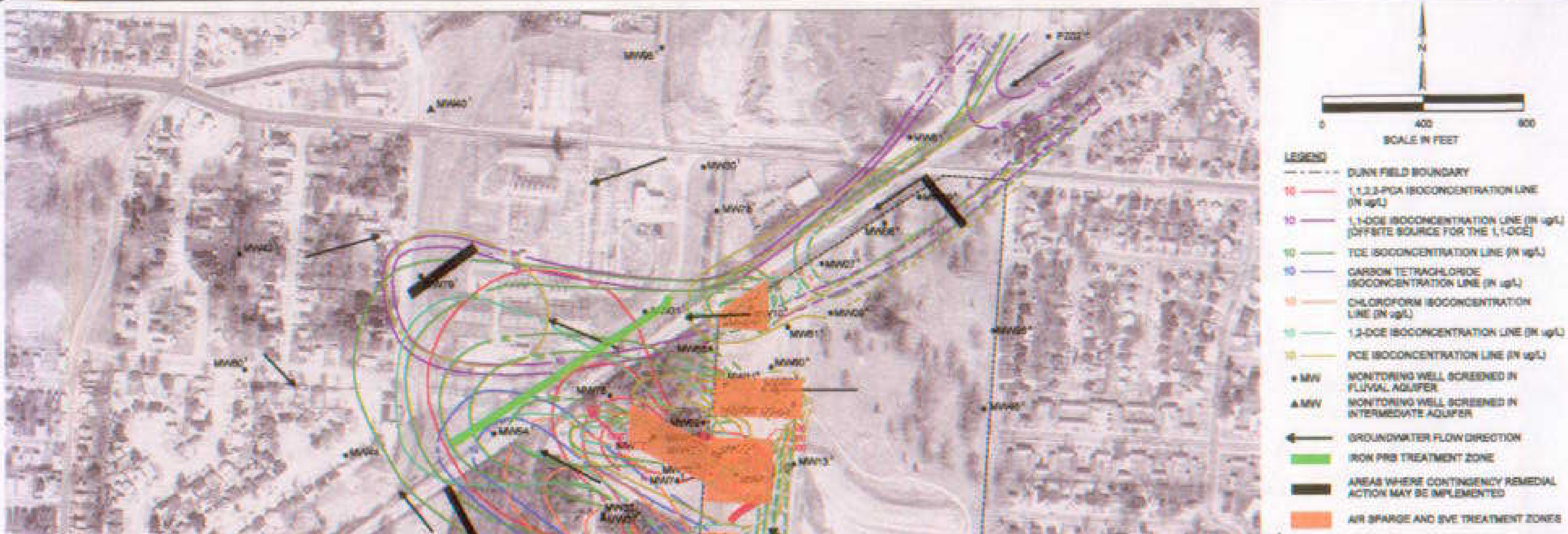

NOTE:

1. SAMPLE COLLECTED MARCH/APRIL 2002; ALL DATA COLLECTED VIA DIFFUSION SAMPLER UNLESS OTHERWISE NOTED.
2. SAMPLE COLLECTED JANUARY/FEBRUARY 2001.
3. SAMPLE COLLECTED MARCH OR NOVEMBER 2000.
4. SAMPLE COLLECTED MARCH 1999.
5. SAMPLE COLLECTED OCTOBER 1998.
6. DUE TO SMALL DIAMETER OF PIEZOMETER, SAMPLED WITH BAILER.

SOME INFERRED ISOCONTOURS (DASHED) ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT (S).

FIGURE 7-4
GROUNDWATER: ALTERNATIVE 4
AIR SPARGING WITH SVE AND
IRON PRB
REV 1 MEMPHIS DEPOT, DUNN FIELD FS

CH2MHILL

8.0 References

Agency for Toxic Substances and Disease Registry. *Toxicological Profiles for Arsenic, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Cyanide, Dieldrin, Manganese, Phenanthrene.* U.S. Dept. of Health & Human Services, Public Health Service. Atlanta, Georgia. 1992.CH2M HILL. *Screening Sites Field Sampling Plan.* Defense Distribution Depot Memphis, Tennessee. Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. August 1995d.

CH2M HILL. *Operable Unit 1 Field Sampling Plan.* Defense Distribution Depot Memphis, Tennessee. Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. September 1995e.

CH2M HILL. Record of Decision for the Interim Remedial Action of the Groundwater at Dunn Field (OU-1) at the Defense Distribution Depot Memphis, Tennessee. Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. January 1996a.

CH2M HILL. *Groundwater Interim Remedial Action, Defense Depot, Memphis, Tennessee: Operation and Maintenance Plan.* Prepared for the U.S. Army Corps of Engineers, Huntsville Division and Defense Logistics Agency. May 1998d.

CH2M HILL. *Final Memphis Depot Main Installation Remedial Investigation Report.* Prepared for the U.S. Army Corps of Engineering and Support Center, Huntsville. January 2001.

CH2M HILL. *Dunn Field Remedial Investigation Report.* Defense Distribution Center (Memphis), Tennessee. Prepared for the U.S. Army Engineering Support Center, Huntsville, Alabama. July 2002.

CH2M HILL. *Final Dunn Field Engineering Evaluation/Cost Analysis Former Pistol Range, Site 60.* Defense Distribution Center (Memphis). Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. July 2002.

CH2M HILL. *Final Dunn Field Action Memorandum Former Pistol Range, Site 60.* Defense Distribution Center (Memphis). Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. October 2002.

CH2M HILL. *Final Dunn Field Five-Year Review.* Defense Distribution Center (Memphis). Prepared for the U.S. Army Engineering Support Center, Huntsville, AL. January 2003.

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Kingsbury, J. A. and W. S. Parks. *Hydrogeology of the Principal Aquifers and Relation of Faults to Interaquifer Leakage in the Memphis area, Tennessee.* U.S. Geological Survey Water-Resources Investigations Report 93-4075. 1993.

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U.S. Environmental Protection Agency. *A Guide to Principal Threat and Low Level Threat Wastes.* Office of Emergency and Remedial Response. Washington, D.C. November 1991.

U.S. Environmental Protection Agency. *Feasibility Study Analysis for CERCLA Sites with VOCs in Soil.* Office of Emergency and Remedial Response. Washington, D.C. August 1994.

APPENDICES

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APPENDIX A-1

Review of the Potential Presence of Ordnance and Explosives (OE) as Defined by References for Dunn Field

Review of the Potential Presence of Ordnance and Explosives (OE) as Defined by References for the Dunn Field Area, Defense Distribution Center (Memphis), Memphis, Tennessee

PREPARED FOR:	US Army Corps of Engineers, Huntsville Center Memphis Depot BRAC Cleanup Team (BCT)
PREPARED BY:	CH2M HILL
DATE:	February 3, 2003

During BCT review of the Rev. 0 *Dunn Field Five-Year Review* document (CH2M HILL, September 2002), comments were received on the second sentence of the fifth paragraph from Section 1.3.1 - Operational History. That paragraph of the document with the sentence highlighted is repeated below:

> *The Chemical Warfare Materiel (CWM) disposal pits were located in the Disposal Area section of Dunn Field and the Stockpile Area portions of Dunn Field (Sites 24-A and 24-B).* ***The remains of destroyed or partially destroyed explosive ordnance (OE) were also buried in pits in the Disposal Area.*** *Reports indicate that a 3.2-inch mortar rounds, smoke pots, hand grenades (smoke), and other unspecified OE were buried in these pits (USATHAMA, 1982 and USACE, 1995b). Section 1.3.4 of the Dunn Field RI presents additional information on the CWM at Dunn Field.*

The comment specifically addresses the origin of the statement regarding OE, and questions if there is any supporting material that states that OE or materials similar in nature, other than that described in Table 1-1 of the *Dunn Field Five-Year Review* document, are present in Dunn Field.

This memorandum seeks to clarify the understanding of the potential presence of OE within the Dunn Field area of the Defense Distribution Center (Memphis) beyond that listed and described in Table 1-1 of the *Dunn Field Five-Year Review* document. The discovery process was completed by reviewing documents that made mention of OE at Dunn Field or presented specific descriptions of disposal of OE at Dunn Field. If the documents included references for the description of OE, an attempt was made to find and review the source of that information.

As noted in the *Dunn Field Five-Year Review* document as well as the *Dunn Field Remedial Investigation* (RI) *Report* (CH2M HILL, July 2002), CWM material (principally remnants of World War II vintage German mustard gas bombs and associated materiel) was removed by UXB International, under contract with the US Army Corps of Engineers - Huntsville Center. The remedial measures were conducted from mid-2000 to March 2001 at Defense

Sites Environmental Tracking System (DSERTS) Sites 1, 24-A, and 24-B, to reduce or eliminate the potential CWM risk posed by these wastes.

1982 Installation Assessment

During the review, the earliest document to note the presence of OE at Dunn Field was the 1982, *Installation Assessment of Defense Depot Memphis, Memphis, Tenn., Report No. 191.* The assessment was conducted by the Chemical Systems Laboratory, Environmental Technology Division, Installation Restoration Branch for the Assessment Division of the US Army Toxic and Hazardous Materials Agency at the Aberdeen Proving Ground, Aberdeen, Maryland.

Section 2.1.4 of the *Installation Assessment* refers to the use and testing of standard flamethrowers, high pressure air compressor flamethrowers, ignition cartridges utilizing No. 2 diesel fuel, standard M2 mechanical smoke generators utilizing SGF1 and 2 fog oil, and smoke pots at the Dunn Field. However, the description of these items does not include the location of the testing and if disposal occurred at Dunn Field. In Appendix D – Interviews of the *Installation Assessment,* an interview with Mr. Paul J. Traut revealed that the flamethrowers were tested against the middle of the northwest side of the curved loading dock on Dunn Field. According to Mr. Traut, diesel fuel was always used in these tests. After the test, the flamethrowers were recharged and placed back into stockage.

Mr. Traut also revealed that after World War II, Military Police personnel would bring ordnance confiscated from returning service members. One confiscated item was a 3.2-inch mortar round. Mr. Traut stated that he would destroy the materials in pits at Dunn Field either by demolition (explosive) or by chemical reaction. The pits were later covered up with bauxite storage. In addition, Mr. Traut discussed the history of approximately 200 bombs that were stored in NC1 Section 1 (most likely a location on the Main Installation portion of the Memphis Depot). After disassembling one of the bombs on Dunn Field, the bomb was found to contain incendiary components. This effort resulted in shipment of the bombs to "another location".

The Contaminated Waste section of Section 2.2.2 - Solid Waste Treatment presents Figures 10 and 11 and Table 7. Figure 11 shows the disposal and storage sites used at Dunn Field from the date of the assessment. Table 7 presents a description of materials at various burial, burn, storage, and other sites. Site 21 is described as a burn site for sanitary waste, smoke pots, and CN (acronym for chloroacetophenone) canisters. See attached Table 7 and Figure 11 from the *Installation Assessment* report.

On page 2-22 of the *Installation Assessment,* Section 2.2.3 – Demolition and Burning Ground Areas, states that a trash-burning operation area was located just north of the Tennessee Valley Authority (TVA) line in Dunn Field. The assessment further stated that "burning in this area dates back to the 1940s and included CN canisters, fuses, and smokes, in addition to sanitary wastes. Operations were conducted in pits and incorporated the weekly cleanup of residue and garbage in addition to material. The ash was then buried in the north end of Dunn Field." Review of Table 7 indicates that this trash-burning area is most likely Site 21. *Installation Assessment* Site 21 correlates to the DSERTS Site 19 (Former Tear Gas Canister Burn Site), as presented in Table 1-1 of the Dunn Field RI report.

Also on page 2-22 of the *Installation Assessment*, Section 2.2.3, the document states: "Another area in the southwest end of Dunn Field was used for burning smoke-pots, CN grenades, and souvenir ordnances. The areas was covered by the bauxite storage pile in early 1949." Review of Table 7 indicates that this burn area is most likely Site 31, which, according to the map presented as Figure 11 in the *Installation Assessment*, is located approximately 150 feet east to southeast of DSERTS Site 24-B. This is most likely the area referenced by Mr. Traut as the location used to destroy confiscated ordnance.

Page 2-23 of the *Installation Assessment*, Section 2.2.4 - Demilitarization, states: "Limited quantities of souvenir ordnances were turned into DDMT after WW II for disposal. These items were destroyed at Dunn Field." There is no discussion as to whether this is the same material mentioned within Sites 21 and 31.

1995 Archives Search Report - Findings

The January 1995 *Archives Search Report* (ASR) - *Findings*, which contains the *Installation Assessment* document, was produced as part of a review of burial and disposal practices of CWM and OE performed by the Chemical Warfare Service (CWS) in association with the Memphis Defense Depot. The document was developed by the US Army Corps of Engineers Mandatory Center of Expertise and Design Center for Ordnance and Explosive Waste, under authority from the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA). The purpose of the ASR was to compile information obtained through historical research at various archives and records holding facilities, interview with persons associated with the site or its operations, and personal visits to the site. All efforts were directed towards determining possible use or disposal of CWM on the site.

Section 5.1 - Historical Summary of OEW Operations, on page 5-1 of the ASR does not mention the presence of OE at Dunn Field beyond the description of a Pistol Range in the northeast area of Dunn Field. The range (known as DSERT Site 60 - Former Pistol Range) and associated soils surrounding the range are reportedly scheduled to be removed in January 2003. An Engineering Evaluation/Cost Assessment (EE/CA) and Action Memorandum have been submitted as final for this site. This range is also mentioned in the 1982 *Installation Assessment* document.

Section 5.1 also states that incendiary bombs were stored in Building 229 of the Main Installation part of the Memphis Depot. These bombs, which are most likely the same as those described by Mr. Traut, were shipped out of the Memphis Depot after World War II.

Appendix A of the ASR contains interviews of former employees associated with the former CWS at the Memphis Depot. An interview of Mr. Charles E. Anderson, who worked with the Chemical Supply Section in 1955 and 1956, revealed that CN capsules were burned in pits at Dunn Field from approximately 1950 to 1953. These pits may be the same as Site 21 referenced above. Importantly, Mr. Anderson did note that no live munitions were buried. The interview summary did not state if this was directly applicable to Dunn Field.

1995 Archives Search Report – Conclusions and Recommendations

The ASR - *Findings* document is accompanied with the *Archives Search Report - Conclusions and Recommendations*. This report generally reviews and summarizes the information presented in the *Findings* document, but also includes maps and drawings of the Memphis Depot area along with RAC worksheets used to define the risk of OE at the Memphis Depot.

Section 2.1 - Conclusions, Dunn Field Area, describes the CWM and other materiel that was buried or destroyed at Dunn Field. In addition, this section states that conventional ordnance was also destroyed in the Dunn Avenue Area following World War II.

Section 2.2 - Recommendations, Dunn Avenue Area, states in the first paragraph: "There is a risk that unexploded Conventional Ordnance may not have been properly disposed of in the Dunn Avenue Area (Map 3, Area A [attached]). The possibility exists, that others may have disposed of conventional ordnance in the pits used by Mr. Traut of the Chemical Supply Section. Mr. Traut used the area to dispose of Conventional Ordnance, which was confiscated from returning service members and brought to the Depot by the local Military Police." Area A in Map 3 corresponds to the southern end of the Disposal Area and the southwest area of the Stockpile Area, as defined the Dunn Field RI report (CH2MHILL, July 2002). Section 2.2 goes on to note that: "Any sub-surface activities in the Dunn Avenue Area, should consider both the Conventional Ordnance and CWM reported above."

Section 3.0 of the ASR - *Conclusions and Recommendations* document evaluates the ordnance and CWM contamination at the Memphis Depot. Section 3.2 discusses the Dunn Avenue Area. The first paragraph of this section states: "There are many areas in the Dunn Avenue Area which contain known burials and destructions. There may be more burials/destruction areas which were not captured by the [ASR] process. Extreme caution should be used in any intrusive type operations in Areas A, B, & C identified on Map 3 of this report. Known and probable disposals are discussed in later paragraphs." The second paragraph of Section 3.2 also notes that: "The remains of conventional ordnance which was destroyed or partially destroyed is in pits located in Area A. This includes at least one mortar round, smoke pots &hand grenades (smoke) and other conventional ordnance not specified in interviews." The reader should note that the document did not mention the burning and destruction of smoke pots and CN canisters in Site 21.

Page 3-2 of the ASR - *Conclusions and Recommendations* document also notes that "...the area identified as being used to test Flamethrowers does not present an ordnance hazard."

1999 Engineering Evaluation/Cost Analysis for the Removal of Chemical Warfare Materiel

In 1998, Parsons Engineering Science, Inc. (Parsons) conducted an EE/CA as part of an investigation into the CWM at Dunn Field. The work only addressed OE related to disposal/burial of German mustard bombs that contained CWM. As part of this EE/CA, Parsons utilized aerial and electromagnetic surveys of the western half of Dunn Field to define the potential CWM areas. Figures 2.8 through 2.18 present the results of the electromagnetic surveys and review of these figures indicates that the area known as Site 31 on Figure 11 of the *Installation Assessment*, which, based on available maps in the ASR, is approximately 150 feet east to southeast of DSERTS Site 24, is shown as an area with more disturbance and higher metallic content than surrounding areas. The surveys did not cover the former Site 21 area.

Conclusions

The documents that have been reviewed for this memorandum have revealed that OE other than that listed and described in Table 1-1 of the *Dunn Field Five-Year Review* document has been brought on to the Dunn Field area and burned, detonated, and chemically destroyed prior to disposal on Dunn Field. The OE in this case reportedly includes "souvenir ordnance," smoke pots, CN canisters, fuses, and smokes, grenades (smoke), and one mortar round and possibly other conventional ordnance not specified in interviews. The pits that were used for the destruction process were located in Sites 21 and 31. Site 21 is now referred to as DSERTS Site 19, whereas Site 31 does not appear to have a DSERTS site designation. The later covering of this site by bauxite storage most likely contributed to the lack of follow up on this location. As stated by the by the US Army Corps of Engineers in the ASR, there may be more burials/destruction areas which were not captured by the ASR process.

Since Dunn Field has been used in the past as a disposal area for OE, procedures described in Engineer Pamphlet EP 75-1-2, *Unexploded Ordnance (UXO) Support During Hazardous, Toxic, and Radioactive Waste (HTRW) and Construction Activities,* (USACE, November 2000) need to be followed during any activity involving intrusive measures. Based on a review of the information provided in this memorandum and qualifications for UXO support during construction activities described in EP 75-1-2, there is a low probability that UXO will be encountered. However, health and safety plans or field sampling plans, etc., describing future activities at Dunn Field will need to include procedures for notifying, obtaining support, and acheiving approval for activities from the USACE – Huntsville OE Center of Expertise.

579 201

Attachments

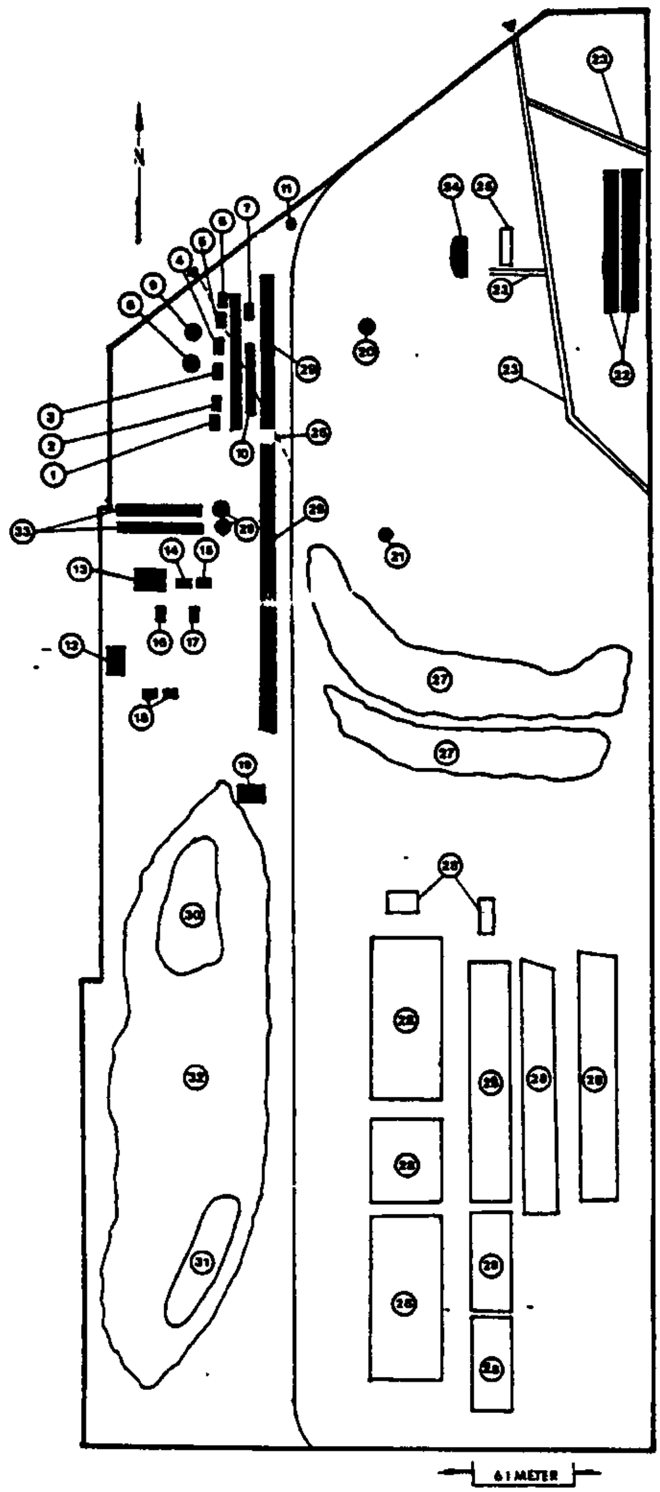


Fig. 11 Dunn Field Disposal and Storage Sites

(See Table 7 for Descriptions of Sites)

579 203

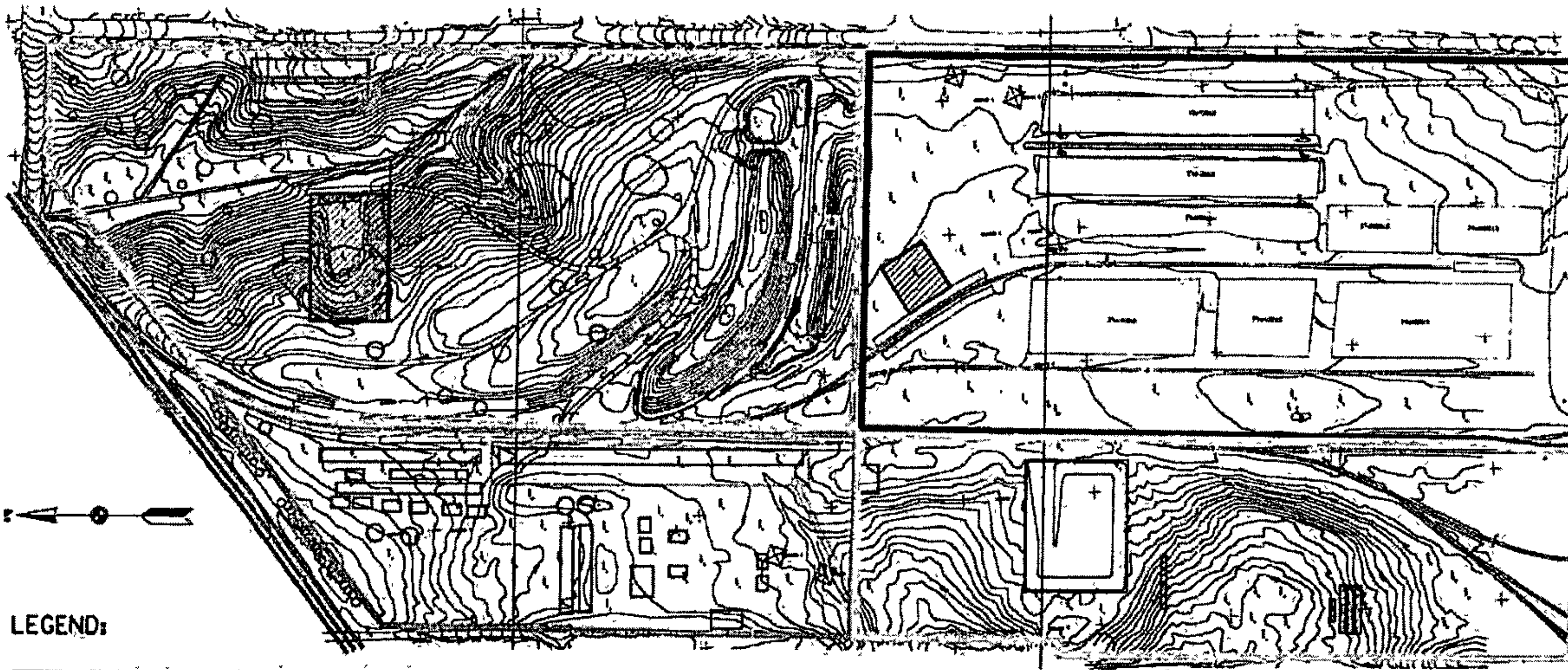
Table 7. Description of Dunn Field Disposal and Storage Sites (Locations of Sites are Shown on Fig. 11)

Location	
Burial Sites	
1	Training sets, nine each, mustard and Lewisite, 1955
2	7 pounds (lbs) ammonium hydroxide, 1 gal glacial acetic acid, 1955
3	3,000 quarts (qt) chemicals, 5 cubic feet (ft^3) ortho-tolidine dihydrochloride, 1955
4	Thirteen 55-gal drums oil, grease, and paint, date unknown
5	Thirty-two 55-gal drums oil, grease, and thinner, 1955
6	3 ft^3 methyl bromide, 1955
7	40,037 units ointment (eye), 1955
8	1,700 bottles fuming nitric acid, 1954
9	3,768 1-gal cans methyl bromide, 1954
10	Ashes and metal refuse from burning pit, 1955
11	1,433 1-ounce (oz) bottles trichloroacetic acid, 1965
12	Sulphuric/hydrochloric acids, 1967
13	32 cubic yards mixed chemicals and acid, 900 lbs detergent, 7,000 lbs aluminum sulphate, 200 lbs sodium
14	Sodium, 1968
15	Sodium phosphate, 1968
16	Acid, 1969
17	Herbicide, cleaning compound, medical supplies, 1969
18	Acid, date unknown
19	Hardware (nuts and bolts)
22	XXCC3 impregnite
29	Food supplies
30	Burial site prior to bauxite storage; foods, construction debris burned; 1948
33	14 burial pits containing sodium phosphate, sodium, acid, medical supplies, chlorinated lime; 1970
Burn Sites	
21	Sanitary waste, smoke pots, CN canisters
31	Old burn area, 1946

Table 7. Description of Dunn Field Disposal and Storage Sites
(Locations of Sites are Shown on Fig. 11)
(Continued, Page 2 of 2)

Location	
Storage Sites	
25	Pesticide storage
27	Bauxite
28	Fluorspar
32	Bauxite, 1942-72
Other Sites	
20	Asphalt dump
23	Open drain ditches
24	Pistol range
26	Buried drainpipe

579 205



LEGEND:

BURIALS PREVIOUSLY IDENTIFIED BY USATHAMA.

UNIDENTIFIED CLEARED AREA (LOCATED ON 1956 AERIAL PHOTO).

PISTOL RANGE

AREAS A, B, OR C: 1947 BURIAL OF 32,636 LBS OF ACETYLENE TETRACHLORIDE.

* NOTE 1: LOCATIONS ARE APPROXIMATE

* NOTE 2: AREA USED AS A BORROW PIT, TO TEST HEAVY ENGINEER EQUIPMENT, AND AS A VEHICLE HOLDING AREA.

MEMPHIS ORDNANCE DEPOT

MEMPHIS, TENNESSEE

GARVER AND GARVER DRAWING

PROJ. DATE: JAN. 1999	DATE OF MAP:

APPENDIX A-2

Lithologic Cross Sections from the Dunn Field RI Report (July 2002)

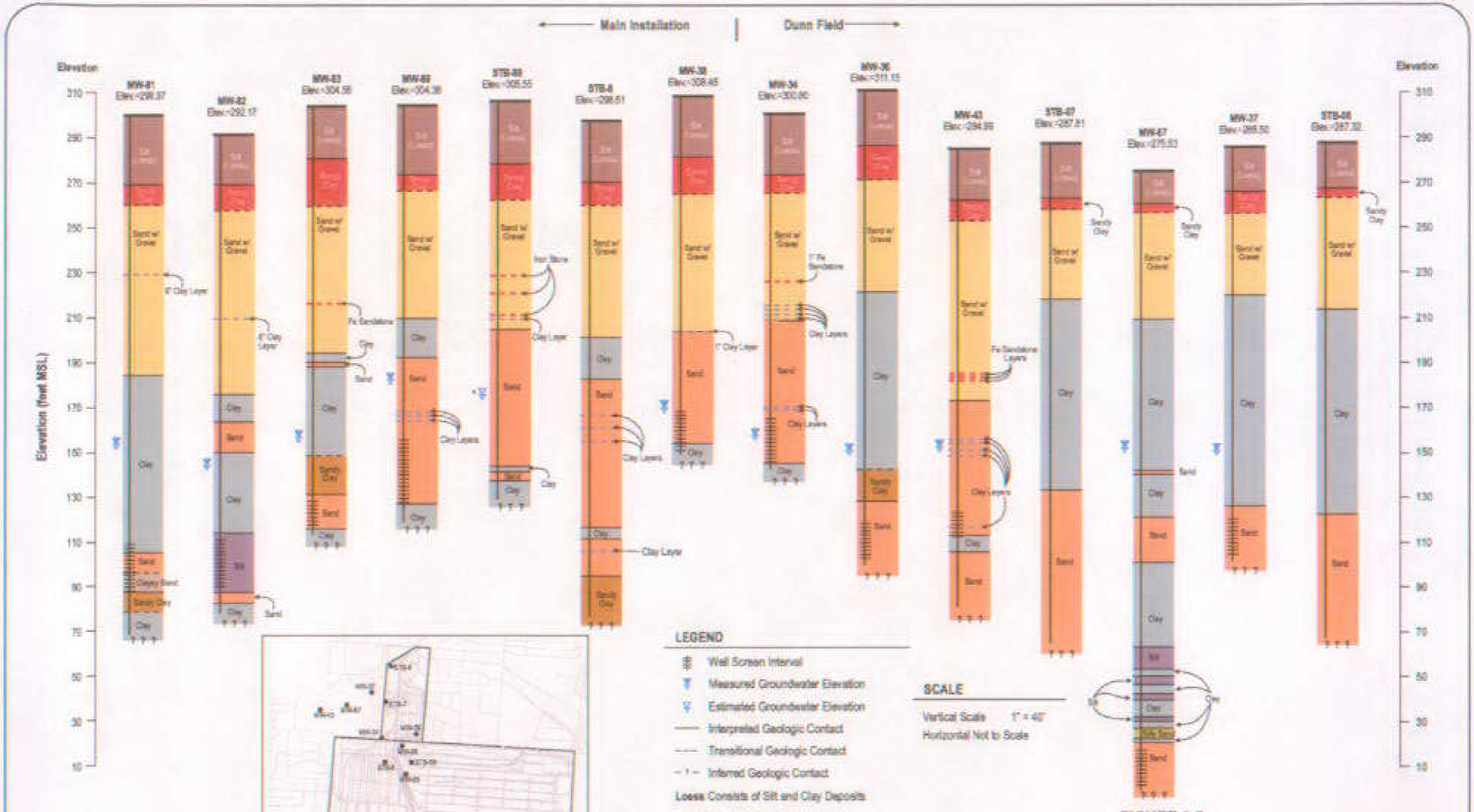
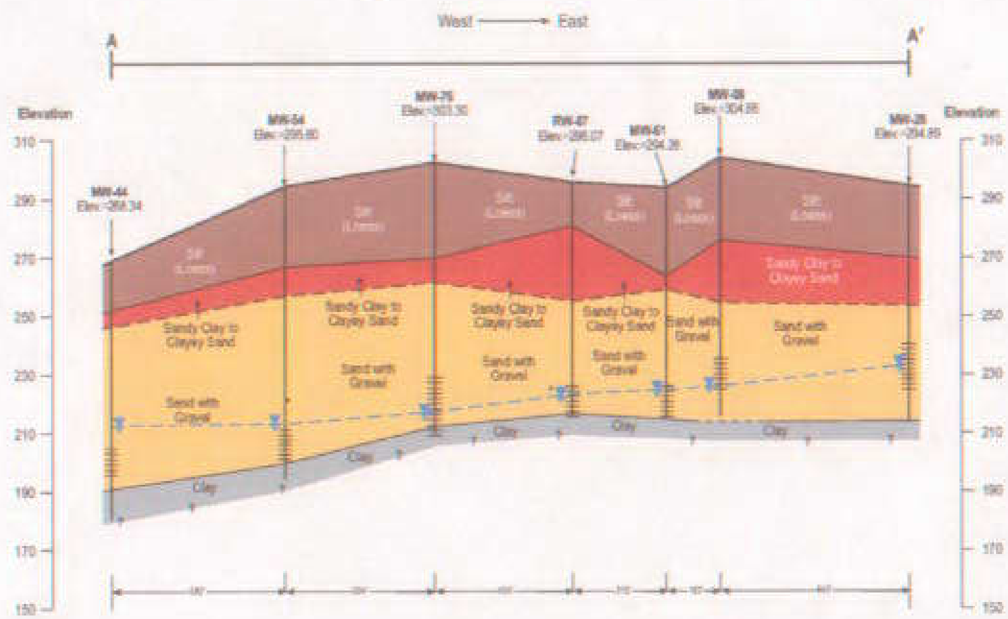


FIGURE 2-7
Reference for the Lithology of the Deepest Wells/ Soil Borings on the Memphis Depot
Memphis Depot Dunn Field RI Report



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

Well Screen Interval
Measured Groundwater Elevation
Interpreted Geologic Contact
Transitional Geologic Contact
Inferred Geologic Contact
Loess Consists of Silt and Clay Deposits

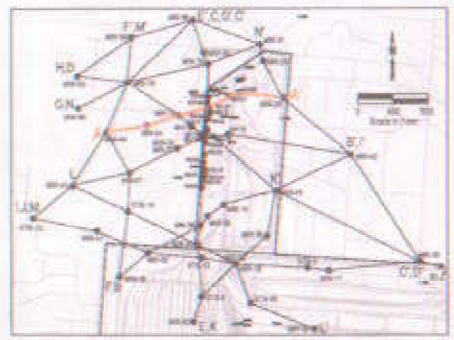


FIGURE 2-8a
Lithologic Cross-Section A - A'
Memphis Depot Dunn Field RI Report

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579 208

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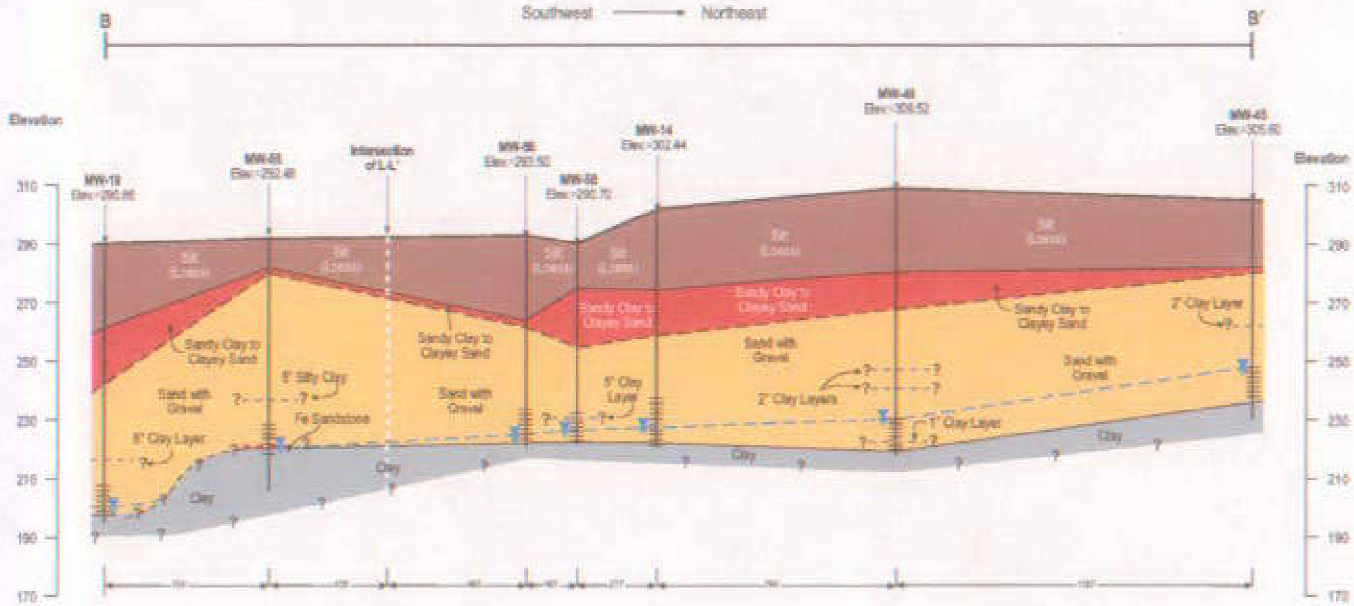

SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

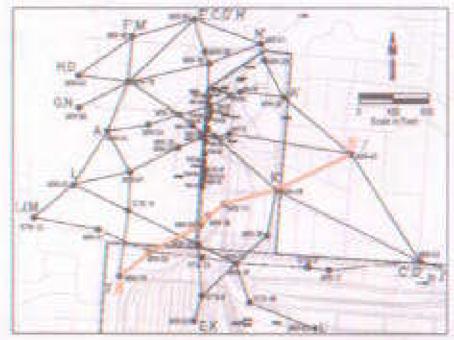

FIGURE 2-8b
Lithologic Cross-Section B - B'
Memphis Depot Dunn Field RI Report

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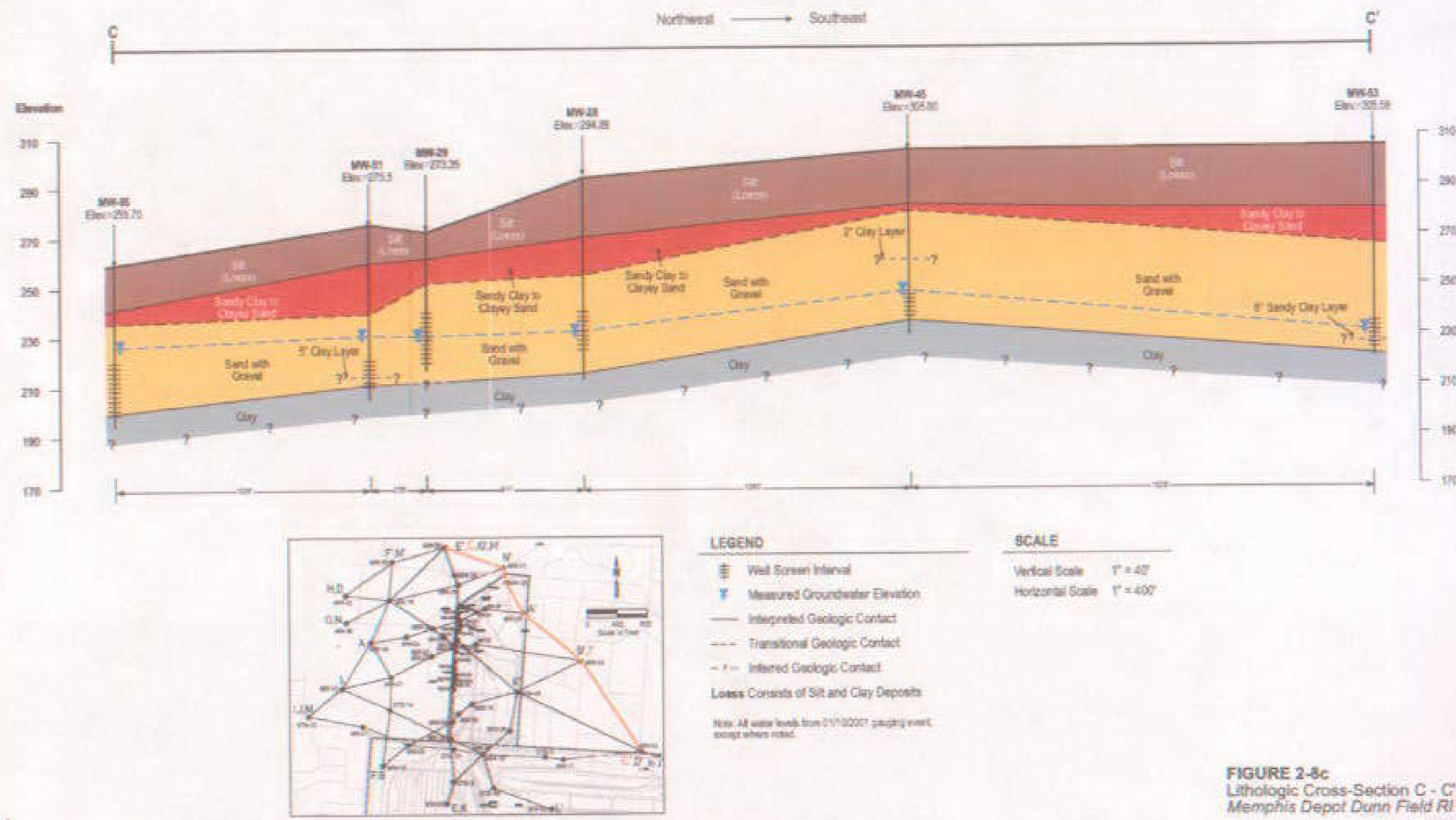

FIGURE 2-8c
Lithologic Cross-Section C - C'
Memphis Depot Dunn Field RI Report

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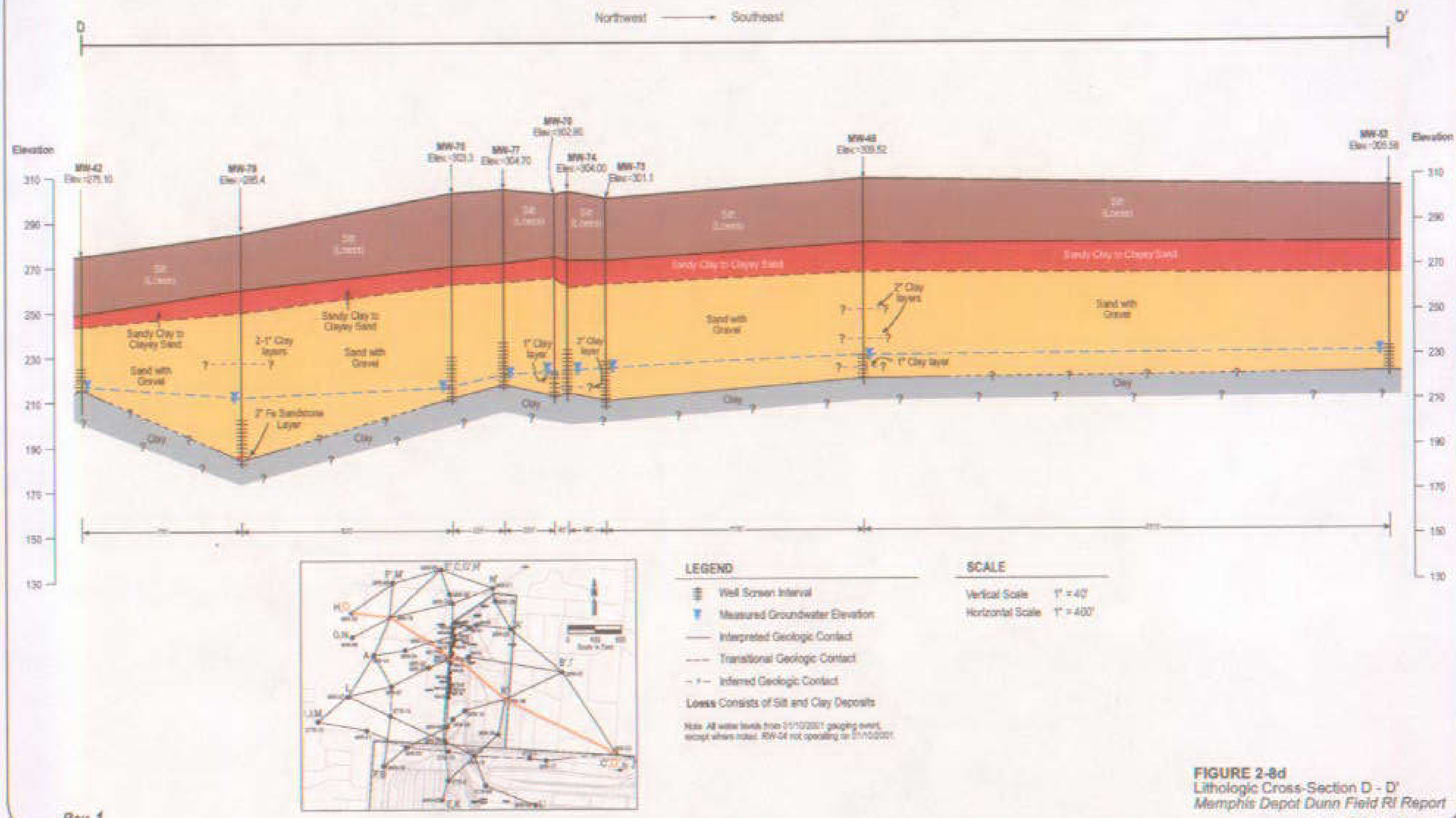
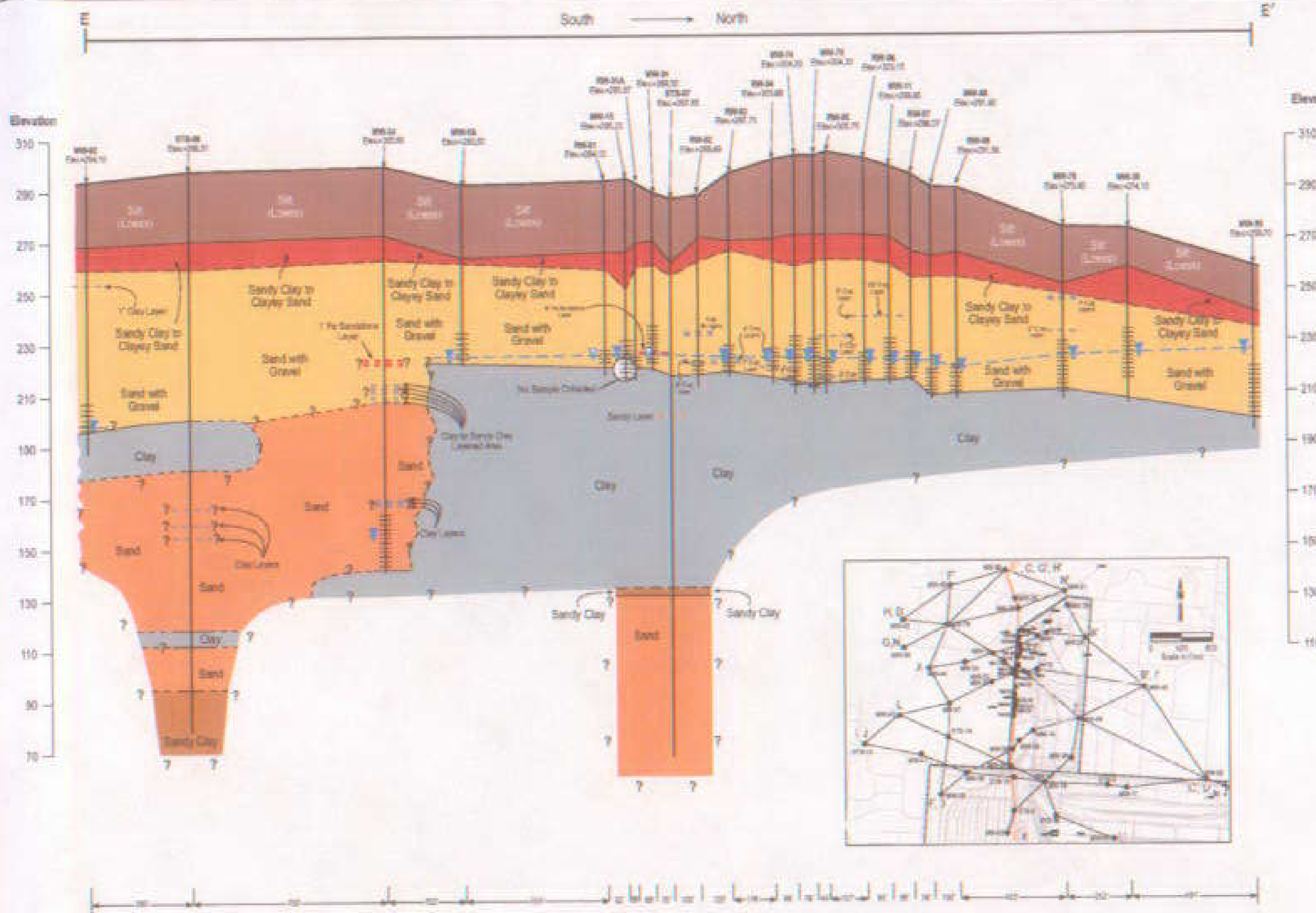


FIGURE 2-8d
Lithologic Cross-Section D - D'
Memphis Depot Dunn Field RI Report



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

FIGURE 2-8e
Lithologic Cross-Section E - E'
Memphis Depot Dunn Field RI Report

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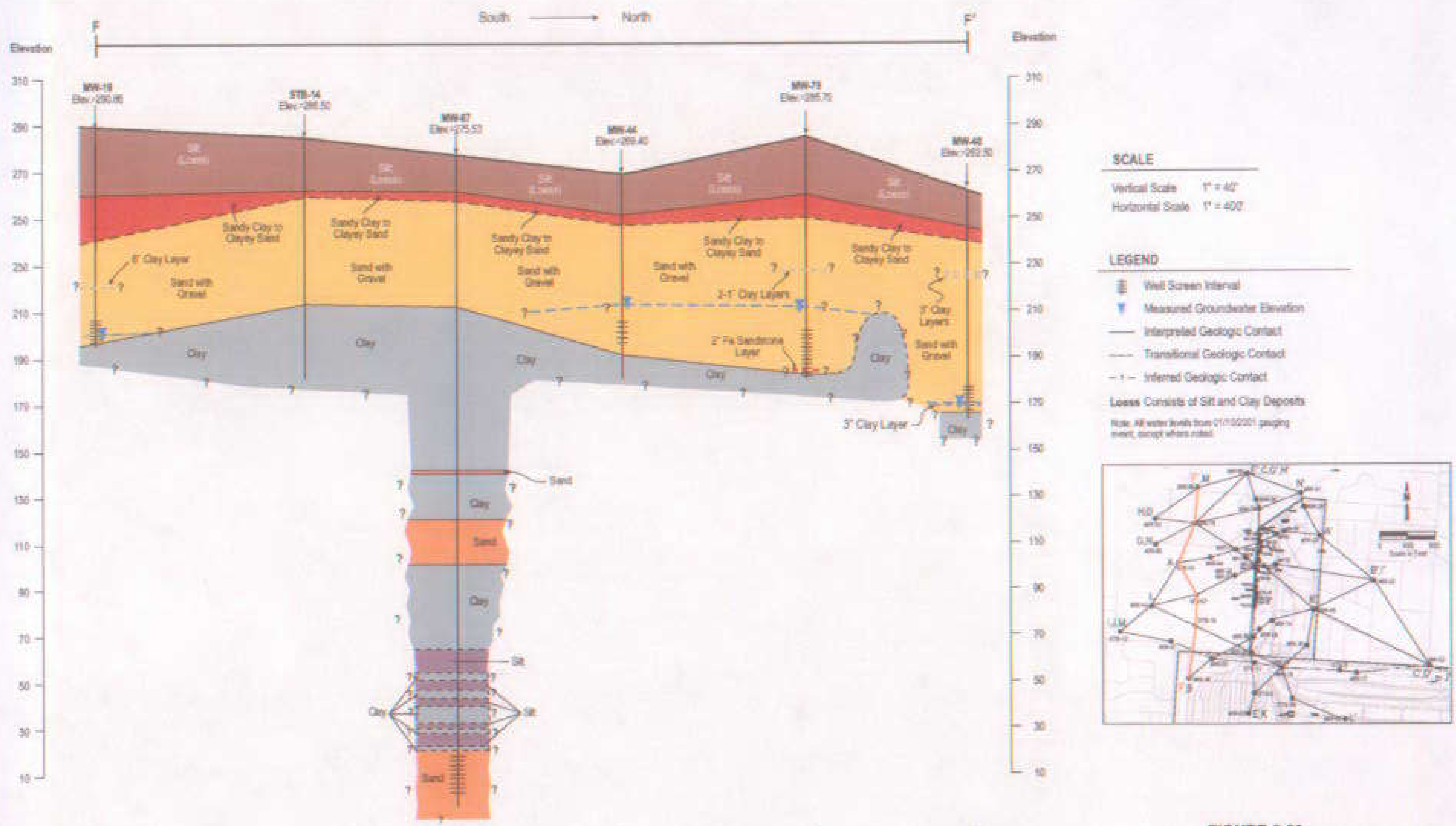

Rev. 1

FIGURE 2-8f
Lithologic Cross-Section F - F'
Memphis Depot Dunn Field RI Report

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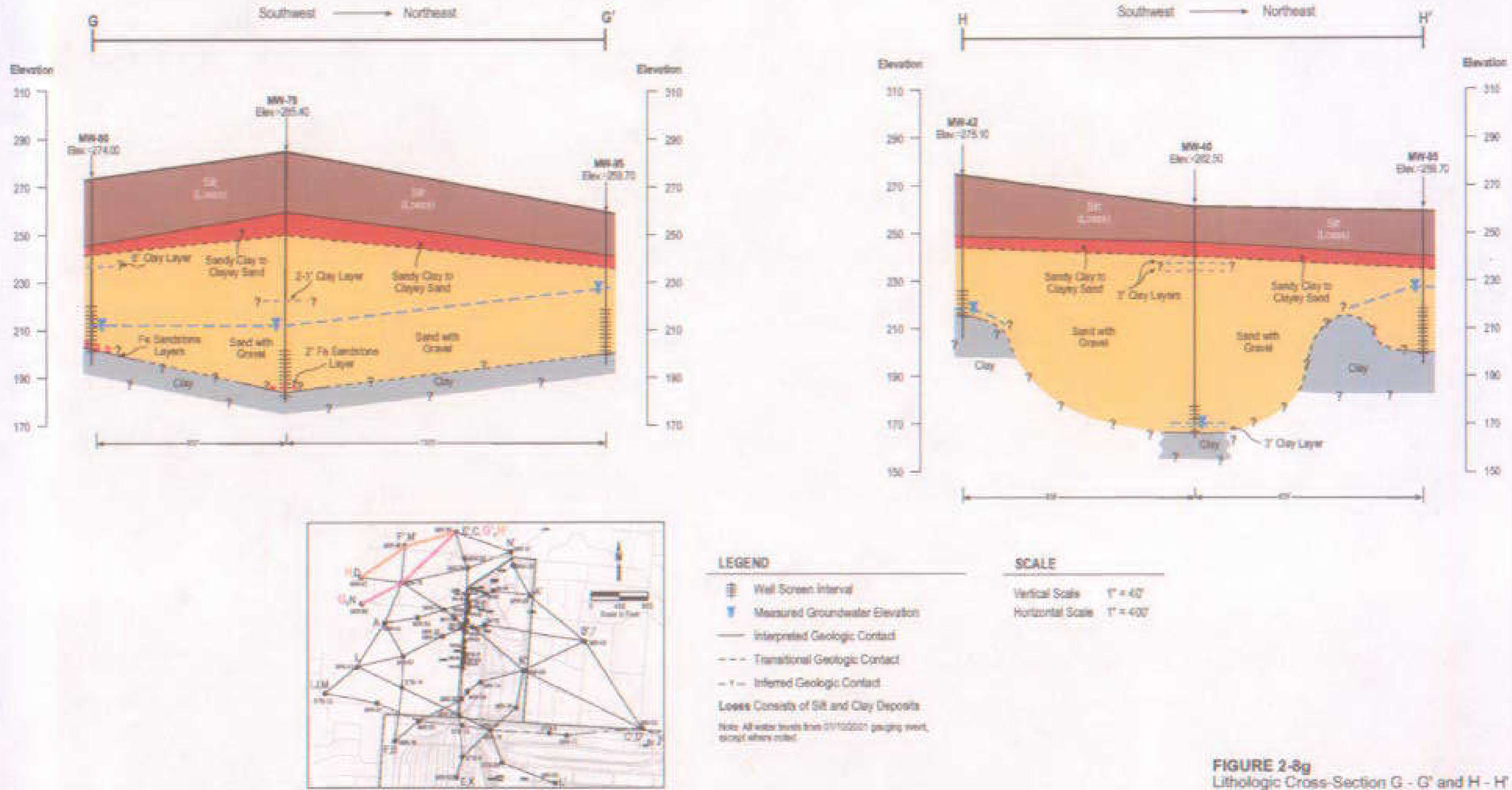

FIGURE 2-8g
Lithologic Cross-Section G - G' and H - H'
Memphis Depot Dunn Field RI Report

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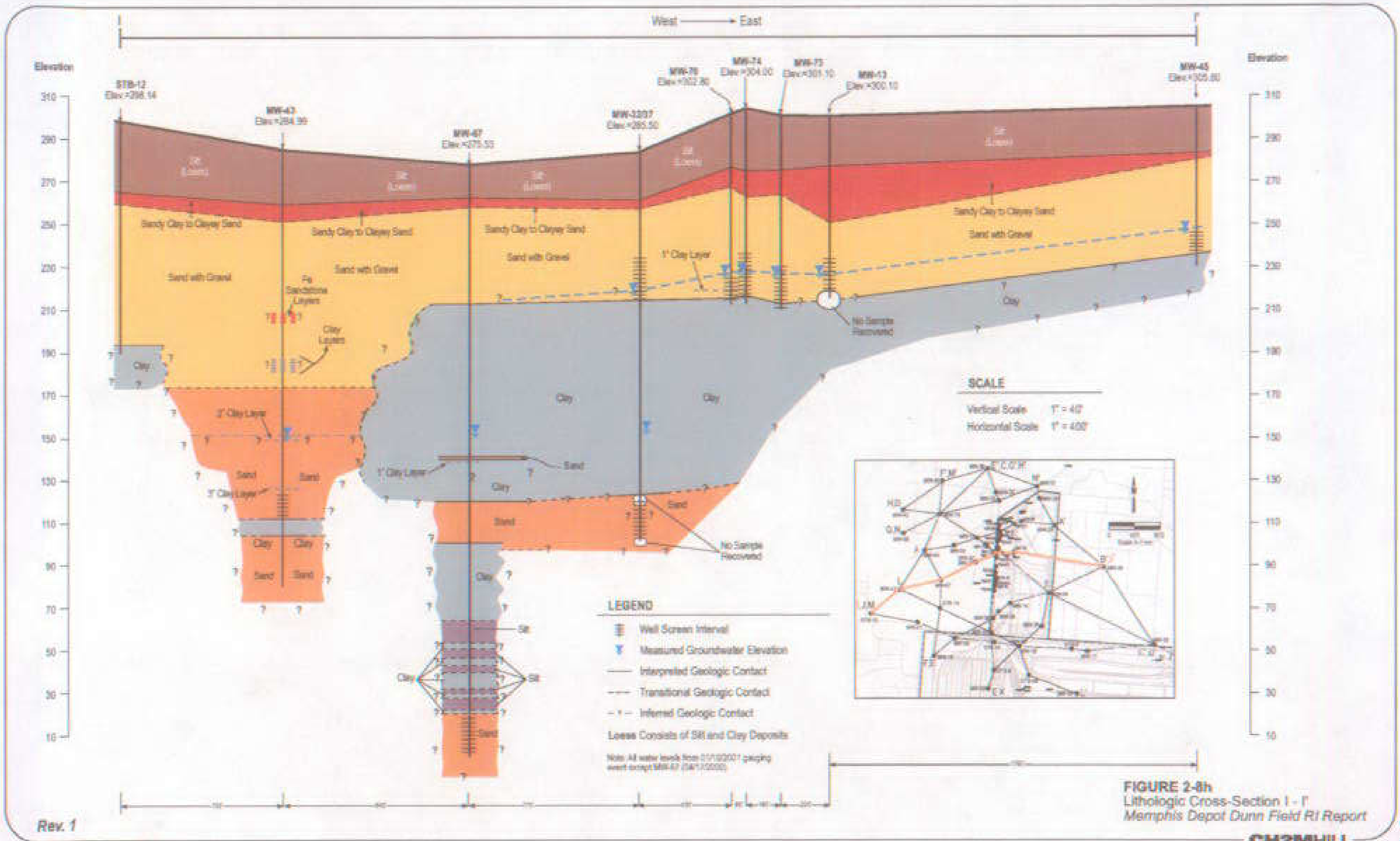


FIGURE 2-8h
Lithologic Cross-Section I - I'
Memphis Depot Dunn Field RI Report

CH2MHILL

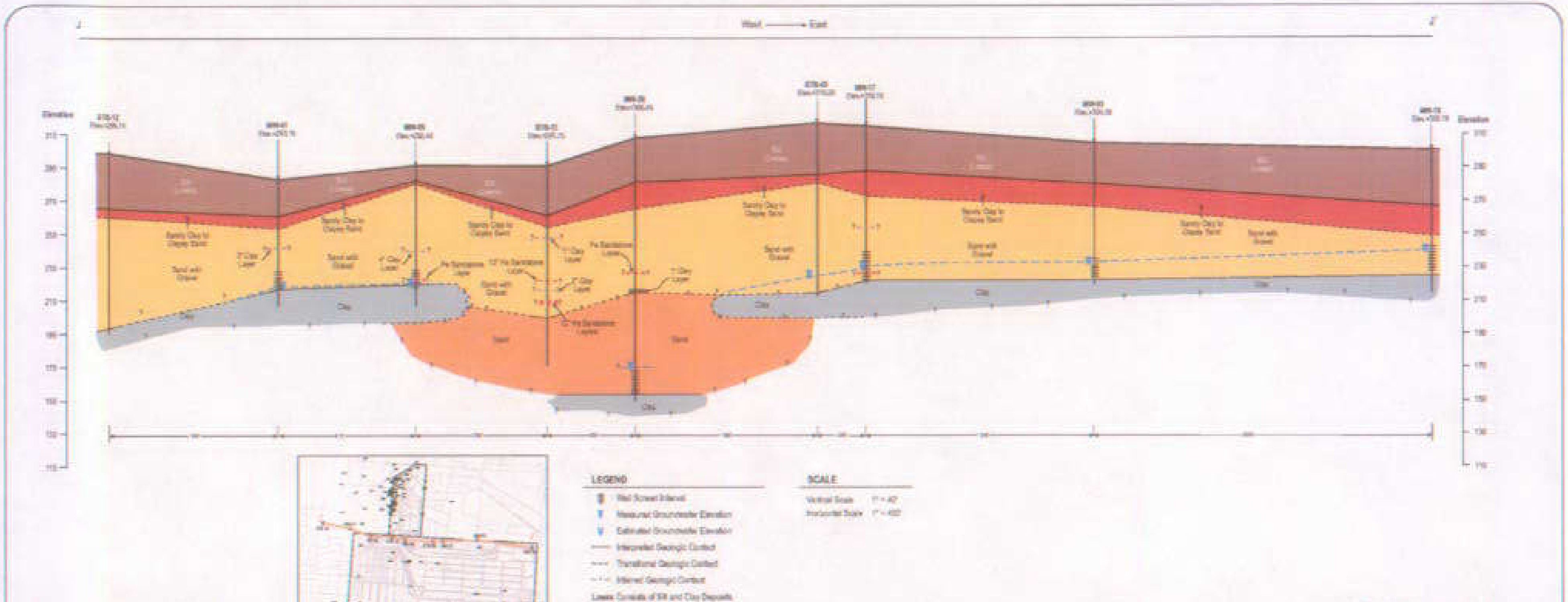
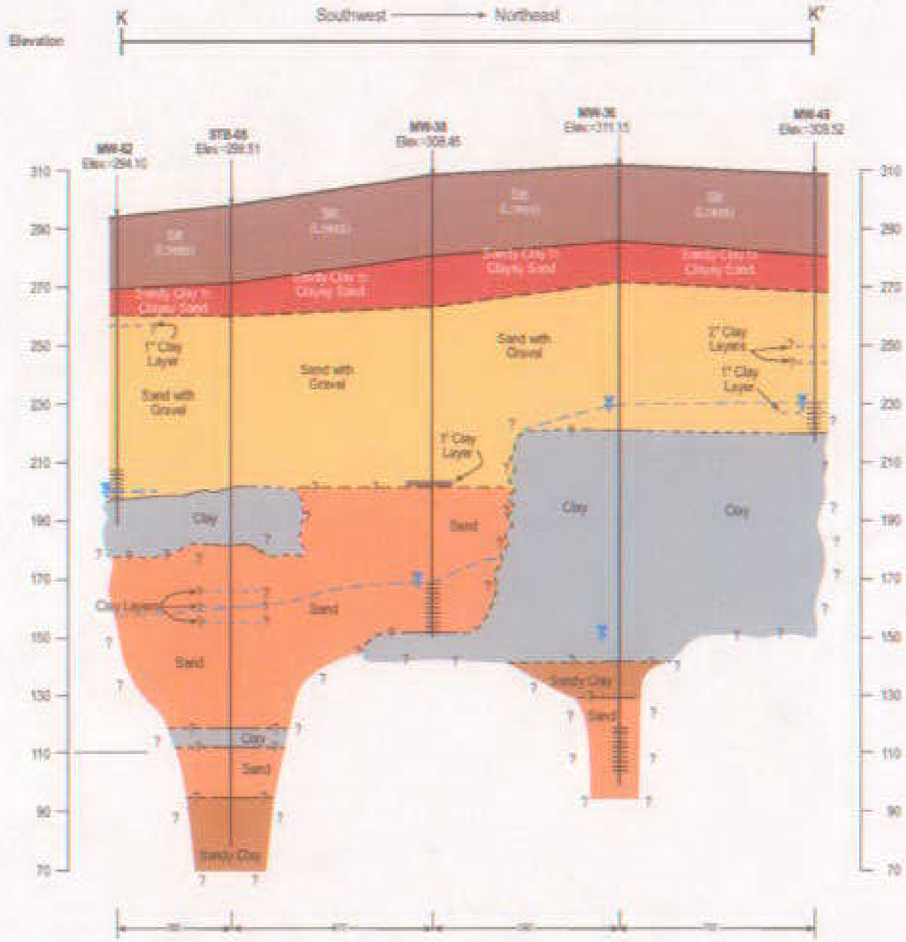


FIGURE 2-8I
Lithologic Cross-Section J - J'
Memphis Depot Dunn Field RI Report

CH2MHILL

579 216



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Estimated Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

Note: All water levels from 1/10/2001 sampling event

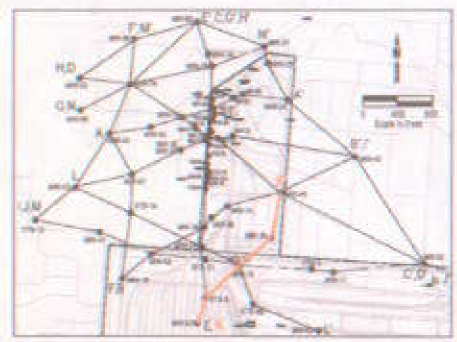


FIGURE 2-8j
Lithologic Cross-Section K - K'
Memphis Depot Dunn Field RI Report

Rev. 1

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579 217

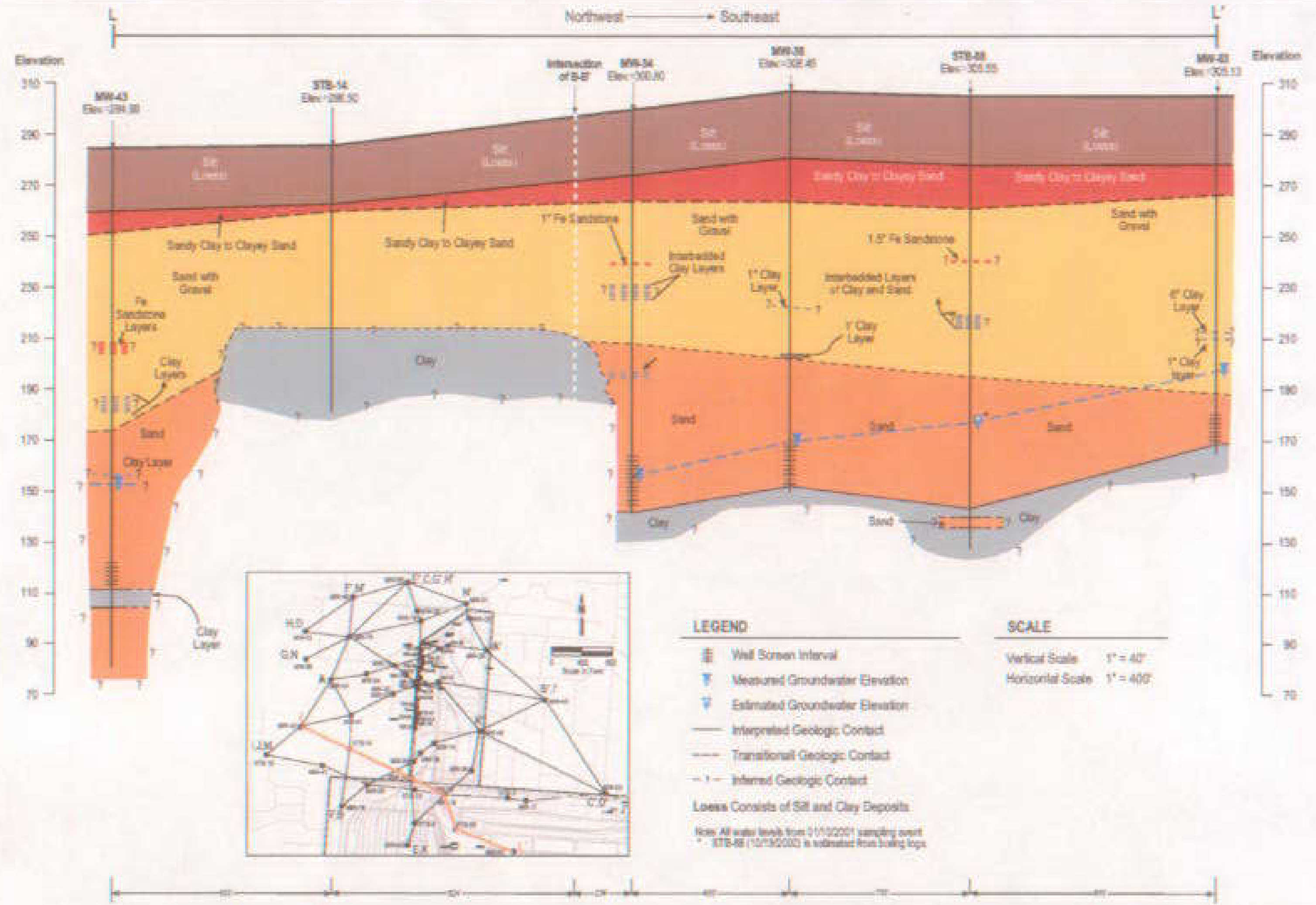

FIGURE 2-8k
Lithologic Cross-Section L - L'
Memphis Depot Dunn Field RI Report

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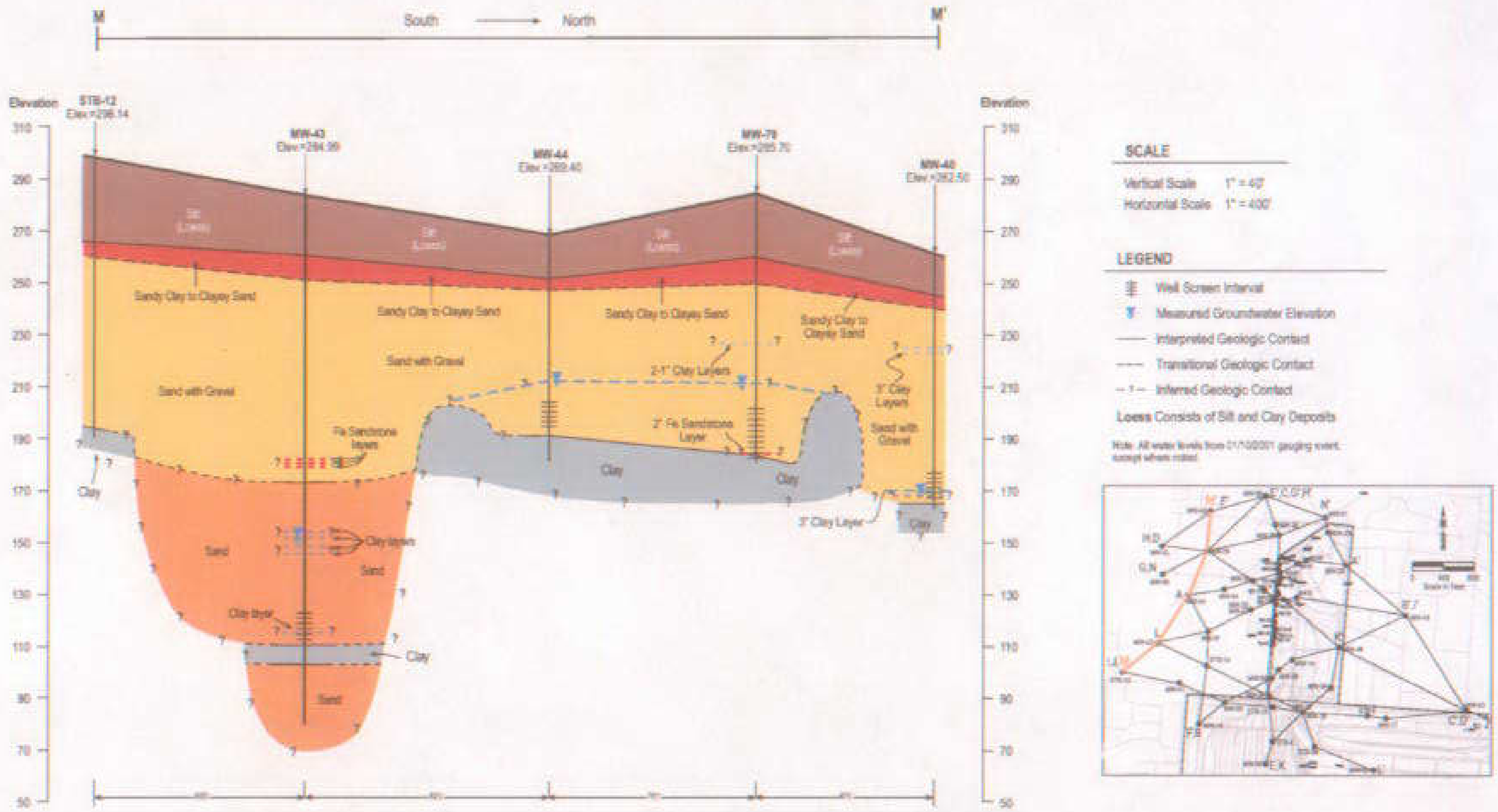
579 218

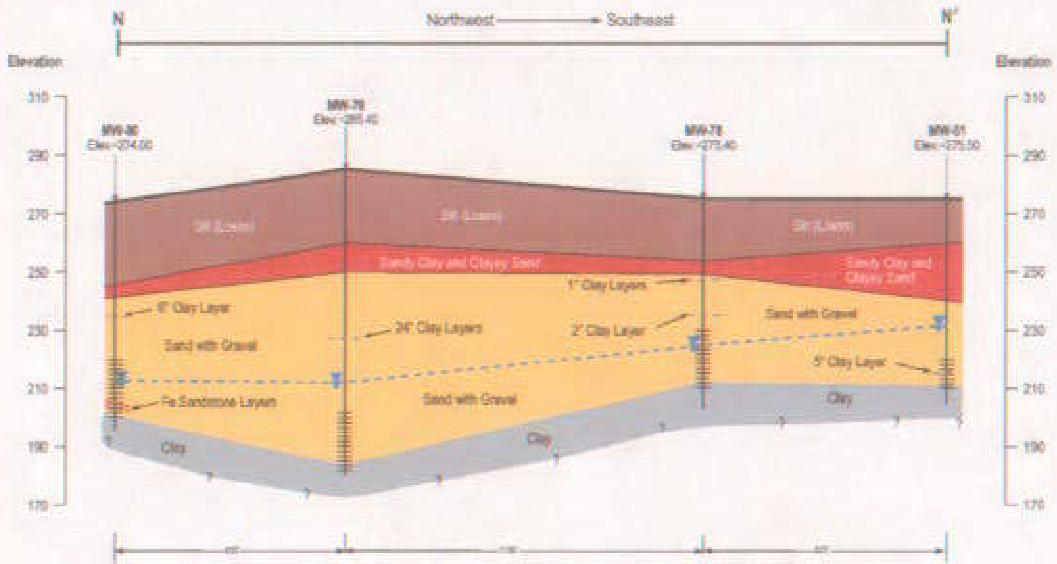


Rev. 1

FIGURE 2-8I
Lithologic Cross-Section M - M'
Memphis Depot Dunn Field RI Report

CH2MHILL

579 219



SCALE

Vertical Scale 1" = 40'
Horizontal Scale 1" = 400'

LEGEND

- Well Screen Interval
- Measured Groundwater Elevation
- Estimated Groundwater Elevation
- Interpreted Geologic Contact
- Transitional Geologic Contact
- Inferred Geologic Contact

Loess Consists of Silt and Clay Deposits

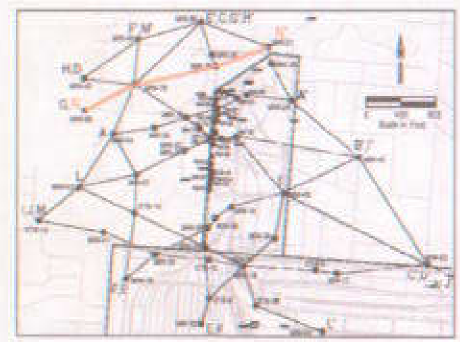


FIGURE 2-8m
Lithologic Cross-Section N - N'
Memphis Depot Dunn Field RI Report

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Rev. 1

APPENDIX A-3

Summary of the Analytical Results of Surface and Subsurface Soil, Sediment and Surface Water Samples from the Northeast Open Area, Dunn Field RI Report (July 2002)

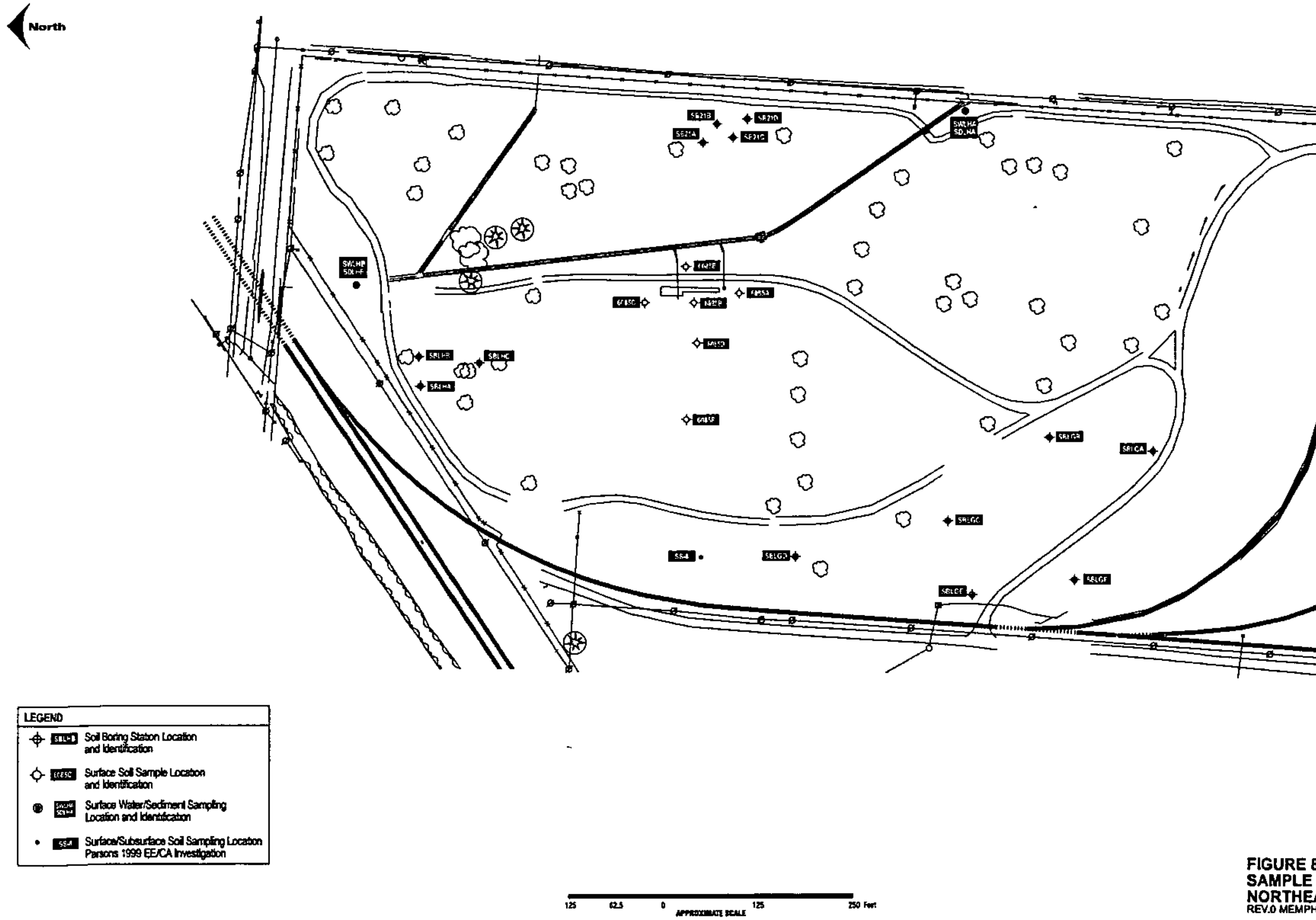


FIGURE 8-3
SAMPLE LOCATIONS
NORTHEAST OPEN AREA
REV.0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

E072001017ATL\Dunn117.FH8

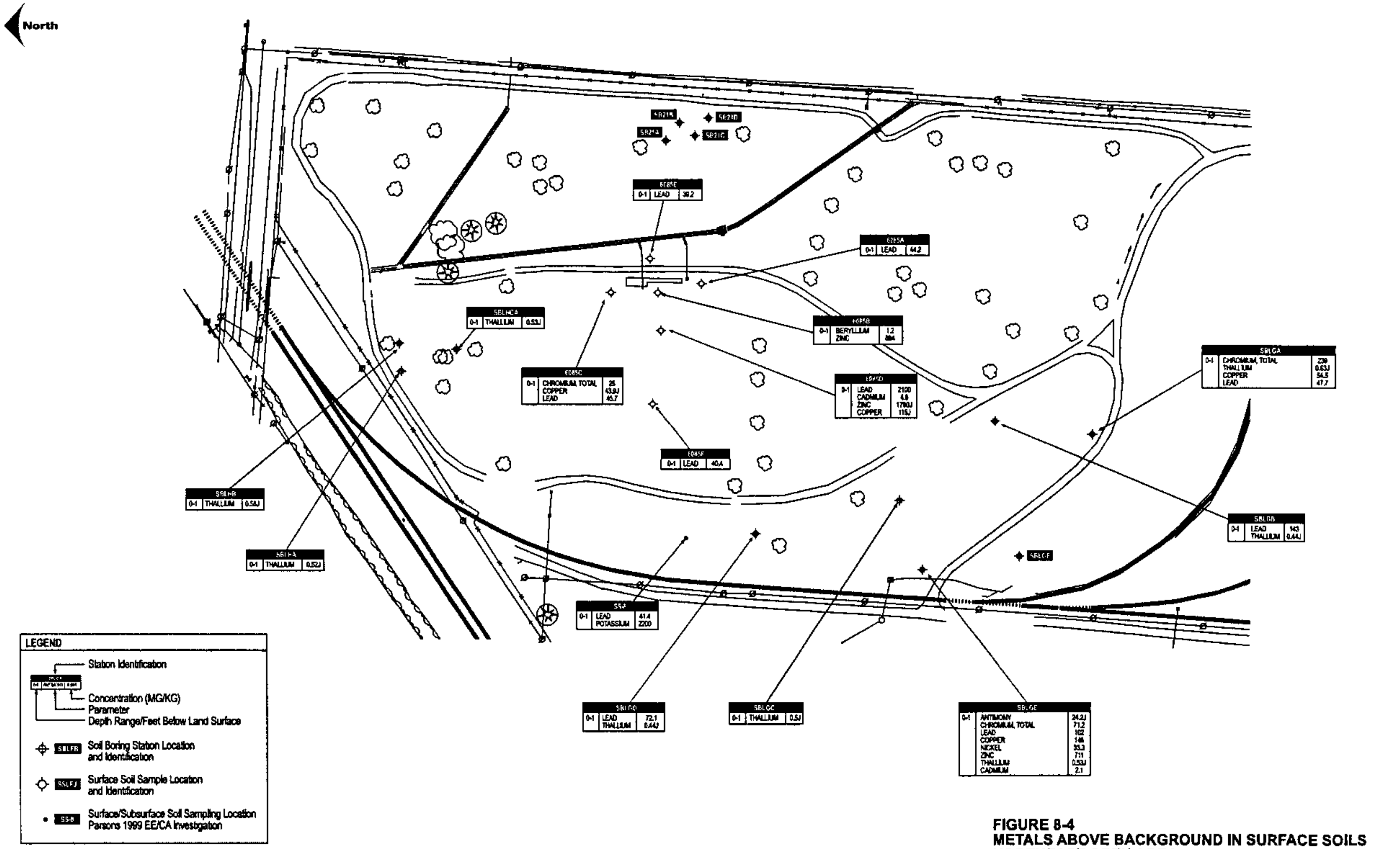


FIGURE 8-4
METALS ABOVE BACKGROUND IN SURFACE SOILS
NORTHEAST OPEN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL1 Dunn118.FH8

CH2MHILL

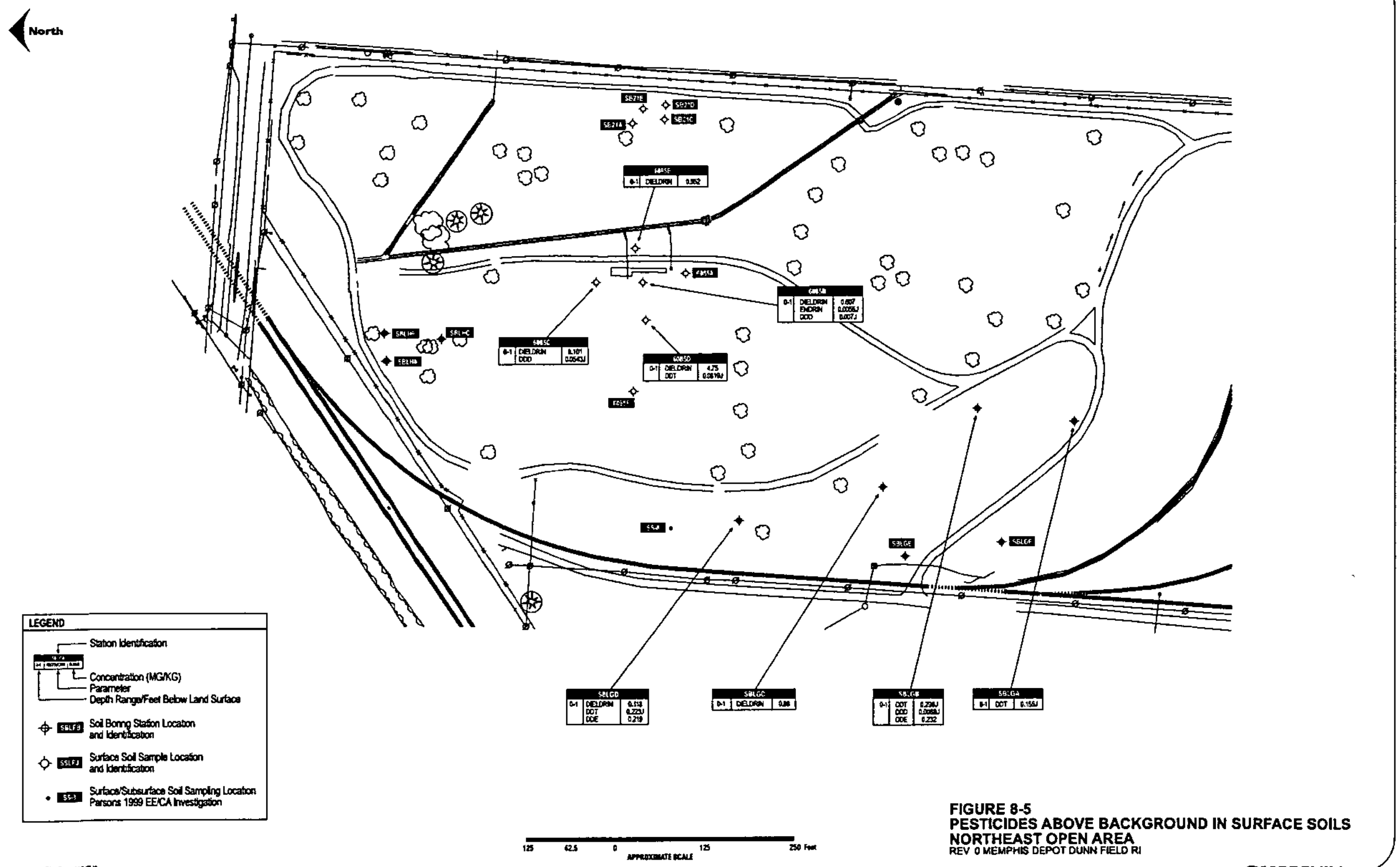
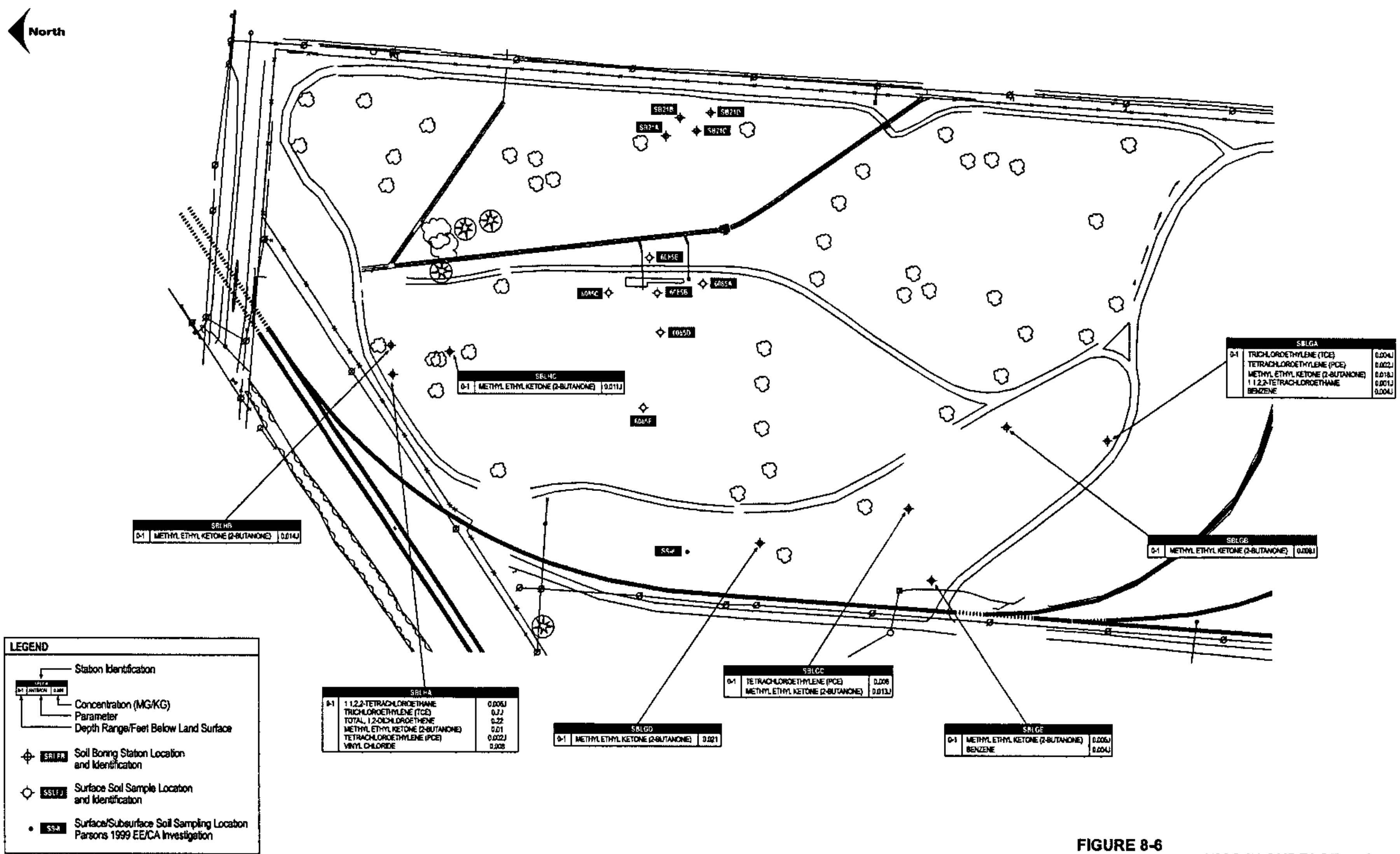


FIGURE 8-5
PESTICIDES ABOVE BACKGROUND IN SURFACE SOILS
NORTHEAST OPEN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

E072001017ATL1 Dunn119.FH8

579 225



125 62.5 0 125 250 Feet
APPROXIMATE SCALE

FIGURE 8-6
VOLATILE ORGANICS IN SURFACE SOILS
NORTHEAST OPEN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL1 Dunn120.FH8

CH2MHILL

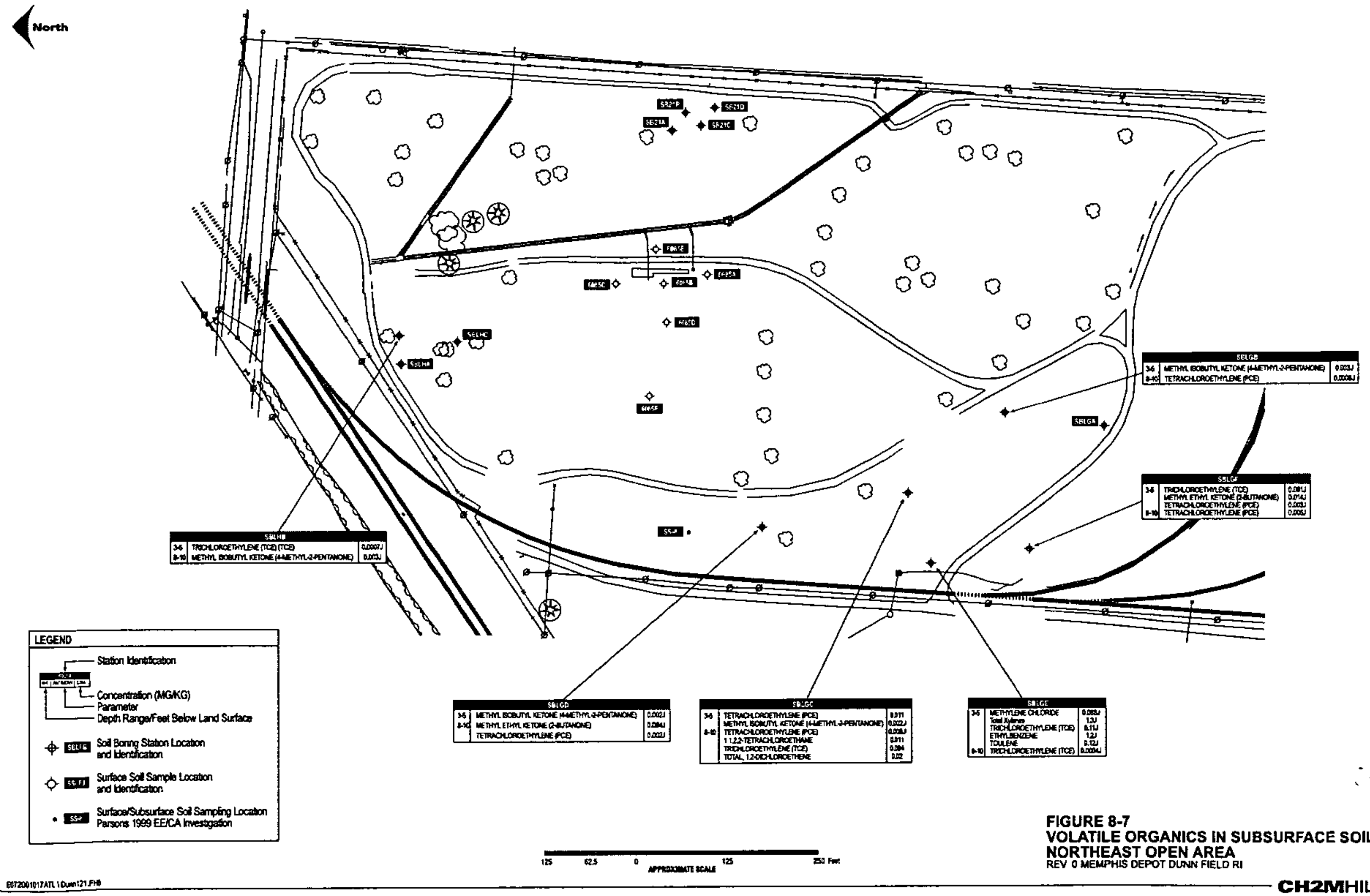


FIGURE 8-7
VOLATILE ORGANICS IN SUBSURFACE SOILS
NORTHEAST OPEN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

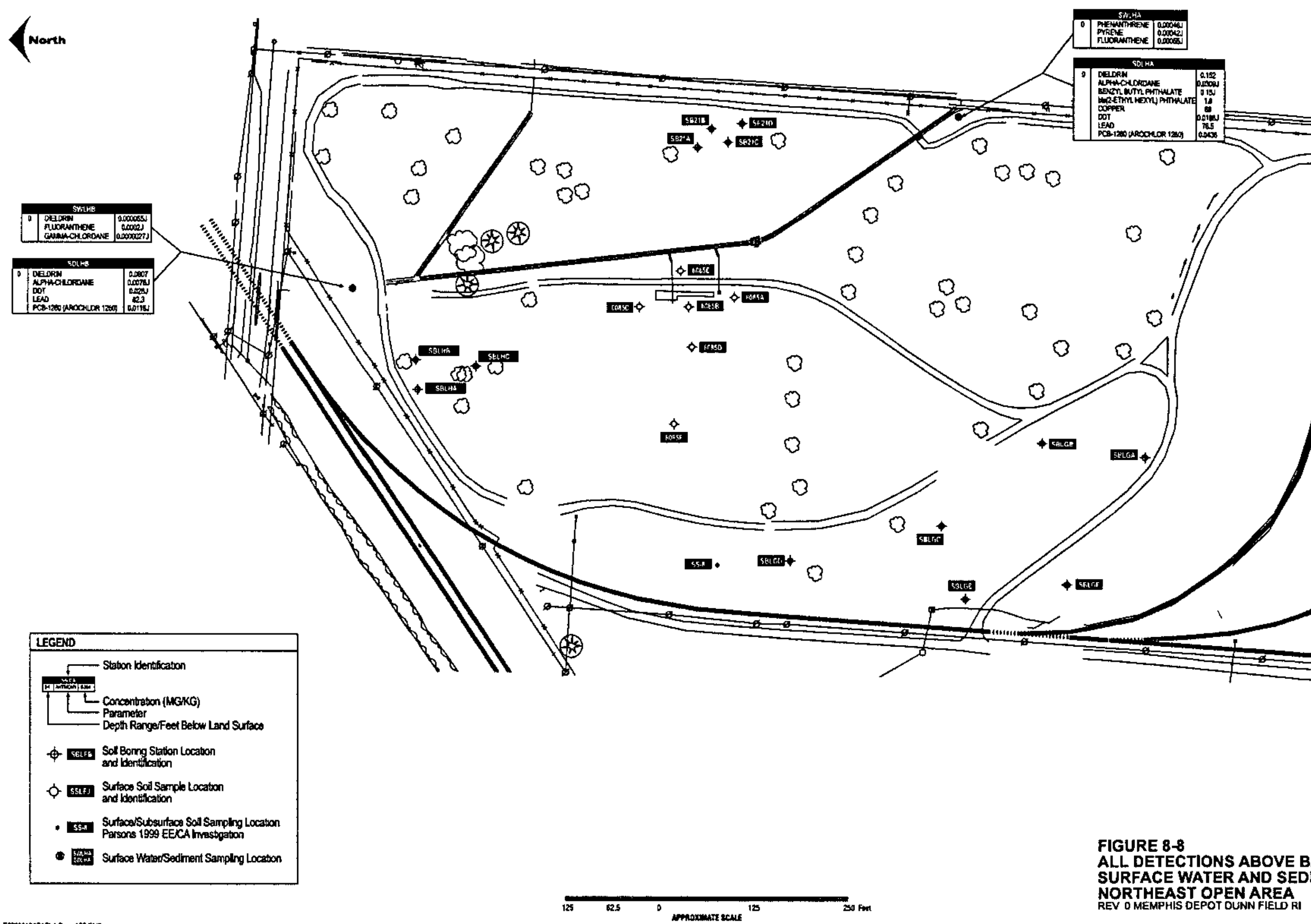


FIGURE 8-8
ALL DETECTIONS ABOVE BACKGROUND IN SURFACE WATER AND SEDIMENT NORTHEAST OPEN AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL \ Dunn122.FH8

CH2MHILL

APPENDIX A-4

Summary of the Analytical Results of Surface and Subsurface Soil, Sediment and Surface Water Samples from the Disposal Area, Dunn Field RI Report (July 2002)

579 229

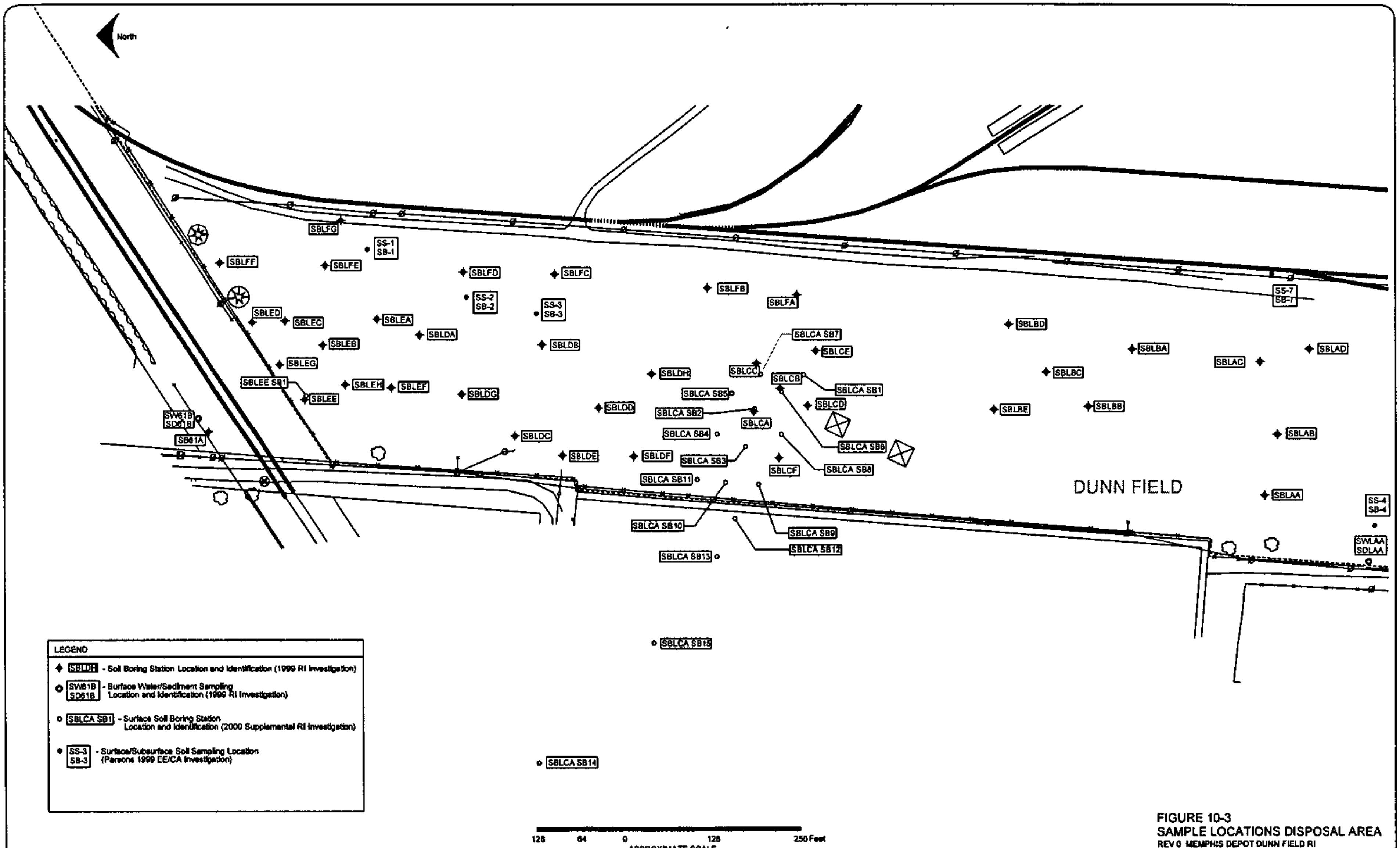


FIGURE 10-3
SAMPLE LOCATIONS DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 31-OCT-2001 08071DFRI01-10-3.dgn

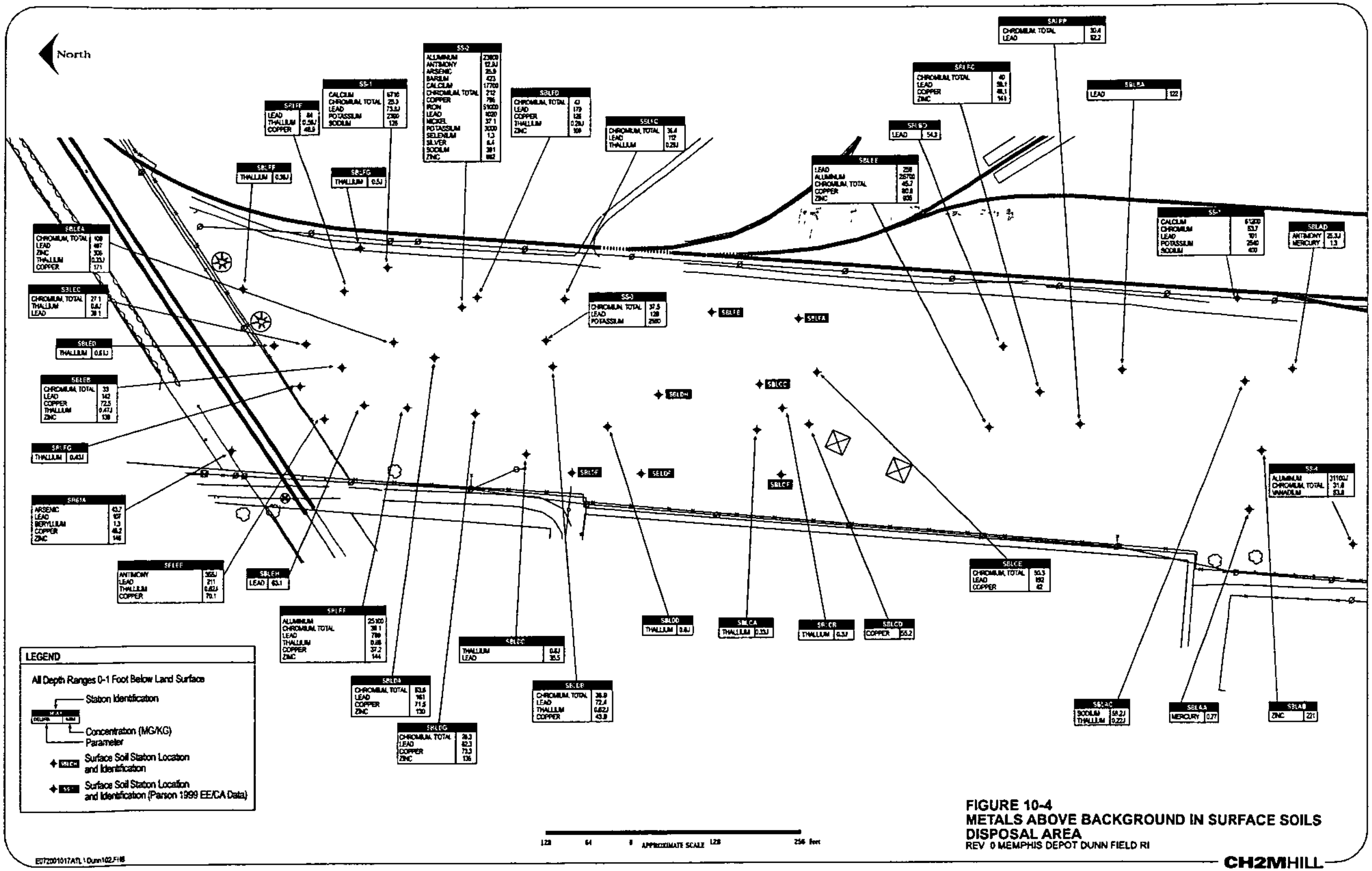


FIGURE 10-4
METALS ABOVE BACKGROUND IN SURFACE SOILS
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

579 231

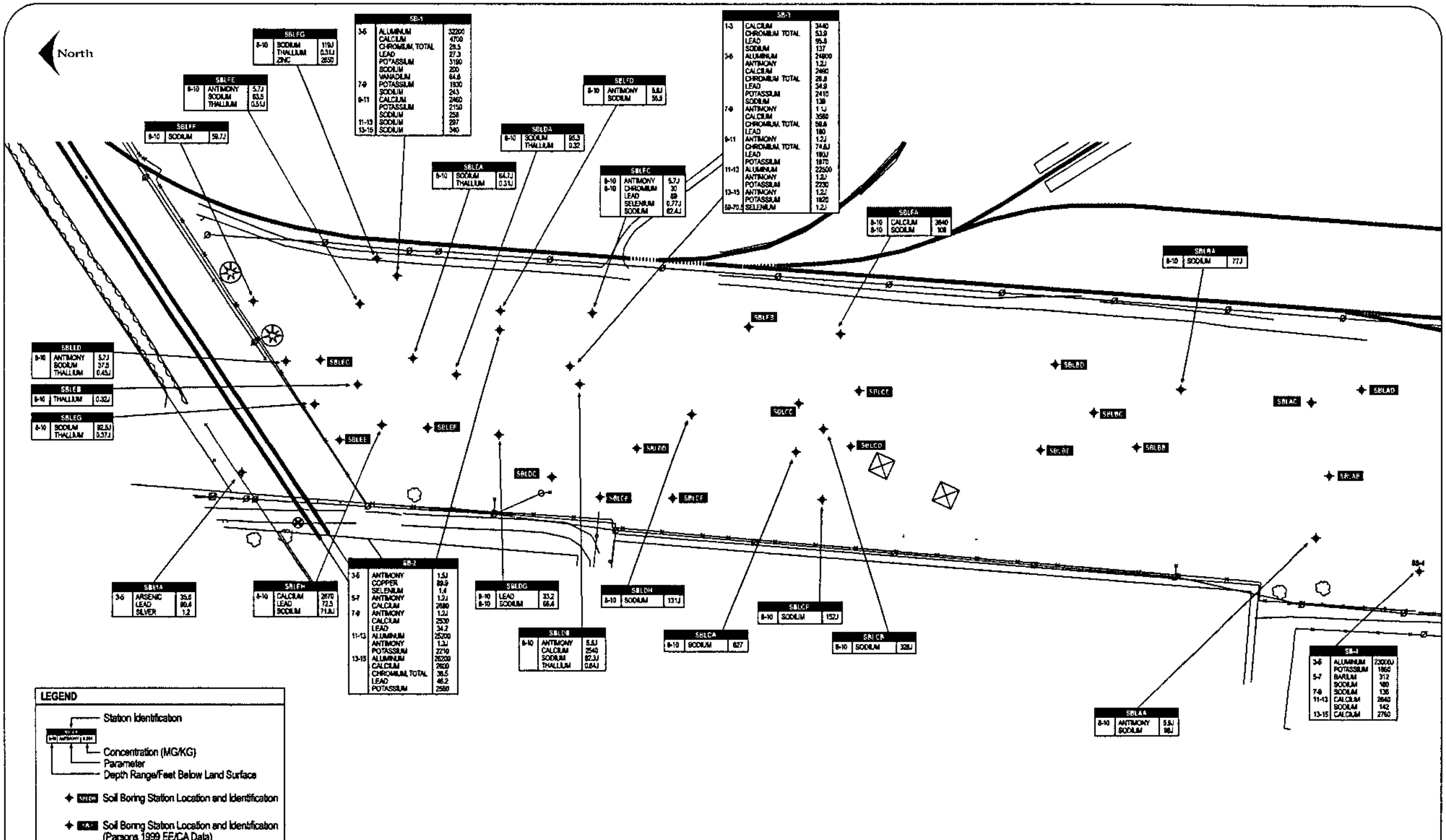


FIGURE 10-5
METALS ABOVE BACKGROUND IN SUBSURFACE SOILS
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL \ Dunn103.FH8

CH2MHILL

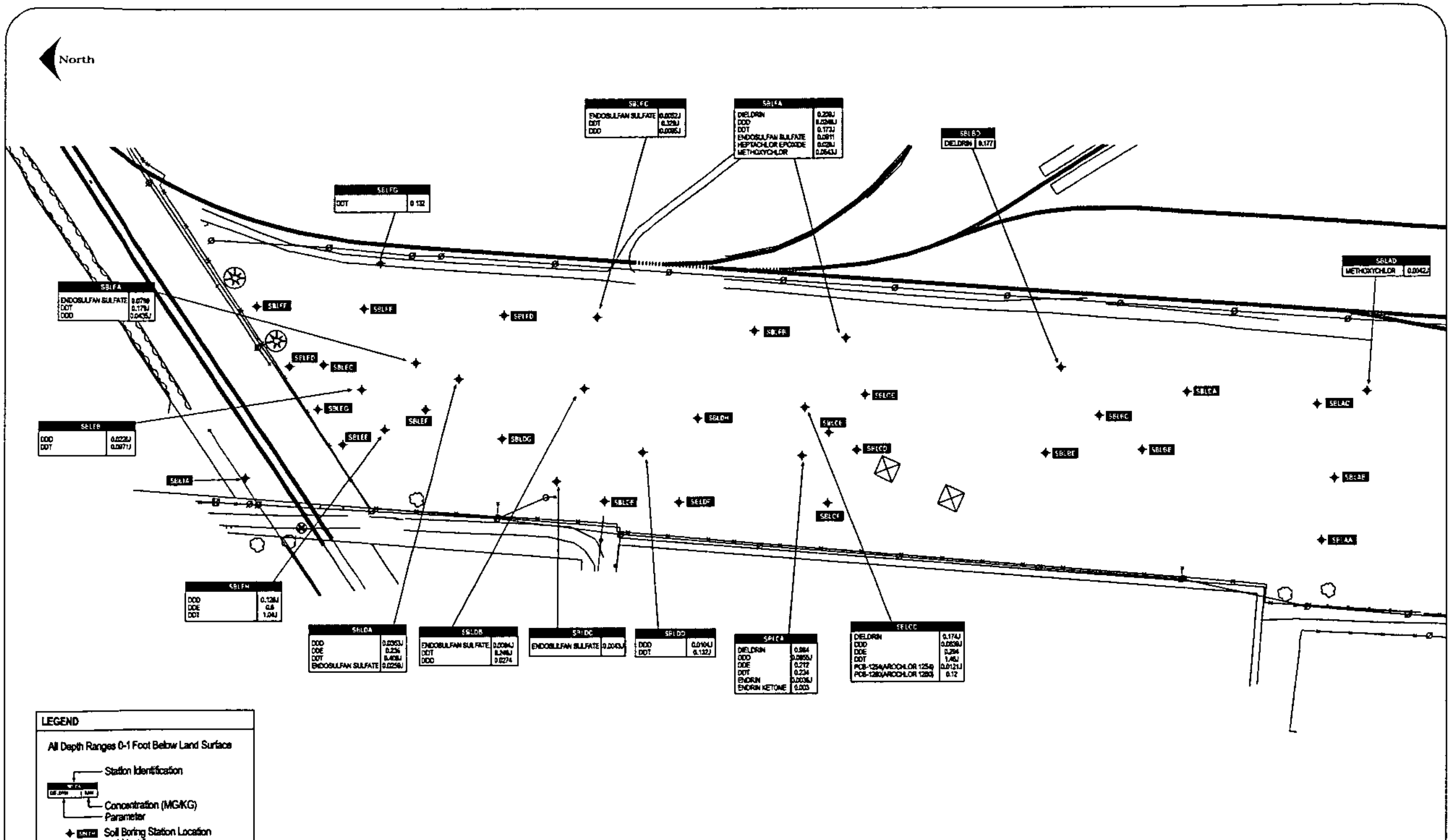


FIGURE 10-6
PESTICIDES/PCBs ABOVE BACKGROUND IN SURFACE SOILS
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL \ Dunn104.FH6

CH2MHILL

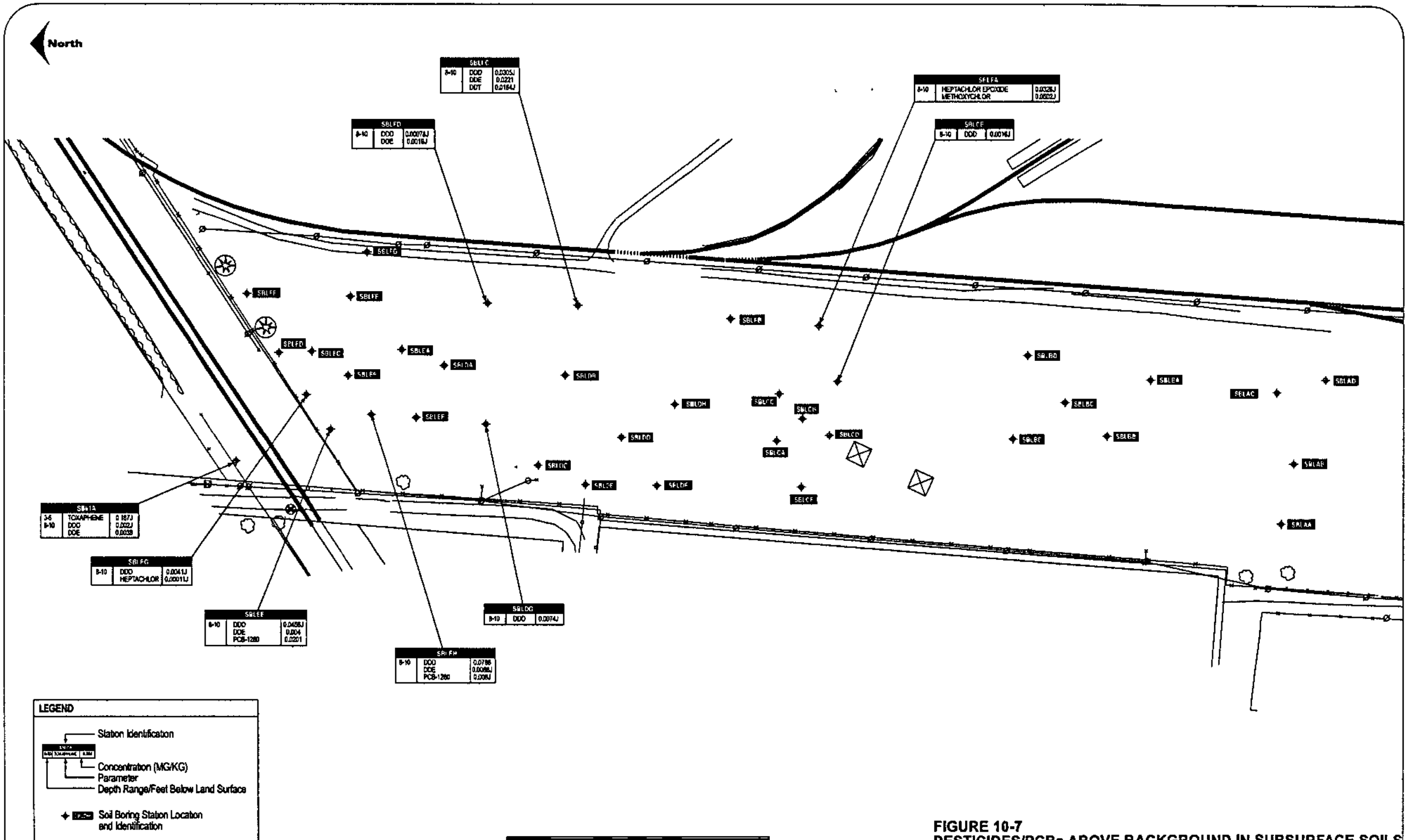


FIGURE 10-7
PESTICIDES/PCBs ABOVE BACKGROUND IN SUBSURFACE SOILS DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

579 234

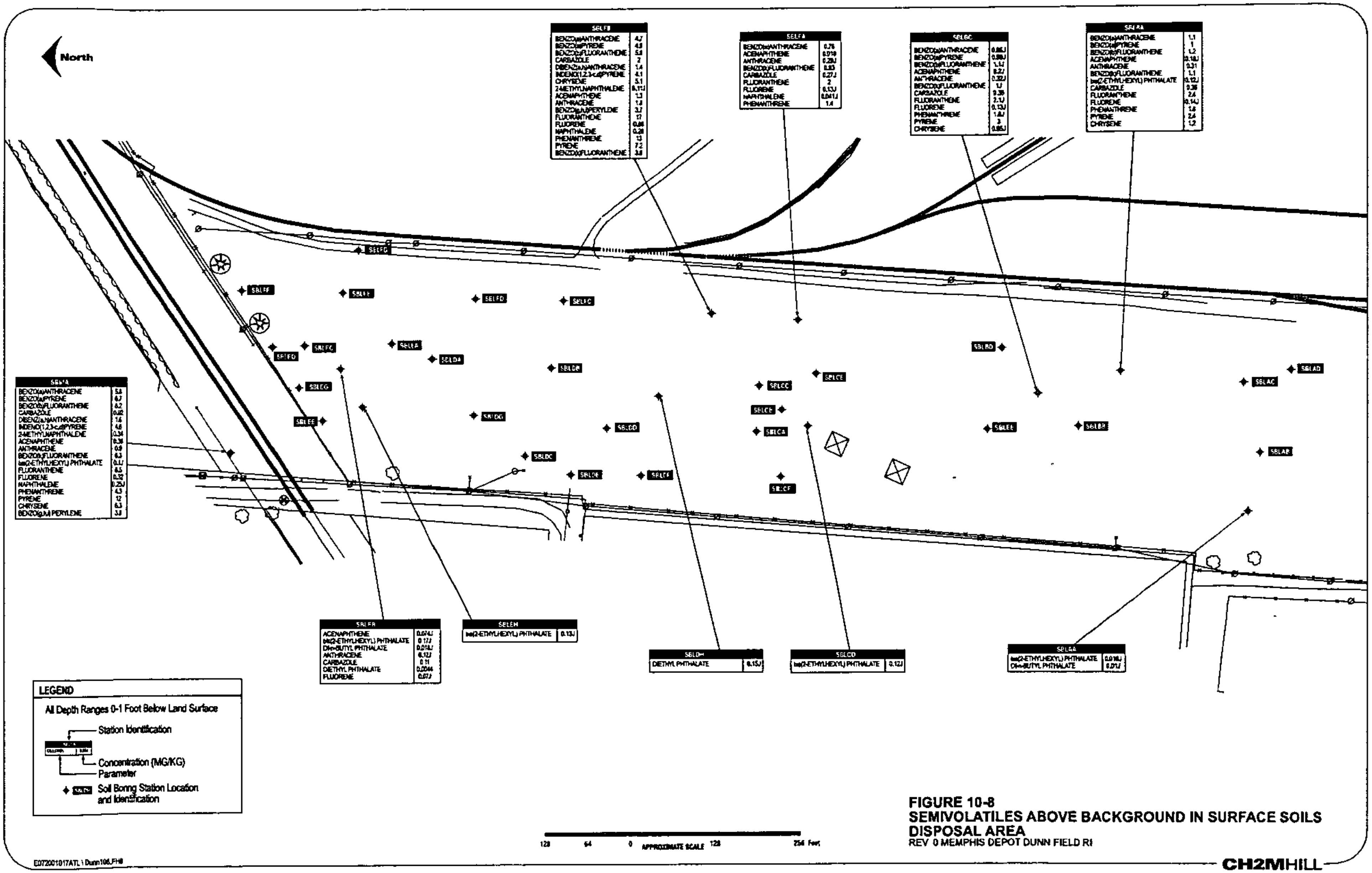


FIGURE 10-8
SEMIVOLATILES ABOVE BACKGROUND IN SURFACE SOILS
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

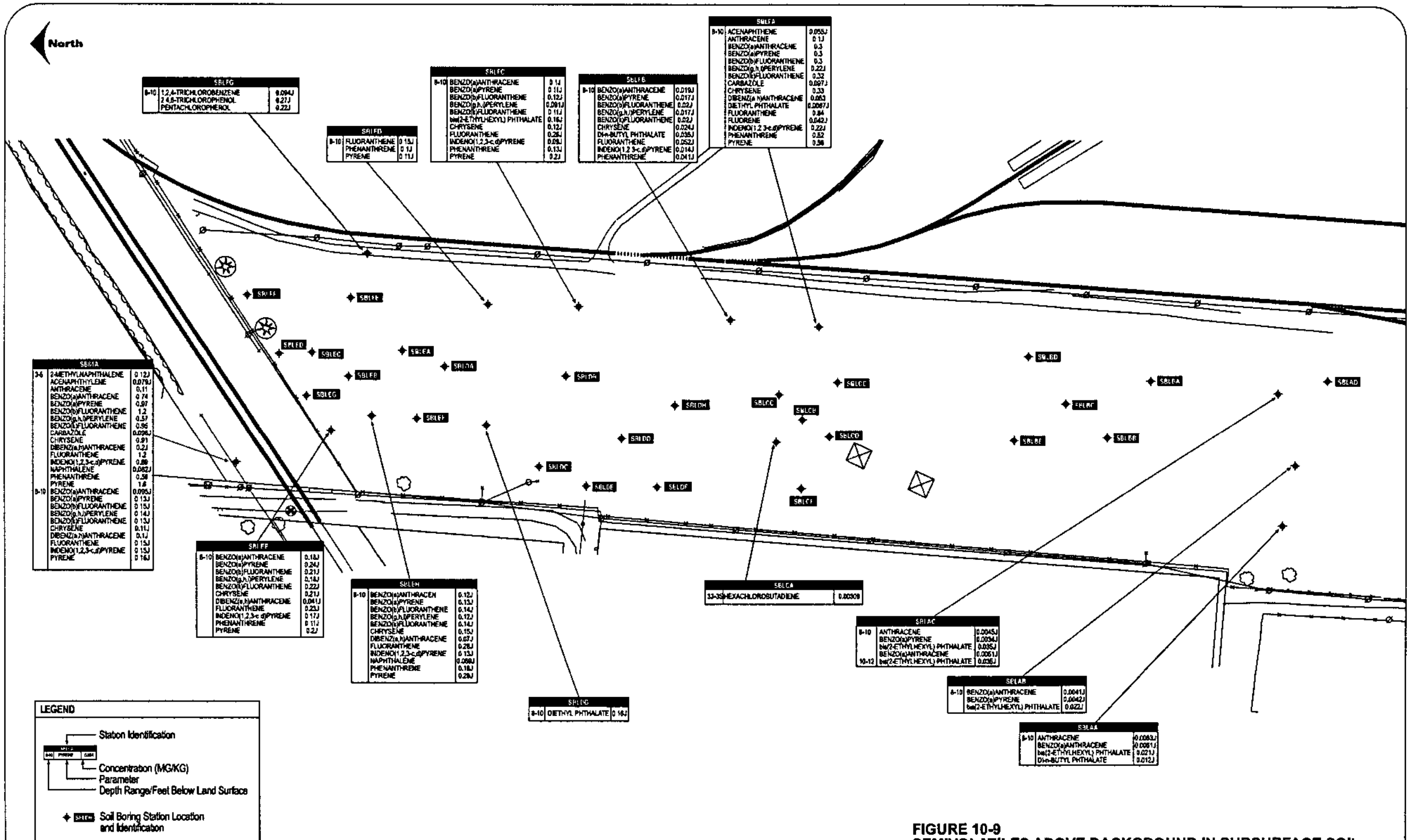


FIGURE 10-9
SEMIVOLATILES ABOVE BACKGROUND IN SUBSURFACE SOIL DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL\Dunn107.FH8

CH2MHILL

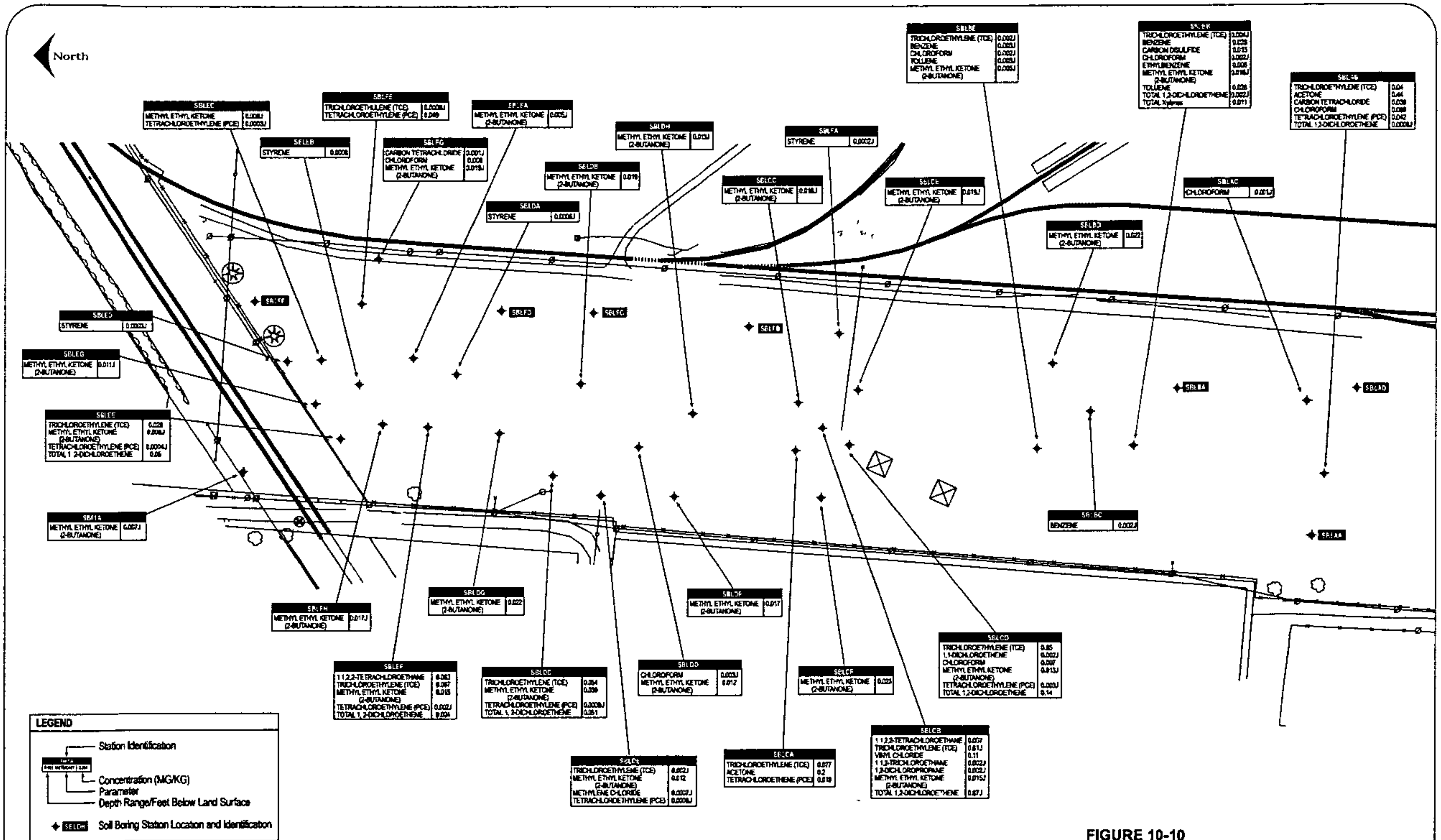


FIGURE 10-10
VOLATILE ORGANICS IN SURFACE SOILS
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

E072001017ATL\Dunn140.FH8

579 237

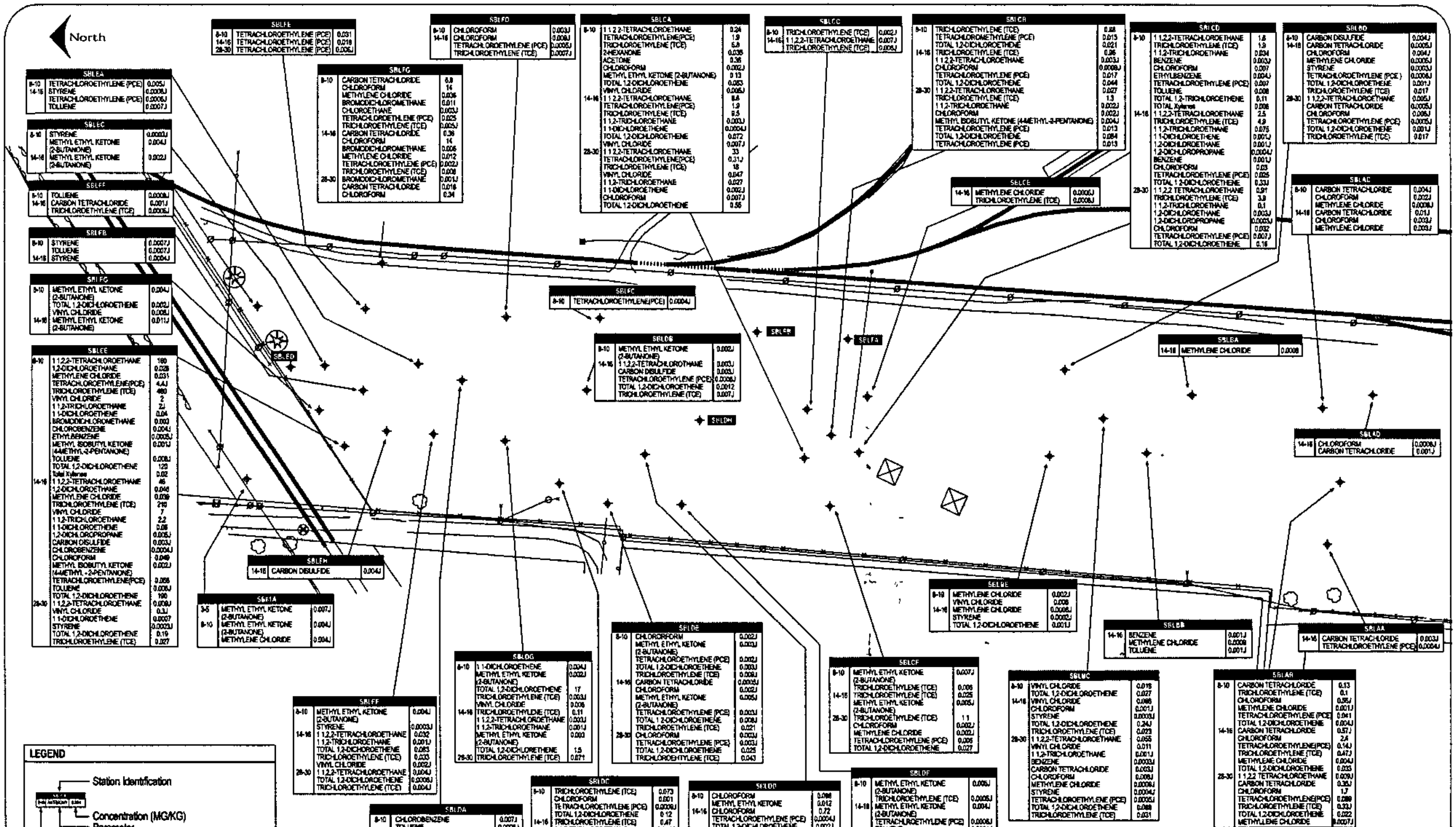


FIGURE 10-11A
VOLATILE ORGANICS IN SUBSURFACE SOILS (1999 INVESTIGATION)
DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

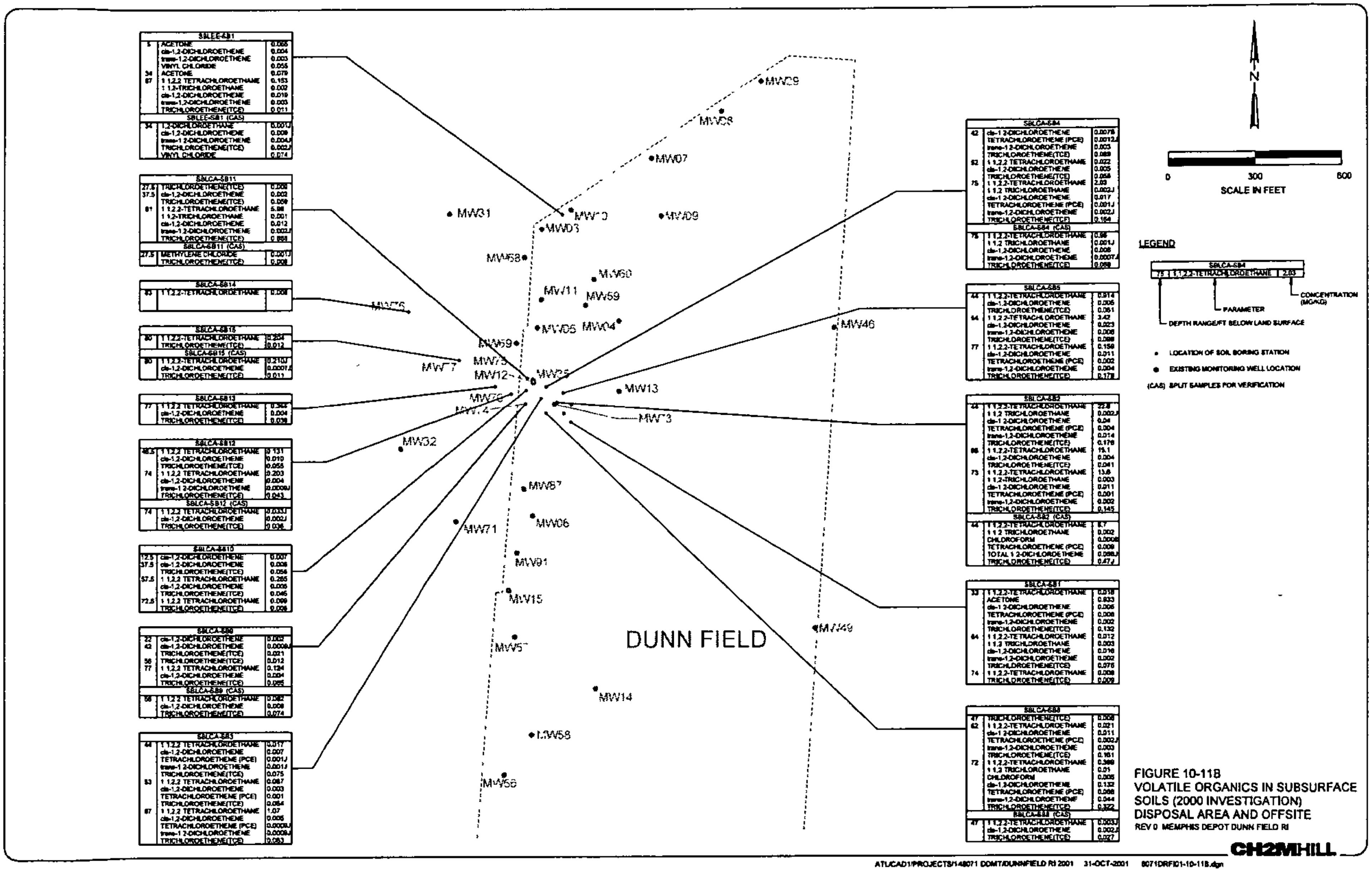


FIGURE 10-11B
VOLATILE ORGANICS IN SUBSURFACE SOILS (2000 INVESTIGATION)
DISPOSAL AREA AND OFFSITE
REV 0 MEMPHIS DEPOT DUNN FIELD RI

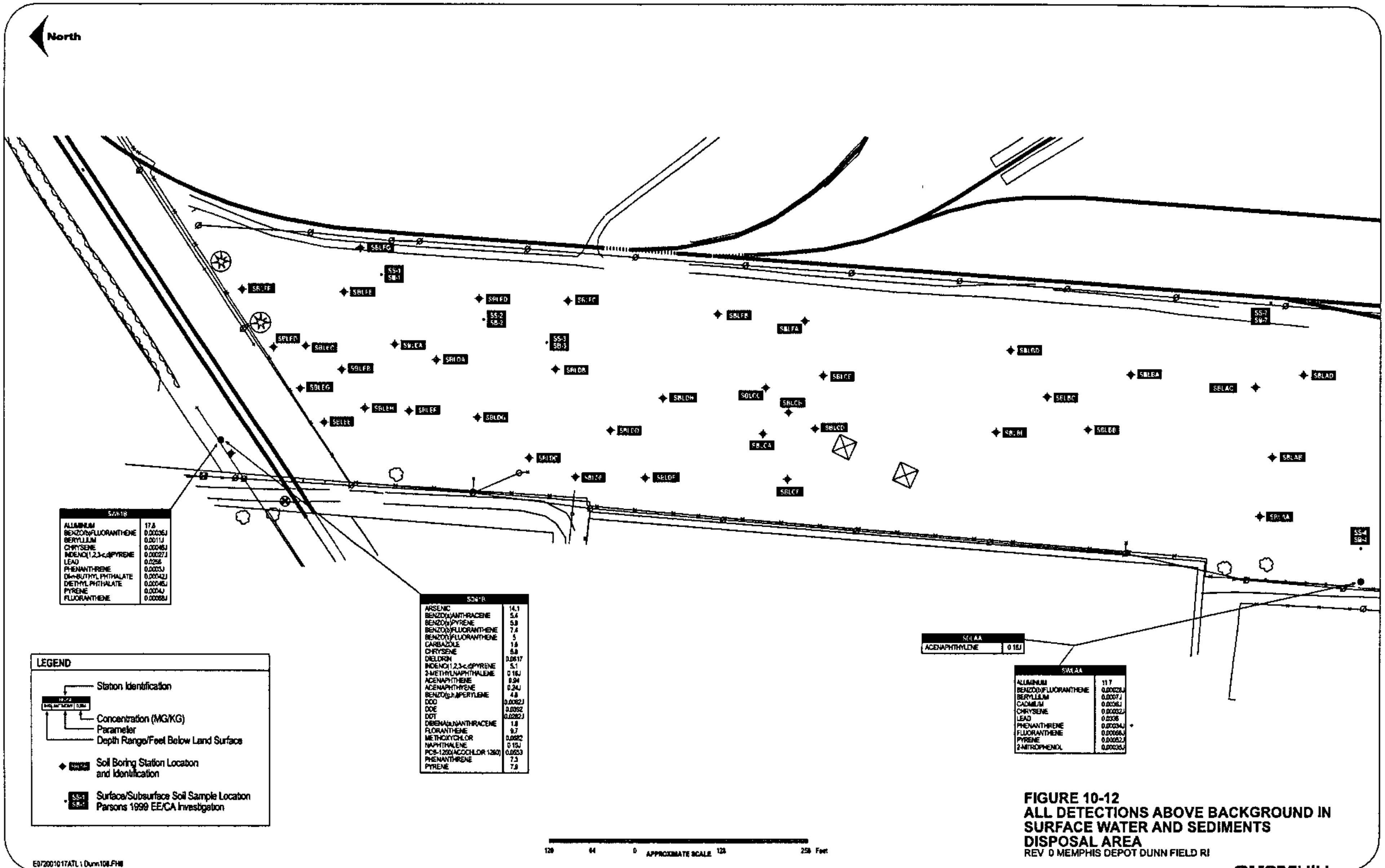


FIGURE 10-12
ALL DETECTIONS ABOVE BACKGROUND IN SURFACE WATER AND SEDIMENTS DISPOSAL AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

APPENDIX A-5

Summary of the Analytical Results of Surface and Subsurface Soil Samples from the Stockpile Area, Dunn Field RI Report (July 2002)

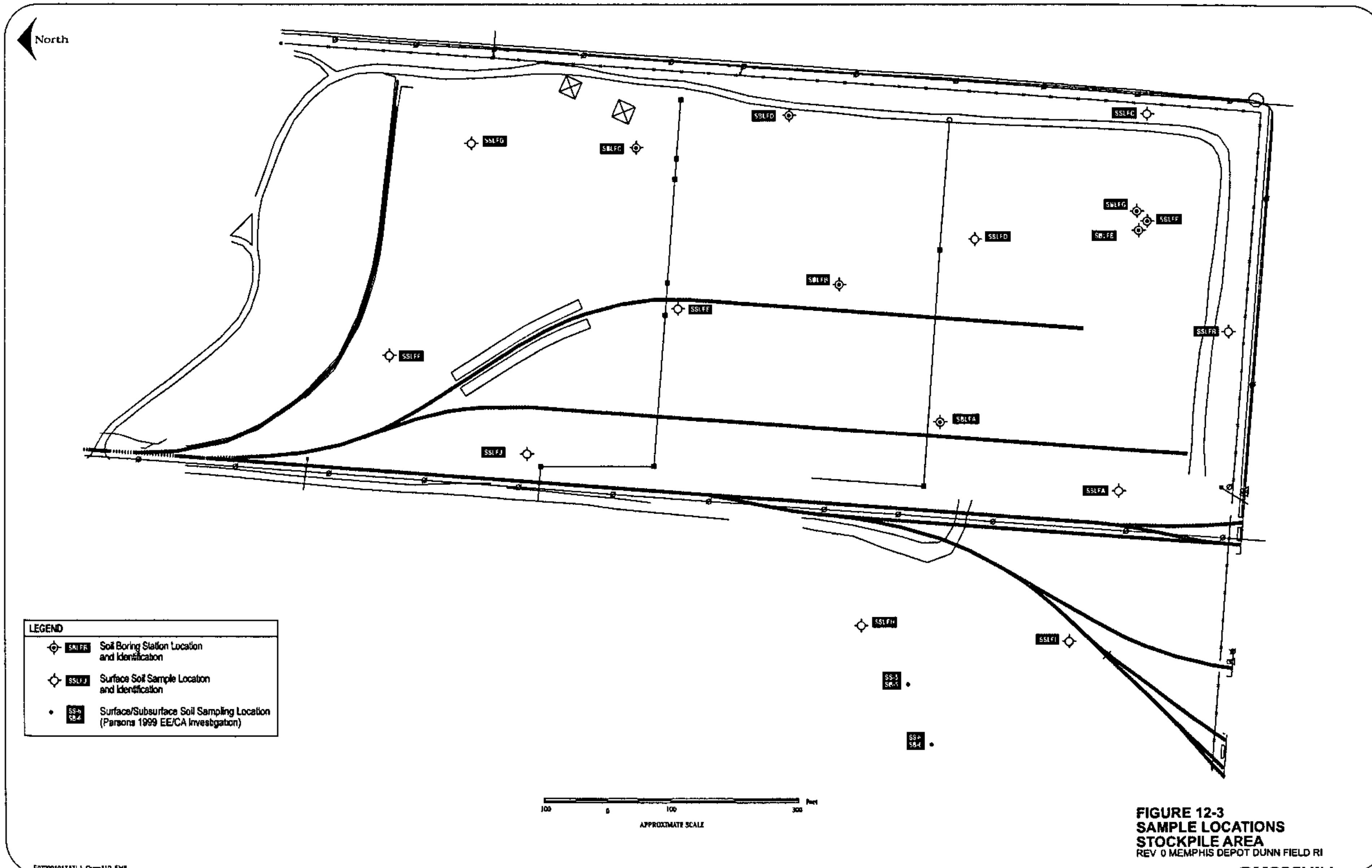


FIGURE 12-3
SAMPLE LOCATIONS
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

579 241

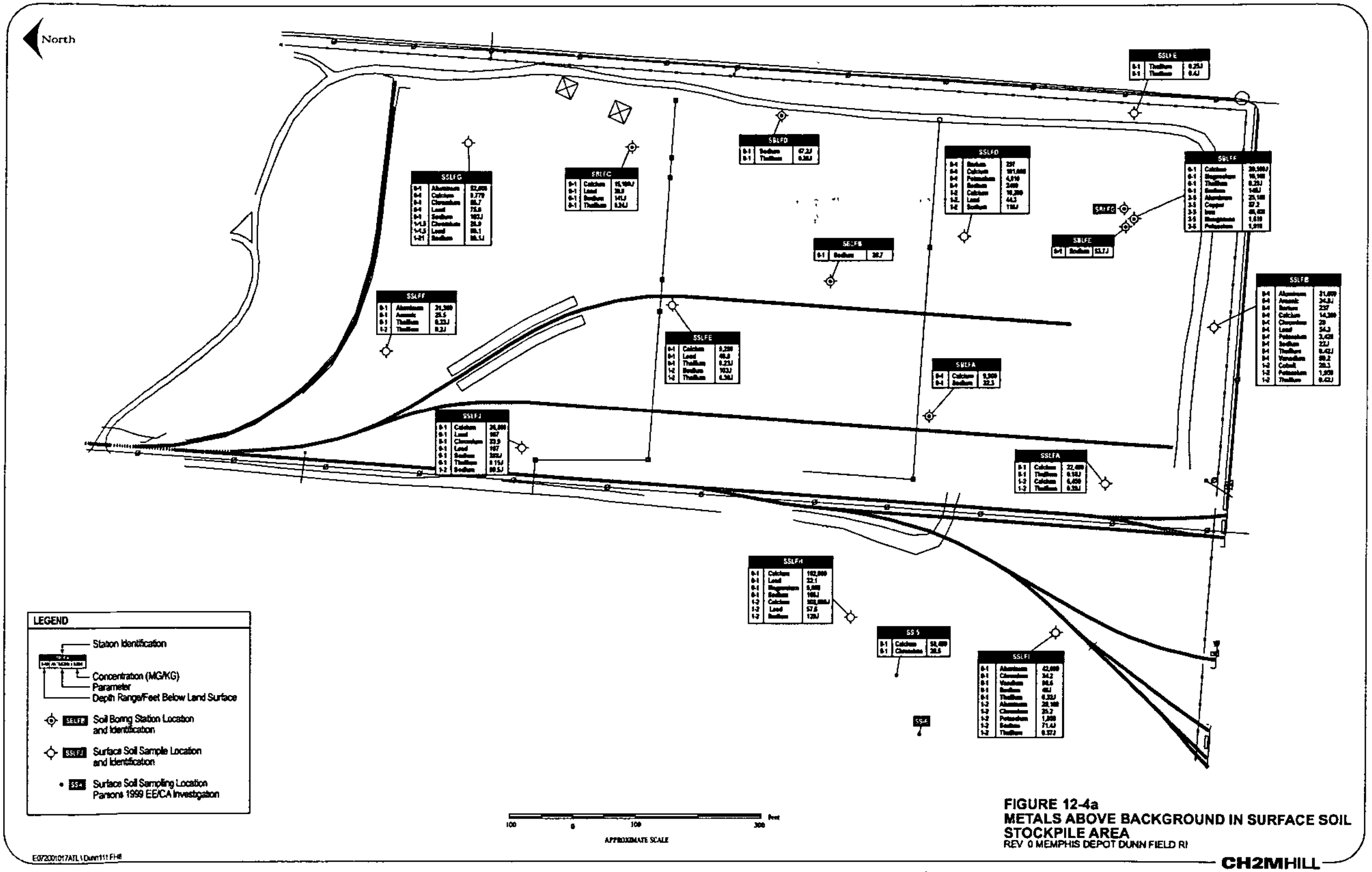


FIGURE 12-4a
METALS ABOVE BACKGROUND IN SURFACE SOIL
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

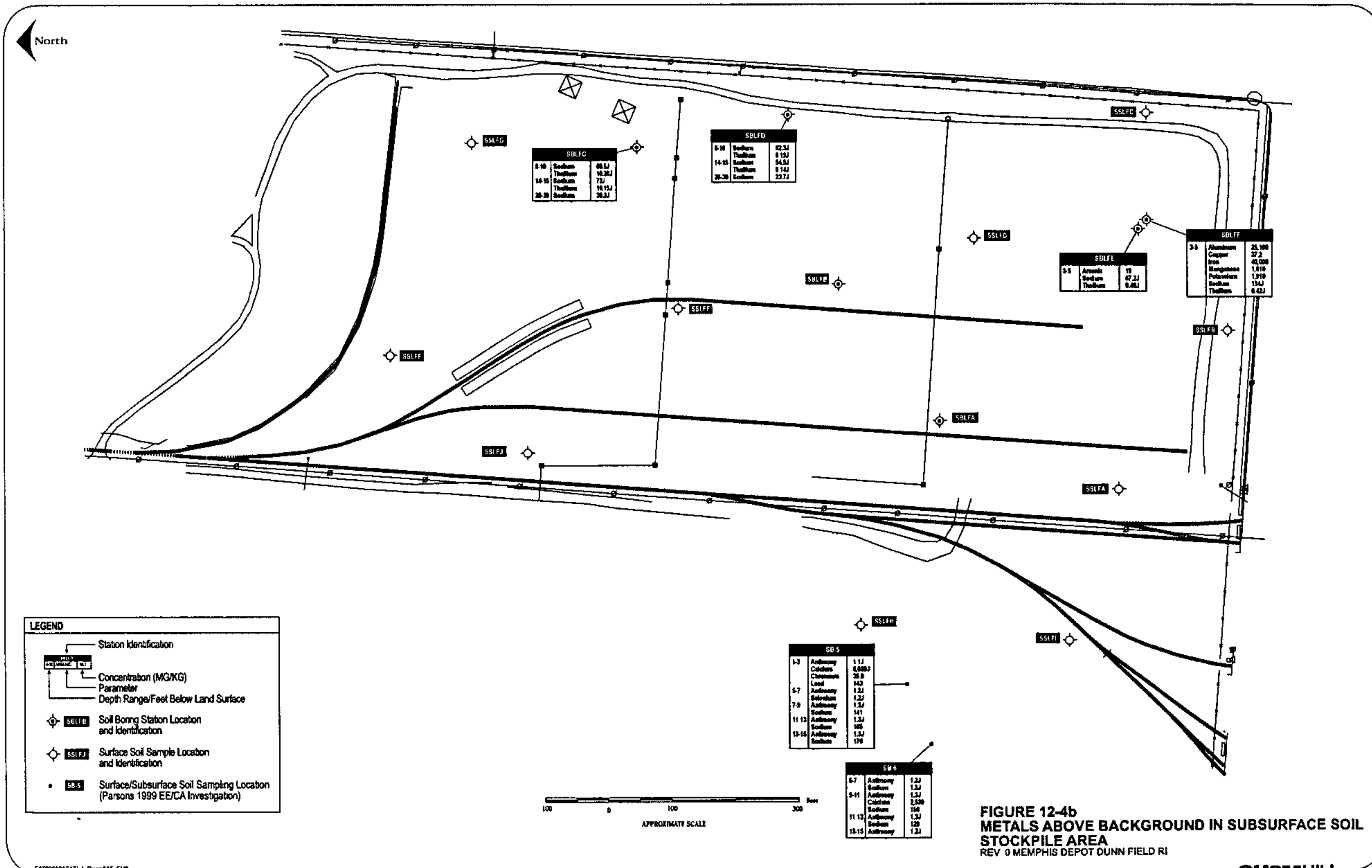


FIGURE 12-4b
METALS ABOVE BACKGROUND IN SUBSURFACE SOIL STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

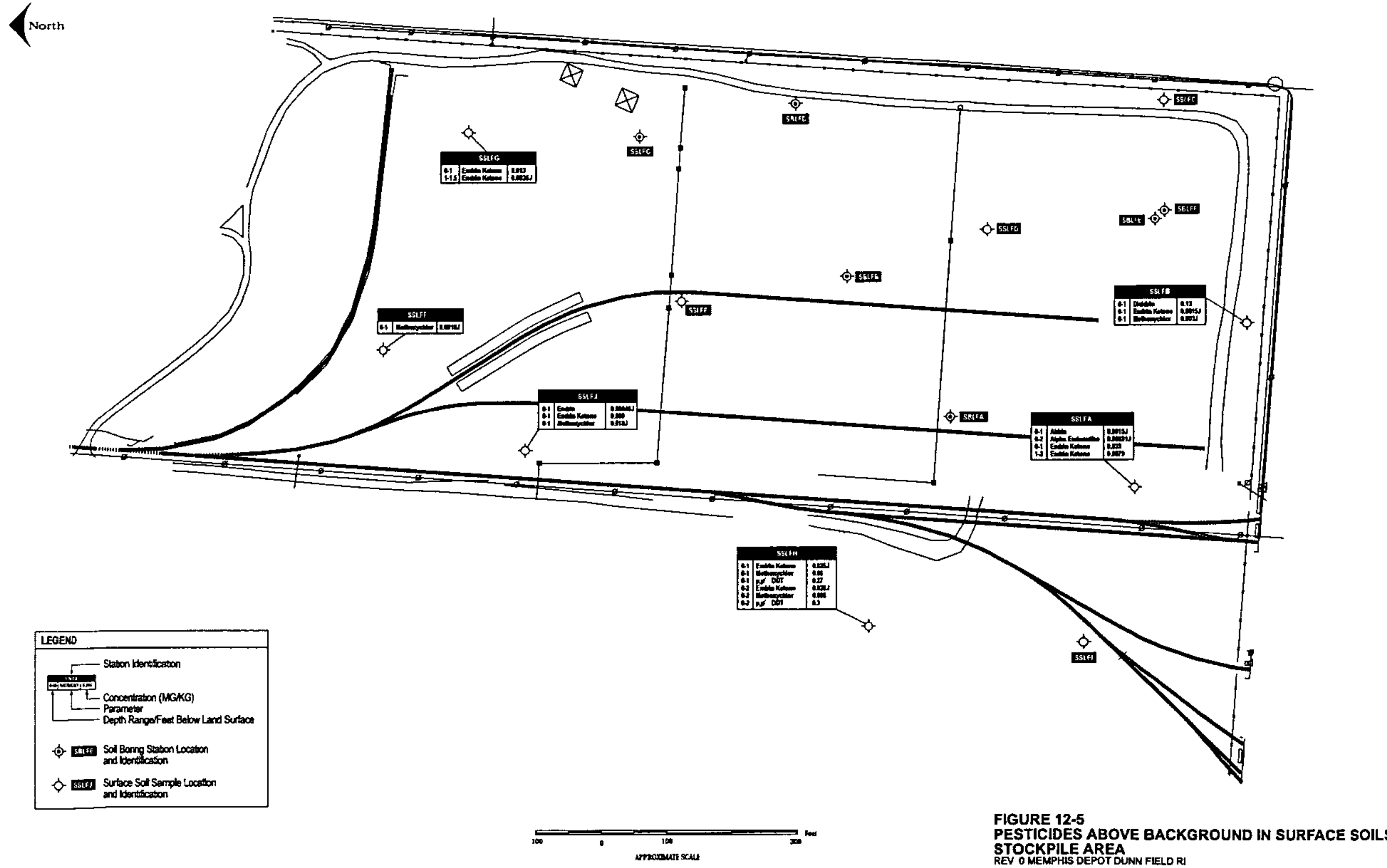


FIGURE 12-5
PESTICIDES ABOVE BACKGROUND IN SURFACE SOILS
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

579 245

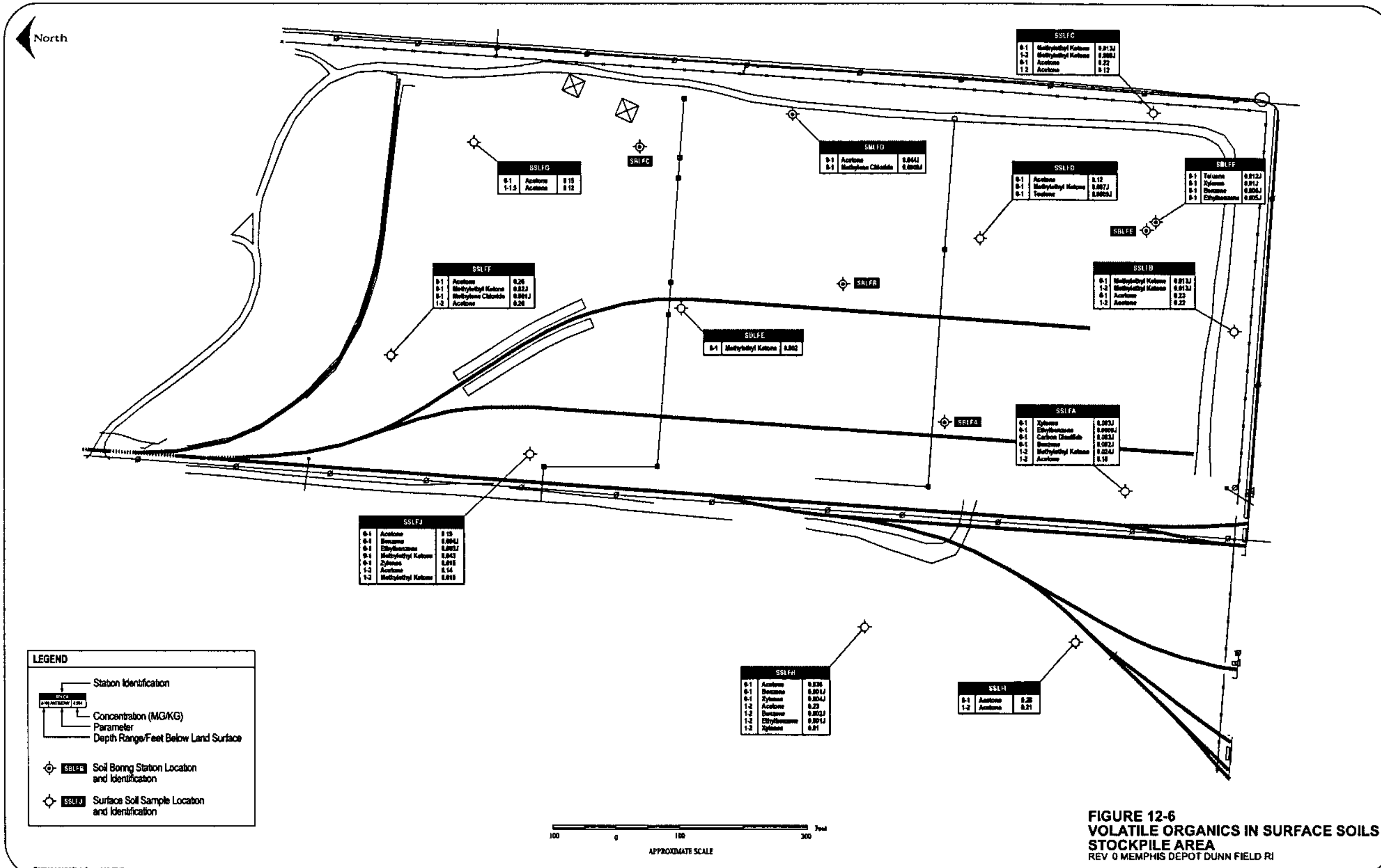
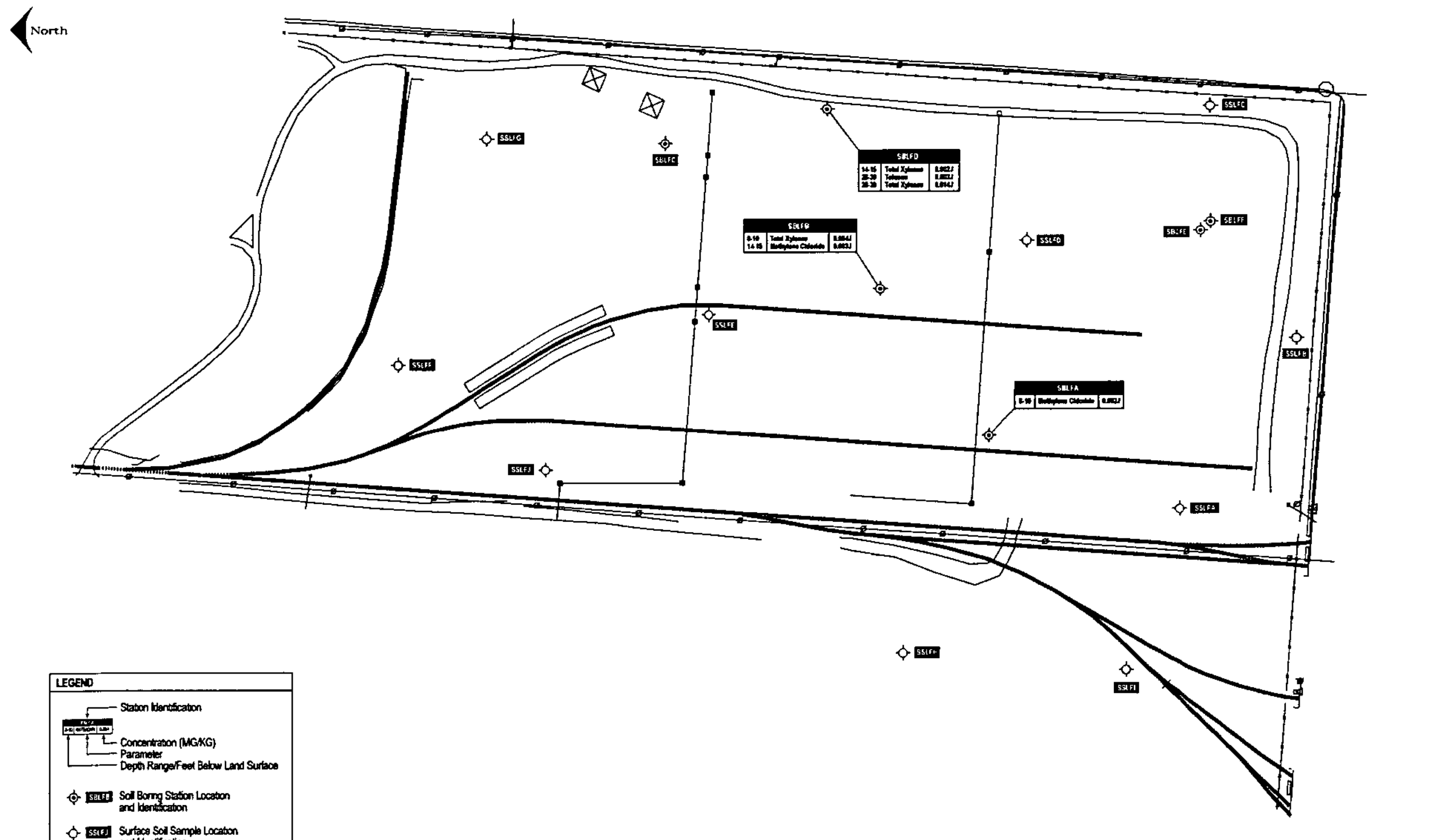


FIGURE 12-6
VOLATILE ORGANICS IN SURFACE SOILS
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL



100 0 100 300 Feet
APPROXIMATE SCALE

FIGURE 12-7
VOLATILE ORGANICS IN SUBSURFACE SOILS
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

E072001017ATL \ Dunn114.FH8

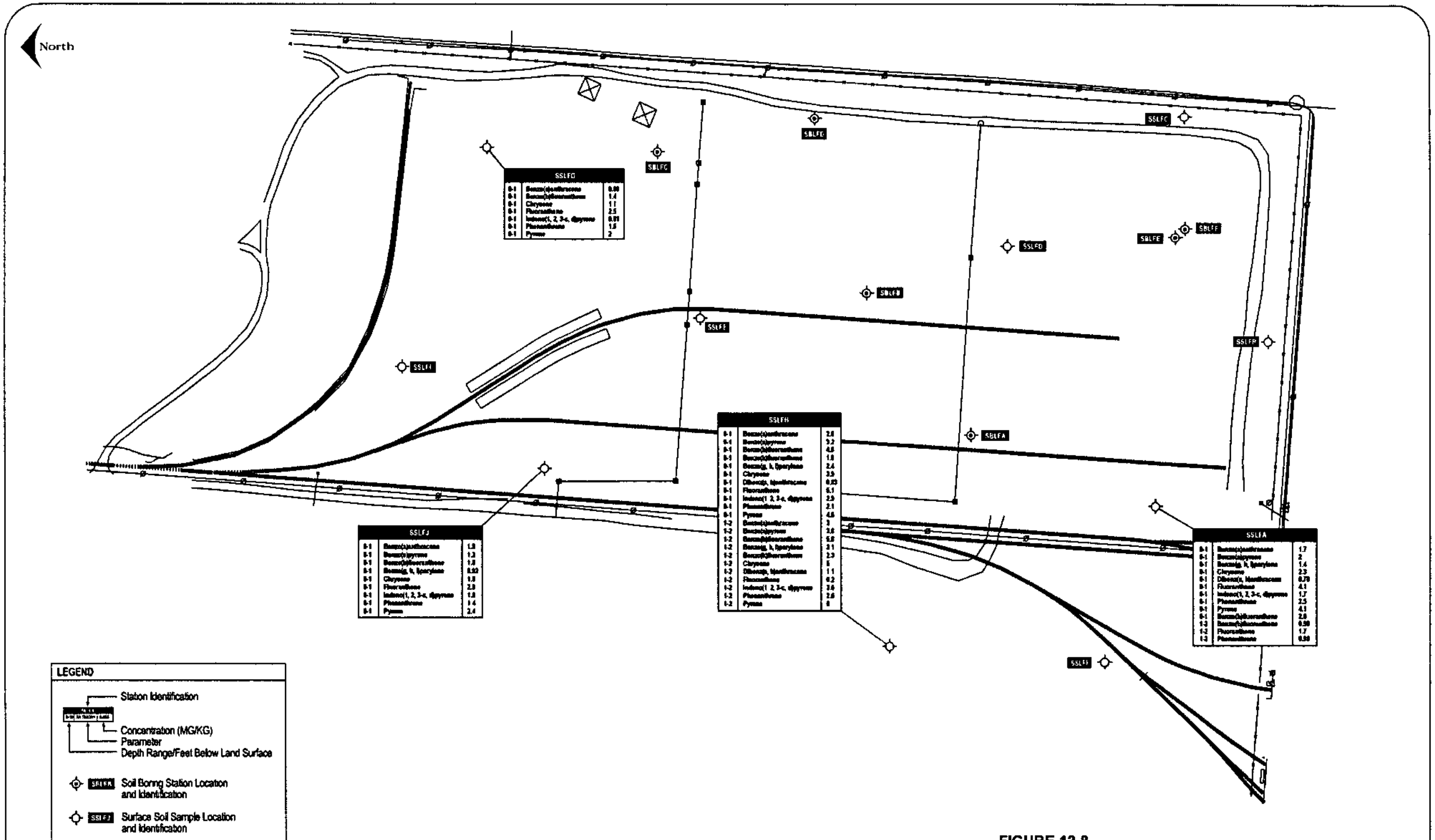


FIGURE 12-8
SVOCs ABOVE BACKGROUND IN SURFACE SOILS
STOCKPILE AREA
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

APPENDIX A-6

Figures for the Disposal Sites

579 249

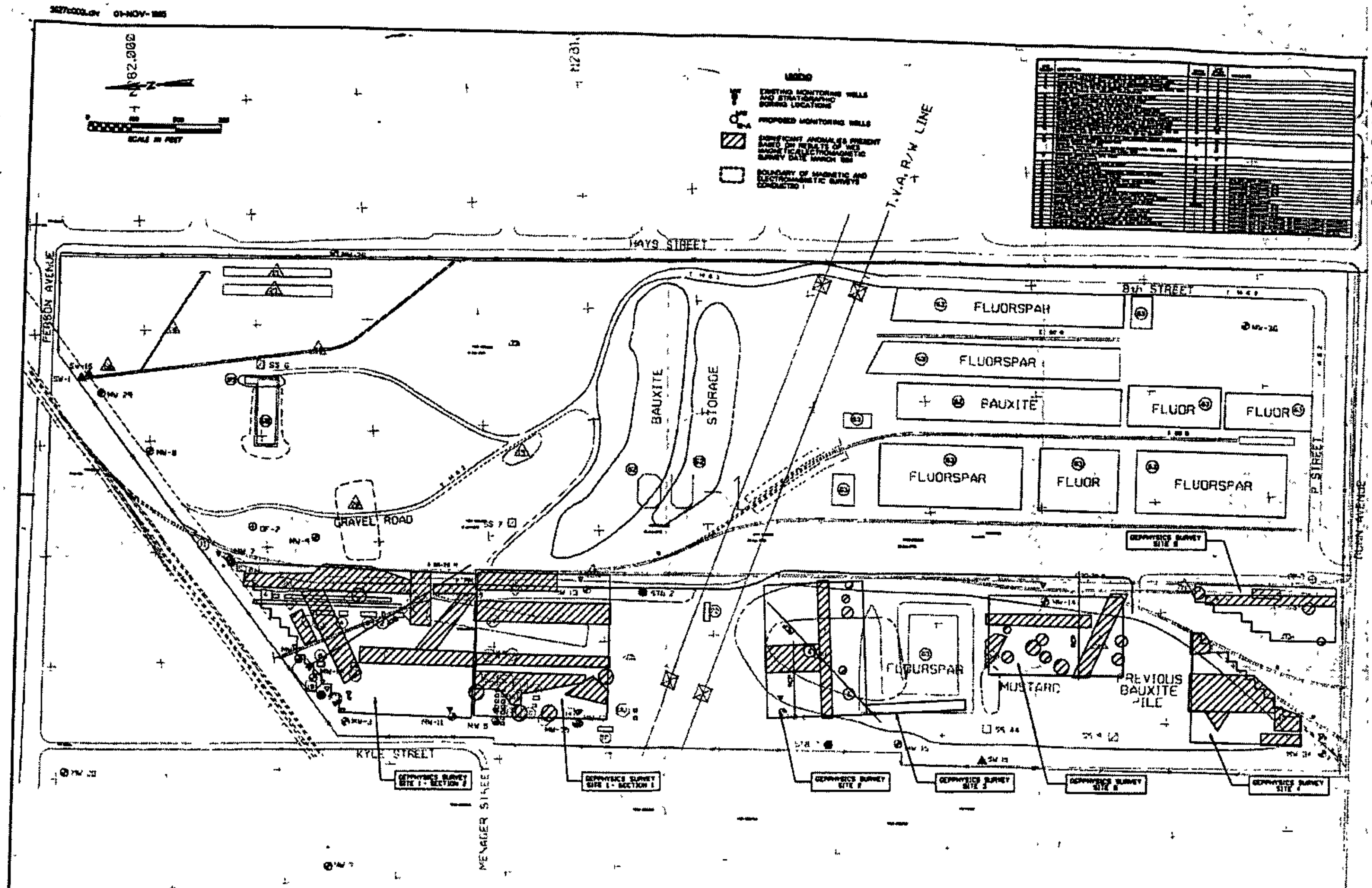
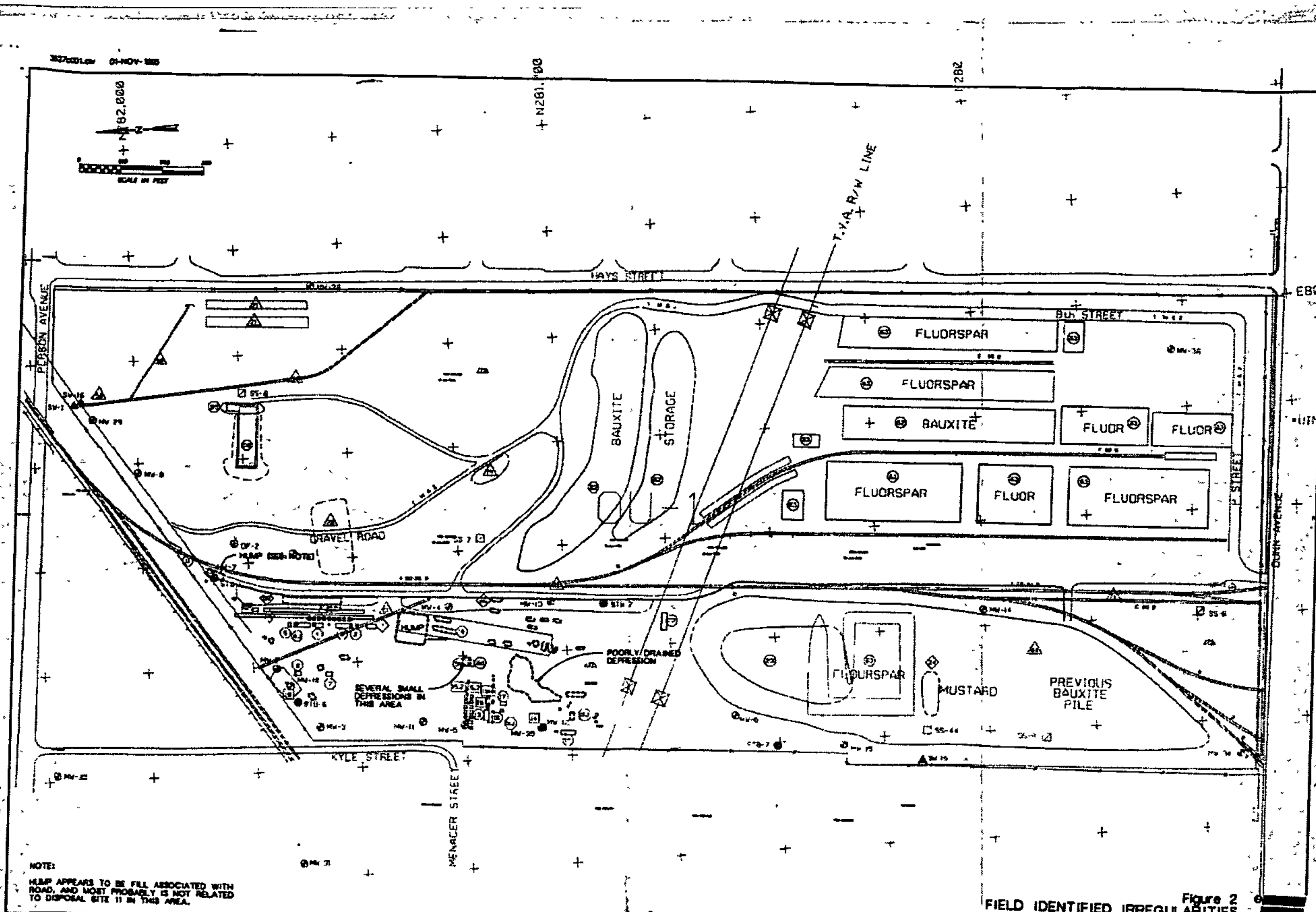


Figure 1
GEOPHYSICAL SURVEY/DISPOSAL MAP OVERLAY
Defense Depot-Memphis, Tennessee



NOTE:
HUMP APPEARS TO BE FILL ASSOCIATED WITH ROAD, AND MOST PROBABLY IS NOT RELATED TO DISPOSAL SITE 11 IN THIS AREA.

Figure 2
FIELD IDENTIFIED IRREGULARITIES
Defense Depot-Memphis, Tennessee

579 251

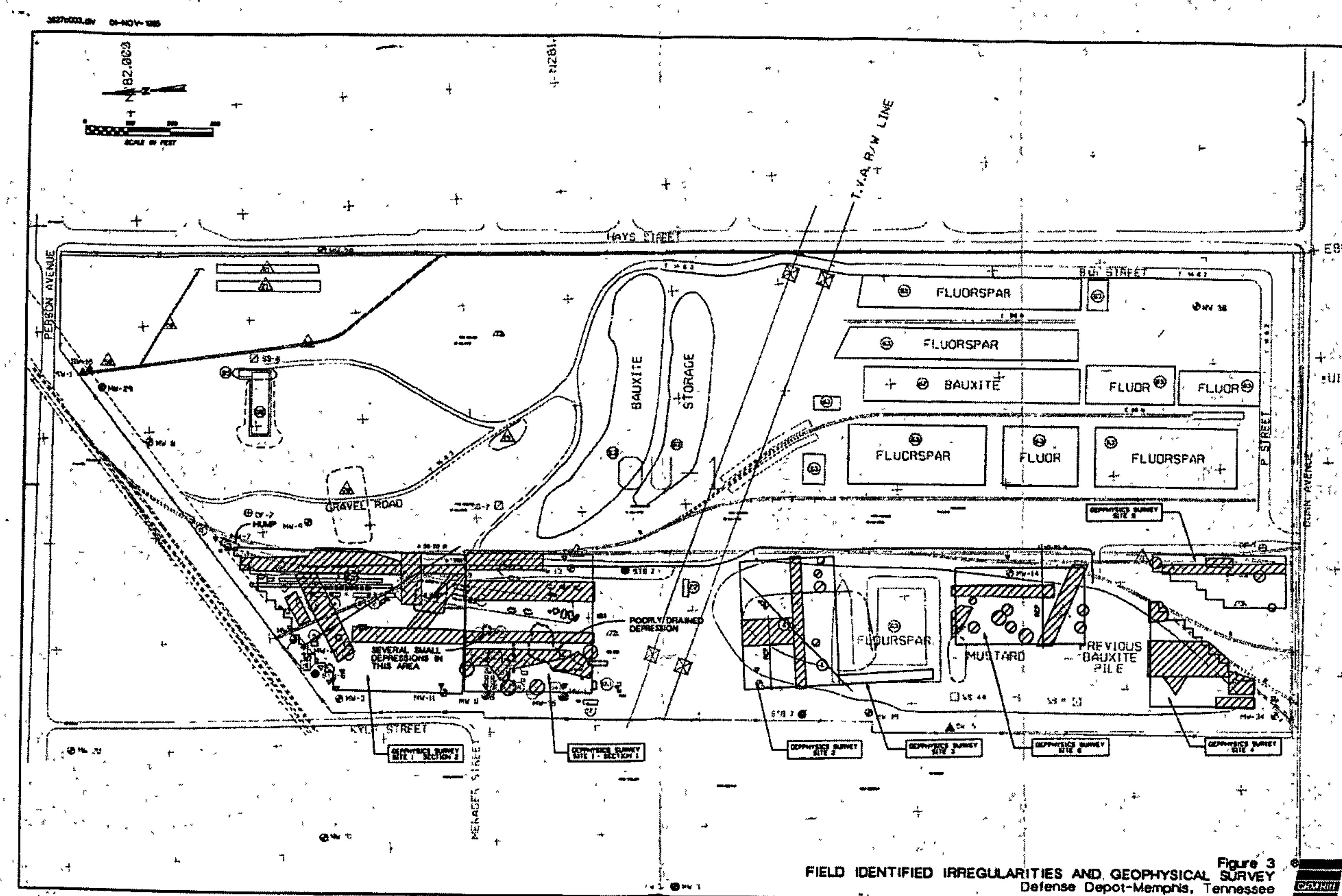
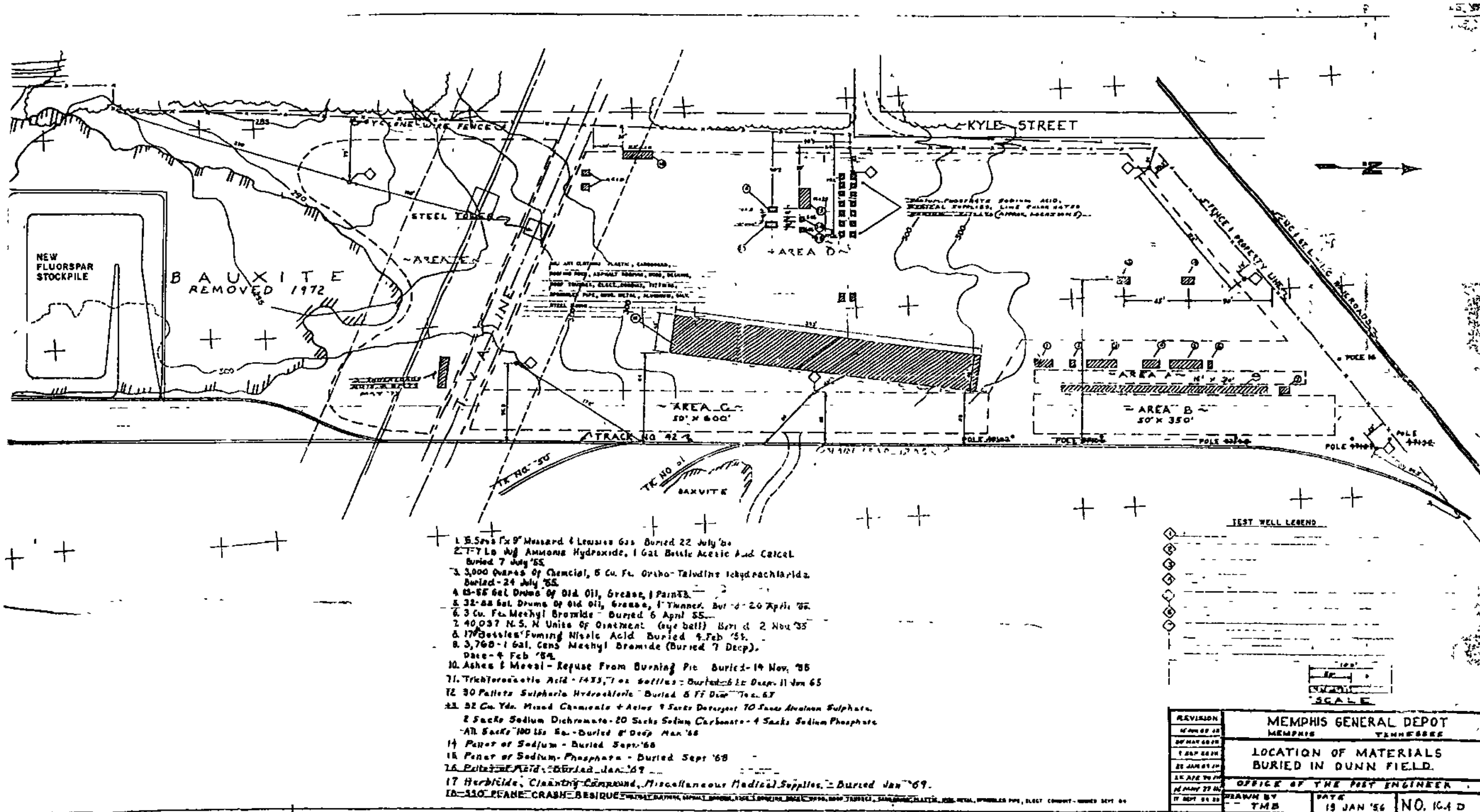


Figure 3
FIELD IDENTIFIED IRREGULARITIES AND GEOPHYSICAL SURVEY
Defense Depot-Memphis, Tennessee


KYLE STREET
CYCLONE WIRE FENCE
FENCE & PROPERTY LINE
FENCE & ST. L. - I.C. RAILROADS
STEEL TOWER
T.V.A. LINE
AREA A
AREA B 50' x 350'
AREA C 50' x 600'
AREA D
AREA E
TRACK NO 42
BAUXITE REMOVED 1972
BAUXITE
NEW FLUORSPAR STOCKPILE
POLE 14
TEST WELL LEGEND
SCALE
1. 5 Sets 1"x 9" Mustard & Lewisite Gas Buried 22 July '55
2. 1-7 Lb Jug Ammonia Hydroxide, 1 Gal Bottle Acetic Acid Calcel Buried 7 July '55
3. 3,000 Quarts Of Chemical, 5 Cu. Ft. Ortho-Toluidine Dihydrochloride. Buried - 24 July '55
4. 13-55 Gal Drums Of Old Oil, Grease, & Paints.
5. 32-55 Gal. Drums Of Old Oil, Grease, & Thinner. Buried - 20 April '55
6. 3 Cu. Ft. Methyl Bromide - Buried 6 April '55
7. 40,037 N.S. N Units Of Ointment (eye ball) Buried 2 Nov '55
8. 17 Bottles Fuming Nitric Acid Buried 4 Feb '55.
9. 3,768 - 1 Gal. Cans Methyl Bromide (Buried 7 Deep). Date - 4 Feb '54.
10. Ashes & Metal - Refuse From Burning Pit Buried - 14 Nov. '55
11. Trichloroacetic Acid - 1433, 1 oz Bottles - Buried 6 Ft Deep - 11 Jan 65
12. 30 Pallets Sulphuric Hydrochloric Buried 6 Ft Deep - Jan. 67
13. 32 Cu. Yds. Mixed Chemicals + Acids 9 Sacks Detergent 70 Sacks Aluminum Sulphate. 2 Sacks Sodium Dichromate - 20 Sacks Sodium Carbonate - 4 Sacks Sodium Phosphate. - All Sacks 100 Lbs Ea. - Buried 8' Deep Mar '68
14. Pallet of Sodium - Buried Sept '68
15. Pallet of Sodium - Phosphate - Buried Sept '68
16. Pallet of Acid - Buried Jan '69
17. Herbicide, Cleaning Compound, Miscellaneous Medical Supplies. - Buried Jan '69.
18. 550 PLANE CRASH RESIDUE
MEMPHIS GENERAL DEPOT
MEMPHIS TENNESSEE
LOCATION OF MATERIALS BURIED IN DUNN FIELD
OFFICE OF THE POST ENGINEER
REVISION
DRAWN BY TMB
DATE 19 JAN '56
NO. 164 D

579 253

APPENDIX A-7

Groundwater Plume Maps from the Dunn Field RI Report (July 2002)

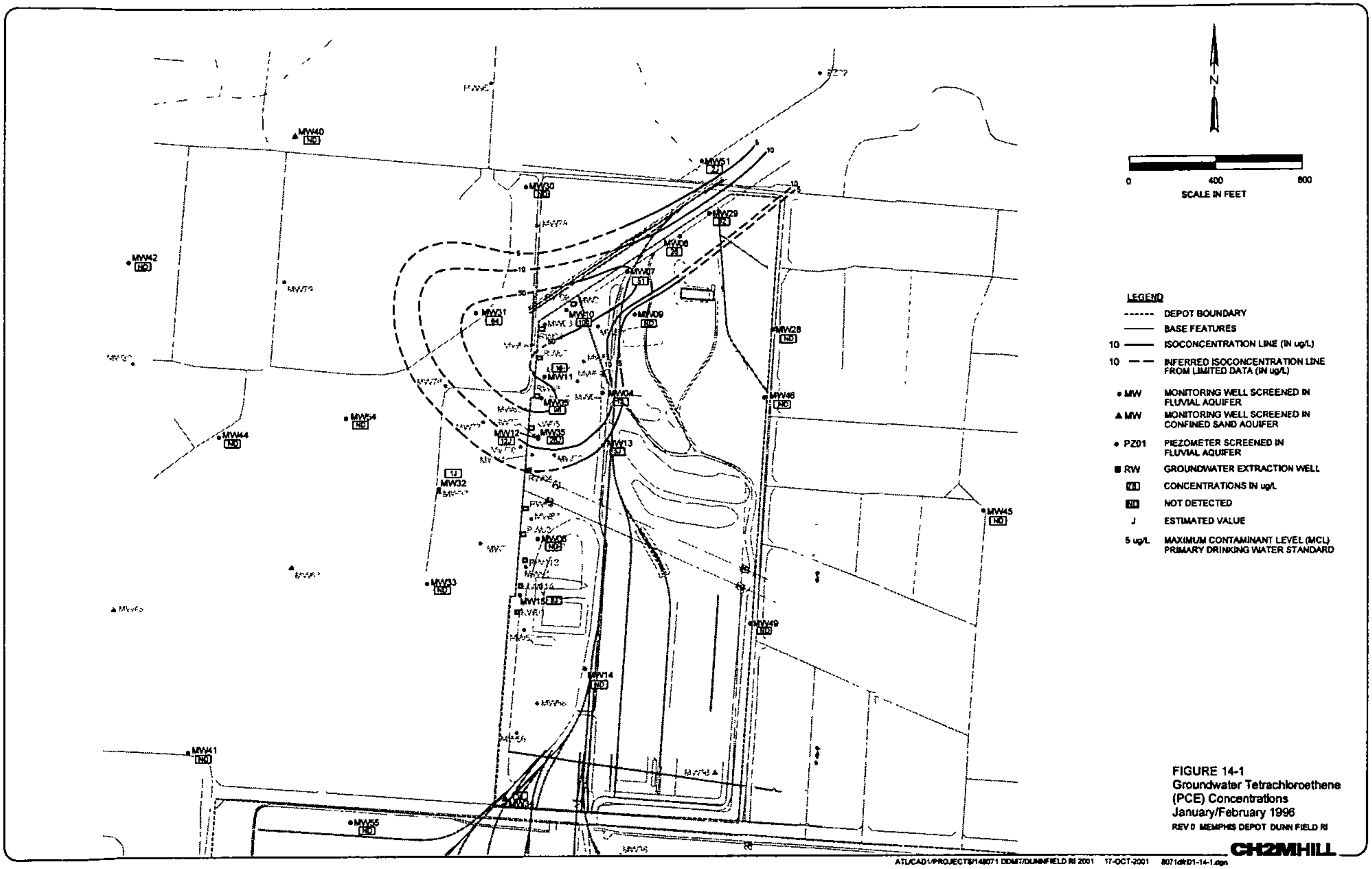
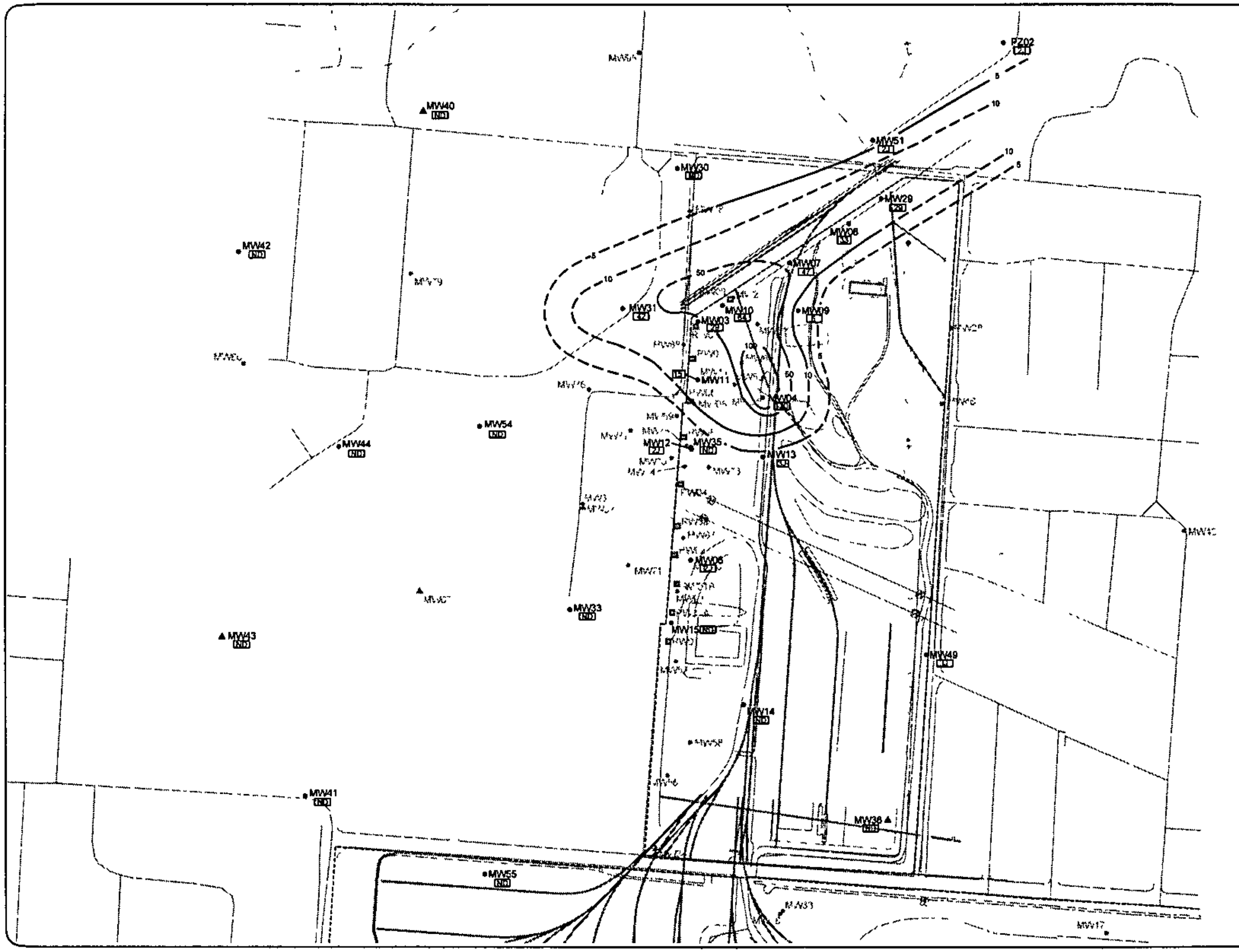


FIGURE 14-1
Groundwater Tetrachloroethene (PCE) Concentrations
January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfrf01-14-1.dgn



N

0 400 800
SCALE IN FEET

LEGEND

------	DEPOT BOUNDARY
——	BASE FEATURES
10 ——	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
● MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	GROUNDWATER EXTRACTION WELL
● PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
78	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER
5 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-2
Groundwater Tetrachloroethene(PCE)
Concentrations - October 1998
REV 0 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01 14-2.dgn

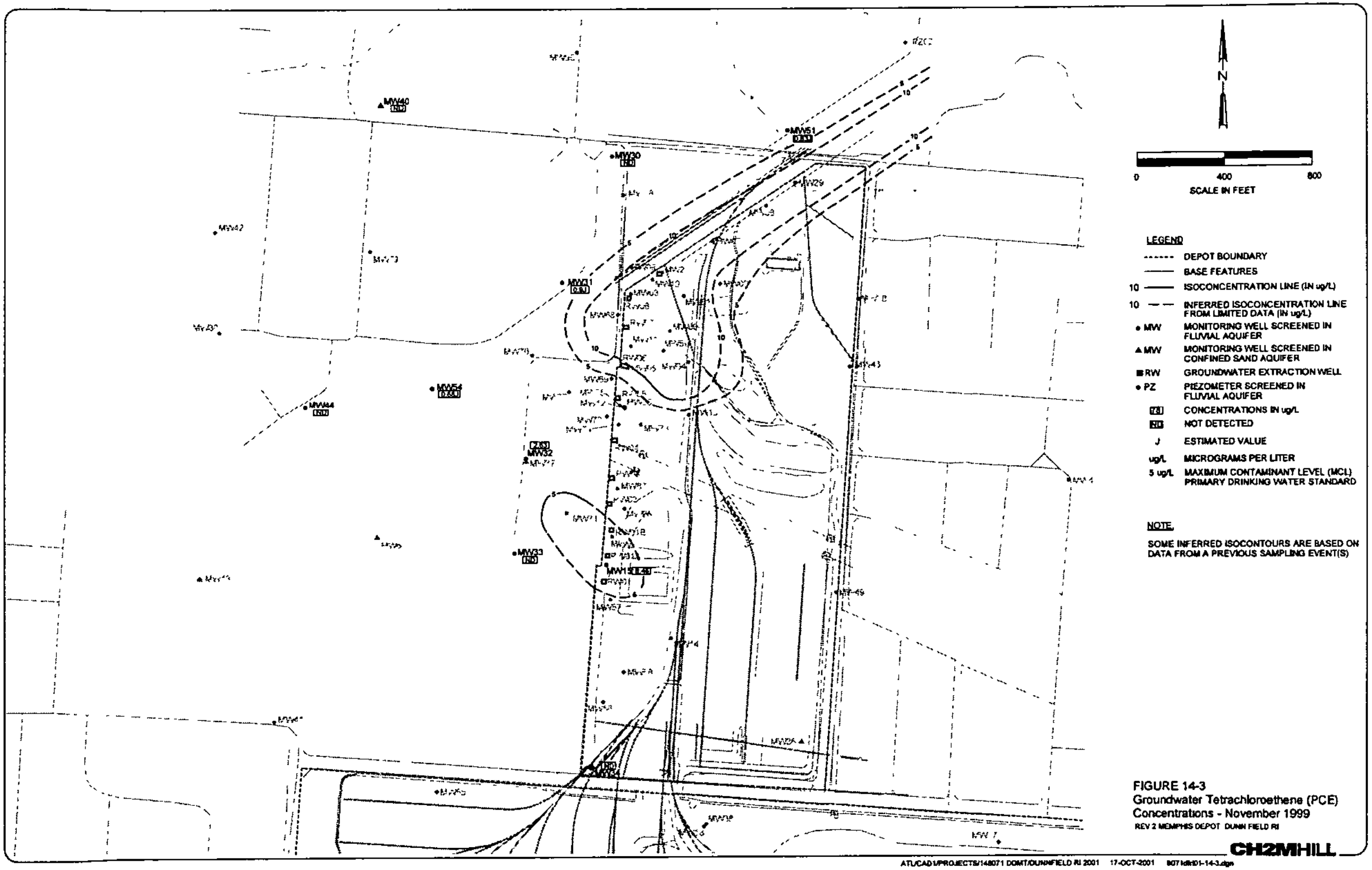
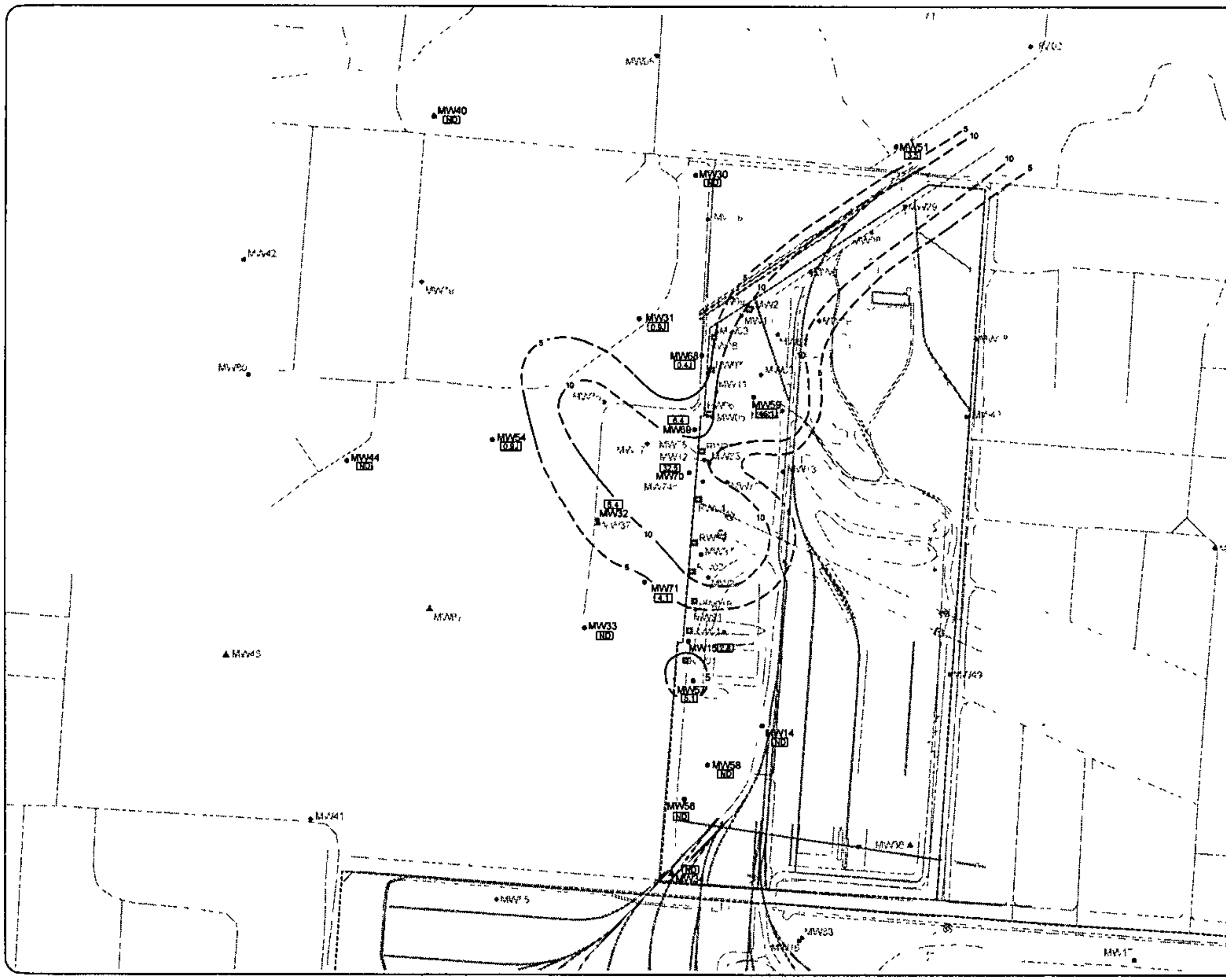


FIGURE 14-3
Groundwater Tetrachloroethene (PCE) Concentrations - November 1999
REV 2 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 907 Idfri01-14-3.dgn



N

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW GROUNDWATER EXTRACTION WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-4
Groundwater Tetrachloroethene (PCE) Concentrations - November 2000
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 5071dfrl01-14-4.dgn

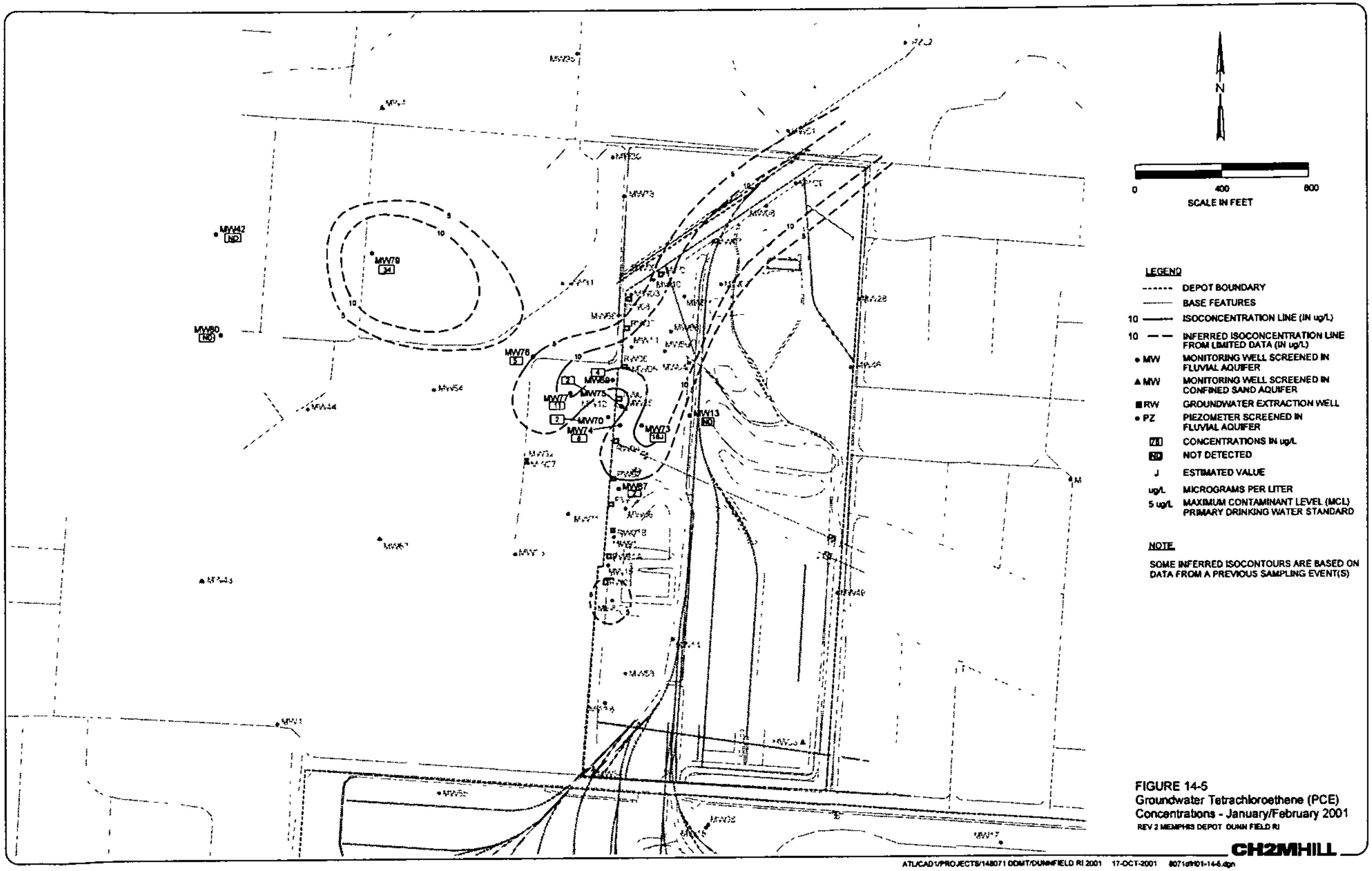
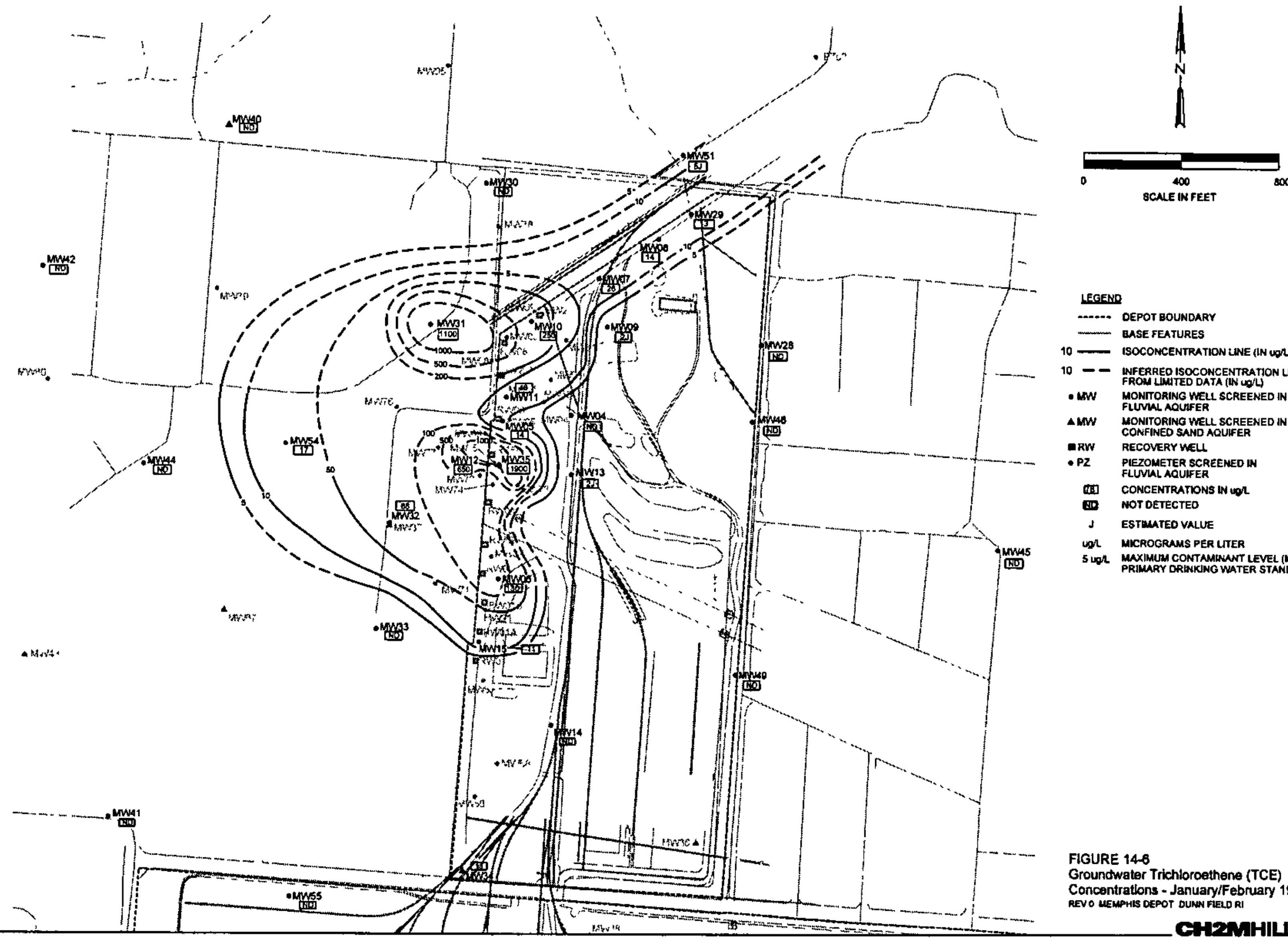


FIGURE 14-5
Groundwater Tetrachloroethene (PCE) Concentrations - January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

579 259



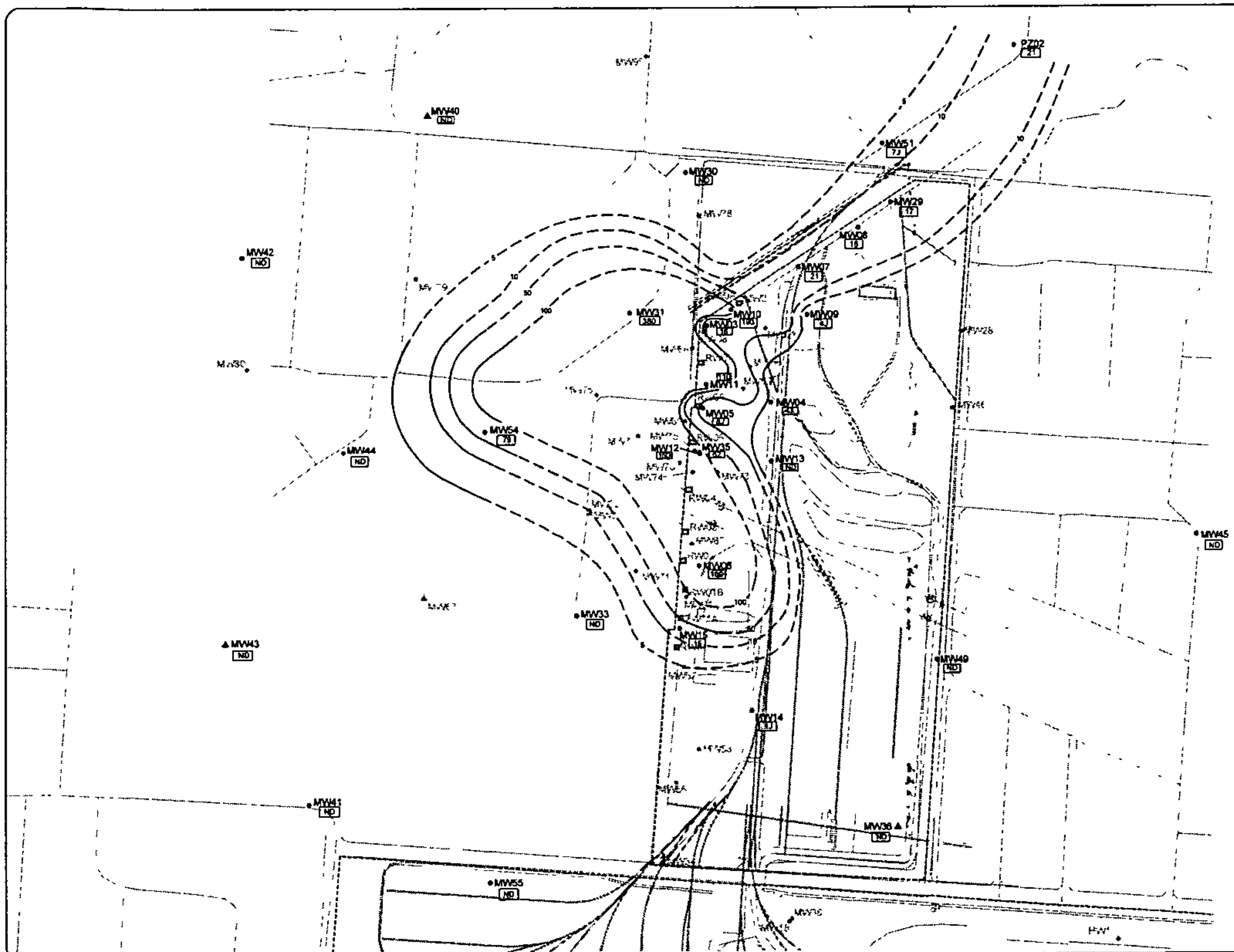
LEGEND

- ------ DEPOT BOUNDARY
- ——— BASE FEATURES
- 10 ——— ISOCONCENTRATION LINE (IN ug/L)
- 10 — — INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- ● MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- ● PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- [78] CONCENTRATIONS IN ug/L
- [ND] NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-6
Groundwater Trichloroethene (TCE)
Concentrations - January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfr01-14-6.dgn



N

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- 78 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

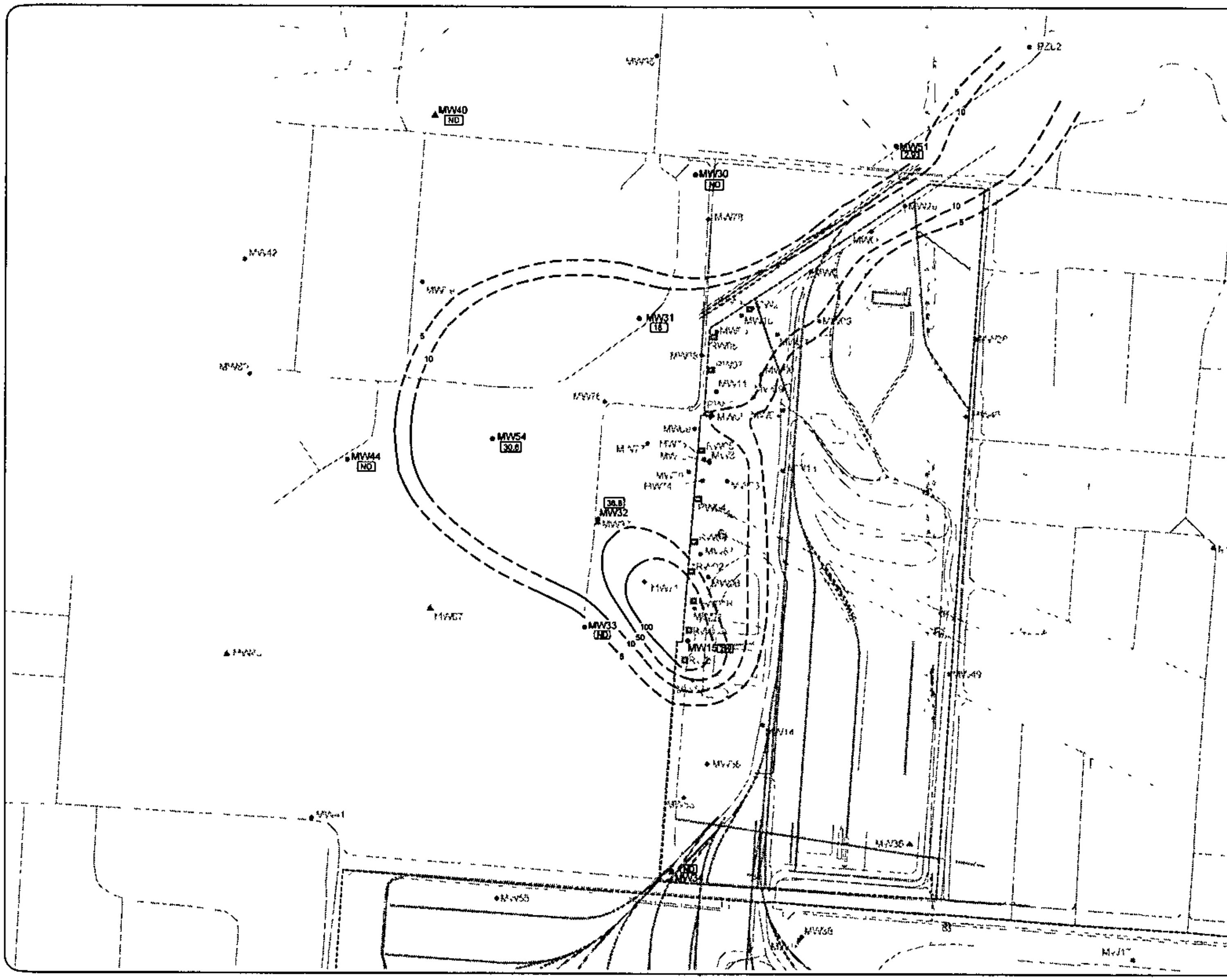
NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-7
Groundwater Trichloroethene (TCE) Concentrations - October 1998
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfrD1-14-7.dgn



0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- 7.8 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-8
Groundwater Trichloroethene (TCE)
Concentrations - November 1999
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATLCAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01-14-8.dgn

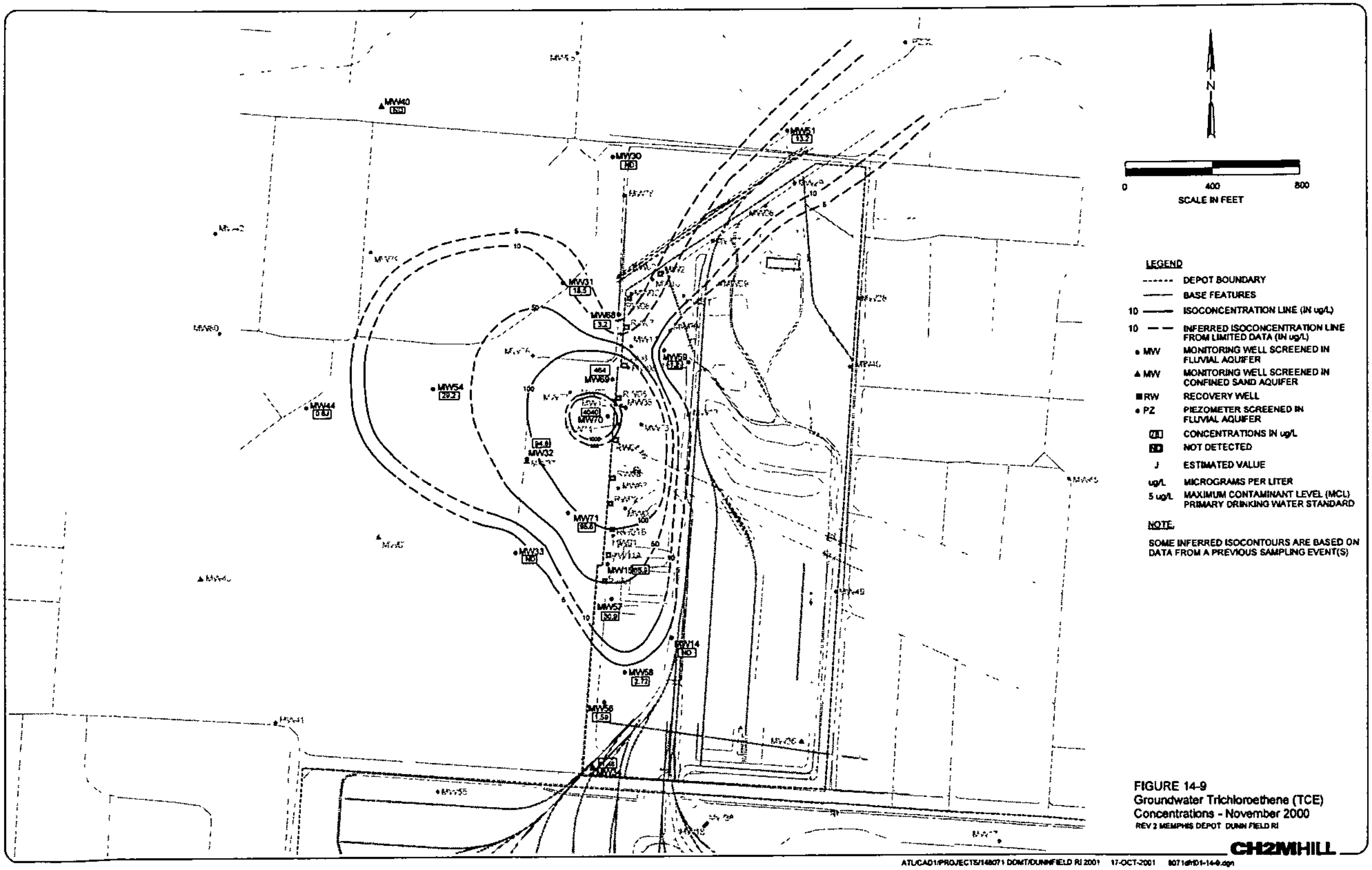


FIGURE 14-9
Groundwater Trichloroethene (TCE) Concentrations - November 2000
REV 2 MEMPHIS DEPOT DUNN FIELD RI

579 263

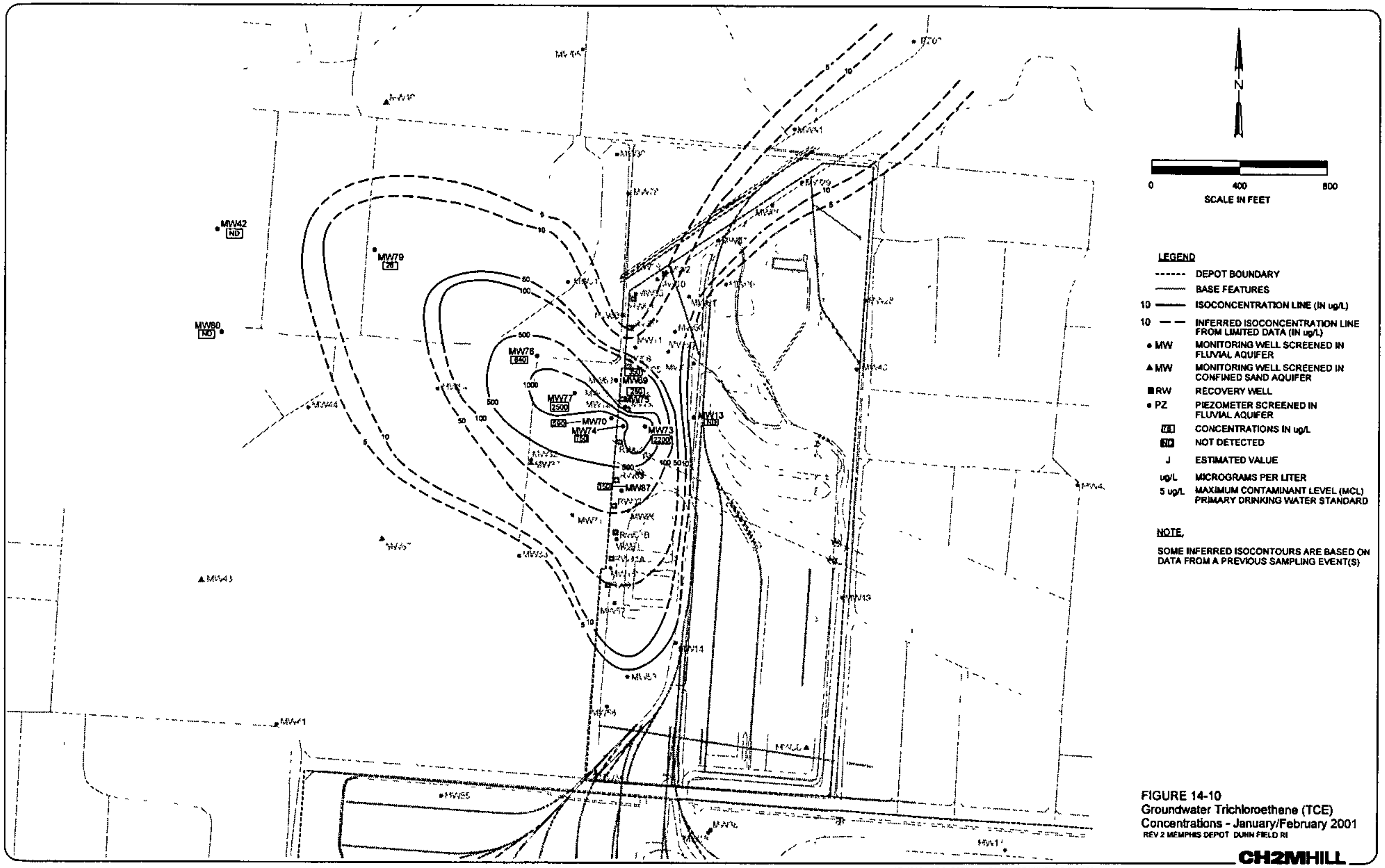


FIGURE 14-10
Groundwater Trichloroethene (TCE)
Concentrations - January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-MARCH-2002 8071dRI01-14-10.dgn

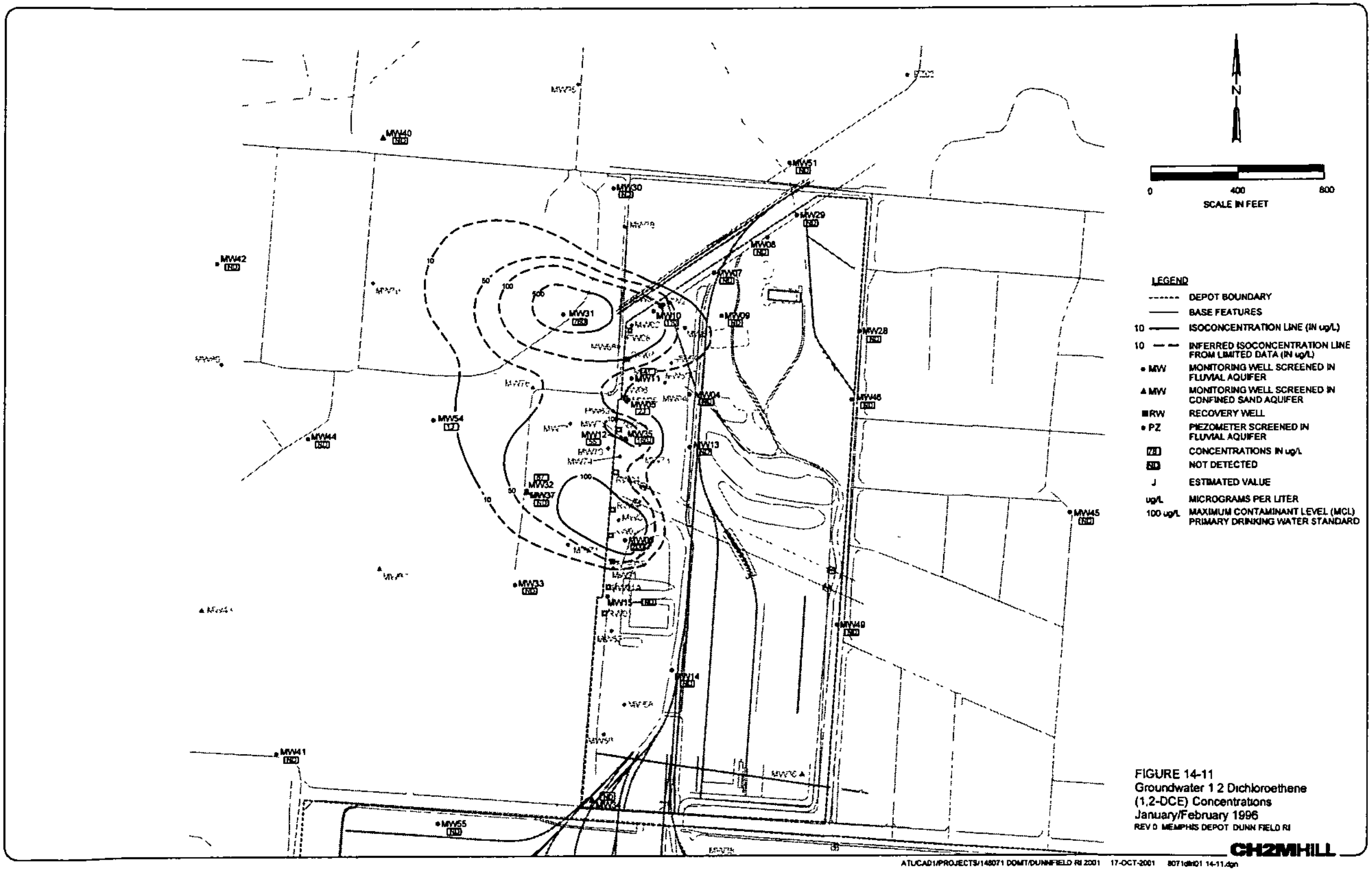


FIGURE 14-11
Groundwater 1 2 Dichloroethene
(1,2-DCE) Concentrations
January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

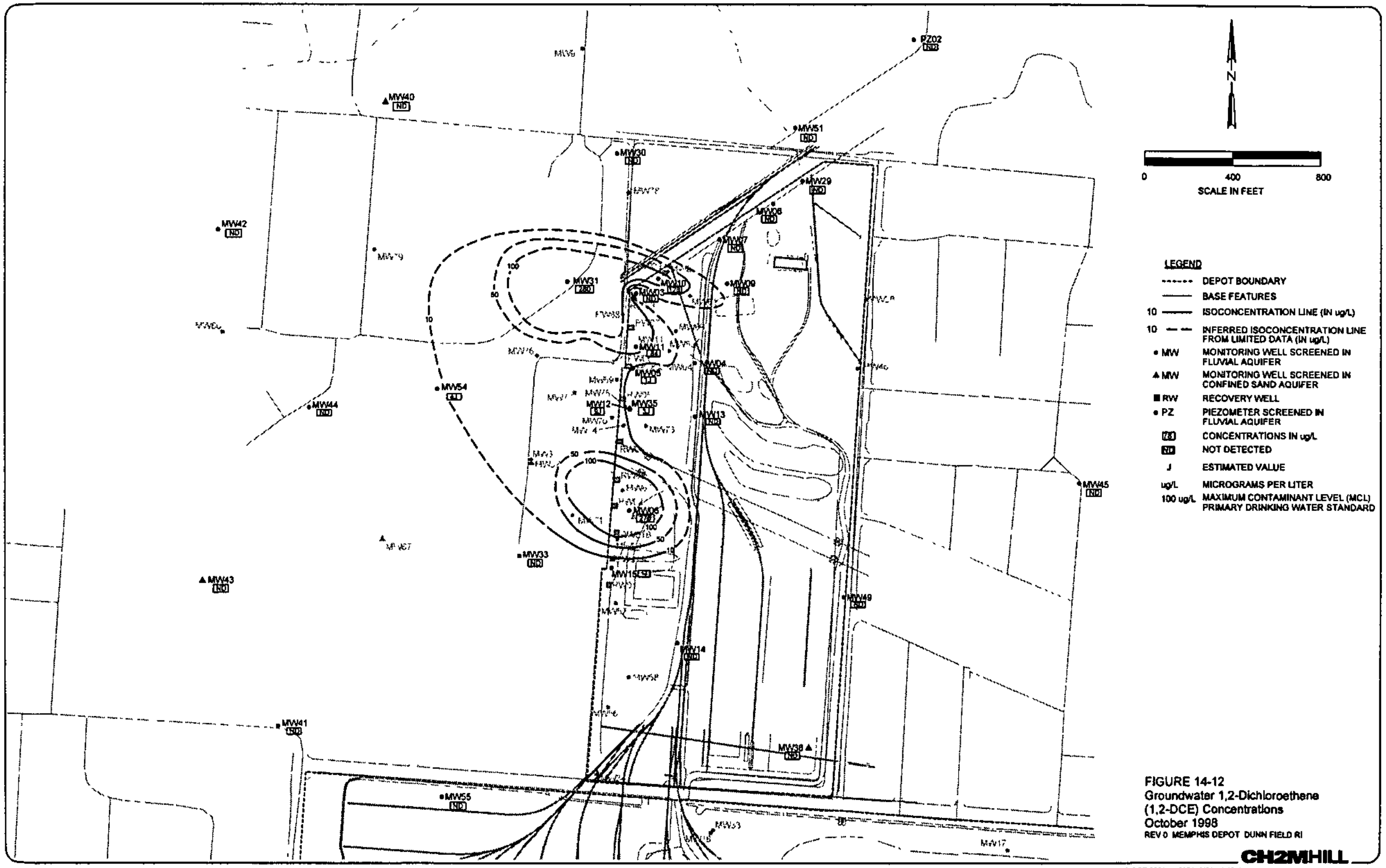
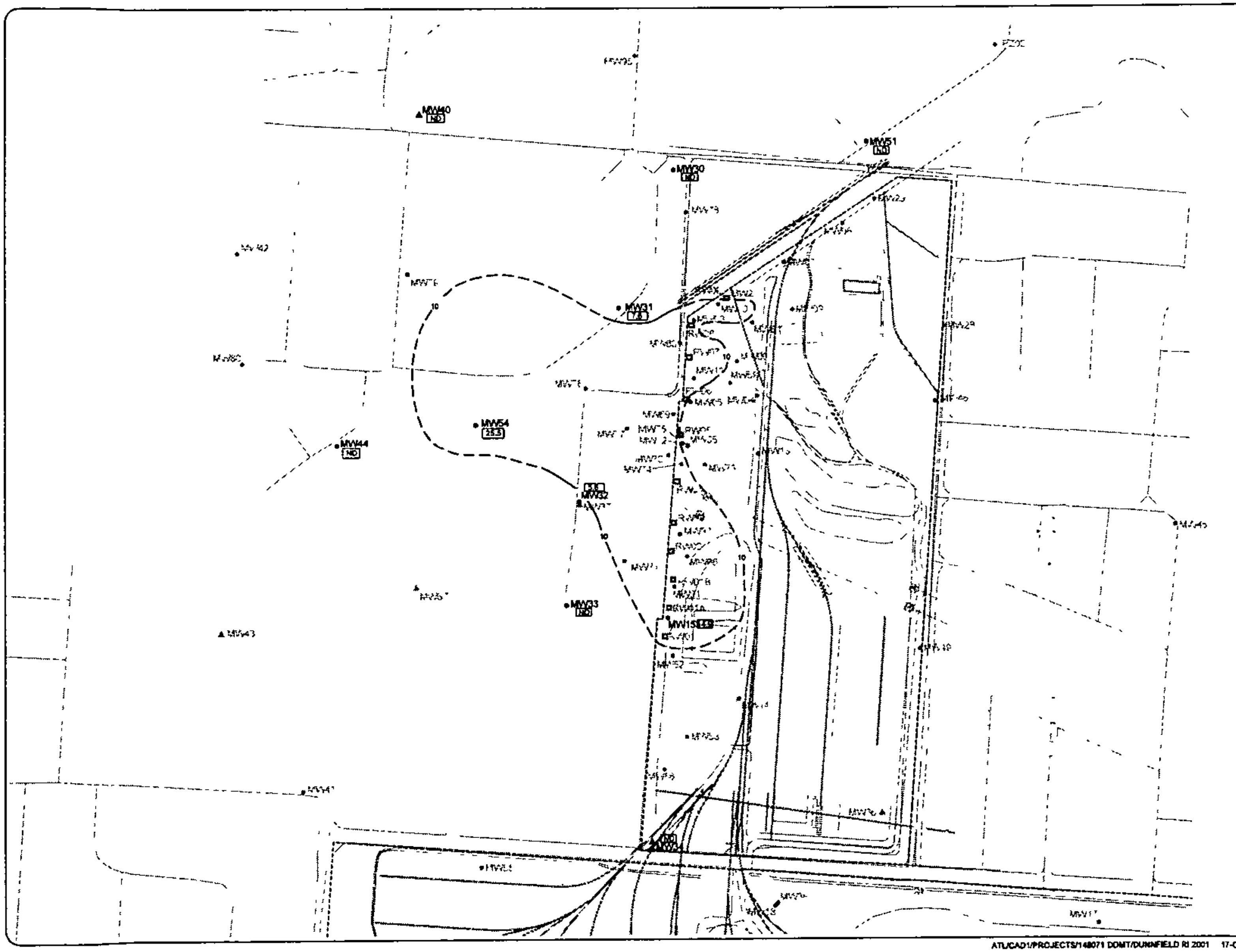


FIGURE 14-12
Groundwater 1,2-Dichloroethene
(1,2-DCE) Concentrations
October 1998
REV 0 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01-14-12.dgn



N

0 400 800
SCALE IN FEET

LEGEND

------	DEPOT BOUNDARY
——	BASE FEATURES
10 ——	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
● MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	RECOVERY WELL
● PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
7.8	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER
100 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

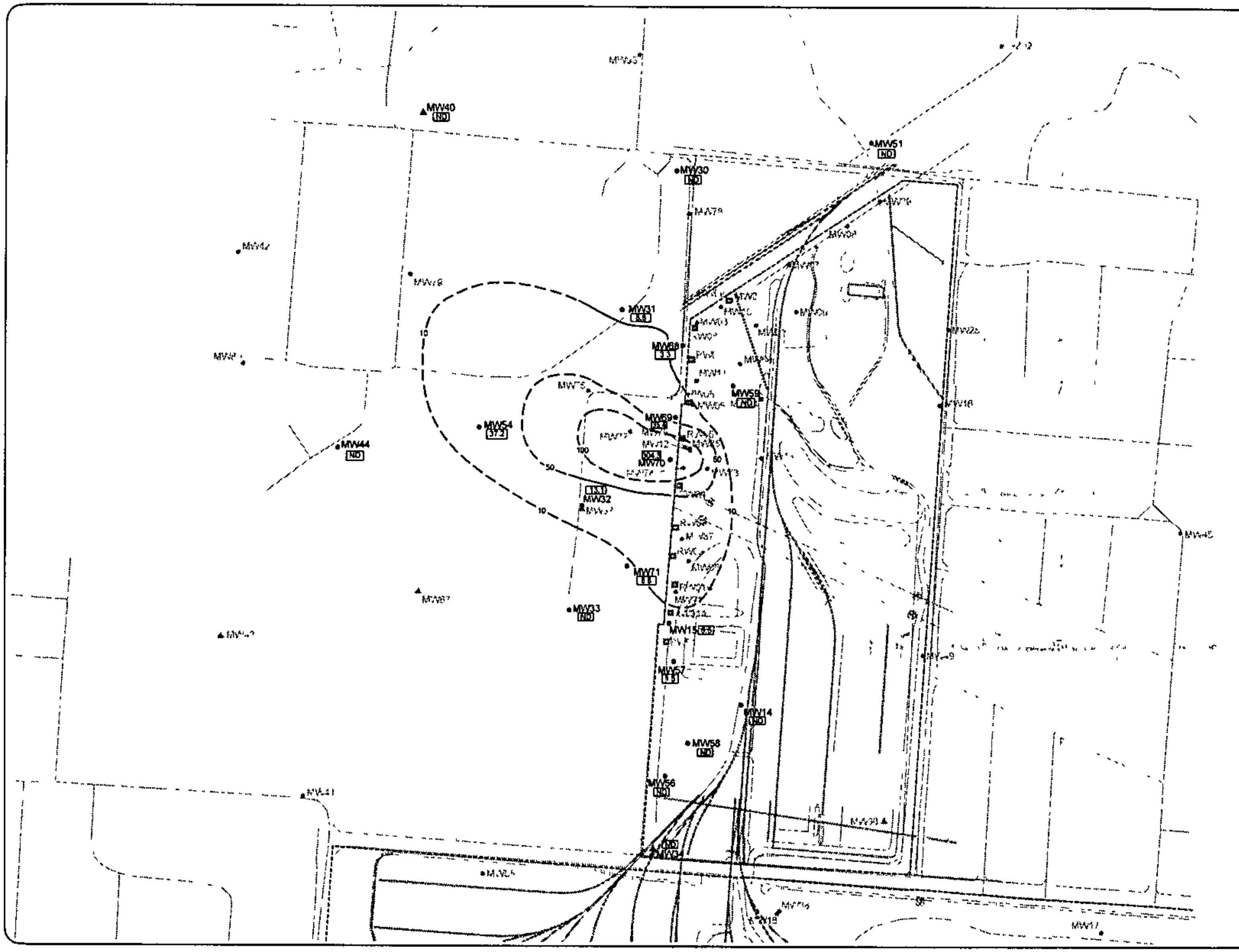
SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-13
Groundwater 1,2-Dichloroethene (1,2-DCE) Concentrations
November 1999
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dn01-14-13.dgn

579 267



0 400 800
SCALE IN FEET

LEGEND

------	DEPOT BOUNDARY
——	BASE FEATURES
10 ——	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
• MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	RECOVERY WELL
• PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
73	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER
100 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-14
Groundwater 1,2-Dichloroethene (1,2-DCE) Concentrations
November 2000
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01-14-14.dgn

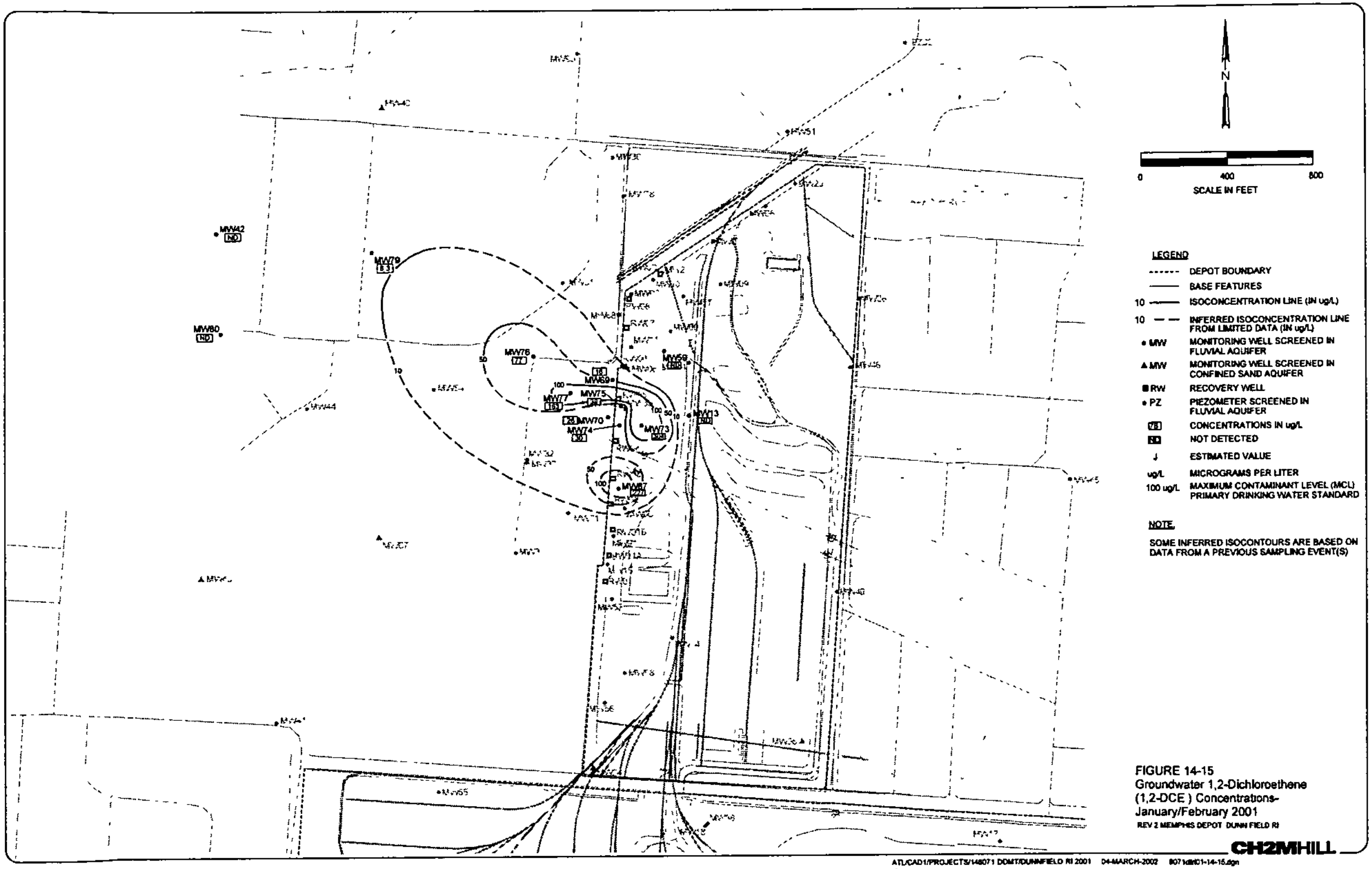


FIGURE 14-15
Groundwater 1,2-Dichloroethene (1,2-DCE) Concentrations-January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-MARCH-2002 807 kdrl01-14-15.dgn

579 269

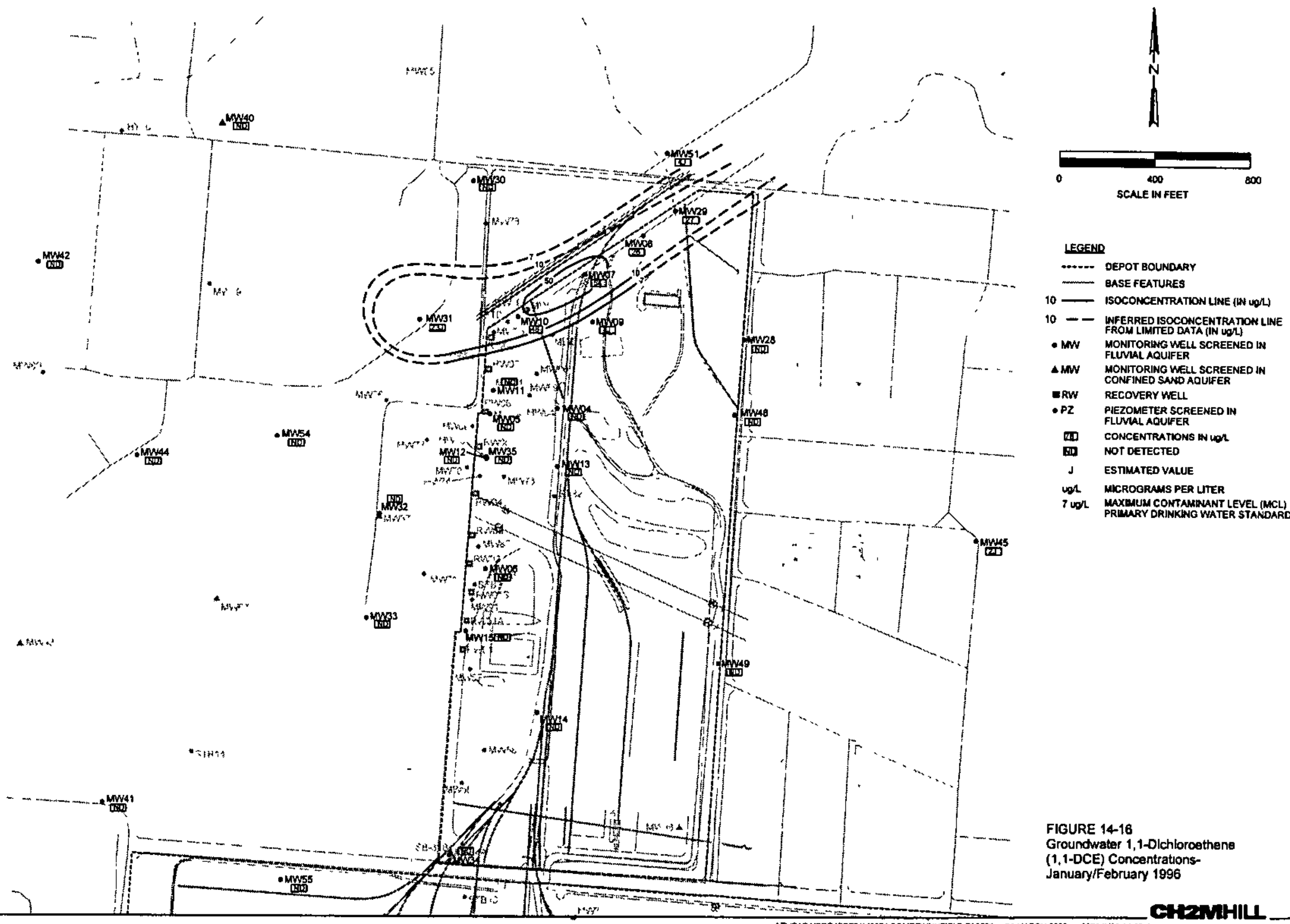
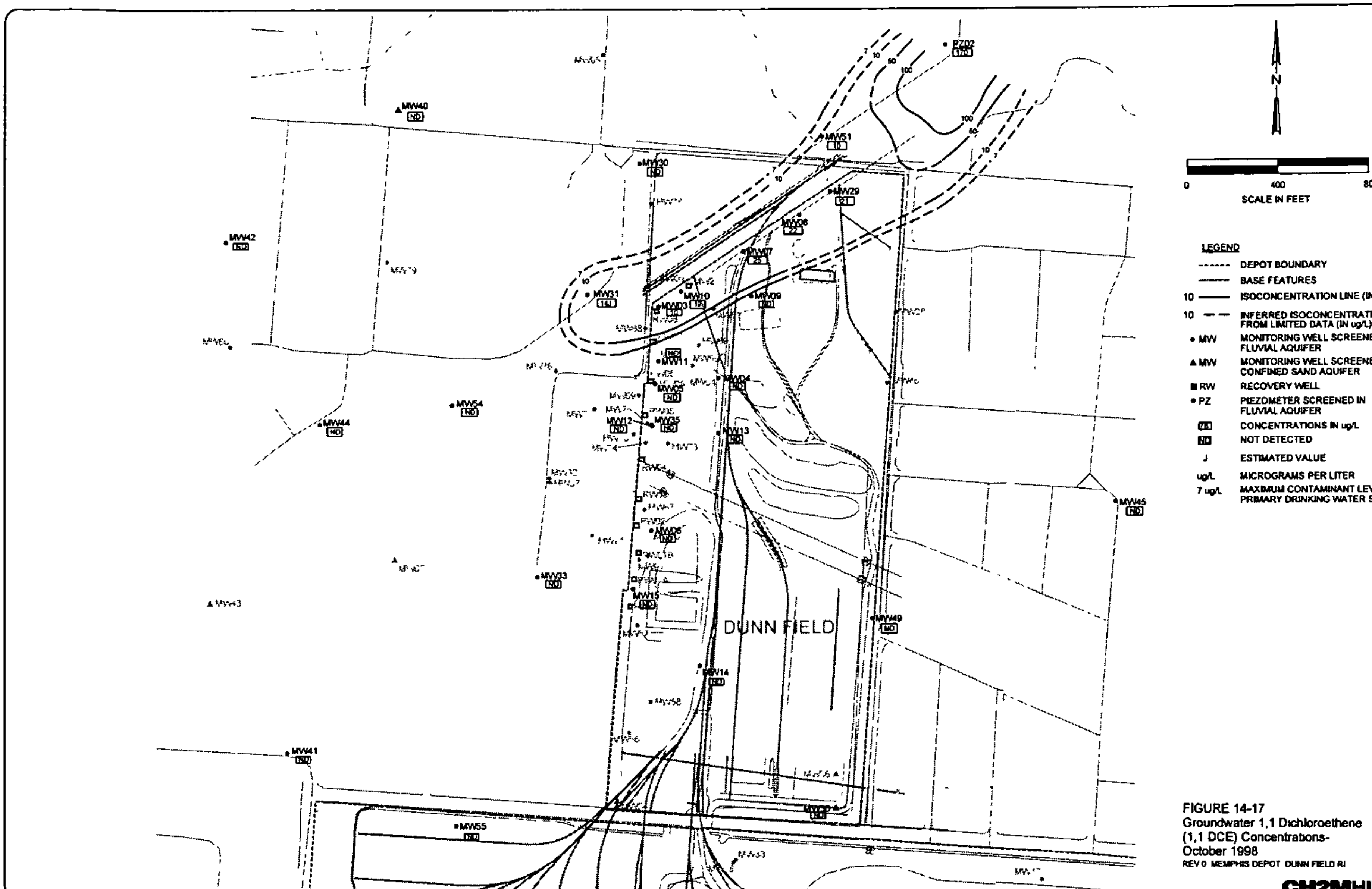


FIGURE 14-16
Groundwater 1,1-Dichloroethene (1,1-DCE) Concentrations-January/February 1996

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-MARCH-2002 8071dlt01-14-16.dgn



LEGEND

- - - - - -	DEPOT BOUNDARY
————	BASE FEATURES
10 ————	ISOCONCENTRATION LINE (IN ug/L)
10 — — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
• MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	RECOVERY WELL
• PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
78	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER
7 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-17
Groundwater 1,1 Dichloroethene (1,1 DCE) Concentrations-October 1998
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dn01-14-17.dgn

N

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- 78 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 7 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-18
Groundwater 1,1-Dichloroethene (1,1-DCE) Concentrations- November 1999
REV 2 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01-14-18.dgn

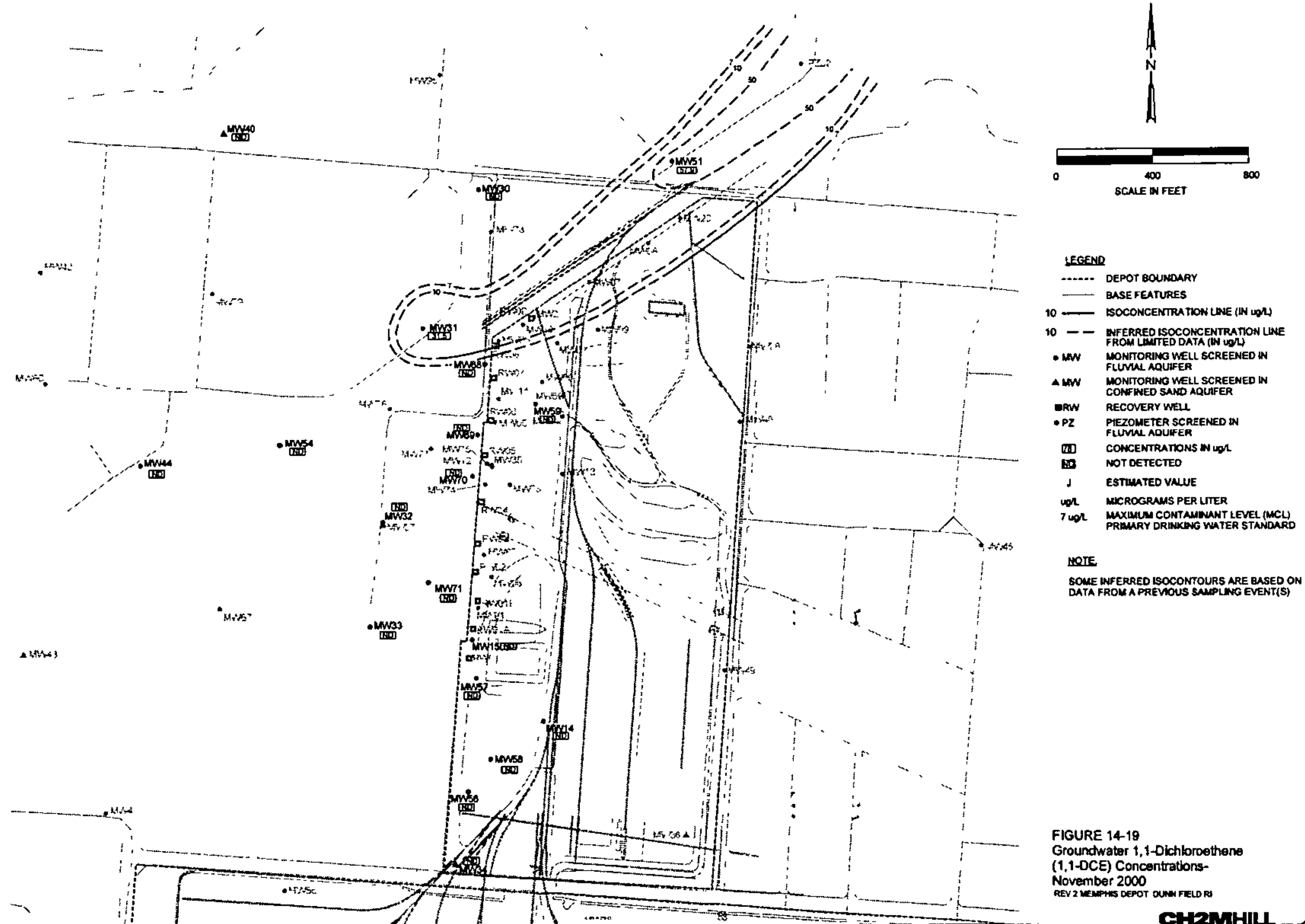


FIGURE 14-19
Groundwater 1,1-Dichloroethene (1,1-DCE) Concentrations-November 2000
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dRD1-14-19.dgn

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- 78 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 7 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-20
Groundwater 1,1-Dichloroethene (1,1-DCE) Concentrations-
January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dH01-14-20 dgn

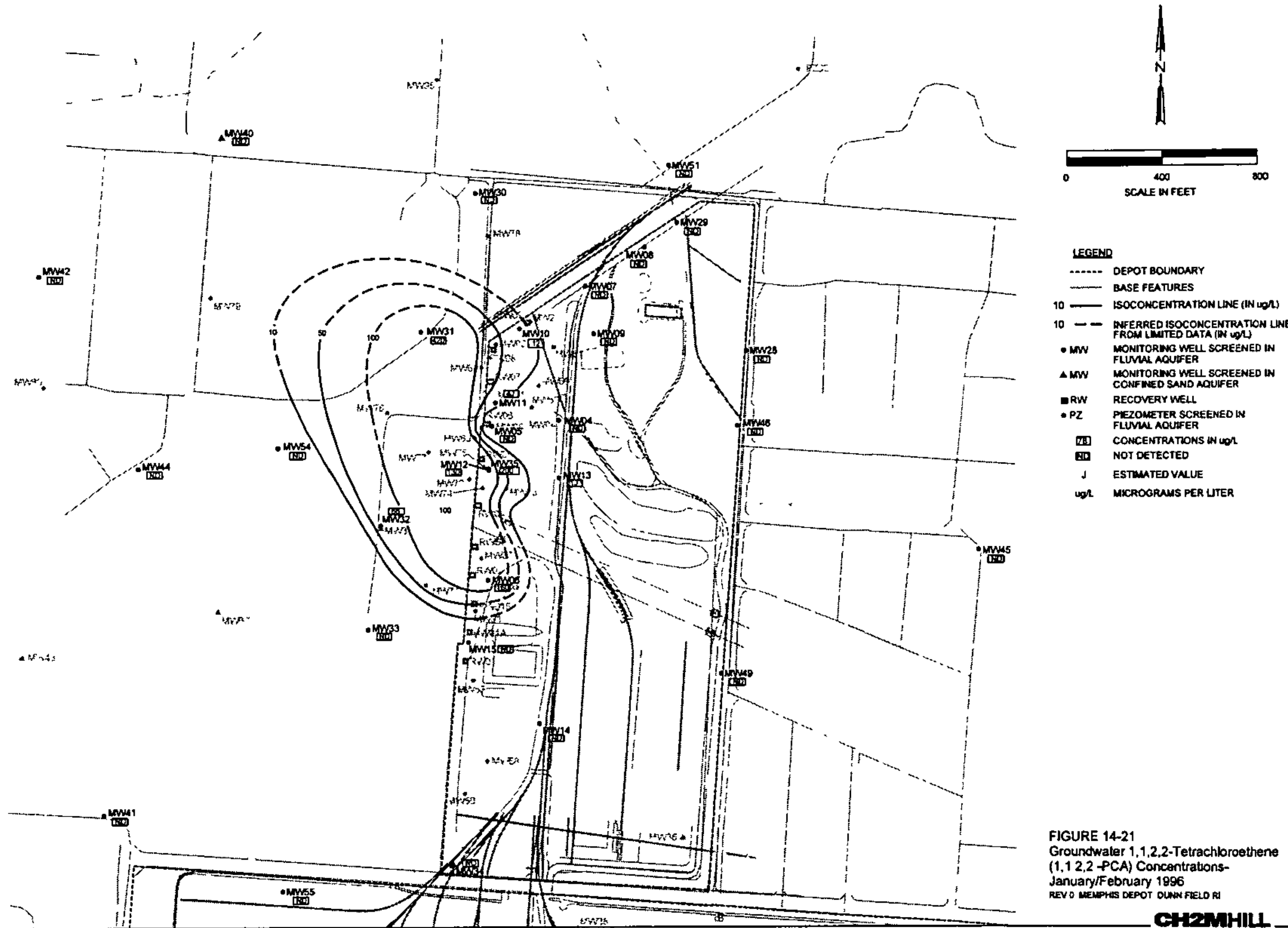


FIGURE 14-21
Groundwater 1,1,2,2-Tetrachloroethene (1,1 2,2 -PCA) Concentrations-January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dRD1 14-21.dgn

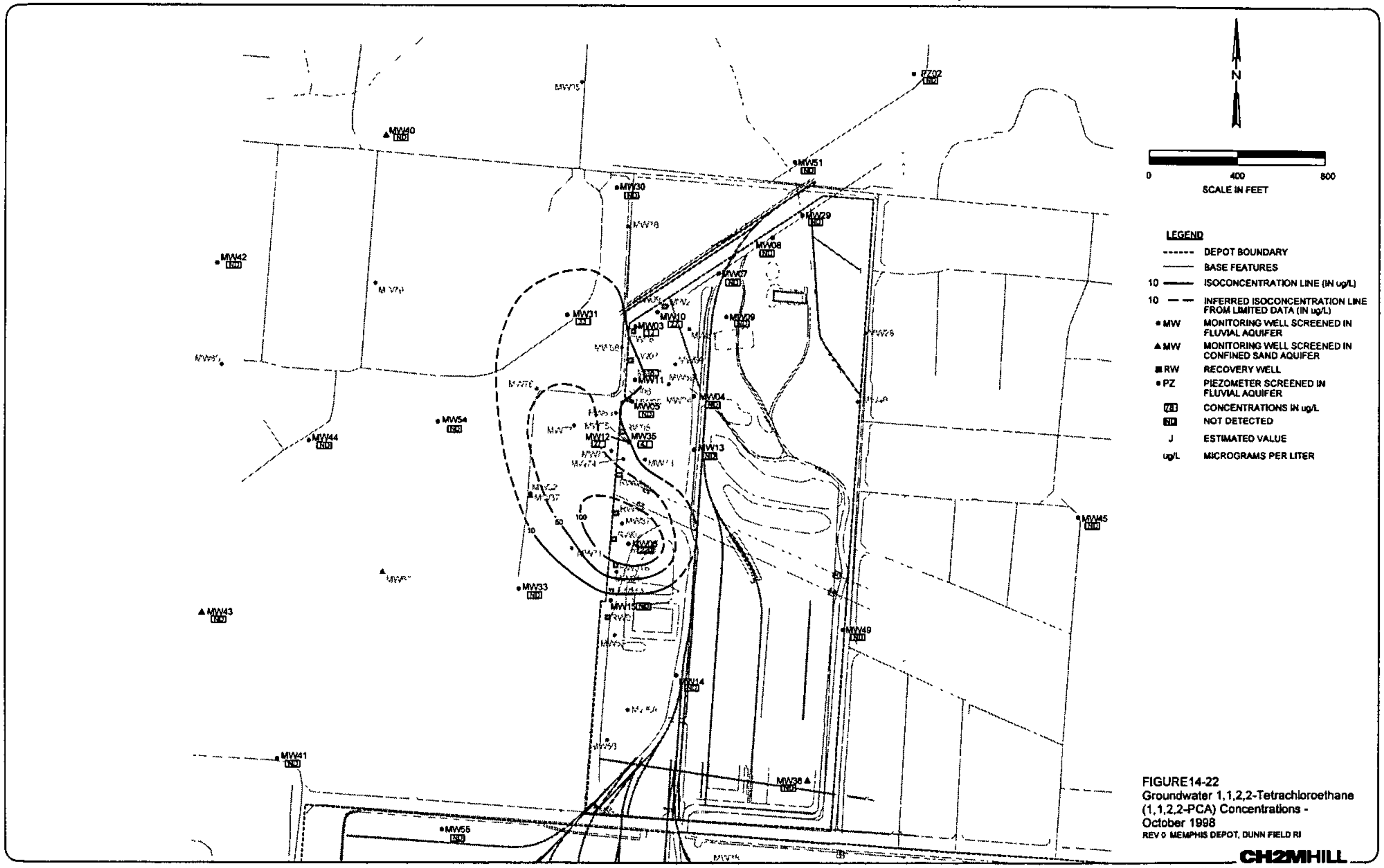
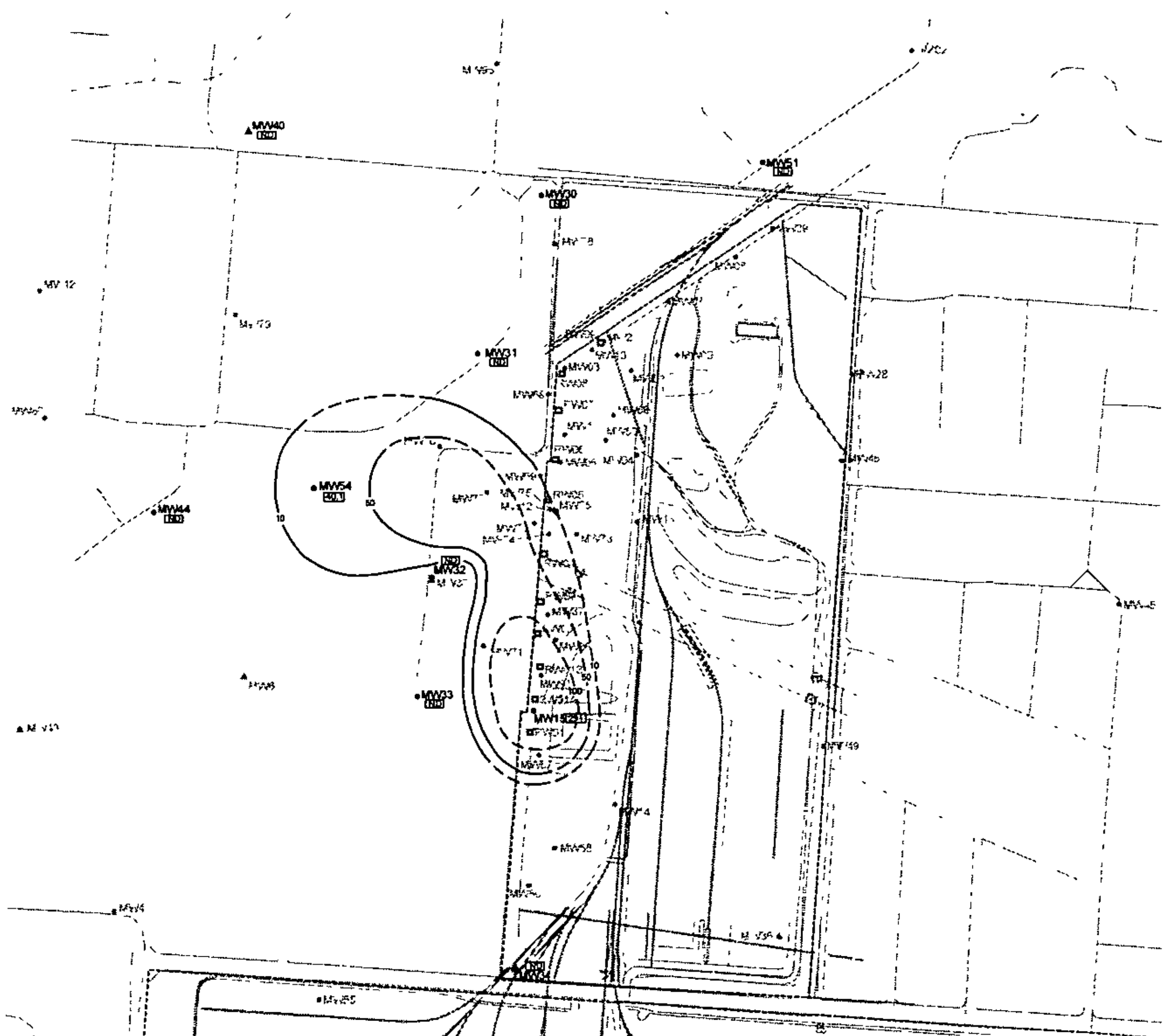


FIGURE14-22
Groundwater 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA) Concentrations - October 1998
REV 0 MEMPHIS DEPOT, DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dM01-14-22.dgn



0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER

NOTE:

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-23
Groundwater 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA) Concentrations - November 1999
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dr01-14-23.dgn

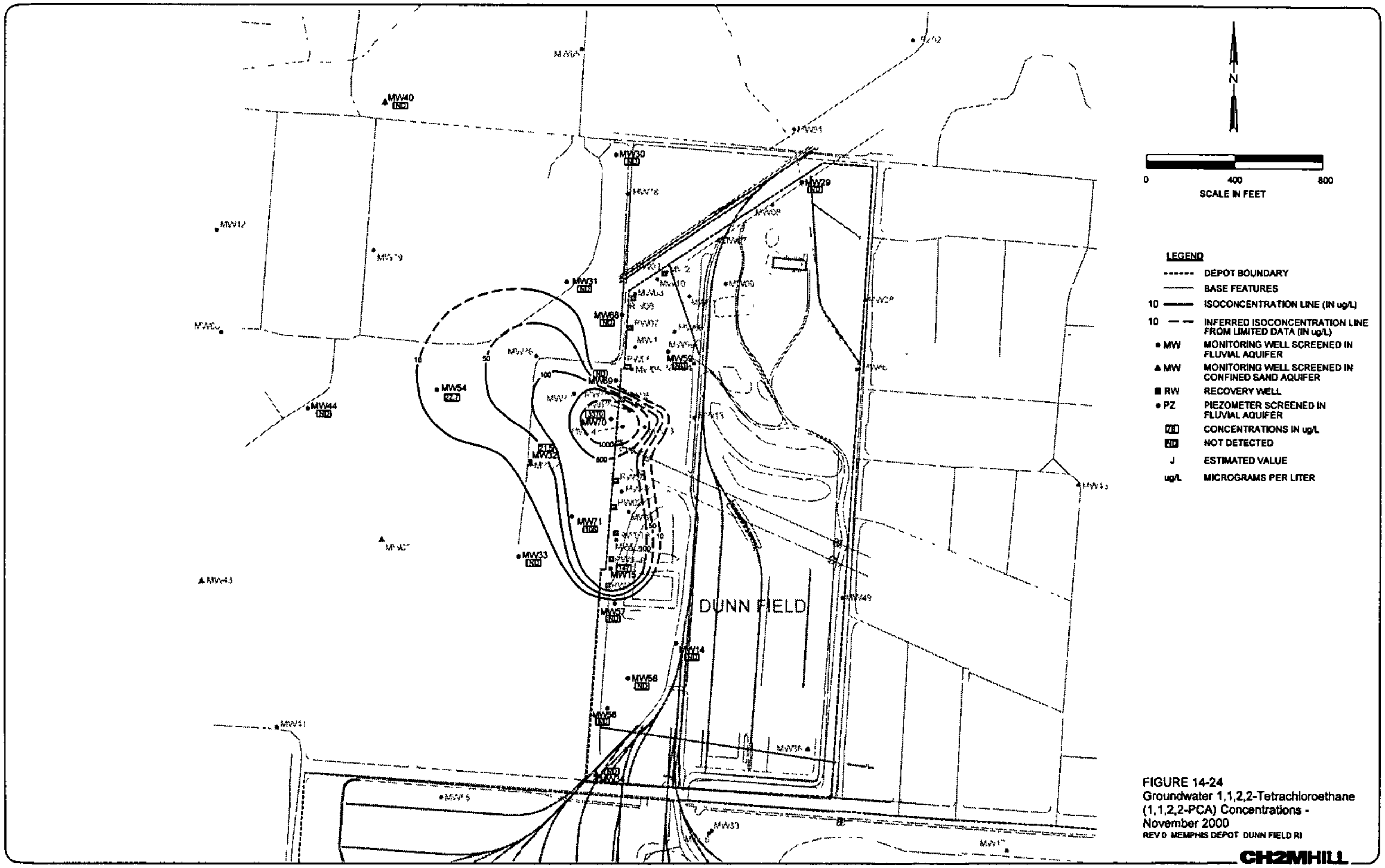


FIGURE 14-24
Groundwater 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA) Concentrations - November 2000
REV 0 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfi01 14-24.dgn

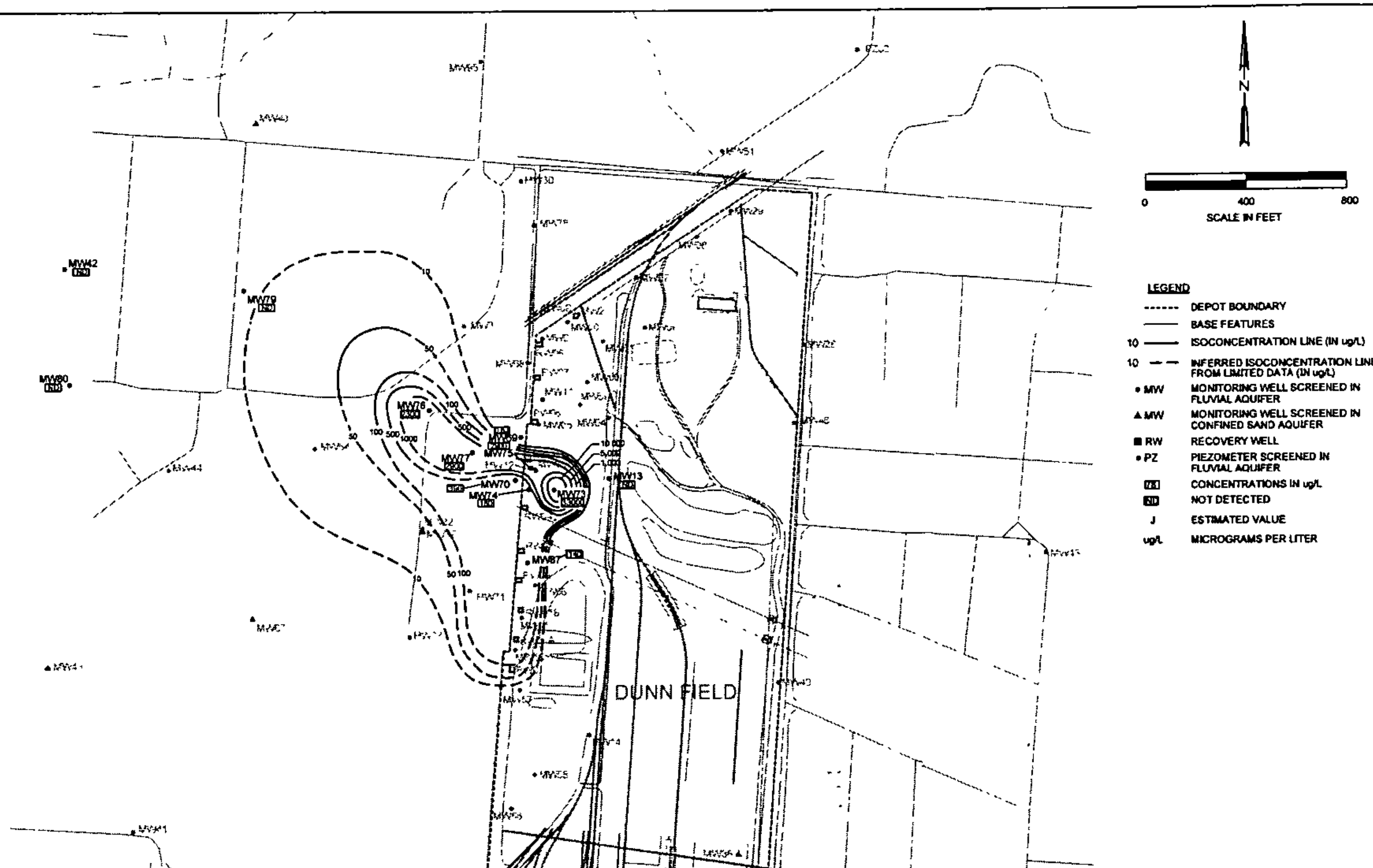
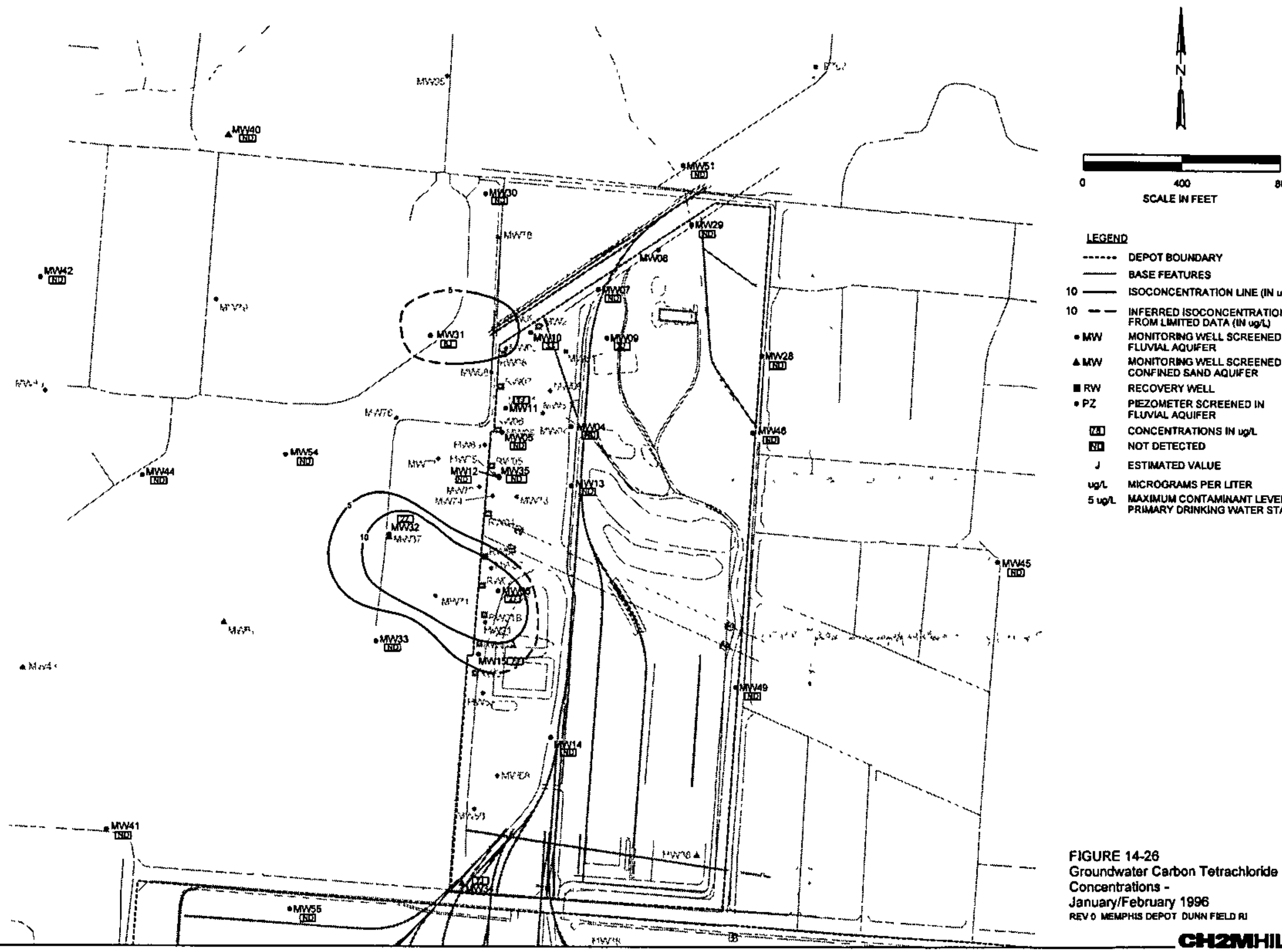


FIGURE 14-25
Groundwater 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA) Concentrations - January/February 2001
REV 0 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

579 279



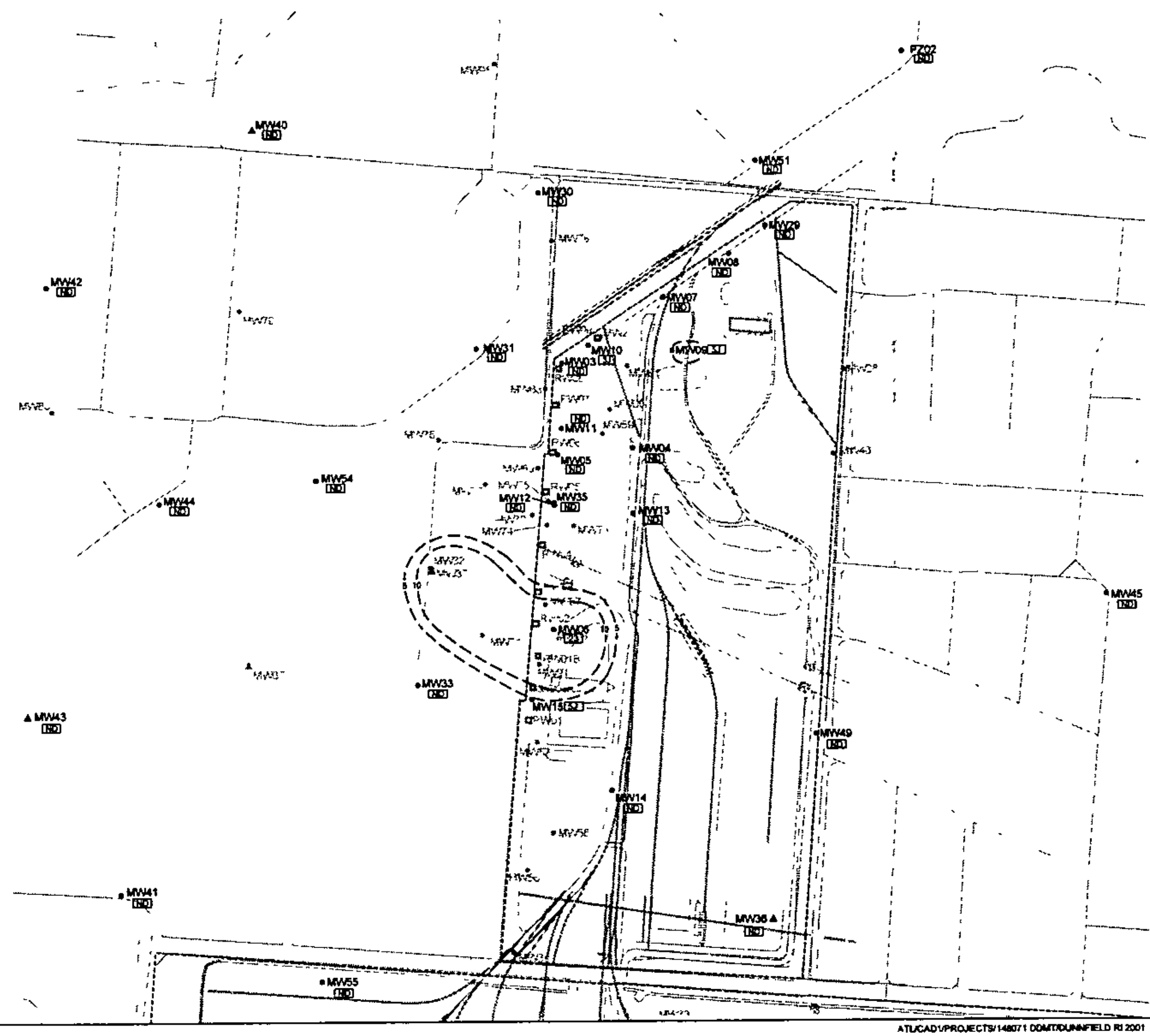
LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 — ISOCONCENTRATION LINE (IN ug/L)
- 10 — INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW — MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW — MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW — RECOVERY WELL
- • PZ — PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- CONCENTRATIONS IN ug/L
- ND — NOT DETECTED
- J — ESTIMATED VALUE
- ug/L — MICROGRAMS PER LITER
- 5 ug/L — MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-26
Groundwater Carbon Tetrachloride Concentrations - January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/146071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dh01 14-26.dgn



LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- [78] CONCENTRATIONS IN ug/L
- [ND] NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-27
Groundwater Carbon Tetrachloride Concentrations-
October 1998
REV 2 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dlrl01-14-27.dgn

579 281

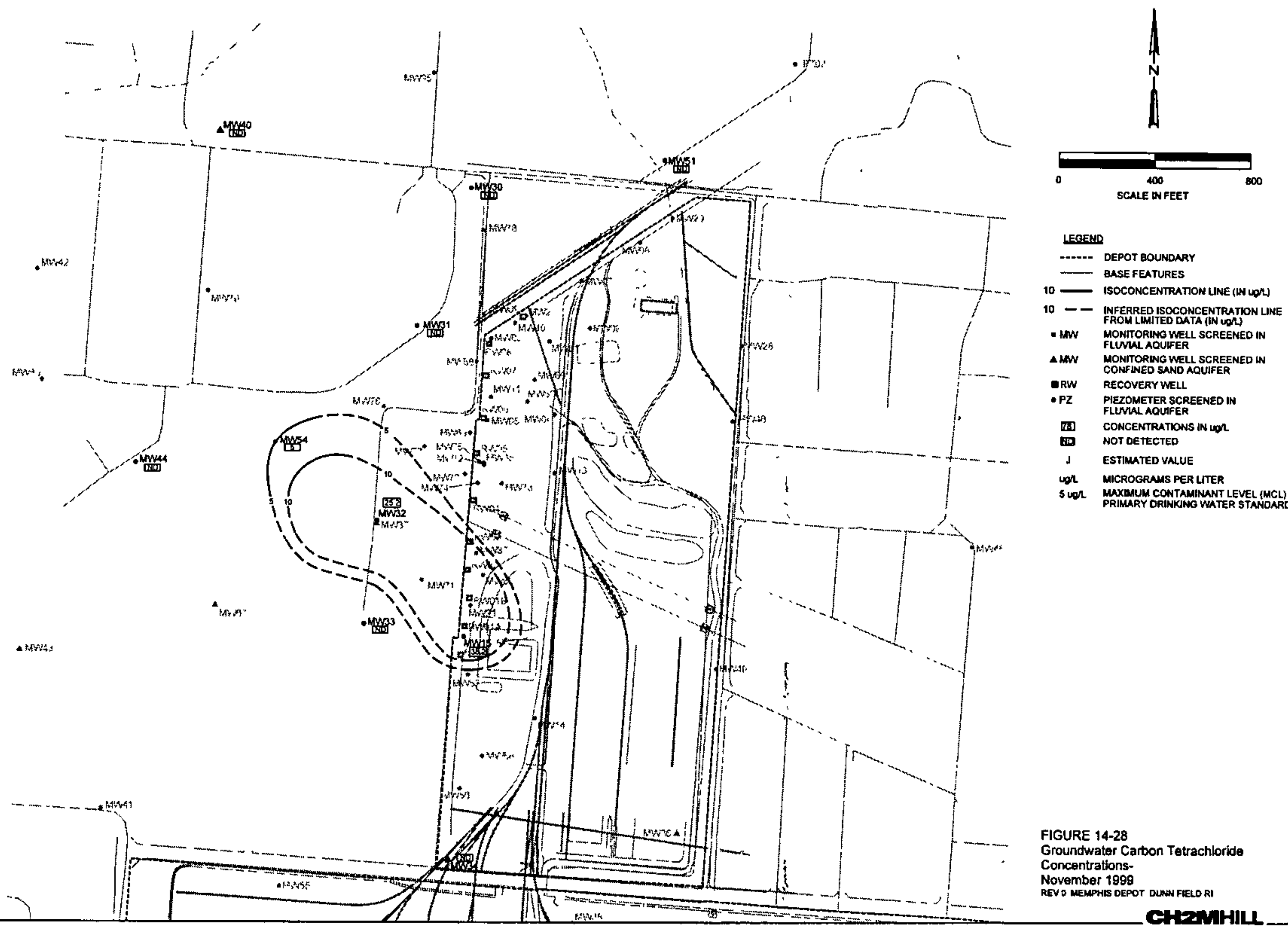
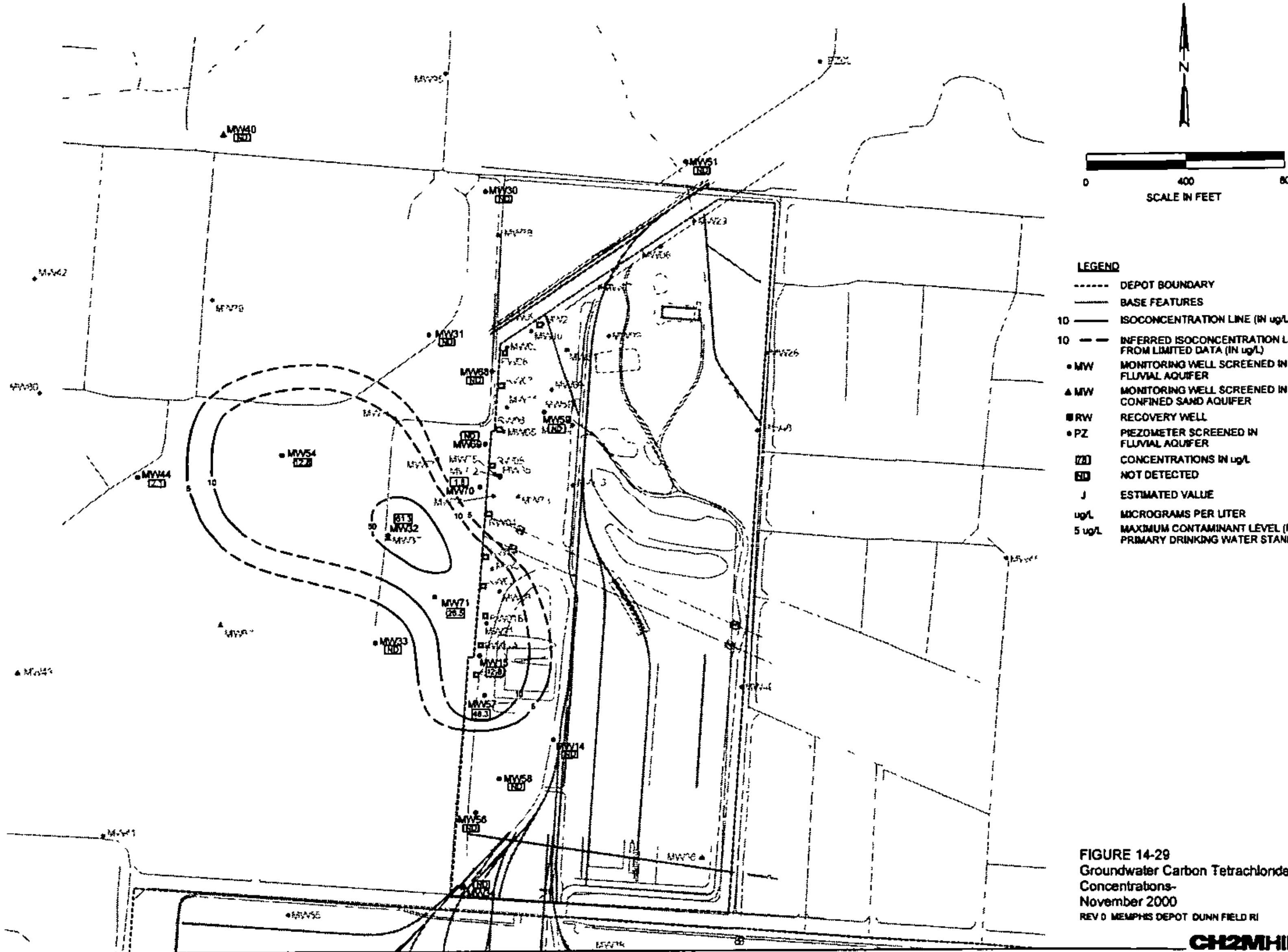


FIGURE 14-28
Groundwater Carbon Tetrachloride Concentrations-
November 1999
REV 0 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfd01-14-28.dgn



LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 — ISOCONCENTRATION LINE (IN ug/L)
- 10 — — INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ■ RW RECOVERY WELL
- • PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-29
Groundwater Carbon Tetrachloride Concentrations-
November 2000
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071d8t01-14-29.dgn

0 400 800
SCALE IN FEET

LEGEND

------	DEPOT BOUNDARY
------	BASE FEATURES
10 ———	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
• MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	RECOVERY WELL
• PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
78	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER
5 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-30
Groundwater Carbon Tetrachloride Concentrations-
January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dtrl01-14-30.dgn

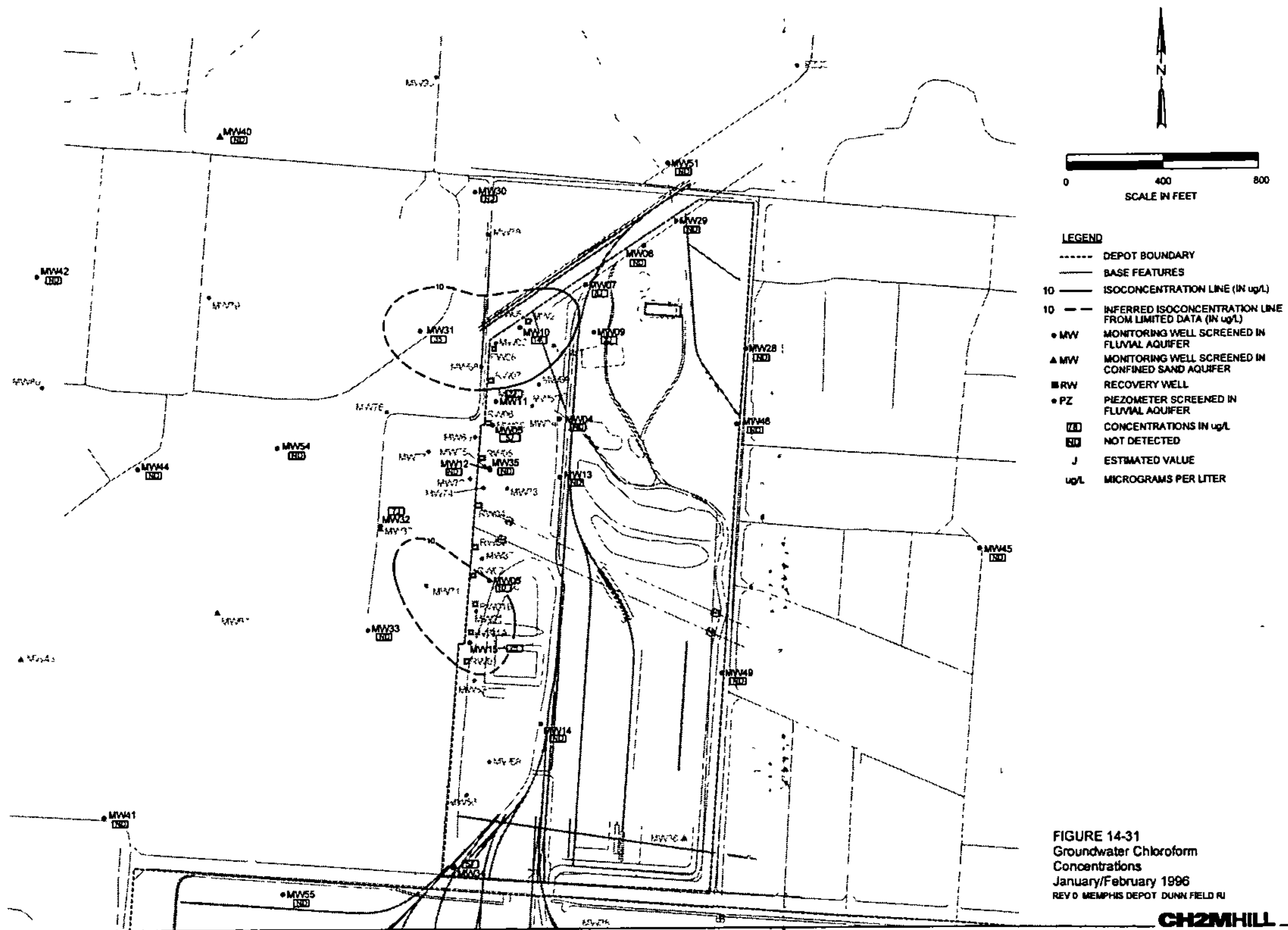


FIGURE 14-31
Groundwater Chloroform Concentrations
January/February 1996
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfri01-14-31.dgn

579 285

FIGURE 14-32
Groundwater Chloroform
Concentrations-
October 1998
REV 0 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dfrI01 14-32.dgn

0 400 800
SCALE IN FEET

LEGEND

------	DEPOT BOUNDARY
——	BASE FEATURES
10 ——	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
• MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
■ RW	RECOVERY WELL
• PZ	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
73	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
ug/L	MICROGRAMS PER LITER

FIGURE 14-33
Groundwater Chloroform
Concentrations-
November 1999
REV 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071eM01 14-33.dgn

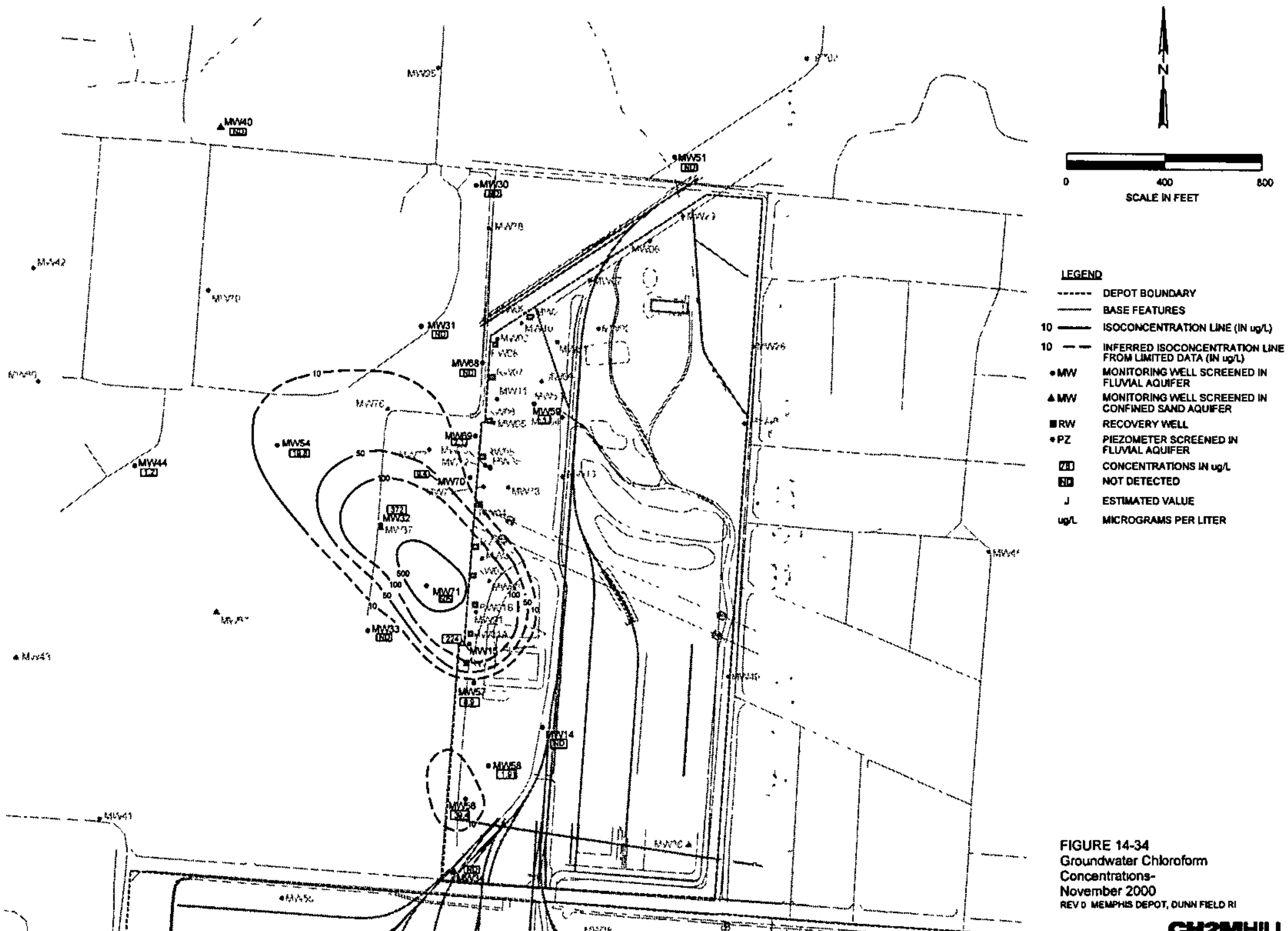


FIGURE 14-34
Groundwater Chloroform Concentrations-
November 2000
REV 0 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 17-OCT-2001 8071dM01 14-34.dgn

LEGEND

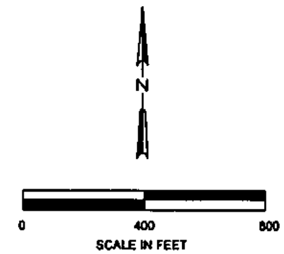
- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- RW RECOVERY WELL
- PZ PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- ug/L MICROGRAMS PER LITER

NOTE:

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-35
Groundwater Chloroform Concentrations
January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-APRIL-2002 s071dfri01-14-35.dgn



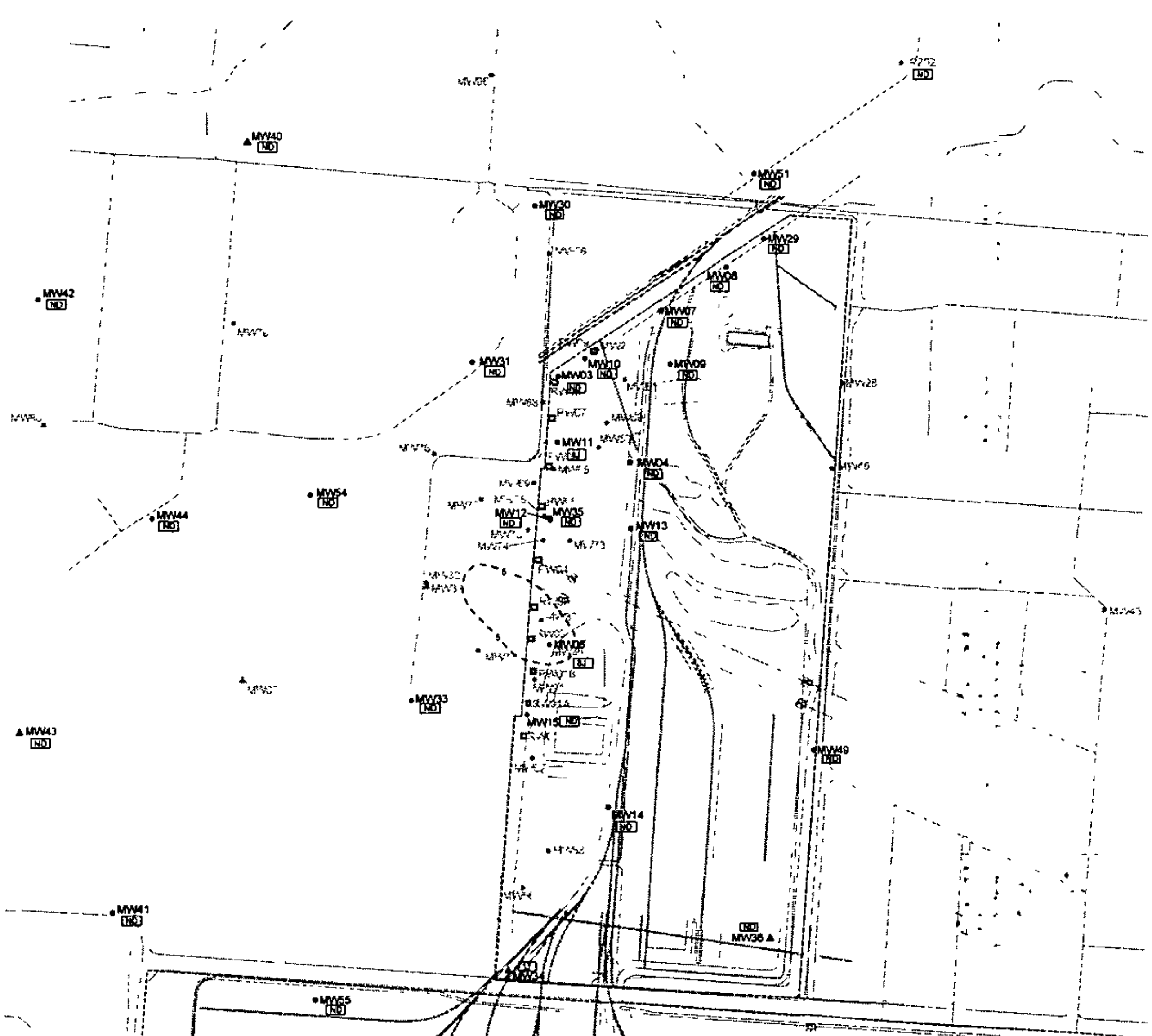
LEGEND

------	DEPOT BOUNDARY
———	BASE FEATURES
10 ———	ISOCONCENTRATION LINE (IN ug/L)
10 — —	INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
• MW	MONITORING WELL SCREENED IN FLUVIAL AQUIFER
▲ MW	MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
• PZ01	PIEZOMETER SCREENED IN FLUVIAL AQUIFER
■ RW	GROUNDWATER EXTRACTION WELL
20	CONCENTRATIONS IN ug/L
ND	NOT DETECTED
J	ESTIMATED VALUE
5 ug/L	MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

FIGURE 14-36
Groundwater 1,1,2-Trichloroethane (1,1,2-TCA) Concentrations
January/February 1996
REV 0 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 13-APR-2001 8071dfri01-14-36.dgn



N

0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- • MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- • PZ01 PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- ■ RW GROUNDWATER EXTRACTION WELL
- 75 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-37
Groundwater 1,1,2-Trichloroethane (1,1,2-TCA) Concentrations
October 1998
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD I/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 13-APR-2001 807 1dfrI01-14-37.dgn

579 291

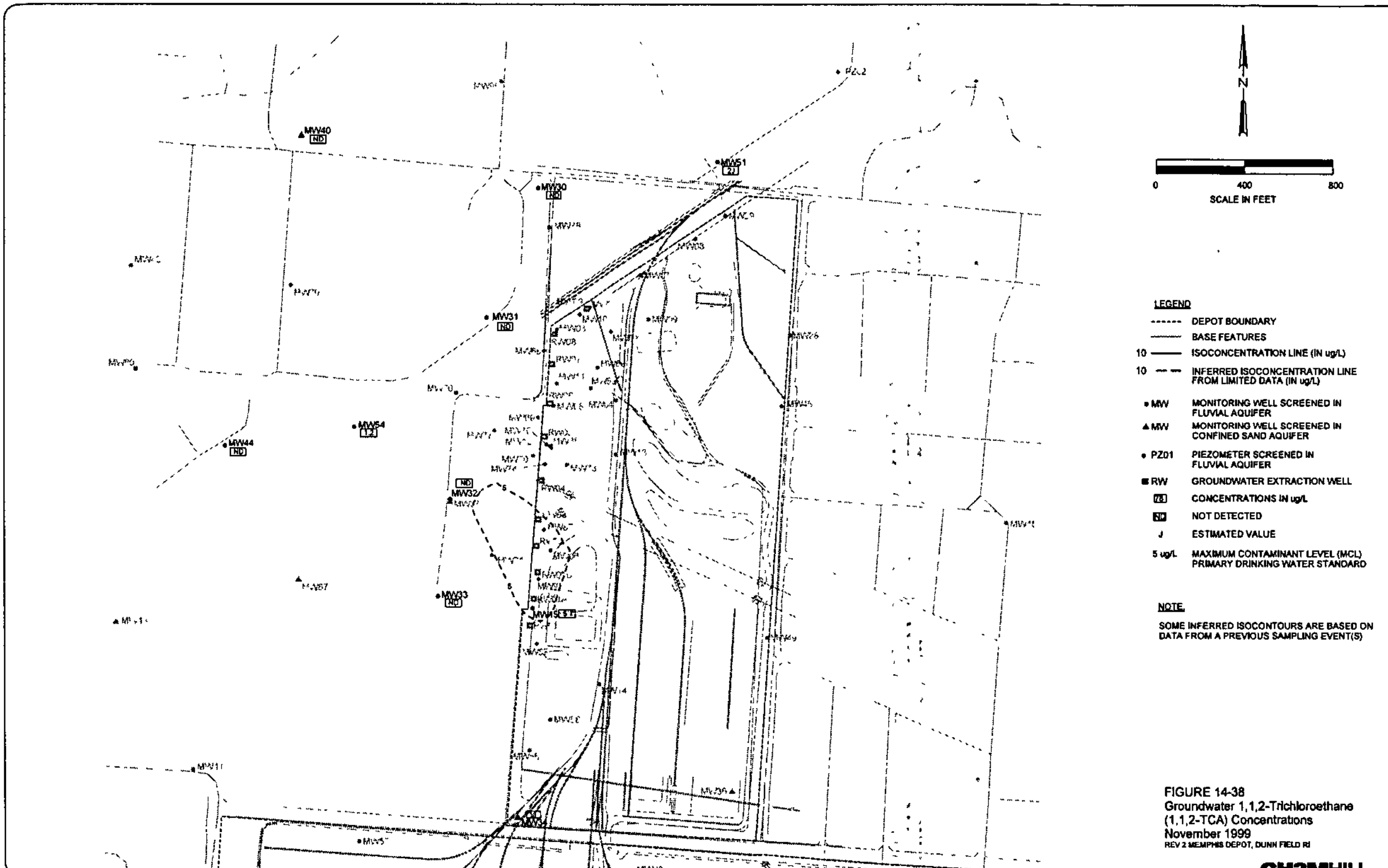
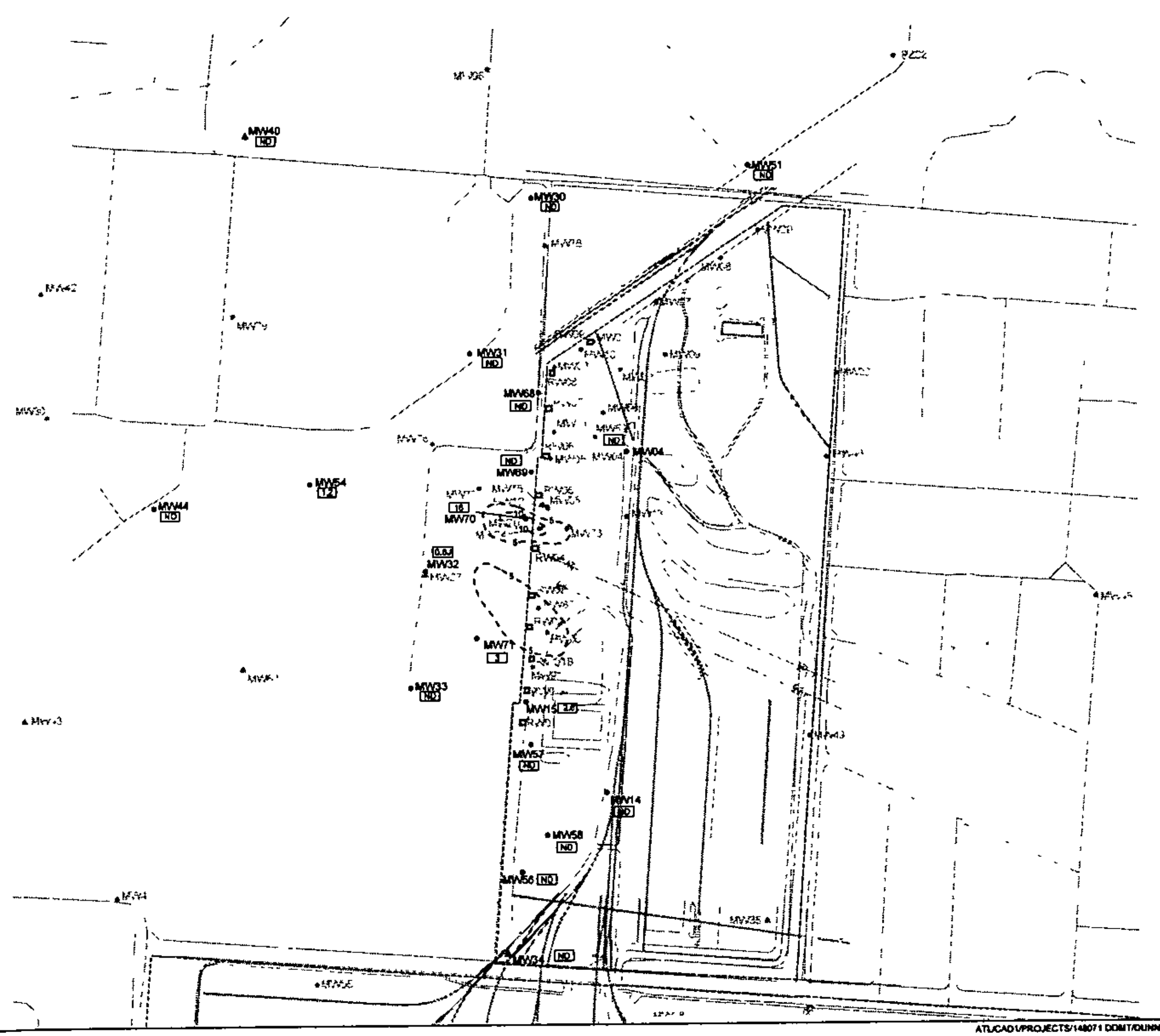


FIGURE 14-38
Groundwater 1,1,2-Trichloroethane (1,1,2-TCA) Concentrations
November 1999
REV 2 MEMPHIS DEPOT, DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 18-OCT-2001 8071dfri01 14-38.dgn



0 400 800
SCALE IN FEET

LEGEND

- DEPOT BOUNDARY
- BASE FEATURES
- 10 ISOCONCENTRATION LINE (IN ug/L)
- 10 INFERRED ISOCONCENTRATION LINE FROM LIMITED DATA (IN ug/L)
- ● MW MONITORING WELL SCREENED IN FLUVIAL AQUIFER
- ▲ MW MONITORING WELL SCREENED IN CONFINED SAND AQUIFER
- ● PZ01 PIEZOMETER SCREENED IN FLUVIAL AQUIFER
- ■ RW GROUNDWATER EXTRACTION WELL
- 75 CONCENTRATIONS IN ug/L
- ND NOT DETECTED
- J ESTIMATED VALUE
- 5 ug/L MAXIMUM CONTAMINANT LEVEL (MCL) PRIMARY DRINKING WATER STANDARD

NOTE

SOME INFERRED ISOCONTOURS ARE BASED ON DATA FROM A PREVIOUS SAMPLING EVENT(S)

FIGURE 14-39
Groundwater 1,1,2-Trichloroethane (1,1,2-TCA) Concentrations
November 2000
REV 2 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

ATL/CAD1/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-MARCH-2002 8071dfr01-14-39.dgn

579 293

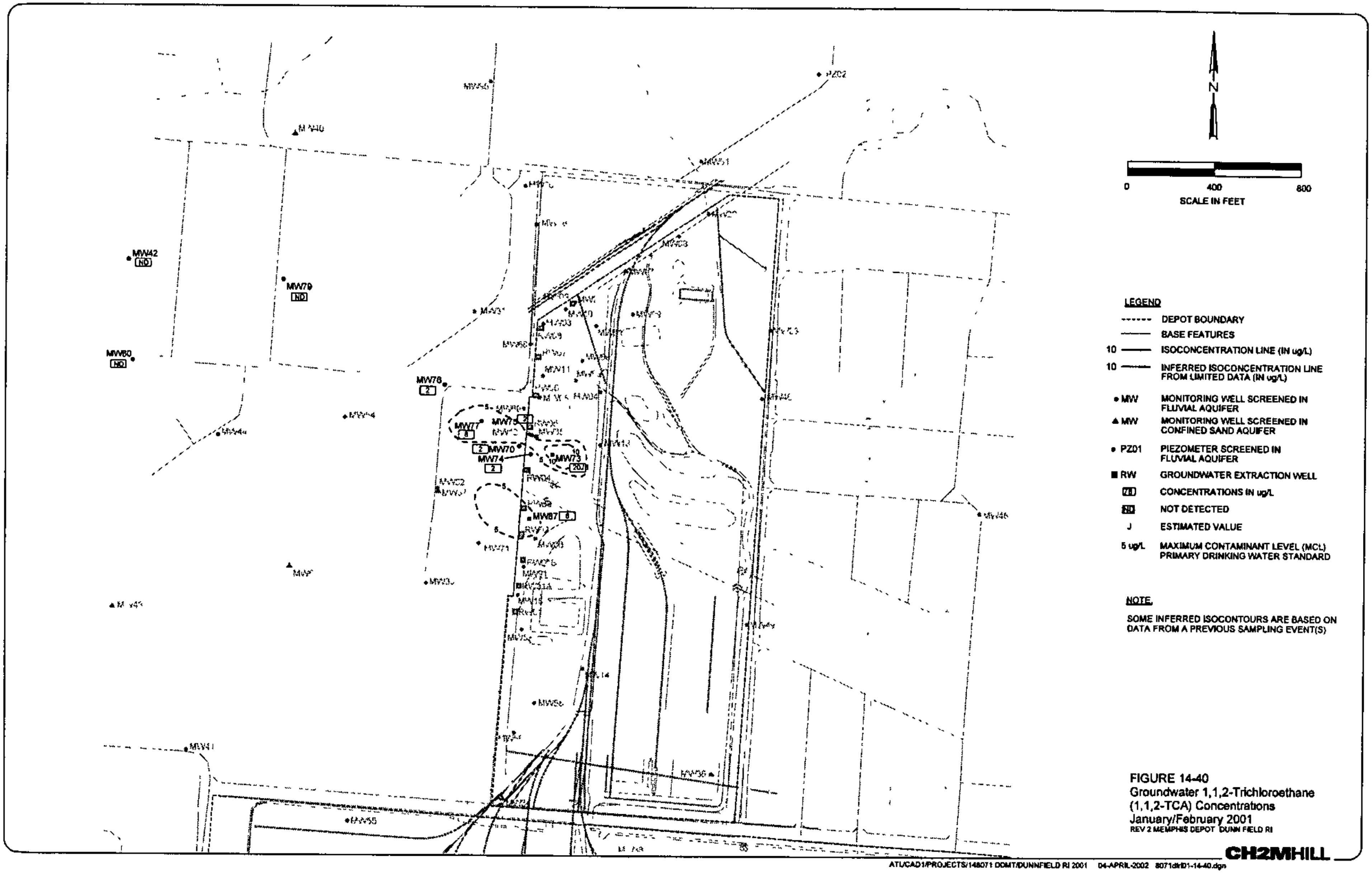


FIGURE 14-40
Groundwater 1,1,2-Trichloroethane (1,1,2-TCA) Concentrations
January/February 2001
REV 2 MEMPHIS DEPOT DUNN FIELD RI

APPENDIX B

Presumptive Remedies: Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils (EPA, September 1993)

579 295

United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | Directive:9355.0-48FS
EPA 540-F-93-048
PB 93-963346
September 1993

EPA

Presumptive Remedies:

Site Characterization and Technology Selection For CERCLA Sites With Volatile Organic Compounds In Soils

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM).**

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to cleanup similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive identifies the presumptive remedies for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites with soils contaminated by ***volatile organic compounds (VOCs).*** In addition, EPA is developing guidance on presumptive remedies for wood treatment, municipal landfill, PCB, grain storage, coal gasification, and contaminated ground-water sites. EPA has also developed a directive entitled *Presumptive Remedies. Policy and Procedures,* (Directive 9355. 0-47FS) which outlines and addresses the issues common to all presumptive remedies (e.g., role of *innovative technologies,* consistency with the NCP, State, community involvement).

PURPOSE

The purpose of this directive is to provide guidance on selecting a presumptive remedy at sites with soils contaminated with VOCs. Specifically this guidance:

- Presents the presumptive remedies for this site type;
- Describes the presumptive remedy process in terms of site characterization and technology screening steps; and
- Outlines the data required to select these presumptive remedies.

Since a presumptive remedy is a technology that EPA believes, based upon its past experience, generally will be the most appropriate remedy for a specified type of site, the presumptive remedy approach will accelerate site-specific analysis of remedies by focusing the feasibility study efforts. Where several presumptive remedies are identified, EPA believes that all deserve substantial consideration before utilizing the presumptive remedy approach. EPA personnel should review the directive entitled *Presumptive Remedies· Policy and Procedures* (Directive 9355.0-47FS) for general information on the presumptive remedy process.

Soil vapor extraction (SVE), thermal resorption, and incineration are the presumptive remedies for Superfund sites with VOC-contaminated soil assuming the site characteristics meet certain criteria. Table 1 provides a brief description of each of these presumptive remedies

The decision to establish these technologies as presumptive remedies for this site type is based on EPA's collective knowledge about site investigation and remedy selection for VOC-contaminated soils,

TABLE 1
Presumptive Remedies for VOCs in Soil

Soil Vapor Extraction - Soil vapor extraction (SVE) is an in-situ or ex-situ process which physically removes contaminants from ***vadose zone*** soils by inducing air flow through the soil matrix. The flowing air strips volatile compounds from the solids and carries them to extraction wells. The recovered vapors may require further treatment. In-situ SVE is the primary focus of this document.

Thermal Resorption - Thermal desorption is an ex-situ process that uses direct or indirect heat exchange to vaporize organic contaminants from soil, sediment, sludge or other solid and semisolid matrices. The vapors are then condensed or otherwise collected for further treatment.

Incineration - Incineration is an ex-situ engineered process that employs thermal decomposition via oxidation at temperatures usually greater than 900 °C to destroy the organic fraction of the waste.

The major difference between thermal desorption and incineration is that incineration oxidizes organic compounds, thereby destroying the hazardous material. Thermal desorption volatilizes contaminants, then concentrates them. Thermal desorption reduces the volume of contamination, but the concentrated waste stream still requires treatment. Disposal or treatment of residual waste stream, ash, and concentrated VOC effluent is not covered by this directive. Options such as off-site disposal/regeneration or reuse should be considered.

including field experience from the Superfund, Resource Conservation and Recovery Act (RCRA), and Underground Storage Tank (UST) programs. In addition, EPA conducted an analysis of FY86 to FY91 Records of Decision (RODS) for sites where VOC contamination drove remedy selection. The results of this analysis, which are provided in Appendix A, demonstrate that these three technologies represent over 90% of the remedies selected in the RODS analyzed

USE OF DOCUMENT

This directive is primarily intended for use by Superfund site managers. However, site managers in other programs (such as RCRA corrective action, the UST program, States), and the private sector, may also use this directive.

This directive is not a "stand alone" document. To ensure a full understanding of VOC site characterization and remedy selection, site managers should refer to all documents cited in the directive. For assistance in understanding complex site conditions, an experienced site manager, the presumptive remedy expert team, the Superfund Technical Assistance and Response Team (START) team, or the Environmental Response Team should be consulted.

ANTICIPATED BENEFITS OF PRESUMPTIVE REMEDIES

Use of this directive will reduce cost and time in remedy selection at VOC sites in the following ways:

1 The directive facilitates identification of the presumed or likely remedial options early in the investigation process, hence allowing for a more focused collection of data during the remedial investigation (RI) or removal site evaluation. In addition, knowledge of the presumptive remedy may facilitate collection of some remedial design data before the ROD or action memo, thereby allowing the action to proceed more quickly after signature of the decision document.

2 This directive eliminates the need for the initial step of identifying and screening a variety of alternatives during the Feasibility Study. Additionally, it will reduce the number of technologies identified and analyzed in the EE/CA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Section 300.430(e)(1)) states that "the lead agency shall include an alternatives screening step, when needed, (emphasis added) to select a reasonable number of alternatives for detailed analysis." EPA's analysis of feasibility studies for VOC-contaminated soil sites (see Appendix A) found that certain technologies are routinely screened out based on effectiveness, implementability, or excessive costs, consistent with NCP Section 300.430(e)(7). Accordingly, EPA has determined that, when using presumptive remedies at VOC-contaminated sites, site-specific identification and screening of alternatives is not necessary. However, this directive and supporting documentation (see "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils") should be included in the Administrative Record for all sites that use the presumptive remedy(ies) to document the basis for eliminating the "site-specific identification and

TABLE 2 Typical VOCs Addressed by this Directive
Halogenated Volatile Organics Carbon Tetrachloride Chlorobenzene Chloroethane Chloroform 1,1-Dichloroethane 1,1-Dichloroethylene 1,2-Dichlorobenzene 1,2-Dichloroethane 1,2-Dichloroethylene 1,2-Dichloropropane 1,4-Dichlorobenzene 1,1,1-Trichloroethane 1,1,2-Trichloroethane 1,1,2,2-Tetrachloroethane Ethylene Dibromide Methylene Chloride Tetrachloroethylene Trichloroethlyene Vinyl Chloride **Non-Halogenated Volatile Organics** Ketones/Furans Acetone Methyl Ethyl Ketone Methyl Isobutyl Ketone Aromatics Benzene Ethyl Benzene Styrene Toluene m-Xylene o-Xylene p-Xylene **Note:** Other compounds that have physical/chemical characteristics similar to the compounds listed may also be addressed by the presumptive remedy process.

screening of technologies" section. In addition, other supporting materials (e.g., FS reports included in the analysis, technical reports) will be made available at EPA Headquarters and are available for inclusion in the Administrative Record if needed.

3. This directive streamlines the detailed analysis portion of the FS. Remedial alternatives developed for a site must be evaluated against the nine criteria (required under NCP Section 300.430(e)(9)). Under this presumptive remedy approach, the detailed analysis can be limited to the three presumptive remedies (in addition to the no-action alternative), thereby streamlining that portion of the FS. Appendix B provides a generic evaluation of the presumptive remedies for seven of the nine criteria. This evaluation may serve as a basis for each detailed analysis conducted under the presumptive remedy process and should be augmented, as needed, to address site-specific conditions.

One of these presumptive remedies is expected to be used for all VOC sites except under unusual circumstances. Such circumstances may include unusual site soil characteristics, demonstration of significant advantages of alternate (or other innovative) technologies over the presumptive remedies, or extraordinary community and state concerns. If such circumstances are encountered, additional analyses may be necessary or a more conventional detailed RI/FS may be performed.

PRESUMPTIVE REMEDIES PROCESS

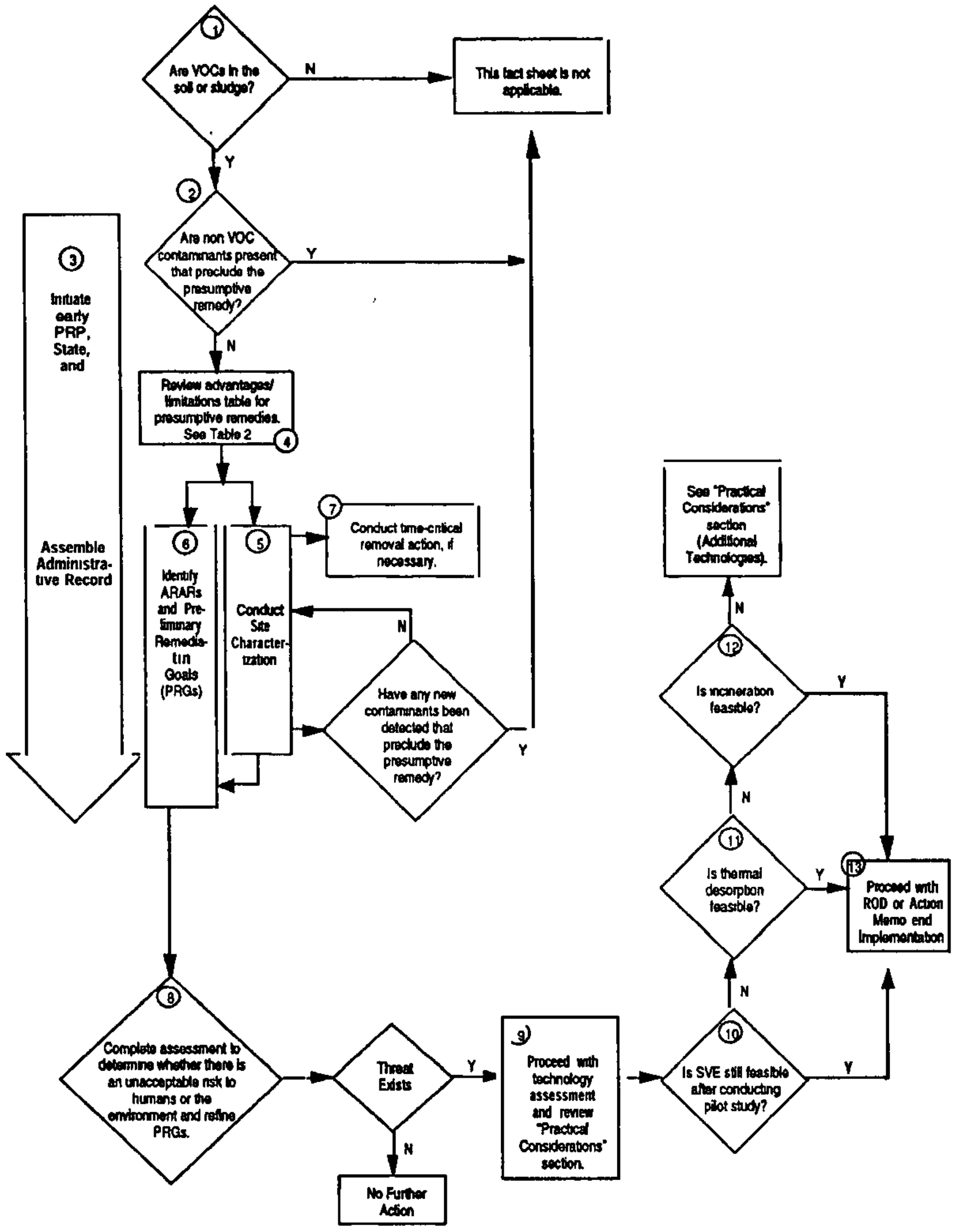
This section and the accompanying diagram (Figure 1) describe the sequence of steps involved in the presumptive remedy process (site characterization and technology selection) for sites containing soil contaminated with VOCs. While the process is not mandatory, EPA believes that following the steps outlined below will expedite the clean-up process for this category of sites.

SVE is the primary presumptive remedy. SVE has been selected most frequently to address VOC contamination at Superfund sites and initial performance data indicate that it effectively treats waste in place at a relatively low cost. In cases where SVE will not work or where there is very highly concentrated contamination, thermal desorption may be the more appropriate response technology. In a limited number of situations, incineration may be more appropriate.

The numbered paragraphs below correspond to the numbered steps in Figure 1 and provide a detailed discussion of each step.

1. Are *VOCs Present in the Soil?* The first step is to determine whether VOCs are the major contaminant present in soil at the site. Table 2 lists the VOCs that are amenable to the presumptive remedies outlined in this directive. If VOCs are present at levels of concern (see forthcoming guidance on soil screening levels), then the presumptive remedies outlined in this directive may be applicable. However, if it is confirmed (at this point or at any later point during the presumptive remedy process) that there are no VOCs present in the soil, then this directive is not applicable for use in technology selection at the site.

FIGURE 1
Decision Tree for Investigating and Selecting a Remedy at Solvent Sites



Most likely, this analysis will occur during scoping of the RI/FS or EE/CA. However, there may be only limited information available at that time about the site. Therefore, whatever information is available should be used to determine whether VOCs are present or suspected in the soil based on prior use. Chemical use at a site can be ascertained from a number of sources such as facility records, previous sampling efforts by local or State agencies or through Information Request letters.

2. Are *Non-VOC Contaminants Present That Preclude the Use of Presumptive Remedies?* In addition to determining whether VOCs are present in the soil, it is also necessary to identify other non-VOC contaminants, if any, present in the soil.

   The site characterization and technology selection procedures outlined in this directive are recommended for use primarily on soil containing VOCs only. See Table 2 for VOCs that are amenable to the presumptive remedies.

   For sites containing a mixture of VOCs and other contaminants in soil, the presumptive remedies should be considered only if they can also be effective in removing the non-VOC contaminants or combined with other, non-presumptive remedies in a treatment train, assuming the presumptive remedies do not exacerbate the problems presented by the non-VOCs. For example, sites with VOCs and metals commingled in soil may be effectively remediated by employing SVE to remove VOCs followed by fixation or solidification to address the metal contamination In contrast, a VOC and polyaromatic hydrocarbons (PAHs) contaminant combination may be treated more appropriately with a single biological treatment scheme that would be effective for both the VOCs and PAHs. Note that sites containing mixtures of VOCs and non-VOCs are varied, and, for this reason, remedy selection may be more complicated than the framework presented in this directive; therefore, the presumptive remedy analysis may need to be supplemented or modified on a site-specific basis

3. *Initiate Early Community, State, and Potentially Responsible Party (PRP) Involvement* As early in the clean-up process as possible, EPA should notify the community, State, and any PRPs that a presumptive remedy is being considered for the site. It is important for all stakeholders to understand completely how the presumptive remedy process varies from the usual clean-up process and the benefits of using the presumptive remedies process.

   Early identification of State applicable or relevant and appropriate requirements (ARARs) also is a critical part of this process. Because the presumption set forth in this directive is national in scope, it does not take into account State ARARs. For this reason, State ARARs relating to the presumptive remedies should be considered on site-specific basis. Regions may want to supplement this directive by compiling the requirements of the States in their Regions that are likely to be associated with the use of the presumptive remedies and placing them in the administrative record for a site where presumptive remedies are being considered. This directive along with the "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils" should be included in the administrative record for the site if one of the presumptive remedies is proposed for a particular VOC-contaminated site.

4. *Review Advantages/Limitations of the Presumptive Remedies.* During initial site characterization, Table 3 should be reviewed to consider the advantages and limitations of the presumptive remedies, This information may be useful in preparing for and/or modifying the site characterization or alternatives analysis process. The "Practical Considerations" section of this directive should also be reviewed at this time to ensure a comprehensive site characterization and remedy evaluation.

5. *Conduct Site Characterization. Site* characterization for sites using VOC presumptive remedies should be designed to:

   - Positively identify the site type (i.e., VOC site);
   - Obtain data to determine whether the presumptive remedy is feasible for the site;
   - Focus (and possibly streamline) site characterization by collecting data to support the selection of presumptive remedy(ies) only (e.g., volume and cost information); and,
   - Collect some design data (i.e., pilot studies to determine radius of influence and flow rates of SVE), thereby streamlining data collection during the remedial design stage.

   Table 4 lists the data that are required for characterization of sites with soil contaminated with VOCs. This table also includes the rationale for collecting these data and references for established collection methods. Note that bench-scale and pilot/treatability studies should be performed whenever possible concurrent with site characterization to define the parameters that will be important to designing the system

   In areas with low organic content soil (e.g., alluvial basins), or where there are impediments to obtaining soil samples (e g , under buildings), soil gas sampling is highly recommended as a site characterization technique. In addition, the use of soil gas sampling during implementation of SVE and confirmatory soil sampling afterward is less expensive than constantly installing new soil borings, especially for deep contamination.

If incineration or thermal desorption is under serious consideration, bench-scale treatability studies may be conducted, especially if metals or other inorganic compounds are present. Thermal desorption generally should be considered if concentrations of VOCs are less than 5 to 10 percent; incineration may be appropriate if VOC concentrations exceed 5 to 10 percent Note that excavation and mixing of soil can produce a desorber input of less than 10 percent contaminant concentration and allow thermal desorption to be chosen.

Additionally, the feasibility of excavation should be determined by evaluating surface contidions and depth of contaminants as well as the potential for any air emissions associated with the excavation. Test digs should be monitored closely to assure protection of the public and the environment.

It is important to note that during the site characterization, the volume and concentration of waste constituting the principal threats at the site should be identified. The NCP (Section 300.430(a)(1)(iii)(A) and *A Guide to Principal Threat and Low Level Threat Wastes,* Superfund Publication: 9380 3-06FS, November 1991, define principal threats as source materials, including liquids, that are highly toxic or highly mobile wastes which generally cannot be reliably contained or would present a significant risk to human health and or environment should exposure occur. In accordance with NCP expectations, waste constituting "principal threats" posed by a site generally are expected to be treated. The site manager is encouraged to characterize the site in terms of principal and low-level threat areas to determine materials to be targeted for treatment and containment.

6. *Identify Potential ARARs, To Be Considered (TBCs), and Preliminary Remediation Goals (PRGs).* Potential Federal and State ARARs and pertinent TBCs information should be identified on a chemical-, location-, and action-specific basis concurrent with site characterization. For a more detailed ARARs discussion, refer to the various ARARs fact sheets. (See *Compendium of CERCLA ARARs Factsheets and Directives,* EPA Publication 9347.3-15, October 1991).

   At this step, PRGs should also be identified (NCP Section 300.430(e)(2)(c)). Note that different health risk-based PRGs are often set for soils, depending on depth. Shallow soil levels are usually based both on direct contact exposure and protection of ground water, while levels for deeper soils are generally based only on mass transport modeling of effects on ground water. Ecological effects may also be important to consider in setting PRGs.

7. *Conduct Time-Critical Removal Action (if necessary).* During initial site characterization, data will be gathered to determine whether a time-critical removal action will be needed and to determine whether the contaminants present are amenable to the presumptive remedies. Time-critical removal actions, such as drum removal or actions addressing highly contaminated (typically small volumes) of soil, should be conducted in accordance with current guidance and regulations. The decision to take a time-critical removal action may be made by the Regional Decision Team (RDT) or if time does not permit, by an On-Scene Coordinator (OSC) or a Remedial Project Manager (RPM) in consultation with an OSC.

8. *Is There a Threat Posed by the Site?* A risk assessment must be conducted to determine if a sufficient health or environmental threat exists to warrant a removal or remedial action. (Refer to *Risk Assessment Guidance for Superfund, Volumes I and II,* EPA/540/1-89/002 and EPA/540/1-89/001). Where it is determined that such a threat exists, site-specific exposure data can be used to modify the PRGs identified in Step 6 (NCP Section 300.430(e)(2)(i)). If it is determined that such a threat does not exist, no further action at the site will be required.

9. *Proceed With Technology Assessment and Review "Practical Considerations" section.* If the analysis described in step 8 confirms that the contaminants are a threat to human health and/or the environment, a proposed remedy should then be identified.

   If this project is a remedial action, a detailed analysis using the nine criteria will be required under NCP Section 300.430(e)(9)) to justify the selection of remedy decision. Appendix B provides an analysis of SVE, thermal resorption, and incineration against seven of the nine selection criteria. In addition to the seven criteria discussed in Appendix B, community, and State acceptance must also be evaluated. If a non-time critical removal action is planned, the streamlined analysis described in the EE/CA guidance will be required that uses the three criteria of effectiveness, implementabiilty, and cost During the technology assessment, the factors listed in the "Practical Considerations" section of this directive should be reviewed to ensure a comprehensive evaluation of alternatives.

10. *Does the Pilot /Treatability Study Indicate that SVE is Feasible?* SVE is the primary presumptive remedy. Pilot/treatability study testing of SVE should be conducted prior to final remedy selection. Such testing will provide information on the rate of removal of contaminants. EPA/540/2-91/091A cited in the References section of this directive provides guidance on conducting the pilot/treatability study. Removal efficiencies and treatment effectiveness must be carefully considered alongside the PRGs identified in the FS to estimate the potential for successful remedial action using SVE

11 *Is Thermal Desorption Feasible?* If SVE will not be sufficiently effective in achieving PRGs due to low permeability, lithology or insufficient removal of contamination during the pilot study, thermal desorption should be considered as the primary ex-situ presumptive remedy.

    Thermal desorption technologies cover a variety of vendors and processes. However, ample data are available to substantiate remedy selection of thermal desorption for soil contaminated solely with VOCs.

12. *Is Incineration Feasible?* If contaminant concentrations and bench-scale testing indicate thermal resorption will not achieve desired PRG levels, incineration is the second ex-situ presumptive remedy.

    If incineration is planned, and a substantial number of inorganic contaminants are expected to be present based on site characterization data, materials handling problems, or slagging problems are likely

    If none of three presumptive remeides is considered to be feasible at a particular site, it will be necessary to consider other technologies. (For more information, refer to the Practical Considerations section below.)

13 *Select Remedy for Remedial/Removal Action.* At this point, there should be enough data to identify a preferred remedy in the proposed plan and distribute the plan for public comment. Once the remedy has been selected in the ROD, the user can proceed to do a limited design which relies largely on the substantial amount of design-related data collected during the RI. The extent of additional or supplemental data required will be determined on a site-specific basis.

Practical Considerations

The following factors should be considered prior to taking any remedial action.

Enforcement: This directive applies to fund-lead sites as well as to sites where a PRP is conducting the investigation and/or response action. In the event that there is an ongoing PRP-lead RI/FS, the scope of work may be amended to reflect the presumptive remedy approach to site characterization and remedy selection. The potential savings in time and money to be gained by using the presumptive remedy approach are expected to outweigh the burden of modifying the scope of work in many cases.

Initial Site Actions: If the VOC material is still in original, intact containers, it may be returned to the manufacturer (if the manufacturer is willing to accept these containers), assuming this response is a cost-effective and feasible action as opposed to treating the material. Reuse of material (i.e., process liquids and relocation of equipment to other permitted facilities) should also be considered. Further, phase separation should be conducted and recycling considered depending on the purity of the recovered phase or for any existing liquids that are high enough in concentration. Refer to Appendix C for a list of the currently recognized waste exchanges.

Site Characterization: Site characterization should proceed as a single, multi-media activity whenever possible. Field screening methods should be integrated into the sampling and analysis plan in order to accelerate information gathering Data quality must reflect the ultimate use of the information.

Ground Water: The decision maker should consider the ground-water strategy for the site since soil clean-up levels are often set to protect ground-water quality. Therefore, ground-water clean-up levels may have a direct impact on the selected clean-up levels for soil. (See forthcoming guidance on Soil Screening Levels and the directive entitled *Presumptive Remedies: Remedial Strategy and Treatment Technologies for CERCLA Sites with Contaminated Ground Water.)* It should be noted that, of the VOC-type contaminants, listed in Table 2, the halogenated volatiles are dense nonaqueous phase liquids (dense NAPLs or DNAPLs) and many of the others are light NAPLs (LNAPLs) in their pure liquid form. If LNAPLs are present, it may be possible to address thereby lowering the water table, removing free product (if present), and applying SVE. To address DNAPLs contamination, refer to the above mentioned ground-water guidance.

Management of Different Soils: A situation may arise where highly contaminated shallow material cannot be addressed by SVE. The action to address this contamination may differ from the rest of the soil contamination and will most likely involve incineration or thermal desorption If it is suspected that soil contamination existing at greater depths will also be treated in this manner, then the excavated shallow material should be staged and stored in order to treat it with the deep material.

Another situation may arise where VOCs are mixed with metals, and none of the presumptive remedies can address both sets of contaminants The action to address this situation may consist of a treatment train where VOCs are addressed through SVE or thermal resorption and the metals are addressed through fixation.

Finally, the site manager should be aware of situations where a mixture of principal and low-level threat wastes call for the use of treatment (i e., SVE or thermal treatment) of principal threat waste and containment (capping) of low-level contamination. (See *A Guide to Principal Threat and Low-Level Wastes* in Reference Section).

Off-Site Disposal: In general, it may not be cost-effective to ship quantities of contaminated soil in excess of 5,000 cubic yards for off-site disposal. For this reason, pretreatment of soil and water may be required prior to shipment or discharge to another treatment facility.

Capping: Capping alone is not recommended to control the migration of VOCs. However, capping can improve the effectiveness of SVE by decreasing the rate of infiltration of residual VOCs through the vadose zone into the ground water as well as possibly increasing the radius of influence and preventing "short circuiting" of air pathways in the vicinity of the extraction well. Capping can also be used to address non-principal threat waste unless it is more cost-effective to treat this waste along with more highly contaminated materials.

Patents: SVE is a patented technology. Royalty payments may be required under certain conditions of implementation.

Attainment of Remediation Goals: It should be noted that, like other in-situ technologies, it is difficult to ascertain with confidence whether SVE will attain remediation goals until the action is actually implemented However, the lower cost and ease of SVE implementation will often weigh heavily in its favor, as long as protection of human health and the environment is ensured.

Additional Technologies: If for some reason none of the presumptive remedies is applicable to a particular site, the site manager is encouraged to refer to EPA's forthcoming document entitled *Contaminants and Remedial Options at Solvent Sites* for a discussion of additional VOC treatment technologies. It should be noted that this comprehensive document, which identifies additional VOCs and technologies, may be appropriate to consider on a site-specific basis.

Thermal Treatment Technologies: The site manager should refer to EPA's Draft Strategy for Combustion of Hazardous Waste (May 18, 1993) when considering any thermal treatment technologies at a particular site.

Conclusion

For sites containing VOC-contaminated soil and appropriate soil characteristics, SVE is a relatively inexpensive and efficient technology. If material needs to be excavated, thermal desorption is preferred. In a few cases, incineration may be the most appropriate remedy -- for example, where SVE and thermal desorption will not meet clean-up criteria based on contaminant concentrations or composition.

As remedies other than SVE, thermal desorption and incineration become more widely used in the future, this directive may be modified to reflect these trends. For further assistance on presumptive remedy related activities consult the Regional Presumptive Remedies contact.

TABLE 3
Comparison of Technologies for VOC Sites

	PERFORMANCE[1]	ADVANTAGES	LIMITATIONS	COSTS[1]
Soil Vapor Extraction	Can be as high as 99% removal of VOC contaminants but is typically lower than other technologies with range of 85-99%	• High level of effectiveness in removing VOCs. • Relatively inexpensive. • Little site disturbance; no excavation required. • Effective for waste under buildings or other construction.	• Soil that is tight or has high moisture content (>50%) has a reduced permeability to air, hindering the operation of SVE. • Soil with a high degree of heterogeneity has highly variable permeabilities, resulting in uneven delivery of gas glow to the contaminated regions, which in turn reduces removal rates by SVE. • Soil with high organic content or that is extremely dry has a high sorption capacity for VOCs, which results in reduced removal rates. • SVE may require treating residual soil tailings, liquids, and spent activated carbon. • Air emissions must be controlled to eliminate possible harm to the public and the environment. • SVE is not effective in the saturated zone. However, lowering the aquifer can expose more media to SVE (this may address concerns regarding LNAPLs).	$10-150/ton
Thermal Desorption	95-99% removal of VOCs	• All compounds that are listed on Table 2 are readily treated by thermal desorption. • Because of lower treatment temperatures and often lower oxygen levels, thermal desorbers should produce less nitrogen oxides and sulfur dioxide than incinerators. • Process can be performed onsite or offsite. • Lower temperatures produce fewer products of incomplete combustion (PICs).	• Requires excavation If contamination is very deep or below the water table, excavation may be difficult and expensive. • Mercury, if present, can be removed from soil by thermal desorption and impose additional treatment costs for the offgas • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the desorber into downstream treatment devices. • Soil that contains constituents greater than 1 to 2 inches in diameter will require screening or crushing to prevent jamming the mechanical equipment. • Soil with a high moisture content (>30%) can result in low processing rates, high operating costs, and difficulty in materials handling. • High or low pH wastes may corrode the metal components of the system, requiring pretreatment. • Potential process residuals are treated solids, oversized debris, condensed contaminants and water, particulate control system solids, and contaminated activated carbon. • Air pollution control system required.	$200-300/ton
Incineration	>99% removal of VOCs	• Capable of accepting a wide range of media. • Processes can be performed onsite or offsite. • Metals can be concentrated in the residuals.	• Requires excavation. If contamination is very deep or below the water table, excavation may be difficult and expensive. • Soil containing high fractions of clay or silt may result in a high percentage of particulate carry-over from the incinerator into downstream treatment devices. • Air pollution control equipment is required. • High treatment temperatures, as compared to thermal desorption, can produce nitrogen oxides, sulfur dioxides, and PICs. • Solids with volatile metals may require additional treatment or more elaborate air pollution equipment.	$200 - 1700/ton

NOTES:

(1) Actual performance and cost for any remediation technology is highly site specific. Both depend upon the original and target clean-up level concentrations of contaminants, soil quantity to be treated, soil characteristics, and the design and operation of the remediation technology equipment used.

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies:		
Site Geology	SVE is most effective in porous, permeable, homogeneous soil. Highly heterogeneous soil (i e , fractured porous rock or sands interspersed with clay lenses) may exhibit air flow channeling through highly permeable soils Also, desorption kinetics may be slow in some situations (i e., high organic content or high clay content soil). In these cases, mass transfer kinetics may reduce the rate of removal of SVE below that which is expected by calculations with a local equilibrium model or pilot scale experiments carried out for only a few days. Often diffusion kinetics limitations can be substantially reduced by proper design of the SVE facility.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
USGS Soil Classification	For SVE to be effective, the soil must have sufficient pneumatic permeability ($>10^{-8}$ cm^2) to permit air to move through the medium. Sandy, gravely soils are the most conductive to SVE, while clays and silts are less conductive. However, remediations using SVE in clays and silts have been successful. Soil permeability may need to be measured in the field.	ASTM D 2487 ASTM D 2488
Soil Moisture	High moisture content in soil may drastically decrease its air permeability and, thus, the effectiveness of SVE. The site must be sufficiently well drained to prevent the severe reduction in air permeability, which occurs when the percent water saturation of the soil is greater than 50% Conversely, organics can be strongly adsorbed onto extremely dry soils, which also impedes SVE. The moisture content of the soil will affect the amount of energy required to heat the soil, the target temperature and the handling properties of fine-grained soil. Thermal desorption requires that the moisture content of the soil be less than 30%.	ASTM D 2216 ASTM D 3017
Depth to Ground Water	SVE is not effective in saturated soil. However, the water table can be lowered by pumping Thermal desorption and incineration are more expensive for high moisture soil.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp 3-3 to 3-20) EPA/540/G-89/004
Contaminant Identity and Properties	<u>Boiling Point</u> - Thermal desorption target temperature is dependent on contaminant boiling point. <u>Vapor Pressure</u> - SVE is effective for compounds with a vapor pressure greater than 0.5 mm Hg at soil temperatures <u>Dimensionless Henry's Constant</u> - SVE is effective for compounds with a dimensionless Henry's constant higher than 0.01 at soil temperatures <u>Water Solubility</u> - SVE is more successful for componds with lower solubilities. <u>Liquid and Vapor Density</u> - A contaminant with a density greater than water may form a DNAPL A contaminant with a density less than water may form an LNAPL. The flow characteristics of a compund's vapor for SVE is a function of its vapor density.	CRC Chemical Handbook

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites
(Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
All Technologies: (continued)		
Contaminant Concentration, Location, Volume, and Depth	These data can be gathered via soil matrix and/or soil gas sampling. Soil gas sampling, both shallow and at depths, may be more appropriate, given depth to ground water and stratigraphy.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Presence of Pipes or Subsurface Material	The presence of water or electircal conduits, soil fracture lines, debris, or any other objects that are more permeable than the surrounding soil will be the preferred pathway for the advecting gases.	Geotechnical Techniques
SVE Only:		
Soil/Air Filled Porosity	Porosity should be less than 40% for SVE to be effective.	Guidance for Conducting Remedial Investigations and Feasiblitiy Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil/Air Permeability	Soil/Air Permeability should be greater than 10^{-6} cm^2 for air to move throughout the contaminated soil. SVE is potentially effective in less permeable soul (i.e., between 10^{-6} to 10^{-10} cm^2), but further pilot-scale testing and/or mathematical modeling is recommended to better predict the time for cleanup (which is likely to be prolonged for lower permeability soil).	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil Temperature	Contaminant vapor pressure, dimensionless Henry's Law constant, water solubility, and phase density are strong functions of temperature.	Guidance for Conducting Remedial Investigations and Feasiblitiy Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil Humic Content	Solvents adhere strongly to soil with high humic content, which decreases the effectiveness of SVE.	Guidance for Conducting Remedial Investigations and Feasiblitiy Studies Under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Contaminant Soil Sorption Coefficient Kd (Since Kd is less readily available, Koc, the equilibrium between contaminants sorbed onto organic carbon versus the ground water is used.)	This parameter describes the tendency of the solvent to sorb onto soil or organic matter in the soil. Higher Koc's indicate that a subsurface is more likely to bind to carbon righ media (i.e., soil) than to remain in water.	RREL Treatability Database
Contaminant Adsorption Characteristics on Activated Carbon	This parameter is related to the feasibility of removing contaminants from residuals by carbon adsorption. This parameter is important since compounds such as MEK become unstable as they are adsorbed onton carbon.	RREL Treatability Database

TABLE 4
Information Required for Characterization and Technology Selection at VOC Sites
(Continued)

INFORMATION	RATIONALE FOR COLLECTING INFORMATION	REFERENCE
Incineration and Thermal Desorption Only:		
Soil Plasticity	Plastic soil, when subjected to compressive forces, can become molded into large particles that are difficult to heat.	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (pp. 3-3 to 3-20) EPA/540/G-89/004
Soil BTU Content	The soil BTU content determines the fuel requirements for thermal desorption and incineration.	ASTM D 3286
Contaminant Combustion Characteristics	Information on combustion characteristics of a VOC is required in order to determine the combustion characteristics of the incinerator.	Bench/Pilot Testing
Soil Particle Size Distribution	Thermal desorption usually requires that soil be pretreated to a maximum soil particle size ranging from 1 to 2 inches.	ASTM D 422
Alkaline Metal Salts (e.g., $NaSO_4$, KSO_4)	Alkaline metal salts may cause refractory attack and slagging at high temperatures.	Percentage of Na, K
Volatile Metals Content (e.g., Hg, Pb, Cd, Zn, Sn)	High metal content may cause ash leaching and stack emissions problems	Heavy Metals Analysis

BTU = British Thermal Units
LNAPL = Light Nonaqueous Phase Liquid
DNAPL = Dense Nonaqueous Phase Liquid
mmHg = millimeters of mercury pressure
NAPL = Nonaqueous Phase Liquid
PIC = Products of Incomplete Combustion

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analyses that EPA conducted of Record of Decision (ROD) and Feasibility Study (FS) data from VOC-contaminated sites which led to establishing soil vapor extraction (SVE), thermal desorption, and incineration as the presumptive remedies for Superfund sites with VOC-contaminated soil. The analyses consisted of:

- Identifying VOC-contaminated sites
- Determining the frequency of technology selection for VOC sites
- Identifying sites for the feasibility study (FS) analysis
- Conducting the FS analysis.

Results of these analyses, along with the scientific and engineering analysis of the performance data on technology application (Primary Reference document), provide a support for the decision to eliminate the initial alternatives identification and screening step for this site type. These technical reviews found that certain technologies are appropriately screened out based on effectiveness, implementability or excessive costs. Review of technologies against the nine criteria led to elimination of additional alternatives. Provided below is a discussion of each analysis.

Identification of VOC-Contaminated Sites

The first analysis involved generating a list of signed Records of Decision (RODS) (post-SARA), documenting VOC contamination, from which data could be used for subsequent analyses. The ROD Information Directory database was used for this purpose. Of the 821 signed FY86-FY91 RODS, 418 are identified in the database as containing VOC contamination in source material. This list of RODS was subsequently divided into two lists: RODS where VOCs were the only contaminants of concern identified in the source material and RODS containing VOCs, as well as other contamination, in source material. For those RODS involving VOC plus other contaminants, a review of the ROD document was conducted to identify cases where only VOCs were driving the selection of remedy. To make this determination, the Remedial Response Objectives and Selected Remedy sections of the ROD were reviewed to identify specific language indicating that the remedial action was designed to address only the VOCs at the site. In addition, if cleanup goals were specified only for VOCs, the assumption was made that VOCs were driving the remedy.

As a result of this analysis, 88 RODS were identified as VOC-only RODS or VOCs plus other contaminants RODS where a clear determination could be made that VOCs were driving the selection of remedy.

Frequency fo Technology Selection for VOC-Contaminated Sites

Table 1 presents the distribution of the 88 FY86-FY91 RODS among the treatment technologies used to address VOCs in soil. This table demonstrates that the three presumptive remedies (SVE, thermal desorption, and incineration) together were selected more often (over 90% of the RODS analyzed) than the other applicable technologies. Presumptive Remedies were also those remedies where a fair amount of performance data on technology implementation was available. Furthermore, SVE, chosen in over two-thirds of the RODS analyzed, was the primary presumptive remedy selected.

Identification of Sites for Feasibility Study Analysis

The purpose of the FS analysis was to document the technology screening step in FSs of VOC-contaminated soil/sludge sites and identify the principal reasons given for eliminating technologies from further consideration. To achieve a representative sample of FSs for the analysis, sites were selected using ROD data according to the following criteria:

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (Continued)

Table 1

Presumptive Remedy VOC Site Treatment Summary Table, FY86-FY91*

TECHNOLOGIES USED TO ADDRESS VOCs IN SOIL	TOTAL
Bioremediation (1)	3
Incineration	11
Soil Flushing/Washing (1)	3
Soil Vapor Extraction	62
Thermal Treatment (2)	9
Total	88

Source: ROD Information Directory (RID), FY86 - FY91

Notes. (1) Relatively limited amount of performance data available for these technologies versus the presumptive remedies.

(2) Thermal treatment includes RODS employing thermal desorption, thermal aeration, low-temperature thermal desorption, and the generic remedy "thermal treatment".

* A population of 418 RODS was identified for this study based on the parameters: FY 1986-1991, and VOC contamination of source media.

- Sites were chosen, based on the selected remedy, to ensure an even distribution among the five treatment technologies for VOCs in soil (i.e., bioremediation incineration, SVE, soil flushing, and thermal treatment).
- Whenever possible, both VOC-only sites and VOC and other contamination sites were represented under each technology.
- Sites were selected to ensure an even distribution in geographic location, ROD signature date, and site size.

Feasibility Study Analysis

The FS analysis involves a review of the technology screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases in each FS and ROD. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this directive. (See "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils", September 1993, available at EPA Headquarters and Regional Offices.)

APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES
(Continued)

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table (Table 2).

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the nine NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a VOC technology was combined with one or more technologies that address minor site contaminants into one or more alternatives. Only the component of the alternative which addressed the VOC contamination was evaluated in this analysis. The disadvantages of a technology/alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

The FS analysis has been completed for 21 sites (representing approximately 25% of universe studied). The information from these FSs has been compiled and summarized in Table 2. Additional FS analysis is planned and will be added to the Administrative Record, when available. Table 2 demonstrates that technologies, other than the presumptive remedies, are consistently eliminated from further consideration in the screening phase due to effectiveness, implementability, or excessive costs. In addition, the analysis indicates that, although certain technologies routinely passed the screening phase, these technologies were selected infrequently because they did not provide the best overall performance with respect to the nine criteria. Together these analyses (Appendix A to this directive and "Feasibility Study Analysis for CERCLA Sites with Volatile Organic Compounds in Soils"), along with the scientific analysis of performance data (USEPA (In Progress) Contaminants and Remedial Options at Solvent Sites) will support the decision of using presumptive remedies and bypassing the technology identification and screening step for a particular site. As previously indicated, this factsheet and accompanying analysis should be part of the Administrative Record for the site. Further supporting materials, not found in the Regional files, can be provided by Headquarters, as needed.

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES[1]																		
REMEDIAL TECHNOLOGY OR TREATMENT[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech Screened Out	Tech. Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out[3]			# RODs Tech. Selected	# RODs Tech Not Selected	#RODs Where Criterion Contributed to Non-Selection								
					Cost	Effectiveness	Implement			Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem	State Concerns[4]	Community Concerns[4]
Capping	21	8	7	6	1	6	2	0	8	5	3	7	6	6	3	1	---	---
Offsite Nonhazardous Landfill	4	0	2	2	0	2	1	0	0	0	0	0	0	0	0	0	---	---
Offsite RCRA Disposal	18	12	4	2	1	3	3	2	10	3	6	7	3	9	5	7	---	---
Onsite Encapsulation	3	1	2	0	1	1	0	0	1	0	0	1	0	0	0	0	---	---
Onsite Nonhazardous Landfill	2	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	---	---
Onsite RCRA Landfill	14	1	11	2	0	8	7	0	1	0	0	1	0	1	1	0	---	---
Activated Sludge	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	---	---
Composting	4	1	3	0	0	3	0	0	1	0	0	0	0	1	0	1	---	---
Land Farming	3	0	3	0	0	1	1	0	0	0	0	0	0	0	0	0	---	---
Bioremediation (unspecified)	6	0	6	0	0	5	4	0	0	0	0	0	0	0	0	0	---	---
Ex-Situ Bioremediation	7	1	6	0	2	5	2	1	0	0	0	0	0	0	0	0	---	---
In-Situ Bioremediation	11	1	10	0	2	9	4	0	0	0	0	0	0	0	0	0	---	---
Dechlorination/ APEG	3	0	3	0	0	3	1	0	0	0	0	0	0	0	0	0	---	---

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

REMEDIAL TECHNOLOGY OR TREATMENT[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech Screened Out	Tech Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out[3]: Cost	Effectiveness	Implement	# RODs Tech Selected	# RODs Tech Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem	State Concerns[4]	Community Concerns[4]
Other Chemical Destruction	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	---	---
Reduction	7	0	6	1	0	5	1	0	0	0	0	0	0	0	0	0	---	---
Neutralization	6	0	6	0	0	5	0	0	0	0	0	0	0	0	0	0	---	---
Oxidation	6	1	5	0	0	4	0	0	1	0	0	0	0	1	1	1	---	---
Offsite Incineration (unspecified)	16	7	8	1	5	5	2	0	7	2	0	1	0	7	6	2	---	---
Onsite Incineration (unspecified)	7	1	6	0	2	3	5	0	1	0	0	0	0	1	1	0	---	---
Fluidized Bed	5	0	4	1	3	1	2	0	0	0	0	0	0	0	0	0	---	---
Infrared	5	1	4	0	2	2	1	1	0	0	0	0	0	0	0	0	---	---
Pyrolysis	3	0	3	0	2	1	1	0	0	0	0	0	0	0	0	0	---	---
Multiple Hearth	5	0	4	1	2	4	1	0	0	0	0	0	0	0	0	0	---	---
Rotary Kiln	11	6	3	2	3	2	3	2	4	1	0	0	0	5	3	4	---	---
Other Incineration	13	1	12	0	5	6	5	1	0	0	0	0	0	0	0	0	---	---
Other Thermal Treatment	6	0	6	0	2	4	3	0	0	0	0	0	0	0	0	0	---	---

TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]					# FSs Where Criterion Contributed To Screening Out 3					#RODs Where Criterion Contributed To Non-Selection							
REMEDIAL TECHNOLOGY OR TREATMENT[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech Screened Out	Tech Not Primary Component of Alternative	Cost	Effectiveness	Implement	# RODs Tech Selected	# RODs Tech. Not Selected	Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns [4]	Community Concerns [4]
Vitrification	12	0	11	1	2	8	5	0	0	0	0	0	0	0	0	0	—	—
Wet Air Oxidation	6	1	5	0	1	4	3	0	1	0	0	0	1	1	1	0	—	—
Low Temperature Thermal Desorp/ Stripping	13	10	3	0	1	1	2	3	7	2	1	1	2	7	3	4	—	—
In-situ Steam Stripping	3	2	1	0	0	1	0	2	0	0	0	0	0	0	0	0	—	—
Soil Flushing	15	3	12	0	0	9	5	0	3	1	1	1	2	2	1	3	—	—
Soil Washing	14	2	12	0	1	10	9	0	2	0	0	1	0	2	2	1	—	—
In-situ Vacuum Extraction	17	11	6	0	0	6	2	10	2	0	0	0	1	0	0	2	—	—
B.E.S.T. Process	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	—	—
Liquified Gas	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	—	—
Other Physical Extraction	4	0	4	0	0	3	0	0	0	0	0	0	0	0	0	0	—	—
Fixation	7	1	6	0	0	6	0	0	1	0	0	1	1	0	1	1	—	—
Stabilization/ Solidification	13	2	7	4	0	6	2	0	2	0	0	2	2	2	0	2	—	—
Aeration	12	2	10	0	1	9	2	1	1	0	0	0	1	1	1	0	—	—

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TABLE 2 • SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR VOC SITES (Continued)[1]

REMEDIAL TECHNOLOGY OR TREATMENT[2]	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech Screened Out	Tech Not Primary Component of Alternative	# FSs Where Criterion Contributed To Screening Out 3: Cost	Effectiveness	Implement	# RODs Tech Selected	# RODs Tech Not Selected	#RODs Where Criterion Contributed to Non-Selection: Protect	ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem	State Concerns 4	Community Concerns 4
In-situ Hydrolysis	4	0	4	0	0	3	2	0	0	0	0	0	0	0	0	0	---	---
Soil Slurries	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	---	---

[1] This study was conducted on 21 RODs and their corresponding FSs.

[2] This does not include the no-action or institutional control only alternatives No RODs selected either of these as remedies

[3] FSs and RODs may contain more than one criterion for screening or non-selection of technology Also, some FSs did not fully explain the criteria for screening out a technology Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.

[4] Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary)

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
SOIL VAPOR EXTRACTION	• Provides both short- and long-term protection by reducing concentration and exposure to VOCs in soil. • Depending on site-specific conditions, prevents further ground water contamination.	• Does not trigger LDRs because it does not involve placement of waste • Because waste is removed in place through limited construction and no excavation, few impacts to wetlands, floodplains, or water quality are likely. • Depending on site-specific conditions, treats wastes to levels that will prevent exceedance of groundwater clean-uplevels • Emission controls are needed to ensure compliance with air quality standards	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Requires some treatment of residuals (spentcarbon or concentrated VOC waste stream) generally through regeneration or disposal. • Hazardous wastes left in place will require 5-year review.	• Significantly reduces toxicity, mobility, or volume through treatment. • Produces few waste streams	• Does not present substantive risks to on site workers or community; potential for some dust generation during well installation. • Potential air emissions are easily controlled through activated carbon adsorption or other technologies. • Generally involves relatively short time frame to achieve clean-up levels, however, difficulty in estimating time frame may exist due to site uncertainties (e.g., irregular soil permeabilities). • Effective for treating waste under buildings. Can be performed on active facilities. • Hardware, such as vacuum blower, is readily available from many sources, but SVE system performance is highly dependent upon the lithology of the site and system design.	• Few administrative difficulties. Technology is readily available from many sources. • Used successfully at numerous Superfund sites to address VOC contamination. • Installing and operating extraction wells requires fewer engineering controls than other technologies (i.e.,excavation and incineration). • Requires series of soil gas sampling to determine when clean-up levels are achieved.	$10-150/ton $50/ton avg

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil (CONTINUED)

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
THERMAL DESORPTION	• Provides both short- and long-term protection by eliminating exposure to VOCs in soil/sludge. • Prevents further groundwater contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite treatment unit may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels, thus, there is no LDR problem with residuals. • Generally, treats wastes to levels that will prevent exceedance of ground-water clean-up levles. • Emission controls are needed to ensure compliance with air quality standards.	• Effectively removes contamination source. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Involves some treatment or disposal of residuals generally through use of carbon adsorption/regeneration or disposal.	• Significantly reduces toxicity, mobility, or volume of contaminants through treatment. • Generally requires test runs to ensure effective treatment	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment). • Involves potential short-term risks from handling and transporting waste (if offsite treatment) • Relatively short time frame to achieve clean-up levels	• Construction and substantive permit requirements of an onsite treatment unit may persent some difficulties. Mobile incineration units for onsite treatment are available. • Limited offsite treatment capacity exists. • Used successfully at other Superfund sites to address solvent contamination • Requires engineering measures to control air emissions, fugitive dust,run-off, erosion and sedimentation, site access, and transportation.	$200-$300/ton $250/ton avg.

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX B
Criteria Evaluation for Technologies Used to Treat VOC-Contaminated Soil
(CONTINUED)

	CRITERIA						
	Overall Protection of Human Health and the Environment	Compliance With Federal ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]
INCINERATION	• Provides both short- and long-term protection by eliminating exposure to solvent contaminants in soil. • Prevents further groundwater contamination and offsite migration. • Requires measures to protect workers and community during excavation, handling, and treatment.	• Requires compliance with RCRA removal, treatment, transportation (if offsite treatment), and land disposal regulations (if a hazardous waste). • Excavation, construction, and operation of onsite incinerators may require compliance with wetlands and other location-specific ARARs. • Treats hazardous waste to BDAT levels; thus, there is no LDR problem with residuals. • Treats wastes to levels that will prevent exceedance of ground-water clean-up levies. • Emission controls are needed to ensure compliance with air quality standards during excavation and construction.	• Effectively destroys source of contamination. • Is a well-demonstrated technique for removing VOCs from soil/sludge. • Involves some treatment or disposal of residuals generally through use of carbon adsorption/ regeneration or disposal	• Significantly reduces toxicity, mobility, or volume of contaminants through treatment.	• Presents potential short-term risks to workers and community from air release during excavation and treatment (if onsite treatment) • Involves potential short-term risks from handling and transporting waste (if offsite treatment) • Relatively short time frame to achieve clean-up levels	• Construction and substantive permit requirements of an onsite incinerator may be somewhat difficult. Mobile incinerators are readily available • Limited offsite incineration capacity exists. • Used successfully at other Superfund sites to address VOC contamination.	$200-$1700/ton $400/ton avg

1. Note: Actual cost of a remediation technology is highly site-specific. It is dependent upon the original and target clean-up level concentrations of contaminants, soil characteristics, and the design and operation of the remediation technology used.

APPENDIX C
U.S. Waste Exchanges

CALIFORNIA WASTE EXCHANGE
Robert McCormick
Department of Health Services
Toxic Substances Control Division
400 P Street
Sacramento, CA 95812
(916) 324-1807

INDIANA WASTE EXCHANGE
Environmental Quality Control
1220 Waterway Boulevard
P.O. Box 1220
Indianapolis, IN 46206
(317) 232-8188

INDUSTRIAL MATERIAL EXCHANGE SERVICE
Diane Shockey
2200 Churchill Road, #31
Springfield, IL 62794-9276
(217) 782-0450
FAX: (217) 782-9142

INDUSTRIAL MATERIALS EXCHANGE
Bill Lawrence
172 20th Avenue
Seattle, WA 98122
(206) 296-4899
FAX: (206) 296-0188

PACIFIC MATERIALS EXCHANGE
Bob Smee
1522 North Washington Street, Suite 202
Spokane, WA 99205
(905) 325-0551
FAX: (509) 325-2086

NATIONAL WASTE EXCHANGE NETWORK
1-800-858-6625

RENEW
Hope Castillo
Texas Water Commission
P.O. Box 13087
Austin, TX 78711
(512) 463-7773
FAX: (512) 463-8317

INDUSTRIAL WASTE INFORMATION EXCHANGE
William E. Payne
New Jersey Chamber of Commerce
5 Commerce Street
Newark, NJ 07102
(201) 623-7070

MONTANA INDUSTRIAL WASTE EXCHANGE
Don Ingles
Montana Chamber of Commerce
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NORTHEAST INDUSTRIAL WASTE EXCHANGE
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SOUTHEAST WASTE EXCHANGE
Maxi May
Urban Institute
Department of Civil Engineering
University of North Carolina
Charlotte, NC 28223
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SOUTHERN WASTE INFORMATION EXCHANGE
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(904) 644-5516
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APPENDIX D
GLOSSARY

Applicable or Relevant and Appropriate Requirements (ARARs) - CERCLA Section 121(d) and the NCP require that onsite remedial actions must attain (or justify a waiver of) requirements of environmental laws that are determined to be Federal or more stringent State applicable or relevant and appropriate requirements

Dense Non-Aqueous Phase Liquid (DNAPL) -DNAPLs are immiscible hydrocarbon liquids that are denser than water, such as chlorinated solvents (either as a single component or as mixtures of solvents), wood preservative wastes, coal tar wastes, PCBs and some pesticides. DNAPLs can sink to great depths, can penetrate into bedrock fractures, can move as a liquid in a direction different from the flow of groundwater and can act as a continual source of groundwater contamination over time.

Engineering Evaluation/Cost Assessment (EE/CA) - An analysis of removal alternatives for non-time critical removal actions.

Ex-Situ Treatment - Removal of material from the ground for treatment.

Feasibility Study (FS) - A description and analysis of the potential clean-up alternatives for a site. It is generally conducted concurrently with the remedial investigation (RI), together the studies are referred to as an RI/FS. (See remedial investigation)

In-Situ Treatment - The treatment or remediation of media occurring in-place.

Innovative Treatment Technologies - Technologies that have been tested, selected, or used for treatment of hazardous substances or contaminated materials but lack well-documented cost and performance under a variety of operating conditions.

Land Disposal Restrictions (LDRs) - The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) include specific restrictions on the land disposal of RCRA hazardous wastes. These restrictions, known as LDRs, prohibit the land disposal of restricted RCRA hazardous wastes unless these wastes meet treatment standards specified in 40 CFR 268 or other compliance options.

Light Non-Aqueous Phase Liquids (LNAPL) - Like DNAPLs, LNAPLs are immiscible liquids, but are lighter than water and therefore float on water As they are lighter than water, they are most frequently found at the ground-water table/vadose zone interface.

Record of Decision (ROD) - A public document that explains the basis for selecting the clean-up alternative(s) that will be taken or served under CERCLA.

Remedial Desigh (RD) - The remedial action that involves designing and testing to determine whether the remedy will be effective at a site.

Remedial Investigation (RI)- An in-depth study designed to gather the data necessary to determine the nature and extent of the threat posed by contamination at a Superfund site. It also helps to establish the preliminary criteria for cleaning up the site in the FS and supports the technical and cost analyses of the alternatives. It is generally completed and combined with the FS and referred to as the RI/FS.

Risk Assessment - The qualitative and/or quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by actual and potential exposures to specific pollutants in air, water, soil or other media.

Superfund Accelerated Cleanup Model (SACM) - An initiative designed to accelerate all aspects of the Superfund clean-up process.

Vadose Zone - The zone in soil that lies above the permanent water table.

Volatile Organic Compounds (VOCs) - Any organic compound which readily dissipates into the air.

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APPENDIX C

SVE Treatability Study Technical Memorandum

Evaluation of Soil Vapor Extraction Treatability Study, Dunn Field, Memphis Depot (Rev. 1)

TO:	U.S. Army Engineering and Support Center, Huntsville
COPIES:	Defense Distribution Center (Memphis)
	U.S. Environmental Protection Agency (USEPA), Region 4
	Tennessee Department of Environment and Conservation (TDEC)
FROM:	CH2M HILL
DATE:	February 24, 2003

I. Introduction

This Technical Memorandum (TM) document summarizes the results of the Soil Vapor Extraction (SVE) Treatability Study, conducted at the Dunn Field of the former Memphis Depot ("the Depot) in Memphis, Tennessee. The purpose of the study was to determine if SVE represents an effective method for remediation of the vadose zone at Dunn Field. Soil in the vadose zone underlying Dunn Field is contaminated with volatile organic compounds (VOCs) as a result of past disposal activities. Additional information on past activities at Dunn Field and the Depot can be found in the *Dunn Field Remedial Investigation (RI)* report (CH2M HILL, July 2002).

SVE has been chosen as a presumptive remedy for the subsurface soil column and soil-to-indoor air at Dunn Field. In the September 1993, Directive 9355.0-48FS from the US Environmental Protection Agency (EPA), SVE was chosen as a presumptive remedy for Superfund sites with VOC-contaminated soil, assuming the site characteristics meet certain criteria. The selection of SVE was a result of EPAs collective knowledge about site investigation and remedy selection for VOC-contaminated soils. Information regarding the presumptive remedy policies and procedures can be found in the September 1993, Directive 9355.0-47FS, also from EPA. As a result of these documents and decisions by the Memphis Depot Base Realignment and Closure Act (BRAC) Cleanup Team (BCT), the presumptive remedy action will be carried forward through the Dunn Field Feasibility Study (FS) effort.

The SVE treatability study at Dunn Field was, to the extent possible and practical, performed in accordance with the specifications of the *Soil Vapor Extraction Treatability Study Workplan* (CH2MHILL, October, 2001). Exceptions to treatability study methodology outlined in the workplan are described in the Deviations From the Workplan section below.

Site Description

Site Name and Location

Dunn Field is a 64 acre rectangular area of undeveloped land at the Depot, which is located in the south central portion of Memphis, Tennessee (Figure 1). Treatability study activities focused on southern portion of an area of Dunn Field referred to as the Disposal Area (approximately 14 acres), which includes a series of former pits and trenches. Area designations of Dunn Field are shown in Figure 2.

Geological Setting

The impacted vadose zone at Dunn Field consists of two distinct geological formations - a shallow, relatively low permeability "loess" formation, and the deep, relatively high permeability alluvium ("fluvial sand") formation. The two formations are separated by a thin, but relatively continuous layer of sandy clay. The loess is positioned from immediately below ground surface (bgs) to approximately 30 feet bgs within the pilot test area. Underlying the loess is several feet of sandy clay, followed by fluvial sands, silt, and gravel, which occur at approximately 30 to 75 feet bgs. Further details regarding the geology and hydrogeology of the site is presented in the Dunn Field RI Report (CH2M HILL, July 2002).

Historical Site Use

Based on information obtained from Depot records and interviews with former Depot military personnel, Dunn Field was used intermittently for burial of waste. Disposal records and interviews with facility personnel indicate specific instances when some of the burial occurred. The earliest records of burial date back to 1946 with the disposal of German bomb casings containing mustard agent that were neutralized and buried in the western portion of Dunn Field. After draining and destruction operations were completed, all mustard-contaminated items (wood, clothing, etc.) were placed into the slurry pit and burned.

During the early to mid-1950s, Chemical Agent Identification Sets (CAIS) were allegedly disposed of and buried at Dunn Field at in the Disposal Area. The CAIS set contained small glass ampoules of diluted mustard, lewisite (a vesicant chemical agent), chloropicrin, and phosgene, which were stored in sealed cylindrical metal containers (PIGS). CAIS stocks found to be leaking or broken during periodic inspection were reportedly buried at Dunn Field.

In addition to the chemicals and ordnance described above, other chemicals associated with the use of chemical agents such as Decontaminating Agent Non-Corrosive (DANC) were buried in Dunn Field. The decontaminant DANC disposed of at Dunn Field is an organic N-chloroamide compound in solution with 1,1,2,2-tetrachloroethane (PCA). DANC typically contained 90 percent to 95 percent 1,1,2,2- PCA. Chlorinating compound number 1 (an N-chloroamide) and 1,3-dichloro-5,5-dimethylhydantoin (RH-195) were used as organic chlorinating compounds in DANC. Food stocks, paints, acids, herbicides, and medical waste were also destroyed or buried in pits and trenches at Dunn Field.

Site Characterization

Subsurface soil samples have been collected at various periods during the RI of Dunn Field and the Disposal Area, and sample analysis has revealed impacts from various contaminants, including VOCs, Semi-volatile Organic Compounds (SVOCs), metals, and pesticides. Concentrations of VOCs in subsurface soil samples collected during RI sampling in 1999 showed significant levels of the following chlorinated VOCs: 1,1,2,2-PCA; 1,2-Dichloroethane (DCA); carbon tetrachloride (CCl4); chloroform; methylene chloride; Tetrachloroethene (PCE); Trichloroethene (TCE); and vinyl chloride. For example, the highest level of TCE detected during the 1999 investigation was 460 milligrams per kilogram (mg/kg).

Based on analysis of the 1999 Dunn Field RI data and on detection of possible dense non-aqueous phase liquid (DNAPL) in groundwater immediately west of the central portion of the Disposal Area, CH2M HILL conducted further soil sampling efforts in October 2000 in an effort to further delineate potential source areas. As part of this effort, fifteen soil borings were installed in the central portion of the Disposal Area, particularly around the former location of soil boring SBLCA (Figure 3). Analysis of soil samples collected from these borings revealed VOC concentrations ranging from 0.7 to 22,600 mg/kg.

During installation of these same borings, soil gas samples were collected using a SimulProbeTM by Parsons Engineering Science, Inc. (Parsons) as part of the Remedial Process Optimization (RPO) Phase II Evaluation Report, Defense Depot Memphis, Tennessee (Parsons, June 2001). The analysis of the soil gas samples revealed VOCs as high as 3.9 parts per billion, volume per volume (ppbv) and that the contamination in soil appears to increase with depth, "suggesting upward diffusion of volatile contaminants from the groundwater". Table 3-1 of the June 2001 Final RPO report contains a summary of the laboratory analytical results for the soil gas samples collected at Dunn Field.

Based on available soil analytical data and review of subsurface soil characteristics, this area of Dunn Field was selected as most representative of Dunn Field vadose zone contaminant concentrations and geology, as well as the best location for a presumptive remedy screening and an SVE test.

Test Area Development

Venting Wells and Monitoring Points

As a result of the studies conducted in 2000 within the central portion of the Disposal Area, two venting wells, VW-1 and VW-2, and four monitoring points, MP-1 through MP-4, were installed to act as the SVE Treatability Study site. The location of the venting wells is found in Figure 3. Construction specification detail sheets on the test venting wells and monitoring points can be found in the Final Soil Vapor Extraction Treatability Study Workplan (CH2MHILL, October, 2001) as well as the Dunn Field RI Report (CH2M HILL, July 2002).

VW-1 (venting well for Test 1) is constructed of two-inch diameter PVC, and screened within the loess formation from 9 to 24 feet bgs. VW-2 (venting well for Test 2) is also constructed of two-inch diameter PVC and screened within the fluvial sands, from 32 to 72 feet bgs. Each monitoring probe is constructed of ¾ inch diameter PVC, with six-inch long screens. In general, two well points from each probe cluster are screened at shallow depth, within the loess, and the remaining two points are screened within the fluvial sands. Table A-1 in Attachment 1 provides the construction details for all venting wells and monitoring points used during the test.

Based on suggestions made within the June 2001 RPO Report (Parsons, June 2001), four additional monitoring points were installed in November 2001 at the test site to augment MP-1 through MP-4 and to refine the anticipated radius of influence of the testing system, especially within the loess deposit. These monitoring points were numbered MP-5 through MP-8. The construction of these monitoring points was similar to that of the previously installed points. As shown in Figure 3, three of the new points, MP-5, MP-6, and MP-7, are located between VW-1 and the nearest existing probe, MP-3, which is 40 feet from VW-1. MP-8 is located approximately 200 feet from VW-1 and served as a background monitoring point outside the anticipated radius of influence (ROI). Except for probes MP-5 and MP-8, two well points from each probe cluster are screened at shallow depth, within the loess, and the remaining two points are screened within the fluvial sands. MP-5 has two points screened entirely within the loess and MP-8 has one point screened within the loess and one point within the sands. Attachment A presents the completion diagrams of MP-5 through MP-8.

Soil Core Samples

Soil core samples through the use of Shelby Tubes were collected for geotechnical analysis of the soil. These cores were collected during the drilling of the borings for MPs 5 through 8 and were collected from both the loess deposits and the vadose zone of the fluvial aquifer at depths of 5, 10, 15, and 20 feet bgs in the loess deposits and at 40, 50, 60, and 70 feet bgs in the sand and gravel fluvial aquifer for a total of eight samples. Each core was analyzed by Law Engineering and Environmental Services, Inc. for the following parameters:

- Hydraulic Conductivity;
- Specific Gravity;
- Organic content.

All samples were collected according to ASTM standards for soil core sampling and according to procedures described in the study workplan. Raw analytical data for the samples can be found in Attachment B. Table 1 summarizes the results of the analysis.

II. Treatment Technology Description

SVE is a common and proven technology used to withdraw contaminant-laden vapor from the vadose zone. SVE is most effective for contaminants that have a tendency to volatilize readily, as indicated by relatively high vapor pressure and Henry's Law constant. Chlorinated solvents, such as those present at Dunn Field, are primarily removed by volatilization (mass transfer) from the vadose zone. SVE also accelerates in-situ aerobic biodegradation of some contaminants. Direct aerobic biodegradation of most chlorinated solvent compounds, other than engineered cometabolic biodegradation, is documented in literature describing SVE techniques and applications.

Technology Limiting Factors

Some of the factors, other than the contaminant characteristics, that impact the effectiveness of SVE are as follows:

- *Permeability*

The permeability of the soil affects the rate of air and vapor movement through the soil; the higher the permeability of the soil, the more rapidly vapor can be extracted, over a larger area.

- *Soil Structure and Stratification*

Soil structure and stratification affect vapor flow patterns and degree of flow uniformity through the soil. Structural anomalies (e.g., layering, fractures) often result in preferential flow pathways which can cause asymptotic "tailing" of mass removal and extend project time frames significantly.

- *Soil Moisture*

High moisture content in soils can reduce soil permeability and, consequently, the effectiveness of SVE by restricting the flow of air through soil pores. Fine-grained soils create a thicker capillary fringe than coarse-grained soils. SVE is generally not effective in treating soils below the top of the capillary fringe unless depression of the water table is performed.

- *Native organic material*

Soil high in organic material tends to adsorb contaminants more strongly, which reduce the efficiency of SVE by volatilization (mass transfer).

- *Temperature*

Vapor pressure and Henry's Law constant increase with temperature. Therefore, thermally enhanced SVE and other corollary remedial strategies, such as steam injection and electrical resistance heating, are becoming increasingly common for accelerated remediation of chlorinated solvents.

- *Depth to Groundwater*

Shallow depth to groundwater renders effective SVE design difficult because a high volume of groundwater can easily be entrained in the extraction wells. In such cases, horizontal wells help to mitigate bulk water entertainment in the vapor stream.

Treatment Process And Scale

Pilot-scale treatability studies are an important part of the design phase. Data provided by this treatability study is necessary to properly design a full-scale SVE system. These studies also provide information on the concentration of VOCs that is likely to be extracted during the early stages of operation of a full-scale system. A pilot-scale test is recommended for evaluating SVE effectiveness and design parameters for any site, especially where SVE is expected to be only marginally to moderately effective.

Pilot-scale studies typically include short-term (1 to 30 days) extraction of soil vapors from a single extraction well, which may be an existing monitoring well at the site. However, longer pilot-scale studies (up to 6 months) that utilize more than one extraction well may be appropriate for larger sites. As a result of the presence of distinct geological formations beneath Dunn Field, and in accordance with the workplan, separate studies ("Test 1" and

"Test 2") were conducted for each formation with removal of at least five pore volumes of gas from each formation being a primary guide. Based on preliminary calculations of the contaminant mass in the two formations and on Table 3-3 of the June 2001 RPO report (Parsons, June 2001), the time required to remove the soil gas from the loess deposits was estimated at 2 days, whereas for the fluvial aquifer, the estimated time was for removal in approximately 6 days.

Operating Features

As detailed in the workplan, "transient" and "steady state" experiments were planned for both Test 1 and Test 2. The transient test consisted of varying the flow at the vacuum pump (using a throttling valve) and observing the effect on vacuum ROI. The steady state test, as the name implies, involved purging the vapor extraction well at a constant flow rate, for a prescribed period of time, as indicated in the preceding section.

III. Treatability Study Approach

Test Objectives and Rationale

Analysis of laboratory analytical data from soil and groundwater samples collected during the Dunn Field RI field effort indicates that contaminants exist in site soils at levels not protective of groundwater. The analysis also indicates that soils may not be protective of human health and the environment. The removal of these contaminants, which act as a contaminant source, will be a priority for the impending Dunn Field remedial action. Therefore, the primary objective of this treatability study is to assist the development of SVE as a presumptive remedy screening tool prior to conclusion of the Dunn Field FS.

SVE is considered a viable technology for removal of VOCs from soil at Dunn Field, based on review of available literature, as well as projects completed by CH2M HILL at similar sites, with similar chemical and geologic characteristics. If SVE is deemed applicable for removal of VOCs after completing the treatability study, it will be presented to the public as the preferred remedial alternative in the Proposed Plan, and selected as the subsurface soil and soil-to-indoor air remedy in the Record of Decision. Data generated from the treatability study will subsequently be used as a design and cost basis for full-scale implementation of SVE at Dunn Field.

Other objectives of this treatability study include definition of:

- the relationship between applied vacuum and flow from the well,
- air permeability of the soils,
- contaminant removal rates as a function of time,
- vacuum distribution in soils surrounding the extraction well,
- water table response to applied vacuum, and
- condensate/liquid production.

The performance of the SVE system has been judged against certain parameters that define the effectiveness of removal of VOCs from the two formations underneath Dunn Field—the loess and underlying fluvial sands and gravels. These parameters include:

- vacuum influence zone ("ROI"),

- soil permeability to air,
- organic vapor concentrations in each formation (prior, during, and post-test),
- soil gas chemistry for each formation; and
- the relationship between applied vacuum and volumetric vapor flow rate.

In addition, analytical sample data for the soil gas was used to develop a potential soil cleanup goal during full-scale technology of the technology. The remedial goals take into account the requirement that the soil levels must be protective of groundwater.

Experimental Design And Procedures

Transient Test

A transient, or "step" test was performed (or attempted) for both Test 1 and Test 2. The objective of the step test was to evaluate the relationship between flow and vacuum ROI. Because of conditions encountered in the field, the step test for Test 1 was abandoned (refer to the Results and Discussion section below for additional information).

In order to perform the step test, the ambient air intake ("dilution") valve or flow control ("throttling") valve was adjusted in three increments, based on a maximum achievable flow rate. The vacuum at the wellhead and surrounding monitoring probes, as well as flow rate, was measured at pre-determined time intervals. This data will be used to predict the vacuum influence zone at various applied flow/vacuum levels.

Steady State Test

The purpose of the steady-state pressure test is to determine approximate steady-state vacuum distribution and soil gas chemistry data. As in the case of an aquifer pump test, the pressure distribution "cone of depression" surrounding a venting well can, in some instances, require an extended period of time to achieve pseudo steady-state conditions. This extended time frame to achieve steady state is especially common in low permeability formations and where sources of recharge or flow barriers may be encountered. Because of the low density of air relative to water, steady state can be established within a short time frame (i.e., minutes to hours). For this test, the steady-state condition was the desired operating condition.

Test Performance - Equipment And Materials

Test 1 – Loess

The test of the loess deposits (Test 1) began on December 18, 2001, and concluded on December 21, 2001. Prior to conducting Test 1 within the silty clay soils comprising the loess deposits, CH2M HILL examined the geologic and physical characteristics of the site. The following information was developed:

- The soil permeability to air flow (k) of silty clay is generally low, and the value of k is further reduced by soils of high moisture content. The moisture content of the loess formation was expected to be high, since the site is unpaved and open to surface water infiltration. A period of heavy rains immediately preceded the test, which exacerbated this condition. Although heavy rains fell immediately before the test was started, no further rain fell during the Test 1 operating period.

- Since the site is unpaved, vertical vapor flow "short circuiting" was expected to occur through shallow soils near grade surface. The effect of vertical flow on the vacuum ROI was considered an important component of the test performance evaluation.

As a result of the expected high moisture content of the loess deposits and the low soil permeability to air flow, an SVE pump of high vacuum capability was specified. High vacuum capability was considered necessary to overcome the resistance of the dense, silty clay soil to air flow and, generate sufficient vacuum to remove entrained surface water or groundwater held by capillary forces. As this entrained water is removed by vacuum dewatering, the effective porosity (i.e. pore space not occupied by capillary water) is increased, and soil permeability to air/vapor flow increases proportionally.

A fully enclosed, skid mounted vacuum extraction system was mobilized to the site for the purpose of Test 1. Equipment with this skid included the following (refer to Figure 4 for a Piping and Instrumentation Diagram (PID) of Test 1):

- Twenty horsepower (hp) oil-sealed, liquid ring vacuum pump, capable of producing approximately 250 acfm at 25 inches of mercury (inches Hg).
- Eighty-gallon moisture separator tank, with integrated progressive cavity discharge pump, capable of purging the separator tank under full vacuum.
- Fifteen hundred-gallon polyethylene holding tank, used for the temporary storage of water purged during the test.
- Three 1,000 pound capacity, vapor phase granular activated carbon beds for vapor treatment.
- Differential pressure (orifice plate type), direct reading vapor flowmeter (placed in line with the vacuum pump, on the influent side) and rotating disc type groundwater flow meter. Various direct reading analog pressure and vacuum gauges.
- Magnehelic differential pressure gauges, of various scale ranges (0.025, 0-1, 0-5, and 0-10 inches of water), used to collect vacuum and pressure measurements at each monitoring probe.

The liquid ring vacuum pump was connected to VW-1 using flexible, semi-transparent, vacuum rated PVC hose, camlock (quick disconnect) fittings, and a rubber "fernco" fitting with threaded hose clamps. Vacuum/flow was throttled using a valve prior to the pump, and resulting vacuum was measured both at the moisture separator tank and at the inlet to the pump. The instantaneous groundwater purge rate VW-1 could not be quantified, because of the combined fluid stream (groundwater and vapor). However, the total purged groundwater volume was recorded periodically during the test.

Test 2 – Fluvial Sands

Unlike the loess test, SVE from the fluvial sands was expected to be relatively straightforward, and a large vacuum ROI was anticipated. The fluvial sands are relatively porous, well drained, and of relatively high permeability. It was expected that vertical "short-circuiting" would be at least partially mitigated by the overlying low permeability loess formation.

Since the conditions of the fluvial sands are distinct from those of the loess, a different vacuum pump was mobilized to the site on January 5, 2002 for Test 2, and the liquid ring unit was transported off-site. Test 2 was conducted from January 7 through 11, 2002. The vacuum pump used for Test 2 needed to be capable of relatively high flow at low vacuum levels.

Equipment for Test 2 included the following (refer to Figure 5 for a PID of the equipment layout for Test 2):

- Skid mounted, five hp, regenerative blower, producing approximately 250 standard cubic feet per minute (scfm) at 30 inches of water column vacuum.
- Thirty-gallon moisture separator tank, differential pressure flowmeter, and analog vacuum gauges.
- Magnehelic differential pressure gauges, of various scale ranges (0.025, 0-1, 0-5, and 0-10 inches of water), used to collect vacuum and pressure measurements at each monitoring probe.

The venting well and monitoring probe network used to conduct the test is depicted in Figure 3. The same monitoring probes, MP-1 through MP-8, used for Test 1 were also used for Test 2.

As in the case of Test 1, MP-8, located approximately 200 feet from VW-2, was used as "background" monitoring point, in order to provide quantification of background pressure/vacuum.

The regenerative blower was connected to VW-1 using flexible, semi-transparent, vacuum rated PVC hose, camlock (quick disconnect) fittings, and a rubber "fernco" fitting with threaded hose clamps. Vacuum/flow was throttled using a valve prior to the pump, and resulting vacuum was measured both at the moisture separator tank and at the inlet to the pump.

Sampling and Data Management Procedures

Sampling routines and data management for the SVE treatability study followed the requirements of the DQOs outlined in the Soil Vapor Extraction Treatability Study Workplan (CH2MHILL, October, 2001). Most of the field data was obtained through the efforts of field screening, which included the use of direct-reading instruments. Other data included fixed laboratory analysis. This section describes the sample numbering system and collection of samples.

Field Screening Data Management

During the SVE treatability study, three tests were conducted; one transient test (at VW-2) and two steady-state tests (at both VW-1 and VW-2). During each test, samples were collected using field screening techniques. The field screening techniques included: ambient air screening with a FID; screening with a FID for VOCs; air monitoring for hazardous ambient conditions using a CGI/O2 meter; pressure and velocity/flow measurements; and air sampling for oxygen and carbon dioxide. Data that were recorded with each measurement included the following:

1. Date and time;
2. Elapsed time since test beginning, as necessary;
3. Location of measurement/location where the sample was collected; and
4. Instrument measurement.

Sample information was recorded on laminated data collection sheets with permanent marker to ease measurement collection and data recording. after the entire test has been completed, the data was transferred into an electronic file for use within the treatability study report. All field vacuum measurements and field vapor analysis data can be found in Attachment C. The following table presents a summary of the field sample information.

Field Sample Reference Table

Sample Task	Venting Well (VW) or Monitoring (MP) Point Number	Test Type	Test Phase (only applicable to Transient test)	Sample Numbering System (where necessary)
Ambient Air Screening	Applicable to site area	Transient	1, 2, 3, or 4	
		Steady-state		
Screening with an FID for VOCs	VW-1 or VW-2 and MP-[and no.]	Transient	1, 2, 3, or 4	
		Steady-state		
Air Sampling for VOCs	VW-1 or VW-2	Transient	1, 2, 3, or 4	VW1-T-1-SMA-** or VW2-T-1-SMA-**
		Steady-state		VW1-S-1-SMA-** or VW2-S-1-SMA-**
Air Monitoring for VOCs	VW-1 or VW-2	Transient	1, 2, 3, or 4	
		Steady-state		
Air Sampling for O_2 and CO_2		Transient	1, 2, 3, or 4	
		Steady-state		
Pressure, Velocity/Flow	VW-1 or VW-2 and MP-[and no.]	Transient	1, 2, 3, or 4	Direct read from gauge. Note time, location, venting well, test type, and phase when collecting reading.
		Steady-state		Direct read from gauge. Note time, location, venting well, test type, when collecting reading.

**Sample number will reflect the time expired since test began. Samples were taken at 4, 12, 36, and 72 hours after the test has begun; therefore, for example, the sample taken during the steady-state test of VW-1 after 4 hours of testing was numbered VW1-S-SMA-4.
SMA = SUMMA® Canister

For background or baseline samples, the acronym BCKG for background and BSLN for baseline samples was inserted as a prefix to the sample numbers presented in the table above. The location of the sampling point is noted in the summary table for those locations not immediately adjacent to MPs or VWs.

Other field notes collected during performance of the treatability study and written in the field notebook(s) include: weather information; personnel on-site during the test;

subcontractor names and activities; sketches of the SVE system used during the study; notes on the proximity of the system to established facilities on Dunn Field: type of test being conducted (transient versus steady-state); and any other pertinent information that would effect the study results. Vacuum vs. time data for both tests was recorded on water-proof, laminated field sheets, using permanent markers.

Analytical Laboratory Data Management

SUMMA canisters were collected from four locations during each test:

1. ambient (background) air, 200 feet from VW-1
2. vacuum pump/blower discharge, prior to vapor treatment
3. treated vapor discharge, after both carbon beds

Samples were taken at 4, 12, 36, and 72 hours, as appropriate, after each test had begun. During collection of the SUMMA canister samples, the date, time, location of sample collection, test type, and sample number was recorded in the field notebook. This information was subsequently transferred to the Chain-of-Custody (COC) documents for each canister. Attachment D contains copies of the SUMMA canister sample COC documents, the analytical reports, and Table D-1, which presents the raw analytical results.

Deviations From the Work Plan

The primary deviation from the workplan regarding sample collection was made within the sample numbering system. Section 7 of the final workplan defined the sample numbers that were to be placed on each of the samples collected, whether field measurement or fixed-based laboratory sample. However, upon reviewing the sample numbering requirements and the time required in the field to collect measurements, the decision was made to develop sample data collection sheets that contained all information necessary to categorize each field measurement or sample. The final data collection sheet format can be found in Attachment C along with the measurements collected. The data collected in the field was immediately transferred to electronic format and compared with the original.

IV. Results and Discussion

Loess Formation – Test 1

As a result of the low permeability and high moisture content of the loess deposits, the step test during Test 1 was abandoned. After conclusion of the first hour of what was to be the transient test, a subsequent opening of the throttling valve resulted in negligible effect in terms of vacuum or vapor flow. Therefore, the transient step test immediately became the steady state test and was continued for 72 hours (from December 18 to December 21, 2001). After the first hour, the vacuum pump was operated at maximum vacuum, with the throttling valve fully opened in an attempt to achieve pseudo "steady state" conditions.

Heavy rains immediately preceding Test 1 were followed by the onset of a cold front, which likely impacted barometric pressure in the area, as well as subsurface air pressures. Water table fluctuation may have also contributed to subsurface pressure fluctuations. Barometric pressure readings collected during both testing periods at the Memphis International Airport, approximately 2 miles from the site, are presented in Attachment E.

Tables 2 through 9 present graphs of the pressure/vacuum versus time data collected during Test 1 for each monitoring probe. Individual monitoring probe vacuum versus time plots for Test 1 can be found in Attachment F. The vacuum response in surrounding monitoring probes was delayed by high moisture content of the uncovered, and presumed nearly saturated, shallow loess soils. Ponded water in the immediate vicinity of VW-1 indicated essentially saturated conditions near the surface. Upon activation of the vacuum pump at the start of the test, relatively continuous pulses or "slugs" of purged water were observed being removed from VW-1. The rate of surface/groundwater extraction from VW-1 declined progressively during the course of the test, as summarized in the following table.

Test 1 Elapsed Time (hours)	Cumulative Purge Water Volume (gallons)	Incremented Average Purge Rate (gallons per minute)
2	200	1.67
19	720	0.51
42	1,080	0.26
72	1,450	0.21

It is assumed that bulk soil water, primarily the result of surface water infiltration from heavy rains, was extracted rapidly, followed by slow extraction of groundwater entrained by capillary forces within the loess. The groundwater extraction rate appeared to stabilize at approximately 0.2 gpm after 72 hours. Depth to water measurements collected in VW-1 varied from 2.45 feet below top of casing (TOC) at the start of Test 1 (December 18, 2001) to 20.38 feet below TOC at the start of Test 2 (January 7, 2002). This indicates that the majority of the water purged during Test 1 was surface runoff.

Based on inspection of the vacuum vs. time data plots, the progress of the test included two distinct phases: Phase 1, dewatering (0-30 hours); and Phase 2 (30-72 hours), vertical recharge. During the initial dewatering phase, surface water entrained in the loess was extracted, and saturated conditions in the shallow subsurface were slowly abated. As the moisture content of the soil adjacent to VW-1 was reduced, the soil permeability to air-flow increased, and the zone of vacuum influence (and vapor flow) progressively expanded. Surface water, ponded and/or entrained in shallow top soil covering the loess, likely mitigated atmospheric air "short-circuiting" (vertical leakage) during Phase 1.

Approximately 30 hours into Test 1, vacuum readings in the periphery monitoring points screened in the loess began to decline sharply. The only monitoring point exhibiting steadily increasing vacuum during the entire test was the 11 foot deep screen interval at MP-5, which is located 9.5 feet from VW-1. Vacuum loss was noted at the 21-foot deep screen interval at MP-5. The loss of vacuum in periphery/deep monitoring points is likely explained by vertical leakage through the uncovered ground surface. As the shallow surface soils surrounding VW-1 were dewatered, the permeability to air increased dramatically and vapor flow pathways were altered significantly. Although VW-1 is screened from 9 to

24 feet below grade, the majority of gas flow would be expected to occur within the first several feet of screen, positioned closest to ground surface.

Similar to a groundwater purge scenario, gas fluid flow toward a vacuum extraction well occurs as a "cone of depression". Accordingly, for an unconfined (i.e. uncovered), shallow vadose zone, such as the loess, the vast majority of gas flow occurs vertically through the ground surface, immediately surrounding the extraction well (i.e. the path of least resistance). This assertion has been verified at similar sites by numerical modeling. Vertical leakage explains the loss of vacuum in periphery monitoring points greater than 10-15 feet from VW-1, as well as vacuum loss at the 21-foot depth interval for MP-5.

Barometic pressure fluctuations also impacted the vacuum data (Attachment E). On the second day of the test, a cold front caused a significant rise in barometric pressure (as measured at the Memphis airport, located approximately 2 miles south of the site). Changes in atmospheric pressure produced corresponding fluctuations in subsurface soil gas pressure. Only negative pressures were recorded during the test, positive pressure readings were recorded as zero negative pressure. To distinguish "ambient" pressure fluctuation from that resulting from the induced vacuum during the test, MP-8 was installed at a distance of approximately 200 feet from VW-1, and designated a "background" monitoring point. The MP-8 location also provides quantification of background pressure/vacuum in both the loess and the fluvial sands.

Fluvial Sand Formation – Test 2

Test 2 for the fluvial sand formation was conducted from January 7 to January 11, 2002, over a continuous period of 96 hours. A preliminary step test, or "transient" test, was performed to evaluate of the relationship between applied vacuum, flowrate, and ROI. Flow and vacuum were progressively throttled (decreased) in three distinct steps, each lasting 1 hour:

- Step 1, 249 scfm @ 30 inches water column (w.c.) vacuum;
- Step 2, 210 scfm @ 18 inches w.c. vacuum; and,
- Step 3, 96 scfm @ 16 inches w.c. vacuum.

After the step test was completed, the flow was increased to maximum levels (252 scfm @ 31 inches w.c, throttle valve fully opened) for the duration of the "steady state" test, which was continued for 93 hours.

Tables 10 through 17 present graphs of the pressure/vacuum versus time data collected during Test 1 for each monitoring probe. Individual monitoring probe vacuum versus time plots for Test 1 can be found in Attachment F. Vacuum response was very rapid for monitoring points screened in the fluvial sands (i.e. screened from a depth of at least 25-30 feet bgs). Some points screened in the loess also produced a limited response, indicating some degree of vertical leakage from the loess. Certain monitoring points showed negligible response: MP-3 (distance from VW-2, 40.0 feet; fluvial screen depths, 49 and 69 feet) and MW-4 (distance from VW-2, 53.5 feet; fluvial screen depths, 48, 58, and 70 feet). The cause of the negligible response in these points, which are well within the vacuum ROI, is uncertain. Improper construction and/or anomalous soil conditions are possible causes. MP-5 is not screened in the fluvial sands, therefore, the lack of response in this well was expected.

Trends in the test data are illustrated in the time vs. vacuum plots. As evident in these data plots (aside from MP-3, MP-4, and MP-5), a highly erratic, but progressive upward trend in the data is visible. The erratic nature of the vacuum vs. time data is unusual. Initially, it was thought that vacuum fluctuations indicate redistribution of preferential flow pathways/ zones and/or vertical leakage. However, the uniform decrease and "rebound" of vacuum levels in the monitoring points refutes these assertions. Significant barometric pressure changes were not indicated at MP-8. Therefore, the only explanation is water table fluctuation, changes in soil moisture content, or other subsurface phenomenon effecting pressure distribution.

V. Data Analysis and Interpretation

Analysis of Treatability Study Data

Test 1 - Loess Formation

Calculation of the vacuum ROI for Test 1 was performed using data collected at elapsed time 27 hours, which corresponds to the maximum vacuum reading at most of the points. The 27 hour data is assumed to correspond to approximate "steady state" conditions with a barrier to surface leakage, in this case, saturated soil.

The in-situ soil permeability (k) of the vadose zone and vacuum ROI were estimated using a semianalytical, graphical model which describes pressure and velocity distribution and volumetric vapor flowrate in homogeneous porous media under equilibrium (steady state) conditions. The 27 hour data was considered to be representative of semi-equilibrium conditions, therefore, this assumption is considered reasonable. This model is based on one dimensional compressible flow to a vertical extraction well (Johnson, P.C. and Kemblowski, M. Qualitative Analysis for the Cleanup of Hydrocarbon-Contaminated Soils by In-Situ Soil Venting, Groundwater, Vol.28, No. 3, 1990). As is common practice for low permeability soil, the radius of influence criterion was selected to be 1 inch of water column vacuum. Conservative selection of the ROI criterion is necessary for silt/clay, because of the low flow rates achievable in these materials.

Model output for Test 1 is presented in Attachment G, as well as equations and a description of variables. The model includes semi-logarithmic regression of absolute pressure squared vs. natural log of distance. Prior to performing this regression, the "background" vacuum in the loess at MP-8 was subtracted from 27-hour data for each of the other points. In addition, MP-6 was eliminated from the regression, since this point was relatively unresponsive during the entire test (MP-6 may have been improperly constructed or installed in a low permeability anomaly).

Based on the regression and model output, the calculated vacuum ROI was determined to be 53.5 feet. The calculated k value was determined to be 0.2 darcy, in the range expected for a low permeability clay/silt. The presence of measurable vacuum does not necessarily indicate flow sufficient to accomplish remedial objectives. The one-dimensional compressible flow model described above was used as a preliminary approximation of ROI and permeability, for the purposes of technology screening. CH2M HILL understands this model represents a simplified and somewhat antiquated approach to SVE well field design, and that numerical flow modeling is a robust alternative. Numerical flow modeling is planned as part of the final design, after SVE is selected for full scale implementation at Dunn Field.

Vapor analytical data is presented in Table 18. Based on review of the organic vapor (FID) data, concentrations of volatile organic compounds increased progressively throughout the test and did not appear to achieve "steady state". Quantitative SUMMA canister data (Attachment D) also exhibits a trend of generally increasing VOC concentrations with time during the course of the test.

Test 2 - Fluvial Sand Formation

Calculation of the vacuum ROI was performed using data collected at elapsed time 92 hours, which corresponds to the maximum vacuum reading at most of the points. The 92-hour data is assumed to correspond to approximate "steady state" conditions.

The in-situ soil permeability (k) of the vadose zone and vacuum ROI were estimated using the identical semi-analytical, graphical model described for Test 1. The ROI for the fluvial sands was selected to be 50 percent of that selected for the loess, or 0.5 inches of water column vacuum. Within higher permeability materials, low vacuum levels may indicate the presence of significant flow, however, numerical modeling would be required to substantiate this assertion.

Model output for Test 2 (Steady-State) is presented in Attachment G, as well as equations and a description of variables. The 92 hour data from all the monitoring points, including MP-3, and MP-4, which did not respond, was included in the regression analysis. Based on the regression and model output, the calculated vacuum ROI was determined to be 104 feet. The calculated k value was determined to be 24 darcy, in the range expected for a fine sand.

Model output for the transient test is also presented in Attachment G. The ROI values obtained for the transient test are: Step 1, 249 scfm, 90.8 feet; Step 2, 210 scfm, 88.2 feet; and Step 3, 96 scfm, 68.1 feet. The decrease in ROI with flow follows an exponential (non linear) curve, as illustrated in the "Vacuum ROI vs. Flow" plot contained in Attachment G.

As stated in the Test 1 section, the presence of measurable vacuum does not necessarily indicate flow sufficient to accomplish remedial objectives. The one-dimensional compressible flow model described above was used as a preliminary approximation of ROI and permeability, for the purposes of technology screening. CH2M HILL understands this model represents a simplified and somewhat antiquated approach to SVE well field design, and that numerical flow modeling is a robust alternative. Numerical flow modeling is planned as part of the final design, after SVE is selected for full scale implementation at Dunn Field.

Analysis of Waste Stream Characteristics

Test 1 - Loess Formation

Based on review of the organic vapor (FID) data collected before the test began and then after the test was completed, concentrations of volatile organic compounds increased progressively. Vapor data collected via field instruments is found in Attachment C. At almost all monitoring points, whether screened in the loess deposits or the fluvial sands, the total VOC values showed an increase in concentration. The values do not appear to achieve "steady state".

Quantitative SUMMA canister data also exhibits a trend of generally increasing VOC concentrations with time during the course of the test. Vapor analytical data collected via SUMMA canisters for Test 1 is presented in Table 18 as well as Attachment D. Figure 6 presents a graph of TCE values from the SUMMA canister samples collected after the liquid ring pump progressively during Test 1 from December 18 to December 21, 2001. The TCE values showed a sharp increase in concentration from beginning to the end of the test. The rise in VOC concentration followed a similar pattern as the TCE values. This data also suggests that a steady-state condition was not reached and that it is likely that higher concentrations exist in the formations underneath Dunn Field.

Purged groundwater analytical data from Test 1 is presented in Attachment H. The dissolved chlorinated solvent concentration within this groundwater ranged from1.36 micrograms per liter (ug/L) of chloroform to 311 ug/L of 1,1,2,2-PCA to 606 ug/L of TCE. These concentrations are reflective of the contaminant plume concentrations in groundwater underlying Dunn Field. It is interesting to note that a majority of this water was derived from shallow sources. Taking into account the amount derived from mixing with the contaminated air flow, the concentrations dissolved in water indicate that the loess deposit soils are continuing to act as a source of groundwater contamination.

Test 2 - Fluvial Sand Formation

Based on review of the organic vapor (FID) data collected before the test began and then after the test was completed, concentrations of VOCs during Test 2 were opposite to those seen during Test 1 and tended to decrease overall. Vapor data collected via field instruments is found in Attachment C. Approximately 75 percent of the monitoring points, whether screened in the loess deposits or the fluvial sands, showed a decrease in the total VOC concentrations. The values appear to represent a marked decrease in concentration of the total VOCs derived from the formations underlying Dunn Field and are in conflict to the concentrations achieved during Test 1 two weeks prior to this test. The decrease in VOC concentrations may be a result of an increase in ambient air leaking through the soil and mixing with the air being pulled upwards by the SVE system.

Quantitative SUMMA canister data from Test 2 exhibits an almost steady-state trend of VOC concentrations during the course of the test. Vapor analytical data collected via SUMMA canisters for Test 1 is presented in Table 19 as well as Attachment D. Figure 7 presents a graph of TCE values from the SUMMA canister samples collected at the exhaust pipe progressively during Test 2 from January 7 to December 11, 2002. The TCE values showed a slight increase in the middle of the test but concentrations decreased again towards the value found at the beginning of the test. The rise in VOC concentration followed a similar pattern as the TCE values. This data, as with the field data measurements, suggests that the VOC concentrations may be a result of an increase in ambient air leaking through the soil and mixing with the air being pulled upwards by the SVE system.

Quality Assurance/Quality Control

DQOs for each sampling task are listed in Table 6-2 of the *Soil Vapor Extraction Treatability Study Workplan* (CH2MHILL, October, 2001). Sampling and analytical requirements, field quality control (QC) requirements, and the required level of quality and data packages are listed in Table 6-3 of the same document. Project-specific QC objectives for those data are included in the August 1995 Memphis Depot Final Generic Quality Assurance Project Plan. These include the quantitation, accuracy, precision, completeness, representativeness, and comparability limits by which the data will be evaluated.

All samples were analyzed according to EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, where necessary. Each air sample for VOCs was analyzed according to Method TO-15. IDW water samples were analyzed for Dunn Field groundwater contaminants according to EPA SW-846 Test Methods. Analytical results from SUMMA canister QC samples can be found in Tables 18 and 19 and Attachment D. In general, VOCs at relatively low concentrations were detected in the equipment and ambient blanks. Equipment blanks were SUMMA canisters sent to the field but not opened and then sent on the laboratory for analysis. The presence of VOCs in these blanks is not clearly understood. Ambient blanks were always collected beside the MP-8 location. The presence of VOCs in these blanks is most likely the result of VOCs released from the test system.

VI. Future Design Considerations

SVE "Stop" Closure Process

As part of the 2000/2001 RPO review of the Memphis Depot site, recommendations were made concerning the development of measures to signal completion of the remedy, which should be implemented, as part of the design process. This includes calculated soil screening level (SSL) protective of groundwater in the fluvial aquifer for contamination in the loess and the fluvial deposits. In addition, soil vapor concentrations in equilibrium with both SSLs (loess and fluvial) were developed for each COC. The measures also include use of the SVE Termination or Optimization Process (STOP) developed by the Air Force Center for Environmental Excellence (AFCEE) in the June 2001 *Final Guidance on Soil Vapor Extraction Optimization*. The STOP process is part of an SVE closure plan in the case where the system has been fully optimized yet continuing operations requires tradeoff between monetary expenditures and uncertain environmental benefits. The decision to continue with SVE will be based on scientific, economic, and engineering judgement included in the STOP process. Part of the decision to discontinue operation of the SVE system includes a determination that contaminant removal rates have stabilized and approached asymptotic levels, following one or more temporary shutdown periods. At this time, EPA believes that ultimate cleanup for purposes of determining that the remedy is complete must be demonstrated by direct measurements of subsurface soil. Soil vapor may be used as a surrogate for the purpose of optimizing the system operations and indicating when confirmation sampling should be initiated. Figure 8 presents a STOP decision tree that will be implemented into the design of the SVE presumptive remedy for Dunn Field.

Jury and EMSOFT Models

The Exposure Model for Soil-Organic Fate and Transport (EMSOFT), developed by ENSR Consulting and Engineering (EPA, 1997), was used to calculate site-specific values of soil concentration and soil vapor concentration that would be protective of groundwater at Dunn Field. The 1-dimensional screening model is based on the work described by Jury et al (1983, 1990) and incorporates volatilization, advective and diffusive transport, sorption, and decay. The model theory, verification, and validation are included in the EMSOFT User's Guide (EPA, 1997).

The Fate and Transport Calculations were performed in the following steps:

1. Calculate an infiltration or porewater flux rate for Dunn Field.
2. Calculate a site-specific dilution attenuation factor (DAF) for the Fluvial Aquifer under Dunn Field.
3. Calculate the target soil leachate concentration for contaminants of concern (COCs) in the Disposal Area.
4. Calculate the total soil concentration in equilibrium with the target soil leachate concentration.
5. Calculate the soil screening level (SSL) protective of groundwater in the Fluvial Aquifer for contamination in the loess deposits and the fluvial deposits.
6. Determine the soil vapor concentration in equilibrium with both SSLs (loess and fluvial) for each COC.

Each of these steps is described in detail below.

Step 1: Determination of Porewater Flux or Infiltration Rate

A flux or infiltration rate through the subsurface at Dunn Field was modeled for the Disposal Area at the Dunn Field using Hydrologic Evaluation of Landfill Performance (HELP, Schroeder et al., 1994). The HELP computer program, developed by the U. S. Army Engineer Waterways Experiment Station (WES), is a quasi-two-dimensional hydrologic model of water movement across, into, through and out of landfills.

Input parameters used for the HELP model for Disposal Area at Dunn Field included weather (climatic) data, and soil and design data. The weather data required in the HELP model are classified into four groups: evapotranspiration, precipitation, temperature, and solar radiation data. Site-specific acres, percent of landfill area where runoff is possible, soil layer data, and runoff curve data were required for soil and design data. HELP model output includes annual precipitation, runoff, evapotranspiration, percolation/leakage through water table, and change in water storage.

Default Evapotranspiration Option, 5 years of historical precipitation data (1974 through 1978), at Memphis, Tennessee was used for the HELP model, evaporative zone depth of 18 inches was estimated based on layer of soil with a grassy form of vegetation, and maximum leaf area index was evaluated as 3.5 for a good stand of grass at the site. Synthetic Precipitation Option, Synthetic Temperature Option, and Synthetic Solar Radiation Option at Memphis, Tennessee were used in the HELP model for the site.

Soil and Design input parameters are described as follow and presented in **Table I-1**. Disposal Area of Dunn Field was estimated about 13 acres, percent of disposal area where runoff is possible was estimated approximately 95%, no method of initialization of moisture storage was used in the model. Four soil layers were used in the model; all were type 1, to calculate vertical percolation. Top two layers (18 inches and 342 inches for the first and second layers, respectively) were classified as ML by CH2M HILL in the Unified Soil Classification System (USCS) to represent approximately top 30 feet of Loess at the site, and bottom two layers (270 inches for each layer) were classified as SW by CH2M HILL in the USCS system to represent approximately bottom 45 feet of Fluvial at the site. Five percent slope with 1000 feet for ML soil with good grass (vegetation = 4) were used in the model to calculate runoff curve.

By running HELP model using above input parameters, the model output gives yearly precipitation of 54.52 inches, runoff of 0.318 inches, evapotranspiration of 35.22 inches, vertical percolation/leakage through layer four of 7.50 inches, and change in water storage of 11.48 inches. The HELP model output is included in **Table I-2**.

Step 2: Calculate Dilution Attenuation Factor (DAF)

Dilution attenuation factors (DAF) are calculated to account for the dilution effect of the aquifer on the soil leachate, once it reaches groundwater. The dilution that occurs in the aquifer reduces concentrations and can be expressed as a ratio of the soil leachate concentration to the receptor point concentration. A site-specific DAF was calculated for the Dunn Field using the formulas (Equation 11 and 12) presented in the Soil Screening Guidance (EPA, 1996).

Equation 11: $DAF = 1 + (Kid/IL)$

Where, K = hydraulic conductivity,
i = hydraulic gradient,
d = mixing zone thickness,
I = infiltration rate, and
L = source length parallel to groundwater flow direction.

Equation 12: $d = (0.0112L^2)^{0.5} + d_a\{1 - \exp[(-LI/Kid_a)]\}$

Where, d_a = aquifer thickness.

The mixing zone thickness is that portion of the aquifer thickness that may be assumed to transport the contamination and may not exceed the aquifer thickness. The source length may be interpreted to be the length of the spill area.

A DAF of 6.1 was calculated for Dunn Field. The parameters used to calculate the value are summarized in **Table I-3**.

Step 3: Calculate Target Soil Leachate Concentrations

The target soil leachate concentration for each COC was determined by multiplying the groundwater protective level by the DAF calculated in Step 2. This is the soil water concentration assumed to be leaching into the groundwater system. The maximum contaminant level (MCL) was selected as the groundwater protective level for all COCs except 1,1,2,2-Tetrachloroethane (PCA), which does not have an MCL. Since the tap-water RBC (0.053 µg/L) for 1,1,2,2-PCA is lower than the available laboratory reporting limit (0.5 µg/L) the laboratory reporting limit was selected as the groundwater protective level.

The MCL used for chloroform, 0.079 mg/L, is based on the MCL for total trihalomethanes (TTHM), which is the sum of chloroform, Bromodichloromethane (BDCM), Dibromochloromethane (DBCM) and bromoform. Based on Table 14-3 of the RI Report for Dunn Field (CH2M HILL, 2002), the maximum detection in groundwater at Dunn Field for chloroform, BDCM, and DBCM, was 1.61 mg/L, 0.0198 mg/L, and 0.001 mg/L, respectively. Bromoform was not detected in any groundwater samples. Assuming that these are concentrations in Dunn Field groundwater, then chloroform makes up 99 percent of the TTHM concentrations. Therefore, the MCL for chloroform, 0.079 mg/L, is assumed to be 0.99 times the MCL for TTHM, 0.080 mg/L. **Table I-4** summarizes the target soil leachate concentration calculated for the site.

Step 4: Calculate Total Soil Concentration

Before running the EMSOFT model, the total soil concentration which is in equilibrium with the soil water or leachate concentration which was calculated in Step 3, was calculated. This was determined using a set of equilibrium partition equations, discussed in Jury, et al (1983). The resulting formulas from these partitioning equations is:

Equation 12: $C_T = R_S C_S = R_L C_L = R_G C_G$,
Equation 13: $R_S = \rho_b + \theta/K_D + aK_H/K_D$;
Equation 14: $R_L = \rho_b K_D + \theta + aK_H$; and
Equation 15: $R_G = \rho_b K_D/K_H + \theta/K_H + a$;

Where, C_T = total soil concentration,
C_S = Concentration sorbed to solids,
C_L = Concentration in solution,
C_g = Concentration in vapor phase,
ρ_b = soil bulk density,
θ = water content,
K_D = soil - water distribution coefficient,
a = air filled porosity, and
K_H = Henry's law constant.

The total soil concentration at the depth of the water table was calculated using the terms C_L and R_L. Initially, this calculation, returns a concentration in units of g/m3. To translate this into soil weight units (mg/kg), the concentration was divided by the bulk density. A summary of the equilibrium total soil concentration at the water table depth is listed in **Table I-4**.

Step 5: Calculate the Soil Screening Level (SSL)

The vadose zone at Dunn Field is comprised of 2 lithologic layers: loess and fluvial deposits (primarily sands). These layers are described in detail in the RI (CH2M HILL, 2002). Soil screening levels (SSLs) protective of groundwater were calculated for each of the 12 COCs for both of these lithologic layers using the EMSOFT model.

The conceptual model for these calculations is based on the 2 layers (loess and fluvial sands). The top boundary is the ground surface and the bottom boundary is the water table, or the top of the fluvial aquifer. Based on soil borings collected in the field (SBLCA and

SBLEE), the depth to the water table was approximated at 75.8 feet below land surface (ft bls) and the depth of the contaminated soil extends to approximately 74 ft bls. As stated in the RI (CH2M HILL, 2002), the thickness of the loess averages around 30 feet at Dunn Field. Within the loess layer, there is approximately 2 feet of clean overburden at the surface. The fluvial sand layer lies beneath the loess layer.

Since EMSOFT requires homogeneous layers and doe sallow for different geologic properties to be entered per model run, the loess and fluvial sand models had to be separately. The models were run in succession to determine a layer-specific SSL for each COC. The target soil concentration (which is in equilibrium with the target leachate concentration) was assumed to the concentration at the bottom of the fluvial sand model. The model was run through a trial and error method to determine the source concentration with the fluvial sand layer which would result in a concentration at the depth of the water table equal to the target soil concentration. This source value in the fluvial sand was assumed to be the soil concentration protective of groundwater, Once this was determined using EMSOFT, the source concentration calculated for the fluvial sand was assumed to be the concentration at the bottom of the loess model, or at the loess-fluvial sand interface. The loess model was then run through a trial and error method to determine the source concentration with in the loess, which would result in the desired "bottom" or interface concentration. This source value was assumed to be the concentration protective of groundwater in the loess at Dunn Field.

Input Parameters

The following general parameters were included in all model runs:

- Time of Interest
- Depth of Interest
- Fraction organic carbon (foc)
- Soil porosity
- Water content
- Soil bulk density
- Porewater Flux/Infiltration rate
- Boundary Layer Thickness
- Number of contaminated layers
- Thickness of clean overburden
- Thickness of contaminated layer(s)

All these parameters are summarized in **Table I-5**. Based on some preliminary model runs, it was determined that maximum concentrations for all contaminants at the water table were reached at a model time of approximately 100 days; therefore this value was selected as the time of interest. The porewater flux was estimated from the HELP model output, as described above.

Layer-Specific Parameters

The depth of interest or the bottom depth for the loess model was assumed to be the bottom of the layer, approximately 30-ft. The depth of interest for the fluvial deposit model was assumed to be the water table, which was the distance between the water table and the bottom of the loess layer. Two feet of clean overburden were input into the loess layer model and no overburden was assumed for the fluvial sand model. Geotechnical parameters (porosity, foc, water content, and bulk density) were determined from tests run on site soil samples. The results from these tests are included in Attachment B.

The stagnant air boundary layer thickness for the loess model was calculated using Equation 28 in the Jury et al. (1983), using meteorological parameters. Since the fluvial sand layer is not exposed to the atmosphere, the stagnant air boundary layer was assumed to be essentially zero.

Equation 28: Thickness = $D^{air}_{WV} * \rho_{WV} * (1-RH)/2*E*\rho_{WL}$

Where, D^{air}_{WV} = binary diffusion coefficient of water vapor in air,
ρ_{WV} = density of water vapor,
RH = relative humidity, and
ρ_{WL} = density of liquid water.

Chemical Specific Parameters
Chemical-specific parameters were also entered into the EMSOFT model. These include:

- Soil organic carbon-water partition coefficient
- Henry's Law Constant
- Air Diffusion Coefficient
- Aqueous Diffusion Coefficient
- Initial soil concentration

The values for these parameters were obtained from the Soil Screening Level Guidance (EPA, 1996). There were no available site-specific degradation rates for the COCs in soil. To be conservative, no degradation was assumed to have occurred.

Results
The SSLs calculated for by the EMSOFT model are presented in **Table I-6**. The EMSOFT calculated values are compared to the SSL values calculated using the generic SSL equations in the Soil Screening Level Guidance (EPA, 1996) using a DAF of 6.1. The EMSOFT calculated values were slightly higher than the generic values for all COCs.

Step 6: Calculate Soil Vapor Concentration

Once the SSL was calculated with EMSOFT, the soil vapor concentration in equilibrium with the SSL was determined, using the equations in Step 4. Assuming that the SSL equals C_T, the C_G term was calculated. The concentrations were then converted into units of parts per billion volume (ppbv) using the following equation:

Concentration (ppbv) = 1000* (Concentration in mg/m3)(273.15 + °C)/(12.187)(MW),

Where, MW = molecular weight.

The temperature for the conversions was assumed to be 25°C. The following molecular weights were obtained from Mackay, et al (2000):

Parameter	Molecular Weight
Carbon Tetrachloride	153.82
Chloroform	119 38
Dichloroethane, 1,2-	98.96
Dichloroethene, 1,1	96.94
Dichloroethene, cis-1,2-	96.94
Dichloroethene,1,2-trans-	96.94
Methylene chloride	50.49
Tetrachloroethane, 1,1,2,2-	167.85
Tetrachloroethene	165.83
Trichloroethane, 1,1,2-	133.41
Trichloroethene	131.39
Vinyl chloride	62.5

These soil vapor concentrations are assumed to be in equilibrium with the soil concentration that is protective of groundwater quality at Dunn Field. They are listed in **Table I-6.**

Model Assumptions and Limitations

Due to the simplicity of the model, there are several limitations to the model calculations. The model does not account for several layers with varying geologic properties. The model only assumes a steady porewater flux and does not account for varying infiltration rates that occur daily. The model can not handle free product and assumes that chemicals are only present in the dissolved phase. Volatilization of soil vapor at the ground surface must flow through a stagnant air boundary layer.

In addition, due to a lack of site-specific information, such as the time and amount of release, and vertical soil profiles over time, the model could not be calibrated to site data. However, the SSL values generated by the EMSOFT model are sufficient for a screening model.

VII. Findings and Recommendations

Test 1 - Loess Formation

Based on the results of Test 1, remediation of the loess via SVE is feasible, provided the ground surface is covered with a polyethylene liner or clay cap to mitigate vertical surface leakage. Vertical leakage was abated by surface water saturation during the early stages of the test. However, atmospheric leakage appeared to predominate the last half of the test, to the extent that vacuum in periphery monitoring points was almost completely lost. Loss of vacuum at the periphery monitoring points indicates negligible flow at these locations.

A "best case" vacuum ROI of approximately 53 feet was obtained after the first 27 hours of the test. This influence zone may be slightly improved by implementation of a fixed, impermeable cover. In consideration of the type of soil comprising the loess formation, 53 feet is considered an above average result. In CH2M HILL's experience, vacuum ROI for clayey soils is typically 25 feet or less. The favorable result of this test, in terms of vacuum ROI, is likely associated with secondary permeability characteristics of the loess, which improve overall soil permeability to air flow.

The flow rate achieved during this test was less than favorable. SVE flow rate and remediation time frame, are, to a certain extent, inter-related. Bioventing is not expected to be a significant mechanism for mass removal at Dunn Field, since bioventing of chlorinated aliphatic hydrocarbons is not well documented in the literature. The flow rate achieved after 27 hours was approximately 24 scfm @ 26 inches Hg inlet vacuum. This result indicates very strong resistance of the loess soils to vapor flow. A technology such as pneumatic fracturing may be beneficial to further enhance the natural secondary permeability of the loess.

Test 2 - Fluvial Sand Formation

Based on the results of Test 2, remediation of the fluvial deposits via SVE is feasible, and a large vacuum ROI can be achieved (approximately 100 feet at 250 scfm). However, because of the somewhat anomalous results of the test (i.e. fluctuation in vacuum response and lack of response in MP-3 and MP-4) conservative selection of vacuum ROI (if used for design purposes) and/or numerical modeling is recommended. It should be noted that numerical modeling is subject to the same inaccuracies resulting from heterogeneous/anomalous subsurface environments as semi-analytical modeling.

High flow from individual wells (i.e. greater than 100 scfm) is not expected to be cost effective for full-scale design. High flow/velocity in the subsurface is typically not cost effective, because contaminant desorption from the soil and subsequent partitioning into air is rate limiting (i.e. increasing vapor flow above a certain point will result in a decrease in concentration contaminant of the vapor stream). Furthermore, the vacuum ROI for Step 3 of the transient test (approximately 100 scfm, less than 50 percent of the original flow) only decreased to 68 feet. Therefore, in general, decreased flow, combined with increased density of vapor extraction wells, results in cost-effective design, as well as increased uniformity of subsurface air flow distribution. This is particularly true for heterogeneous/anomalous subsurface environments.

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579 347

Tables

Table 1

Shelby Tube Sample Results

Memphis Depot Dunn Field SVE Treatability Study

Sample No.	Percent Soil Moisture	Percent Organic Matter	Vertical Permeability (cm/sec)	Horizontal Permeability (cm/sec)
MP-5 (4-6)	27.02	0 97	2.90E-06	1.10E-05
MP-5 (14-16)	21.27	0 72	6.00E-06	5.20E-06
MP-6 (9-11)	23.53	0 64	1.60E-05	9.40E-07
MP-6 (49-51)	4.53	0.11	5.90E-04	4.50E-04
MP-6 (65-67)	7.29	0.07	1.70E-03	7.10E-04
MP-7 (19-21)	29.21	0.62	1 50E-05	1.40E-06
MP-7 (39-41)	14.03	0 33	3 30E-04	9.70E-05
MP-7 (59-61)	2.6	0.04	2 00E-03	2.80E-04

cm/sec = centimeters per second

MP= monitoring point

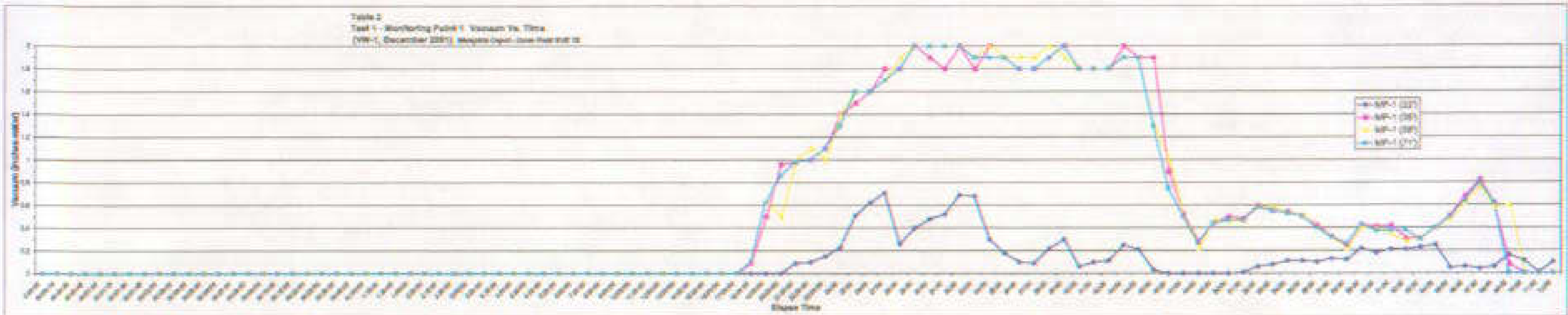
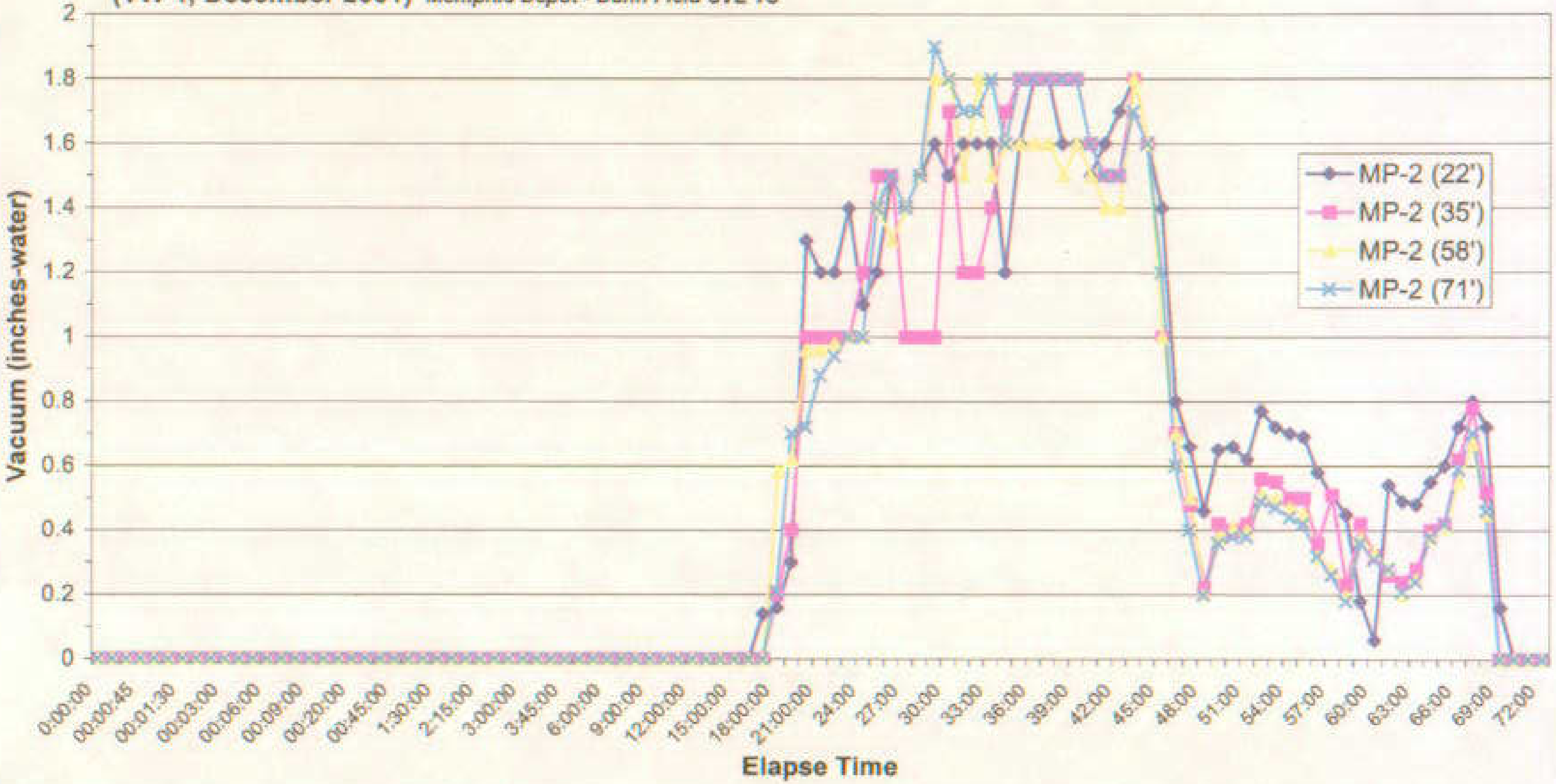


Table 2
Test 1 - Monitoring Point 1 Vacuum Vs. Time
Elapse Time

Table 3
Test 1 - Monitoring Point 2 Vacuum Vs. Time
(VW-1, December 2001) *Memphis Depot - Dunn Field SVE TS*



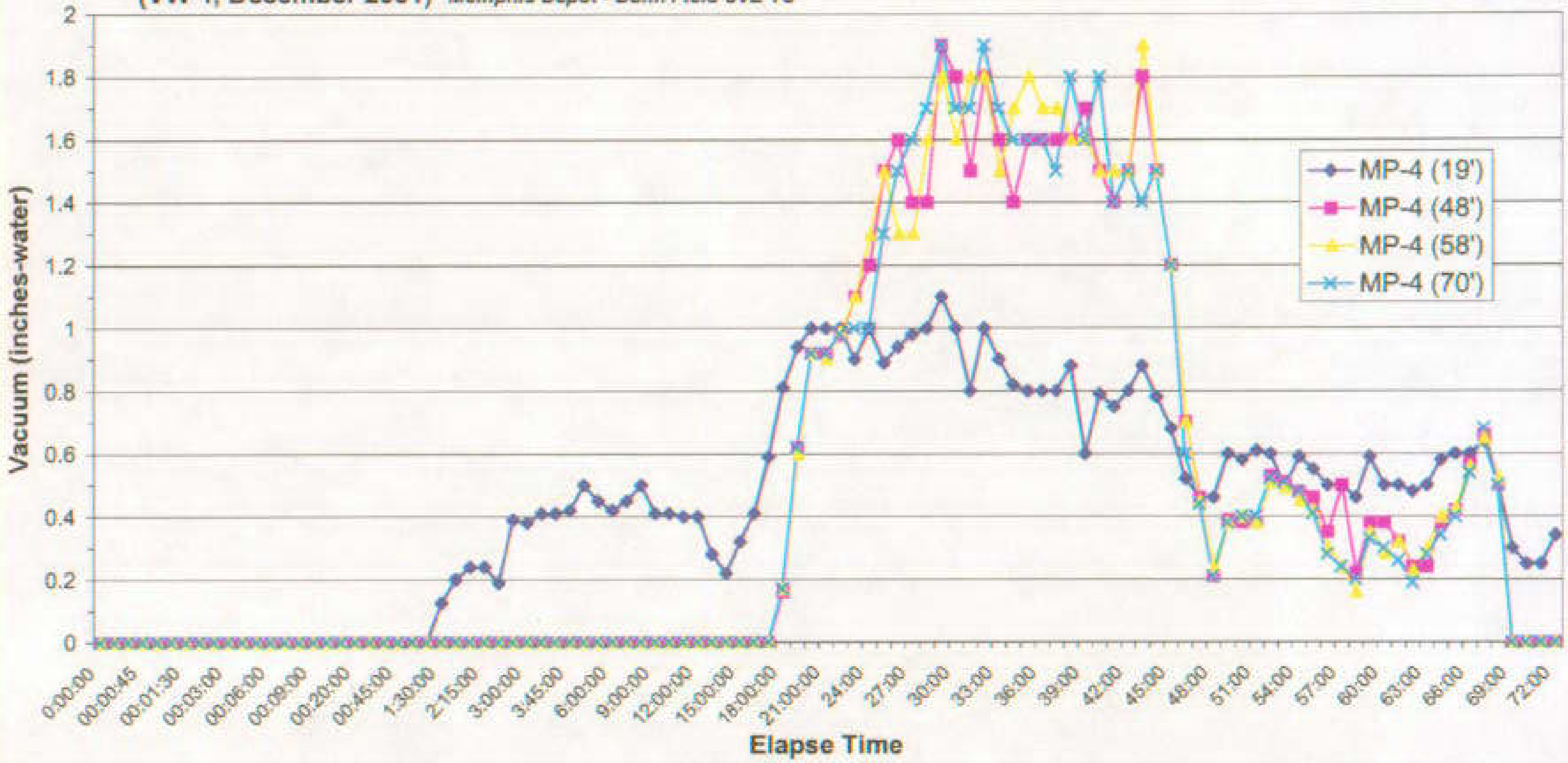
579 349A

Table 4

Test 1 - Monitoring Point 3 Vacuum Vs. Time

(VW-1, December 2001) *Memphis Depot - Dunn Field SVE TS*

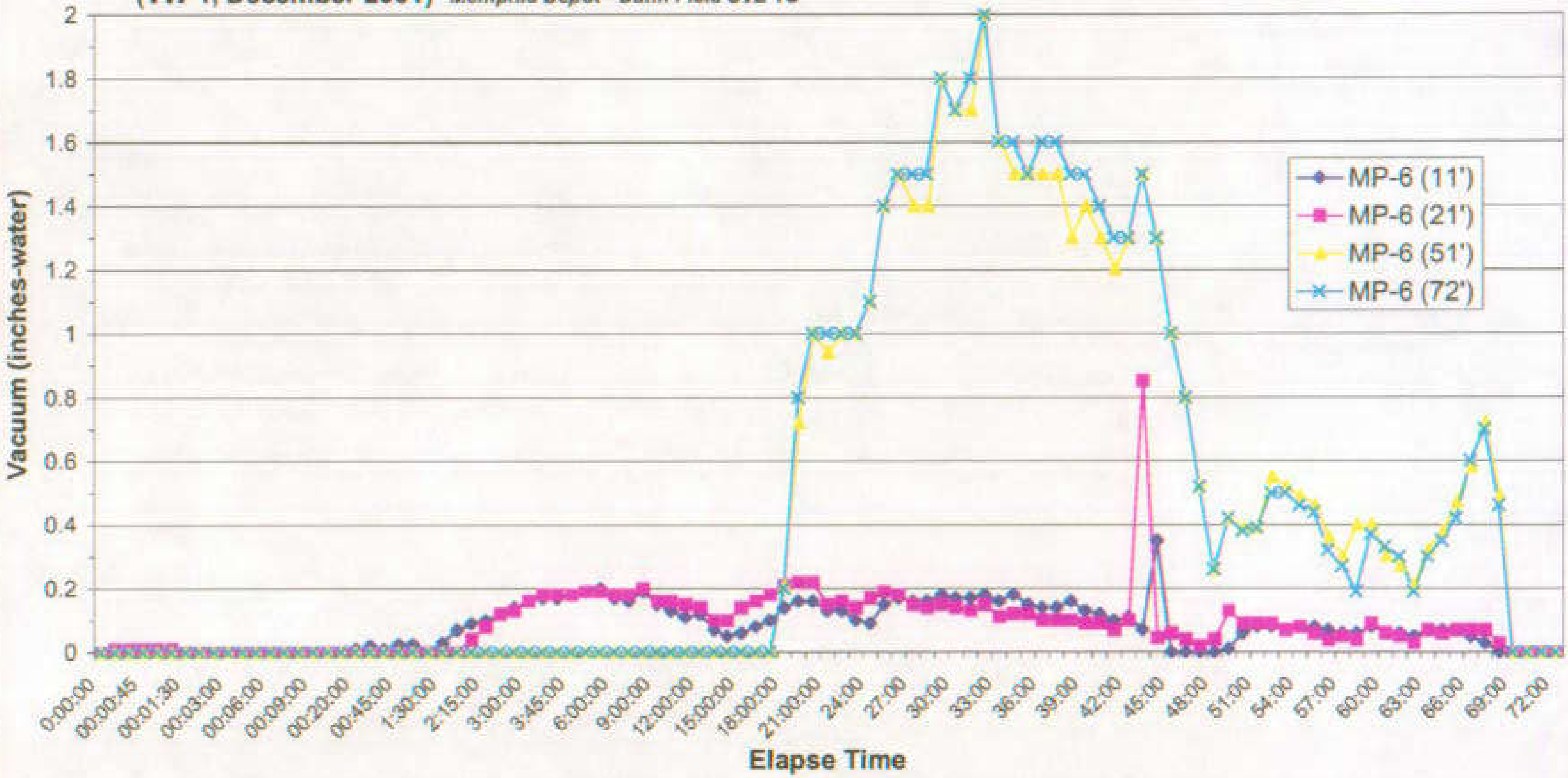
Table 5
Test 1 - Monitoring Point 4 Vacuum Vs. Time
(VW-1, December 2001) ***Memphis Depot - Dunn Field SVE TS***



579 351

Table 6
Test 1 - Monitoring Point 5 Vacuum Vs. Time
(VW-1, December 2001) *Memphis Depot - Dunn Field SVE TS*

Table 7
Test 1 - Monitoring Point 6 Vacuum Vs. Time
(VW-1, December 2001) *Memphis Depot - Dunn Field SVE TS*



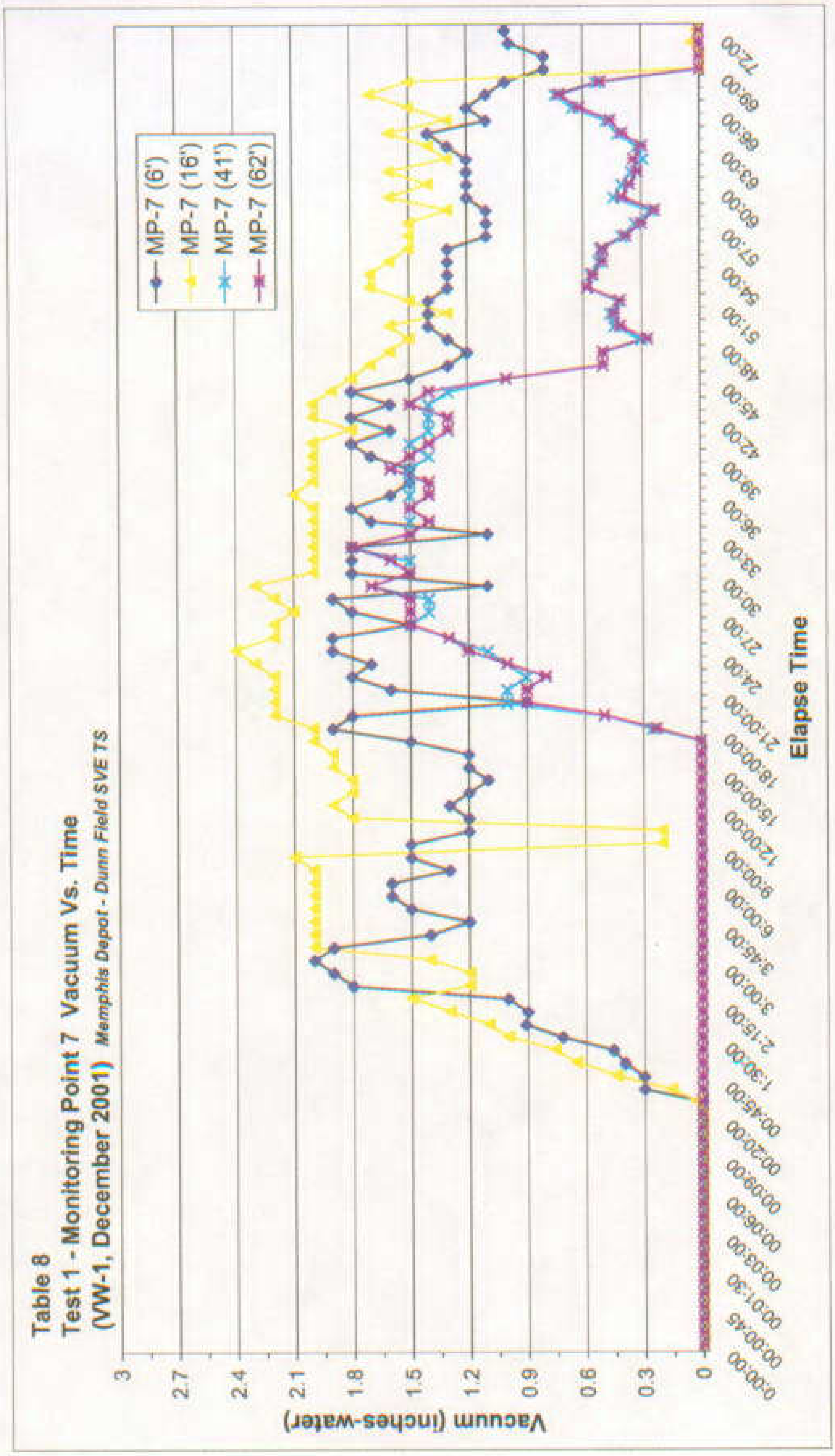
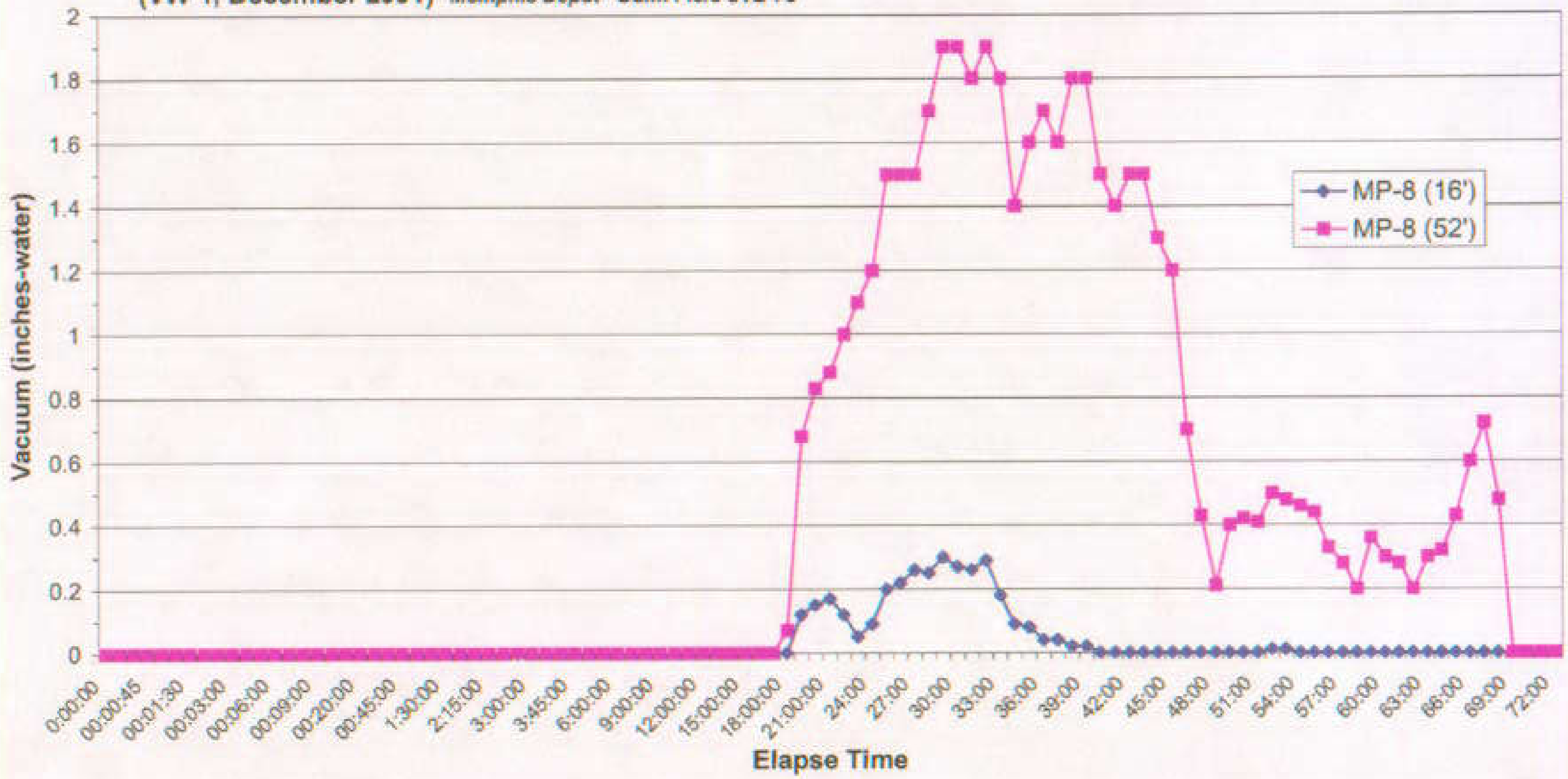


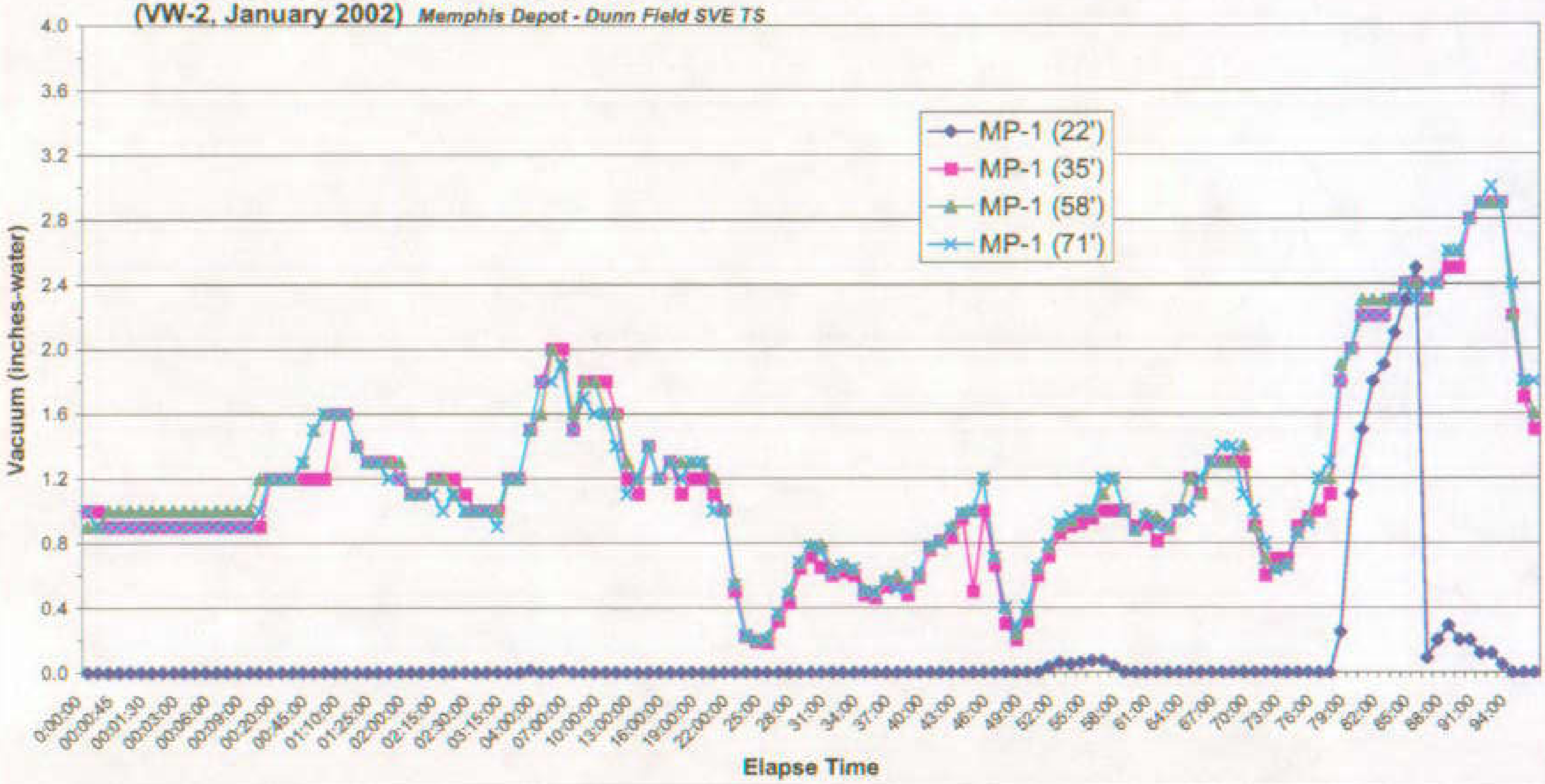
Table 8
Test 1 - Monitoring Point 7 Vacuum Vs. Time
(VW-1, December 2001) Memphis Depot - Dunn Field SVE TS
MP-7 (6')
MP-7 (16')
MP-7 (41')
MP-7 (62')
Vacuum (inches-water)
3
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

Table 9
Test 1 - Monitoring Point 8 Vacuum Vs. Time
(VW-1, December 2001) *Memphis Depot - Dunn Field SVE TS*



579 355

Table 10
Test 2 - Monitoring Point 1 Vacuum Vs. Time
(VW-2, January 2002) *Memphis Depot - Dunn Field SVE TS*



579 356

Table 11
Test 2 - Monitoring Point 2 Vacuum Vs. Time
(VW-2, January 2002)

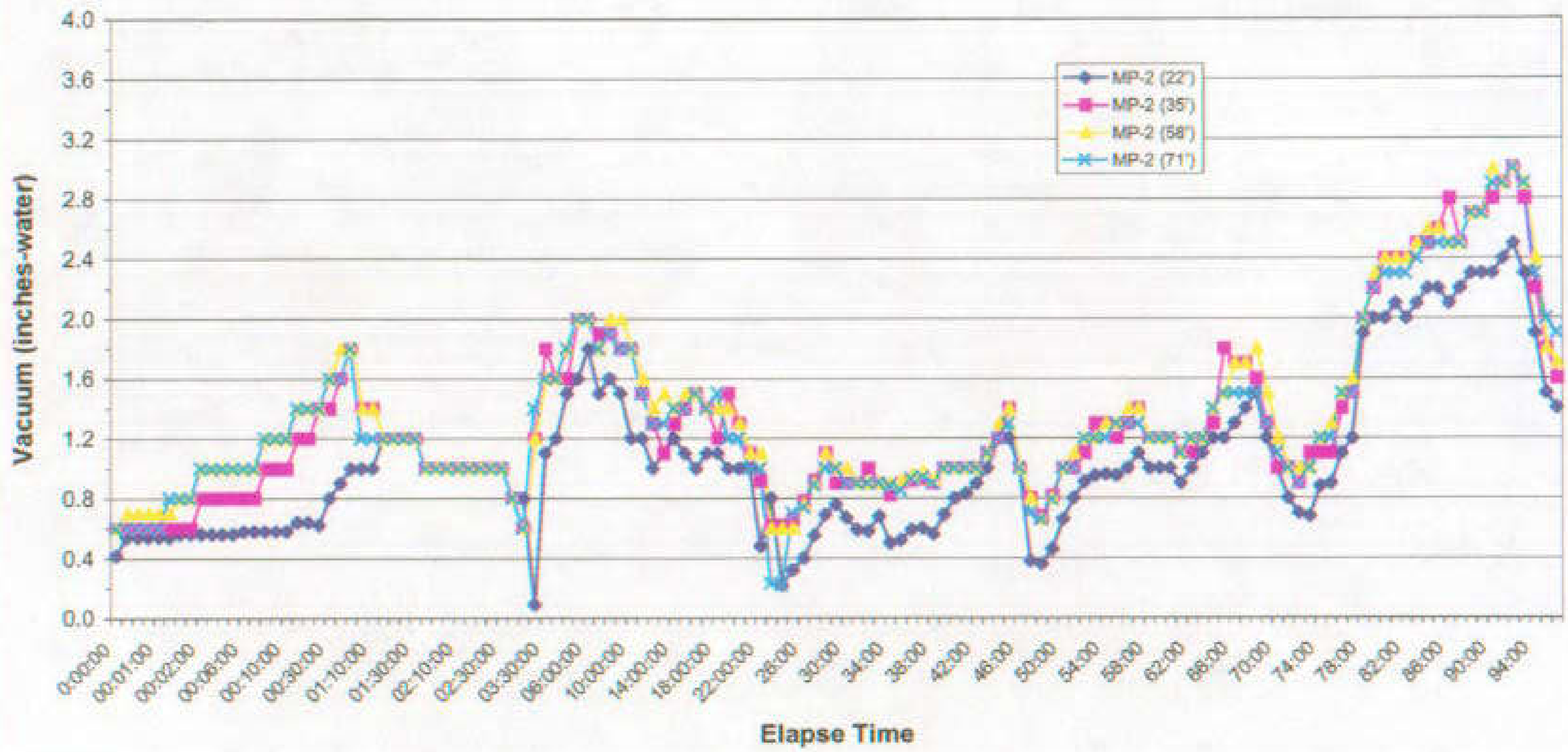


Table 12
Test 2 - Monitoring Point 3 Vacuum Vs. Time
(VW-2, January 2002) ***Memphis Depot - Dunn Field SVE TS***

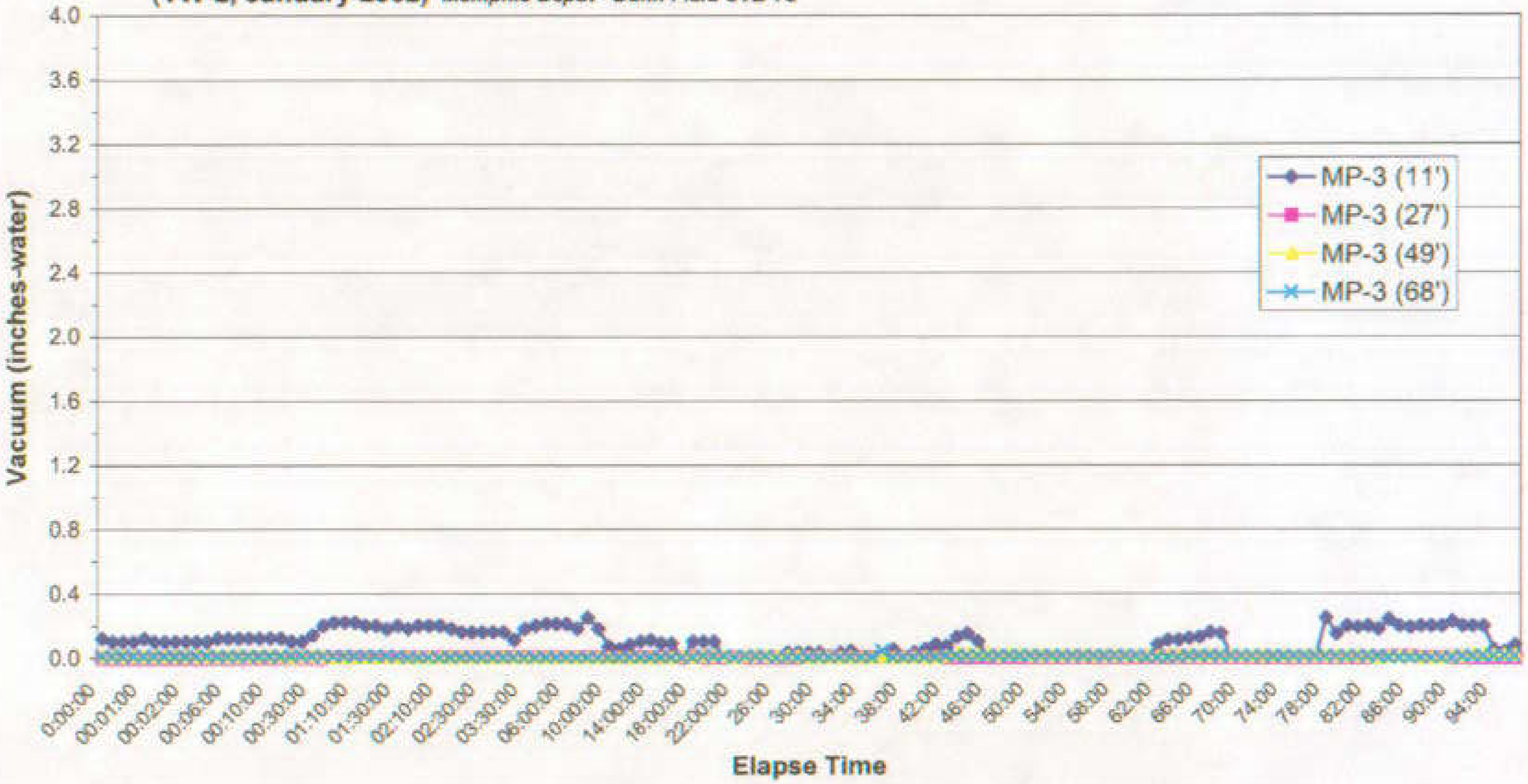


Table 13
Test 2 - Monitoring Point 4 Vacuum Vs. Time
(VW-2, January 2002) *Memphis Depot - Dunn Field SVE TS*

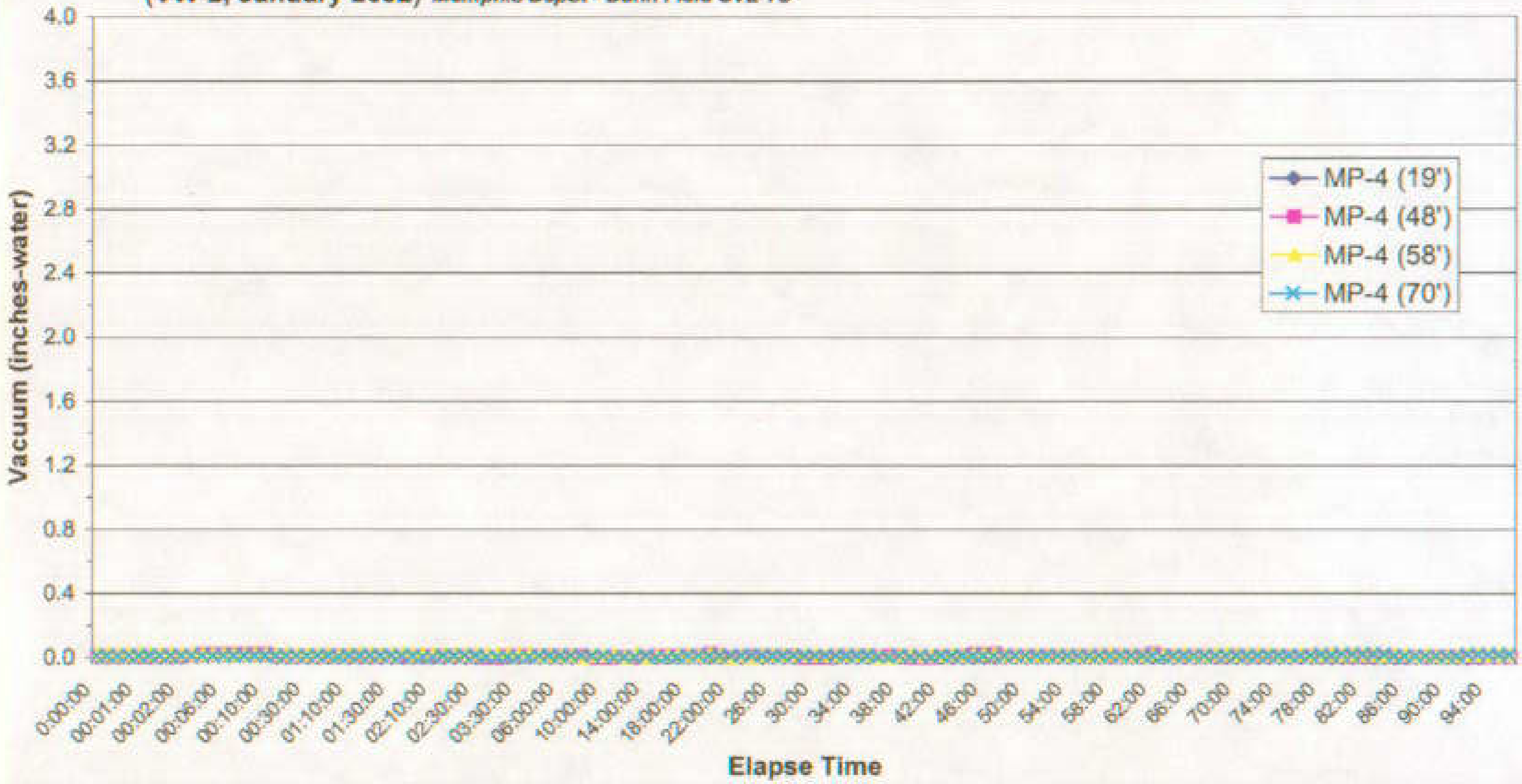
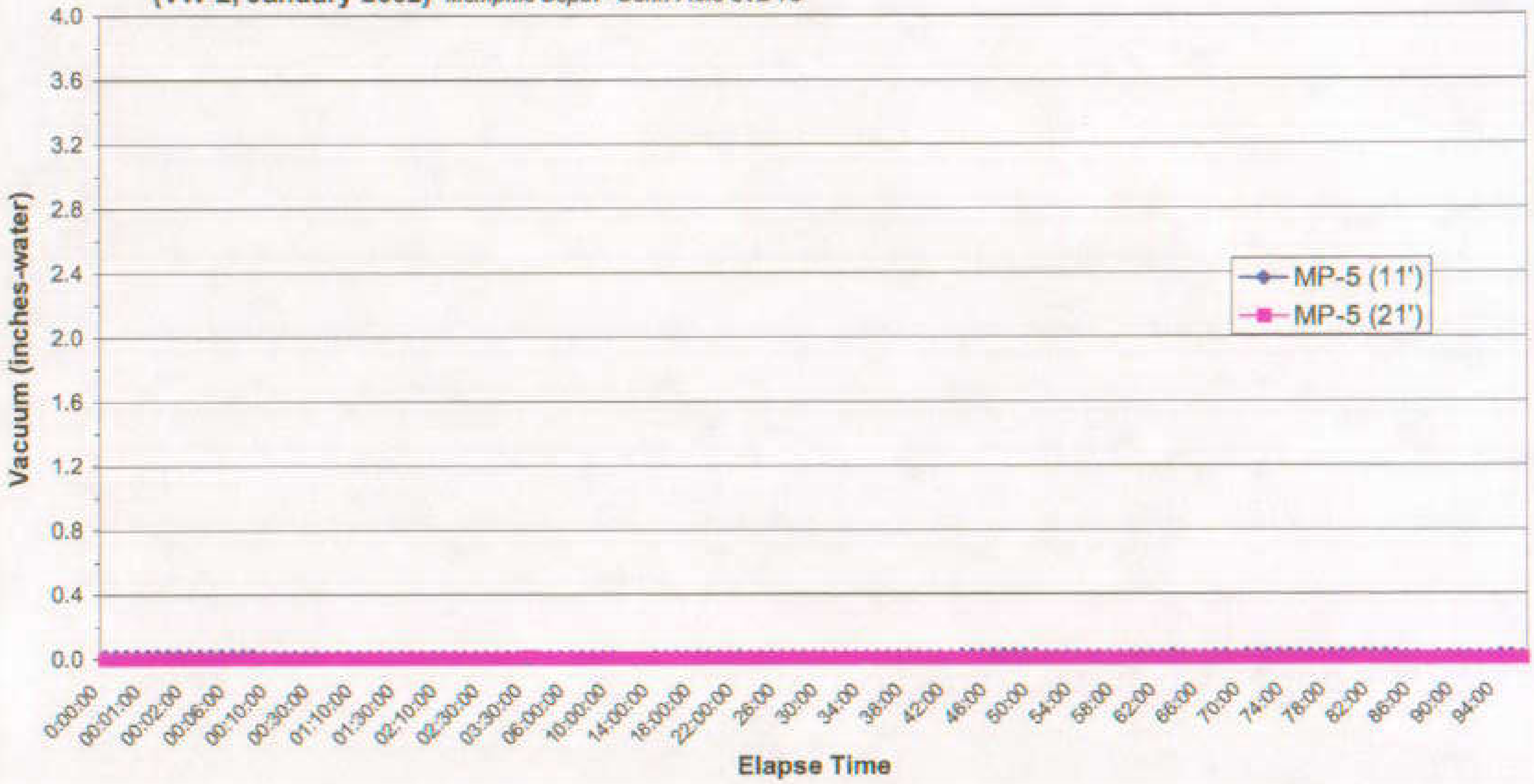
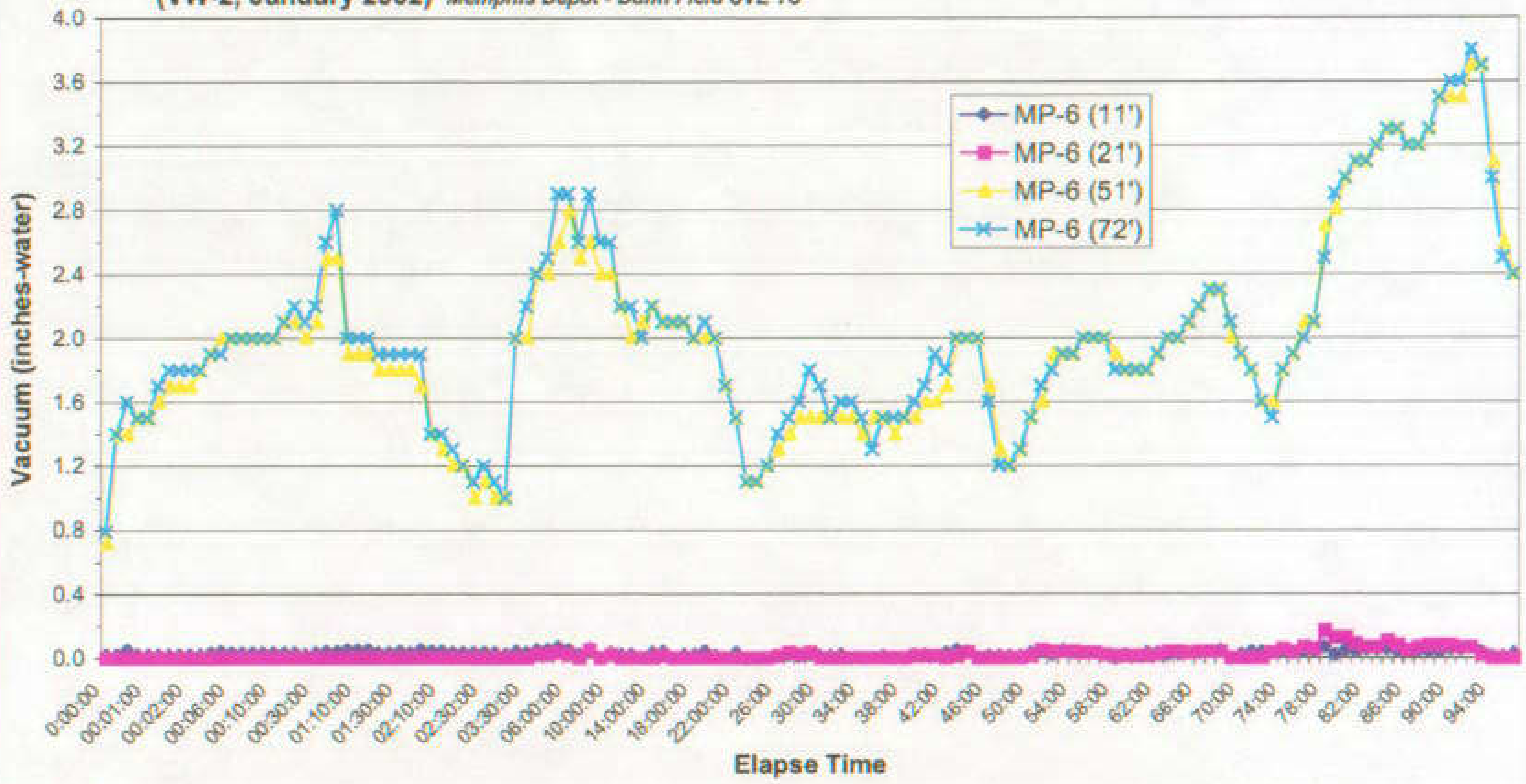


Table 14
Test 2 - Monitoring Point 5 Vacuum Vs. Time
(VW-2, January 2002) *Memphis Depot - Dunn Field SVE TS*



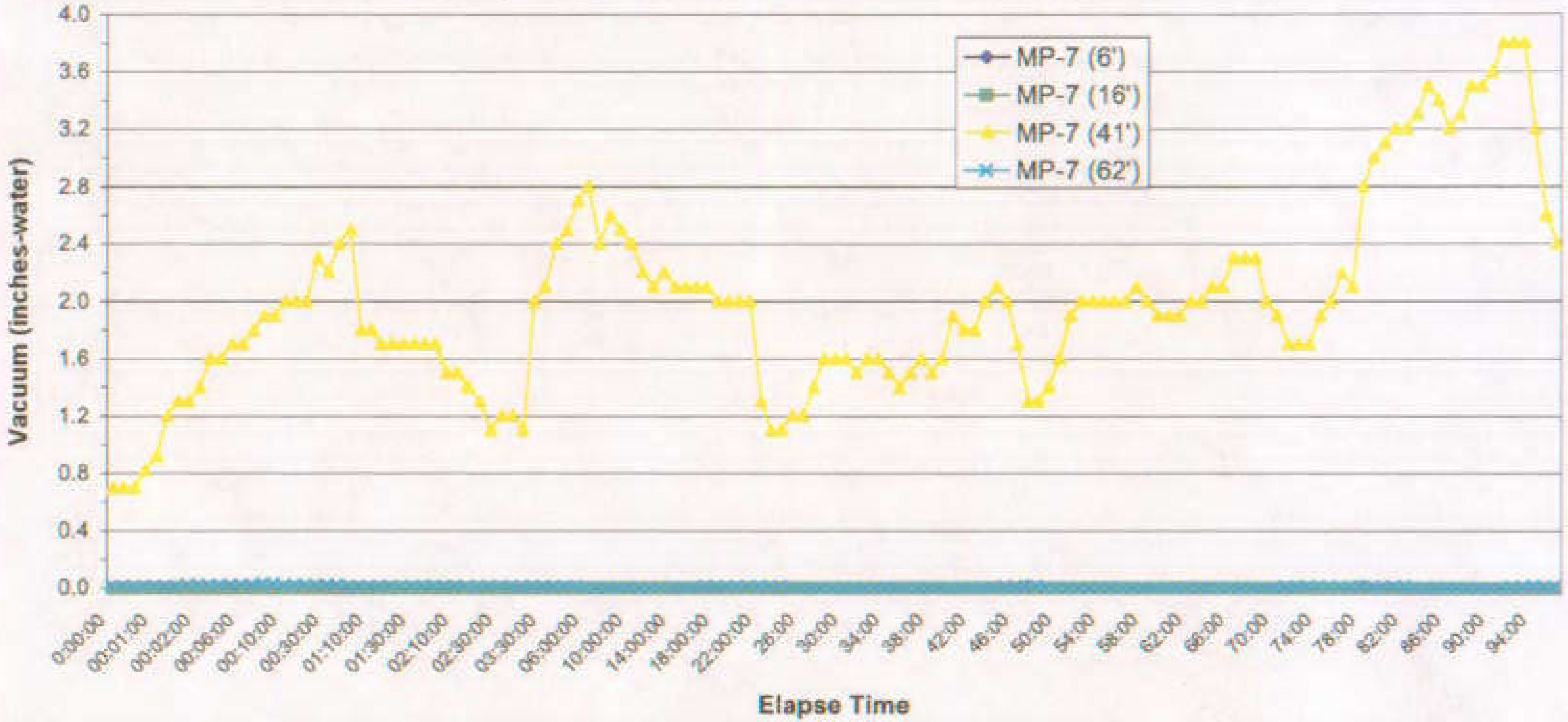
579 360

Table 15
Test 2 - Monitoring Point 6 Vacuum Vs. Time
(VW-2, January 2002) *Memphis Depot - Dunn Field SVE TS*



579 361

Table 16
Test 2 - Monitoring Point 7 Vacuum Vs. Time
(VW-2, January 2002) *Memphis Depot - Dunn Field SVE TS*



579 362

Table 17
Test 2 - Monitoring Point 8 Vacuum Vs. Time
(VW-2, January 2002) Memphis Depot - Dunn Field SVE TS

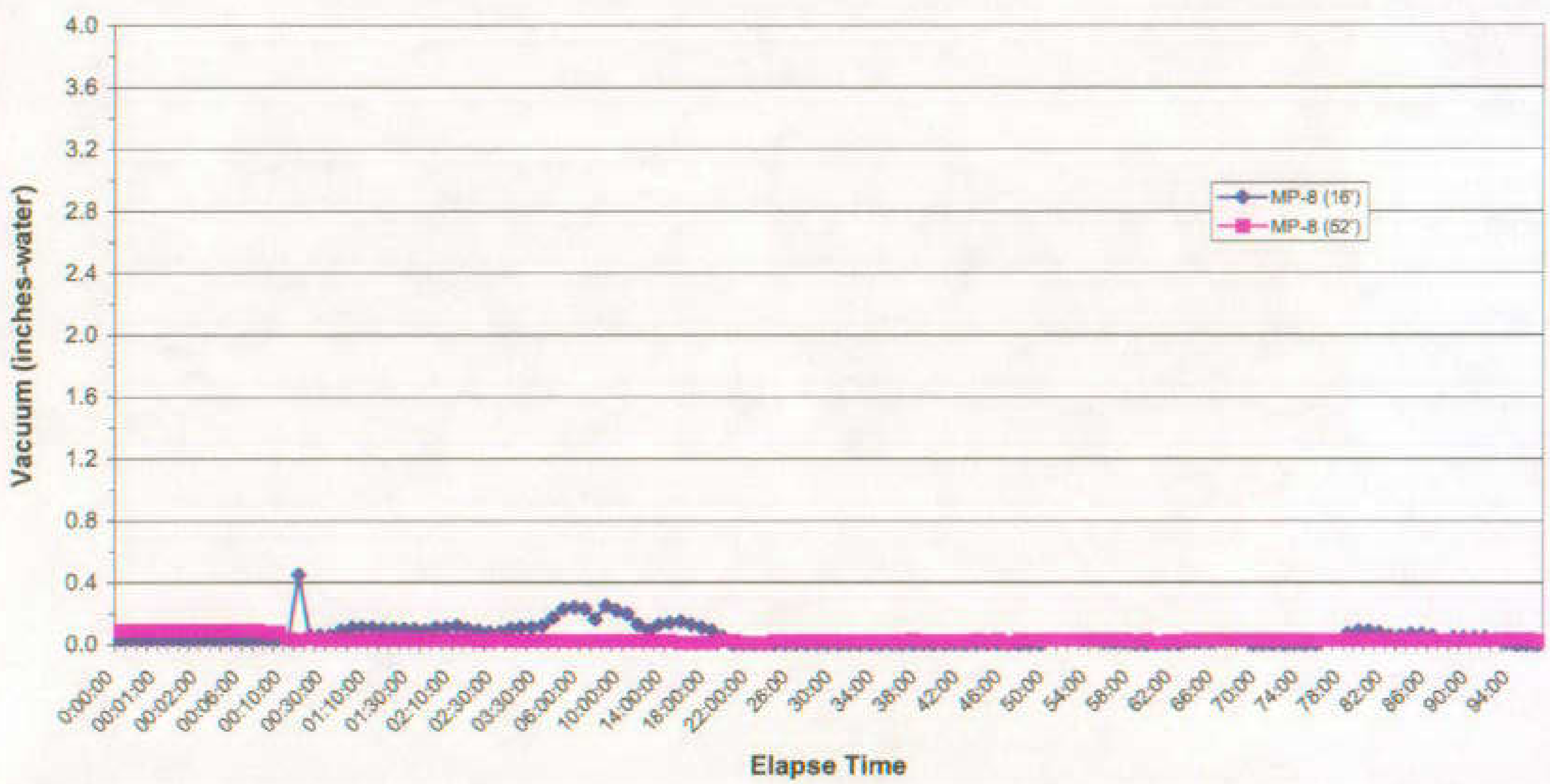


Table 18
Summary of SUMMA Canister Vapor VOCs Analytical Results for Test 1 (VW-1)
Memphis Depot - December 2001
Dunn Field Memphis Depot SVE Treatability Study

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Carbon Canister	Chlorobenzene	12/18/2001 18 32	50 0		100%
		Methylene Chlonde	12/18/2001 18 32	1 7	0 8	
		cis-1,2-Dichloroethene	12/18/2001 18 32	40 5	0 8	
		Benzene	12/18/2001 18 32	1 6	0 8	
		Tnchloroethene	12/18/2001 18 32	585 8	0 8	
		Toluene	12/18/2001 18 32	1 9	0 8	
		1,1,2-Tnchloroethane	12/18/2001 18 32	3 8	0 8	
		Tetrachloroethene	12/18/2001 18 32	147 8	0 8	
		Ethylbenzene	12/18/2001 18 32	1 2	0 8	
		m,p-Xylene	12/18/2001 18 32	3 0	0 8	
		o-Xylene	12/18/2001 18·32	2 6	0 8	
		1,1,2,2-Tetrachloroethane	12/18/2001 18 32	473 3	0 8	
		Bromofluorobenzene	12/18/2001 18 32	72 3		145%
		1,3,5-Tnmethylbenzene	12/18/2001 18·32	2 6	0 8	
		1,2,4-Tnmethylbenzene	12/18/2001 18 32	5 4	0 8	
		Hexachlorobutadiene	12/18/2001 18 32	32 8	0 8	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/18/2001 18 32	50 0		100%
		Vinyl chloride	12/18/2001 18 32	263 4	4 7	
		1,1-Dichloroethene	12/18/2001 18·32	32 5	4 7	
		cis-1,2-Dichloroethene	12/18/2001 18 32	847 0	4 7	
		Chloroform	12/18/2001 18.32	62 5	4 7	
		1,2-Dichloroethane	12/18/2001 18 32	14 1	4 7	
		Benzene	12/18/2001 18 32	21 0	4 7	
		Tnchloroethene	12/18/2001 18 32	3169 6	4 7	
		Toluene	12/18/2001 18 32	19 6	4 7	
		1,1,2-Tnchloroethane	12/18/2001 18 32	114 8	4 7	
		Tetrachloroethene	12/18/2001 18 32	1195 7	4 7	
		Ethylbenzene	12/18/2001 18 32	64 4	4 7	
		m,p-Xylene	12/18/2001 18 32	45 6	4 7	
		o-Xylene	12/18/2001 18 32	34 9	4 7	
		1,1,2,2-Tetrachloroethane	12/18/2001 18 32	2391 3	4 7	
		Bromofluorobenzene	12/18/2001 18 32	26 1		52%
		1,3,5-Tnmethylbenzene	12/18/2001 18 32	65 3	4 7	
		1,2,4-Tnmethylbenzene	12/18/2001 18 32	160 4	4 7	
		1,2,4-Tnchlorobenzene	12/18/2001 18 32	8 4	4 7	
		Hexachlorobutadiene	12/18/2001 18 32	109 4	4 7	
VW-1	Equipment blank	Chlorobenzene	12/18/2001 18 32	50 0		100%
		Tnchloroethene	12/18/2001 18 32	14 5	0 5	
		Tetrachloroethene	12/18/2001 18 32	2 0	0 5	
		1,1,2,2-Tetrachloroethane	12/18/2001 18.32	17 3	0.5	
		Bromofluorobenzene	12/18/2001 18 32	49 5		99%
VW-1	After Carbon Canister	Chlorobenzene	12/19/2001 2 32	50 0		100%
		cis-1,2-Dichloroethene	12/19/2001 2 32	16 2	0 6	
		Tnchloroethene	12/19/2001 2 32	103 6	0 6	
		Toluene	12/19/2001 2 32	0 9	0 6	
		trans-1,3-dichloropropene	12/19/2001 2 32	3 9	0 6	
		1,1,2-Tnchloroethane	12/19/2001 2 32	0 7	0 6	
		Tetrachloroethene	12/19/2001 2 32	32 6	0 6	
		m,p-Xylene	12/19/2001 2 32	0 9	0 6	
		o-Xylene	12/19/2001 2 32	0 7	0 6	
		1,1,2,2-Tetrachloroethane	12/19/2001 2 32	124 2	0 6	
		Bromofluorobenzene	12/19/2001 2 32	49 3		99%
		1,3,5-Tnmethylbenzene	12/19/2001 2 32	0 7	0 6	
		1,2,4-Trimethylbenzene	12/19/2001 2 32	1 7	0 6	
		Hexachlorobutadiene	12/19/2001 2.32	4 4	0 6	

Table 18
Summary of SUMMA Canister Vapor VOCs Analytical Results for Test 1 (VW-1)
Memphis Depot - December 2001
Dunn Field Memphis Depot SVE Treatability Study

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Liquid Ring Pump	Chlorobenzene	12/19/2001 2 32	50 0		100%
		Vinyl chloride	12/19/2001 2 32	88.1	6 0	
		1,1-Dichloroethene	12/19/2001 2 32	8 8	6 0	
		cis-1,2-Dichloroethene	12/19/2001 2 32	520 2	6 0	
		Chloroform	12/19/2001 2 32	23 8	6 0	
		1,2-Dichloroethane	12/19/2001 2 32	11.7	6 0	
		Trichloroethene	12/19/2001 2 32	1314 2	6 0	
		Toluene	12/19/2001 2 32	10 8	6 0	
		1,1,2-Trichloroethane	12/19/2001 2:32	15 8	6 0	
		Tetrachloroethene	12/19/2001 2:32	819 6	6 0	
		m,p-Xylene	12/19/2001 2 32	6 5	6 0	
		1,1,2,2-Tetrachloroethane	12/19/2001 2 32	937 9	6 0	
		Bromofluorobenzene	12/19/2001 2 32	48 8		98%
		1,2,4-Trimethylbenzene	12/19/2001 2.32	8.1	6 0	
		Hexachlorobutadiene	12/19/2001 2:32	17 4	6 0	
VW-1	After Carbon Canister	Chlorobenzene	12/20/2001 2 30	50 0	NA	100%
		Vinyl chloride	12/20/2001 2 30	312 8	168 0	
		cis-1,2-Dichloroethene	12/20/2001 2 30	2611 4	168 0	
		Trichloroethene	12/20/2001 2 30	43300 4	168 0	
		Tetrachloroethene	12/20/2001 2 30	9404 2	168 0	
		1,1,2,2-Tetrachloroethane	12/20/2001 2 30	14284 9	168 0	
		Bromofluorobenzene	12/20/2001 2 30	43.8	NA	88%
VW-1	After Liquid Ring Pump	Chlorobenzene	12/20/2001 2.35	50 0	NA	100%
		Vinyl chloride	12/20/2001 2 35	317.4	100 0	
		cis-1,2-Dichloroethene	12/20/2001 2 35	2435 5	100 0	
		Chloroform	12/20/2001 2 35	115 1	100 0	
		Trichloroethene	12/20/2001 2 35	31625 9	100 0	
		Tetrachloroethene	12/20/2001 2 35	8306 3	100 0	
		1,1,2,2-Tetrachloroethane	12/20/2001 2 35	12484 7	100 0	
		Bromofluorobenzene	12/20/2001 2 35	44 1	NA	86%
VW-1	Duplicate after Pump	Chlorobenzene	12/20/2001 2 36	50 0	NA	100%
		Vinyl chloride	12/20/2001 2 36	156 2	100 0	
		cis-1,2-Dichloroethene	12/20/2001 2 36	2409 0	100 0	
		Chloroform	12/20/2001 2 36	110 8	100 0	
		Trichloroethene	12/20/2001 2.36	32072 3	100 0	
		Tetrachloroethene	12/20/2001 2 36	8828 6	100 0	
		1,1,2,2-Tetrachloroethane	12/20/2001 2 36	14784 7	100 0	
		Bromofluorobenzene	12/20/2001 2:36	44 7	NA	89%
VW-1	Ambient Background	Chlorobenzene	12/20/2001 15 00	50 0	NA	100%
		cis-1,2-Dichloroethene	12/20/2001 15 00	1 0	0 8	
		Trichloroethene	12/20/2001 15:00	56 0	0 8	
		Tetrachloroethene	12/20/2001 15:00	6 7	0 8	
		1,1,2,2-Tetrachloroethane	12/20/2001 15 00	28 5	0 8	
		Bromofluorobenzene	12/20/2001 15 00	43 2	NA	86%

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Table 18
Summary of SUMMA Canister Vapor VOCs Analytical Results for Test 1 (VW-1)
Memphis Depot - December 2001
Dunn Field Memphis Depot SVE Treatability Study

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Carbon Canister	Chlorobenzene	12/21/2001 14 30	50 0	NA	100%
		Vinyl chloride	12/21/2001 14:30	0 7	0 5	
		1,1-Dichloroethene	12/21/2001 14:30	0 5	0 5	
		cis-1,2-Dichloroethene	12/21/2001 14:30	25 8	0 5	
		Trichloroethene	12/21/2001 14:30	130 2	0 5	
		Toluene	12/21/2001 14 30	1 6	0 5	
		1,1,2-Trichloroethane	12/21/2001 14 30	1 5	0 5	
		Tetrachloroethene	12/21/2001 14:30	71 1	0 5	
		1,1,2,2-Tetrachloroethane	12/21/2001 14 30	117.7	0 5	
		Bromofluorobenzene	12/21/2001 14 30	48 9	NA	98%
		Hexachlorobutadiene	12/21/2001 14 30	3.1	0 5	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/21/2001 14 30	50 0	NA	100%
		Vinyl chloride	12/21/2001 14 30	458.1	168 0	
		cis-1,2-Dichloroethene	12/21/2001 14 30	3228 8	168 0	
		Trichloroethene	12/21/2001 14 30	46929 9	168 0	
		Tetrachloroethene	12/21/2001 14 30	11167 4	168 0	
		1,1,2,2-Tetrachloroethane	12/21/2001 14 30	19502 7	168 0	
		Bromofluorobenzene	12/21/2001 14 30	44 3	NA	89%
VW-1	Duplicate after Pump	Chlorobenzene	12/21/2001 14 30	50 0	NA	100%
		Vinyl chloride	12/21/2001 14 30	176 0	147	
		cis-1,2-Dichloroethene	12/21/2001 14 30	2675 3	147	
		Trichloroethene	12/21/2001 14 30	51571 9	147	
		Tetrachloroethene	12/21/2001 14:30	11499 5	147	
		1,1,2,2-Tetrachloroethane	12/21/2001 14 30	19785.3	147	
		Bromofluorobenzene	12/21/2001 14 30	41 1	NA	82%

Note
ppbv = parts per billion, volume per volume
NA = Not Applicable
Benzyl chloride has been removed from the target list due to instability in the standards
SS = Surrogate Standard
IS = Internal Standard 50 ng each
Benzyl chloride has been removed from the target list due to instability in the standards

Table 19
Summary of SUMMA Canister Vapor VOCs Analytical Results for Test 2 (VW-2)
Memphis Depot - January 2002
Dunn Field Memphis Depot SVE Treatability Study

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-2	Exhausting Pipe	Chlorobenzene	01/07/2002 18:30	50 0		100%
		Vinyl chlonde	01/07/2002 18:30	7463 9	147 0	
		1,1-Dichloroethene	01/07/2002 18:30	437.6	147.0	
		cis-1,2-Dichloroethene	01/07/2002 18:30	47656.5	147.0	
		Chloroform	01/07/2002 18:30	1605 3	147 0	
		Carbon tetrachloride	01/07/2002 18:30	637.5	147.0	
		Tnchloroethene	01/07/2002 18:30	87003 2	147.0	
		1,1,2-Tnchloroethane	01/07/2002 18:30	881 6	147 0	
		Tetrachloroethene	01/07/2002 18:30	17820.1	147.0	
		1,1,2,2-Tetrachloroethane	01/07/2002 18:30	27024 2	147 0	
		Bromofluorobenzene	01/07/2002 18.30	51.3		103%
VW-2	Equipment blank	Chlorobenzene	01/07/2002 18.30	50 0		100%
		Tetrachloroethene	01/07/2002 18:30	234.5	100.0	
		Bromofluorobenzene	01/07/2002 18:30	48 0		96%
VW-2	Exhausting Pipe	Chlorobenzene	01/08/2002 2:00	50.0		100%
		Vinyl chlonde	01/08/2002 2:00	2279.6	100.0	
		1,1-Dichloroethene	01/08/2002 2:00	248.5	100.0	
		cis-1,2-Dichloroethene	01/08/2002 2:00	27539.8	100 0	
		Chloroform	01/08/2002 2:00	772 4	100 0	
		Carbon tetrachloride	01/08/2002 2.00	363 2	100 0	
		Trichloroethene	01/08/2002 2.00	70494 0	100.0	
		1,1,2-Trichloroethane	01/08/2002 2:00	541 5	100 0	
		Tetrachloroethene	01/08/2002 2:00	10056 0	100 0	
		1,1,2,2-Tetrachloroethane	01/08/2002 2 00	13191.5	100.0	
		Bromofluorobenzene	01/08/2002 2 00	50 5		101%
VW-2	Duplicate Exhausting	Chlorobenzene	01/08/2002 2 00	50.0		100%
		Vinyl chloride	01/08/2002 2:00	3448 1	133 5	
		1,1-Dichloroethene	01/08/2002 2:00	302.4	133 5	
		cis-1,2-Dichloroethene	01/08/2002 2:00	35588.5	133 5	
		Chloroform	01/08/2002 2:00	992.5	133 5	
		Carbon tetrachlonde	01/08/2002 2:00	468.4	133 5	
		Tnchloroethene	01/08/2002 2 00	88158.4	133 5	
		1,1,2-Trichloroethane	01/08/2002 2:00	616.7	133.5	
		Tetrachloroethene	01/08/2002 2.00	12667.9	133.5	
		1,1,2,2-Tetrachloroethane	01/08/2002 2 00	21842.2	133.5	
		Bromofluorobenzene	01/08/2002 2.00	50.5		101%
VW-2	Exhausting Pipe	Chlorobenzene	01/09/2002 2 00	50.0	NA	100%
		Vinyl chlonde	01/09/2002 2:00	2319.8	168 0	
		1,1-Dichloroethene	01/09/2002 2:00	205 0	168.0	
		cis-1,2-Dichloroethene	01/09/2002 2:00	40977.4	168 0	
		Chloroform	01/09/2002 2:00	1202 9	168 0	
		Carbon tetrachlonde	01/09/2002 2:00	855 3	168 0	
		Tnchloroethene	01/09/2002 2:00	108661.8	168 0	
		1,1,2-Trichloroethane	01/09/2002 2:00	1039.4	168 0	
		Tetrachloroethene	01/09/2002 2:00	16032.7	168 0	
		1,1,2,2-Tetrachloroethane	01/09/2002 2:00	22305 3	168 0	

579 368

Table 19
Summary of SUMMA Canister Vapor VOCs Analytical Results for Test 2 (VW-2)
Memphis Depot - January 2002
Dunn Field Memphis Depot SVE Treatability Study

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
		Bromofluorobenzene	01/09/2002 2:00	50.7	NA	101%
VW-2	Duplicate Exhausting	Chlorobenzene	01/09/2002 2 00	50.0	NA	100%
		Vinyl chloride	01/09/2002 2:00	1533 2	168.0	
		1,1-Dichloroethene	01/09/2002 2.00	209.9	168 0	
		cis-1,2-Dichloroethene	01/09/2002 2 00	42045.9	168.0	
		Chloroform	01/09/2002 2.00	1257 3	168 0	
		Carbon tetrachloride	01/09/2002 2:00	861.1	168 0	
		Trichloroethene	01/09/2002 2 00	110798.1	168.0	
		1,1,2-Trichloroethane	01/09/2002 2 00	1012.1	168.0	
		Tetrachloroethene	01/09/2002 2·00	14878 7	168.0	
		Bromofluorobenzene	01/09/2002 2.00	51.7	NA	103%
VW-2	Exhausting Pipe	Chlorobenzene	01/10/2002 14 00	50.0	NA	100%
		Vinyl chloride	01/10/2002 14:00	602 2	168.0	
		cis-1,2-Dichloroethene	01/10/2002 14.00	31509 5	168.0	
		Chloroform	01/10/2002 14.00	1002.9	168.0	
		Carbon tetrachloride	01/10/2002 14·00	946 7	168.0	
		Trichloroethene	01/10/2002 14:00	88841 1	168.0	
		1,1,2-Trichloroethane	01/10/2002 14·00	869 8	168.0	
		Tetrachloroethene	01/10/2002 14:00	12789 5	168.0	
		1,1,2,2-Tetrachloroethane	01/10/2002 14.00	46540 0	168 0	
		Bromofluorobenzene	01/10/2002 14·00	47.3	NA	95%
VW-2	Ambient Air	Chlorobenzene	01/10/2002 14.00	50.0	NA	100%
		Dichlorodifluoromethane	01/10/2002 14:00	1 1	0 8	
		Trichloroethene	01/10/2002 14.00	2.7	0 8	
		1,1,2,2-Tetrachloroethane	01/10/2002 14.00	2.6	0.8	
		Bromofluorobenzene	01/10/2002 14·00	46.0	NA	92%
VW-2	Exhausting Pipe	Chlorobenzene	01/11/2002 14:10	50.0	NA	100%
		Vinyl chloride	01/11/2002 14·10	552 8	168 0	
		cis-1,2-Dichloroethene	01/11/2002 14:10	30332 8	168 0	
		Chloroform	01/11/2002 14 10	1032.5	168 0	
		Carbon tetrachloride	01/11/2002 14·10	1086.5	168 0	
		Trichloroethene	01/11/2002 14·10	86466.7	168 0	
		1,1,2-Trichloroethane	01/11/2002 14.10	828 9	168 0	
		Tetrachloroethene	01/11/2002 14·10	12029.3	168 0	
		Bromofluorobenzene	01/11/2002 14 10	49.8	NA	100%

Note
ppbv = parts per billion, volume per volume
NA = Not Applicable
Surr. = Surrogate Standard
IS = Internal Standard 50 ng each
Benzyl chloride has been removed from the target list due to instability in the standards

Table 20
Vapor Mass Removal Calculations
Memphis Depot Dunn Field SVE Treatability Study Technical Memorandum

		Mass Removed (lbs)
Vapor Mass Removed through Test 1	Vinyl chloride	0.00779
	1,1-Dichloroethene	0 00005
	cis-1,2-Dichloroethene	0.08513
	Chloroform	0.00146
	Trichloroethene	1.61757
	1,1,2-Trichloroethane	0.00017
	Tetrachloroethene	0.50102
	1,1,2,2-Tetrachloroethane	0 85117
	Total:	**3.06**

		Mass Removed (lbs)
Vapor Mass Removed through Test 2	Vinyl chloride	0.33864
	1,1-Dichloroethene	0.03249
	cis-1,2-Dichloroethene	8.09669
	Chloroform	0.47795
	Carbon tetrachloride	0.51834
	Trichloroethene	45.19457
	1,1,2-Trichloroethane	0.43836
	Tetrachloroethene	8.34083
	1,1,2,2-Tetrachloroethane	15.92897
	Total:	**79.37**

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Table 21

Vapor Mass Removal Calculations

Memphis Depot Dunn Field SVE Treatability Study Technical Memorandum

Test 1

Date & Time	Venting Well	Compound	Analytical Results (ppbv)	Molecular Weight (g/mol)	Converted Analytical Results (g/L)	Air Velocity (ACFM)	Vacuum @ Pump (in-Hg)	Air Velocity (SCFM)	Vapor Mass Removal Rate (lbs/hr)	SVE Running Period (hrs)	Vapor Mass Removed (lbs)
12/18/2001 18 32	VW-1	Vinyl chloride	263 4	62 5	6 75E-07	100	26	13 1	0 00003	4	0 00013
12/18/2001 18 32	VW-1	1,1-Dichloroethene	32 5	96	1 28E-07	100	26	13 1	0 00001	4	0 00003
12/18/2001 18 32	VW-1	cis-1,2-Dichloroethene	847 0	96	3 33E-06	100	26	13 1	0 00016	4	0 00065
12/18/2001 18 32	VW-1	Chloroform	62 5	119 5	3 06E-07	100	26	13 1	0 00002	4	0 00006
12/18/2001 18 32	VW-1	Trichloroethene	3,169 6	131 5	1 71E-05	100	26	13 1	0 00084	4	0 00335
12/18/2001 18 32	VW-1	1,1,2-Trichloroethane	114 8	133 5	6 28E-07	100	26	13 1	0 00003	4	0 00012
12/18/2001 18 32	VW-1	Tetrachloroethene	1,195 7	166	8 14E-06	100	26	13 1	0 00040	4	0 00160
12/18/2001 18 32	VW-1	1,1,2,2-Tetrachloroethane	2,391 3	168	1 65E-05	100	26	13 1	0 00081	4	0 00323
12/19/2001 2 32	VW-1	Vinyl chloride	88 1	62 5	2 26E-07	150	26	19 7	0 00002	8	0 00013
12/19/2001 2 32	VW-1	1,1-Dichloroethene	8 8	96	3 46E-08	150	26	19 7	0 00000	8	0 00002
12/19/2001 2 32	VW-1	cis-1,2-Dichloroethene	520 2	96	2 05E-06	150	26	19 7	0 00015	8	0 00120
12/19/2001 2 32	VW-1	Chloroform	23 8	119 5	1 17E-07	150	26	19 7	0 00001	8	0 00007
12/19/2001 2 32	VW-1	Trichloroethene	1,314 2	131 5	7 09E-06	150	26	19 7	0 00052	8	0 00417
12/19/2001 2 32	VW-1	1,1,2-Trichloroethane	15 8	133 5	8 65E-08	150	26	19 7	0 00001	8	0 00005
12/19/2001 2 32	VW-1	Tetrachloroethene	819 6	166	5 58E-06	150	26	19 7	0 00041	8	0 00328
12/19/2001 2 32	VW-1	1,1,2,2-Tetrachloroethane	937 9	168	6 46E-06	150	26	19 7	0 00048	8	0 00380
12/20/2001 2 35	VW-1	Vinyl chloride	317 4	62 5	8 13E-07	200	26	26 2	0 00008	24	0 00191
12/20/2001 2 35	VW-1	1,1-Dichloroethene	0 0	96	0 00E+00	200	26	26 2	0 00000	24	0 00000
12/20/2001 2 35	VW-1	cis-1,2-Dichloroethene	2,435 5	96	9 59E-06	200	26	26 2	0 00094	24	0 02256
12/20/2001 2 35	VW-1	Chloroform	115 1	119 5	5 64E-07	200	26	26 2	0 00006	24	0 00133
12/20/2001 2 35	VW-1	Trichloroethene	31,625 9	131 5	1 71E-04	200	26	26 2	0 01672	24	0 40133
12/20/2001 2 35	VW-1	1,1,2-Trichloroethane	0 0	133 5	0 00E+00	200	26	26 2	0 00000	24	0 00000
12/20/2001 2 35	VW-1	Tetrachloroethene	8,306 3	166	5 65E-05	200	26	26 2	0 00554	24	0 13306
12/20/2001 2 35	VW-1	1,1,2,2-Tetrachloroethane	12,484 7	168	8 60E-05	200	26	26 2	0 00843	24	0 20241
12/21/2001 14 30	VW-1	Vinyl chloride	458 1	62 5	1 17E-06	240	25 5	35 5	0 00016	36	0 00561
12/21/2001 14 30	VW-1	1,1-Dichloroethene	0 0	96	0 00E+00	240	25 5	35 5	0 00000	36	0 00000
12/21/2001 14 30	VW-1	cis-1,2-Dichloroethene	3,228 8	96	1 27E-05	240	25 5	35 5	0 00169	36	0 06071
12/21/2001 14 30	VW-1	Chloroform	0 0	119 5	0 00E+00	240	25 5	35 5	0 00000	36	0 00000
12/21/2001 14 30	VW-1	Trichloroethene	46,929 9	131 5	2 53E-04	240	25 5	35 5	0 03358	36	1 20871
12/21/2001 14 30	VW-1	1,1,2-Trichloroethane	0 0	133 5	0 00E+00	240	25 5	35 5	0 00000	36	0 00000
12/21/2001 14 30	VW-1	Tetrachloroethene	11,167 4	166	7 60E-05	240	25 5	35 5	0 01009	36	0 36308
12/21/2001 14 30	VW-1	1,1,2,2-Tetrachloroethane	19,502 7	168	1 34E-04	240	25 5	35 5	0 01783	36	0 64173
										Total	**3 06**

Table 21

Vapor Mass Removal Calculations

Memphis Depot Dunn Field SVE Treatability Study Technical Memorandum

Test 2

Date & Time	Venting Well	Compound	Analytical Results (ppbv)	Molecular Weight (g/mol)	Converted Analytical Results (g/L)	Air Velocity (ACFM)	Vacuum @ Pump (in-Hg)	Air Velocity (SCFM)	Vapor Mass Removal Rate (lbs/hr)	SVE Running Period (hrs)	Vapor Mass Removed (lbs)
01/07/2002 18 30	VW-2	Vinyl chlonde	7,463 9	62 5	1 91E-05	275	2 4	252 9	0 01811	4	0 07243
01/07/2002 18 30	VW-2	1,1-Dichloroethene	437.6	96	1 72E-06	275	2 4	252 9	0 00163	4	0 00652
01/07/2002 18 30	VW-2	cis-1,2-Dichloroethene	47,656 5	96	1 88E-04	275	2 4	252 9	0 17758	4	0 71031
01/07/2002 18 30	VW-2	Chloroform	1,605 3	119 5	7 87E-06	275	2 4	252 9	0 00745	4	0 02978
01/07/2002 18 30	VW-2	Carbon tetrachlonde	637.5	154	4 03E-06	275	2 4	252 9	0 00381	4	0 01524
01/07/2002 18 30	VW-2	Tnchloroethene	87,003 2	131 5	4 69E-04	275	2 4	252 9	0 44407	4	1 77629
01/07/2002 18 30	VW-2	1,1,2-Tnchloroethane	881.6	133 5	4 83E-06	275	2 4	252 9	0 00457	4	0 01827
01/07/2002 18 30	VW-2	Tetrachloroethene	17,820 1	166	1 21E-04	275	2 4	252 9	0 11482	4	0 45927
01/07/2002 18 30	VW-2	1,1,2,2-Tetrachloroethane	27,024 2	168	1 86E-04	275	2 4	252 9	0 17622	4	0 70488
01/08/2002 2 00	VW-2	Vinyl chlonde	2,279 6	62 5	5 84E-06	275	2 3	253 9	0 00555	8	0 04440
01/08/2002 2 00	VW-2	1,1-Dichloroethene	248 5	96	9 78E-07	275	2 3	253 9	0 00093	8	0 00743
01/08/2002 2·00	VW-2	cis-1,2-Dichloroethene	27,539 8	96	1 08E-04	275	2 3	253 9	0 10299	8	0 82393
01/08/2002 2 00	VW-2	Chloroform	772 4	119 5	3 78E-06	275	2 3	253 9	0 00360	8	0 02877
01/08/2002 2 00	VW-2	Carbon tetrachlonde	363 2	154	2 29E-06	275	2 3	253 9	0 00218	8	0 01743
01/08/2002 2 00	VW-2	Tnchloroethene	70,494 0	131 5	3 80E-04	275	2 3	253 9	0 36111	8	2 88892
01/08/2002 2 00	VW-2	1,1,2-Tnchloroethane	541 5	133 5	2 96E-06	275	2 3	253 9	0 00282	8	0 02253
01/08/2002 2 00	VW-2	Tetrachloroethene	10,056.0	166	6 84E-05	275	2 3	253 9	0 06503	8	0 52022
01/08/2002 2 00	VW-2	1,1,2,2-Tetrachloroethane	13,191 5	168	9 09E-05	275	2 3	253 9	0 08633	8	0 69065
01/09/2002 2 00	VW-2	Vinyl chlonde	2,319 8	62 5	5 94E-06	275	2 1	255 7	0 00569	24	0 13653
01/09/2002 2 00	VW-2	1,1-Dichloroethene	205 0	96	8 07E-07	275	2 1	255 7	0 00077	24	0 01853
01/09/2002 2 00	VW-2	cis-1,2-Dichloroethene	40,977 4	96	1 61E-04	275	2 1	255 7	0 15435	24	3 70448
01/09/2002 2 00	VW-2	Chloroform	1,202.9	119 5	5 89E-06	275	2 1	255 7	0 00564	24	0 13537
01/09/2002 2 00	VW-2	Carbon tetrachlonde	855 3	154	5 40E-06	275	2 1	255 7	0 00517	24	0 12404
01/09/2002 2 00	VW-2	Tnchloroethene	108,661 8	131 5	5 86E-04	275	2 1	255 7	0 56066	24	13 45596
01/09/2002 2 00	VW-2	1,1,2-Tnchloroethane	1,039 4	133 5	5 69E-06	275	2 1	255 7	0 00544	24	0 13067
01/09/2002 2 00	VW-2	Tetrachloroethene	16,032 7	166	1 09E-04	275	2 1	255 7	0 10443	24	2 50626
01/09/2002 2 00	VW-2	1,1,2,2-Tetrachloroethane	22,305 3	168	1 54E-04	275	2 1	255 7	0 14703	24	3 52882
01/10/2002 14 00	VW-2	Vinyl chlonde	602 2	62 5	1 54E-06	275	2 2	254 8	0 00147	36	0 05297
01/10/2002 14 00	VW-2	1,1-Dichloroethene	0 0	96	0 00E+00	275	2 2	254 8	0 00000	36	0 00000
01/10/2002 14 00	VW-2	cis-1,2-Dichloroethene	1,002 9	96	3 95E-06	275	2 2	254 8	0 00376	36	0 13551
01/10/2002 14 00	VW-2	Chloroform	1,002 9	119 5	4 91E-06	275	2 2	254 8	0 00469	36	0 16868
01/10/2002 14 00	VW-2	Carbon tetrachlonde	946 7	154	5 98E-06	275	2 2	254 8	0 00570	36	0 20520
01/10/2002 14 00	VW-2	Tnchloroethene	88,841 1	131 5	4 79E-04	275	2 2	254 8	0 45675	36	16 44292
01/10/2002 14 00	VW-2	1,1,2-Tnchloroethane	869.8	133 5	4 76E-06	275	2 2	254 8	0 00454	36	0 16343
01/10/2002 14 00	VW-2	Tetrachloroethene	12,789 5	166	8 70E-05	275	2 2	254 8	0 08300	36	2 98814
01/10/2002 14 00	VW-2	1,1,2,2-Tetrachloroethane	46,540 0	168	3 21E-04	275	2 2	254 8	0 30568	36	11 00462
01/11/2002 14 10	VW-2	Vinyl chlonde	552 8	62 5	1 42E-06	275	2 3	253 9	0 00135	24	0 03230
01/11/2002 14 10	VW-2	1,1-Dichloroethene	0 0	96	0 00E+00	275	2 3	253 9	0 00000	24	0 00000
01/11/2002 14 10	VW-2	cis-1,2-Dichloroethene	30,332 8	96	1 19E-04	275	2 3	253 9	0 11344	24	2 72246
01/11/2002 14 10	VW-2	Chloroform	1,032 5	119 5	5 06E-06	275	2 3	253 9	0 00481	24	0 11536
01/11/2002 14 10	VW-2	Carbon tetrachlonde	1,086.5	154	6 86E-06	275	2 3	253 9	0 00652	24	0 15643
01/11/2002 14 10	VW-2	Tnchloroethene	86,466 7	131 5	4 66E-04	275	2 3	253 9	0 44294	24	10 63049
01/11/2002 14 10	VW-2	1,1,2-Tnchloroethane	828 9	133 5	4 54E-06	275	2 3	253 9	0 00431	24	0 10346
01/11/2002 14 10	VW-2	Tetrachloroethene	12,029 3	166	8 19E-05	275	2 3	253 9	0 07779	24	1 86693
01/11/2002 14 10	VW-2	1,1,2,2-Tetrachloroethane	0 0	168	0 00E+00	275	2 3	253 9	0 00000	24	0 00000
										Total	79.37

Table 21

Vapor Mass Removal Calculations

Memphis Depot Dunn Field SVE Treatability Study Technical Memorandum

Note

Vapor total mass removed through SVE pilot test was underestimated due to

1 ppmv detected at the end of each period was used for the entire period (vapor concentrations usually are lower than that at the beginning)

2 only part of VOCs were analyzed, listed, and used for calculation

Calculation Background

1 Assumed gases are ideal gases, convert analytical results (ppbv) to (g/L) for each pollutant

ppbv = (Vs/Vt) * 1E9

where Vs = n_sRT/P = volume of pollutant

Vt = n_tRT/P = total volume

n_s = moles of pollutant

n_t = moles total (assumed to be moles of gas)

R = universal gas constant = 0 08206 (atm L/g mol - °K)

for standard conditions P = 1 atm and T = 25 °C = 298 15 °K

Ideal gas law PVs = n_sRT = (Ws/Ms) RT

Vs = (RT/P) (Ws/Ms)

Vs/Vt = (RT/P) (Ws/Ms)/Vt = ppbv/1E9

therefore Ws/Vt (g/L) = (P/RT) (ppbv/1E9) Ms

g/L = (1 atm/(0 08206 atm L/g mol - °K * 298 15 °K)) (ppbv/1E9) Ms

g/L = 0 041 (g-mol/L) (ppbv/1E9) * Ms (g/g-mol)

2 SCFM = [29 92 (in-Hg) - Vacuum (in-Hg)]/29 92 (in-Hg) * ACFM

3 lb/hr = g/L * (lb/454g) * (28 32 L/ft^3) * SCFM (ft^3/min) * 60 (min/hr)

Figures

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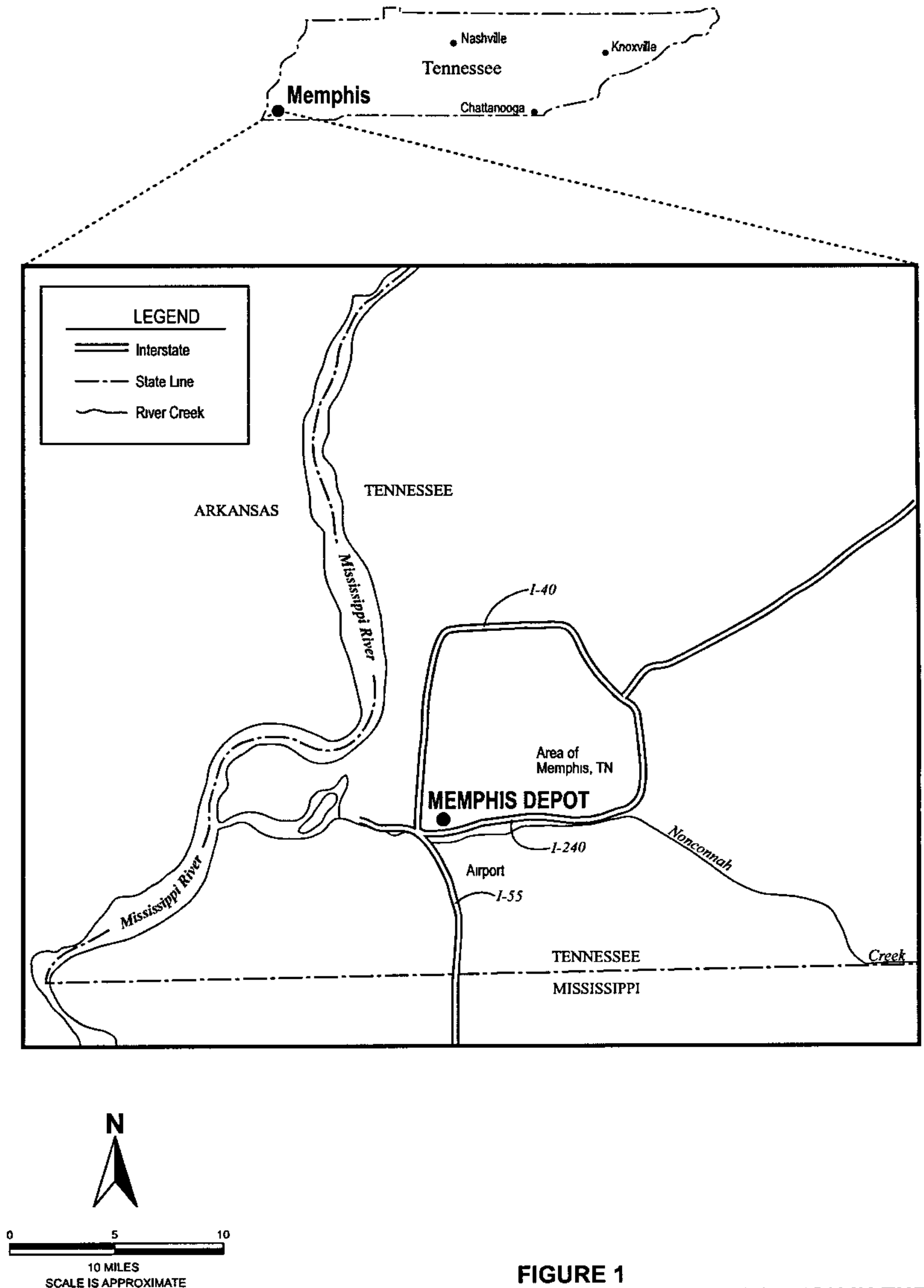

FIGURE 1
MEMPHIS DEPOT LOCATION IN THE MEMPHIS METROPOLITAN AREA
REV. 0 DUNN FIELD SVE TECHNICAL MEMORANDUM

E072001017ATL \ Dunn128 FH8

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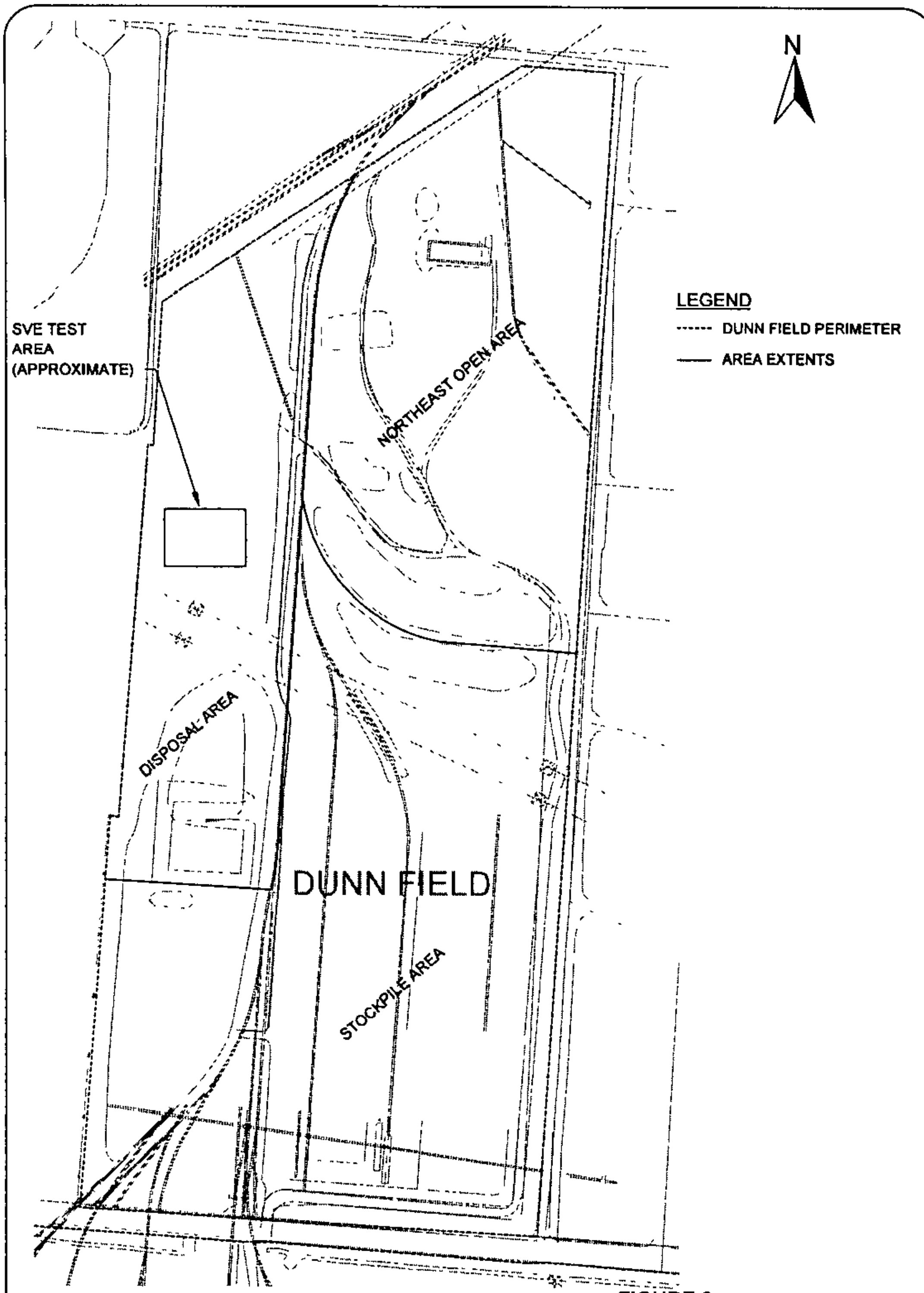

FIGURE 2
Area Designations at Dunn Field
Rev 0 Dunn Field
SVE Technical Memorandum

Source: RI Report, 1990

ATL/CAD1/PROJECTS/160492/0492-2 dgn

CH2MHILL

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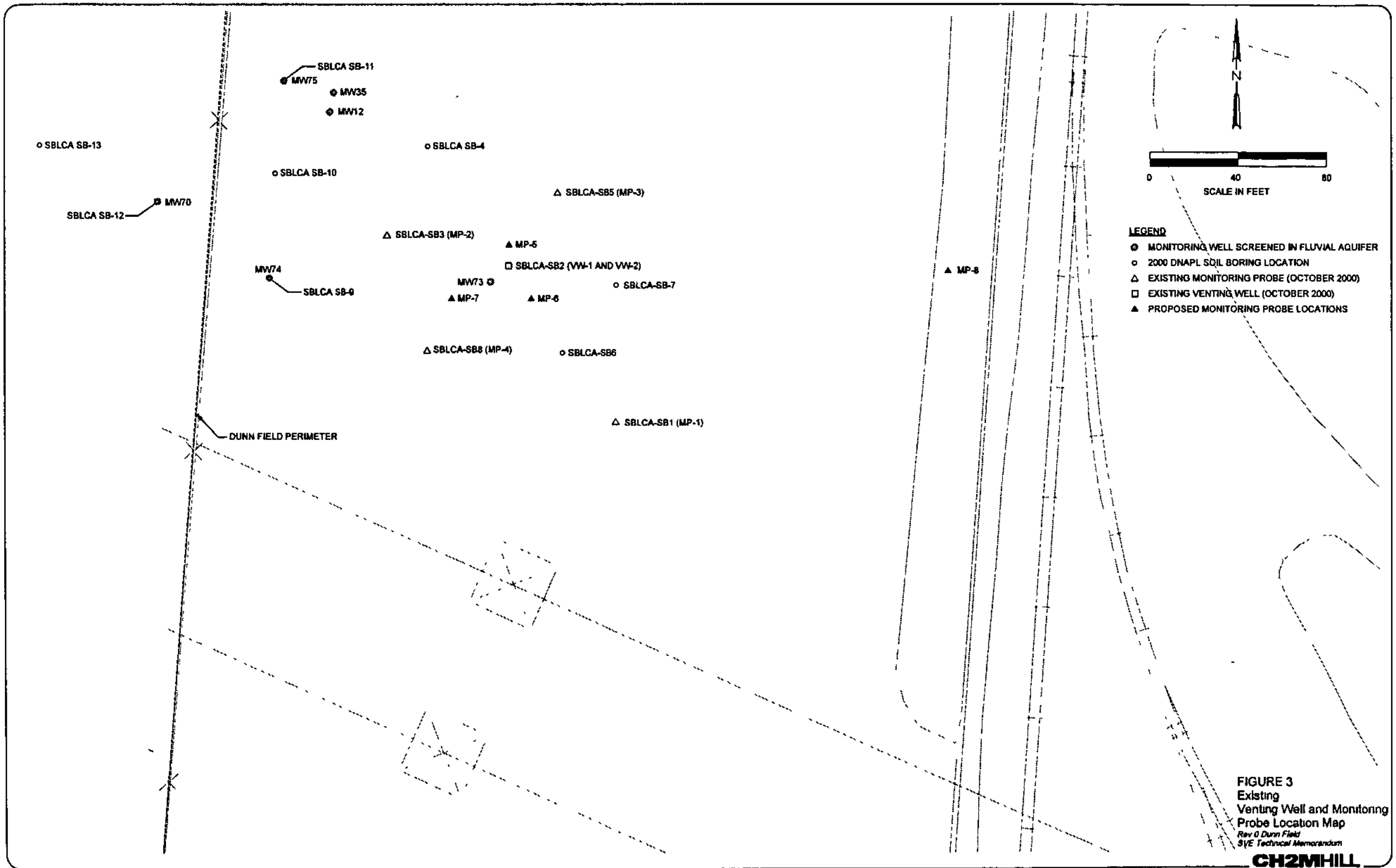

FIGURE 3
Existing
Venting Well and Monitoring
Probe Location Map
Rev 0 Dunn Field
SVE Technical Memorandum

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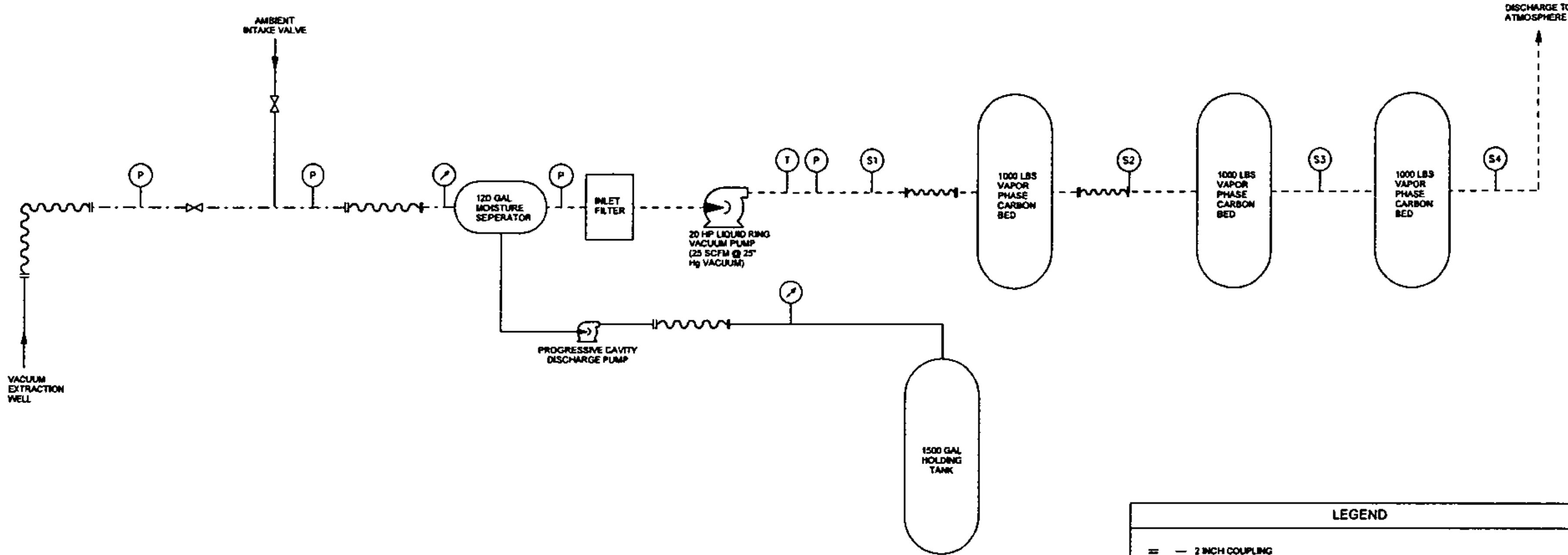
ATL/CAD I/PROJECTS/148071 DDMT/DUNNFIELD RI 2001 04-OCT-2001 0492-1-2.dgn



NOTES

1. WELL HEAD TO PRESSURE GAUGE. 1 1/2" FLEXIBLE PVC HOSE
2. DISCHARGE PUMP TO THE HOLDING TANK AND VACUUM PUMP TO CARBON BED 4" FLEXIBLE PVC HOSE.
3. OTHER CONNECTIONS. 1" SCH. 40 PVC

LEGEND

- = — 2 INCH COUPLING
- P — PRESSURE/VACUUM GAUGE
- — FLOW INDICATOR
- T — TEMPERATURE GAUGE
- S1 SAMPLE PORTS
- — GATE VALVE (OR GLOBE/BUTTERFLY VALVE)
- II — CAMLOCK HOSE COUPLER
- — FLEXIBLE HOSE

PRELIMINARY

NOT FOR CONSTRUCTION

DSGN	S SMITH
DR	M HALES
CHK	
APVD	

NO	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL

SVE SYSTEM
DUNN FIELD
DEFENSE DEPOT-MEMPHIS TENNESSEE

FIGURE 4
SVE PILOT TEST PROCESS FLOW DIAGRAM - TEST 1
REV 0 DUNN FIELD
SVE TECHNICAL MEMORANDUM

SHEET	
DWG	
DATE	DEC 2001
PROJ	160492 TS 06

05-FEB-2002 0492-4-1.dgn

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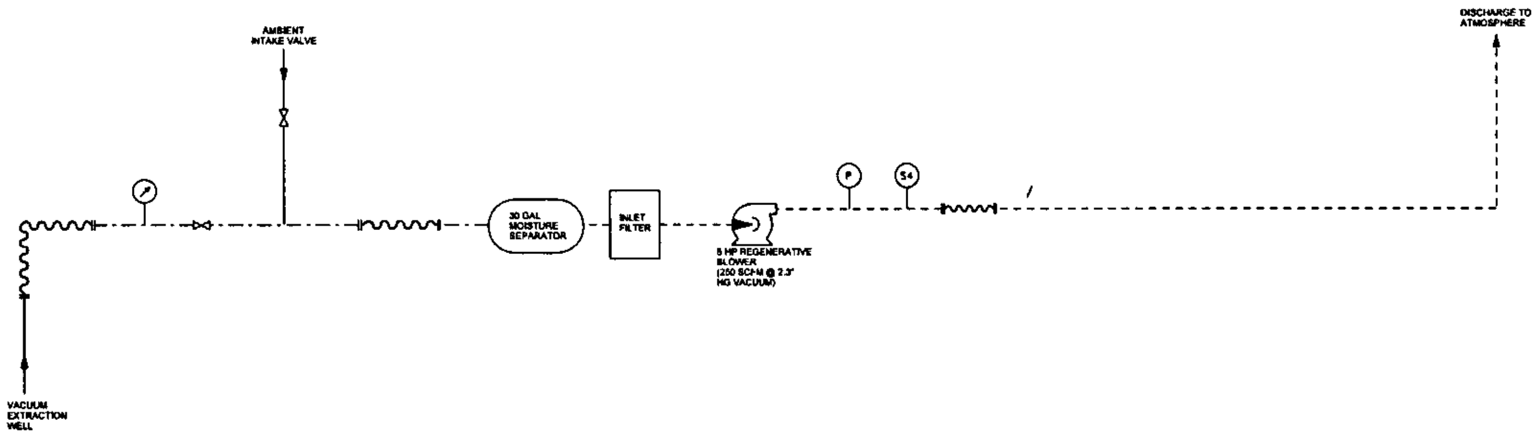

NOTES:

1. WELL HEAD TO MOISTURE SEPARATOR 1 1/2" FLEXIBLE PVC HOSE.
2. BLOWER TO CARBON BED 4" FLEXIBLE PVC HOSE

LEGEND

- — 2 INCH COUPLING
- — PRESSURE/ VACUUM GAUGE
- — FLOW INDICATOR
- SAMPLE PORTS
- — GATE VALVE (OR GLOBE/BUTTERFLY VALVE)
- — CAMLOCK HOSE COUPLER
- — FLEXIBLE HOSE

PRELIMINARY
NOT FOR CONSTRUCTION

DSGN S SMITH
DR M HALES
CHK
APVD

NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

CH2MHILL

SVE SYSTEM
DUNN FIELD
DEFENSE DEPOT-MEMPHIS TENNESSEE

FIGURE 5
SVE PILOT TEST PROCESS FLOW DIAGRAM - TEST 2
REV 0 DUNN FIELD
SVE TECHNICAL MEMORANDUM

SHEET
DWG
DATE JAN 2002
PROJ 160492 TS.06

08-FEB-2002 0492-4-1-2.dgn

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ATLANTA\CAD\PROJECTS\160492 Memphis Depot

Figure 6
TCE Values After Liquid Ring Pump
Test 1 - VW-1 - Dunn Field SVE

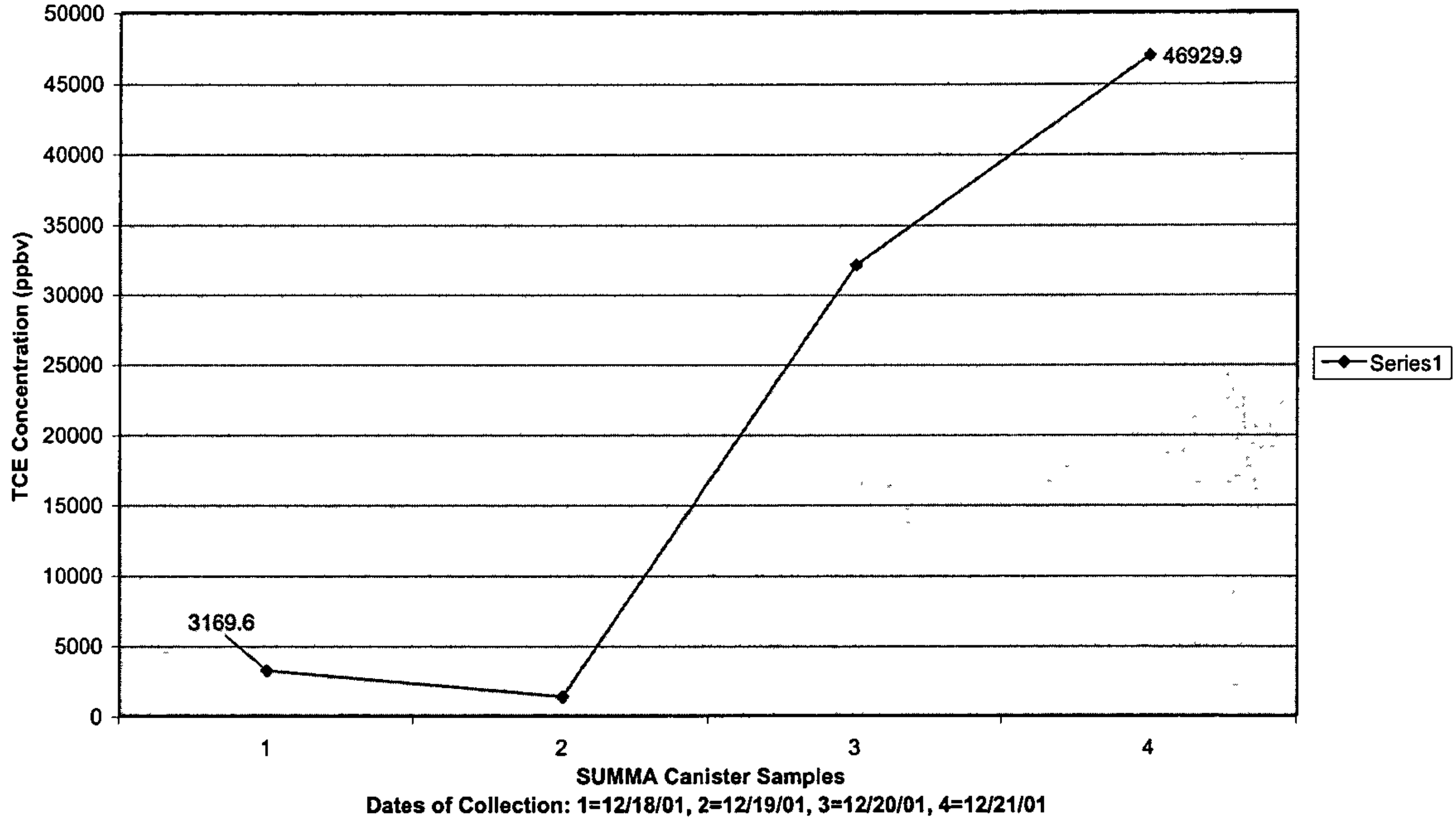
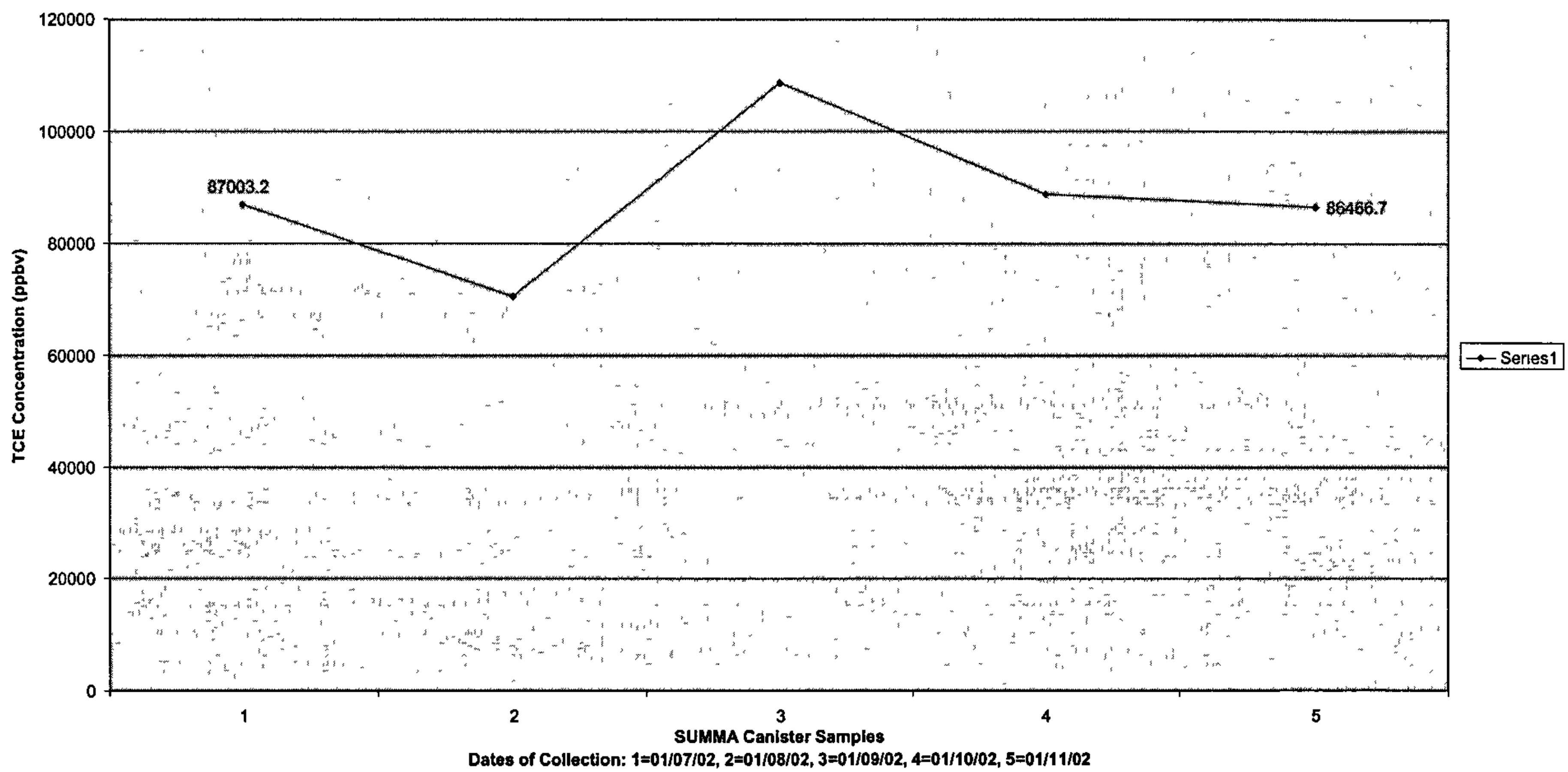


Figure 7
TCE Values from After Exhaust Pipe
Test 2 - VW-2 - Dunn Field SVE



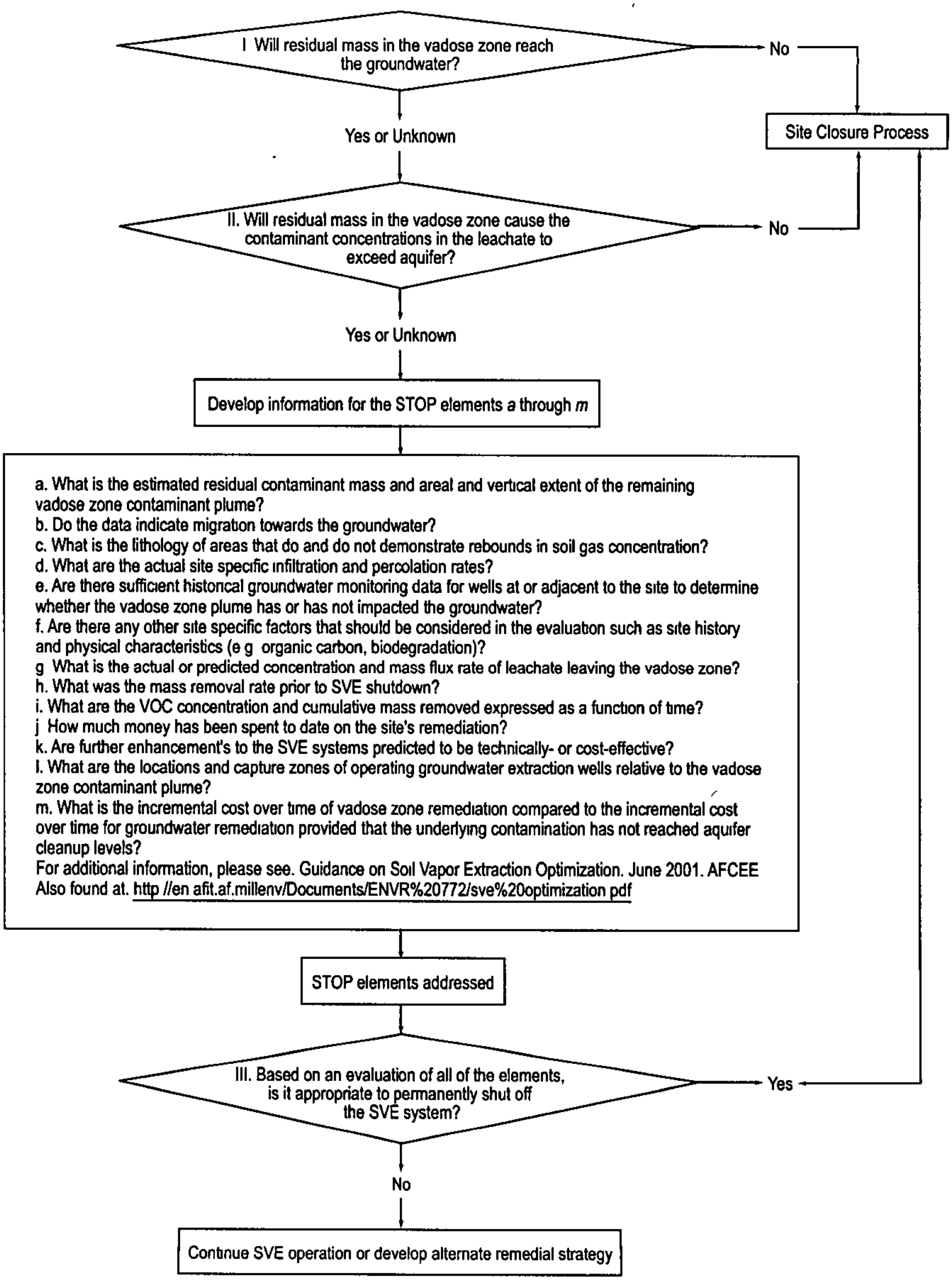


Figure 8 - STOP Decision Tree

Attachments

Attachment A

579 384

Table A-1
Venting Well and Monitoring Point Construction Details
Rev 0 SVE Treatability Study Memphis Depot, Dunn Field

Identification	ID	Related to Main Installation (MI) or Dunn Field (DF)	Onsite or Offsite	Northing	Easting	Boring Type	Ground Elevation	Length of Screen	Depth to Top of Screen	Depth to Bottom of Screen	Elevation of Top of Screen	Elevation of Bottom of Screen	Depth of Boring (ft bgs)	Elevation of Bottom of Boring (ft)
VW-1	SBLCA SB2 (VW-1)	DF	On	280996 43	802153 34	SB/VW	301 20	15 00	9 00	24 00	292.20	277 20	93 0	208.2
VW-2	SBLCA SB2 (VW-2)	DF	On	280996 43	802153 34	SB/VW	301 20	40 00	32 00	72 00	269 20	229 20		
MP-1	SBLCA SB1 (MP-1)	DF	On	280925 92	802202 04	SB/MP	299 80	0 50	21 50	22 00	278 30	278 80	90 0	209 8
									34 50	35 00	265 30	265 80		
									57 50	58 00	242 30	242 80		
									70 00	70 50	229 80	230 30		
MP-2	SBLCA SB3 (MP-2)	DF	On	281010 26	802098 19	SB/MP	301 00	0 50	21 50	22 00	279 50	280 00	88 0	213 0
									34 50	35 00	266 50	267 00		
									57 50	58 00	243 50	244 00		
									70 00	70 50	231 00	231 50		
MP-3	SBLCA SB5 (MP-3)	DF	On	281029 52	802175 45	SB/MP	301 20	0 50	10 50	11 00	290 70	291.20	90 0	211.2
									26 50	27 00	274 70	275.20		
									48 50	49 00	252 70	253 20		
									67 00	67 50	234 20	234 70		
MP-4	SBLCA SB8 (MP-4)	DF	On	280957 77	802115 90	SB/MP	300 80	0 50	18 50	19 00	312 30	312 80	87 0	213.8
									47 5	48 0	253 3	253 8		
									57 5	58	243 3	243 8		
									69 5	70	231 3	231 8		
MP-5	MP-5	DF	On	?	?	SB/MP	300 80	1 0	9 50	10 50	291 30	290 30	21 0	279.8
									19 5	20 5	281 30	280 30		
MP-6	MP-6	DF	On	?	?	SB/MP	300 80	1 0	9 50	10 50	291.30	290 30	72 0	228 8
									19 5	20 5	281.30	280 30		
									49 5	50 5	251.30	250 30		
									69 5	70 5	231.30	230 30		
MP-7	MP-7	DF	On	?	?	SB/MP	300 80	1 0	4 50	5 50	296.30	295 30	87 0	213.8
									14 5	15 5	286.30	285 30		
									39 5	40 5	261 30	260 30		
									59 5	60 5	241.30	240 30		
MP-8	MP-8	DF	On	?	?	SB/MP	300 80	1 0	14 50	15 50	286 30	285 30	52 0	248 8
									49 5	50 5	251 3	250 30		

VW= Venting Well
MP= Monitoring Point
SB= Soil Boring
ft bgs =feet below ground surface

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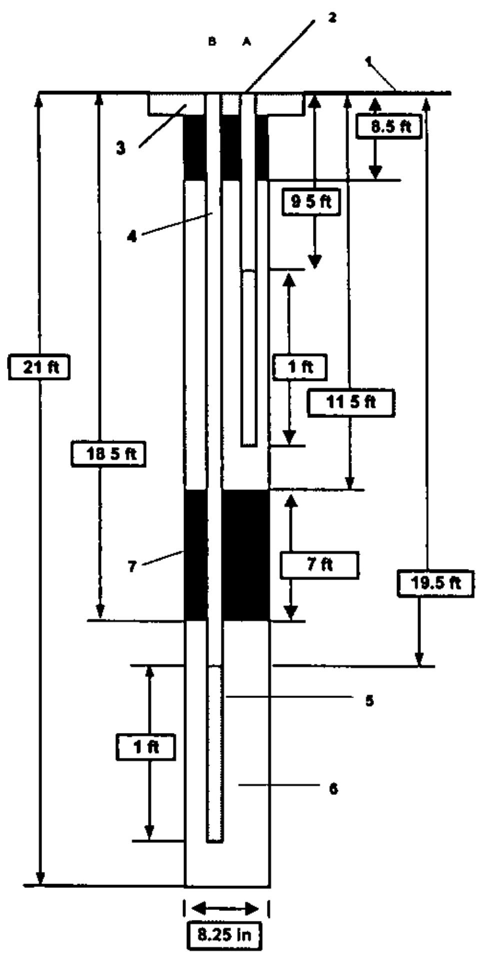
PROJECT NUMBER	WELL NUMBER	
160492.TS.04	MP-5	SHEET 1 OF 1

MONITORING POINT COMPLETION DIAGRAM

PROJECT . Dunn Field Monitoring Point Installation LOCATION Memphis, Tennessee
DRILLING CONTRACTOR Tri-State Drilling Services
DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger 4 25 inch ID
WATER LEVELS None START . 11/12/01 END 11/12/01 LOGGER Bryan Burkingstock



1- Ground elevation at well	None	feet MSL
2- Top of casing elevation	None	feet MSL
3- a) concrete pad dimensions	3ft x 3 ft	
4- Diameter/type of well casing	0 5-inch PVC	
5- Type/slot size of screen	0 010 slot PVC	
6- Type screen filter	#2 filter sand	
a) Quantity used	bags	
7- Type of seal	Bentonite Chips	
a) Quantity used	bags	

Notes

Monitoring Point A. Screen length = 1 feet
Depth to top of screen 9 5 ft bgs
Depth to bottom of screen 10 5 ft bgs

Monitoring Point B Screen length = 1 feet
Depth to top of screen 19 5 ft bgs
Depth to bottom of screen 20 5 ft bgs

NOTE Diagram is not to scale

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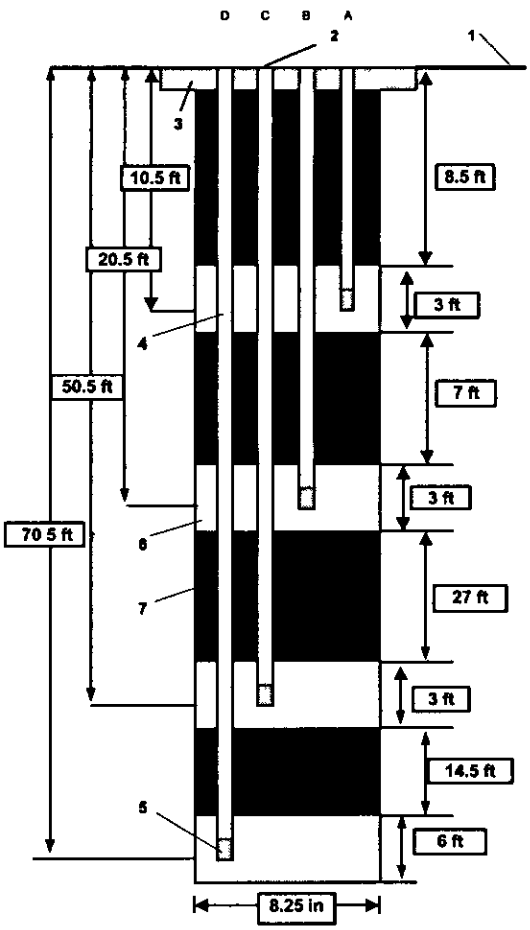
CH2MHILL

PROJECT NUMBER	WELL NUMBER
160492.TS.04	MP-6 SHEET 1 OF 1

MONITORING POINT COMPLETION DIAGRAM

PROJECT Dunn Field Monitoring Point Installation LOCATION · Memphis, Tennessee
DRILLING CONTRACTOR Tri-State Drilling Services
DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger 4 25 inch ID
WATER LEVELS None START 11/12/01 END 11/12/01 LOGGER Bryan Burkingstock



1- Ground elevation at well None feet MSL

2- Top of casing elevation None feet MSL

3- a) concrete pad dimensions 3ft x 3 ft

4- Diameter/type of well casing 0 5-inch PVC

5- Type/slot size of screen 0 010 slot PVC

6- Type screen filter #2 filter sand
a) Quantity used bags

7- Type of seal Bentonite Chips
a) Quantity used bags

Notes

Monitoring Point A. Screen length = 1 feet
Depth to top of screen 9 5 ft bgs
Depth to bottom of screen 10 5 ft bgs

Monitoring Point B Screen length = 1 feet
Depth to top of screen 19 5 ft bgs
Depth to bottom of screen 20 5 ft bgs

Monitoring Point C Screen length = 1 feet
Depth to top of screen 49 5 ft bgs
Depth to bottom of screen 50 5 ft bgs

Monitoring Point D Screen length = 1 feet
Depth to top of screen 69 5 ft bgs
Depth to bottom of screen 70 5 ft bgs

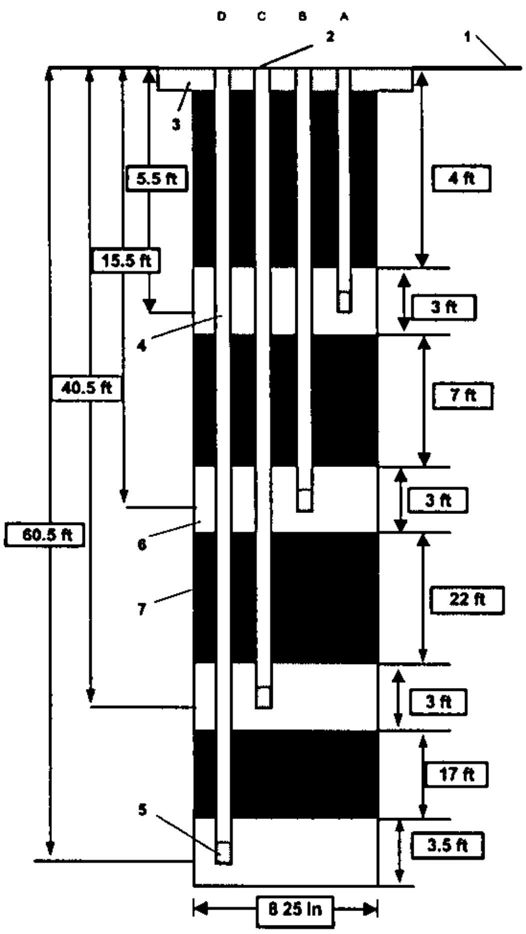
NOTE: Diagram is not to scale

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
160492.TS.04	MP-7	SHEET 1 OF 1

MONITORING POINT COMPLETION DIAGRAM

PROJECT Dunn Field Monitoring Point Installation LOCATION Memphis, Tennessee
DRILLING CONTRACTOR Tri-State Drilling Services
DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger 4 25 inch ID
WATER LEVELS None START 11/13/01 END 11/13/01 LOGGER Bryan Burkingstock



1- Ground elevation at well None feet MSL

2- Top of casing elevation None feet MSL

3- a) concrete pad dimensions 3ft x 3 ft

4- Diameter/type of well casing 0 5-inch PVC

5- Type/slot size of screen 0 010 slot PVC

6- Type screen filter #2 filter sand
a) Quantity used bags

7- Type of seal Bentonite Chips
a) Quantity used bags

Notes

Monitoring Point A. Screen length = 1 feet
Depth to top of screen 4 5 ft bgs
Depth to bottom of screen 5 5 ft bgs

Monitoring Point B Screen length = 1 feet
Depth to top of screen 14 5 ft bgs
Depth to bottom of screen 15 5 ft bgs

Monitoring Point C Screen length = 1 feet
Depth to top of screen 39 5 ft bgs
Depth to bottom of screen 40 5 ft bgs

Monitoring Point D Screen length = 1 feet
Depth to top of screen 59 5 ft bgs
Depth to bottom of screen 60 5 ft bgs

NOTE: Diagram is not to scale

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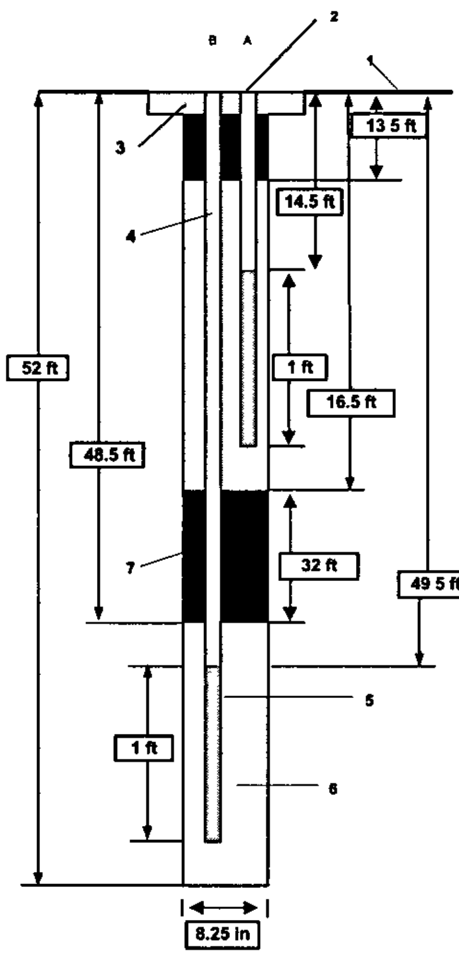
PROJECT NUMBER	WELL NUMBER	
160492.TS.04	MP-8	SHEET 1 OF 1

MONITORING POINT COMPLETION DIAGRAM

PROJECT Dunn Field Monitoring Point Installation LOCATION Memphis, Tennessee
DRILLING CONTRACTOR Tri-State Drilling Services
DRILLING METHOD AND EQUIPMENT USED Hollow Stem Auger 4 25 inch ID
WATER LEVELS None START 11/13/01 END 11/13/01 LOGGER Bryan Burkingstock



1- Ground elevation at well: None feet MSL

2- Top of casing elevation: None feet MSL

3- a) concrete pad dimensions: 3ft x 3 ft

4- Diameter/type of well casing: 0 5-inch PVC

5- Type/slot size of screen: 0 010 slot PVC

6- Type screen filter: #2 filter sand
a) Quantity used: bags

7- Type of seal: Bentonite Chips
a) Quantity used: bags

Notes

Monitoring Point A.
Screen length = 1 feet
Depth to top of screen 14 5 ft bgs
Depth to bottom of screen 15 5 ft bgs

Monitoring Point B
Screen length = 1 feet
Depth to top of screen 49 5 ft bgs
Depth to bottom of screen 50 5 ft bgs

NOTE. Diagram is not to scale

Attachment B

579 390

JACOBS ENGINEERING

A Jacobs Company

Federal Operations

TO: CH2M Hill

DATE: 4/25/02

ATTN: David Nelson

JOB NO. DO #10 – Mobile PRAC

PROJECT: SVE Pilot Study at Dunn Field

THE FOLLOWING IS TRANSMITTED

x Herewith
___ Under Separate Cover
___ For Your Use or Distribution
___ For Review and Comments
___ For Correction and Resubmittal

QUANTITY 1

DESCRIPTION

Law-Gibb Geotechnical Test Results.

THIS TRANSMITTAL IS PER

X Federal Express
___ Your Letter
___ Your Telegram
___ Your Telephone Request

REMARKS: Enclosed is a hard copy of the geotechnical analytical results from the soil samples collected during the installation of the additional monitoring points needed as part of the SVE Pilot Study. I am happy to hear the results are acceptable even though there was a substantial delay in obtaining them

JACOBS ENGINEERING GROUP INC.

BY: Virgil W Jansen

c:

LAW
RESOURCES CREATING SOLUTIONS

April 10, 2002

Jacobs Engineering Group Inc.
13723 Riverport Drive
Maryland Heights, MO 83043

Attention: Mr. Virgil Jansen

Subject: **Transmittal of Test Results: Memphis Depot**
Geotechnical Testing Services
Law Engineering & Environmental Services Job Number 50160-2-0113

Dear Mr. Jansen:

Law Engineering and Environmental Services, Inc. has completed the assigned laboratory tests for the samples you had delivered to our office. We are transmitting to you the tabular summary for the samples tested. These are the final results, thus, we have enclosed two copies of the following test results for your distribution:

Hydraulic Conductivity (ASTM D 5084) (including unit weight)
Organic Content (ASTM 2974-87(95))
Specific Gravity (ASTM D 854-92)

If you have any questions pertaining to these test results or require additional information, please do not hesitate to call us at (404) 817-0257.

Sincerely,
LAW ENGINEERING and ENVIRONMENTAL SERVICES, INC.

David M. Jensen
Project Professional II

LAW Engineering and Environmental Services, Inc
396 Plasters Avenue, N E • Atlanta, GA 30324
404-873-4761 • Fax 404-881-0508

LAWGIBB GROUP

ORGANIC CONTENT

(ASTM D2974-87) (1995)

Project No. 50160-2-0113
Tested By JM
Test Date 3/28/02

Project Name Memphis Depot
Reviewed By [signature]
Review Date 4/9/02

Boring No.	MP-5	MP-5	MP-6	MP-6
Sample No.	Ud	Ud	Ud	Ud
Sample Depth	4-6 Ft.	14-16 Ft.	9-11 Ft.	49-51 Ft.
A) Tare No.	R-14	R-33	V-69	R-6
B) Tare Weight, grams	16.03	16.44	16.42	16.76
C) Wet Soil + Tare, grams	129.7	152.5	146.98	143.88
D) Dry Soil + Tare, grams	105.52	128.64	122.11	138.37
E) Weight of Dry Soil, grams [D - B]	89.49	112.2	105.69	121.61
F) Weight of Moisture, grams [C - D]	24.18	23.86	24.87	5.51
G) Moisture Content, % [F * 100 / E]	27.02	21.27	23.53	4.53
(based on over-dried weight)				
H) Tare No.	E-3	E-8	E-2	L-1
I) Weight of Tare, grams	107.65	100.45	103.49	99.8
J) Weight of Over-Dried Soil + Tare, grams	165.46	137.74	161.09	174.51
K) Weight of Oven- Dried Soil, grams [J - I]	57.81	37.29	57.6	74.71
L) Weight of Ignited Soil + Tare, grams	164.9	137.47	160.72	174.43
M) Ash, grams [L - I]	57.25	37.02	57.23	74.63
N) Ash Content, % [M *100 / K]	99.03	99.28	99.36	99.89
O) Organic Matter, % [100 - N]	0.97	0.72	0.64	0.11

LAWGIBB GROUP

ORGANIC CONTENT

(ASTM D2974-87) (1995)

Project No. 50160-2-0113
Tested By JM
Test Date 3/28/02

Project Name Memphis Depot
Reviewed By [signature]
Review Date 4/9/02

Boring No.	MP-6	MP-7	MP-7	MP-7
Sample No.	Ud	Ud	Ud	Ud
Sample Depth	65-67 Ft.	19-21 Ft.	39-41 Ft.	59-61 Ft.
A) Tare No.	R-63	V-9	R-55	R-64
B) Tare Weight, grams	15.99	15.32	31.8	15.96
C) Wet Soil + Tare, grams	109.9	71.94	148 61	118.03
D) Dry Soil + Tare, grams	103.52	59.14	134.24	115.44
E) Weight of Dry Soil, grams [D - B]	87.53	43.82	102.44	99.48
F) Weight of Moisture, grams [C - D]	6.38	12.8	14.37	2.59
G) Moisture Content, % [F * 100 / E]	7.29	29.21	14.03	2.60
(based on over-dried weight)				
H) Tare No.	L-3	E-7	L-2	E-3
I) Weight of Tare, grams	99.41	102.78	99.68	107.66
J) Weight of Over-Dried Soil + Tare, grams	166.12	146.5	166.59	182.47
K) Weight of Oven- Dried Soil, grams [J - I]	66.71	43.72	66.91	74.81
L) Weight of Ignited Soil + Tare, grams	166.07	146.23	166.37	182.44
M) Ash, grams [L - I]	66.66	43.45	66.69	74.78
N) Ash Content, % [M *100 / K]	99.93	99.38	99.67	99.96
O) Organic Matter, % [100 - N]	0.07	0.62	0.33	0.04

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LAWGIBB GROUP

SPECIFIC GRAVITY TEST

(ASTM D854 - 92)

Project No. 50160-2-0113
Project Name Memphis Depot

Tested By WFL
Test Date 1/25-3/27/2002

Reviewed By [signature]
Review Date 4/4/02

(1) Sample No.	(2) Flask No.	(3) Temperature (°F)	(4) Weight, WF (grams)	(5) Weight, WFS (grams)	(6) Weight of Soil (grams) (5)-(4)	(7) Weight, CWF (grams)	(8) Weight, DS (grams)	(9) Specific Gravity (6)/[(7)-(8)+(6)]	(10) Specific Gravity at 20° C
MP-5, 4-6'	SP-9	24.0	239.72	262.81	23.09	361.45	375.68	2.606	
MP-5, 14-16'	SP-10	24 0	256.92	282.55	25 63	361.65	377.27	2.560	
MP-6, 49-51'	24	23.0	237.54	308.74	71.20	363 26	407.58	2.649	
MP-6, 65-67'	28	23.0	234 31	303.15	68.84	359.51	402 53	2 666	
MP-6, 9-11'	30	23 0	231.86	276.78	44.92	359.80	388.02	2.690	
MP-7, 19-21'	SP-16	23 0	210.89	246.53	35.64	343.17	365.59	2.696	
MP-7, 39-41'	SP-10	23.0	204.13	277.76	73.63	361.70	407.13	2 611	
MP-7, 59-61'	SP-9	23 0	207.65	280 18	72.53	361.51	406.60	2 643	

WF - Water and Flask
WFS - Water, Flask and Soil
CWF - Calibration Water and Flask
DS - Deaired Sample

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-5*
Sample No.	*Ud*
Sample Depth	*14-16'*
Sample Description	*Tan, sandy silt*

Tested By	*DMJ*
Test Date	*01/17/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	Ud
Sample Orientation:	Vertical
Initial Water Content, %:	22.2
Wet Unit Weight, pcf	127.2
Dry Unit Weight, pcf:	104.1
Compaction, %:	N/A
Hydraulic Conductivity, cm/sec. @20 °C	**6.0E-06**

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-5
Sample No. Ud
Sample Depth 14-16'
Sample Description Tan, sandy silt

Tested By DMJ
Test Date 01/17/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	K-49
Location 1	3.962	Location 1	2.869	Dry Soil+Pan, grams	749.89
Location 2	3.960	Location 2	2.870	Pan Weight, grams	49.76
Location3	3.962	Location 3	2.872		
Average	3.961	Average	2.870	Moisture Content, %	22.2
		Wet Soil + Tare, grams	855.59	Wet Unit Weight, pcf	127.2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	104.1

Chamber Pressure, psi 50
Back Pressure, psi 40
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1515	0.0	5.0	128.38	123.38	6.3E-06	22	6.0E-06
				3120	0.0	10.0	128.38	118.38	6.3E-06	22	6.0E-06
				6660	0.0	20.0	128.38	108.38	6.1E-06	22	5.9E-06

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Ud		N/A	Vertical

Avg. k at 20 °C 6.0E-06 cm/sec

a = area of burette in cm^2
L = length of sample in cm
A = area of sample in cm^2

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm^2
A = 41.75 cm^2
L = 10.06 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-5*
Sample No.	*Ud*
Sample Depth	*14-16'*
Sample Description	*Tan, sandy silt*

Tested By	*DMJ*
Test Date	*01/17/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*23.3*
Wet Unit Weight, pcf:	*120.0*
Dry Unit Weight, pcf:	*97.3*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***5.2E-06***

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PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-5
Sample No. Ud
Sample Depth 14-16'
Sample Description Tan, sandy silt

Tested By DMJ
Test Date 01/17/02
Reviewed By [illegible]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	X-30
Location 1	1.411	Location 1	2.910	Dry Soil+Pan, grams	276.25
Location 2	1.411	Location 2	2.780	Pan Weight, grams	48.77
Location3	1.411	Location 3	2.815		
Average	1.411	Average	2.835	Moisture Content, %	23.3
		Wet Soil + Tare, grams	280.53	Wet Unit Weight, pcf	120.0
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	97.3

Chamber Pressure, psi 25
Back Pressure, psi 15
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				700	0.0	5 0	126.22	121.22	5.1E-06	22	4 9E-06
				1573	0.0	10 0	126.22	116.22	4.6E-06	22	4.4E-06
				2242	0.0	20.0	126.22	106.22	6.8E-06	22	6.5E-06

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Ud		N/A	Horizontal

Avg. k at 20 °C 5.2E-06 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 40.73 cm²
L = 3.58 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-5*
Sample No.	*Ud*
Sample Depth	*4-6'*
Sample Description	*Tan, sandy silt*

Tested By	*DMJ*
Test Date	*01/16/02*
Reviewed By	[signature]
Review Date	4/9/0-

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*28.2*
Wet Unit Weight, pcf:	*103.8*
Dry Unit Weight, pcf:	*81.0*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.1E-05***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-5
Sample No. Ud
Sample Depth 4-6'
Sample Description Tan, sandy silt

Tested By DMJ
Test Date 01/16/02
Reviewed By [signature]
Review Date 4/9/0[illegible]

Sample Data

Length, in		Diameter, in		Pan No.	N-8
Location 1	1.392	Location 1	2.810	Dry Soil+Pan, grams	228.72
Location 2	1.400	Location 2	2.750	Pan Weight, grams	48.80
Location3	1.398	Location 3	2.772		
Average	1.397	Average	2.777	Moisture Content, %	28.2
		Wet Soil + Tare, grams	230.57	Wet Unit Weight, pcf	103.8
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	81 0

Chamber Pressure, psi 25
Back Pressure, psi 15
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				304	0.0	5.0	126.22	121.22	1.2E-05	22	1 2E-05
				630	0.0	10.0	126.22	116.22	1.2E-05	22	1.1E-05
				966	0.0	15.0	126.22	111.22	1.2E-05	22	1.1E-05

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Ud		N/A	Horizontal

Avg. k at 20 °C 1.1E-05 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 39.09 cm²
L = 3.55 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-5*
Sample No.	*Ud*
Sample Depth	*4-6'*
Sample Description	*Tan, sandy silt*

Tested By	*DMJ*
Test Date	*01/17/02*
Reviewed By	[signature]
Review Date	4/8/02

ASTM D5084 - Falling Head

Sample Type:	Ud
Sample Orientation:	Vertical
Initial Water Content, %:	28.8
Wet Unit Weight, pcf:	114.0
Dry Unit Weight, pcf.	88.5
Compaction, %:	N/A
Hydraulic Conductivity, cm/sec. @20 °C	**2.9E-06**

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-5
Sample No. Ud
Sample Depth 4-6'
Sample Description Tan, sandy silt

Tested By DMJ
Test Date 01/17/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	AB-20
Location 1	3.932	Location 1	2.860	Dry Soil+Pan, grams	671.25
Location 2	3.931	Location 2	2.829	Pan Weight, grams	89.94
Location3	3.931	Location 3	2.851		
Average	3 931	Average	2.847	Moisture Content, %	28 8
		Wet Soil + Tare, grams	748.63	Wet Unit Weight, pcf	114.0
		Tare Weight, grams	0 00	Dry Unit Weight, pcf	88.5

Chamber Pressure, psi 50
Back Pressure, psi 40
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1260	0.0	2.0	128.38	126.38	3.0E-06	22	2.9E-06
				1894	0.0	3.0	128.38	125.38	3.0E-06	22	2.9E-06
				6557	0.0	10.0	128.38	118.38	3.0E-06	22	2.9E-06

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Ud		N/A	Vertical

Avg. k at 20 °C **2.9E-06** **cm/sec**

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.06 cm²
L = 9.99 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-6*
Sample No.	*Ud*
Sample Depth	*49-51'*
Sample Description	*Brown sand*

Tested By	*DMJ*
Test Date	*03/23/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*6.1*
Wet Unit Weight, pcf:	*81.4*
Dry Unit Weight, pcf:	*76.7*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***4.5E-04***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 49-51'
Sample Description Brown sand

Tested By DMJ
Test Date 03/23/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No	J-5
Location 1	2.338	Location 1	2.680	Dry Soil+Pan, grams	488 10
Location 2	2.337	Location 2	2.680	Pan Weight, grams	222.59
Location3	2.338	Location 3	2.679		
Average	2.338	Average	2.680	Moisture Content, %	6.1
		Wet Soil + Tare, grams	281.70	Wet Unit Weight, pcf	81.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	76.7

Chamber Pressure, psi 44
Back Pressure, psi 34
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				13	0 0	5.0	123.43	118.43	5 2E-04	22	5.0E-04
				30	0.0	10.0	123.43	113.43	4.6E-04	22	4.4E-04
				68	0.0	20.0	123.43	103.43	4.2E-04	22	4.1E-04
				13	0.0	5.0	123.43	118.43	5.2E-04	22	5.0E-04
				29	0.0	10.0	123.43	113.43	4.8E-04	22	4.5E-04
				67	0.0	20.0	123.43	103.43	4.3E-04	22	4.1E-04

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Horizontal

Avg. k at 20 °C 4.5E-04 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 36.38 cm²
L = 5.94 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-6*
Sample No.	*Ud*
Sample Depth	*49-51'*
Sample Description	*Brown sand*

Tested By	*DMJ*
Test Date	*03/23/02*
Reviewed By	[signature]
Review Date	4/?/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*4.7*
Wet Unit Weight, pcf:	*86.2*
Dry Unit Weight, pcf:	*82.4*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***5.9E-04***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 49-51'
Sample Description Brown sand

Tested By DMJ
Test Date 03/23/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	N-11
Location 1	3.053	Location 1	2.787	Dry Soil+Pan, grams	451.39
Location 2	3.051	Location 2	2.786	Pan Weight, grams	49.04
Location3	3.050	Location 3	2.787		
Average	3.051	Average	2.787	Moisture Content, %	4.7
		Wet Soil + Tare, grams	421.20	Wet Unit Weight, pcf	86.2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	82.4

Chamber Pressure, psi 60
Back Pressure, psi 50
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				12	0.0	5 0	123.04	118.04	6 8E-04	22	6.5E-04
				25	0.0	10.0	123.04	113.04	6 7E-04	22	6.4E-04
				53	0.0	20.0	123.04	103.04	6.6E-04	22	6.3E-04
				14	0.0	5.0	123.04	118.04	5.8E-04	22	5.6E-04
				30	0.0	10.0	123.04	113.04	5.6E-04	22	5.3E-04
				64	0 0	20.0	123.04	103.04	5.5E-04	22	5.2E-04

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Vertical

Avg. k at 20 °C 5.9E-04 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 39.35 cm²
L = 7.75 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/26/02*
Boring No.	*MP-6*	Reviewed By	[signature]
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*65-67'*		
Sample Description	*Orange sand*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*8.8*
Wet Unit Weight, pcf:	*100.2*
Dry Unit Weight, pcf:	*92.1*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***7.1E-04***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 65-67'
Sample Description Orange sand

Tested By DMJ
Test Date 03/26/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No	LS-68
Location 1	2.188	Location 1	2.880	Dry Soil+Pan, grams	433.03
Location 2	2.186	Location 2	2 879	Pan Weight, grams	88.88
Location3	2.185	Location 3	2.880		
Average	2.186	Average	2.880	Moisture Content, %	8.8
		Wet Soil + Tare, grams	374.50	Wet Unit Weight, pcf	100.2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	92.1

Chamber Pressure, psi 55
Back Pressure, psi 45
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				7	0.0	5.0	116.44	111.442	8.3E-04	22	7.9E-04
				15	0.0	10.0	116.44	106.442	7.9E-04	22	7.6E-04
				31	0.0	20.0	116 44	96.442	8.0E-04	22	7.7E-04
				9	0.0	5.0	116.44	111.442	6.4E-04	22	6.2E-04
				17	0.0	10.0	116.44	106.442	7.0E-04	22	6.7E-04
				35	0.0	20.0	116.44	96.442	7.1E-04	22	6.8E-04

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Horizontal

Avg. k at 20 °C 7.1E-04 cm/sec

a = area of burette in cm^2
L = length of sample in cm
A = area of sample in cm^2

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm^2
A = 42.02 cm^2
L = 5.55 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/26/02*
Boring No.	*MP-6*	Reviewed By	[signature]
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*65-67'*		
Sample Description	*Orange sand*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*7.3*
Wet Unit Weight, pcf:	*96.9*
Dry Unit Weight, pcf:	*90.3*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.7E-03***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 65-67'
Sample Description Orange sand

Tested By DMJ
Test Date 03/26/02
Reviewed By [signature]
Review Date 9/9/02

Sample Data

Length, in		Diameter, in		Pan No.	LS-40
Location 1	4.710	Location 1	2.885	Dry Soil+Pan, grams	823.29
Location 2	4.711	Location 2	2.883	Pan Weight, grams	94.60
Location3	4.711	Location 3	2.882		
Average	4.711	Average	2.883	Moisture Content, %	7.3
		Wet Soil + Tare, grams	782.00	Wet Unit Weight, pcf	96.9
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	90.3

Chamber Pressure, psi 55
Back Pressure, psi 45
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				7	0.0	5.0	116.44	111.442	1.8E-03	22	1.7E-03
				14	0.0	10.0	116.44	106.442	1.8E-03	22	1.7E-03
				30	0.0	20.0	116.44	96.442	1.8E-03	22	1.7E-03
				7	0.0	5.0	116.44	111.442	1 8E-03	22	1.7E-03
				14	0.0	10.0	116.44	106.442	1.8E-03	22	1.7E-03
				29	0 0	20.0	116.44	96.442	1.8E-03	22	1.8E-03

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Vertical

Avg. k at 20 °C 1.7E-03 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 42.13 cm²
L = 11.97 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/22/02*
Boring No.	*MP-6*	Reviewed By	(signature)
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*9-11'*		
Sample Description	*Red-brown sandy silt*		

ASTM D5084 - Falling Head

Sample Type:	Ud
Sample Orientation:	Horizontal
Initial Water Content, %:	24.1
Wet Unit Weight, pcf:	116.6
Dry Unit Weight, pcf:	93.9
Compaction, %:	N/A
Hydraulic Conductivity, cm/sec. @20 °C	**9.4E-07**

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 9-11'
Sample Description Red-brown sandy silt

Tested By DMJ
Test Date 03/22/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	B-7
Location 1	2.357	Location 1	2.810	Dry Soil+Pan, grams	579.61
Location 2	2.356	Location 2	2.809	Pan Weight, grams	219.79
Location3	2.356	Location 3	2.807		
Average	2.356	Average	2.809	Moisture Content, %	24.1
		Wet Soil + Tare, grams	446.70	Wet Unit Weight, pcf	116.6
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	93.9

Chamber Pressure, psi 44
Back Pressure, psi 34
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				3300	0.0	3.0	123.04	120.04	1.1E-06	22	1.1E-06
				6300	0.0	5.0	123.04	118.04	9.9E-07	22	9.4E-07
				10800	0.0	8.0	123.04	115.04	9.3E-07	22	8.9E-07
				12480	0.0	9.0	123.04	114 04	9.1E-07	22	8.7E-07

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
4	Ud		N/A	Horizontal

Avg. k at 20 °C 9.4E-07 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 39.97 cm²
L = 5.99 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-6*
Sample No.	*Ud*
Sample Depth	*9-11'*
Sample Description	*Red-brown sandy silt*

Tested By	*DMJ*
Test Date	*03/26/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*24.0*
Wet Unit Weight, pcf:	*119.5*
Dry Unit Weight, pcf:	*96.3*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.6E-05***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-6
Sample No. Ud
Sample Depth 9-11'
Sample Description Red-brown sandy silt

Tested By DMJ
Test Date 03/26/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No	T-19
Location 1	4.721	Location 1	2.845	Dry Soil+Pan, grams	810.72
Location 2	4.720	Location 2	2.848	Pan Weight, grams	50.58
Location3	4.720	Location 3	2 850		
Average	4.720	Average	2 848	Moisture Content, %	24.0
		Wet Soil + Tare, grams	942.80	Wet Unit Weight, pcf	119.5
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	96.3

Chamber Pressure, psi 61
Back Pressure, psi 51
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				277	0.0	2.0	125.33	123.332	1.7E-05	22	1.6E-05
				599	0.0	4.0	125.33	121.332	1.6E-05	22	1.5E-05
				918	0.0	6.0	125.33	119.332	1.6E-05	22	1.5E-05
				253	0.0	2.0	125.33	123.332	1.9E-05	22	1.8E-05
				594	0.0	4.0	125.33	121.332	1.6E-05	22	1.5E-05
				920	0.0	6 0	125.33	119.332	1.6E-05	22	1.5E-05

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Vertical

Avg. k at 20 °C 1.6E-05 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.09 cm²
L = 11.99 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-7*
Sample No.	*Ud*
Sample Depth	*19-21'*
Sample Description	*Red-brown, silty sand*

Tested By	*DMJ*
Test Date	*03/26/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*31.9*
Wet Unit Weight, pcf:	*101.4*
Dry Unit Weight, pcf:	*76.9*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***1.4E-06***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number	50160-2-0113	Tested By	DMJ
Project Name	Memphis Depot	Test Date	03/26/02
Boring No.	MP-7	Reviewed By	[signature]
Sample No.	Ud	Review Date	4/9/02
Sample Depth	19-21'		
Sample Description	Red-brown, silty sand		

Sample Data

Length, in		Diameter, in		Pan No.	LS-58
Location 1	2.035	Location 1	2.874	Dry Soil+Pan, grams	353.62
Location 2	2.035	Location 2	2.872	Pan Weight, grams	87.55
Location3	2 035	Location 3	2.870		
Average	2.035	Average	2.872	Moisture Content, %	31.9
		Wet Soil + Tare, grams	350.94	Wet Unit Weight, pcf	101.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	76.9

Chamber Pressure, psi 60
Back Pressure, psi 50
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				2087	0.0	3.0	120.44	117.44	1.5E-06	22	1.4E-06
				4367	0.0	6.0	120.44	114.44	1.4E-06	22	1.4E-06
				6540	0.0	9.0	120.44	111.44	1.5E-06	22	1.4E-06

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Ud		N/A	Horizontal

Avg. k at 20 °C 1.4E-06 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.80 cm²
L = 5.17 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/23/02*
Boring No.	*MP-7*	Reviewed By	[signature]
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*19-21'*		
Sample Description	*Red-brown silty sand*		

ASTM D5084 - Falling Head

Sample Type:	Ud
Sample Orientation:	Vertical
Initial Water Content, %:	29.7
Wet Unit Weight, pcf:	118.4
Dry Unit Weight, pcf:	91.3
Compaction, %:	N/A
Hydraulic Conductivity, cm/sec. @20 °C	**1.5E-05**

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PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-7
Sample No. Ud
Sample Depth 19-21'
Sample Description Red-brown silty sand

Tested By DMJ
Test Date 03/23/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	S-23
Location 1	4.703	Location 1	2.850	Dry Soil+Pan, grams	763.66
Location 2	4.704	Location 2	2.848	Pan Weight, grams	45.00
Location3	4.704	Location 3	2.850		
Average	4.704	Average	2.849	Moisture Content, %	29.7
		Wet Soil + Tare, grams	932.40	Wet Unit Weight, pcf	118.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	91.3

Chamber Pressure, psi 60
Back Pressure, psi 50
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				150	0.0	1.0	123.04	122.04	1.6E-05	22	1.5E-05
				315	0.0	2.0	123.04	121.04	1.5E-05	22	1.4E-05
				650	0.0	4.0	123.04	119.04	1.5E-05	22	1.4E-05
				300	0.0	2.0	123.04	121.04	1.6E-05	22	1.5E-05
				780	0.0	5 0	123.04	118.04	1.5E-05	22	1.5E-05

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
5	Ud		N/A	Vertical

Avg. k at 20 °C 1.5E-05 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.14 cm²
L = 11.95 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/25/02*
Boring No.	*MP-7*	Reviewed By	[signature]
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*39-41'*		
Sample Description	*Red-brown, silty sand*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*14.4*
Wet Unit Weight, pcf:	*113.4*
Dry Unit Weight, pcf:	*99.1*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***9.7E-05***

579 420

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-7
Sample No. Ud
Sample Depth 39-41'
Sample Description Red-brown, silty sand

Tested By DMJ
Test Date 03/25/02
Reviewed By [illegible]
Review Date 9/9/02

Sample Data

Length, in		Diameter, in		Pan No.	AL-11
Location 1	2.126	Location 1	2.850	Dry Soil+Pan, grams	533.82
Location 2	2.127	Location 2	2.848	Pan Weight, grams	181.55
Location3	2.126	Location 3	2.846		
Average	2.126	Average	2.848	Moisture Content, %	14.4
		Wet Soil + Tare, grams	403.10	Wet Unit Weight, pcf	113.4
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	99.1

Chamber Pressure, psi 60
Back Pressure, psi 50
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				83	0.0	10.0	127.11	117.11	1.3E-04	22	1.2E-04
				224	0.0	20.0	127.11	107.11	1 0E-04	22	9.6E-05
				40	0.0	5.0	127.11	122.11	1.3E-04	22	1.3E-04
				109	0.0	10.0	127.11	117.11	9.9E-05	22	9.4E-05
				295	0.0	20.0	127.11	107.11	7.6E-05	22	7.3E-05
				57	0.0	5.0	125.84	120.84	9.3E-05	22	8.9E-05
				141	0.0	10.0	125.84	115.84	7.7E-05	22	7.4E-05

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
7	Ud		N/A	Horizontal

Avg. k at 20 °C 9.7E-05 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.10 cm²
L = 5.40 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*
Project Name	*Memphis Depot*
Boring No.	*MP-7*
Sample No.	*Ud*
Sample Depth	*39-41'*
Sample Description	*Red-brown, silty sand*

Tested By	*DMJ*
Test Date	*03/26/02*
Reviewed By	[signature]
Review Date	4/9/02

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*12.8*
Wet Unit Weight, pcf:	*119.2*
Dry Unit Weight, pcf:	*105.8*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***3.3E-04***

579 422

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-7
Sample No. Ud
Sample Depth 39-41'
Sample Description Red-brown, silty sand

Tested By DMJ
Test Date 03/26/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	J-1
Location 1	4.685	Location 1	2.821	Dry Soil+Pan, grams	1038 85
Location 2	4.686	Location 2	2.820	Pan Weight, grams	226.30
Location3	4.685	Location 3	2.820		
Average	4.685	Average	2.820	Moisture Content, %	12.8
		Wet Soil + Tare, grams	916 20	Wet Unit Weight, pcf	119.2
		Tare Weight, grams	0 00	Dry Unit Weight, pcf	105.8

Chamber Pressure, psi 64
Back Pressure, psi 54
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				34	0.0	5.0	118.22	113.22	3.8E-04	22	3.6E-04
				76	0.0	10 0	118.22	108.22	3.4E-04	22	3.3E-04
				169	0.0	20 0	118.22	98.22	3.2E-04	22	3.1E-04
				36	0.0	5 0	118.22	113.22	3.5E-04	22	3.4E-04
				79	0.0	10.0	118.22	108.22	3.3E-04	22	3.2E-04
				174	0.0	20.0	118.22	98.22	3.1E-04	22	3.0E-04

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Vertical

Avg. k at 20 °C 3.3E-04 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 40.30 cm²
L = 11.90 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/25/02*
Boring No.	*MP-7*	Reviewed By	[signature]
Sample No.	*Ud*	Review Date	4/9/02
Sample Depth	*59-61'*		
Sample Description	*Orange sand*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Horizontal*
Initial Water Content, %:	*6.1*
Wet Unit Weight, pcf:	*96.2*
Dry Unit Weight, pcf:	*90.7*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.8E-04***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-7
Sample No. Ud
Sample Depth 59-61'
Sample Description Orange sand

Tested By DMJ
Test Date 03/25/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	LS-49
Location 1	1.701	Location 1	2.873	Dry Soil+Pan, grams	350.29
Location 2	1.700	Location 2	2.872	Pan Weight, grams	87.94
Location3	1.700	Location 3	2..873		
Average	1.700	Average	2.873	Moisture Content, %	6 1
		Wet Soil + Tare, grams	278.25	Wet Unit Weight, pcf	96 2
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	90.7

Chamber Pressure, psi 60
Back Pressure, psi 50
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				14	0.0	5.0	127.11	122.11	3.0E-04	22	2.8E-04
				32	0.0	10.0	127.11	117.11	2.6E-04	22	2.5E-04
				66	0.0	20.0	127.11	107.11	2.7E-04	22	2.6E-04
				12	0.0	5 0	127.11	122.11	3.5E-04	22	3.3E-04
				28	0.0	10.0	127.11	117.11	3.0E-04	22	2.9E-04
				67	0.0	20.0	127.11	107.11	2.6E-04	22	2.5E-04

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Horizontal

Avg. k at 20 °C 2.8E-04 cm/sec

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 41.81 cm²
L = 4.32 cm

LAWGIBB GROUP

HYDRAULIC CONDUCTIVITY

Project No.	*50160-2-0113*	Tested By	*DMJ*
Project Name	*Memphis Depot*	Test Date	*03/26/02*
Boring No.	*MP-7*	Reviewed By	*[signature]*
Sample No.	*Ud*	Review Date	*4/2/02*
Sample Depth	*59-61'*		
Sample Description	*Orange sand*		

ASTM D5084 - Falling Head

Sample Type:	*Ud*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*4.5*
Wet Unit Weight, pcf:	*99.5*
Dry Unit Weight, pcf:	*95.2*
Compaction, %:	*N/A*
Hydraulic Conductivity, cm/sec. @20 °C	***2.0E-03***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAWGIBB GROUP

Project Number 50160-2-0113
Project Name Memphis Depot
Boring No. MP-7
Sample No. Ud
Sample Depth 59-61'
Sample Description Orange sand

Tested By DMJ
Test Date 03/26/02
Reviewed By [signature]
Review Date 4/9/02

Sample Data

Length, in		Diameter, in		Pan No.	LS-69
Location 1	4.716	Location 1	2.885	Dry Soil+Pan, grams	858.99
Location 2	4.715	Location 2	2.885	Pan Weight, grams	88 84
Location3	4.717	Location 3	2.885		
Average	4.716	Average	2.885	Moisture Content, %	4.5
		Wet Soil + Tare, grams	805.10	Wet Unit Weight, pcf	99.5
		Tare Weight, grams	0.00	Dry Unit Weight, pcf	95.2

Chamber Pressure, psi 64
Back Pressure, psi 54
Confining Pressure, psi 10

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H_0 (cm)	H_f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				5	0.0	5.0	118.22	113.22	2.5E-03	22	2.3E-03
				11	0.0	10 0	118.22	108.22	2.3E-03	22	2.2E-03
				24	0.0	20.0	118.22	98.22	2.2E-03	22	2.1E-03
				7	0.0	5.0	118.22	113.22	1.8E-03	22	1.7E-03
				13	0.0	10.0	118.22	108.22	1.9E-03	22	1.8E-03
				29	0.0	20.0	118.22	98.22	1.8E-03	22	1.7E-03

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
6	Ud		N/A	Vertical

Avg. k at 20 °C **2.0E-03 cm/sec**

a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

H_0 = initial head in cm
H_f = final head in cm
t = time in seconds

a = 1.00 cm²
A = 42.17 cm²
L = 11.98 cm

Attachment C

579 428

Memphis Depot
Dunn Field SVE TS Field Data- Test 1 - VW-1 (December, 2001)

Date	Actual Time	Elapsed Time (hrs)	Vapor Flow Rate		Groundwater Flow	Vacuum																													
			Liquid Ring Pump (acfm)	Calculated Air SCFM	Flow Totalizer (gal)	Liquid Ring Pump (in-Hg)	Knock out Tank (in-Hg)	MP-1 22' Wellhead (in-H2O)	MP-1 35' Wellhead (in-H2O)	MP 1 58' Wellhead (in-H2O)	MP 1 71' Wellhead (in-H2O)	MP-2 22' Wellhead (in-H2O)	MP 2 35' Wellhead (in-H2O)	MP-2 58' Wellhead (in-H2O)	MP 2 71' Wellhead (in-H2O)	MP-3 11' Wellhead (in-H2O)	MP-3 27' Wellhead (in-H2O)	MP-3 49' Wellhead (in-H2O)	MP-3 66' Wellhead (in-H2O)	MP-4 19' Wellhead (in-H2O)	MP-4 48' Wellhead (in-H2O)	MP-4 58' Wellhead (in-H2O)	MP-4 70' Wellhead (in-H2O)	MP-5 11' Wellhead (in-H2O)	MP 5 21 Wellhead (in-H2O)	MP-6 11' Wellhead (in-H2O)	MP-6 21 Wellhead (in-H2O)	MP-6 51' Wellhead (in-H2O)	MP-6 72' Wellhead (in-H2O)	MP-7 6' Wellhead (in-H2O)	MP-7 16' Wellhead (in-H2O)	MP-7 41' Wellhead (in-H2O)	MP-7 62' Wellhead (in-H2O)	MP-8 16' Wellhead (in-H2O)	MP-8 52' Wellhead (in-H2O)
12/18/2001	14 32:00	0:00:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 32 15	00:00 15						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 10	0 02	0 01	0 01	0	0	0	0	0	0	0	0
12/18/2001	14 32 30	00:00 30						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 20	0.03	0 01	0.01	0	0	0	0	0	0	0	0
12/18/2001	14 32 45	00.00 45						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 20	0 05	0 01	0 01	0	0	0	0	0	0	0	0
12/18/2001	14 33.00	00:01 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 30	0.06	0 01	0 01	0	0	0	0	0	0	0	0
12/18/2001	14 33 15	00:01 15	20-50	1 6-4 0		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 35	0.07	0 01	0 01	0	0	0	0	0	0	0	0
12/18/2001	14 33 30	00:01 30						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 38	0 07	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 33 45	00:01 45						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.40	0.075	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 34.00	00 02 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 42	0 08	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 35.00	00:03.00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 48	0.08	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 36:00	00:04 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 50	0.09	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 37:00	00:05 00	30-60	2.4-4.9		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 52	0.09	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 38.00	00:06 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 55	0.09	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 39:00	00:07 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 60	0 10	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 40.00	00:08:00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 62	0 10	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 41:00	00:09 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 70	0 11	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 42:00	00 10 00	30-60	2 4-4 9		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 80	0 12	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 47:00	00 15:00	40-70	3 2-5 7		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 95	0 14	0	0	0	0	0	0	0	0	0	0
12/18/2001	14 52:00	00 20 00	50-80	4 0-6 5		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 95	0 18	0 01	0	0	0	0	0	0	0	0	0
12/18/2001	14 57:00	00 25 00	50-90	4 0-7 3		27 5	26 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 10	0 22	0 02	0	0	0	0	0.03	0	0	0	0
12/18/2001	15.02:00	00 30 00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 10	0 10	0.01	0	0	0	0 30	0 16	0	0	0	0
12/18/2001	15.17:00	00.45 00	50-100	4 9-9.8		27	26	0	0	0	0	0	0	0	0	0 035	0	0	0	0	0	0	0	0 28	0.20	0.025	0	0	0	0 30	0 44	0	0	0	0
12/18/2001	15.32:00	01:00 00	70-100	6 8-9.8		27	26	0	0	0	0	0	0	0	0	0 16	0	0	0	0	0	0	0	0 52	0 58	0 025	0	0	0	0 40	0 65	0	0	0	0
12/18/2001	15.47:00	1 15:00						0	0	0	0	0	0	0	0	0 21	0	0	0	0	0	0	0	0 72	0 76	0	0	0	0	0.46	0 76	0	0	0	0
12/18/2001	16.02:00	1 30:00	80-100	7 8-9.8		27	26	0	0	0	0	0	0	0	0	0 39	0	0	0	0 125	0	0	0	1 0	1.8	0 03	0	0	0	0 72	1 0	0	0	0	0
12/18/2001	16 17:00	1 45:00	80-100	7 8-9.8		27	26	0	0	0	0	0	0	0	0	0 50	0	0	0	0 20	0	0	0	0 15	3.0	0.07	0	0	0	0 91	1 1	0	0	0	0
12/18/2001	16 32:00	2 00:00	80-100	7 8-9.8	200	27	26	0	0	0	0	0	0	0	0	0 55	0	0	0	0.24	0	0	0	0 50	4 0	0 09	0 04	0	0	0 90	1 3	0	0	0	0
12/18/2001	16 47:00	2 15:00						0	0	0	0	0	0	0	0	0.62	0	0	0	0 24	0	0	0	0.72	5 0	0 10	0 08	0	0	1 0	1 6	0	0	0	0
12/18/2001	17 02:00	2 30:00						0	0	0	0	0	0	0	0	0 72	0	0	0	0.19	0	0	0	1 0	5.8	0 12	0 12	0	0	1 8	1 2	0	0	0	0
12/18/2001	17 17:00	2 45:00	80-100	9 1-11 4		28 5	25 5	0	0	0	0	0	0	0	0	0 80	0 04	0	0	0 39	0	0	0	1 0	5 8	0 14	0 13	0	0	1 9	1 2	0	0	0	0
12/18/2001	17 32:00	3:00:00	80-105	9 1-12		28 5	25 5	0	0	0	0	0	0	0	0	0 84	0 11	0	0	0 38	0	0	0	1 2	3 5	0 16	0 16	0	0	2 0	1 4	0	0	0	0
12/18/2001	17 47:00	3 15:00	80-105	9 1-12		28 5	25 5	0	0	0	0	0	0	0	0	0 92	0 18	0	0	0.41	0	0	0	1.4	4 0	0 17	0 18	0	0	1 9	2.0	0	0	0	0
12/18/2001	18:02:00	3 30:00						0	0	0	0	0	0	0	0	0 92	0 18	0	0	0.41	0	0	0	1.4	4 5	0 17	0 18	0	0	1 4	2.0	0	0	0	0
12/18/2001	18 17 00	3 45 00						0	0	0	0	0	0	0	0	0 98	0 23	0	0	0 42	0	0	0	1 3	4 5	0 18	0 18	0	0	1 2	2 0	0	0	0	0
12/18/2001	18 32:00	4.00 00	90-110	11 6-14 4		28	25	0	0	0	0	0	0	0	0	1 0	0 28	0	0	0 50	0	0	0	1 5	4.5	0 19	0 19	0	0	1 6	2.0	0	0	0	0
12/18/2001	19 32:00	5 00:00	100-120	13.1-15 7		28	25	0	0	0	0	0	0	0	0	1 0	0 24	0	0	0 45	0	0	0	1.2	4 5	0.20	0 19	0	0	1 6	2 0	0	0	0	0
12/18/2001	20 32 00	6 00 00	110-130	14 4-17 0		28	25	0	0	0	0	0	0	0	0	1 0	0 20	0	0	0 42	0	0	0	3 1	4 9	0 17	0 18	0	0	1 6	2.0	0	0	0	0
12/18/2001	21 32 00	7:00 00	120-130	15.7-17.0		28	25	0	0	0	0	0	0	0	0	1 0	0.20	0	0	0 45	0	0	0	4 5	4.3	0 16	0 18	0	0	1 3	2.0	0	0	0	0
12/18/2001	22 32:00	8:00 00	130-140	17 0-18 3		28	25	0	0	0	0	0	0	0	0	1 0	0 39	0	0	0 50	0	0	0	5.5	4 9	0 19	0 20	0	0	1 5	2.1	0	0	0	0
12/18/2001	23 32 00	9:00.00	130-150	17 0-19 7		28	25	0	0	0	0	0	0	0	0	1 0	0.20	0	0	0 41	0	0	0	6 9	5 1	0 15	0 16	0	0	1 5	0.20	0	0	0	0
12/19/2001	0:30.00	10:00:00	150	19 7		28	25	0	0	0	0	0	0	0	0	0 90	0 18	0	0	0 41	0	0	0	7 6	5 1	0 13	0 16	0	0	1 2	0.20	0	0	0	0

Memphis Depot
Dunn Field SVE TS Field Data- Test 1 - VW-1 (December, 2001)

Date	Actual Time	Elapsed Time (hrs)	Vapor Flow Rate		Groundwater Flow	Vacuum																													
			Liquid Ring Pump (acfm)	Calculated Air SCFM	Flow Totalizer (gal)	Liquid Ring Pump (in-Hg)	Knock out Tank (in-Hg)	MP-1 22' Wellhead (in-H₂O)	MP-1 35' Wellhead (in-H₂O)	MP-1 58' Wellhead (in-H₂O)	MP-1 71 Wellhead (in-H₂O)	MP-2 22' Wellhead (in-H₂O)	MP-2 35' Wellhead (in-H₂O)	MP-2 58' Wellhead (in-H₂O)	MP-2 71 Wellhead (in-H₂O)	MP-3 11 Wellhead (in-H₂O)	MP-3 27' Wellhead (in-H₂O)	MP-3 49' Wellhead (in-H₂O)	MP-3 68' Wellhead (in-H₂O)	MP-4 19' Wellhead (in-H₂O)	MP-4 48' Wellhead (in-H₂O)	MP-4 58' Wellhead (in-H₂O)	MP-4 70' Wellhead (in-H₂O)	MP-5 11' Wellhead (in-H₂O)	MP-5 21 Wellhead (in-H₂O)	MP-6 11 Wellhead (in-H₂O)	MP-6 21 Wellhead (in-H₂O)	MP-6 51 Wellhead (in-H₂O)	MP-6 72' Wellhead (in-H₂O)	MP-7 6' Wellhead (in-H₂O)	MP 7 16' Wellhead (in-H₂O)	MP-7 41' Wellhead (in-H₂O)	MP-7 62' Wellhead (in-H₂O)	MP-8 16' Wellhead (in-H₂O)	MP-8 52' Wellhead (in-H₂O)
12/19/2001	1:30:00	11:00:00	150	19.7		26	25	0	0	0	0	0	0	0	0	0.90	0.09	0	0	0.40	0	0	0	7.2	5.1	0.11	0.15	0	0	1.2	1.8	0	0	0	0
12/19/2001	2:30:00	12:00:00	150	19.7		26	24.5	0	0	0	0	0	0	0	0	0.90	0.12	0	0	0.40	0	0	0	7.0	5.1	0.12	0.14	0	0	1.3	1.9	0	0	0	0
12/19/2001	3:30:00	13:00:00	150	19.7		26	24.5	0	0	0	0	0	0	0	0	1.0	0	0	0	0.28	0	0	0	6.9	5.0	0.07	0.10	0	0	1.2	1.8	0	0	0	0
12/19/2001	4:30:00	14:00:00	150-160	19.7-21.0		26	24.5	0	0	0	0	0	0	0	0	1.0	0	0	0	0.22	0	0	0	6.4	5.0	0.05	0.10	0	0	1.1	1.8	0	0	0	0
12/19/2001	5:30:00	15:00:00	140	18.3		26	24	0	0	0	0	0	0	0	0	1.0	0	0	0	0.32	0	0	0	6.4	5.0	0.06	0.14	0	0	1.2	1.9	0	0	0	0
12/19/2001	6:30:00	16:00:00	140	18.3		26	24	0	0	0	0	0	0	0	0	0.90	0.20	0	0	0.41	0	0	0	6.2	5.3	0.06	0.16	0	0	1.2	1.9	0	0	0	0
12/19/2001	7:30:00	17:00:00	140-150	18.5-19.7		26	24	0	0	0	0	0.14	0	0	0	1.0	0.38	0	0	0.59	0	0	0	6.2	6.0	0.10	0.18	0	0	1.5	2.0	0	0	0	0
12/19/2001	8:30:00	18:00:00	150-170	19.7-22.3		26	24	0	0.09	0.11	0.11	0.16	0.20	0.58	0.21	1.0	0.79	0.20	0.20	0.81	0.16	0.17	0.17	6.4	4.6	0.14	0.21	0.21	0.20	1.9	2.0	0.25	0.23	0	0.07
12/19/2001	9:30:00	19:00:00	160-170	21.0-22.3	720	26	24	0	0.50	0.62	0.62	0.30	0.40	0.62	0.70	0.60	0.78	0.50	0.80	0.94	0.62	0.80	0.62	6.2	4.2	0.16	0.22	0.72	0.80	1.9	2.2	0.50	0.50	0.12	0.68
12/19/2001	10:30:00	20:00:00	170	22.3		26	24	0	0.96	0.50	0.86	1.3	1.0	0.96	0.72	1.4	1.0	1.0	0.92	1.0	0.92	0.92	0.92	6.2	4.2	0.18	0.22	1.0	1.0	0.90	2.2	1.0	0.90	0.15	0.83
12/19/2001	11:30:00	21:00:00	170-180	22.3-23.6		26	24	0.09	0.96	1.0	0.98	1.2	1.0	0.96	0.88	1.4	1.0	0.98	0.96	1.0	0.92	0.90	0.92	6.2	2.4	0.13	0.15	0.94	1.0	1.6	2.2	1.0	0.90	0.17	0.88
12/19/2001	12:30:00	22:00:00	180-190	23.6-24.9		26	24	0.10	1.0	1.1	1.0	1.2	1.0	0.98	0.94	1.4	1.1	1.0	0.99	1.0	0.98	0.99	0.98	6.2	3.0	0.13	0.16	1.0	1.0	1.6	2.2	0.90	0.80	0.12	1.0
12/19/2001	13:30:00	23:00:00	180-200	23.6-26.2		26	24	0.15	1.1	1.0	1.1	1.4	1.0	1.0	1.0	1.5	1.1	1.1	1.0	0.90	1.1	1.1	1.0	6.5	3.1	0.10	0.14	1.0	1.0	1.7	2.3	1.0	1.0	0.05	1.1
12/19/2001	14:30:00	24:00	180-200	23.6-26.2		26	24	0.23	1.4	1.4	1.3	1.1	1.2	1.0	1.0	1.5	1.1	1.1	1.2	1.0	1.2	1.3	1.0	6.5	3.2	0.09	0.17	1.1	1.1	1.9	2.4	1.1	1.2	0.09	1.2
12/19/2001	15:30:00	25:00	180-200	23.6-26.2		26	24	0.51	1.5	1.6	1.6	1.2	1.5	1.4	1.4	1.0	0.80	1.4	1.5	0.89	1.5	1.5	1.3	6.5	3.8	0.15	0.19	1.4	1.4	1.9	2.2	1.3	1.3	0.20	1.5
12/19/2001	16:30:00	26:00	180-200	23.6-26.2		26	24	0.62	1.6	1.6	1.6	1.5	1.5	1.3	1.5	1.2	1.4	1.6	1.6	0.94	1.6	1.3	1.5	6.5	4.0	0.17	0.18	1.5	1.5	1.6	2.2	1.5	1.5	0.22	1.5
12/19/2001	17:30:00	27:00	180-190	23.6-24.9		26	24	0.71	1.8	1.7	1.7	1.4	1.0	1.4	1.4	1.4	1.0	1.5	1.5	0.96	1.4	1.3	1.6	6.4	4.0	0.16	0.15	1.4	1.5	1.8	2.1	1.4	1.5	0.26	1.5
12/19/2001	18:30:00	28:00	170-180	22.3-23.6		26	24	0.26	1.8	1.9	1.8	1.5	1.0	1.5	1.5	1.2	1.4	1.6	1.6	1.0	1.4	1.6	1.7	6.3	4.0	0.16	0.14	1.4	1.5	1.9	2.2	1.4	1.5	0.25	1.7
12/19/2001	19:30:00	29:00	180-190	23.6-24.9		26	24	0.40	2.0	2.0	2.0	1.6	1.0	1.6	1.9	1.5	1.4	1.8	1.9	1.1	1.9	1.6	1.9	6.4	4.1	0.18	0.15	1.8	1.8	1.1	2.3	1.7	1.7	0.30	1.9
12/19/2001	20:30:00	30:00	180-190	23.6-24.9		26	24	0.48	1.9	2.0	2.0	1.5	1.7	1.8	1.8	1.4	1.4	1.5	1.6	1.0	1.8	1.6	1.7	6.4	4.0	0.17	0.14	1.7	1.7	1.8	2.0	1.5	1.5	0.27	1.9
12/19/2001	21:30:00	31:00	190-200	24.9-26.2		26	24	0.52	1.8	2.0	2.0	1.6	1.2	1.5	1.7	1.5	1.4	1.5	1.6	0.80	1.5	1.6	1.7	6.4	4.0	0.17	0.13	1.7	1.8	1.8	2.0	1.5	1.6	0.26	1.8
12/19/2001	22:30:00	32:00	190-200	24.9-26.2		26	24	0.69	2.0	2.0	2.0	1.6	1.2	1.8	1.7	1.5	1.5	1.6	1.9	1.0	1.8	1.6	1.9	6.4	4.0	0.18	0.15	2.0	2.0	1.8	2.0	1.6	1.8	0.29	1.9
12/19/2001	23:30:00	33:00	190-200	24.9-26.2		26	24.5	0.66	1.8	1.9	1.9	1.6	1.4	1.5	1.8	1.4	1.4	1.5	1.6	0.90	1.6	1.5	1.7	6.4	3.9	0.16	0.11	1.6	1.6	1.1	2.0	1.5	1.5	0.18	1.8
12/20/2001	0:30:00	34:00	190-200	24.9-26.2		26	24.5	0.30	2.0	2.0	1.9	1.2	1.7	1.6	1.6	1.3	1.4	1.6	1.6	0.82	1.4	1.7	1.6	6.4	3.2	0.18	0.12	1.5	1.6	1.7	2.0	1.5	1.4	0.09	1.4
12/20/2001	1:30:00	35:00	190-200	24.9-26.2		26	24.5	0.16	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.6	0.90	1.6	1.6	0.80	1.6	1.8	1.6	6.6	3.2	0.15	0.12	1.5	1.5	1.8	2.0	1.5	1.5	0.06	1.6
12/20/2001	2:30:00	36:00	200	26.2		26	24.5	0.10	1.8	1.9	1.8	1.8	1.8	1.6	1.8	1.6	1.5	1.5	1.5	0.80	1.6	1.7	1.6	6.4	3.2	0.14	0.10	1.5	1.6	1.8	2.1	1.5	1.4	0.04	1.7
12/20/2001	3:30:00	37:00	200-210	26.2-27.5		26	24	0.09	1.8	1.9	1.8	1.8	1.8	1.6	1.8	1.5	1.4	1.4	1.5	0.80	1.6	1.7	1.5	6.4	3.2	0.14	0.10	1.5	1.6	1.5	2.0	1.5	1.4	0.04	1.6
12/20/2001	4:30:00	38:00	200-210	26.2-27.5		26	24	0.22	1.9	2.0	1.9	1.6	1.8	1.5	1.8	1.3	1.3	1.3	1.6	0.88	1.6	1.6	1.8	6.7	3.2	0.16	0.10	1.3	1.5	1.5	2.0	1.5	1.6	0.02	1.8
12/20/2001	5:30:00	39:00	200	26.2		26	24	0.30	2.0	1.9	2.0	1.6	1.8	1.6	1.8	1.5	1.3	1.4	1.5	0.60	1.7	1.6	1.6	6.7	3.2	0.13	0.09	1.4	1.5	1.7	2.0	1.4	1.5	0.02	1.8
12/20/2001	6:30:00	40:00	200	26.2		26	24	0.06	1.8	1.8	1.8	1.5	1.6	1.5	1.6	1.5	1.2	1.4	1.4	0.79	1.5	1.5	1.6	7.0	3.0	0.12	0.09	1.3	1.4	1.8	2.0	1.5	1.4	0	1.5
12/20/2001	7:30:00	41:00	210	27.5		26	24	0.10	1.8	1.6	1.6	1.6	1.5	1.4	1.5	1.4	1.3	1.5	1.4	0.75	1.4	1.5	1.4	7.0	2.5	0.10	0.07	1.2	1.3	1.6	1.8	1.4	1.3	0	1.4
12/20/2001	8:30:00	42:00	210-220	27.5-28.8	1080	26	24	0.11	1.8	1.6	1.6	1.7	1.5	1.4	1.5	1.5	1.5	1.5	1.3	0.80	1.5	1.5	1.5	7.2	2.5	0.11	0.10	1.3	1.3	1.8	2.0	1.4	1.3	0	1.5
12/20/2001	9:30:00	43:00	210	27.5		26	24	0.25	2.0	1.9	1.9	1.8	1.8	1.6	1.7	1.1	1.4	1.7	1.7	0.88	1.8	1.9	1.4	7.1	2.5	0.07	0.85	1.5	1.5	1.6	2.0	1.4	1.5	0	1.5
12/20/2001	10:30:00	44:00	210-220	27.5-28.8		26	24	0.21	1.9	1.9	1.9	1.6	1.6	1.6	1.6	1.3	1.4	1.5	1.4	0.78	1.5	1.5	1.5	7.9	2.5	0.35	0.045	1.3	1.3	1.8	1.9	1.3	1.4	0	1.3
12/20/2001	11:30:00	45:00	210-230	27.5-30.1		26	24	0.03	1.9	1.3	1.3	1.4	1.0	1.0	1.2	1.2	1.2	1.0	1.2	0.68	1.2	1.2	1.2	7.5	2.1	0	0.06	1.0	1.0	1.5	1.8	1.0	1.0	0	1.2
12/20/2001	12:30:00	46:00	210-230	27.5-30.1		26	24	0	0.90	1.0	0.75	0.80	0.70	0.70	0.60	1.1	0.80	0.63	0.80	0.52	0.70	0.70	0.60	7.2	1.9	0	0.04	0.80	0.80	1.3	1.7	0.50	0.50	0	0.70
12/20/2001	13:30:00	47:00	220-230	28.8-30.1		26	24	0	0.52	0.50	0.50	0.66	0.48	0.50	0.40	1.2	0.72	0.44	0.42	0.46	0.46	0.45	0.44	7.2	1.8	0	0.02	0.52	0.52	1.2	1.6	0.50	0.50	0	0.43
12/20/2001	14:30:00	48:00	220-230	28.8-30.1		26	24	0	0.28	0.22	0.27	0.46	0.22	0.20	0.20	1.1	0.60	0.19	0.19	0.46	0.21	0.24	0.21	7.2	1.8	0	0.04	0.28	0.26	1.3	1.5	0.30	0.27	0	0.21
12/20/2001	15:30:00	49:00	220-230	28.8-30.1		26	23.5	0	0.45	0.47	0.44	0.65	0.42	0.38	0.36	1.2	0.72	0.40	0.35	0.60	0.39	0.38	0.38	7.4	-1.6	0.01	0.13	0.42	0.42	1.4	1.6	0.44	0.41	0	0.40
12/20/2001	16:30:00	50:00	220-230	32.5-34.0		25.5	23.5	0	0.50	0.46	0.47	0.66	0.40	0.41	0.38	1.0	0.70	0.40	0.35	0.58	0.38	0.40	0.40	7.4	1.7	0.06	0.08	0.39	0.38	1.4	1.3	0.46	0.44	0	0.42
12/20/2001	17:30:00	51:00	220-230	32.5-34.0		25.5	23.5	0.01	0.48	0.46	0.47	0.62	0.42	0.40	0.38	1.0	0.72	0.39	0.35	0.81	0.38	0.38	0.40	7.3	1.7	0.08	0.08	0.39	0.39	1.4	1.5	0.42	0.41	0	0.41

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Memphis Depot
Dunn Field SVE TS Field Data- Test 1 - VW-1 (December, 2001)

Date	Actual Time	Elapsed Time (hrs)	Vapor Flow Rate: Liquid Ring Pump (acfm)	Vapor Flow Rate: Calculated Air SCFM	Groundwater Flow: Flow Totalizer (gal)	Vacuum: Liquid Ring Pump (in-Hg)	Vacuum: Knock out Tank (in-Hg)	MP-1 22' Wellhead (in-H₂O)	MP-1 35' Wellhead (in-H₂O)	MP-1 58' Wellhead (in-H₂O)	MP-1 71' Wellhead (in-H₂O)	MP-2 22' Wellhead (in-H₂O)	MP-2 35' Wellhead (in-H₂O)	MP-2 58' Wellhead (in-H₂O)	MP-2 71' Wellhead (in-H₂O)
12/20/2001	18:30:00	52:00	220-230	32.5-34.0	1240	25.5	23.5	0.06	0.60	0.59	0.58	0.77	0.56	0.51	0.49
12/20/2001	19:30:00	53:00	220-230	32.5-34.0		25.5	23.5	0.06	0.55	0.58	0.55	0.72	0.55	0.50	0.47
12/20/2001	20:30:00	54:00	220-240	32.5-35.5		25.5	23.5	0.11	0.54	0.53	0.53	0.70	0.50	0.47	0.44
12/20/2001	21:30:00	55:00	220-240	32.5-35.5		25.5	23.5	0.11	0.51	0.52	0.50	0.69	0.50	0.45	0.42
12/20/2001	22:30:00	56:00	230	34.0		25.5	23.5	0.10	0.42	0.40	0.40	0.58	0.36	0.32	0.32
12/20/2001	23:30:00	57:00	220-240	32.5-35.5		25.5	23.5	0.13	0.32	0.31	0.32	0.51	0.51	0.28	0.26
12/21/2001	0:30:00	58:00	230-240	34.0-35.5		25.5	23.5	0.12	0.25	0.22	0.26	0.45	0.23	0.20	0.18
12/21/2001	1:30:00	59:00	220-230	32.5-34.0		25.5	23.5	0.22	0.43	0.40	0.43	0.18	0.42	0.38	0.36
12/21/2001	2:30:00	60:00	220-230	32.5-34.0		25.5	23.5	0.18	0.41	0.39	0.37	0.06	0.32	0.33	0.31
12/21/2001	3:30:00	61:00	230	34.0		25.5	23.5	0.21	0.42	0.34	0.38	0.54	0.26	0.28	0.28
12/21/2001	4:30:00	62:00	230-240	34.0-35.5		25.5	23.5	0.21	0.31	0.28	0.38	0.49	0.24	0.20	0.21
12/21/2001	5:30:00	63:00	230-240	34.0-35.5		25.5	23.5	0.23	0.31	0.31	0.30	0.48	0.28	0.25	0.24
12/21/2001	6:30:00	64:00	230-240	34.0-35.5		25.5	23.5	0.25	0.40	0.40	0.40	0.55	0.40	0.38	0.38
12/21/2001	7:30:00	65:00	230-240	34.0-35.5		25.5	23.5	0.05	0.51	0.48	0.50	0.60	0.42	0.41	0.42
12/21/2001	8:30:00	66:00	230-240	34.0-35.5		25.5	23.5	0.06	0.68	0.62	0.64	0.72	0.62	0.55	0.59
12/21/2001	9:30:00	67:00	230-240	34.0-35.5		25.5	23.5	0.04	0.82	0.76	0.80	0.80	0.78	0.67	0.70
12/21/2001	10:30:00	68:00	230-240	34.0-35.5		25.5	23.5	0.06	0.62	0.58	0.62	0.72	0.52	0.45	0.46
12/21/2001	11:30:00	69:00	230	34.0		25.5	23.5	0.16	0.06	0.60	0	0.16	0	0	0
12/21/2001	12:30:00	70:00	240	35.5		25.5	23.5	0.11	0	0	0	0	0	0	0
12/21/2001	13:30:00	71:00	240	35.5		25.5	23.5	0.01	0	0	0	0	0	0	0
12/21/2001	14:30:00	72:00	240	35.5	1450	25.5	23.5	0.10	0	0	0	0	0	0	0

Date	Actual Time	MP-3 11' Wellhead (in-H₂O)	MP-3 27' Wellhead (in-H₂O)	MP-3 49' Wellhead (in-H₂O)	MP 3 68' Wellhead (in-H₂O)	MP-4 19' Wellhead (in-H₂O)	MP-4 48' Wellhead (in-H₂O)	MP-4 58' Wellhead (in-H₂O)	MP-4 70' Wellhead (in-H₂O)	MP-5 11' Wellhead (in-H₂O)	MP-5 21' Wellhead (in-H₂O)	MP-6 11' Wellhead (in-H₂O)	MP-6 21' Wellhead (in-H₂O)	MP-6 51' Wellhead (in-H₂O)	MP-6 72' Wellhead (in-H₂O)	MP-7 6' Wellhead (in-H₂O)	MP-7 16' Wellhead (in-H₂O)	MP 7 41 Wellhead (in-H₂O)	MP-7 62' Wellhead (in-H₂O)	MP-8 16' Wellhead (in-H₂O)	MP-8 52' Wellhead (in-H₂O)
12/20/2001	18:30:00	1.1	0.80	0.50	0.52	0.60	0.53	0.51	0.52	7.3	1.7	0.08	0.09	0.55	0.50	1.3	1.7	0.58	0.58	0.01	0.50
12/20/2001	19:30:00	1.0	0.79	0.50	0.52	0.49	0.51	0.49	0.51	7.3	1.8	0.07	0.07	0.52	0.50	1.3	1.7	0.56	0.55	0.01	0.48
12/20/2001	20:30:00	1.0	0.74	0.45	0.46	0.59	0.48	0.45	0.48	7.4	1.7	0.08	0.06	0.49	0.48	1.3	1.6	0.52	0.50	0	0.46
12/20/2001	21:30:00	1.0	0.74	0.42	0.44	0.55	0.46	0.42	0.41	7.4	1.8	0.08	0.06	0.46	0.44	1.3	1.5	0.51	0.50	0	0.44
12/20/2001	22:30:00	1.0	0.68	0.31	0.30	0.50	0.35	0.30	0.28	7.4	1.6	0.07	0.04	0.36	0.32	1.1	1.5	0.40	0.38	0	0.33
12/20/2001	23:30:00	1.0	0.65	0.25	0.24	0.50	0.50	0.24	0.24	7.4	1.5	0.06	0.05	0.30	0.27	1.1	1.5	0.33	0.30	0	0.28
12/21/2001	0:30:00	0.90	0.58	0.18	0.16	0.46	0.22	0.16	0.20	7.4	1.5	0.06	0.04	0.40	0.19	1.1	1.3	0.25	0.23	0	0.20
12/21/2001	1:30:00	1.0	0.73	0.35	0.34	0.59	0.38	0.35	0.33	7.4	1.5	0.08	0.09	0.40	0.37	1.2	1.6	0.44	0.40	0	0.36
12/21/2001	2:30:00	1.1	0.66	0.31	0.26	0.50	0.38	0.28	0.30	7.3	1.3	0.06	0.06	0.30	0.33	1.2	1.4	0.40	0.36	0	0.30
12/21/2001	3:30:00	1.0	0.64	0.28	0.26	0.50	0.32	0.32	0.26	7.3	1.2	0.06	0.05	0.27	0.30	1.2	1.6	0.35	0.32	0	0.28
12/21/2001	4:30:00	1.0	0.58	0.20	0.18	0.48	0.24	0.23	0.19	7.4	1.0	0.05	0.03	0.21	0.19	1.2	1.3	0.29	0.34	0	0.20
12/21/2001	5:30:00	1.0	0.68	0.30	0.30	0.50	0.24	0.30	0.28	7.6	1.2	0.07	0.07	0.32	0.30	1.3	1.4	0.32	0.30	0	0.30
12/21/2001	6:30:00	1.0	0.70	0.36	0.34	0.58	0.38	0.40	0.34	7.6	1.2	0.07	0.08	0.38	0.35	1.4	1.6	0.42	0.40	0	0.32
12/21/2001	7:30:00	1.0	0.75	0.44	0.42	0.60	0.42	0.43	0.40	7.4	1.0	0.07	0.07	0.47	0.42	1.1	1.3	0.48	0.46	0	0.43
12/21/2001	8:30:00	1.0	0.85	0.62	0.58	0.60	0.57	0.56	0.54	7.5	0.90	0.05	0.07	0.58	0.60	1.2	1.5	0.65	0.62	0	0.60
12/21/2001	9:30:00	1.0	0.84	0.72	0.68	0.64	0.66	0.65	0.68	7.6	0.80	0.03	0.07	0.72	0.70	1.1	1.7	0.74	0.72	0	0.72
12/21/2001	10:30:00	0.73	1.0	0.46	0.47	0.50	0.50	0.52	0.50	7.5	0.50	0	0.03	0.49	0.46	1.0	1.5	0.53	0.51	0	0.48
12/21/2001	11:30:00	0.86	0.40	0	0	0.30	0	0	0	7.5	0	0	0	0	0	0.80	0	0	0	0	0
12/21/2001	12:30:00	0.88	0.20	0	0	0.25	0	0	0	7.2	0	0	0	0	0	0.80	0	0	0	0	0
12/21/2001	13:30:00	0.92	0.18	0	0	0.25	0	0	0	7.5	0	0	0	0	0	0.98	0.04	0	0	0	0
12/21/2001	14:30:00	0.94	0.22	0	0	0.34	0	0	0	7.6	0	0	0	0	0	1.0	0.015	0	0	0	0

Memphis Depot
Dunn Field SVE TS Field Data - Test 2 - VW-2 (January 2002)

Date	Current Time	Elapsed Time	Air Flow Rate ACFM	Air Flow Rate Calculated SCFM	Vacuum @ Pump (In-Hg)	MP-1 22' Wellhead (in-H_2O)	MP-1 35' Wellhead (in-H_2O)	MP-1 58' Wellhead (in-H_2O)	MP-1 71 Wellhead (in-H_2O)	MP-2 22' Wellhead (in-H_2O)	MP-2 35' Wellhead (in-H_2O)	MP-2 58' Wellhead (in-H_2O)	MP-2 71 Wellhead (in-H_2O)	MP-3 11' Wellhead (in-H_2O)	MP-3 27' Wellhead (in-H_2O)	MP-3 49' Wellhead (in-H_2O)	MP-3 68' Wellhead (in-H_2O)	MP-4 19' Wellhead (in-H_2O)	MP-4 48' Wellhead (in-H_2O)	MP-4 58' Wellhead (in-H_2O)	MP-4 70' Wellhead (in-H_2O)	MP-5 11' Wellhead (in-H_2O)	MP-5 21 Wellhead (in-H_2O)	MP-6 11' Wellhead (in-H_2O)	MP-6 21 Wellhead (in-H_2O)	MP-6 51 Wellhead (in-H_2O)	MP-6 72' Wellhead (in-H_2O)	MP-7 6' Wellhead (in-H_2O)	MP-7 16' Wellhead (in-H_2O)	MP-7 41' Wellhead (in-H_2O)	MP-7 62' Wellhead (in-H_2O)	MP-8 16' Wellhead (in-H_2O)	MP-8 52' Wellhead (in-H_2O)
01/07/2002	14:00:00	00:00:00 (Before)	270	249	2.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01/07/2002	14:00:15	00:00:15	270	249	2.3	0	0.5	0.8	0.7	0.41	0.40	0.30	0.50	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	0.72	1.4	0	0	0.70	0.01	0.03	0.09
01/07/2002	14:00:30	00:00:30	270	249	2.3	0	0.9	1.0	0.9	0.54	0.60	0.70	0.60	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.05	0	1.4	1.6	0	0	0.70	0.01	0.03	0.09
01/07/2002	14:00:45	00:00:45	270	249	2.3	0	0.9	1.0	0.9	0.54	0.60	0.70	0.60	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.5	1.5	0	0	0.82	0.01	0.03	0.09
01/07/2002	14:01:00	00:01:00	270	249	2.3	0	0.9	1.0	0.9	0.54	0.60	0.70	0.60	0.12	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.5	1.5	0	0	0.92	0.01	0.03	0.09
01/07/2002	14:01:15	00:01:15	270	249	2.3	0	0.9	1.0	0.9	0.54	0.60	0.70	0.80	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.6	1.7	0	0	1.2	0.01	0.03	0.09
01/07/2002	14:01:30	00:01:30	270	249	2.3	0	0.9	1.0	0.9	0.56	0.60	0.80	0.80	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.7	1.8	0	0	1.3	0.01	0.03	0.09
01/07/2002	14:01:45	00:01:45	270	249	2.3	0	0.9	1.0	0.9	0.56	0.60	0.80	0.80	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.7	1.8	0	0	1.3	0.02	0.03	0.09
01/07/2002	14:02:00	00:02:00	270	249	2.3	0	0.9	1.0	0.9	0.56	0.80	1.0	1.0	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0	1.7	1.8	0	0	1.4	0.02	0.03	0.09
01/07/2002	14:03:00	00:03:00	270	249	2.3	0	0.9	1.0	0.9	0.56	0.80	1.0	1.0	0.10	0	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0	0.02	0	1.8	1.8	0	0	1.6	0.02	0.03	0.09
01/07/2002	14:04:00	00:04:00	270	249	2.3	0	0.9	1.0	0.9	0.56	0.80	1.0	1.0	0.10	0	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0	0.03	0	1.9	1.9	0	0	1.6	0.02	0.03	0.09
01/07/2002	14:05:00	00:05:00	270	249	2.3	0	0.9	1.0	0.9	0.56	0.80	1.0	1.0	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0	0.04	0	2.0	1.9	0	0	1.7	0.02	0.03	0.09
01/07/2002	14:06:00	00:06:00	270	249	2.3	0	0.9	1.0	0.9	0.58	0.80	1.0	1.0	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0	0.03	0	2.0	2.0	0	0	1.7	0.02	0.03	0.09
01/07/2002	14:07:00	00:07:00	270	249	2.3	0	0.9	1.0	0.9	0.58	0.80	1.0	1.0	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0	0.03	0	2.0	2.0	0	0	1.8	0.02	0.03	0.09
01/07/2002	14:08:00	00:08:00	270	249	2.3	0	0.9	1.0	0.9	0.58	1.0	1.2	1.2	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0	0.03	0	2.0	2.0	0	0	1.9	0.03	0.03	0.08
01/07/2002	14:09:00	00:09:00	270	249	2.3	0	0.9	1.0	0.9	0.58	1.0	1.2	1.2	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0	0.03	0	2.0	2.0	0	0	1.9	0.03	0.03	0.08
01/07/2002	14:10:00	00:10:00	270	249	2.3	0	0.9	1.2	1.0	0.58	1.0	1.2	1.2	0.12	0	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0	0.03	0	2.0	2.0	0	0	2.0	0.01	0.03	0.04
01/07/2002	14:15:00	00:15:00	270	249	2.3	0	1.2	1.2	1.2	0.64	1.2	1.4	1.4	0.12	0	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0	2.1	2.1	0	0	2.0	0.02	0.45	0.03
01/07/2002	14:20:00	00:20:00	270	249	2.3	0	1.2	1.2	1.2	0.64	1.2	1.4	1.4	0.10	0	0.005	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0	2.1	2.2	0	0	2.0	0.02	0.06	0.04
01/07/2002	14:25:00	00:25:00	270	249	2.3	0	1.2	1.2	1.2	0.62	1.4	1.4	1.4	0.10	0	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0.02	0	2.0	2.1	0	0	2.3	0.02	0.06	0.03
01/07/2002	14:30:00	00:30:00	270	249	2.3	0	1.2	1.3	1.3	0.80	1.4	1.6	1.6	0.14	0	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0	2.1	2.2	0	0	2.2	0.02	0.06	0.03
01/07/2002	14:45:00	00:45:00	270	249	2.3	0	1.2	1.5	1.5	0.90	1.8	1.8	1.6	0.20	0	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0.04	0	2.5	2.6	0	0	2.4	0.02	0.09	0.03
01/07/2002	15:00:00	01:00:00	270	249	2.3	0	1.2	1.6	1.6	1.0	1.8	1.6	1.8	0.22	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.04	0	2.5	2.8	0	0	2.5	0.01	0.11	0.03
01/07/2002	15:05:00	01:05:00	220	210	1.3	0	1.6	1.6	1.6	1.0	1.4	1.4	1.2	0.22	0	0	0.01	0	0.01	0.01	0	0.01	0	0.05	0	1.9	2.0	0	0	1.8	0.01	0.11	0.03
01/07/2002	15:10:00	01:10:00	220	210	1.3	0	1.6	1.6	1.6	1.0	1.4	1.4	1.2	0.22	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.05	0	1.9	2.0	0	0	1.8	0.01	0.11	0.03
01/07/2002	15:15:00	01:15:00	220	210	1.3	0	1.4	1.4	1.4	1.2	1.2	1.2	1.2	0.20	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.05	0	1.9	2.0	0	0	1.7	0.01	0.10	0.03
01/07/2002	15:20:00	01:20:00	220	210	1.3	0	1.3	1.3	1.3	1.2	1.2	1.2	1.2	0.20	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0	1.8	1.9	0	0	1.7	0.01	0.10	0.028
01/07/2002	15:25:00	01:25:00	220	210	1.3	0	1.3	1.3	1.3	1.2	1.2	1.2	1.2	0.18	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0	1.8	1.9	0	0	1.7	0.01	0.10	0.03
01/07/2002	15:30:00	01:30:00	220	210	1.3	0	1.3	1.3	1.2	1.2	1.2	1.2	1.2	0.20	0	0	0.01	0	0.01	0.02	0.01	0.01	0	0.04	0	1.8	1.9	0	0	1.7	0.01	0.10	0.03
01/07/2002	15:45:00	01:45:00	220	210	1.3	0	1.2	1.3	1.2	1.0	1.0	1.0	1.0	0.18	0	0	0	0	0.01	0.03	0.01	0.01	0	0.03	0	1.8	1.9	0	0	1.7	0.01	0.09	0.03
01/07/2002	16:00:00	02:00:00	220	210	1.3	0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.20	0	0	0	0	0.01	0.02	0.01	0.01	0	0.05	0	1.7	1.9	0	0	1.7	0.01	0.11	0.03
01/07/2002	16:05:00	02:05:00	100	96	1.2	0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.2	0	0	0	0	0.01	0.02	0	0.01	0	0.04	0	1.4	1.4	0	0	1.5	0.01	0.11	0.03
01/07/2002	16:10:00	02:10:00	100	96	1.2	0	1.2	1.2	1.1	1.0	1.0	1.0	1.0	0.2	0	0	0	0	0.01	0.02	0	0.01	0	0.04	0	1.3	1.4	0	0	1.5	0.01	0.12	0.03
01/07/2002	16:15:00	02:15:00	100	96	1.2	0	1.2	1.2	1.0	1.0	1.0	1.0	1.0	0.18	0	0	0	0	0.01	0.02	0.01	0.01	0	0.03	0	1.2	1.3	0	0	1.4	0.01	0.10	0.03
01/07/2002	16:20:00	02:20:00	100	96	1.2	0	1.2	1.1	1.1	1.0	1.0	1.0	1.0	0.16	0	0	0	0	0.01	0.02	0.01	0.01	0	0.03	0	1.2	1.2	0	0	1.3	0.01	0.09	0.02
01/07/2002	16:25:00	02:25:00	100	96	1.2	0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	0.16	0	0	0	0	0.01	0.02	0.01	0.01	0	0.03	0	1.0	1.1	0	0	1.1	0.01	0.08	0.02
01/07/2002	16:30:00	02:30:00	100	96	1.2	0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.16	0	0	0	0	0.01	0.02	0.01	0.01	0	0.03	0	1.1	1.2	0	0	1.2	0.01	0.08	0.03
01/07/2002	16:45:00	02:45:00	100	96	1.2	0	1.0	1.0	1.0	0.80	0.80	0.80	0.80	0.16	0	0	0	0	0	0.02	0	0.01	0	0.03	0	1.0	1.1	0	0	1.2	0.01	0.10	0.02
01/07/2002	17:00:00	03:00:00	100	96	1.2	0	1.0	1.0	0.9	0.80	0.60	0.60	0.60	0.16	0	0	0	0	0	0.02	0	0.01	0	0.02	0	1.0	1.0	0	0	1.1	0	0.11	0.02
01/07/2002	17:15:00	03:15:00	275	243	3.4	0	1.2	1.2	1.2	0.9	1.2	1.2	1.4	0.1	0	0	0	0	0.01	0.02	0	0.01	0	0.04	0	2.0	2.0	0	0	2.0	0.01	0.11	0.02
01/07/2002	17:30:00	03:30:00	275	252	2.4	0	1.2	1.2	1.2	1.1	1.8	1.6	1.6	0.18	0	0	0	0	0.01	0.02	0	0	0.01	0.03	0	2.0	2.2	0	0	2.1	0.01	0.12	0.02
01/07/2002	17:45:00	03:45:00	275	252	2.4	0.01	1.5	1.5	1.5	1.2	1.6	1.6	1.6	0.20	0	0	0	0	0.01	0.02	0	0.01	0	0.05	0.02	2.4	2.4	0	0	2.4	0.01	0.17	0.02
01/07/2002	18:00:00	04:00:00	275	252	2.4	0	1.8	1.8	1.8	1.5	1.8	1.8	1.8	0.21	0	0	0	0	0.01	0.01	0.01	0.01	0	0.05	0.02	2.4	2.5	0	0	2.5	0.01	0.23	0.02
01/07/2002	19:00:00	05:00:00	275	253	2.3	0	2.0	2.0	1.8	1.6	2.0	2.0	2.0	0.21	0	0	0	0	0.01	0.01	0.01	0.01	0	0.07	0.03	2.6	2.9	0	0	2.7	0.01	0.24	0.02
01/07/2002	20:00:00	06:00:00	275	253	2.3	0.01	2.0	1.9	1.9	1.8	2.0	2.0	2.0	0.21	0	0	0	0	0.01	0.01	0.01	0.01	0	0.05	0.02	2.8	2.9	0	0	2.8	0	0.23	0.02
01/07/2002	21:00:00	07:00:00	275	253	2.3	0	1.5	1.6	1.5	1.5	1.9	1.8	1.6	0.18	0	0	0	0	0.01	0.01	0.01	0.01	0	0.02	0	2.5	2.6	0	0	2.4	0	0.16	0.02
01/07/2002	22:00:00	08:00:00	275	253	2.3	0	1.8	1.8	1.7	1.6	1.9	2.0	1.9	0.25	0	0	0	0	0.01	0	0.01	0.01	0	0.08	0.05	2.6	2.9	0	0	2.6	0	0.25	0.02
01/07/2002	23:00:00	9:00:00	275	253	2.3	0	1.8	1.8	1.6	1.5	1.8	2.0	1.8	0.18	0	0	0	0	0	0.01	0.01	0.01	0	0	0	2.4	2.6	0	0	2.5	0	0.22	0.02

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Memphis Depot
Dunn Field SVE TS Field Data - Test 2 - VW-2 (January 2002)

Date	Current Time	Elapsed Time	Air Flow Rate ACFM	Air Flow Rate Calculated SCFM	Vacuum Data: Vacuum @ Pump (in-Hg)	MP-1 22' Wellhead (in-H2O)	MP-1 35 Wellhead (in-H2O)	MP 1 58 Wellhead (in-H2O)	MP-1 71' Wellhead (in-H2O)	MP-2 22' Wellhead (in-H2O)	MP-2 35' Wellhead (in-H2O)	MP-2 58' Wellhead (in-H2O)	MP-2 71' Wellhead (in-H2O)	MP-3 11' Wellhead (in-H2O)	MP-3 27' Wellhead (in-H2O)	MP 3 49' Wellhead (in-H2O)	MP-3 68' Wellhead (in-H2O)	MP-4 19' Wellhead (in-H2O)	MP-4 48' Wellhead (in-H2O)	MP-4 58 Wellhead (in-H2O)	MP-4 70' Wellhead (in-H2O)	MP-5 11' Wellhead (in-H2O)	MP-5 21 Wellhead (in-H2O)	MP-6 11 Wellhead (in-H2O)	MP-6 21 Wellhead (in-H2O)	MP-6 51' Wellhead (in-H2O)	MP-6 72' Wellhead (in-H2O)	MP 7 6' Wellhead (in-H2O)	MP-7 16' Wellhead (in-H2O)	MP-7 41' Wellhead (in-H2O)	MP-7 62' Wellhead (in-H2O)	MP-8 16' Wellhead (in-H2O)	MP-8 52' Wellhead (in-H2O)
01/08/2002	0:00:00	10:00:00	275	253	2.3	0	1.8	1.6	1.6	1.2	1.8	1.8	1.8	0.07	0	0	0	0	0	0.01	0.01	0.01	0	0.03	0.02	2.4	2.6	0	0	2.4	0	0.20	0.02
01/08/2002	1:00:00	11:00:00	275	253	2.3	0	1.6	1.6	1.4	1.2	1.5	1.6	1.5	0.05	0	0	0	0	0	0.01	0	0	0	0.02	0	2.2	2.2	0	0	2.2	0	0.13	0.02
01/08/2002	2:00:00	12:00:00	275	253	2.3	0	1.2	1.3	1.1	1.0	1.3	1.4	1.3	0.08	0	0	0	0	0	0	0	0	0	0.02	0	2.0	2.2	0	0	2.1	0	0.09	0.02
01/08/2002	3:00:00	13:00:00	275	253	2.3	0	1.1	1.2	1.2	1.1	1.1	1.5	1.3	0.10	0	0	0	0	0	0.02	0	0	0	0	0	2.1	2.0	0	0	2.2	0	0.13	0.02
01/08/2002	4:00:00	14:00:00	275	253	2.3	0	1.4	1.4	1.4	1.2	1.3	1.4	1.4	0.11	0	0	0	0	0	0	0.01	0.01	0	0.03	0	2.2	2.2	0	0	2.1	0	0.14	0.02
01/08/2002	5:00:00	15:00:00	275	253	2.3	0	1.2	1.2	1.2	1.1	1.4	1.5	1.4	0.09	0	0	0	0	0.01	0.01	0	0.01	0	0.04	0.01	2.1	2.1	0	0	2.1	0	0.15	0.01
01/08/2002	6:00:00	16:00:00	275	253	2.3	0	1.3	1.3	1.3	1.0	1.5	1.5	1.5	0.09	0	0	0	0	0.01	0.01	0	0.01	0	0	0	2.1	2.1	0	0	2.1	0	0.13	0.01
01/08/2002	7:00:00	17:00:00	275	253	2.3	0	1.1	1.3	1.2	1.1	1.4	1.4	1.4	0	0	0.01	0	0	0.01	0.01	0	0.01	0	0.02	0	2.1	2.1	0	0	2.1	0.01	0.11	0.01
01/08/2002	8:00:00	18:00:00	275	253	2.3	0	1.2	1.3	1.3	1.1	1.2	1.4	1.5	0.10	0	0	0	0	0.01	0.01	0.01	0.01	0	0.02	0	2.0	2.0	0	0	2.0	0.01	0.09	0.01
01/08/2002	9:00:00	19:00:00	275	253	2.3	0	1.2	1.3	1.3	1.0	1.5	1.4	1.2	0.10	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.04	0	2.0	2.1	0	0	2.0	0.01	0.05	0.02
01/08/2002	10:00:00	20:00:00	275	253	2.3	0	1.1	1.2	1.0	1.0	1.3	1.3	1.2	0.10	0	0.01	0.01	0	0.02	0.02	0.01	0.01	0	0.01	0	2.0	2.0	0	0	2.0	0.01	0	0.02
01/08/2002	11:00:00	21:00:00	275	253	2.3	0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0	0	1.7	1.7	0	0	2.0	0.01	0	0.01
01/08/2002	12:00:00	22:00:00	275	253	2.3	0	0.50	0.56	0.54	0.48	0.92	1.1	1.0	0	0	0	0	0	0	0	0.01	0.015	0	0.03	0	1.5	1.5	0	0	1.3	0.01	0	0.01
01/08/2002	13:00:00	23:00:00	275	253	2.3	0	0.22	0.23	0.23	0.80	0.62	0.60	0.23	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0	0	1.1	1.1	0	0	1.1	0.01	0	0.01
01/08/2002	14:00:00	24:00	275	254	2.2	0	0.19	0.20	0.20	0.22	0.62	0.60	0.22	0	0	0.01	0.01	0	0.01	0	0.01	0.01	0	0	0	1.1	1.1	0	0	1.1	0.01	0	0.02
01/08/2002	15:00:00	25:00	275	254	2.2	0	0.18	0.22	0.20	0.32	0.66	0.60	0.70	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0	0	1.2	1.2	0	0	1.2	0	0	0.02
01/08/2002	16:00:00	26:00	275	254	2.2	0	0.32	0.36	0.36	0.40	0.78	0.76	0.74	0	0	0.01	0	0	0.01	0.01	0.01	0.01	0	0.01	0.01	1.3	1.4	0	0	1.2	0	0	0.02
01/08/2002	17:00:00	27:00	275	255	2.1	0	0.43	0.50	0.48	0.55	0.92	0.90	0.89	0.03	0	0.01	0	0	0.01	0.01	0.01	0.01	0	0.02	0.03	1.4	1.5	0	0	1.4	0	0	0.02
01/08/2002	18:00:00	28:00	275	255	2.1	0	0.64	0.68	0.66	0.69	1.1	1.1	1.0	0.03	0	0.01	0	0	0.01	0.01	0.01	0.01	0	0.01	0.02	1.5	1.6	0	0	1.6	0	0	0.02
01/08/2002	19:00:00	29:00	275	255	2.1	0	0.72	0.79	0.78	0.76	0.90	1.0	1.0	0.03	0	0	0	0	0	0.01	0.01	0.01	0	0.02	0.03	1.5	1.6	0	0	1.6	0	0	0.02
01/08/2002	20:00:00	30:00	275	255	2.1	0	0.65	0.79	0.75	0.67	0.90	1.0	0.90	0.03	0	0	0	0	0	0.01	0.01	0.01	0	0.01	0	1.5	1.7	0	0	1.6	0	0	0.02
01/08/2002	21:00:00	31:00	275	255	2.1	0	0.60	0.64	0.62	0.59	0.90	0.90	0.90	0.01	0	0	0	0	0	0.01	0.01	0.01	0	0.01	0	1.5	1.5	0	0	1.5	0	0	0.02
01/08/2002	22:00:00	32:00	275	255	2.1	0	0.62	0.67	0.66	0.58	1.0	0.90	0.90	0.03	0	0	0	0	0.01	0.01	0.01	0.01	0	0.02	0	1.5	1.6	0	0	1.6	0	0	0.02
01/08/2002	23:00:00	33:00	275	255	2.1	0	0.60	0.64	0.64	0.68	0.90	0.90	0.90	0.04	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	1.5	1.6	0	0	1.6	0	0	0.02
01/09/2002	0:00:00	34:00	275	255	2.1	0	0.48	0.51	0.50	0.50	0.82	0.90	0.88	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	1.4	1.5	0	0	1.5	0	0	0.02
01/09/2002	1:00:00	35:00	275	255	2.1	0	0.46	0.50	0.49	0.52	0.90	0.92	0.85	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	1.5	1.3	0	0	1.4	0	0	0.02
01/09/2002	2:00:00	36:00	275	255	2.1	0	0.53	0.58	0.56	0.59	0.82	0.96	0.93	0	0	0	0.04	0	0	0	0	0.01	0	0.01	0	1.5	1.5	0	0	1.5	0	0	0.02
01/09/2002	3:00:00	37:00	275	255	2.1	0	0.55	0.60	0.52	0.60	0.93	0.98	0.94	0.05	0	0	0	0	0.01	0	0	0.01	0	0	0	1.4	1.5	0	0	1.6	0	0	0.03
01/09/2002	4:00:00	38:00	275	255	2.1	0	0.48	0.53	0.52	0.56	0.90	0.93	0.90	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	1.5	1.5	0	0	1.5	0	0	0.02
01/09/2002	5:00:00	39:00	275	255	2.1	0	0.59	0.61	0.61	0.69	1.0	1.0	1.0	0.03	0	0	0	0	0	0.01	0	0.01	0	0.02	0.01	1.5	1.6	0	0	1.6	0	0	0.02
01/09/2002	6:00:00	40:00	275	255	2.1	0	0.76	0.78	0.78	0.80	1.0	1.0	1.0	0.05	0	0	0	0	0	0.01	0.01	0.01	0	0.02	0.01	1.6	1.7	0	0	1.9	0	0	0.02
01/09/2002	7:00:00	41:00	275	255	2.1	0	0.81	0.81	0.80	0.83	1.0	1.0	1.0	0.08	0	0	0	0	0	0.01	0	0.01	0	0.01	0.01	1.6	1.9	0	0	1.8	0	0	0.02
01/09/2002	8:00:00	42:00	275	255	2.1	0	0.83	0.90	0.88	0.90	1.0	1.0	1.0	0.07	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.03	0	1.7	1.8	0	0	1.8	0	0	0.02
01/09/2002	9:00:00	43:00	275	255	2.1	+0.06	0.95	0.99	0.98	1.0	1.1	1.1	1.1	0.13	0	0.02	0.01	0	0.01	0.02	0.01	0.02	0	0.05	0.01	2.0	2.0	0	0	2.0	0	+0.11	0.03
01/09/2002	10:00:00	44:00	275	255	2.1	0	0.50	1.0	1.0	1.2	1.2	1.3	1.2	0.15	0	0.02	0.01	0	0.01	0.01	0.01	0.02	0	0.04	0.03	2.0	2.0	0	0	2.1	0	0	0.02
01/09/2002	11:00:00	45:00	275	255	2.1	0	1.0	1.2	1.2	1.2	1.4	1.4	1.3	0.10	0	0.02	0.01	0	0.02	0.02	0.01	0.02	0	0	0	2.0	2.0	0	0	2.0	0.01	+0.03	0.03
01/09/2002	12:00:00	46:00	275	256	2.0	+0.09	0.66	0.72	0.7	1.0	1.0	1.0	1.0	0.0	0	0.02	0.01	0	0.02	0.02	0.01	0.02	0	0.01	0	1.7	1.6	0	0	1.7	0	+0.04	0.01
01/09/2002	13:00:00	47:00	275	256	2.0	+0.15	0.30	0.40	0.40	0.38	0.80	0.80	0.70	+0.05	0	0.01	0.01	0	0.02	0.02	0.01	0.02	+0.01	0.01	+0.15	1.3	1.2	0.01	0	1.3	0.01	+0.06	0.03
01/09/2002	14:00:00	48:00	275	256	2.0	+0.02	0.20	0.24	0.28	0.36	0.68	0.66	0.66	+0.05	0	0.02	0.01	0	0.01	0.01	0.01	0.02	0	0.01	+0.19	1.2	1.2	0	0	1.3	0.01	0	0.03
01/09/2002	15:00:00	49:00	275	256	2.0	0	0.32	0.38	0.41	0.46	0.82	0.80	0.79	0	0	0.02	0.01	0	0.01	0.01	0.01	0.02	0	0.01	+0.01	1.3	1.3	0	0	1.4	0	0	0.03
01/09/2002	16:00:00	50:00	275	256	2.0	0	0.60	0.65	0.65	0.66	1.0	1.0	1.0	0	0	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.03	0.01	1.5	1.5	0	0	1.6	0	0.03	0.03
01/09/2002	17:00:00	51:00	275	256	2.0	0.03	0.72	0.78	0.79	0.80	1.0	1.1	1.0	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.04	0.05	1.6	1.7	0	0	1.9	0	0.03	0.03
01/09/2002	18:00:00	52:00	275	256	2.0	0.06	0.86	0.91	0.92	0.91	1.1	1.2	1.2	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.02	0.04	1.9	1.8	0	0	2.0	0	0.03	0.03
01/09/2002	19:00:00	53:00	275	256	2.0	0.05	0.90	0.94	0.96	0.95	1.3	1.2	1.2	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.05	0.04	1.9	1.9	0	0	2.0	0	0.02	0.03
01/09/2002	20:00:00	54:00	275	256	2.0	0.06	0.92	1.0	1.0	0.96	1.3	1.3	1.2	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.03	0.04	1.9	1.9	0	0	2.0	0	0.02	0.03
01/09/2002	21:00:00	55:00	275	256	2.0	0.07	0.95	1.0	1.0	0.95	1.2	1.3	1.3	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.03	0.03	2.0	2.0	0	0	2.0	0	0.01	0.03
01/09/2002	22:00:00	56:00	275	256	2.0	0.07	1.0	1.1	1.2	1.0	1.30	1.4	1.3	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.03	0.03	2.0	2.0	0	0	2.0	0	0.01	0.03
01/09/2002	23:00:00	57:00	275	256	2.0	0.04	1.0	1.2	1.2	1.1	1.4	1.4	1.3	0	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.02	0.02	2.0	2.0	0	0	2.1	0	0.01	0.03

Memphis Depot

Dunn Field SVE TS Field Data - Test 2 - VW-2 (January 2002)

Date	Current Time	Elapsed Time	Air Flow Rate ACFM	Air Flow Rate Calculated SCFM	Vacuum Data: Vacuum @ Pump (In-Hg)	MP-1 22' Wellhead (in-H_2O)	MP 1 35' Wellhead (in-H_2O)	MP-1 58' Wellhead (in-H_2O)	MP-1 71 Wellhead (in-H_2O)	MP-2 22' Wellhead (in-H_2O)	MP-2 35' Wellhead (in-H_2O)	MP-2 58' Wellhead (in-H_2O)	MP-2 71 Wellhead (in-H_2O)	MP-3 11 Wellhead (in-H_2O)	MP-3 27' Wellhead (in-H_2O)
01/10/2002	0:00:00	58:00	275	255	2.1	0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	0	0
01/10/2002	1:00:00	59:00	275	255	2.1	+0.01	0.90	0.88	0.88	1.0	1.2	1.2	1.2	0	0
01/10/2002	2:00:00	60:00	275	253	2.3	0	0.92	0.98	1.0	1.0	1.2	1.2	1.2	0	0
01/10/2002	3:00:00	61:00	275	253	2.3	0	0.81	0.96	0.90	0.90	1.1	1.1	1.1	0	0
01/10/2002	4:00:00	62:00	275	253	2.3	0	0.89	0.90	0.92	1.0	1.1	1.2	1.2	0.08	0
01/10/2002	5:00:00	63:00	275	253	2.3	0	1.0	1.0	1.0	1.1	1.2	1.2	1.2	0.11	0
01/10/2002	6:00:00	64:00	275	253	2.3	0	1.2	1.2	1.0	1.2	1.3	1.4	1.4	0.11	0
01/10/2002	7:00:00	65:00	275	253	2.3	0	1.1	1.1	1.2	1.2	1.8	1.5	1.5	0.12	0
01/10/2002	8:00:00	66:00	275	253	2.3	0	1.3	1.3	1.3	1.3	1.7	1.7	1.5	0.13	0
01/10/2002	9:00:00	67:00	275	253	2.3	0	1.3	1.3	1.4	1.4	1.7	1.7	1.6	0.16	0
01/10/2002	10:00:00	68:00	275	253	2.3	0	1.3	1.3	1.4	1.5	1.6	1.8	1.5	0.15	0
01/10/2002	11:00:00	69:00	275	253	2.3	0	1.3	1.4	1.1	1.2	1.3	1.5	1.3	0	0
01/10/2002	12:00:00	70:00	275	254	2.2	0	0.90	0.90	1.0	1.0	1.0	1.2	1.1	0	0
01/10/2002	13:00:00	71:00	275	254	2.2	0	0.60	0.70	0.80	0.80	1.0	1.0	1.0	0	0
01/10/2002	14:00:00	72:00	275	254	2.2	0	0.70	0.65	0.63	0.70	0.90	1.0	0.90	0	0
01/10/2002	15:00:00	73:00	275	254	2.2	0	0.70	0.67	0.66	0.68	1.1	1.0	1.0	0	0
01/10/2002	16:00:00	74:00	275	254	2.2	0	0.90	0.87	0.86	0.88	1.1	1.2	1.2	0	0
01/10/2002	17:00:00	75:00	275	254	2.2	0	0.96	0.95	0.92	0.90	1.1	1.3	1.2	0	0
01/10/2002	18:00:00	76:00	275	254	2.2	0	1.0	1.2	1.2	1.1	1.4	1.5	1.5	0	0
01/10/2002	19:00:00	77:00	275	254	2.2	0	1.1	1.2	1.3	1.2	1.5	1.6	1.5	0	0
01/10/2002	20:00:00	78:00	275	253	2.3	0.25	1.8	1.9	1.8	1.9	2.0	2.0	2.0	0.25	0
01/10/2002	21:00:00	79:00	275	253	2.3	1.1	2.0	2.0	2.0	2.0	2.2	2.3	2.2	0.15	0
01/10/2002	22:00:00	80:00	275	253	2.3	1.5	2.2	2.3	2.2	2.0	2.4	2.4	2.3	0.20	0
01/10/2002	23:00:00	81:00	275	253	2.3	1.8	2.2	2.3	2.2	2.1	2.4	2.4	2.3	0.19	0
01/11/2002	0:00:00	82:00	275	252	2.4	1.9	2.2	2.3	2.2	2.0	2.4	2.4	2.3	0.20	0
01/11/2002	1:00:00	83:00	275	253	2.3	2.1	2.3	2.3	2.3	2.1	2.5	2.5	2.4	0.18	0
01/11/2002	2:00:00	84:00	275	253	2.3	2.3	2.4	2.4	2.4	2.2	2.5	2.6	2.5	0.24	0.01
01/11/2002	3:00:00	85:00	275	252	2.4	2.5	2.4	2.4	2.3	2.2	2.6	2.6	2.5	0.20	0.01
01/11/2002	4:00:00	86:00	275	252	2.4	0.09	2.3	2.3	2.4	2.1	2.8	2.5	2.5	0.19	0.01
01/11/2002	5:00:00	87:00	275	252	2.4	0.20	2.4	2.4	2.4	2.2	2.5	2.5	2.5	0.20	0
01/11/2002	6:00:00	88:00	275	252	2.4	0.29	2.5	2.6	2.6	2.3	2.7	2.7	2.7	0.20	0
01/11/2002	7:00:00	89:00	275	252	2.4	0.20	2.5	2.6	2.6	2.3	2.7	2.7	2.7	0.20	0
01/11/2002	8:00:00	90:00	275	252	2.4	0.20	2.8	2.8	2.8	2.3	2.8	3.0	2.9	0.23	0
01/11/2002	9:00:00	91:00	275	252	2.4	0.12	2.9	2.9	2.9	2.4	2.9	2.9	2.9	0.20	0
01/11/2002	10:00:00	92:00	275	252	2.4	0.12	2.9	2.9	3.0	2.5	3.0	3.0	3.0	0.20	0
01/11/2002	11:00:00	93:00	275	252	2.4	0.05	2.9	2.9	2.9	2.3	2.8	2.9	2.9	0.20	0
01/11/2002	12:00:00	94:00	275	252	2.4	0	2.2	2.2	2.4	1.9	2.2	2.4	2.3	0.05	0
01/11/2002	13:00:00	95:00	275	252	2.4	+0.4	1.7	1.8	1.8	1.5	1.8	1.8	2.0	0.04	0
01/11/2002	14:00:00	96:00	275	253	2.3	0	1.5	1.6	1.8	1.4	1.6	1.7	1.9	0.08	0

Date	Current Time	MP-3 49' Wellhead (in-H_2O)	MP-3 68' Wellhead (in-H_2O)	MP-4 19' Wellhead (in-H_2O)	MP-4 48' Wellhead (in-H_2O)	MP-4 58' Wellhead (in-H_2O)	MP-4 70' Wellhead (in-H_2O)	MP-5 11' Wellhead (in-H_2O)	MP-5 21' Wellhead (in-H_2O)	MP-6 11 Wellhead (in-H_2O)	MP-6 21' Wellhead (in-H_2O)	MP-6 51' Wellhead (in-H_2O)	MP-6 72' Wellhead (in-H_2O)	MP-7 6' Wellhead (in-H_2O)	MP-7 16' Wellhead (in-H_2O)	MP-7 41 Wellhead (in-H_2O)	MP-7 62' Wellhead (in-H_2O)	MP-8 18' Wellhead (in-H_2O)	MP-8 52' Wellhead (in-H_2O)
01/10/2002	0:00:00	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0	0.01	1.9	1.8	0	0	2.0	0	0	0.02
01/10/2002	1:00:00	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.02	0.01	1.8	1.8	0	0	1.9	0	0	0.03
01/10/2002	2:00:00	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.01	0.01	1.8	1.8	0	0	1.9	0	0	0.01
01/10/2002	3:00:00	0.01	0	0	0.01	0.01	0.01	0.01	0	0.03	0.01	1.8	1.8	0	0	1.9	0	0	0.02
01/10/2002	4:00:00	0.01	0	0	0.02	0.02	0.01	0.01	0	0.03	0.02	1.9	1.9	0	0	2.0	0	0	0.02
01/10/2002	5:00:00	0.01	0	0	0.01	0.01	0	0.02	0	0.02	0.04	2.0	2.0	0	0	2.0	0	0.01	0.03
01/10/2002	6:00:00	0.01	0	0	0.01	0.01	0.01	0.01	0	0.02	0.04	2.0	2.0	0	0	2.1	0	0.01	0.03
01/10/2002	7:00:00	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0.03	0.03	2.1	2.1	0	0	2.1	0	0.01	0.03
01/10/2002	8:00:00	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.03	0.04	2.2	2.2	0	0	2.3	0	0.02	0.03
01/10/2002	9:00:00	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.04	0.04	2.3	2.3	0	0	2.3	0	0.02	0.03
01/10/2002	10:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.05	0.04	2.3	2.3	0 -	0	2.3	0	0.02	0.03
01/10/2002	11:00:00	0.01	0.01	0	0.01	0.02	0.01	0.01	0	0	+0.05	2.0	2.1	0	0	2.0	0	0	0.03
01/10/2002	12:00:00	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.02	+0.11	1.9	1.9	0	0	1.9	0	+0.02	0.03
01/10/2002	13:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.04	0	1.6	1.8	0	0	1.7	0.01	0	0.03
01/10/2002	14:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.04	0	1.6	1.6	0	0	1.7	0.01	+0.03	0.03
01/10/2002	15:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.03	0.03	1.6	1.5	0	0	1.7	0.01	+0.03	0.03
01/10/2002	16:00:00	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.04	0.06	1.8	1.8	0	0	1.9	0.01	0	0.03
01/10/2002	17:00:00	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.03	0.04	1.9	1.9	0	0	2.0	0.01	0	0.03
01/10/2002	18:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.04	0.07	2.1	2.0	0	0	2.2	0.01	0.03	0.03
01/10/2002	19:00:00	0.01	0.01	0	0.01	0.01	0.01	0.02	0	0.04	0.06	2.1	2.1	0	0	2.1	0.01	0.03	0.03
01/10/2002	20:00:00	0.01	0.01	0	0.01	0.02	0.02	0.02	0	0.07	0.17	2.7	2.5	0.01	0	2.8	0.01	0.07	0.03
01/10/2002	21:00:00	0.01	0.01	0	0.01	0.02	0.01	0.02	0	0.02	0.13	2.8	2.9	0	0	3.0	0.01	0.08	0.03
01/10/2002	22:00:00	0.01	0.01	0	0.01	0.02	0.02	0.02	0	0.05	0.13	3.0	3.0	0	0	3.1	0.01	0.09	0.03
01/10/2002	23:00:00	0.01	0.01	0	0.01	0.02	0.02	0.02	0	0.04	0.09	3.1	3.1	•0	0	3.2	0.01	0.08	0.03
01/11/2002	0:00:00	0.01	0.01	0	0.01	0.02	0.02	0.02	0	0.06	0.07	3.1	3.1	0	0	3.2	0.01	0.06	0.03
01/11/2002	1:00:00	0	0.01	0	0.01	0.02	0.02	0.02	0	0.06	0.07	3.2	3.2	0	0	3.3	0	0.06	0.03
01/11/2002	2:00:00	0.01	0	0	0.01	0.01	0.02	0.02	0	0.06	0.11	3.3	3.3	0	0	3.5	0	0.07	0.03
01/11/2002	3:00:00	0.01	0	0	0.01	0.02	0.01	0.01	0	0.04	0.08	3.3	3.3	0	0	3.4	0	0.07	0.03
01/11/2002	4:00:00	0.01	0	0	0.01	0.02	0.01	0.01	0	0.05	0.05	3.2	3.2	0	0	3.2	0	0.06	0.03
01/11/2002	5:00:00	0	0	0	0.01	0.01	0.01	0	0	0.05	0.07	3.2	3.2	0	0	3.3	0	0.03	0.03
01/11/2002	6:00:00	0	0	0	0.01	0.02	0.01	0.01	0	0.04	0.08	3.3	3.3	0	0	3.5	0	0.05	0.03
01/11/2002	7:00:00	0	0	0	0.01	0.01	0.01	0.01	0	0.04	0.08	3.5	3.5	0	0	3.5	0	0.05	0.03
01/11/2002	8:00:00	0.01	0	0	0.01	0.01	0.01	0.01	0	0.08	0.08	3.5	3.6	0	0	3.6	0	0.05	0.03
01/11/2002	9:00:00	0.01	0.01	0	0.01	0.01	0.01	0.01	0	0.06	0.07	3.5	3.6	0	0	3.8	0	0.05	0.03
01/11/2002	10:00:00	0.02	0.01	0	0.01	0.02	0.02	0.01	0	0.07	0.07	3.7	3.8	0	0	3.8	0.01	0.04	0.035
01/11/2002	11:00:00	0.02	0.01	0	0.01	0.02	0.02	0.01	0	0.04	0.02	3.7	3.7	0	0	3.8	0.01	0.01	0.04
01/11/2002	12:00:00	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0	0.01	+0.04	3.1	3	0	0	3.2	0.01	+0.03	0.04
01/11/2002	13:00:00	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0	0.01	0	2.6	2.5	0	0	2.6	0.01	+0.05	0.04
01/11/2002	14:00:00	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0	0.03	+0.12	2.4	2.4	0	0	2.4	0.01	+0.01	0.03

Note

Positive signs represent pressures measured at wellheads.

579 433

579 434

Memphis Depot - Test 1

Dunn Field SVE TS Recording Sheet for before test and after test

Before Test: 12/17/01 After Test 12/21/01

Recorder: Jacobs

		VW 1 Wellhead	VW 2 Wellhead	MP-1-22' Wellhead	MP 1 35' Wellhead	MP-1-58 Wellhead	MP 1 71 Wellhead	MP-2 22' Wellhead	MP-2-35' Wellhead	MP-2-58 Wellhead	MP 2 71' Wellhead	MP-3-11 Wellhead	MP-3-27' Wellhead	MP-3-49' Wellhead	MP 3-68' Wellhead	MP-4-19' Wellhead	MP-4-48' Wellhead	MP-4-58 Wellhead	MP-4-70' Wellhead
Screening with an FID for VOCs Tedlar bag w/ pump (ppm)	Before Test	787	68	NS	745	862	434	43	204	690	1326	242	991	418	542	155	3159	2919	2302
	After Test	2495	63	254	117	1055	260	87	585	2210	1020	40	621	739	650	147	3840	2320	4918
Air Sampling for O_2 (%)	Before Test			20 0	13 1	13.2	20 5	19 9	20 3	12 7	14.2	17 8	20.3	14 8	14 4	19 3	12 3	12 4	12 6
	After Test			21.9	22.0	15 1	17 1	22 7	22 7	16.3	17 3	21 9	22 8	16 5	16 3	21 5	14.2	15.0	14.5
Air Sampling for CO_2 (%)	Before Test			0 5	8 0	7 7	0 1	0 6	0 4	0 7	6 7	2 1	0 5	6 1	6.4	0 6	8 9	8 7	8.8
	After Test			0 5	0.3	7 0	4.5	0 0	0.0	6.2	4 9	2 1	0.0	5 7	5 6	0 3	8.0	7 0	7 7
Air Sampling for CH_4 (%)	Before Test			0 0	0.0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0 0
	After Test			0 0	0 0	0 0	0.0	0.0	0.0	0.0	0 0	0 0	0.0	0 0	0 1	0 1	0 1	0 1	0 1

		MP-5-11 Wellhead	MP 5-21 Wellhead	MP-6-11 Wellhead	MP-6-21 Wellhead	MP-6-51 Wellhead	MP-6-72' Wellhead	MP 7-6' Wellhead	MP 7-16' Wellhead	MP-7-41 Wellhead	MP 7-62' Wellhead	MP-8-16' Wellhead	MP-8-52' Wellhead
Screening with an FID for VOCs Tedlar bag w/ pump (ppm)	Before Test	NS	NS	NS	NS	5771	4475	181	135	188	3959	NS	1154
	After Test	62	211	49	473	8592	5530	19700	20	32	4830	NS	133
Air Sampling for O_2 (%)	Before Test	19.9	20 2	16.2	18 9	13 5	12 7	12.4	13 3	2 3	12.8	19 9	15 0
	After Test	22 7	22 7	22.8	22 8	15.0	15 0	21 3	22 3	5 8	14 1	22 5	22 8
Air Sampling for CO_2 (%)	Before Test	1 0	0.4	2 5	0.9	5.8	7 9	0 0	0.0	14 6	7 9	0 2	5.0
	After Test	0 0	0 0	0 1	0 1	7 7	7 4	1 3	0.0	15.0	7.2	0 2	0 1
Air Sampling for CH_4 (%)	Before Test	0.1	0 1	0 0	0.0	0.2	1.4	4 0	0 5	0.0	0 1	0.2	0.2
	After Test	0.0	0.2	0 0	0 0	0.1	0 1	0 1	0 0	0.0	0.2	0.8	0.2

Note

NS -- Not Sampled air could not be pumped and sampled from location due to presence of water

Memphis Depot - Test 2
Dunn Field SVE TS Recording Sheet (January 2002)

Before Test 1/7/2002 After Test 1/11/2002

Recorder: Jacobs

		VW-1 Wellhead	VW-2 Wellhead	MP-1-22' Wellhead	MP-1-35' Wellhead	MP-1-58' Wellhead	MP-1 71 Wellhead	MP-2-22' Wellhead	MP-2-35' Wellhead	MP-2-58' Wellhead	MP-2 71 Wellhead	MP-3-11' Wellhead	MP-3-27' Wellhead	MP-3-49' Wellhead	MP-3-68' Wellhead	MP-4-19' Wellhead	MP-4-48' Wellhead	MP-4-58' Wellhead	MP-4-70' Wellhead
Screening with an FID for VOCs Tedlar bag w/ pump (ppm)	Before Test	110	11.2	43.7	41.4	37.6	26.2	7206	50 4	413	559	165	1003	27 7	758	351	63.2	66.8	41.3
	After Test	32.4	33 5	17 1	46 1	288	305	189	23.6	432	221	3.1	29 6	6 7	2 1	4 6	6.9	5 1	16.3
Air Sampling for O_2 (%)	Before Test	15.5	20.5	8.0	17.8	14 0	13 4	8 6	20.5	17 0	15.3	19 1	15.6	20 6	14.5	20 7	20.8	20.8	20.8
	After Test	18.2	20 9	15.4	21.9	21.8	19 1	6 9	21.9	20.7	21.0	21 1	21 9	21 9	19.6	21 0	22 1	21 1	21.5
Air Sampling for CO_2 (%)	Before Test	1.3	0	3 6	1.9	6 1	6.2	7.8	0 1	3.2	5.2	1 7	5.3	0 3	5 7	0 1	0	0	0
	After Test	1 0	0	1.8	0	0.1	1.2	10.3	0.2	0 1	0 1	1 7	0	0	0.5	0	0	0	0.4
Air Sampling for CH_4 (%)	Before Test	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	After Test	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		MP-5-11 Wellhead	MP-5-21' Wellhead	MP-6-11 Wellhead	MP-6-21 Wellhead	MP-6-51 Wellhead	MP-6-72' Wellhead	MP-7-6' Wellhead	MP 7-16' Wellhead	MP-7-41 Wellhead	MP 7-62' Wellhead	MP-8-16' Wellhead	MP-8-52' Wellhead
Screening with an FID for VOCs Tedlar bag w/ pump (ppm)	Before Test	191	488	495	2506	263	2630	2862	79	309	2268	7.5	6 8
	After Test	481	3.3	56.3	1.9	3035	3395	1153	39 7	156	130	5.6	8.8
Air Sampling for O_2 (%)	Before Test	16.0	20 4	8 3	20 1	20.4	13.5	0	1.9	3.3	10.3	20.4	17.0
	After Test	21.9	21 8	8.8	21 4	21.9	22 1	11 4	0.8	15.4	20 7	21.8	20.0
Air Sampling for CO_2 (%)	Before Test	2.3	1.0	6.0	0.8	0 2	7.0	12.2	13.2	14 1	6 7	0 3	1.9
	After Test	0	0.8	6.6	0 7	0	0 1	3.2	18.5	7 8	1.5	0 1	0.5
Air Sampling for CH_4 (%)	Before Test	0	0	0	0	0	0.2	5 8	0.2	0 2	0.2	0.2	0
	After Test	0	0 1	0.1	0 1	0	0 1	0.6	0	0	0	0 3	0 1

579 435

Attachment D

Research Triangle Park Labs, Inc

579 437

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/18/01 VW-1 Test/VW-1 Wellhead — **Autosampler: 3** — **Dil. Fact:** 9 3
Method: 1702 18 32 — **File:** ?CHEM\1\1702\ 1475132.D — GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.46	117	5998874	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.13	85	3922	ND	4.7	
Chloromethane	74-87-3	2 77	50	2228	ND	4.7	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	4.7	
Vinyl chloride	75-01-4	3.10	62	966817	263.4	4.7	
Bromomethane	74-83-9	0.00	94	0	ND	4.7	
Chloroethane	75-00-3	4.23	64	5040	ND	4.7	
Trichlorofluoromethane (11)	75-69-4	4.54	101	2680	ND	4 7	
1,1-Dichloroethene	75-35-4	5 40	61	375713	32.5	4 7	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	4.7	
Methylene Chloride	75-09-2	6.23	84	15985	ND	4.7	
MTBE (TO-15 only)	1634-04-4	6 66	73	2392	ND	4.7	
1,1-dichloroethane	75-34-3	7.17	63	5701	ND	4.7	
cis-1,2-Dichloroethene	156-59-2	7.76	61	14446832	874.0	4 7	
Chloroform	67-66-3	8.06	83	1481616	62.5	4.7	
1,1,1-Trichloroethane	71-55-6	8.27	97	8657	ND	4.7	
1,2-Dichloroethane	107-06-2	8.84	62	291241	14 1	4.7	
Carbon tetrachloride	56-23-5	8.20	117	15109	ND	4.7	
Benzene	71-43-2	8.65	78	776995	21.0	4.7	
Trichloroethene	79-01-6	9.33	130	60148322	3169 6	4.7	
1,2-dichloropropane	78-87-5	9.76	63	6228	ND	4.7	
cis-1,3-dichloropropene	542-75-6	10.53	75	10928	ND	4.7	
Toluene	108-88-3	10.79	91	1312542	19.6	4.7	
trans-1,3-dichloropropene	10061-02-6	11.17	75	633	ND	4.7	
1,1,2-Trichloroethane	79-00-5	11.41	97	2357431	114.8	4 7	
Tetrachloroethene	127-18-4	11.20	166	34278871	1195 7	4.7	
1,2-Dibromoethane	106-93-4	11.87	107	23432	ND	4.7	
Chlorobenzene	108-90-7	12.47	112	191675	ND	4 7	
Ethyl benzene	100-41-4	12.51	91	4966444	64.4	4.7	
m,p-Xylene	1330-20-7	12.51	91	4966444	45 6	4 7	
o-Xylene	95-47-6	13.40	91	2260274	34.9	4.7	
Styrene	100-42-5	13.31	104	118120	ND	4.7	
1,1,2,2-Tetrachloroethane	79-34-5	14.14	83	1.24E+08	2391.3	4.7	
Bromofluorobenzene (SS)		13.92	95	1152120	26.1		52%
1,3,5-Trimethylbenzene	108-67-8	14.47	105	4858693	65.3	4.7	
1,2,4-Trimethylbenzene	95-63-6	14.87	105	12000497	160.4	4.7	
1,3-Dichlorobenzene	541-73-1	15.27	146	126082	ND	4 7	
1,4-Dichlorobenzene	106-46-7	15.38	146	213585	ND	4.7	
1,2-Dichlorobenzene	95-50-1	15 94	146	140480	ND	4 7	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	236468	8.4	4 7	
Hexachlorobutadiene	87-68-3	17.92	225	3880373	109 4	4 7	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I D

Date Printed. 1/30/02 3:44 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582, direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech· -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci

TO15crt4.crt

579 438

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip/Jacobs Dunfield SVE 12/18/01
Misc: 500mL, VW-1 Test/Carbon canister sys, 0066 — 1472133.D
Method: 10801 18 32 **File:** 'CHEM\1\10801\ ~~30201_01.D~~
Autosampler: 3
Dil. Fact: 1.7
GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.42	117	1267684	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	0.8	
Chloromethane	74-87-3	2.70	50	1316	ND	0 8	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	0.8	
Vinyl chloride	75-01-4	0.00	62	0	ND	0.8	
Bromomethane	74-83-9	0.00	94	0	ND	0.8	
Chloroethane	75-00-3	0.00	64	0	ND	0.8	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	0 8	
1,1-Dichloroethene	75-35-4	5.40	61	2607	ND	0 8	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	0.8	
Methylene Chloride	75-09-2	6.25	84	16387	1.7	0.8	
MTBE (TO-15 only)	1634-04-4	7.31	73	568	ND	0.8	
1,1-dichloroethane	75-34-3	7.15	63	1609	ND	0 8	
cis-1,2-Dichloroethene	156-59-2	7.74	61	784798	40.5	0 8	
Chloroform	67-66-3	8.04	83	14870	ND	0.8	
1,1,1-Trichloroethane	71-55-6	8.25	97	9338	ND	0.8	
1,2-Dichloroethane	107-06-2	8.82	62	5069	ND	0 8	
Carbon tetrachloride	56-23-5	0.00	117	0	ND	0.8	
Benzene	71-43-2	8.63	78	68187	1.6	0.8	
Trichloroethene	79-01-6	9.24	130	13045245	585.8	0.8	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	0.8	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	0 8	
Toluene	108-88-3	10.75	91	151731	1.9	0.8	
trans-1,3-dichloropropene	10061-02-6	10.98	75	7366	ND	0.8	
1,1,2-Trichloroethane	79-00-5	11.36	97	91591	3.8	0.8	
Tetrachloroethene	127-18-4	11.19	166	4974366	147.8	0.8	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	0.8	
Chlorobenzene	108-90-7	12.44	112	11741	ND	0.8	
Ethyl benzene	100-41-4	12.48	91	105413	1.2	0.8	
m,p-Xylene	1330-20-7	12 65	91	380307	3 0	0.8	
o-Xylene	95-47-6	13.19	91	194509	2 6	0 8	
Styrene	100-42-5	13.22	104	24236	ND	0.8	
1,1,2,2-Tetrachloroethane	79-34-5	14.15	83	28688501	473.3	0 8	
Bromofluorobenzene (SS)		13.88	95	673310	72 3		145%
1,3,5-Trimethylbenzene	108-67-8	14 34	105	229626	2.6	0.8	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	476407	5 4	0 8	
1,3-Dichlorobenzene	541-73-1	15.22	146	4915	ND	0.8	
1,4-Dichlorobenzene	106-46-7	15.33	146	24039	ND	0 8	
1,2-Dichlorobenzene	95-50-1	15.89	146	6356	ND	0.8	
1,2,4-Trichlorobenzene	120-82-1	17.92	180	9890	ND	0.8	
Hexachlorobutadiene	87-68-3	17.89	225	1366684	32.8	0.8	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I.D

Date Printed: 1/31/02 2.32 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.

TO15crt4 crt

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/18/01 VW-1 Test/ equipment blank
Method: 1702 18 3 **File:** ?CHEM\1\1702\ 1475134 D

Autosampler: 4 **Dil. Fact:** 1.0

GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.42	117	3778304	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	0.5	
Chloromethane	74-87-3	2.91	50	1383	ND	0 5	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	0 5	
Vinyl chloride	75-01-4	0.00	62	0	ND	0.5	
Bromomethane	74-83-9	0 00	94	0	ND	0.5	
Chloroethane	75-00-3	0.00	64	0	ND	0.5	
Trichlorofluoromethane (11)	75-69-4	0 00	101	0	ND	0.5	
1,1-Dichloroethene	75-35-4	0 00	61	0	ND	0 5	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	0.5	
Methylene Chloride	75-09-2	6 25	84	16800	ND	0.5	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	0 5	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	0.5	
cis-1,2-Dichloroethene	156-59-2	7.76	61	26300	ND	0.5	
Chloroform	67-66-3	8.06	83	6943	ND	0.5	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	0.5	
1,2-Dichloroethane	107-06-2	8.84	62	3142	ND	0 5	
Carbon tetrachloride	56-23-5	0 00	117	0	ND	0 5	
Benzene	71-43-2	8 63	78	11534	ND	0.5	
Trichloroethene	79-01-6	9 24	130	1617527	14 5	0.5	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	0.5	
cis-1,3-dichloropropene	542-75-6	10.51	75	1807	ND	0 5	
Toluene	108-88-3	10.77	91	29887	ND	0.5	
trans-1,3-dichloropropene	10061-02-6	11 21	75	1868	ND	0.5	
1,1,2-Trichloroethane	79-00-5	11.38	97	1994	ND	0.5	
Tetrachloroethene	127-18-4	11 19	166	329037	2.0	0.5	
1,2-Dibromoethane	106-93-4	11.85	107	1692	ND	0.5	
Chlorobenzene	108-90-7	12.46	112	5375	ND	0 5	
Ethyl benzene	100-41-4	12 48	91	15160	ND	0 5	
m,p-Xylene	1330-20-7	12.65	91	38262	ND	0.5	
o-Xylene	95-47-6	13.17	91	9879	ND	0.5	
Styrene	100-42-5	13.23	104	6040	ND	0.5	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	5241444	17.3	0.5	
Bromofluorobenzene (SS)		13.89	95	1373002	49.5		99%
1,3,5-Trimethylbenzene	108-67-8	14.30	105	19031	ND	0.5	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	31808	ND	0.5	
1,3-Dichlorobenzene	541-73-1	15.23	146	14235	ND	0.5	
1,4-Dichlorobenzene	106-46-7	15.35	146	18715	ND	0.5	
1,2-Dichlorobenzene	95-50-1	15.90	146	15582	ND	0.5	
1,2,4-Trichlorobenzene	120-82-1	17 94	180	25286	ND	0.5	
Hexachlorobutadiene	87-68-3	17.92	225	47773	ND	0 5	

Note than benzyl chloride has been removed from the target list due to instability in the standards

Calibration Data: NIST Traceable Standard Cylinder. Spectra Gases L69236, 1ppmv

108_20R D 108_10B.D 108_30I D

Date Printed: 1/31/02 2:33 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582, direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci.

TO15crt4 crt

579 440

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/19/01 VW-1 Test/ carbon canister **Autosampler:** 5 **Dil. Fact:** 1 1
Method: 1702 **File:** ?CHEM\1\1702\ 1475135.D GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	3754044	50 0		100%
Dichlorodifluoromethane (12)	75-71-8	2.13	85	6106	ND	0.6	
Chloromethane	74-87-3	2.79	50	2783	ND	0.6	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	0 6	
Vinyl chloride	75-01-4	3.07	62	2532	ND	0.6	
Bromomethane	74-83-9	0.00	94	0	ND	0.6	
Chloroethane	75-00-3	0.00	64	0	ND	0 6	
Trichlorofluoromethane (11)	75-69-4	4.57	101	2873	ND	0.6	
1,1-Dichloroethene	75-35-4	5.40	61	2467	ND	0.6	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	0.6	
Methylene Chloride	75-09-2	6.24	84	13318	ND	0.6	
MTBE (TO-15 only)	1634-04-4	7.31	73	3308	ND	0.6	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	0.6	
cis-1,2-Dichloroethene	156-59-2	7.75	61	1419850	16.2	0.6	
Chloroform	67-66-3	8.06	83	18373	ND	0.6	
1,1,1-Trichloroethane	71-55-6	8 25	97	18343	ND	0.6	
1,2-Dichloroethane	107-06-2	8.84	62	10992	ND	0.6	
Carbon tetrachloride	56-23-5	8.18	117	2057	ND	0.6	
Benzene	71-43-2	8.64	78	65449	ND	0.6	
Trichloroethene	79-01-6	9.25	130	10439939	103.6	0 6	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	0 6	
cis-1,3-dichloropropene	542-75-6	10.50	75	1788	ND	0.6	
Toluene	108-88-3	10.76	91	317908	0.9	0.6	
trans-1,3-dichloropropene	10061-02-6	10.98	75	364765	3 9	0.6	
1,1,2-Trichloroethane	79-00-5	11.38	97	72149	0.7	0.6	
Tetrachloroethene	127-18-4	11.19	166	4964178	32.6	0.6	
1,2-Dibromoethane	106-93-4	11.84	107	1825	ND	0.6	
Chlorobenzene	108-90-7	12.45	112	11976	ND	0.6	
Ethyl benzene	100-41-4	12.48	91	147374	ND	0.6	
m,p-Xylene	1330-20-7	12.65	91	528827	0.9	0.6	
o-Xylene	95-47-6	13.18	91	251259	0.7	0.6	
Styrene	100-42-5	13.23	104	62350	ND	0.6	
1,1,2,2-Tetrachloroethane	79-34-5	14.15	83	34064206	124.2	0.6	
Bromofluorobenzene (SS)		13.89	95	1359487	49.3		99%
1,3,5-Trimethylbenzene	108-67-8	14.34	105	273409	0 7	0.6	
1,2,4-Trimethylbenzene	95-63-6	14 81	105	689153	1.7	0.6	
1,3-Dichlorobenzene	541-73-1	15.23	146	13808	ND	0.6	
1,4-Dichlorobenzene	106-46-7	15.35	146	46494	ND	0.6	
1,2-Dichlorobenzene	95-50-1	15 91	146	16068	ND	0.6	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	26493	ND	0.6	
Hexachlorobutadiene	87-68-3	17.91	225	821468	4.4	0.6	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I D

Date Printed: 1/31/02 2:33 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1 4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_Ici.

TO15crt4 crt

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/19/01 VW-1 Test/Wellhead — **Autosampler: 6** — **Dil. Fact:** 12.0
Method: 1702 — **File:** ?CHEM\1\1702\ 1475136 D — GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12 43	117	4447590	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.11	85	5667	ND	6 0	
Chloromethane	74-87-3	2.76	50	699	ND	6.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	6.0	
Vinyl chloride	75-01-4	3 07	62	186519	88.1	6.0	
Bromomethane	74-83-9	0.00	94	0	ND	6.0	
Chloroethane	75-00-3	0.00	64	0	ND	6 0	
Trichlorofluoromethane (11)	75-69-4	4.57	101	2662	ND	6.0	
1,1-Dichloroethene	75-35-4	5.40	61	58430	8 8	6.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	6.0	
Methylene Chloride	75-09-2	6.24	84	22448	ND	6.0	
MTBE (TO-15 only)	1634-04-4	6.67	73	3012	ND	6.0	
1,1-dichloroethane	75-34-3	7.17	63	1247	ND	6 0	
cis-1,2-Dichloroethene	156-59-2	7.75	61	4956277	520 2	6.0	
Chloroform	67-66-3	8.06	83	325813	23.8	6.0	
1,1,1-Trichloroethane	71-55-6	8.25	97	5119	ND	6.0	
1,2-Dichloroethane	107-06-2	8.84	62	139689	11.7	6.0	
Carbon tetrachloride	56-23-5	8.18	117	3258	ND	6.0	
Benzene	71-43-2	8.64	78	89191	ND	6.0	
Trichloroethene	79-01-6	9.26	130	14376156	1314 2	6.0	
1,2-dichloropropane	78-87-5	9.78	63	4151	ND	6.0	
cis-1,3-dichloropropene	542-75-6	10.51	75	1158	ND	6.0	
Toluene	108-88-3	10.76	91	416951	10 8	6.0	
trans-1,3-dichloropropene	10061-02-6	10.98	75	15920	ND	6 0	
1,1,2-Trichloroethane	79-00-5	11.38	97	187005	15.8	6.0	
Tetrachloroethene	127-18-4	11.19	166	13545596	819.6	6 0	
1,2-Dibromoethane	106-93-4	11 85	107	1787	ND	6 0	
Chlorobenzene	108-90-7	12.45	112	14367	ND	6 0	
Ethyl benzene	100-41-4	12.48	91	141186	ND	6.0	
m,p-Xylene	1330-20-7	12.65	91	405763	6.5	6 0	
o-Xylene	95-47-6	13.18	91	185088	ND	6 0	
Styrene	100-42-5	13.23	104	30199	ND	6 0	
1,1,2,2-Tetrachloroethane	79-34-5	14.15	83	27926332	937.9	6.0	
Bromofluorobenzene (SS)		13.89	95	1595878	48 8		98%
1,3,5-Trimethylbenzene	108-67-8	14 32	105	183040	ND	6.0	
1,2,4-Trimethylbenzene	95-63-6	14 81	105	348616	8.1	6.0	
1,3-Dichlorobenzene	541-73-1	15.35	146	63071	ND	6.0	
1,4-Dichlorobenzene	106-46-7	15 35	146	63071	ND	6.0	
1,2-Dichlorobenzene	95-50-1	15.91	146	10743	ND	6.0	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	17286	ND	6 0	
Hexachlorobutadiene	87-68-3	17 91	225	355338	17.4	6.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I.D

Date Printed: 1/31/02 2:33 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard, IS = Internal Standard 50 ng each

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci

TO15crt4 crt

579 442

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/18/01 VW-1 Test/equil baseline **Autosampler: 7** **Dil. Fact:** 3.4
Method: 1702 **File:** ?CHEM\1\1702\ 1475137.D GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.44	117	6449414	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.11	85	15661	ND	1 7	
Chloromethane	74-87-3	2.77	50	9770	ND	1.7	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	2.53	85	1148	ND	1 7	
Vinyl chloride	75-01-4	3.09	62	3116674	284.4	1 7	
Bromomethane	74-83-9	0.00	94	0	ND	1.7	
Chloroethane	75-00-3	4 23	64	32981	4.4	1.7	
Trichlorofluoromethane (11)	75-69-4	4.55	101	8953	ND	1.7	
1,1-Dichloroethene	75-35-4	5.40	61	2984962	86.4	1.7	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0 00	151	0	ND	1 7	
Methylene Chloride	75-09-2	6.23	84	53707	2.2	1.7	
MTBE (TO-15 only)	1634-04-4	6.79	73	3342	ND	1.7	
1,1-dichloroethane	75-34-3	7.17	63	10001	ND	1.7	
cis-1,2-Dichloroethene	156-59-2	7.75	61	12910303	261.6	1 7	
Chloroform	67-66-3	8.06	83	1356935	19.2	1.7	
1,1,1-Trichloroethane	71-55-6	8.27	97	4372	ND	1.7	
1,2-Dichloroethane	107-06-2	8.84	62	472980	7.7	1.7	
Carbon tetrachloride	56-23-5	8.18	117	86247	1.8	1.7	
Benzene	71-43-2	8.63	78	252836	2.3	1.7	
Trichloroethene	79-01-6	9.26	130	14175812	250.2	1.7	
1,2-dichloropropane	78-87-5	9.76	63	3289	ND	1 7	
cis-1,3-dichloropropene	542-75-6	10.84	75	2838	ND	1.7	
Toluene	108-88-3	10.77	91	1183826	5.9	1.7	
trans-1,3-dichloropropene	10061-02-6	11.09	75	15318	ND	1 7	
1,1,2-Trichloroethane	79-00-5	11.40	97	1029013	16.8	1.7	
Tetrachloroethene	127-18-4	11.19	166	22516499	263.1	1.7	
1,2-Dibromoethane	106-93-4	11.87	107	2865	ND	1.7	
Chlorobenzene	108-90-7	12.46	112	168183	ND	1.7	
Ethyl benzene	100-41-4	12.50	91	680922	3.0	1 7	
m,p-Xylene	1330-20-7	12.67	91	2042468	6.3	1.7	
o-Xylene	95-47-6	13.19	91	1294328	6.7	1 7	
Styrene	100-42-5	13.24	104	30786	ND	1 7	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	28375453	184.0	1.7	
Bromofluorobenzene (SS)		13.89	95	2487902	52.5		105%
1,3,5-Trimethylbenzene	108-67-8	14.32	105	46747	ND	1.7	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	137824	ND	1.7	
1,3-Dichlorobenzene	541-73-1	15.23	146	35332	ND	1.7	
1,4-Dichlorobenzene	106-46-7	15.35	146	57381	ND	1.7	
1,2-Dichlorobenzene	95-50-1	15.90	146	12792	ND	1.7	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	28262	ND	1.7	
Hexachlorobutadiene	87-68-3	17.92	225	14246209	134.6	1.7	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R D 108_10B D 108_30I D

Date Printed: 1/31/02 2:34 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col.RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech. -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_Ici.

TO15crt4.crt

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE   **Autosampler: 8**   **Dil. Fact:** 1.7
Misc: 500mL; 12/18/01 VW-2 Test/equil baseline   GC/MS #1
Method: 1702   **File:** ?CHEM\1\1702\   1475138.D

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	3803729	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.13	85	24177	1.4	0.8	
Chloromethane	74-87-3	2.71	50	9784	0 9	0.8	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	2.64	85	1795	ND	0.8	
Vinyl chloride	75-01-4	3.07	62	1160	ND	0.8	
Bromomethane	74-83-9	0.00	94	0	ND	0.8	
Chloroethane	75-00-3	0.00	64	0	ND	0.8	
Trichlorofluoromethane (11)	75-69-4	4.57	101	15311	ND	0.8	
1,1-Dichloroethene	75-35-4	5.40	61	3234	ND	0.8	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	5.56	151	1875	ND	0.8	
Methylene Chloride	75-09-2	6 24	84	15185	ND	0.8	
MTBE (TO-15 only)	1634-04-4	6.41	73	1262	ND	0.8	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	0 8	
cis-1,2-Dichloroethene	156-59-2	7 75	61	224082	3.8	0 8	
Chloroform	67-66-3	8 06	83	16285	ND	0.8	
1,1,1-Trichloroethane	71-55-6	8.25	97	7507	ND	0.8	
1,2-Dichloroethane	107-06-2	8.83	62	6789	ND	0 8	
Carbon tetrachloride	56-23-5	8 19	117	9546	ND	0.8	
Benzene	71-43-2	8.64	78	1186721	9.1	0.8	
Trichloroethene	79-01-6	9.25	130	8214917	122.9	0.8	
1,2-dichloropropane	78-87-5	10.06	63	1782	ND	0.8	
cis-1,3-dichloropropene	542-75-6	10.76	75	22322	ND	0.8	
Toluene	108-88-3	10.76	91	2585515	11.0	0.8	
trans-1,3-dichloropropene	10061-02-6	11.21	75	1183	ND	0.8	
1,1,2-Trichloroethane	79-00-5	11.37	97	11655	ND	0.8	
Tetrachloroethene	127-18-4	11.18	166	2011836	19.9	0.8	
1,2-Dibromoethane	106-93-4	0 00	107	0	ND	0.8	
Chlorobenzene	108-90-7	12 45	112	3166	ND	0 8	
Ethyl benzene	100-41-4	12.48	91	193609	ND	0.8	
m,p-Xylene	1330-20-7	12 66	91	418484	1.1	0.8	
o-Xylene	95-47-6	13.16	91	232994	1.0	0 8	
Styrene	100-42-5	13.23	104	30068	ND	0 8	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	20784000	114.3	0.8	
Bromofluorobenzene (SS)		13.89	95	1423317	50 9		102%
1,3,5-Trimethylbenzene	108-67-8	14.31	105	44662	ND	0.8	
1,2,4-Trimethylbenzene	95-63-6	14 79	105	165858	ND	0.8	
1,3-Dichlorobenzene	541-73-1	15 33	146	24664	ND	0.8	
1,4-Dichlorobenzene	106-46-7	15.33	146	24664	ND	0.8	
1,2-Dichlorobenzene	95-50-1	15 89	146	4204	ND	0.8	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	7667	ND	0.8	
Hexachlorobutadiene	87-68-3	17 91	225	862023	6.9	0.8	

Note than benzyl chloride has been removed from the target list due to instability in the standards.
Calibration Data·   NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R.D   108_10B.D   108_30I D
Date Printed: 1/31/02 2:34 PM
ND = Not Detected at the Reporting Limits.   SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica, 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m, 35-300 amu full scan
Nutech -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.
TO15crt4 crt

579 444

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles R port

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 500mL; 12/18/01 VW-1 Test/pumped baseline
Method: 1702 File: ?CHEM\1\1702\ 1475139 D
Autosampler: 9
Dil. Fact: 2.2
GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.44	117	6213878	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.14	85	18834	ND	1.1	
Chloromethane	74-87-3	2.77	50	14851	1 1	1.1	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	2.33	85	1345	ND	1.1	
Vinyl chloride	75-01-4	3.12	62	3569758	222.4	1.1	
Bromomethane	74-83-9	0.00	94	0	ND	1 1	
Chloroethane	75-00-3	4.27	64	27345	2.5	1 1	
Trichlorofluoromethane (11)	75-69-4	4.56	101	11326	ND	1 1	
1,1-Dichloroethene	75-35-4	5.41	61	1429211	28 2	1.1	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	1.1	
Methylene Chloride	75-09-2	6.25	84	28413	ND	1.1	
MTBE (TO-15 only)	1634-04-4	6 72	73	546	ND	1.1	
1,1-dichloroethane	75-34-3	7.17	63	26163	ND	1.1	
cis-1,2-Dichloroethene	156-59-2	7.76	61	13879494	192 0	1 1	
Chloroform	67-66-3	8.07	83	1376113	13.3	1 1	
1,1,1-Trichloroethane	71-55-6	8.28	97	19191	ND	1.1	
1,2-Dichloroethane	107-06-2	8.87	62	883257	9.8	1 1	
Carbon tetrachloride	56-23-5	8 21	117	92254	1 3	1.1	
Benzene	71-43-2	8.68	78	366261	2.3	1.1	
Trichloroethene	79-01-6	9.26	130	14235081	171 5	1.1	
1,2-dichloropropane	78-87-5	9.74	63	2828	ND	1.1	
cis-1,3-dichloropropene	542-75-6	10.54	75	5959	ND	1.1	
Toluene	108-88-3	10.77	91	2587047	8.9	1.1	
trans-1,3-dichloropropene	10061-02-6	11.26	75	1442	ND	1.1	
1,1,2-Trichloroethane	79-00-5	11.40	97	2491709	27.7	1.1	
Tetrachloroethene	127-18-4	11.19	166	26644782	212.5	1 1	
1,2-Dibromoethane	106-93-4	11.83	107	5343	ND	1.1	
Chlorobenzene	108-90-7	12.46	112	208980	ND	1.1	
Ethyl benzene	100-41-4	12.49	91	3727300	11.1	1.1	
m,p-Xylene	1330-20-7	12.67	91	11933153	25.0	1.1	
o-Xylene	95-47-6	13.24	91	7401044	26.2	1.1	
Styrene	100-42-5	13.24	104	324176	1.7	1 1	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	21471260	95 1	1.1	
Bromofluorobenzene (SS)		13.90	95	2547997	55.8		112%
1,3,5-Trimethylbenzene	108-67-8	14.37	105	588332	1.8	1.1	
1,2,4-Trimethylbenzene	95-63-6	14.82	105	1771865	5.4	1.1	
1,3-Dichlorobenzene	541-73-1	15.24	146	22569	ND	1.1	
1,4-Dichlorobenzene	106-46-7	15.35	146	127678	ND	1.1	
1,2-Dichlorobenzene	95-50-1	15.90	146	12824	ND	1.1	
1,2,4-Trichlorobenzene	120-82-1	17.94	180	20038	ND	1.1	
Hexachlorobutadiene	87-68-3	17 90	225	5120282	33.0	1.1	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I.D

Date Printed: 1/31/02 2:34 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard, IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface, -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.

TO15crt4.crt

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209131 Jacobs Dunnfield SVE
Misc: 2.5mL; 12/18/01 VW-2 Pumped baseline **Autosampler:** 10 **Dil. Fact:** 400.0
Method: 1702 **File:** ?CHEM\1\1702\ 1475140 D GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	3017983	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	200.0	
Chloromethane	74-87-3	0.00	50	0	ND	200.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	200.0	
Vinyl chloride	75-01-4	3.00	62	51642	1198.8	200.0	
Bromomethane	74-83-9	0.00	94	0	ND	200.0	
Chloroethane	75-00-3	0.00	64	0	ND	200.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	200.0	
1,1-Dichloroethene	75-35-4	5.37	61	15558	ND	200.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	200.0	
Methylene Chloride	75-09-2	6.22	84	1818	ND	200.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	200.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	200.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	2267293	11688.9	200.0	
Chloroform	67-66-3	8.04	83	95453	342.9	200.0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	200.0	
1,2-Dichloroethane	107-06-2	8.81	62	7707	ND	200.0	
Carbon tetrachloride	56-23-5	8.17	117	14319	ND	200.0	
Benzene	71-43-2	8.62	78	7136	ND	200.0	
Trichloroethene	79-01-6	9.26	130	17980026	80742.2	200.0	
1,2-dichloropropane	78-87-5	9.75	63	1558	ND	200.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	200.0	
Toluene	108-88-3	10.74	91	9167	ND	200.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	200.0	
1,1,2-Trichloroethane	79-00-5	11.37	97	56243	233.3	200.0	
Tetrachloroethene	127-18-4	11.18	166	5721084	17005.5	200.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	200.0	
Chlorobenzene	108-90-7	12.43	112	3396	ND	200.0	
Ethyl benzene	100-41-4	12.46	91	3793	ND	200.0	
m,p-Xylene	1330-20-7	12.64	91	9665	ND	200.0	
o-Xylene	95-47-6	13.14	91	6660	ND	200.0	
Styrene	100-42-5	0.00	104	0	ND	200.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	23071485	38064.7	200.0	
Bromofluorobenzene (SS)		13.87	95	993979	44.8		90%
1,3,5-Trimethylbenzene	108-67-8	14.31	105	1305	ND	200.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	4466	ND	200.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	200.0	
1,4-Dichlorobenzene	106-46-7	0.00	146	0	ND	200.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	200.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	200.0	
Hexachlorobutadiene	87-68-3	17.89	225	67124	ND	200.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B D 108_30I D

Date Printed: 1/31/02 2:34 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci.

TO15crt4 crt

579 446

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209247 Jacobs Dunnfield SVE
Misc: 2 5mL; 1/7/02 VW-2 Equipment blank
Method: 1702 18 3o **File:** ?CHEM\1\1702\ 1475789 D
Autosampler: 9
Dil. Fact: 200 0
GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	2763757	50 0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	100.0	
Chloromethane	74-87-3	0 00	50	0	ND	100.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0 00	85	0	ND	100 0	
Vinyl chloride	75-01-4	0.00	62	0	ND	100 0	
Bromomethane	74-83-9	0.00	94	0	ND	100.0	
Chloroethane	75-00-3	0.00	64	0	ND	100.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	100 0	
1,1-Dichloroethene	75-35-4	0.00	61	0	ND	100 0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	100.0	
Methylene Chloride	75-09-2	6.23	84	2388	ND	100.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	100.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	100.0	
cis-1,2-Dichloroethene	156-59-2	7.75	61	3554	ND	100.0	
Chloroform	67-66-3	8.06	83	3550	ND	100 0	
1,1,1-Trichloroethane	71-55-6	0 00	97	0	ND	100 0	
1,2-Dichloroethane	107-06-2	0 00	62	0	ND	100.0	
Carbon tetrachloride	56-23-5	0 00	117	0	ND	100.0	
Benzene	71-43-2	0.00	78	0	ND	100.0	
Trichloroethene	79-01-6	9.24	130	12600	ND	100.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	100.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	100.0	
Toluene	108-88-3	10.77	91	1219	ND	100.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	100.0	
1,1,2-Trichloroethane	79-00-5	0.00	97	0	ND	100.0	
Tetrachloroethene	127-18-4	11.19	166	144467	234.5	100.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	100.0	
Chlorobenzene	108-90-7	0.00	112	0	ND	100 0	
Ethyl benzene	100-41-4	12.43	91	7859	ND	100.0	
m,p-Xylene	1330-20-7	12.43	91	7859	ND	100.0	
o-Xylene	95-47-6	0 00	91	0	ND	100.0	
Styrene	100-42-5	0.00	104	0	ND	100.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	64040	ND	100.0	
Bromofluorobenzene (SS)		13.89	95	975548	48.0		96%
1,3,5-Trimethylbenzene	108-67-8	13.89	105	1772	ND	100.0	
1,2,4-Trimethylbenzene	95-63-6	0.00	105	0	ND	100.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	100.0	
1,4-Dichlorobenzene	106-46-7	0.00	146	0	ND	100 0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	100 0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	100 0	
Hexachlorobutadiene	87-68-3	0.00	225	0	ND	100 0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R D 108_10B.D 108_30I D

Date Printed: 1/31/02 2:43 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582, direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci.

TO15crt4 crt

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209247 Jacobs Dunnfield SVE **Autosampler:** 13 **Dil. Fact:** 200 0
Misc: 2.5mL, 1/8/02 VW-2 Wellhead GC/MS #1
Method: 1702 ? 60 **File:** ?CHEM\1\1702\ 1475790.D

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	3442876	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	100.0	
Chloromethane	74-87-3	2.72	50	607	ND	100.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	100.0	
Vinyl chloride	75-01-4	3 07	62	224053	2279 6	100 0	
Bromomethane	74-83-9	0.00	94	0	ND	100.0	
Chloroethane	75-00-3	0.00	64	0	ND	100 0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	100.0	
1,1-Dichloroethene	75-35-4	5.40	61	76981	248 5	100.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	100.0	
Methylene Chloride	75-09-2	6.24	84	5141	ND	100.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	100.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	100.0	
cis-1,2-Dichloroethene	156-59-2	7.75	61	12187884	27539.8	100.0	
Chloroform	67-66-3	8.06	83	490585	772.4	100.0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	100.0	
1,2-Dichloroethane	107-06-2	8.85	62	29132	ND	100.0	
Carbon tetrachloride	56-23-5	8.18	117	153725	363.2	100.0	
Benzene	71-43-2	8 64	78	14172	ND	100.0	
Trichloroethene	79-01-6	9.32	130	35815949	70494.0	100 0	
1,2-dichloropropane	78-87-5	9.79	63	10311	ND	100.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	100.0	
Toluene	108-88-3	10.78	91	62195	ND	100.0	
trans-1,3-dichloropropene	10061-02-6	11.45	75	2387	ND	100 0	
1,1,2-Trichloroethane	79-00-5	11.39	97	297810	541.5	100 0	
Tetrachloroethene	127-18-4	11.19	166	7718806	10056.0	100.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	100.0	
Chlorobenzene	108-90-7	12.45	112	7618	ND	100.0	
Ethyl benzene	100-41-4	12.48	91	40355	ND	100.0	
m,p-Xylene	1330-20-7	12.66	91	82598	ND	100.0	
o-Xylene	95-47-6	13.18	91	36807	ND	100.0	
Styrene	100-42-5	13.25	104	3011	ND	100.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	18242346	13191.5	100.0	
Bromofluorobenzene (SS)		13.89	95	1276584	50.5		101%
1,3,5-Trimethylbenzene	108-67-8	14.32	105	4454	ND	100.0	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	11714	ND	100.0	
1,3-Dichlorobenzene	541-73-1	15.35	146	4965	ND	100.0	
1,4-Dichlorobenzene	106-46-7	15.35	146	4965	ND	100.0	
1,2-Dichlorobenzene	95-50-1	0 00	146	0	ND	100.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	100 0	
Hexachlorobutadiene	87-68-3	17.91	225	37576	ND	100 0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R D 108_10B D 108_30I.D

Date Printed: 1/31/02 2:43 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci. TO15crt4.crt

579 448

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatil s Report

Sample: Philip 209247 Jacobs Dunnfield SVE
Misc: 2 5mL; 1/8/02 VW-2 Source B **Autosampler:** 14 **Dil. Fact:** 267.0
Method: 1702 2 co dup **File:** ?CHEM\1\1702\ 1475791 D GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	3526427	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	133.5	
Chloromethane	74-87-3	2.70	50	557	ND	133 5	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	133.5	
Vinyl chloride	75-01-4	3 07	62	260024	3448.1	133.5	
Bromomethane	74-83-9	0.00	94	0	ND	133.5	
Chloroethane	75-00-3	3.92	64	570	ND	133 5	
Trichlorofluoromethane (11)	75-69-4	0 00	101	0	ND	133.5	
1,1-Dichloroethene	75-35-4	5.40	61	71861	302.4	133.5	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	133.5	
Methylene Chloride	75-09-2	6 24	84	5222	ND	133 5	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	133.5	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	133 5	
cis-1,2-Dichloroethene	156-59-2	7 75	61	12083957	35588.5	133.5	
Chloroform	67-66-3	8.06	83	483656	992.5	133.5	
1,1,1-Trichloroethane	71-55-6	7.92	97	1132	ND	133.5	
1,2-Dichloroethane	107-06-2	8.84	62	33741	ND	133.5	
Carbon tetrachloride	56-23-5	8.18	117	152115	468.4	133.5	
Benzene	71-43-2	8.64	78	13200	ND	133.5	
Trichloroethene	79-01-6	9.31	130	34365292	88158.4	133.5	
1,2-dichloropropane	78-87-5	9.78	63	10015	ND	133.5	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	133.5	
Toluene	108-88-3	10.78	91	37091	ND	133.5	
trans-1,3-dichloropropene	10061-02-6	11 44	75	2278	ND	133.5	
1,1,2-Trichloroethane	79-00-5	11.38	97	260207	616 7	133.5	
Tetrachloroethene	127-18-4	11.19	166	7460368	12667.9	133 5	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	133 5	
Chlorobenzene	108-90-7	12.46	112	7031	ND	133.5	
Ethyl benzene	100-41-4	12.48	91	21884	ND	133.5	
m,p-Xylene	1330-20-7	12.65	91	56761	ND	133.5	
o-Xylene	95-47-6	13.18	91	26448	ND	133 5	
Styrene	100-42-5	0 00	104	0	ND	133.5	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	23174812	21842 2	133.5	
Bromofluorobenzene (SS)		13.89	95	1308003	50 5		101%
1,3,5-Trimethylbenzene	108-67-8	14.22	105	11155	ND	133.5	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	7253	ND	133.5	
1,3-Dichlorobenzene	541-73-1	15.35	146	3139	ND	133.5	
1,4-Dichlorobenzene	106-46-7	15 35	146	3139	ND	133.5	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	133.5	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	133.5	
Hexachlorobutadiene	87-68-3	17.91	225	14125	ND	133.5	

Note than benzyl chloride has been removed from the target list due to instability in the standards.
Calibration Data. NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R.D 108_10B.D 108_30I D
Date Printed 1/31/02 2:43 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica, 30m x 0 25mm, 1.4u film S/N 214582; direct interface, -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.
TO15crt4 crt

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209247 Jacobs Dunnfield SVE
Misc: 2 5mL; 1/7/02 VW-2 Wellhead
Method: 1702 18 30 **File:** ?CHEM\1\1702\ 1475792.D

Autosampler: 15

Dil. Fact: 294 0
GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.44	117	3718826	50 0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	147 0	
Chloromethane	74-87-3	2.73	50	844	ND	147.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	147.0	
Vinyl chloride	75-01-4	3.07	62	539057	7463.9	147.0	
Bromomethane	74-83-9	0 00	94	0	ND	147.0	
Chloroethane	75-00-3	4 06	64	725	ND	147.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	147.0	
1,1-Dichloroethene	75-35-4	5.41	61	99603	437.6	147.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	147.0	
Methylene Chloride	75-09-2	6.25	84	4808	ND	147.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	147 0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	147.0	
cis-1,2-Dichloroethene	156-59-2	7.76	61	15497302	47656 5	147.0	
Chloroform	67-66-3	8.06	83	749218	1605.3	147.0	
1,1,1-Trichloroethane	71-55-6	8.21	97	743	ND	147.0	
1,2-Dichloroethane	107-06-2	8.84	62	43625	ND	147.0	
Carbon tetrachloride	56-23-5	8.20	117	198254	637 5	147.0	
Benzene	71-43-2	8.65	78	16206	ND	147 0	
Trichloroethene	79-01-6	9.33	130	32480800	87003.2	147.0	
1,2-dichloropropane	78-87-5	9.81	63	15768	ND	147.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	147.0	
Toluene	108-88-3	10.77	91	39478	ND	147.0	
trans-1,3-dichloropropene	10061-02-6	11 45	75	3752	ND	147.0	
1,1,2-Trichloroethane	79-00-5	11.38	97	356260	881.6	147.0	
Tetrachloroethene	127-18-4	11.21	166	10050785	17820.1	147.0	
1,2-Dibromoethane	106-93-4	0 00	107	0	ND	147.0	
Chlorobenzene	108-90-7	12.46	112	11538	ND	147.0	
Ethyl benzene	100-41-4	12.49	91	22809	ND	147.0	
m,p-Xylene	1330-20-7	12.67	91	50968	ND	147 0	
o-Xylene	95-47-6	13.17	91	24942	ND	147 0	
Styrene	100-42-5	0.00	104	0	ND	147.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	27460450	27024.2	147.0	
Bromofluorobenzene (SS)		13 90	95	1401120	51.3		103%
1,3,5-Trimethylbenzene	108-67-8	14.23	105	12278	ND	147.0	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	9431	ND	147.0	
1,3-Dichlorobenzene	541-73-1	15.35	146	3359	ND	147.0	
1,4-Dichlorobenzene	106-46-7	15.35	146	3359	ND	147.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	147 0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	147.0	
Hexachlorobutadiene	87-68-3	17.90	225	32645	ND	147.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I.D

Date Printed: 1/31/02 2:44 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface, -20C to 210 @ 12C/m, 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.

TO15crt4.crt

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE **ENVIRONMENTAL TESTING**

- EPA/NVLAP 101282-0
- AIHA ACCREDITATION NO. 100439
- NC DENR 599
- NY DOH 10903
- PA DER 06-353
- NJ DEP 77678
- CT DPH PH-0238

ANALYTICAL REPORT

Client: Jacobs Engineering

Report to: Kraig Smith
Jacobs Engineering
13723 Riverport Dr.
Maryland Heights MO 63043

Project: 209146
Received: 24-DEC-01
Reported: 14-JAN-02

PURCHASE ORDER: C5X61110

Project Description: Memphis Depot SVE

	RESULT	UNITS	METHOD	DATE	ANALYST

VW-1 Test/Carbon Canister Unit (804)
Lab Sample: 1475316
sampled: 21-DEC-01 14:30

See Attached Report

VW-1 Test/Source B (02316)
Lab Sample: 1475317
sampled: 21-DEC-01 14:30

See Attached Report

VW-1 Test/Ambient Background (11208)
Lab Sample: 1475318
sampled: 20-DEC-01 15:00

See Attached Report

VW-1 Test/Well Head (12830)
Lab Sample: 1475319
sampled: 21-DEC-01 14:30

See Attached Report

VW-1 Test/Carbon Canister West (19301)
Lab Sample: 1475320
sampled: 20-DEC-01 02:30

See Attached Report

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE | **ENVIRONMENTAL TESTING**

- EPA/NVLAP 101262-0
- AIHA ACCREDITATION NO 100439
- NC DENR 599
- NY DOH 10903
- PA DER 06-353
- NJ DEP 77678
- CT DPH PH-0238

Client: Jacobs Engineering
Project: 209146

	RESULT	UNITS	METHOD	DATE	ANALYST

VW-1 Test/Well Head (93047)
Lab Sample: 1475321
sampled: 20-DEC-01 02:35

See Attached Report

VW-1 Test/~~Source B~~ (12155) dup!
Lab Sample: 1475322
sampled: 20-DEC-01 02:36

See Attached Report

< indicates less than the limit of quantitation.

579 452

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209148 Jacobs Dunnfield SVE
Misc: 500mL; 12/21/01 VW-1 Test carbon canister — Autosampler: 3 — Dil. Fact: 1.0
Method: 1702 — File: ?CHEM\1\1702\ 1475318.D — GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	3555891	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.13	85	1338	ND	0.5	
Chloromethane	74-87-3	2.72	50	6541	ND	0.5	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	0.5	
Vinyl chloride	75-01-4	3.08	62	14330	0.7	0.5	
Bromomethane	74-83-9	0.00	94	0	ND	0.5	
Chloroethane	75-00-3	0.00	64	0	ND	0.5	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	0.5	
1,1-Dichloroethene	75-35-4	5.40	61	32515	0.5	0.5	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	0.5	
Methylene Chloride	75-09-2	6.24	84	20804	ND	0.5	
MTBE (TO-15 only)	1634-04-4	7.30	73	581	ND	0.5	
1,1-dichloroethane	75-34-3	7.18	63	2150	ND	0.5	
cis-1,2-Dichloroethene	156-59-2	7.75	61	2367577	25.8	0.5	
Chloroform	67-66-3	8.06	83	20341	ND	0.5	
1,1,1-Trichloroethane	71-55-6	8.25	97	10178	ND	0.5	
1,2-Dichloroethane	107-06-2	8.63	62	5683	ND	0.5	
Carbon tetrachloride	56-23-5	8.25	117	1266	ND	0.5	
Benzene	71-43-2	8.64	78	54115	ND	0.5	
Trichloroethene	79-01-6	9.28	130	13664163	130.2	0.5	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	0.5	
cis-1,3-dichloropropene	542-75-6	10.76	75	5214	ND	0.5	
Toluene	108-88-3	10.76	91	578535	1.6	0.5	
trans-1,3-dichloropropene	10061-02-6	11.23	75	1832	ND	0.5	
1,1,2-Trichloroethane	79-00-5	11.39	97	175011	1.5	0.5	
Tetrachloroethene	127-18-4	11.19	166	11267905	71.1	0.5	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	0.5	
Chlorobenzene	108-90-7	12.45	112	25360	ND	0.5	
Ethyl benzene	100-41-4	12.48	91	141335	ND	0.5	
m,p-Xylene	1330-20-7	12.88	91	238628	ND	0.5	
o-Xylene	95-47-6	13.18	91	100944	ND	0.5	
Styrene	100-42-5	13.23	104	18021	ND	0.5	
1,1,2,2-Tetrachloroethane	79-34-5	14.17	83	33819858	117.7	0.5	
Bromofluorobenzene (SS)		13.89	95	1277439	48.9		98%
1,3,5-Trimethylbenzene	108-67-8	14.32	105	64988	ND	0.5	
1,2,4-Trimethylbenzene	95-63-6	14.81	105	174745	ND	0.5	
1,3-Dichlorobenzene	541-73-1	15.25	146	18204	ND	0.5	
1,4-Dichlorobenzene	106-46-7	15.35	146	29540	ND	0.5	
1,2-Dichlorobenzene	95-50-1	15.91	146	15427	ND	0.5	
1,2,4-Trichlorobenzene	120-82-1	17.84	180	15664	ND	0.5	
Hexachlorobutadiene	87-68-3	17.91	225	615002	3.1	0.5	

Note that benzyl chloride has been removed from the target list due to instability in the standards.
Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R.D 108_10B D 108_30I.D
Date Printed 1/8/02 9:58 AM
ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214682; direct interface; -20C to 210 @ 12C/m, 35-300 amu full scan
Nutech. -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_ki
TO15crt4.crt

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample. Philp 209146 Jacobs Dunnfield SVE
Misc: 2.5mL; 12/21/01 VW-1 Source B — Autosampler: 14 — Dil. Fact: 294 0
Method: 1702 — File: ?CHEM\1\1702\ 1475317.D — GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.43	117	1976716	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	147.0	
Chloromethane	74-87-3	0.00	50	0	ND	147 0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	147.0	
Vinyl chloride	75-01-4	3.05	62	6757	178.0	147.0	
Bromomethane	74-83-9	0.00	94	0	ND	147 0	
Chloroethane	75-00-3	0.00	64	0	ND	147.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	147.0	
1,1-Dichloroethene	75-35-4	5.40	61	6437	ND	147 0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	147 0	
Methylene Chloride	75-09-2	0.00	84	0	ND	147.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	147.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	147.0	
cis-1,2-Dichloroethene	156-59-2	7.75	61	462430	2675.3	147 0	
Chloroform	67-66-3	8 04	83	33261	ND	147.0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	147 0	
1,2-Dichloroethane	107-06-2	8.83	62	2370	ND	147.0	
Carbon tetrachloride	56-23-5	0 00	117	0	ND	147.0	
Benzene	71-43-2	8.64	78	3925	ND	147.0	
Trichloroethene	79-01-6	9.24	130	10233942	51571.9	147.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	147.0	
cis-1,3-dichloropropene	542-75-6	0 00	75	0	ND	147.0	
Toluene	108-88-3	10 76	91	7567	ND	147.0	
trans-1,3-dichloropropene	10061-02-6	0 00	75	0	ND	147.0	
1,1,2-Trichloroethane	79-00-5	11.37	97	12363	ND	147.0	
Tetrachloroethene	127-18-4	11.18	166	3447519	11499.5	147.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	147.0	
Chlorobenzene	108-90-7	0.00	112	0	ND	147.0	
Ethyl benzene	100-41-4	12.46	91	4380	ND	147,0	
m,p-Xylene	1330-20-7	12.84	91	6534	ND	147.0	
o-Xylene	95-47-6	13.16	91	3508	ND	147.0	
Styrene	100-42-5	0.00	104	0	ND	147 0	
1,1,2,2-Tetrachloroethane	79-34-5	14.13	83	10676708	19765.3	147.0	
Bromofluorobenzene (SS)		13.89	95	597300	41.1		82%
1,3,5-Trimethylbenzene	108-67-8	14.18	105	4818	ND	147.0	
1,2,4-Trimethylbenzene	95-63-6	0 00	105	0	ND	147.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	147.0	
1,4-Dichlorobenzene	106-46-7	0.00	146	0	ND	147.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	147.0	
1,2,4-Trichlorobenzene	120-82-1	0 00	180	0	ND	147 0	
Hexachlorobutadiene	87-68-3	17.69	225	10523	ND	147.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R.D 108_109 D 108_301.D

Date Printed: 1/9/02 9:06 AM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica: 30m x 0.25mm, 1 4u film S/N 214582; direct interface, -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C, TO14/15_lci TO15crt4.crt

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209148 Jacobs Dunnfield SVE
Misc: 500mL; 12/20/01 VW-1 Test Ambient bkgrd
Method: 1702 File: ?CHEM\1\1702\ 1475316 D
Autosampler: 12 Dil. Fact: 1.7 GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.42	117	2222381	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.11	85	7638	ND	0.8	
Chloromethane	74-87-3	2.75	50	1585	ND	0.8	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	0.8	
Vinyl chloride	75-01-4	0.00	62	0	ND	0.8	
Bromomethane	74-83-9	0.00	94	0	ND	0.8	
Chloroethane	75-00-3	0.00	64	0	ND	0.8	
Trichlorofluoromethane (11)	75-69-4	4.64	101	6654	ND	0.8	
1,1-Dichloroethene	75-35-4	0.00	61	0	ND	0.8	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	0.8	
Methylene Chloride	75-09-2	6.23	84	11328	ND	0.8	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	0.8	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	0.8	
cis-1,2-Dichloroethene	156-59-2	7.74	61	32915	1.0	0.8	
Chloroform	67-66-3	8.06	83	3870	ND	0.8	
1,1,1-Trichloroethane	71-55-6	8.26	97	2507	ND	0.8	
1,2-Dichloroethane	107-06-2	8.62	62	7058	ND	0.8	
Carbon tetrachloride	56-23-5	8.18	117	6509	ND	0.8	
Benzene	71-43-2	8.63	78	21874	ND	0.8	
Trichloroethene	79-01-6	9.24	130	2146817	56.0	0.8	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	0.8	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	0.8	
Toluene	108-88-3	10.75	91	58752	ND	0.8	
trans-1,3-dichloropropene	10061-02-6	10.98	75	2409	ND	0.8	
1,1,2-Trichloroethane	79-00-5	17.19	97	584	ND	0.8	
Tetrachloroethene	127-18-4	11.17	166	394472	5.7	0.8	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	0.8	
Chlorobenzene	108-90-7	0.00	112	0	ND	0.8	
Ethyl benzene	100-41-4	12.47	91	11943	ND	0.8	
m,p-Xylene	1330-20-7	12.65	91	33352	ND	0.8	
o-Xylene	95-47-6	13.15	91	12251	ND	0.8	
Styrene	100-42-5	0.00	104	0	ND	0.8	
1,1,2,2-Tetrachloroethane	79-34-5	14.11	83	3032550	28.5	0.8	
Bromofluorobenzene (SS)		13.88	95	704923	43.2		86%
1,3,5-Trimethylbenzene	108-67-8	14.30	105	4382	ND	0.8	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	13607	ND	0.8	
1,3-Dichlorobenzene	541-73-1	15.33	146	1827	ND	0.8	
1,4-Dichlorobenzene	106-46-7	16.33	146	1827	ND	0.8	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	0.8	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	0.8	
Hexachlorobutadiene	87-68-3	17.68	225	13801	ND	0.8	

Note that benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data. NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
106_20R D 106_10B.D 108_30I.D

Date Printed: 1/8/02 4:38 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard IS = Internal Standard 50 ng each.
Col RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m, 35-300 amu full scan
Nutech -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_icl
TO15crt4.crt

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209148 Jacobs Dunnfield SVE
Misc: 2 5mL; 12/21/01 VW-1 Wellhead — Autosampler: 13 — Dil. Fact: 336 0
Method: 1702 — File: >CHEM\1\1702\ 1475319.D — GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	2880354	50 0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168.0	
Chloromethane	74-87-3	0 00	50	0	ND	168.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	168 0	
Vinyl chloride	75-01-4	3.01	62	20864	458.1	168.0	
Bromomethane	74-83-9	0.00	94	0	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.38	61	10299	ND	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168 0	
Methylene Chloride	75-09-2	6.23	84	1957	ND	168.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7 74	61	882176	3228 8	168.0	
Chloroform	67-66-3	8.04	83	45482	ND	168 0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	168.0	
1,2-Dichloroethane	107-06-2	8.62	62	2903	ND	168.0	
Carbon tetrachloride	56-23-5	0,00	117	0	ND	168.0	
Benzene	71-43-2	8.81	78	8107	ND	168.0	
Trichloroethene	79-01-6	9 24	130	11049323	46929.9	168.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	168.0	
Toluene	108-88-3	10.74	91	7313	ND	168.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	168 0	
1,1,2-Trichloroethane	79-00-5	11.36	97	12525	ND	168.0	
Tetrachloroethene	127-18-4	11.17	166	3879352	11187.4	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12.44	112	2148	ND	168.0	
Ethyl benzene	100-41-4	12.48	91	4397	ND	168.0	
m,p-Xylene	1330-20-7	12.63	91	7475	ND	168.0	
o-Xylene	95-47-6	13.15	91	3751	ND	168.0	
Styrene	100-42-5	0 00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	14 11	83	12496070	19502.7	168.0	
Bromofluorobenzene (SS)		13.87	95	872880	44.3		89%
1,3,5-Trimethylbenzene	108-67-8	14.16	105	4467	ND	168.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	3624	ND	168.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	168.0	
1,4-Dichlorobenzene	106-46-7	0 00	146	0	ND	168.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	168.0	
Hexachlorobutadiene	87-68-3	17 90	225	25222	ND	168 0	

Note then benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69238, 1ppmv

108_20R.D 108_10B.D 108_30I D

Date Printed: 1/8/02 6:43 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.

Col RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lci.

TO15crt4 crt

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209146 Jacobs Dunnfield SVE
Misc: 2.5mL; 12/20/01 VW-1 Carbon canister unit
Method: 1702 File: ^CHEM\1\1702\ 1475320.D

Autosampler: 11
Dil. Fact: 336.0
GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12 42	117	2806870	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168 0	
Chloromethane	74-87-3	0.00	50	0	ND	168 0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	168.0	
Vinyl chloride	75-01-4	3.07	62	14920	312.8	168.0	
Bromomethane	74-83-9	0.00	94	0	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.38	61	10004	ND	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168.0	
Methylene Chloride	75-09-2	6.21	84	1961	ND	168.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7.74	61	560781	2611 4	168.0	
Chloroform	67-66-3	8.04	83	40563	ND	168.0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	168.0	
1,2-Dichloroethane	107-06-2	8.82	62	2287	ND	168.0	
Carbon tetrachloride	56-23-5	0.00	117	0	ND	168.0	
Benzene	71-43-2	8.81	78	8704	ND	168 0	
Trichloroethene	79-01-6	9.24	130	10675210	43300.4	168.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0 00	75	0	ND	168.0	
Toluene	108-88-3	10.75	91	7411	ND	168.0	
trans-1,3-dichloropropane	10061-02-6	0 00	75	0	ND	168.0	
1,1,2-Trichloroethane	79-00-5	11.36	97	11707	ND	168.0	
Tetrachloroethene	127-18-4	11.17	166	3502722	9404.2	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12 44	112	1547	ND	168 0	
Ethyl benzene .	100-41-4	12.48	91	2663	ND	168.0	
m,p-Xylene	1330-20-7	12.63	91	6282	ND	168.0	
o-Xylene	95-47-6	13.15	91	3140	ND	168.0	
Styrene	100-42-5	0.00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.11	83	9585756	14284.9	168.0	
Bromofluorobenzene (SS)		13.87	95	904118	43 8		88%
1,3,5-Trimethylbenzene	108-67-8	14 18	105	2990	ND	168 0	
1,2,4-Trimethylbenzene	95-63-6	14 68	105	1301	ND	168.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	168 0	
1,4-Dichlorobenzene	106-46-7	0.00	146	0	ND	168.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	168.0	
Hexachlorobutadiene	87-68-3	17.90	225	7166	ND	168.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R.D 108_10B.D 108_30I D

Date Printed: 1/8/02 6:52 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each

Col RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Ambersorb 747 Trap; desorb @ 180C; TO14/15_kl. TO15crt4.crt

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209146 Jacobs Dunnfield SVE | Autosampler: 15 | Dil. Fact: 200.0

Misc: 2.5mL; 12/20/01 VW-1 Wellhead | GC/MS #1

Method: 1702 | File: ?CHEM\1\1702\ 1475321.D

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	2888164	50 0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	100.0	
Chloromethane	74-87-3	2.88	50	1196	ND	100.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	100.0	
Vinyl chloride	75-01-4	3.02	62	26172	317.4	100.0	
Bromomethane	74-83-9	0.00	94	0	ND	100.0	
Chloroethane	75-00-3	0.00	64	0	ND	100.0	
Trichlorofluoromethane (11)	75-69-4	0 00	101	0	ND	100.0	
1,1-Dichloroethene	75-35-4	5.38	61	14057	ND	100.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	100.0	
Methylene Chloride	75-09-2	6.22	84	1734	ND	100 0	
MTBE (TO-15 only)	1634-04-4	0 00	73	0	ND	100.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	100.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	804175	2435.5	100.0	
Chloroform	67-66-3	8.05	83	81334	115 1	100.0	
1,1 1-Trichloroethane	71-55-6	0.00	97	0	ND	100.0	
1,2-Dichloroethane	107-06-2	8.83	62	4177	ND	100 0	
Carbon tetrachloride	56-23-5	0.00	117	0	ND	100.0	
Benzene	71-43-2	8.62	78	9324	ND	100.0	
Trichloroethene	79-01-6	9.25	130	13479319	31625.9	100.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	100 0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	100.0	
Toluene	108-88-3	10.78	91	9987	ND	100.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	100.0	
1,1,2-Trichloroethane	79-00-5	11.37	97	18133	ND	100 0	
Tetrachloroethene	127-18-4	11.18	166	5348461	8306.3	100.0	
1,2-Dibromoethane	106-93-4	0 00	107	0	ND	100.0	
Chlorobenzene	108-90-7	12.43	112	2897	ND	100 0	
Ethyl benzene	100-41-4	12.46	91	4731	ND	100.0	
m,p-Xylene	1330-20-7	12.84	91	9747	ND	100.0	
o-Xylene	95-47-6	13.16	91	5061	ND	100.0	
Styrene	100-42-5	0.00	104	0	ND	100.0	
1,1,2,2-Tetrachloroethane	79-34-5	14 12	83	14463253	12464.7	100.0	
Bromofluorobenzene (SS)		13.87	95	936836	44.1		88%
1,3,5-Trimethylbenzene	108-67-8	14 17	105	4603	ND	100.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	3777	ND	100.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	100.0	
1,4-Dichlorobenzene	106-46-7	0 00	146	0	ND	100.0	
1,2-Dichlorobenzene	95-50-1	0 00	146	0	ND	100 0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	100.0	
Hexachlorobutadiene	87-68-3	17.69	225	12546	ND	100.0	

Note that benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R D 108_108.D 108_30I.D

Data Printed 1/9/02 7:54 AM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each

Col:RTX-VMS Fused Silica: 30m x 0.25mm, 1.4u film S/N 214582, direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap: desorb @ 180C; TO14/15_lcl. TO15crt4.crt

579 458

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209146 Jacobs Dunnfield SVE   **Autosampler:** 18   **Dil. Fact.:** 200.0

Misc: 2.5mL; 12/20/01 VW-1 Source B   GC/MS #1

Method: 1702   **File:** ?CHEM\1\1702\ 1475322.D

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	2898984	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	100.0	
Chloromethane	74-87-3	0.00	50	0	ND	100.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	100.0	
Vinyl chloride	75-01-4	2.98	62	12924	156.2	100.0	
Bromomethane	74-83-9	0.00	94	0	ND	100.0	
Chloroethane	75-00-3	0.00	64	0	ND	100.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	100.0	
1,1-Dichloroethene	75-35-4	5.37	61	14874	ND	100.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	100.0	
Methylene Chloride	75-09-2	6.20	84	2005	ND	100.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	100.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	100.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	697676	2409.0	100.0	
Chloroform	67-66-3	8.04	83	59232	110.6	100.0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	100.0	
1,2-Dichloroethane	107-06-2	8.65	62	3612	ND	100.0	
Carbon tetrachloride	56-23-5	0.00	117	0	ND	100.0	
Benzene	71-43-2	8.62	78	8079	ND	100.0	
Trichloroethene	79-01-6	9.24	130	13720668	32072.3	100.0	
1,2-dichloropropane	78-87-5	0.00	63	0	ND	100.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	100.0	
Toluene	108-88-3	10.74	91	8721	ND	100.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	100.0	
1,1,2-Trichloroethane	79-00-5	11.37	97	22076	ND	100.0	
Tetrachloroethene	127-18-4	11.18	166	5708084	8828.6	100.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	100.0	
Chlorobenzene	108-90-7	12.43	112	3547	ND	100.0	
Ethyl benzene	100-41-4	12.46	91	5802	ND	100.0	
m,p-Xylene	1330-20-7	12.64	91	13516	ND	100.0	
o-Xylene	95-47-6	13.14	91	8511	ND	100.0	
Styrene	100-42-5	0.00	104	0	ND	100.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.11	83	17215619	14764.7	100.0	
Bromofluorobenzene (SS)		13.67	95	951402	44.7		89%
1,3,5-Trimethylbenzene	108-67-8	14.29	105	4094	ND	100.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	8082	ND	100.0	
1,3-Dichlorobenzene	541-73-1	0.00	146	0	ND	100.0	
1,4-Dichlorobenzene	106-46-7	0.00	146	0	ND	100.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	100.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	100.0	
Hexachlorobutadiene	87-68-3	17.89	225	68360	ND	100.0	

Note that benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L80235, 1ppmv

108_20R.D   108_10B.D   108_30I.D

Date Printed: 1/9/02 7:56 AM

ND = Not Detected at the Reporting Limits.   SS = Surrogate Standard; IS = Internal Standard 50 ng each

Col.RTX-VMS Fused Silica: 30m x 0.25mm, 1.4u film S/N 214582; direct interface: -20C to 210 @ 12C/m; 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap, desorb @ 180C; TO14/15_ici   TO15crt4 ort

Research Triangle Park Laboratories, Inc
8109 Ebenezer Church Road
Raleigh, North Carolina 27612-7307
Phone: 919-510-0228 Fax: 919-510-0141
Web Site: www.rtp-labs.com

Chain of Custody Record

ISO 17025 Compliant for Testing Labs

RTPLabs

209146

Client (Billing): JACOBS ENGINEERING
Send Report To Attention: KRAIG SMITH
Phone Number: 615 301-6V37
Fax Number: 615 833 8328
Date: 12/21/01
Address: 3354 Perimeter Hill Dr. Ste 310
City: Nashville State: TN Zip Code: 37211
Page 1 of 2
Contract/Purchase Order No.: CS75I110
Project Name: Memphis Depot SVE
RTP Labs Proj. Tracking No.: 306-01-

Comments:

Requested Analyses: VOC

#	Sample ID No. & Description	Date Sampled	Time	Matrix: Air – Ambient	Matrix: Air – Source	Liquid/Solid	Compliance Test	Preservatives	# of Containers	VOC		USE ONLY FOR Canister – vacuum or pressure: Field Initial	Field Final	Lab Receipt	Final	DF	RTP Labs Sample ID
1	VW-1 Test/carbon canister unit	12/21/01	1430		X				1	X	809						
2	VW-1 Test/Source B	12/21/01	1430		X				1	X	02316						
3	VW-1 Test/Ambient Background	12/20/01	1500	X					1	X	11808						
4	VW-1 Test/Well Head	12/21/01	1430		X				1	X	12830						
5																	
6																	
7																	
8																	
9																	
10																	

Turn Around Time Requested for Report: Business Days; *Rush Multipliers (Xx)
☐ 1 day*(4x) ☐ 2 days*(3x) ☐ 3 days*(2x) ☐ 5 days*(1.5x) ☐ 10 days*(1.1x) ☒ 15 days

Data Pack: Std ☒ Full ☐ (1.1x surchar)
Electronic Deliverable: ☒ (1.1x surchar)

QC Requirements:
Screen ☐ Standard ☒ EPA Level IV ☐
Level IV (requires approved QAPP)

Relinquished By: [signature] Date: 12-21-01 Time: 17:00
Received By: [signature] Date: 12/24/01 Time: 10:30
Relinquished By: Date: Time:
Received By: Date: Time:

File: chain_RTP doc/als revision 9/5/2001

579 460

Research Triangle Park Laboratories, Inc
8109 Ebenezer Church Road.
Raleigh, North Carolina 27612-7307
Phone: 919-510-0228 Fax: 919-510-0141
Web Site: www.rtp-labs.com

Chain of Custody Record

ISO 17025 Compliant for Testing Labs

RTP Labs

Box 1

209146

Client (Billing)	JACOBS ENGINEERING
Send Report To Attention	KRAIG SMITH
Phone Number	615 205 6437
Fax Number	615 833 8328
Date	12-21-01
Address	3354 Perimeter Hill Dr. Ste 310
Page	2 of 2
City	Nashville,
State	TN
Zip Code	37211
RTP Labs Proj. Tracking No.	306-01-
Contract/Purchase Order No.	CSXS7110
Project Name	Memphis Depot SVE
Comments	

Requested Analyses: VOC

USE ONLY FOR Canister — Vacuum or pressure

#	Sample ID No. & Description	Date Sampled	Time	Matrix: Air – Ambient	Matrix: Air – Source	Liquid/Solid	Compliance Test	Preservatives	# of Containers	VOC		Field Initial	Field Final	Lab Receipt	Final	DF	RTP Labs Sample ID
1	VW-1 Test/Carbon Canister Inlet	12/20/01	0230		X				1	X	B301						
2	VW-1 Test/Well Head	12/20/01	0235		X				1	X	93047						
3	VW-1 Test/Source B	12/20/01	0236		X				1	X	12155						
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Turn Around Time Requested for Report: Business Days; *Rush Multipliers (Xx)
☐ 1 day*(4x) ☐ 2 days*(3x) ☐ 3 days*(2x) ☐ 5 days*(1.5x) ☐ 10 days*(1.1x) ☒ 15 days

Data Pack: Std ☒ Full ☐ (1.1x surchar)
Electronic Deliverable: ☒ (1.1x surchar)

QC Requirements: Screen ☐ Standard ☒ EPA Level IV ☐ (Level IV requires approved QAPP)

Relinquished By: Kraig Smith	Date: 12-21-01	Time: 17:00	Received By: Alston Sylar		Date: 12/26/01	Time: 10:30
Relinquished By	Date:	Time:	Received By:		Date:	Time:

File: chain_RTP.doc/als revision 8/5/2001

Jan 24 02 08:31a PSC Analytical Services 6109219667 p.1

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

- EPA/NVLAP 101262-0
- AIHA ACCREDITATION NO 100439
- NC DENR 599
- NY DOH/NELAC 10903
- PA DEP 06-353
- NJ DEP 77020
- CT DPH PH-0238

ANALYTICAL REPORT

Client: Jacobs Engineering

Report to: Kraig Smith
Jacobs Engineering
3354 Perimeter Hill Dr
Suite 310
Nashville TN 37211

Project: 209278
Received: 11-JAN-02
Reported: 23-JAN-02

Project Description: SVE Pilot Study / TO-14

	RESULT	UNITS	CONCENTRATION	UNITS	METHOD

SVE Test/VW-2/Source B
Air Volume:
Lab Sample: 1475889
sampled: 09-JAN-02

See Attached Report

SVE Test/VW-2/Wellhead
Air Volume:
Lab Sample: 1475890
sampled: 09-JAN-02

See Attached Report

SVE Test/VW-2/Wellhead
Air Volume:
Lab Sample. 1475891
sampled: 10-JAN-02

See Attached Report

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 208278 Jacobs VW-2 1/9/02 Source B
Misc: 2.5mL
Method: 1702 File: ^CHEM\1\1702\ 1475889 O
Autosampler: 9
Dil. Fact: 338.0
GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr Recovery
Chlorobenzene-d5 (IS)		12 41	117	3547198	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168 0	
Chloromethane	74-87-3	2.72	50	718	ND	168.0	
1,2- Cl- 1,1,2,2-F ethene (114)	76-14-2	0.00	85	0	ND	168.0	
Vinyl chloride	75-01-4	3 05	62	92420	1533.2	168 0	
Bromomethane	74-83-9	3.87	94	2010	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.37	61	39873	209.9	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168.0	
Methylene Chloride	75-09-2	6.22	84	3753	ND	168 0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	11411563	42045.9	168.0	
Chloroform	67-66-3	8.03	83	489740	1257 3	168 0	
1,1,1-Trichloroethane	71-55-6	0.00	97	0	ND	168.0	
1,2-Dichloroethane	107-06-2	8.81	62	34745	ND	168.0	
Carbon tetrachloride	56-23-5	8 17	117	223494	861 1	168.0	
Benzene	71-43-2	8.62	78	13003	ND	168.0	
Trichloroethene	79-01-6	9.30	130	34523231	110798.1	168 0	
1,2-dichloropropane	78-87-5	9.77	63	10426	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	168.0	
Toluene	108-88-3	10 74	91	9256	ND	168.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	168 0	
1,1,2-Trichloroethane	79-00-5	11.35	97	341361	1012.1	168 0	
Tetrachloroethene	127-18-4	11.18	188	6909787	14878 7	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12 43	112	7110	ND	168 0	
Ethyl benzene	100-41-4	12 46	91	7260	ND	168.0	
m,p-Xylene	1330-20-7	12.64	91	16837	ND	168 0	
o-Xylene	95-47-6	13 16	91	20095	ND	168 0	
Styrene	100-42-5	0.00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	0 00	83	0	ND	168.0	
Bromofluorobenzene (SS)		13.87	95	1347810	51.7		103%
1,3,5-Trimethylbenzene	108-67-8	14.31	105	3234	ND	168.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	5944	ND	168 0	
1,3-Dichlorobenzene	541-73-1	15.32	146	5019	ND	168.0	
1,4-Dichlorobenzene	106-46-7	15.32	146	5019	ND	168.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	17.92	180	1904	ND	168 0	
Hexachlorobutadiene	87-68-3	17 89	225	83322	ND	168.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder; Spectra Gases L89238, 1ppmv
108_20R D 108_10B.D 108_30I.D

Date Printed 1/15/02 5:59 PM

ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1 4u film S/N 214582; direct interface, -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_.loi
TO15crt4.crt

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209278 Jacobs VW-2 1/9/02 Wellhead
Misc: 2.5mL
Method: 1702 File: ?CHEM\1\1702\ 1475890 D

Autosampler: 10 Dil. Fact: 336.0 GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	3585321	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168.0	
Chloromethane	74-87-3	2.88	50	1343	ND	168.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	168.0	
Vinyl chloride	75-01-4	3.01	62	140543	2319.8	168.0	
Bromomethane	74-83-9	0.00	94	0	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.38	61	39149	205.0	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168.0	
Methylene Chloride	75-09-2	6.21	84	4566	ND	168.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	11178409	40977.4	168.0	
Chloroform	67-66-3	8.04	83	470940	1202.9	168.0	
1,1,1-Trichloroethane	71-55-6	8.09	97	576	ND	168.0	
1,2-Dichloroethane	107-06-2	8.81	62	33217	ND	168.0	
Carbon tetrachloride	56-23-5	8.18	117	223145	655.3	168.0	
Benzene	71-43-2	8.61	78	14560	ND	168.0	
Trichloroethene	79-01-6	9.29	130	34030547	108681.8	168.0	
1,2-dichloropropane	78-87-5	9.76	63	10480	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	168.0	
Toluene	108-88-3	10.75	91	10872	ND	168.0	
trans-1,3-dichloropropene	10061-02-6	11.41	75	2824	ND	168.0	
1,1,2-Trichloroethane	79-00-5	11.35	97	352381	1039.4	168.0	
Tetrachloroethene	127-18-4	11.17	166	7585728	18032.7	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12.42	112	8590	ND	168.0	
Ethyl benzene	100-41-4	12.46	91	5798	ND	168.0	
m,p-Xylene	1330-20-7	12.83	91	13817	ND	168.0	
o-Xylene	95-47-6	13.15	91	18252	ND	168.0	
Styrene	100-42-5	0.00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.11	83	19013581	22305.3	168.0	
Bromofluorobenzene (SS)		13.87	95	1328887	50.7		101%
1,3,5-Trimethylbenzene	108-67-8	14.30	105	1382	ND	168.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	4891	ND	168.0	
1,3-Dichlorobenzene	541-73-1	15.24	146	3442	ND	168.0	
1,4-Dichlorobenzene	106-46-7	15.33	146	14057	ND	168.0	
1,2-Dichlorobenzene	95-50-1	15.42	146	547	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	168.0	
Hexachlorobutadiene	87-68-3	17.88	225	65432	ND	168.0	

Note than benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv

108_20R D 108_10B.D 108_30I.D

Date Printed 1/16/02 7:03 PM

ND = Not Detected at the Reporting Limits SS = Surrogate Standard, IS = Internal Standard 50 ng each.

Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m, 35-300 amu full scan

Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_lo.

TO15cm4 ort

579 464

Research Triangle Park Labs, Inc

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209278 Jacobs VW-2 1/10/02 Wellhead
Misc: 2.5mL
Method: 1702
File: ᴾCHEM\1\1702\ 1475891 D
Autosampler: 11
Dil. Fact: 338.0
GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	3571185	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168.0	
Chloromethane	74-87-3	2.74	50	537	ND	168.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	65	0	ND	168.0	
Vinyl chloride	75-01-4	3.01	62	38543	602.2	168.0	
Bromomethane	74-83-9	0.00	94	0	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.38	61	27781	ND	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168.0	
Methylene Chloride	75-09-2	6.21	84	4256	ND	168.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	6809732	31509.5	168.0	
Chloroform	67-66-3	8.04	83	393283	1002.9	168.0	
1,1,1-Trichloroethane	71-55-6	7.78	97	1785	ND	168.0	
1,2-Dichloroethane	107-06-2	8.81	62	25279	ND	168.0	
Carbon tetrachloride	56-23-5	8.16	117	247394	946.7	168.0	
Benzene	71-43-2	8.61	78	14686	ND	168.0	
Trichloroethene	79-01-6	9.28	130	27868906	88841.1	168.0	
1,2-dichloropropane	78-87-5	9.75	63	7454	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	168.0	
Toluene	108-88-3	10.75	91	7149	ND	168.0	
trans-1,3-dichloropropene	10061-02-6	0.00	75	0	ND	168.0	
1,1,2-Trichloroethane	79-00-5	11.35	97	295365	869.8	168.0	
Tetrachloroethane	127-18-4	11.17	166	6061212	12789.5	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12.42	112	5639	ND	168.0	
Ethyl benzene	100-41-4	12.49	91	4171	ND	168.0	
m,p-Xylene	1330-20-7	12.83	91	6482	ND	168.0	
o-Xylene	95-47-6	13.15	91	5977	ND	168.0	
Styrene	100-42-5	0.00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	14.15	83	39737061	45540.0	168.0	
Bromofluorobenzene (SS)		13.87	95	1240615	47.3		95%
1,3,5-Trimethylbenzene	108-67-8	14.22	105	3474	ND	168.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	2800	ND	168.0	
1,3-Dichlorobenzene	541-73-1	15.22	146	3541	ND	168.0	
1,4-Dichlorobenzene	106-46-7	15.31	146	9891	ND	168.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	168.0	
Hexachlorobutadiene	87-68-3	17.89	225	66676	ND	168.0	

Note that benzyl chloride has been removed from the target list due to instability in the standards.
Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L89236, 1ppmv
108_20R.D 108_10B.D 108_30I.D
Date Printed: 1/16/02 7:03 PM
ND = Not Detected at the Reporting Limits. SS = Surrogate Standard; IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582; direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap, desorb @ 180C: TO14/15_lcl
TO15crt4.crt

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Phrip 209278/Jacobs VW-2 1/10/02 Ambient Air
Misc: 500mL Autosampler: 8 Dil. Fact: 1 7
Method: 1702 File: ^CHEM1\1702\ 1475892.D GC/MS #1

Compound	CAS #	R.T.	Q Ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12 41	117	3308884	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	2.11	85	16885	1.1	0.8	
Chloromethane	74-87-3	2.77	50	5278	ND	0.8	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	2.23	85	1109	ND	0.8	
Vinyl chloride	75-01-4	0 00	62	0	ND	0.8	
Bromomethane	74-83-9	0.00	94	0	ND	0.8	
Chloroethane	75-00-3	0.00	64	0	ND	0.8	
Trichlorofluoromethane (11)	75-69-4	4.63	101	12898	ND	0.8	
1,1-Dichloroethene	75-35-4	5.52	61	10549	ND	0.8	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	5.53	151	1250	ND	0.8	
Methylene Chloride	75-09-2	6.23	84	13712	ND	0.8	
MTBE (TO-15 only)	1634-04-4	6.40	73	6977	ND	0.8	
1,1-dichloroethane	75-34-3	0.00	83	0	ND	0.8	
cis-1,2-Dichloroethene	156-59-2	7.73	61	3566	ND	0.8	
Chloroform	67-66-3	8.04	83	4838	ND	0 8	
1,1,1-Trichloroethane	71-55-6	8 23	97	4488	ND	0.8	
1,2-Dichloroethane	107-06-2	8.82	62	1397	ND	0 8	
Carbon tetrachloride	56-23-5	8.16	117	10852	ND	0.8	
Benzene	71-43-2	8 61	78	54327	ND	0.8	
Trichloroethene	79-01-6	9.22	130	154195	ND	0.8	
1,2-dichloropropane	78-87-5	0.00	63	0	2.7	0.8	
cis-1,3-dichloropropene	542-75-6	0 00	75	0	ND	0.8	
Toluene	108-88-3	10.74	91	128205	ND	0.8	
trans-1,3-dichloropropene	10061-02-6	10.95	75	26624	ND	0.8	
1,1,2-Trichloroethane	79-00-5	11.36	97	1755	ND	0 8	
Tetrachloroethene	127-18-4	11.17	188	20603	ND	0.8	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	0.8	
Chlorobenzene	108-90-7	12.42	112	12824	ND	0.8	
Ethyl benzene	100-41-4	12.46	91	31574	ND	0.8	
m,p-Xylene	1330-20-7	12 63	91	73406	ND	0.8	
o-Xylene	95-47-6	13.14	91	28947	ND	0.8	
Styrene	100-42-5	13.21	104	20005	ND	0 8	
1,1,2,2-Tetrachloroethane	79-34-5	14 11	83	411196	ND	0.8	
Bromofluorobenzene (SS)		13 87	95	1118651	2.6	0.8	
1,3,5-Trimethylbenzene	108-67-8	14 28	105	7584	48.0		92%
1,2,4-Trimethylbenzene	95-63-6	14.79	105	25280	ND	0.8	
1,3-Dichlorobenzene	541-73-1	15.21	146	2522	ND	0.8	
1,4-Dichlorobenzene	106-46-7	15.31	148	4539	ND	0.8	
1,2-Dichlorobenzene	95-50-1	15.87	146	2760	ND	0 8	
1,2,4-Trichlorobenzene	120-82-1	17.82	180	4812	ND	0.8	
Hexachlorobutadiene	87-68-3	0.00	225	0	ND	0.8	

Note then benzyl chloride has been removed from the target list due to instability in the standards.

Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69236, 1ppmv
108_20R.D 108_108.D 108_30I D
Date Printed 1/16/02 3:43 PM

ND = Not Detected at the Reporting Limits, SS = Surrogate Standard, IS = Internal Standard 50 ng each.
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214562; direct interface; -20C to 210 @ 12C/m, 35-300 amu full scan
Nutech: -5C Tenax/Ansorb 747 Trap: desorb @ 180C, TO14/15_lcl.
TO15crt4.crt

579 466

PSC ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

- EPA/NVLAP 101262-0
- AIHA ACCREDITATION NO. 100439
- NC DENR 599
- NY DOH/NELAC 10903
- PA DEP 06-353
- NJ DEP 77020
- CT DPH PH-0238

ANALYTICAL REPORT

Client: Jacobs Engineering

Report to: Kraig Smith
Jacobs Engineering
3354 Perimeter Hill Dr.
Suite 310
Nashville TN 37211

Project: 209313
Received: 14-JAN-02
Reported: 23-JAN-02
PURCHASE ORDER: C5X51110

Project Description: SVE Pilot Study / TO-15 Analysis

Sampled: 11-JAN-02 14:10

	RESULT	UNITS	CONCENTRATION	UNITS	METHOD
VW-2/Wellhead 04316 Lab Sample: 1476062					

See Attached Report

Final sample concentrations calculated from sample areas supplied on chain of custody.
< Indicates less than the limit of quantitation.

Research Triangle Park Labs, Inc.

TO-14A/TO-15 GC/MS Volatiles Report

Sample: Philip 209313 Jacobs VW-2 1/11/02 Wellhead
Misc: 2.5mL Autosampler: 12 Dil. Fact: 336.0
Method: 1702 File: ^CHEM\1\1702\ 1475062.D GC/MS #1

Compound	CAS #	R.T.	Q ion	Area	ppbv	Reporting Limits ppbv	IS/Surr. Recovery
Chlorobenzene-d5 (IS)		12.41	117	3369872	50.0		100%
Dichlorodifluoromethane (12)	75-71-8	0.00	85	0	ND	168.0	
Chloromethane	74-87-3	0.00	50	0	ND	168.0	
1,2- Cl- 1,1,2,2-F ethane (114)	76-14-2	0.00	85	0	ND	168.0	
Vinyl chloride	75-01-4	3.05	62	31851	552.8	168.0	
Bromomethane	74-83-9	0.00	94	0	ND	168.0	
Chloroethane	75-00-3	0.00	64	0	ND	168.0	
Trichlorofluoromethane (11)	75-69-4	0.00	101	0	ND	168.0	
1,1-Dichloroethene	75-35-4	5.36	61	21814	ND	168.0	
1,1,2- Cl 1,2,2- F ethane (113)	76-13-1	0.00	151	0	ND	168.0	
Methylene Chloride	75-09-2	8.22	84	3549	ND	168.0	
MTBE (TO-15 only)	1634-04-4	0.00	73	0	ND	168.0	
1,1-dichloroethane	75-34-3	0.00	63	0	ND	168.0	
cis-1,2-Dichloroethene	156-59-2	7.73	61	7820475	30332.8	168.0	
Chloroform	67-66-3	8.03	83	382031	1032.5	168.0	
1,1,1-Trichloroethane	71-55-6	8.03	97	1086	ND	168.0	
1,2-Dichloroethane	107-06-2	8.81	62	25907	ND	168.0	
Carbon tetrachloride	56-23-5	8.16	117	267888	1096.5	168.0	
Benzene	71-43-2	8.82	78	12577	ND	168.0	
Trichloroethene	79-01-6	9.28	130	25593534	86466.7	168.0	
1,2-dichloropropane	78-87-5	9.75	63	6041	ND	168.0	
cis-1,3-dichloropropene	542-75-6	0.00	75	0	ND	168.0	
Toluene	108-88-3	10.74	91	8605	ND	168.0	
trans-1,3-dichloropropene	10061-02-6	11.40	75	589	ND	168.0	
1,1,2-Trichloroethane	79-00-5	11.35	97	265594	828.9	168.0	
Tetrachloroethene	127-18-4	11.17	166	5379254	12029.3	168.0	
1,2-Dibromoethane	106-93-4	0.00	107	0	ND	168.0	
Chlorobenzene	108-90-7	12.43	112	6283	ND	168.0	
Ethyl benzene	100-41-4	12.46	91	2177	ND	168.0	
m,p-Xylene	1330-20-7	12.63	91	3380	ND	168.0	
o-Xylene	95-47-6	13.16	91	6122	ND	168.0	
Styrene	100-42-5	0.00	104	0	ND	168.0	
1,1,2,2-Tetrachloroethane	79-34-5	0.00	83	0	ND	168.0	
Bromofluorobenzene (SS)		13.87	95	1232009	49.8		100%
1,3,5-Trimethylbenzene	108-67-8	14.22	105	1816	ND	168.0	
1,2,4-Trimethylbenzene	95-63-6	14.79	105	2788	ND	168.0	
1,3-Dichlorobenzene	541-73-1	15.21	146	3151	ND	168.0	
1,4-Dichlorobenzene	106-46-7	15.31	146	20849	ND	168.0	
1,2-Dichlorobenzene	95-50-1	0.00	146	0	ND	168.0	
1,2,4-Trichlorobenzene	120-82-1	0.00	180	0	ND	168.0	
Hexachlorobutadiene	87-68-3	17.87	225	49351	ND	168.0	

Note then benzyl chloride has been removed from the target list due to instability in the standards.
Calibration Data: NIST Traceable Standard Cylinder: Spectra Gases L69238, 1ppmv
108_20R.D 108_10B.D 108_30I.D
Date Printed 1/15/02 7:17 PM
ND = Not Detected at the Reporting Limits. SS = Surrogate Standard, IS = Internal Standard 50 ng each
Col:RTX-VMS Fused Silica; 30m x 0.25mm, 1.4u film S/N 214582, direct interface; -20C to 210 @ 12C/m; 35-300 amu full scan
Nutech: -5C Tenax/Anasorb 747 Trap; desorb @ 180C; TO14/15_ki.
TO15crt4.crt

579 468

Vapor VOCs Analytical Results for Test 1 (VW-1)

Dunn Field - Memphis Depot (December 2001)

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-1	After Carbon Canister	Chlorobenzene	12/18/2001 18:32	50.0		100%
VW-1	After Carbon Canister	Dichlorodifluoromethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Chloromethane	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	1,2-Cl - 1,1,2,2-F ethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Vinyl chloride	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	Bromomethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Chloroethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Trichlorofluoromethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	1,1-Dichloroethene	12/18/2001 18 32	ND	0.8	
VW-1	After Carbon Canister	1,1,2-Cl - 1,2,2-F ethane	12/18/2001 18 32	ND	0.8	
VW-1	After Carbon Canister	Methylene Chloride	12/18/2001 18:32	1 7	0.8	
VW-1	After Carbon Canister	MTBE	12/18/2001 18.32	ND	0.8	
VW-1	After Carbon Canister	1,1-dichloroethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	cis-1,2-Dichloroethene	12/18/2001 18:32	40.5	0.8	
VW-1	After Carbon Canister	Chloroform	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	1,1,1-Trichloroethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	1,2-Dichloroethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Carbon tetrachloride	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Benzene	12/18/2001 18:32	1.6	0 8	
VW-1	After Carbon Canister	Trichloroethene	12/18/2001 18:32	585.8	0.8	
VW-1	After Carbon Canister	1,2-Dichloropropane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	cis-1,3-Dichloroproene	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Toluene	12/18/2001 18:32	1.9	0.8	
VW-1	After Carbon Canister	trans-1,3-dichloropropene	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	1,1,2-Trichloroethane	12/18/2001 18:32	3.8	0 8	
VW-1	After Carbon Canister	Tetrachloroethene	12/18/2001 18:32	147 8	0.8	
VW-1	After Carbon Canister	1,2-Dibromoethane	12/18/2001 18:32	ND	0.8	
VW-1	After Carbon Canister	Chlorobenzene	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	Ethylbenzene	12/18/2001 18:32	1.2	0 8	
VW-1	After Carbon Canister	m,p-Xylene	12/18/2001 18:32	3.0	0 8	
VW-1	After Carbon Canister	o-Xylene	12/18/2001 18:32	2.6	0.8	
VW-1	After Carbon Canister	Styrene	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	1,1,2,2-Tetrachloroethane	12/18/2001 18:32	473.3	0 8	
VW-1	After Carbon Canister	Bromofluorobenzene	12/18/2001 18:32	72 3		145%
VW-1	After Carbon Canister	1,3,5-Trimethylbenzene	12/18/2001 18:32	2.6	0.8	
VW-1	After Carbon Canister	1,2,4-Trimethylbenzene	12/18/2001 18:32	5.4	0 8	
VW-1	After Carbon Canister	1,3-Dichlorobenzene	12/18/2001 18 32	ND	0 8	
VW-1	After Carbon Canister	1,4-Dichlorobenzene	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	1,2-Dichlorobenzene	12/18/2001 18 32	ND	0.8	
VW-1	After Carbon Canister	1,2,4-Trichlorobenzene	12/18/2001 18:32	ND	0 8	
VW-1	After Carbon Canister	Hexachlorobutadiene	12/18/2001 18:32	32 8	0.8	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/18/2001 18 32	50 0		100%
VW-1	After Liquid Ring Pump	Dichlorodifluoromethane	12/18/2001 18:32	ND	4 7	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-1	After Liquid Ring Pump	Chloromethane	12/18/2001 18:32	ND	4 7	
VW-1	After Liquid Ring Pump	1,2-Cl - 1,1,2,2-F ethane	12/18/2001 18:32	ND	4 7	
VW-1	After Liquid Ring Pump	Vinyl chloride	12/18/2001 18:32	263 4	4 7	
VW-1	After Liquid Ring Pump	Bromomethane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Chloroethane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Trichlorofluoromethane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	1,1-Dichloroethene	12/18/2001 18:32	32.5	4.7	
VW-1	After Liquid Ring Pump	1,1,2-Cl - 1,2,2-F ethane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Methylene Chloride	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	MTBE	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	1,1-dichloroethane	12/18/2001 18 32	ND	4 7	
VW-1	After Liquid Ring Pump	cis-1,2-Dichloroethene	12/18/2001 18:32	847.0	4.7	
VW-1	After Liquid Ring Pump	Chloroform	12/18/2001 18:32	62.5	4.7	
VW-1	After Liquid Ring Pump	1,1,1-Trichloroethane	12/18/2001 18:32	ND	4 7	
VW-1	After Liquid Ring Pump	1,2-Dichloroethane	12/18/2001 18:32	14.1	4.7	
VW-1	After Liquid Ring Pump	Carbon tetrachloride	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Benzene	12/18/2001 18:32	21.0	4.7	
VW-1	After Liquid Ring Pump	Trichloroethene	12/18/2001 18:32	3169.6	4.7	
VW-1	After Liquid Ring Pump	1,2-Dichloropropane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	cis-1,3-Dichloroproene	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Toluene	12/18/2001 18 32	19 6	4.7	
VW-1	After Liquid Ring Pump	trans-1,3-dichloropropene	12/18/2001 18.32	ND	4.7	
VW-1	After Liquid Ring Pump	1,1,2-Trichloroethane	12/18/2001 18:32	114.8	4.7	
VW-1	After Liquid Ring Pump	Tetrachloroethene	12/18/2001 18 32	1195 7	4 7	
VW-1	After Liquid Ring Pump	1,2-Dibromoethane	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/18/2001 18:32	ND	4 7	
VW-1	After Liquid Ring Pump	Ethylbenzene	12/18/2001 18:32	64.4	4 7	
VW-1	After Liquid Ring Pump	m,p-Xylene	12/18/2001 18:32	45.6	4.7	
VW-1	After Liquid Ring Pump	o-Xylene	12/18/2001 18:32	34.9	4.7	
VW-1	After Liquid Ring Pump	Styrene	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	1,1,2,2-Tetrachloroethane	12/18/2001 18:32	2391.3	4.7	
VW-1	After Liquid Ring Pump	Bromofluorobenzene	12/18/2001 18:32	26.1		52%
VW-1	After Liquid Ring Pump	1,3,5-Trimethylbenzene	12/18/2001 18:32	65.3	4.7	
VW-1	After Liquid Ring Pump	1,2,4-Trimethylbenzene	12/18/2001 18 32	160 4	4.7	
VW-1	After Liquid Ring Pump	1,3-Dichlorobenzene	12/18/2001 18 32	ND	4.7	
VW-1	After Liquid Ring Pump	1,4-Dichlorobenzene	12/18/2001 18.32	ND	4.7	
VW-1	After Liquid Ring Pump	1,2-Dichlorobenzene	12/18/2001 18:32	ND	4.7	
VW-1	After Liquid Ring Pump	1,2,4-Trichlorobenzene	12/18/2001 18:32	8.4	4 7	
VW-1	After Liquid Ring Pump	Hexachlorobutadiene	12/18/2001 18:32	109 4	4.7	
VW-1	Equipment blank	Chlorobenzene	12/18/2001 18:32	50.0		100%
VW-1	Equipment blank	Dichlorodifluoromethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Chloromethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	1,2-Cl - 1,1,2,2-F ethane	12/18/2001 18 32	ND	0 5	
VW-1	Equipment blank	Vinyl chloride	12/18/2001 18 32	ND	0.5	
VW-1	Equipment blank	Bromomethane	12/18/2001 18 32	ND	0.5	
VW-1	Equipment blank	Chloroethane	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	Trichlorofluoromethane	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	1,1-Dichloroethene	12/18/2001 18 32	ND	0.5	

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Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-1	Equipment blank	1,1,2-Cl - 1,2,2-F ethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Methylene Chloride	12/18/2001 18 32	ND	0 5	
VW-1	Equipment blank	MTBE	12/18/2001 18 32	ND	0 5	
VW-1	Equipment blank	1,1-dichloroethane	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	cis-1,2-Dichloroethene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	Chloroform	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	1,1,1-Trichloroethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	1,2-Dichloroethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Carbon tetrachloride	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Benzene	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Trichloroethene	12/18/2001 18 32	14 5	0.5	
VW-1	Equipment blank	1,2-Dichloropropane	12/18/2001 18 32	ND	0.5	
VW-1	Equipment blank	cis-1,3-Dichloroproene	12/18/2001 18 32	ND	0.5	
VW-1	Equipment blank	Toluene	12/18/2001 18.32	ND	0 5	
VW-1	Equipment blank	trans-1,3-dichloropropene	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	1,1,2-Trichloroethane	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Tetrachloroethene	12/18/2001 18:32	2 0	0 5	
VW-1	Equipment blank	1,2-Dibromoethane	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	Chlorobenzene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	Ethylbenzene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	m,p-Xylene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	o-Xylene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	Styrene	12/18/2001 18:32	ND	0 5	
VW-1	Equipment blank	1,1,2,2-Tetrachloroethane	12/18/2001 18·32	17.3	0.5	
VW-1	Equipment blank	Bromofluorobenzene	12/18/2001 18·32	49.5		99%
VW-1	Equipment blank	1,3,5-Trimethylbenzene	12/18/2001 18·32	ND	0 5	
VW-1	Equipment blank	1,2,4-Trimethylbenzene	12/18/2001 18 32	ND	0 5	
VW-1	Equipment blank	1,3-Dichlorobenzene	12/18/2001 18.32	ND	0.5	
VW-1	Equipment blank	1,4-Dichlorobenzene	12/18/2001 18·32	ND	0.5	
VW-1	Equipment blank	1,2-Dichlorobenzene	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	1,2,4-Trichlorobenzene	12/18/2001 18:32	ND	0.5	
VW-1	Equipment blank	Hexachlorobutadiene	12/18/2001 18:32	ND	0.5	
VW-1	After Carbon Canister	Chlorobenzene	12/19/2001 2:32	50 0		100%
VW-1	After Carbon Canister	Dichlorodifluoromethane	12/19/2001 2.32	ND	0.6	
VW-1	After Carbon Canister	Chloromethane	12/19/2001 2·32	ND	0.6	
VW-1	After Carbon Canister	1,2-Cl - 1,1,2,2-F ethane	12/19/2001 2·32	ND	0.6	
VW-1	After Carbon Canister	Vinyl chloride	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	Bromomethane	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Chloroethane	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Trichlorofluoromethane	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	1,1-Dichloroethene	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	1,1,2-Cl - 1,2,2-F ethane	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	Methylene Chloride	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	MTBE	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	1,1-dichloroethane	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	cis-1,2-Dichloroethene	12/19/2001 2:32	16.2	0 6	
VW-1	After Carbon Canister	Chloroform	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	1,1,1-Trichloroethane	12/19/2001 2:32	ND	0 6	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Carbon Canister	1,2-Dichloroethane	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	Carbon tetrachloride	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Benzene	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	Trichloroethene	12/19/2001 2:32	103 6	0.6	
VW-1	After Carbon Canister	1,2-Dichloropropane	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	cis-1,3-Dichloroproene	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	Toluene	12/19/2001 2:32	0.9	0.6	
VW-1	After Carbon Canister	trans-1,3-dichloropropene	12/19/2001 2:32	3.9	0 6	
VW-1	After Carbon Canister	1,1,2-Trichloroethane	12/19/2001 2:32	0 7	0 6	
VW-1	After Carbon Canister	Tetrachloroethene	12/19/2001 2:32	32.6	0.6	
VW-1	After Carbon Canister	1,2-Dibromoethane	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Chlorobenzene	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Ethylbenzene	12/19/2001 2:32	ND	0 6	
VW-1	After Carbon Canister	m,p-Xylene	12/19/2001 2 32	0.9	0.6	
VW-1	After Carbon Canister	o-Xylene	12/19/2001 2.32	0.7	0 6	
VW-1	After Carbon Canister	Styrene	12/19/2001 2.32	ND	0 6	
VW-1	After Carbon Canister	1,1,2,2-Tetrachloroethane	12/19/2001 2:32	124.2	0 6	
VW-1	After Carbon Canister	Bromofluorobenzene	12/19/2001 2:32	49 3		99%
VW-1	After Carbon Canister	1,3,5-Trimethylbenzene	12/19/2001 2:32	0 7	0 6	
VW-1	After Carbon Canister	1,2,4-Trimethylbenzene	12/19/2001 2:32	1 7	0.6	
VW-1	After Carbon Canister	1,3-Dichlorobenzene	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	1,4-Dichlorobenzene	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	1,2-Dichlorobenzene	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	1,2,4-Trichlorobenzene	12/19/2001 2:32	ND	0.6	
VW-1	After Carbon Canister	Hexachlorobutadiene	12/19/2001 2:32	4.4	0.6	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/19/2001 2:32	50.0		100%
VW-1	After Liquid Ring Pump	Dichlorodifluoromethane	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	Chloromethane	12/19/2001 2 32	ND	6 0	
VW-1	After Liquid Ring Pump	1,2-Cl - 1,1,2,2-F ethane	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	Vinyl chloride	12/19/2001 2:32	88.1	6 0	
VW-1	After Liquid Ring Pump	Bromomethane	12/19/2001 2.32	ND	6 0	
VW-1	After Liquid Ring Pump	Chloroethane	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	Trichlorofluoromethane	12/19/2001 2 32	ND	6.0	
VW-1	After Liquid Ring Pump	1,1-Dichloroethene	12/19/2001 2:32	8 8	6.0	
VW-1	After Liquid Ring Pump	1,1,2-Cl - 1,2,2-F ethane	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	Methylene Chloride	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	MTBE	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	1,1-dichloroethane	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	cis-1,2-Dichloroethene	12/19/2001 2:32	520 2	6.0	
VW-1	After Liquid Ring Pump	Chloroform	12/19/2001 2:32	23.8	6.0	
VW-1	After Liquid Ring Pump	1,1,1-Trichloroethane	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	1,2-Dichloroethane	12/19/2001 2:32	11 7	6.0	
VW-1	After Liquid Ring Pump	Carbon tetrachloride	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	Benzene	12/19/2001 2 32	ND	6 0	
VW-1	After Liquid Ring Pump	Trichloroethene	12/19/2001 2 32	1314.2	6 0	
VW-1	After Liquid Ring Pump	1,2-Dichloropropane	12/19/2001 2 32	ND	6.0	
VW-1	After Liquid Ring Pump	cis-1,3-Dichloroproene	12/19/2001 2 32	ND	6 0	
VW-1	After Liquid Ring Pump	Toluene	12/19/2001 2 32	10 8	6 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-1	After Liquid Ring Pump	trans-1,3-dichloropropene	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	1,1,2-Trichloroethane	12/19/2001 2:32	15.8	6 0	
VW-1	After Liquid Ring Pump	Tetrachloroethene	12/19/2001 2:32	819 6	6.0	
VW-1	After Liquid Ring Pump	1,2-Dibromoethane	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/19/2001 2.32	ND	6.0	
VW-1	After Liquid Ring Pump	Ethylbenzene	12/19/2001 2.32	ND	6.0	
VW-1	After Liquid Ring Pump	m,p-Xylene	12/19/2001 2:32	6 5	6.0	
VW-1	After Liquid Ring Pump	o-Xylene	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	Styrene	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	1,1,2,2-Tetrachloroethane	12/19/2001 2:32	937.9	6.0	
VW-1	After Liquid Ring Pump	Bromofluorobenzene	12/19/2001 2:32	48.8		98%
VW-1	After Liquid Ring Pump	1,3,5-Trimethylbenzene	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	1,2,4-Trimethylbenzene	12/19/2001 2:32	8 1	6.0	
VW-1	After Liquid Ring Pump	1,3-Dichlorobenzene	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	1,4-Dichlorobenzene	12/19/2001 2:32	ND	6.0	
VW-1	After Liquid Ring Pump	1,2-Dichlorobenzene	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	1,2,4-Trichlorobenzene	12/19/2001 2:32	ND	6 0	
VW-1	After Liquid Ring Pump	Hexachlorobutadiene	12/19/2001 2 32	17 4	6 0	
VW-1	After Carbon Canister	Chlorobenzene	12/20/2001 2:30	50.0	NA	100%
VW-1	After Carbon Canister	Dichlorodifluoromethane	12/20/2001 2 30	ND	168.0	
VW-1	After Carbon Canister	Chloromethane	12/20/2001 2.30	ND	168.0	
VW-1	After Carbon Canister	1,2-Cl - 1,1,2,2-F ethane	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Vinyl chloride	12/20/2001 2:30	312.8	168 0	
VW-1	After Carbon Canister	Bromomethane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Chloroethane	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Trichlorofluoromethane	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	1,1-Dichloroethene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,1,2-Cl - 1,2,2-F ethane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Methylene Chloride	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	MTBE	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,1-dichloroethane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	cis-1,2-Dichloroethene	12/20/2001 2:30	2611.4	168 0	
VW-1	After Carbon Canister	Chloroform	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,1,1-Trichloroethane	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	1,2-Dichloroethane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Carbon tetrachloride	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Benzene	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Trichloroethene	12/20/2001 2:30	43300 4	168.0	
VW-1	After Carbon Canister	1,2-Dichloropropane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	cis-1,3-Dichloroproene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Toluene	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	trans-1,3-dichloropropene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,1,2-Trichloroethane	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Tetrachloroethene	12/20/2001 2:30	9404 2	168 0	
VW-1	After Carbon Canister	1,2-Dibromoethane	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Chlorobenzene	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Ethylbenzene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	m,p-Xylene	12/20/2001 2:30	ND	168 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Carbon Canister	o-Xylene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	Styrene	12/20/2001 2.30	ND	168.0	
VW-1	After Carbon Canister	1,1,2,2-Tetrachloroethane	12/20/2001 2:30	14284.9	168.0	
VW-1	After Carbon Canister	Bromofluorobenzene	12/20/2001 2.30	43.8	NA	88%
VW-1	After Carbon Canister	1,3,5-Trimethylbenzene	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	1,2,4-Trimethylbenzene	12/20/2001 2 30	ND	168 0	
VW-1	After Carbon Canister	1,3-Dichlorobenzene	12/20/2001 2 30	ND	168 0	
VW-1	After Carbon Canister	1,4-Dichlorobenzene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,2-Dichlorobenzene	12/20/2001 2:30	ND	168 0	
VW-1	After Carbon Canister	1,2,4-Trichlorobenzene	12/20/2001 2:30	ND	168.0	
VW-1	After Carbon Canister	Hexachlorobutadiene	12/20/2001 2:30	ND	168.0	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/20/2001 2:35	50.0	NA	100%
VW-1	After Liquid Ring Pump	Dichlorodifluoromethane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Chloromethane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	1,2-Cl - 1,1,2,2-F ethane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Vinyl chloride	12/20/2001 2:35	317.4	100.0	
VW-1	After Liquid Ring Pump	Bromomethane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Chloroethane	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	Trichlorofluoromethane	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,1-Dichloroethene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,1,2-Cl - 1,2,2-F ethane	12/20/2001 2.35	ND	100 0	
VW-1	After Liquid Ring Pump	Methylene Chloride	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	MTBE	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,1-dichloroethane	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	cis-1,2-Dichloroethene	12/20/2001 2.35	2435 5	100 0	
VW-1	After Liquid Ring Pump	Chloroform	12/20/2001 2:35	115.1	100.0	
VW-1	After Liquid Ring Pump	1,1,1-Trichloroethane	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,2-Dichloroethane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Carbon tetrachloride	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Benzene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Trichloroethene	12/20/2001 2:35	31625.9	100.0	
VW-1	After Liquid Ring Pump	1,2-Dichloropropane	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	cis-1,3-Dichloroproene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Toluene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	trans-1,3-dichloropropene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	1,1,2-Trichloroethane	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	Tetrachloroethene	12/20/2001 2 35	8306.3	100 0	
VW-1	After Liquid Ring Pump	1,2-Dibromoethane	12/20/2001 2 35	ND	100.0	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/20/2001 2 35	ND	100.0	
VW-1	After Liquid Ring Pump	Ethylbenzene	12/20/2001 2 35	ND	100 0	
VW-1	After Liquid Ring Pump	m,p-Xylene	12/20/2001 2 35	ND	100 0	
VW-1	After Liquid Ring Pump	o-Xylene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	Styrene	12/20/2001 2:35	ND	100.0	
VW-1	After Liquid Ring Pump	1,1,2,2-Tetrachloroethane	12/20/2001 2:35	12484 7	100.0	
VW-1	After Liquid Ring Pump	Bromofluorobenzene	12/20/2001 2:35	44.1	NA	86%
VW-1	After Liquid Ring Pump	1,3,5-Trimethylbenzene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,2,4-Trimethylbenzene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,3-Dichlorobenzene	12/20/2001 2 35	ND	100 0	

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VW-1	After Liquid Ring Pump	1,4-Dichlorobenzene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,2-Dichlorobenzene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	1,2,4-Trichlorobenzene	12/20/2001 2:35	ND	100 0	
VW-1	After Liquid Ring Pump	Hexachlorobutadiene	12/20/2001 2:35	ND	100 0	
VW-1	Duplicate after Pump	Chlorobenzene	12/20/2001 2:36	50 0	NA	100%
VW-1	Duplicate after Pump	Dichlorodifluoromethane	12/20/2001 2 36	ND	100.0	
VW-1	Duplicate after Pump	Chloromethane	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	1,2-Cl - 1,1,2,2-F ethane	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Vinyl chloride	12/20/2001 2:36	156.2	100.0	
VW-1	Duplicate after Pump	Bromomethane	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Chloroethane	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Trichlorofluoromethane	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	1,1-Dichloroethene	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	1,1,2-Cl - 1,2,2-F ethane	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Methylene Chloride	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	MTBE	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,1-dichloroethane	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	cis-1,2-Dichloroethene	12/20/2001 2:36	2409 0	100 0	
VW-1	Duplicate after Pump	Chloroform	12/20/2001 2:36	110.8	100 0	
VW-1	Duplicate after Pump	1,1,1-Trichloroethane	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,2-Dichloroethane	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	Carbon tetrachloride	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Benzene	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Trichloroethene	12/20/2001 2:36	32072.3	100 0	
VW-1	Duplicate after Pump	1,2-Dichloropropane	12/20/2001 2.36	ND	100.0	
VW-1	Duplicate after Pump	cis-1,3-Dichloroproene	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	Toluene	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	trans-1,3-dichloropropene	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,1,2-Trichloroethane	12/20/2001 2 36	ND	100 0	
VW-1	Duplicate after Pump	Tetrachloroethene	12/20/2001 2 36	8828 6	100.0	
VW-1	Duplicate after Pump	1,2-Dibromoethane	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	Chlorobenzene	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	Ethylbenzene	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	m,p-Xylene	12/20/2001 2.36	ND	100.0	
VW-1	Duplicate after Pump	o-Xylene	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	Styrene	12/20/2001 2:36	ND	100.0	
VW-1	Duplicate after Pump	1,1,2,2-Tetrachloroethane	12/20/2001 2:36	14784 7	100.0	
VW-1	Duplicate after Pump	Bromofluorobenzene	12/20/2001 2.36	44 7	NA	89%
VW-1	Duplicate after Pump	1,3,5-Trimethylbenzene	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,2,4-Trimethylbenzene	12/20/2001 2 36	ND	100 0	
VW-1	Duplicate after Pump	1,3-Dichlorobenzene	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,4-Dichlorobenzene	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	1,2-Dichlorobenzene	12/20/2001 2:36	ND	100 0	
VW-1	Duplicate after Pump	1,2,4-Trichlorobenzene	12/20/2001 2.36	ND	100 0	
VW-1	Duplicate after Pump	Hexachlorobutadiene	12/20/2001 2 36	ND	100 0	
VW-1	Ambient Background	Chlorobenzene	12/20/2001 15:00	50.0	NA	100%
VW-1	Ambient Background	Dichlorodifluoromethane	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Chloromethane	12/20/2001 15:00	ND	0.8	

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VW-1	Ambient Background	1,2-Cl - 1,1,2,2-F ethane	12/20/2001 15.00	ND	0 8	
VW-1	Ambient Background	Vinyl chloride	12/20/2001 15 00	ND	0 8	
VW-1	Ambient Background	Bromomethane	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	Chloroethane	12/20/2001 15 00	ND	0.8	
VW-1	Ambient Background	Trichlorofluoromethane	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,1-Dichloroethene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,1,2-Cl - 1,2,2-F ethane	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	Methylene Chloride	12/20/2001 15.00	ND	0.8	
VW-1	Ambient Background	MTBE	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	1,1-dichloroethane	12/20/2001 15.00	ND	0.8	
VW-1	Ambient Background	cis-1,2-Dichloroethene	12/20/2001 15:00	1 0	0.8	
VW-1	Ambient Background	Chloroform	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,1,1-Trichloroethane	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	1,2-Dichloroethane	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	Carbon tetrachloride	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	Benzene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	Trichloroethene	12/20/2001 15:00	56.0	0.8	
VW-1	Ambient Background	1,2-Dichloropropane	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	cis-1,3-Dichloroproene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Toluene	12/20/2001 15.00	ND	0.8	
VW-1	Ambient Background	trans-1,3-dichloropropene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	1,1,2-Trichloroethane	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Tetrachloroethene	12/20/2001 15:00	6.7	0 8	
VW-1	Ambient Background	1,2-Dibromoethane	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Chlorobenzene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Ethylbenzene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	m,p-Xylene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	o-Xylene	12/20/2001 15 00	ND	0.8	
VW-1	Ambient Background	Styrene	12/20/2001 15 00	ND	0.8	
VW-1	Ambient Background	1,1,2,2-Tetrachloroethane	12/20/2001 15:00	28 5	0.8	
VW-1	Ambient Background	Bromofluorobenzene	12/20/2001 15:00	43.2	NA	86%
VW-1	Ambient Background	1,3,5-Trimethylbenzene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,2,4-Trimethylbenzene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,3-Dichlorobenzene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,4-Dichlorobenzene	12/20/2001 15:00	ND	0 8	
VW-1	Ambient Background	1,2-Dichlorobenzene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	1,2,4-Trichlorobenzene	12/20/2001 15:00	ND	0.8	
VW-1	Ambient Background	Hexachlorobutadiene	12/20/2001 15.00	ND	0 8	
VW-1	After Carbon Canister	Chlorobenzene	12/21/2001 14:30	50 0	NA	100%
VW-1	After Carbon Canister	Dichlorodifluoromethane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	Chloromethane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,2-Cl - 1,1,2,2-F ethane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	Vinyl chloride	12/21/2001 14 30	0 7	0 5	
VW-1	After Carbon Canister	Bromomethane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	Chloroethane	12/21/2001 14 30	ND	0 5	
VW-1	After Carbon Canister	Trichlorofluoromethane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,1-Dichloroethene	12/21/2001 14:30	0.5	0 5	
VW-1	After Carbon Canister	1,1,2-Cl - 1,2,2-F ethane	12/21/2001 14:30	ND	0.5	

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Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Carbon Canister	Methylene Chloride	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	MTBE	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	1,1-dichloroethane	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	cis-1,2-Dichloroethene	12/21/2001 14 30	25.8	0 5	
VW-1	After Carbon Canister	Chloroform	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,1,1-Trichloroethane	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	1,2-Dichloroethane	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	Carbon tetrachloride	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	Benzene	12/21/2001 14.30	ND	0 5	
VW-1	After Carbon Canister	Trichloroethene	12/21/2001 14 30	130 2	0 5	
VW-1	After Carbon Canister	1,2-Dichloropropane	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	cis-1,3-Dichloroproene	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	Toluene	12/21/2001 14:30	1.6	0.5	
VW-1	After Carbon Canister	trans-1,3-dichloropropene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	1,1,2-Trichloroethane	12/21/2001 14:30	1.5	0.5	
VW-1	After Carbon Canister	Tetrachloroethene	12/21/2001 14:30	71.1	0.5	
VW-1	After Carbon Canister	1,2-Dibromoethane	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	Chlorobenzene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	Ethylbenzene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	m,p-Xylene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	o-Xylene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	Styrene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	1,1,2,2-Tetrachloroethane	12/21/2001 14.30	117.7	0.5	
VW-1	After Carbon Canister	Bromofluorobenzene	12/21/2001 14:30	48.9	NA	98%
VW-1	After Carbon Canister	1,3,5-Trimethylbenzene	12/21/2001 14.30	ND	0.5	
VW-1	After Carbon Canister	1,2,4-Trimethylbenzene	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,3-Dichlorobenzene	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,4-Dichlorobenzene	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,2-Dichlorobenzene	12/21/2001 14:30	ND	0 5	
VW-1	After Carbon Canister	1,2,4-Trichlorobenzene	12/21/2001 14:30	ND	0.5	
VW-1	After Carbon Canister	Hexachlorobutadiene	12/21/2001 14:30	3 1	0.5	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/21/2001 14:30	50 0	NA	100%
VW-1	After Liquid Ring Pump	Dichlorodifluoromethane	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	Chloromethane	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,2-Cl - 1,1,2,2-F ethane	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Vinyl chloride	12/21/2001 14:30	458 1	168.0	
VW-1	After Liquid Ring Pump	Bromomethane	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Chloroethane	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	Trichlorofluoromethane	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,1-Dichloroethene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,1,2-Cl - 1,2,2-F ethane	12/21/2001 14.30	ND	168 0	
VW-1	After Liquid Ring Pump	Methylene Chloride	12/21/2001 14.30	ND	168 0	
VW-1	After Liquid Ring Pump	MTBE	12/21/2001 14 30	ND	168 0	
VW-1	After Liquid Ring Pump	1,1-dichloroethane	12/21/2001 14 30	ND	168 0	
VW-1	After Liquid Ring Pump	cis-1,2-Dichloroethene	12/21/2001 14 30	3228 8	168 0	
VW-1	After Liquid Ring Pump	Chloroform	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,1,1-Trichloroethane	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,2-Dichloroethane	12/21/2001 14.30	ND	168 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-1	After Liquid Ring Pump	Carbon tetrachloride	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Benzene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Trichloroethene	12/21/2001 14.30	46929 9	168 0	
VW-1	After Liquid Ring Pump	1,2-Dichloropropane	12/21/2001 14.30	ND	168.0	
VW-1	After Liquid Ring Pump	cis-1,3-Dichloroproene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Toluene	12/21/2001 14.30	ND	168.0	
VW-1	After Liquid Ring Pump	trans-1,3-dichloropropene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	1,1,2-Trichloroethane	12/21/2001 14 30	ND	168.0	
VW-1	After Liquid Ring Pump	Tetrachloroethene	12/21/2001 14.30	11167.4	168 0	
VW-1	After Liquid Ring Pump	1,2-Dibromoethane	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Chlorobenzene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	Ethylbenzene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	m,p-Xylene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	o-Xylene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Styrene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	1,1,2,2-Tetrachloroethane	12/21/2001 14:30	19502.7	168 0	
VW-1	After Liquid Ring Pump	Bromofluorobenzene	12/21/2001 14:30	44 3	NA	89%
VW-1	After Liquid Ring Pump	1,3,5-Trimethylbenzene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,2,4-Trimethylbenzene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,3-Dichlorobenzene	12/21/2001 14:30	ND	168 0	
VW-1	After Liquid Ring Pump	1,4-Dichlorobenzene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	1,2-Dichlorobenzene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	1,2,4-Trichlorobenzene	12/21/2001 14:30	ND	168.0	
VW-1	After Liquid Ring Pump	Hexachlorobutadiene	12/21/2001 14:30	ND	168.0	
VW-1	Duplicate after Pump	Chlorobenzene	12/21/2001 14:30	50.0	NA	100%
VW-1	Duplicate after Pump	Dichlorodifluoromethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Chloromethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,2-Cl - 1,1,2,2-F ethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Vinyl chloride	12/21/2001 14:30	176 0	147	
VW-1	Duplicate after Pump	Bromomethane	12/21/2001 14 30	ND	147	
VW-1	Duplicate after Pump	Chloroethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Trichlorofluoromethane	12/21/2001 14.30	ND	147	
VW-1	Duplicate after Pump	1,1-Dichloroethene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,1,2-Cl - 1,2,2-F ethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Methylene Chloride	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	MTBE	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,1-dichloroethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	cis-1,2-Dichloroethene	12/21/2001 14:30	2675 3	147	
VW-1	Duplicate after Pump	Chloroform	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,1,1-Trichloroethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,2-Dichloroethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Carbon tetrachloride	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Benzene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Trichloroethene	12/21/2001 14:30	51571 9	147	
VW-1	Duplicate after Pump	1,2-Dichloropropane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	cis-1,3-Dichloroproene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Toluene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	trans-1,3-dichloropropene	12/21/2001 14:30	ND	147	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-1	Duplicate after Pump	1,1,2-Trichloroethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Tetrachloroethene	12/21/2001 14:30	11499 5	147	
VW-1	Duplicate after Pump	1,2-Dibromoethane	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Chlorobenzene	12/21/2001 14.30	ND	147	
VW-1	Duplicate after Pump	Ethylbenzene	12/21/2001 14 30	ND	147	
VW-1	Duplicate after Pump	m,p-Xylene	12/21/2001 14.30	ND	147	
VW-1	Duplicate after Pump	o-Xylene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Styrene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,1,2,2-Tetrachloroethane	12/21/2001 14:30	19785.3	147	
VW-1	Duplicate after Pump	Bromofluorobenzene	12/21/2001 14:30	41.1	NA	82%
VW-1	Duplicate after Pump	1,3,5-Trimethylbenzene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,2,4-Trimethylbenzene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	1,3-Dichlorobenzene	12/21/2001 14.30	ND	147	
VW-1	Duplicate after Pump	1,4-Dichlorobenzene	12/21/2001 14.30	ND	147	
VW-1	Duplicate after Pump	1,2-Dichlorobenzene	12/21/2001 14 30	ND	147	
VW-1	Duplicate after Pump	1,2,4-Trichlorobenzene	12/21/2001 14:30	ND	147	
VW-1	Duplicate after Pump	Hexachlorobutadiene	12/21/2001 14:30	ND	147	

Note:
ND = Not Detected at the Reporting Limits
NA = Not Applicable
Benzyl chloride has been removed from the target list due to instability in the standards
SS = Surrogate Standard
IS = Internal Standard 50 ng each
Benzyl chloride has been removed from the target list due to instability in the standards

Vapor VOCs Analytical Results for Test 2 (VW-2)
Dunn Field - Memphis Depot (January 2002)

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-2	Exhausting Pipe	Chlorobenzene	01/09/2002 2 00	50 0	NA	100%
VW-2	Exhausting Pipe	Dichlorodifluoromethane	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Chloromethane	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	1,2-Cl - 1,1,2,2-F ethane	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	Vinyl chloride	01/09/2002 2:00	2319.8	168.0	
VW-2	Exhausting Pipe	Bromomethane	01/09/2002 2.00	ND	168.0	
VW-2	Exhausting Pipe	Chloroethane	01/09/2002 2.00	ND	168.0	
VW-2	Exhausting Pipe	Trichlorofluoromethane	01/09/2002 2.00	ND	168 0	
VW-2	Exhausting Pipe	1,1-Dichloroethene	01/09/2002 2:00	205 0	168.0	
VW-2	Exhausting Pipe	1,1,2-Cl - 1,2,2-F ethane	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Methylene Chloride	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	MTBE	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	1,1-dichloroethane	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	cis-1,2-Dichloroethene	01/09/2002 2:00	40977.4	168.0	
VW-2	Exhausting Pipe	Chloroform	01/09/2002 2 00	1202.9	168.0	
VW-2	Exhausting Pipe	1,1,1-Trichloroethane	01/09/2002 2 00	ND	168 0	
VW-2	Exhausting Pipe	1,2-Dichloroethane	01/09/2002 2.00	ND	168.0	
VW-2	Exhausting Pipe	Carbon tetrachloride	01/09/2002 2:00	855.3	168.0	
VW-2	Exhausting Pipe	Benzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Trichloroethene	01/09/2002 2:00	108661 8	168.0	
VW-2	Exhausting Pipe	1,2-Dichloropropane	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	cis-1,3-Dichloroproene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Toluene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	trans-1,3-dichloropropene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	1,1,2-Trichloroethane	01/09/2002 2.00	1039.4	168 0	
VW-2	Exhausting Pipe	Tetrachloroethene	01/09/2002 2:00	16032 7	168 0	
VW-2	Exhausting Pipe	1,2-Dibromoethane	01/09/2002 2.00	ND	168.0	
VW-2	Exhausting Pipe	Chlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Ethylbenzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	m,p-Xylene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	o-Xylene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	Styrene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	1,1,2,2-Tetrachloroethane	01/09/2002 2 00	22305 3	168 0	
VW-2	Exhausting Pipe	Bromofluorobenzene	01/09/2002 2.00	50.7	NA	101%
VW-2	Exhausting Pipe	1,3,5-Trimethylbenzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	1,2,4-Trimethylbenzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	1,3-Dichlorobenzene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	1,4-Dichlorobenzene	01/09/2002 2:00	ND	168 0	
VW-2	Exhausting Pipe	1,2-Dichlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	1,2,4-Trichlorobenzene	01/09/2002 2 00	ND	168.0	
VW-2	Exhausting Pipe	Hexachlorobutadiene	01/09/2002 2 00	ND	168.0	
VW-2	Duplicate Exhausting	Chlorobenzene	01/09/2002 2:00	50 0	NA	100%
VW-3	Duplicate Exhausting	Dichlorodifluoromethane	01/09/2002 2 00	ND	168 0	

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Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr Recovery
VW-2	Duplicate Exhausting	Chloromethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,2-Cl - 1,1,2,2-F ethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Vinyl chloride	01/09/2002 2 00	1533.2	168.0	
VW-2	Duplicate Exhausting	Bromomethane	01/09/2002 2.00	ND	168 0	
VW-2	Duplicate Exhausting	Chloroethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Trichlorofluoromethane	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	1,1-Dichloroethene	01/09/2002 2:00	209 9	168 0	
VW-2	Duplicate Exhausting	1,1,2-Cl - 1,2,2-F ethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Methylene Chloride	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	MTBE	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,1-dichloroethane	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	cis-1,2-Dichloroethene	01/09/2002 2.00	42045.9	168.0	
VW-2	Duplicate Exhausting	Chloroform	01/09/2002 2:00	1257 3	168.0	
VW-2	Duplicate Exhausting	1,1,1-Trichloroethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,2-Dichloroethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Carbon tetrachloride	01/09/2002 2:00	861.1	168.0	
VW-2	Duplicate Exhausting	Benzene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Trichloroethene	01/09/2002 2:00	110798 1	168.0	
VW-2	Duplicate Exhausting	1,2-Dichloropropane	01/09/2002 2 00	ND	168.0	
VW-2	Duplicate Exhausting	cis-1,3-Dichloroproene	01/09/2002 2.00	ND	168 0	
VW-3	Duplicate Exhausting	Toluene	01/09/2002 2:00	ND	168.0	
VW-4	Duplicate Exhausting	trans-1,3-dichloropropene	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	1,1,2-Trichloroethane	01/09/2002 2:00	1012.1	168.0	
VW-2	Duplicate Exhausting	Tetrachloroethene	01/09/2002 2:00	14878.7	168 0	
VW-2	Duplicate Exhausting	1,2-Dibromoethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Chlorobenzene	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	Ethylbenzene	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	m,p-Xylene	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	o-Xylene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Styrene	01/09/2002 2:00	ND	168 0	
VW-2	Duplicate Exhausting	1,1,2,2-Tetrachloroethane	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Bromofluorobenzene	01/09/2002 2:00	51.7	NA	103%
VW-2	Duplicate Exhausting	1,3,5-Trimethylbenzene	01/09/2002 2.00	ND	168.0	
VW-2	Duplicate Exhausting	1,2,4-Trimethylbenzene	01/09/2002 2.00	ND	168.0	
VW-2	Duplicate Exhausting	1,3-Dichlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,4-Dichlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,2-Dichlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	1,2,4-Trichlorobenzene	01/09/2002 2:00	ND	168.0	
VW-2	Duplicate Exhausting	Hexachlorobutadiene	01/09/2002 2:00	ND	168.0	
VW-2	Exhausting Pipe	Chlorobenzene	01/10/2002 14:00	50 0	NA	100%
VW-2	Exhausting Pipe	Dichlorodifluoromethane	01/10/2002 14.00	ND	168.0	
VW-2	Exhausting Pipe	Chloromethane	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	1,2-Cl - 1,1,2,2-F ethane	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	Vinyl chloride	01/10/2002 14:00	602 2	168.0	
VW-2	Exhausting Pipe	Bromomethane	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	Chloroethane	01/10/2002 14.00	ND	168.0	
VW-2	Exhausting Pipe	Trichlorofluoromethane	01/10/2002 14 00	ND	168.0	
VW-2	Exhausting Pipe	1,1-Dichloroethene	01/10/2002 14:00	ND	168 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-2	Exhausting Pipe	1,1,2-Cl - 1,2,2-F ethane	01/10/2002 14.00	ND	168 0	
VW-2	Exhausting Pipe	Methylene Chloride	01/10/2002 14.00	ND	168 0	
VW-2	Exhausting Pipe	MTBE	01/10/2002 14·00	ND	168 0	
VW-2	Exhausting Pipe	1,1-dichloroethane	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	cis-1,2-Dichloroethene	01/10/2002 14:00	31509 5	168 0	
VW-2	Exhausting Pipe	Chloroform	01/10/2002 14:00	1002.9	168 0	
VW-2	Exhausting Pipe	1,1,1-Trichloroethane	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	1,2-Dichloroethane	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	Carbon tetrachloride	01/10/2002 14:00	946.7	168.0	
VW-2	Exhausting Pipe	Benzene	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	Trichloroethene	01/10/2002 14:00	88841 1	168 0	
VW-2	Exhausting Pipe	1,2-Dichloropropane	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	cis-1,3-Dichloroproene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	Toluene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	trans-1,3-dichloropropene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	1,1,2-Trichloroethane	01/10/2002 14:00	869.8	168.0	
VW-2	Exhausting Pipe	Tetrachloroethene	01/10/2002 14:00	12789.5	168.0	
VW-2	Exhausting Pipe	1,2-Dibromoethane	01/10/2002 14·00	ND	168 0	
VW-2	Exhausting Pipe	Chlorobenzene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	Ethylbenzene	01/10/2002 14.00	ND	168 0	
VW-2	Exhausting Pipe	m,p-Xylene	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	o-Xylene	01/10/2002 14:00	ND	168 0	
VW-2	Exhausting Pipe	Styrene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	1,1,2,2-Tetrachloroethane	01/10/2002 14:00	46540.0	168 0	
VW-2	Exhausting Pipe	Bromofluorobenzene	01/10/2002 14:00	47.3	NA	95%
VW-2	Exhausting Pipe	1,3,5-Trimethylbenzene	01/10/2002 14:00	ND	168.0	
VW-2	Exhausting Pipe	1,2,4-Trimethylbenzene	01/10/2002 14·00	ND	168 0	
VW-2	Exhausting Pipe	1,3-Dichlorobenzene	01/10/2002 14.00	ND	168.0	
VW-2	Exhausting Pipe	1,4-Dichlorobenzene	01/10/2002 14 00	ND	168 0	
VW-2	Exhausting Pipe	1,2-Dichlorobenzene	01/10/2002 14 00	ND	168 0	
VW-2	Exhausting Pipe	1,2,4-Trichlorobenzene	01/10/2002 14.00	ND	168 0	
VW-2	Exhausting Pipe	Hexachlorobutadiene	01/10/2002 14:00	ND	168 0	
VW-2	Ambient Air	Chlorobenzene	01/10/2002 14:00	50 0	NA	100%
VW-2	Ambient Air	Dichlorodifluoromethane	01/10/2002 14:00	1.1	0.8	
VW-2	Ambient Air	Chloromethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	1,2-Cl - 1,1,2,2-F ethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Vinyl chloride	01/10/2002 14·00	ND	0 8	
VW-2	Ambient Air	Bromomethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Chloroethane	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	Trichlorofluoromethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	1,1-Dichloroethene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	1,1,2-Cl - 1,2,2-F ethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Methylene Chloride	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	MTBE	01/10/2002 14.00	ND	0.8	
VW-2	Ambient Air	1,1-dichloroethane	01/10/2002 14 00	ND	0.8	
VW-2	Ambient Air	cis-1,2-Dichloroethene	01/10/2002 14 00	ND	0.8	
VW-2	Ambient Air	Chloroform	01/10/2002 14 00	ND	0 8	
VW-2	Ambient Air	1,1,1-Trichloroethane	01/10/2002 14·00	ND	0 8	

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VW-2	Ambient Air	1,2-Dichloroethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Carbon tetrachloride	01/10/2002 14 00	ND	0 8	
VW-2	Ambient Air	Benzene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Trichloroethene	01/10/2002 14:00	2 7	0.8	
VW-2	Ambient Air	1,2-Dichloropropane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	cis-1,3-Dichloroproene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Toluene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	trans-1,3-dichloropropene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	1,1,2-Trichloroethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Tetrachloroethene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	1,2-Dibromoethane	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Chlorobenzene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	Ethylbenzene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	m,p-Xylene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	o-Xylene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Styrene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	1,1,2,2-Tetrachloroethane	01/10/2002 14:00	2 6	0 8	
VW-2	Ambient Air	Bromofluorobenzene	01/10/2002 14.00	46.0	NA	92%
VW-2	Ambient Air	1,3,5-Trimethylbenzene	01/10/2002 14.00	ND	0 8	
VW-2	Ambient Air	1,2,4-Trimethylbenzene	01/10/2002 14.00	ND	0 8	
VW-2	Ambient Air	1,3-Dichlorobenzene	01/10/2002 14.00	ND	0 8	
VW-2	Ambient Air	1,4-Dichlorobenzene	01/10/2002 14:00	ND	0.8	
VW-2	Ambient Air	1,2-Dichlorobenzene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	1,2,4-Trichlorobenzene	01/10/2002 14:00	ND	0 8	
VW-2	Ambient Air	Hexachlorobutadiene	01/10/2002 14:00	ND	0 8	
VW-2	Exhausting Pipe	Chlorobenzene	01/11/2002 14:10	50 0	NA	100%
VW-2	Exhausting Pipe	Dichlorodifluoromethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Chloromethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,2-Cl - 1,1,2,2-F ethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Vinyl chloride	01/11/2002 14:10	552 8	168 0	
VW-2	Exhausting Pipe	Bromomethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Chloroethane	01/11/2002 14 10	ND	168 0	
VW-2	Exhausting Pipe	Trichlorofluoromethane	01/11/2002 14 10	ND	168.0	
VW-2	Exhausting Pipe	1,1-Dichloroethene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,1,2-Cl - 1,2,2-F ethane	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	Methylene Chloride	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	MTBE	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	1,1-dichloroethane	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	cis-1,2-Dichloroethene	01/11/2002 14:10	30332.8	168.0	
VW-2	Exhausting Pipe	Chloroform	01/11/2002 14:10	1032 5	168.0	
VW-2	Exhausting Pipe	1,1,1-Trichloroethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,2-Dichloroethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Carbon tetrachloride	01/11/2002 14:10	1086.5	168 0	
VW-2	Exhausting Pipe	Benzene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Trichloroethene	01/11/2002 14:10	86466 7	168 0	
VW-2	Exhausting Pipe	1,2-Dichloropropane	01/11/2002 14 10	ND	168 0	
VW-2	Exhausting Pipe	cis-1,3-Dichloroproene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Toluene	01/11/2002 14.10	ND	168 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-2	Exhausting Pipe	trans-1,3-dichloropropene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	1,1,2-Trichloroethane	01/11/2002 14:10	828 9	168 0	
VW-2	Exhausting Pipe	Tetrachloroethene	01/11/2002 14:10	12029.3	168.0	
VW-2	Exhausting Pipe	1,2-Dibromoethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Chlorobenzene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	Ethylbenzene	01/11/2002 14.10	ND	168.0	
VW-2	Exhausting Pipe	m,p-Xylene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	o-Xylene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Styrene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,1,2,2-Tetrachloroethane	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	Bromofluorobenzene	01/11/2002 14:10	49.8	NA	100%
VW-2	Exhausting Pipe	1,3,5-Trimethylbenzene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,2,4-Trimethylbenzene	01/11/2002 14:10	ND	168 0	
VW-2	Exhausting Pipe	1,3-Dichlorobenzene	01/11/2002 14 10	ND	168.0	
VW-2	Exhausting Pipe	1,4-Dichlorobenzene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	1,2-Dichlorobenzene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	1,2,4-Trichlorobenzene	01/11/2002 14:10	ND	168.0	
VW-2	Exhausting Pipe	Hexachlorobutadiene	01/11/2002 14:10	ND	168 0	
VW-2	Equipment blank	Chlorobenzene	01/07/2002 18:30	50.0		100%
VW-2	Equipment blank	Dichlorodifluoromethane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Chloromethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,2-Cl - 1,1,2,2-F ethane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Vinyl chloride	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Bromomethane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Chloroethane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Trichlorofluoromethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,1-Dichloroethene	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,1,2-Cl - 1,2,2-F ethane	01/07/2002 18.30	ND	100.0	
VW-2	Equipment blank	Methylene Chloride	01/07/2002 18.30	ND	100.0	
VW-2	Equipment blank	MTBE	01/07/2002 18.30	ND	100 0	
VW-2	Equipment blank	1,1-dichloroethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	cis-1,2-Dichloroethene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Chloroform	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	1,1,1-Trichloroethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,2-Dichloroethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	Carbon tetrachloride	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Benzene	01/07/2002 18.30	ND	100.0	
VW-2	Equipment blank	Trichloroethene	01/07/2002 18.30	ND	100.0	
VW-2	Equipment blank	1,2-Dichloropropane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	cis-1,3-Dichloroproene	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	Toluene	01/07/2002 18 30	ND	100 0	
VW-2	Equipment blank	trans-1,3-dichloropropene	01/07/2002 18 30	ND	100 0	
VW-2	Equipment blank	1,1,2-Trichloroethane	01/07/2002 18 30	ND	100 0	
VW-2	Equipment blank	Tetrachloroethene	01/07/2002 18:30	234 5	100.0	
VW-2	Equipment blank	1,2-Dibromoethane	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Chlorobenzene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Ethylbenzene	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	m,p-Xylene	01/07/2002 18.30	ND	100 0	

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VW-2	Equipment blank	o-Xylene	01/07/2002 18 30	ND	100 0	
VW-2	Equipment blank	Styrene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	1,1,2,2-Tetrachloroethane	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	Bromofluorobenzene	01/07/2002 18:30	48 0		96%
VW-2	Equipment blank	1,3,5-Trimethylbenzene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	1,2,4-Trimethylbenzene	01/07/2002 18.30	ND	100.0	
VW-2	Equipment blank	1,3-Dichlorobenzene	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,4-Dichlorobenzene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	1,2-Dichlorobenzene	01/07/2002 18:30	ND	100 0	
VW-2	Equipment blank	1,2,4-Trichlorobenzene	01/07/2002 18:30	ND	100.0	
VW-2	Equipment blank	Hexachlorobutadiene	01/07/2002 18:30	ND	100.0	
VW-2	Exhausting Pipe	Chlorobenzene	01/08/2002 2:00	50 0		100%
VW-2	Exhausting Pipe	Dichlorodifluoromethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Chloromethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,2-Cl - 1,1,2,2-F ethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Vinyl chloride	01/08/2002 2:00	2279 6	100.0	
VW-2	Exhausting Pipe	Bromomethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Chloroethane	01/08/2002 2 00	ND	100.0	
VW-2	Exhausting Pipe	Trichlorofluoromethane	01/08/2002 2.00	ND	100.0	
VW-2	Exhausting Pipe	1,1-Dichloroethene	01/08/2002 2:00	248.5	100.0	
VW-2	Exhausting Pipe	1,1,2-Cl - 1,2,2-F ethane	01/08/2002 2:00	ND	100 0	
VW-2	Exhausting Pipe	Methylene Chloride	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	MTBE	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,1-dichloroethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	cis-1,2-Dichloroethene	01/08/2002 2:00	27539.8	100.0	
VW-2	Exhausting Pipe	Chloroform	01/08/2002 2:00	772.4	100.0	
VW-2	Exhausting Pipe	1,1,1-Trichloroethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,2-Dichloroethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Carbon tetrachloride	01/08/2002 2:00	363.2	100.0	
VW-2	Exhausting Pipe	Benzene	01/08/2002 2.00	ND	100.0	
VW-2	Exhausting Pipe	Trichloroethene	01/08/2002 2:00	70494.0	100.0	
VW-2	Exhausting Pipe	1,2-Dichloropropane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	cis-1,3-Dichloroproene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Toluene	01/08/2002 2.00	ND	100.0	
VW-2	Exhausting Pipe	trans-1,3-dichloropropene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,1,2-Trichloroethane	01/08/2002 2:00	541 5	100.0	
VW-2	Exhausting Pipe	Tetrachloroethene	01/08/2002 2:00	10056.0	100.0	
VW-2	Exhausting Pipe	1,2-Dibromoethane	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Chlorobenzene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Ethylbenzene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	m,p-Xylene	01/08/2002 2:00	ND	100 0	
VW-2	Exhausting Pipe	o-Xylene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	Styrene	01/08/2002 2:00	ND	100 0	
VW-2	Exhausting Pipe	1,1,2,2-Tetrachloroethane	01/08/2002 2:00	13191 5	100.0	
VW-2	Exhausting Pipe	Bromofluorobenzene	01/08/2002 2:00	50.5		101%
VW-2	Exhausting Pipe	1,3,5-Trimethylbenzene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,2,4-Trimethylbenzene	01/08/2002 2:00	ND	100 0	
VW-2	Exhausting Pipe	1,3-Dichlorobenzene	01/08/2002 2 00	ND	100 0	

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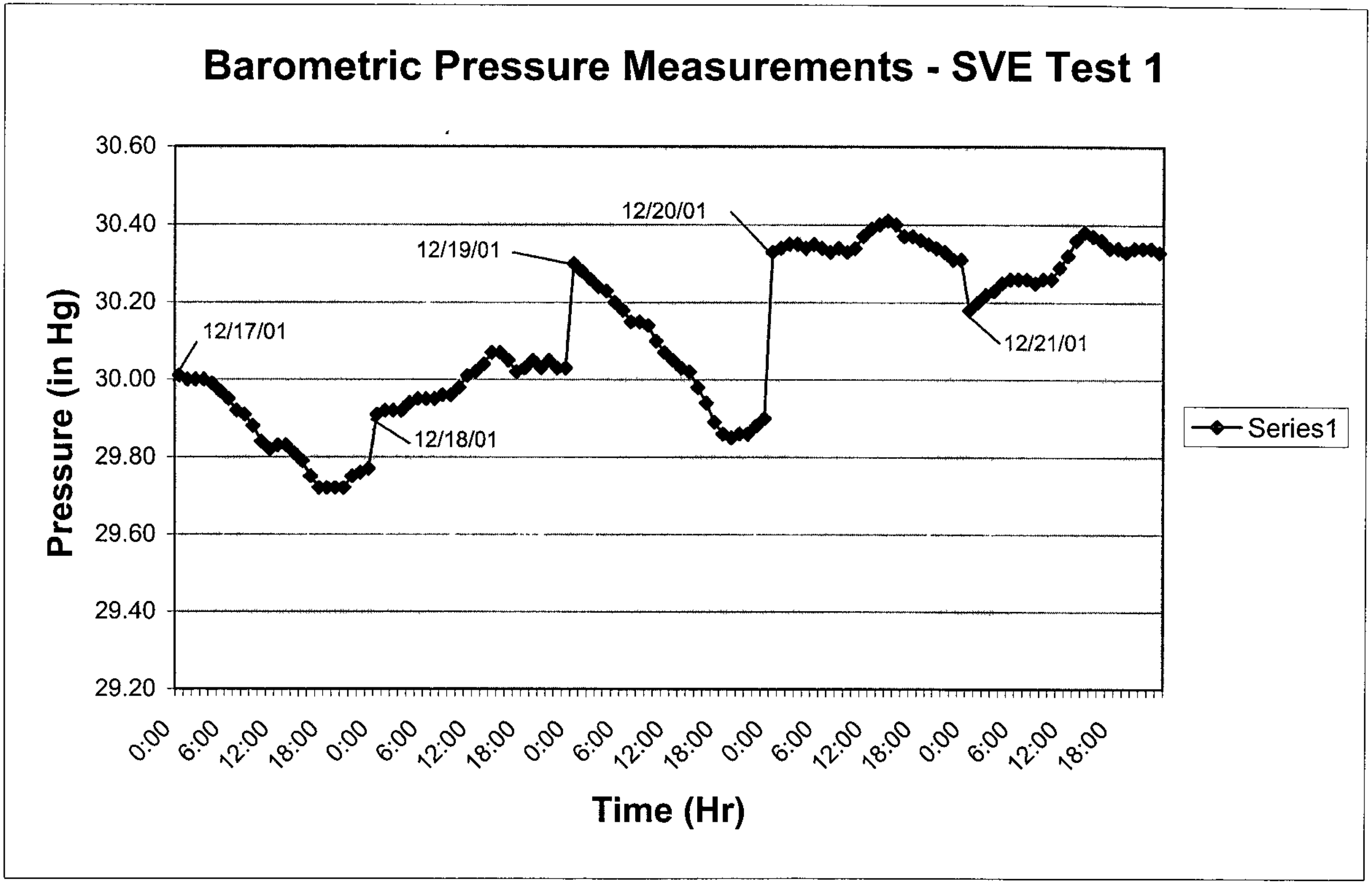
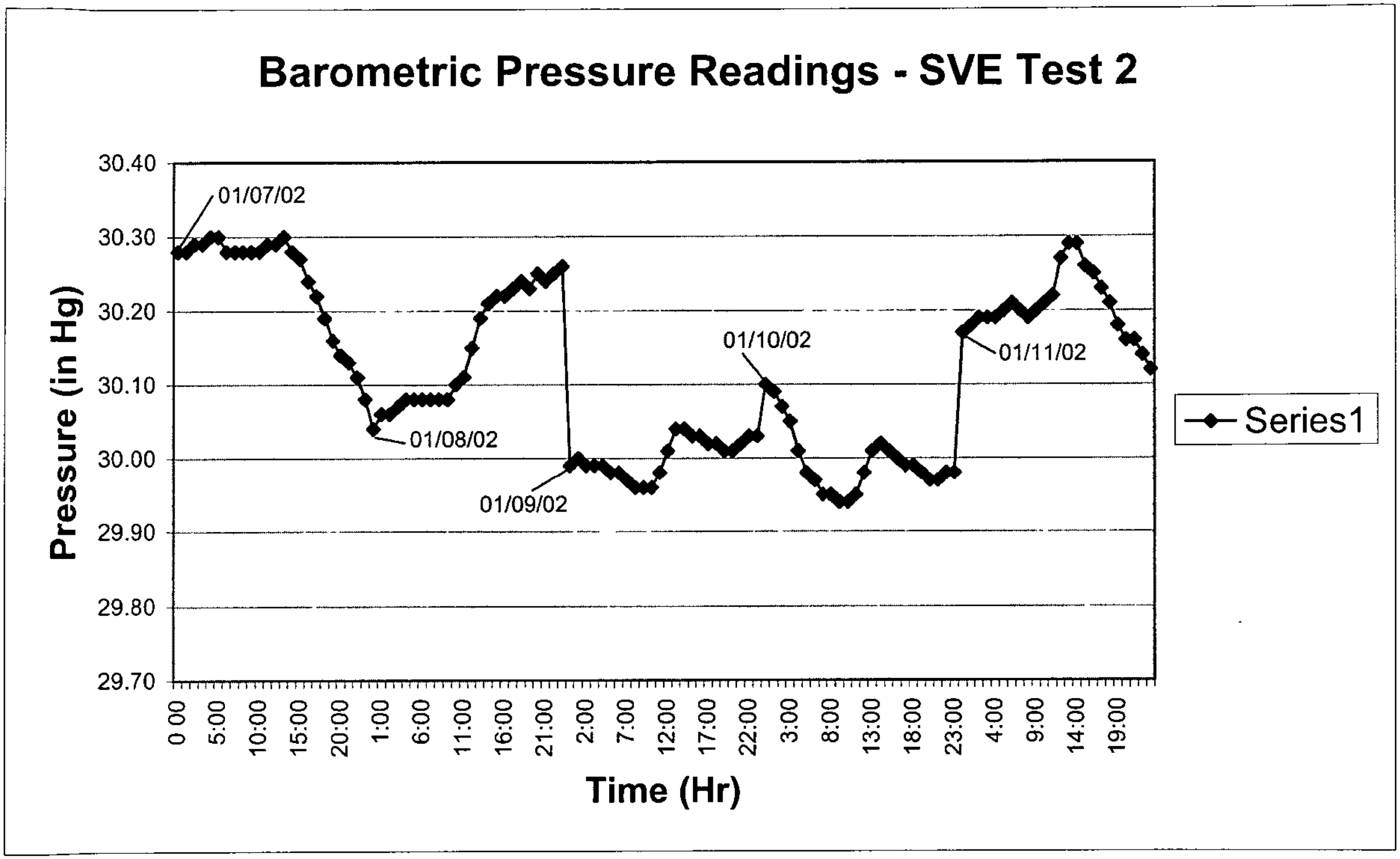
VW-2	Exhausting Pipe	1,4-Dichlorobenzene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,2-Dichlorobenzene	01/08/2002 2:00	ND	100.0	
VW-2	Exhausting Pipe	1,2,4-Trichlorobenzene	01/08/2002 2.00	ND	100.0	
VW-2	Exhausting Pipe	Hexachlorobutadiene	01/08/2002 2:00	ND	100.0	
VW-2	Duplicate Exhausting	Chlorobenzene	01/08/2002 2:00	50.0		100%
VW-2	Duplicate Exhausting	Dichlorodifluoromethane	01/08/2002 2.00	ND	133.5	
VW-2	Duplicate Exhausting	Chloromethane	01/08/2002 2 00	ND	133.5	
VW-2	Duplicate Exhausting	1,2-Cl - 1,1,2,2-F ethane	01/08/2002 2 00	ND	133 5	
VW-2	Duplicate Exhausting	Vinyl chloride	01/08/2002 2:00	3448.1	133.5	
VW-2	Duplicate Exhausting	Bromomethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Chloroethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Trichlorofluoromethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	1,1-Dichloroethene	01/08/2002 2:00	302.4	133.5	
VW-2	Duplicate Exhausting	1,1,2-Cl - 1,2,2-F ethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Methylene Chloride	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	MTBE	01/08/2002 2.00	ND	133 5	
VW-2	Duplicate Exhausting	1,1-dichloroethane	01/08/2002 2 00	ND	133.5	
VW-2	Duplicate Exhausting	cis-1,2-Dichloroethene	01/08/2002 2.00	35588.5	133 5	
VW-2	Duplicate Exhausting	Chloroform	01/08/2002 2:00	992 5	133.5	
VW-2	Duplicate Exhausting	1,1,1-Trichloroethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	1,2-Dichloroethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Carbon tetrachloride	01/08/2002 2:00	468.4	133.5	
VW-2	Duplicate Exhausting	Benzene	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Trichloroethene	01/08/2002 2:00	88158.4	133 5	
VW-2	Duplicate Exhausting	1,2-Dichloropropane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	cis-1,3-Dichloroproene	01/08/2002 2.00	ND	133:5	
VW-2	Duplicate Exhausting	Toluene	01/08/2002 2:00	ND	133 5	
VW-2	Duplicate Exhausting	trans-1,3-dichloropropene	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	1,1,2-Trichloroethane	01/08/2002 2:00	616.7	133.5	
VW-2	Duplicate Exhausting	Tetrachloroethene	01/08/2002 2:00	12667.9	133.5	
VW-2	Duplicate Exhausting	1,2-Dibromoethane	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	Chlorobenzene	01/08/2002 2:00	ND	133 5	
VW-2	Duplicate Exhausting	Ethylbenzene	01/08/2002 2 00	ND	133.5	
VW-2	Duplicate Exhausting	m,p-Xylene	01/08/2002 2:00	ND	133 5	
VW-2	Duplicate Exhausting	o-Xylene	01/08/2002 2 00	ND	133.5	
VW-2	Duplicate Exhausting	Styrene	01/08/2002 2 00	ND	133 5	
VW-2	Duplicate Exhausting	1,1,2,2-Tetrachloroethane	01/08/2002 2:00	21842.2	133.5	
VW-2	Duplicate Exhausting	Bromofluorobenzene	01/08/2002 2:00	50 5		101%
VW-2	Duplicate Exhausting	1,3,5-Trimethylbenzene	01/08/2002 2:00	ND	133 5	
VW-2	Duplicate Exhausting	1,2,4-Trimethylbenzene	01/08/2002 2:00	ND	133 5	
VW-2	Duplicate Exhausting	1,3-Dichlorobenzene	01/08/2002 2.00	ND	133.5	
VW-2	Duplicate Exhausting	1,4-Dichlorobenzene	01/08/2002 2 00	ND	133 5	
VW-2	Duplicate Exhausting	1,2-Dichlorobenzene	01/08/2002 2:00	ND	133.5	
VW-2	Duplicate Exhausting	1,2,4-Trichlorobenzene	01/08/2002 2.00	ND	133.5	
VW-2	Duplicate Exhausting	Hexachlorobutadiene	01/08/2002 2:00	ND	133.5	
VW-2	Exhausting Pipe	Chlorobenzene	01/07/2002 18 30	50 0		100%
VW-2	Exhausting Pipe	Dichlorodifluoromethane	01/07/2002 18 30	ND	147.0	
VW-2	Exhausting Pipe	Chloromethane	01/07/2002 18:30	ND	147 0	

Venting Well ID	SUMMA Canister Sampling Locations	Parameter ID	Date & Time Collected	Analytical Results (ppbv)	Reporting Limits (ppbv)	IS/Surr. Recovery
VW-2	Exhausting Pipe	1,2-Cl - 1,1,2,2-F ethane	01/07/2002 18 30	ND	147 0	
VW-2	Exhausting Pipe	Vinyl chloride	01/07/2002 18:30	7463.9	147 0	
VW-2	Exhausting Pipe	Bromomethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Chloroethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Trichlorofluoromethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	1,1-Dichloroethene	01/07/2002 18:30	437 6	147 0	
VW-2	Exhausting Pipe	1,1,2-Cl - 1,2,2-F ethane	01/07/2002 18.30	ND	147.0	
VW-2	Exhausting Pipe	Methylene Chloride	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	MTBE	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	1,1-dichloroethane	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	cis-1,2-Dichloroethene	01/07/2002 18:30	47656.5	147.0	
VW-2	Exhausting Pipe	Chloroform	01/07/2002 18:30	1605 3	147.0	
VW-2	Exhausting Pipe	1,1,1-Trichloroethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	1,2-Dichloroethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Carbon tetrachloride	01/07/2002 18:30	637.5	147.0	
VW-2	Exhausting Pipe	Benzene	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Trichloroethene	01/07/2002 18:30	87003.2	147 0	
VW-2	Exhausting Pipe	1,2-Dichloropropane	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	cis-1,3-Dichloroproene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	Toluene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	trans-1,3-dichloropropene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,1,2-Trichloroethane	01/07/2002 18:30	881.6	147 0	
VW-2	Exhausting Pipe	Tetrachloroethene	01/07/2002 18:30	17820.1	147.0	
VW-2	Exhausting Pipe	1,2-Dibromoethane	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Chlorobenzene	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	Ethylbenzene	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	m,p-Xylene	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	o-Xylene	01/07/2002 18.30	ND	147.0	
VW-2	Exhausting Pipe	Styrene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,1,2,2-Tetrachloroethane	01/07/2002 18.30	27024.2	147 0	
VW-2	Exhausting Pipe	Bromofluorobenzene	01/07/2002 18.30	51.3		103%
VW-2	Exhausting Pipe	1,3,5-Trimethylbenzene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,2,4-Trimethylbenzene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,3-Dichlorobenzene	01/07/2002 18:30	ND	147.0	
VW-2	Exhausting Pipe	1,4-Dichlorobenzene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,2-Dichlorobenzene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	1,2,4-Trichlorobenzene	01/07/2002 18:30	ND	147 0	
VW-2	Exhausting Pipe	Hexachlorobutadiene	01/07/2002 18:30	ND	147 0	

Note:
ND = Not Detected at the Reporting Limits
NA = Not Applicable
SS = Surrogate Standard
IS = Internal Standard 50 ng each
Benzyl chloride has been removed from the target list due to instability in the standards

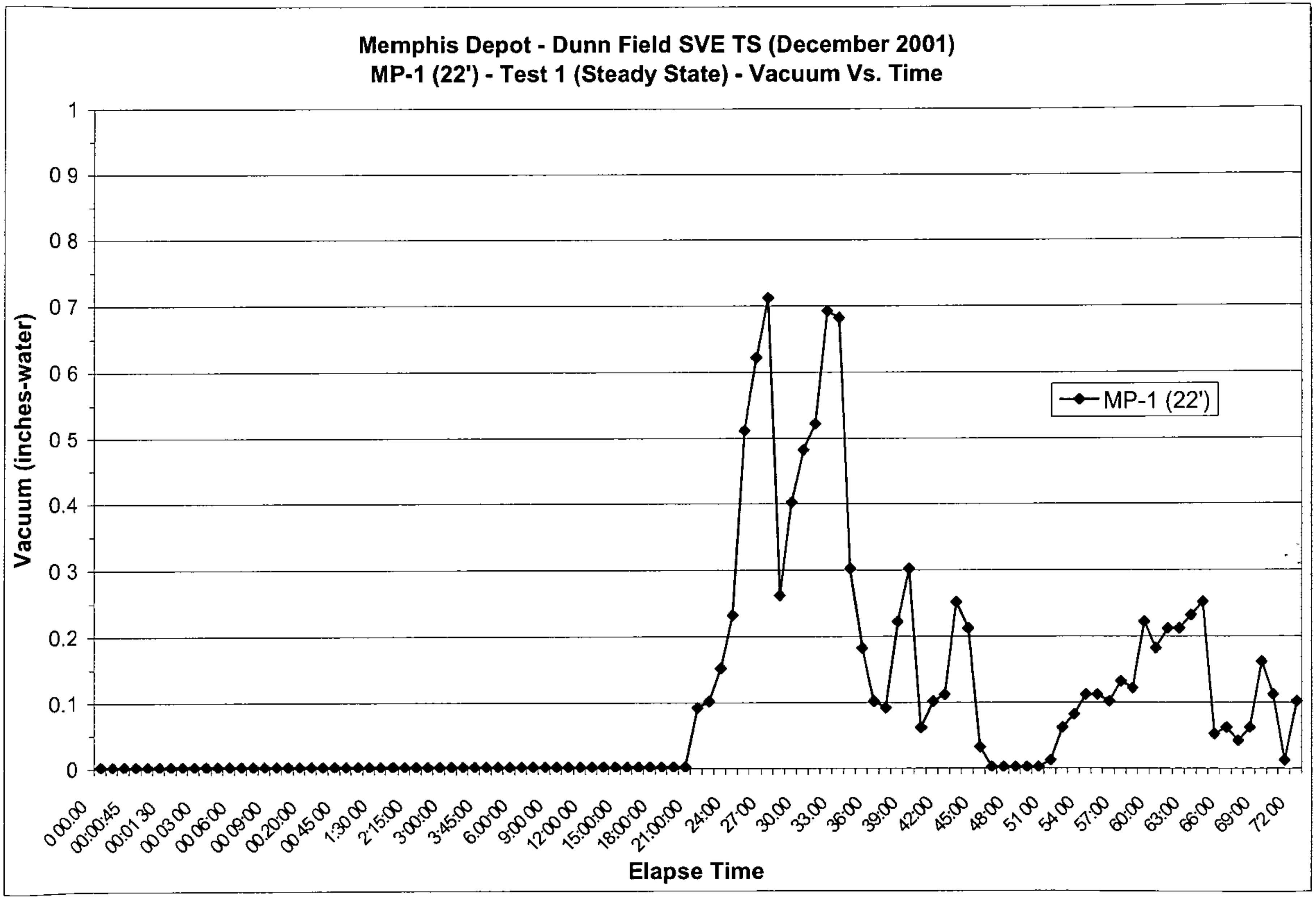
Attachment E


Barometric Pressure Measurements - SVE Test 1
Pressure (in Hg)
30.60
30.40
30.20
30.00
29.80
29.60
29.40
29.20
12/17/01
12/18/01
12/19/01
12/20/01
12/21/01
Series1
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
0:00
6:00
12:00
18:00
Time (Hr)

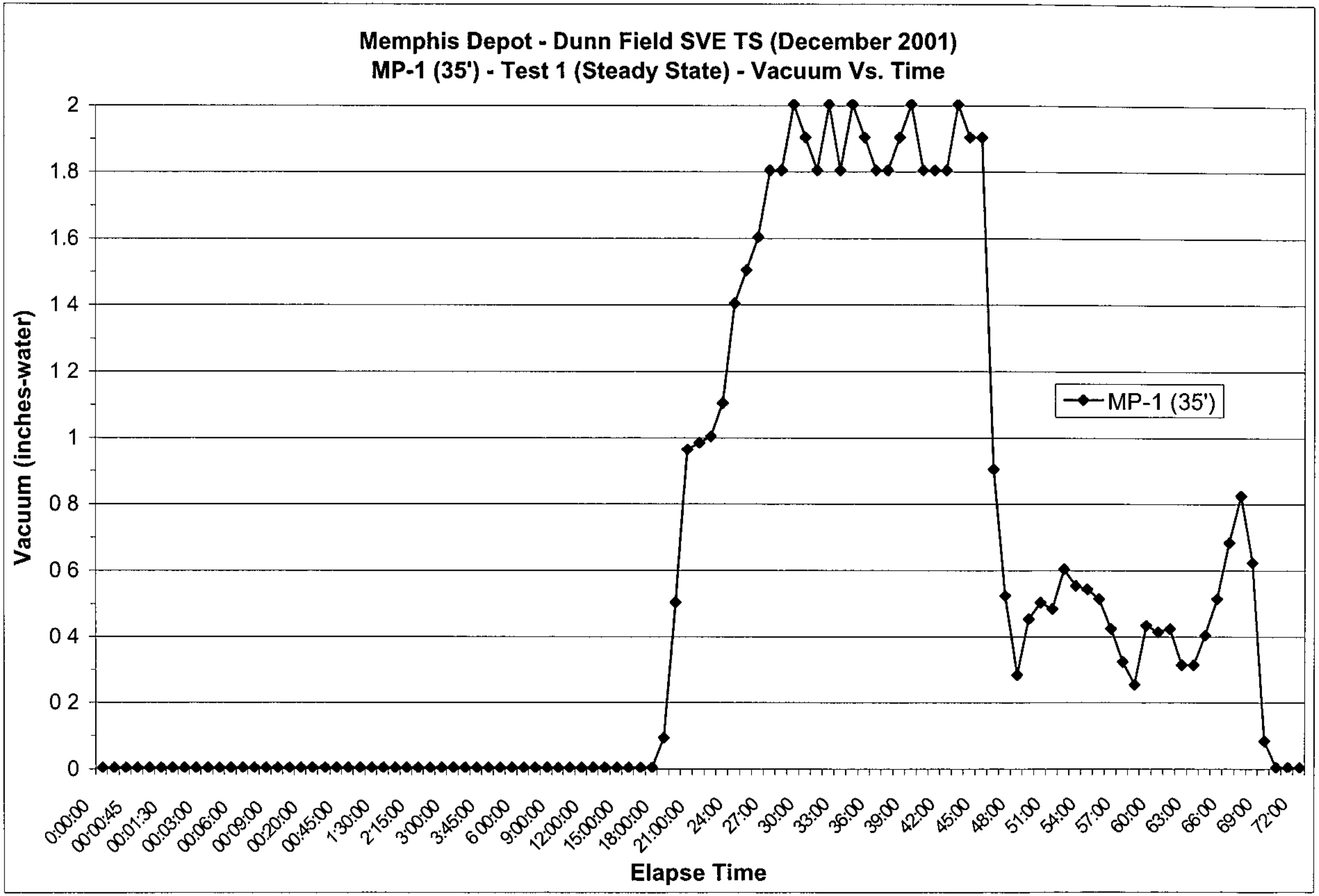

Barometric Pressure Readings - SVE Test 2
Pressure (in Hg)
30.40
30.30
30.20
30.10
30.00
29.90
29.80
29.70
01/07/02
01/08/02
01/09/02
01/10/02
01/11/02
0:00
5:00
10:00
15:00
20:00
1:00
6:00
11:00
16:00
21:00
2:00
7:00
12:00
17:00
22:00
3:00
8:00
13:00
18:00
23:00
4:00
9:00
14:00
19:00
Time (Hr)
Series1

Attachment F

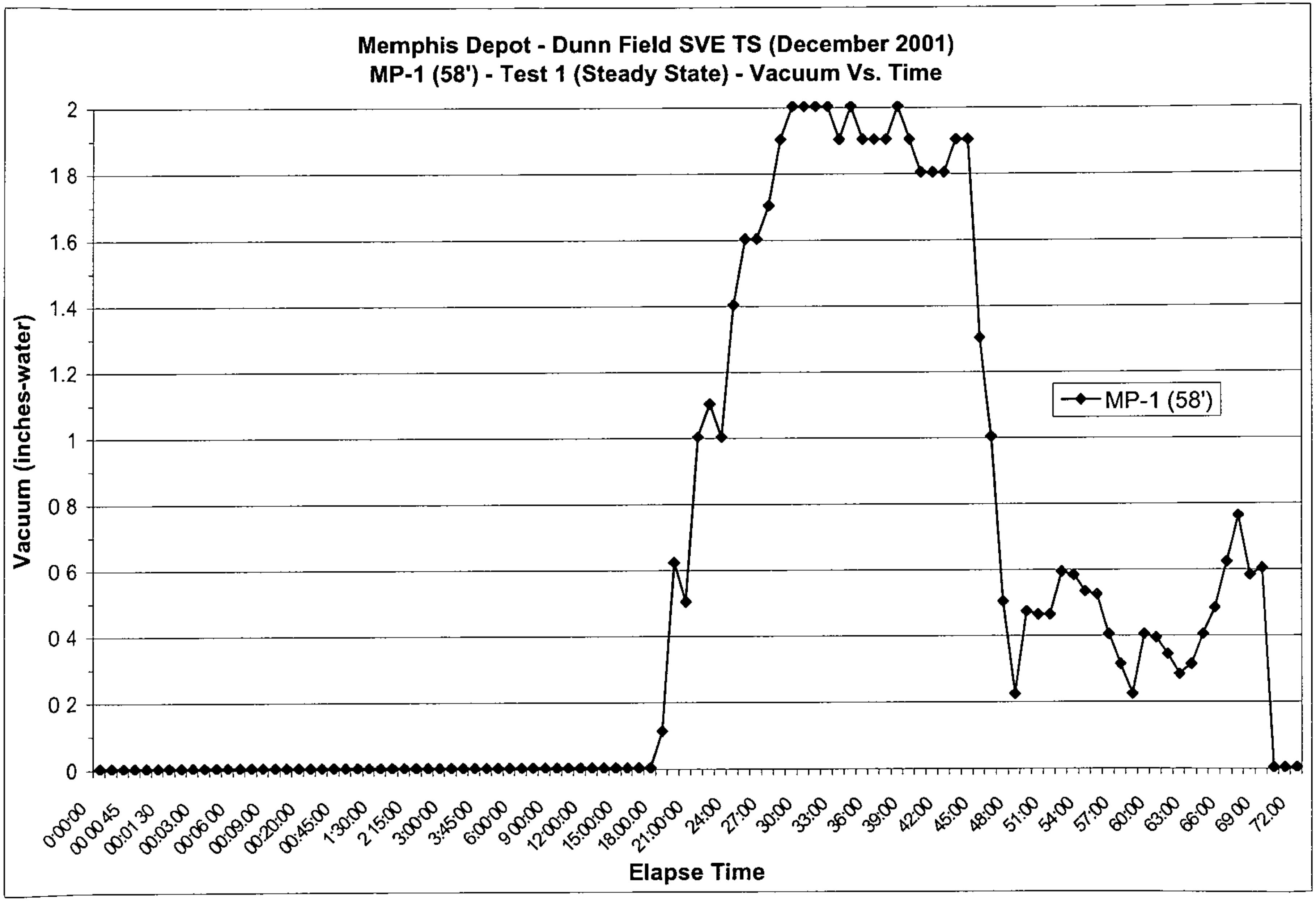
579 491

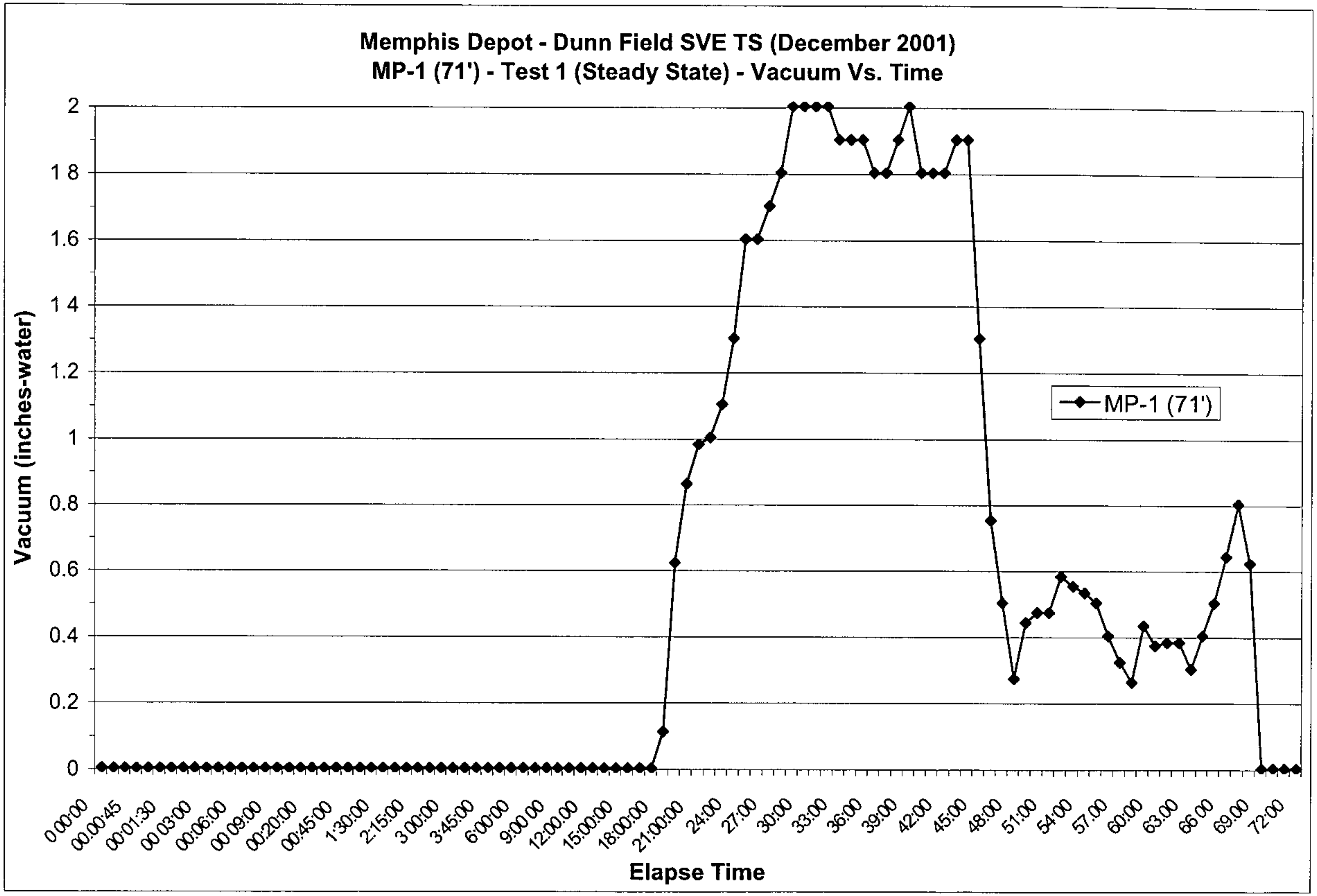


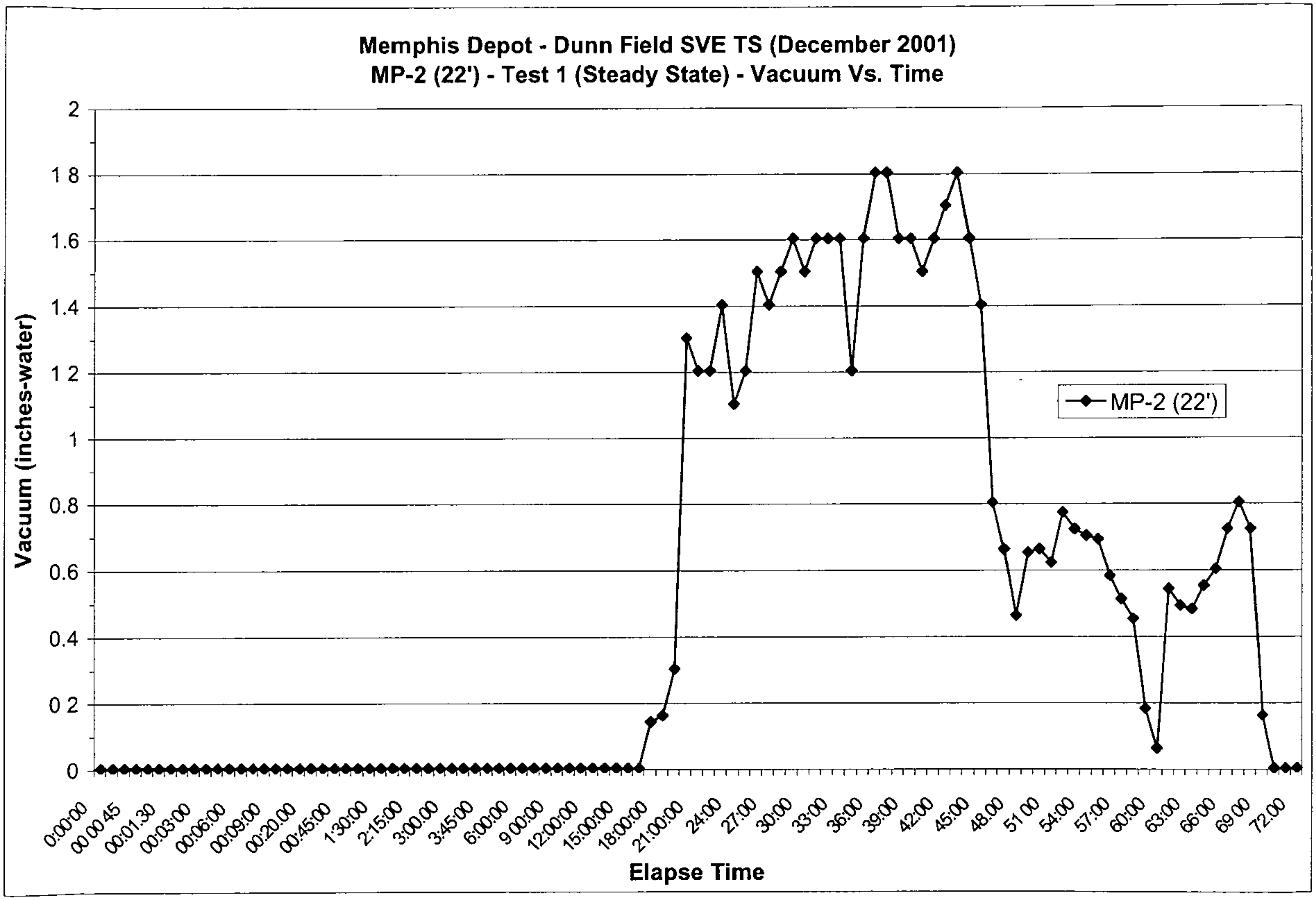
Memphis Depot - Dunn Field SVE TS (December 2001)
MP-1 (22') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
1
0 9
0 8
0 7
0 6
0 5
0.4
0 3
0.2
0.1
0
MP-1 (22')
0:00:00
00:00:45
00:01 30
00 03 00
00 06:00
00 09:00
00:20:00
00 45 00
1:30 00
2:15:00
3:00:00
3:45:00
6:00:00
9:00 00
12:00 00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51 00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

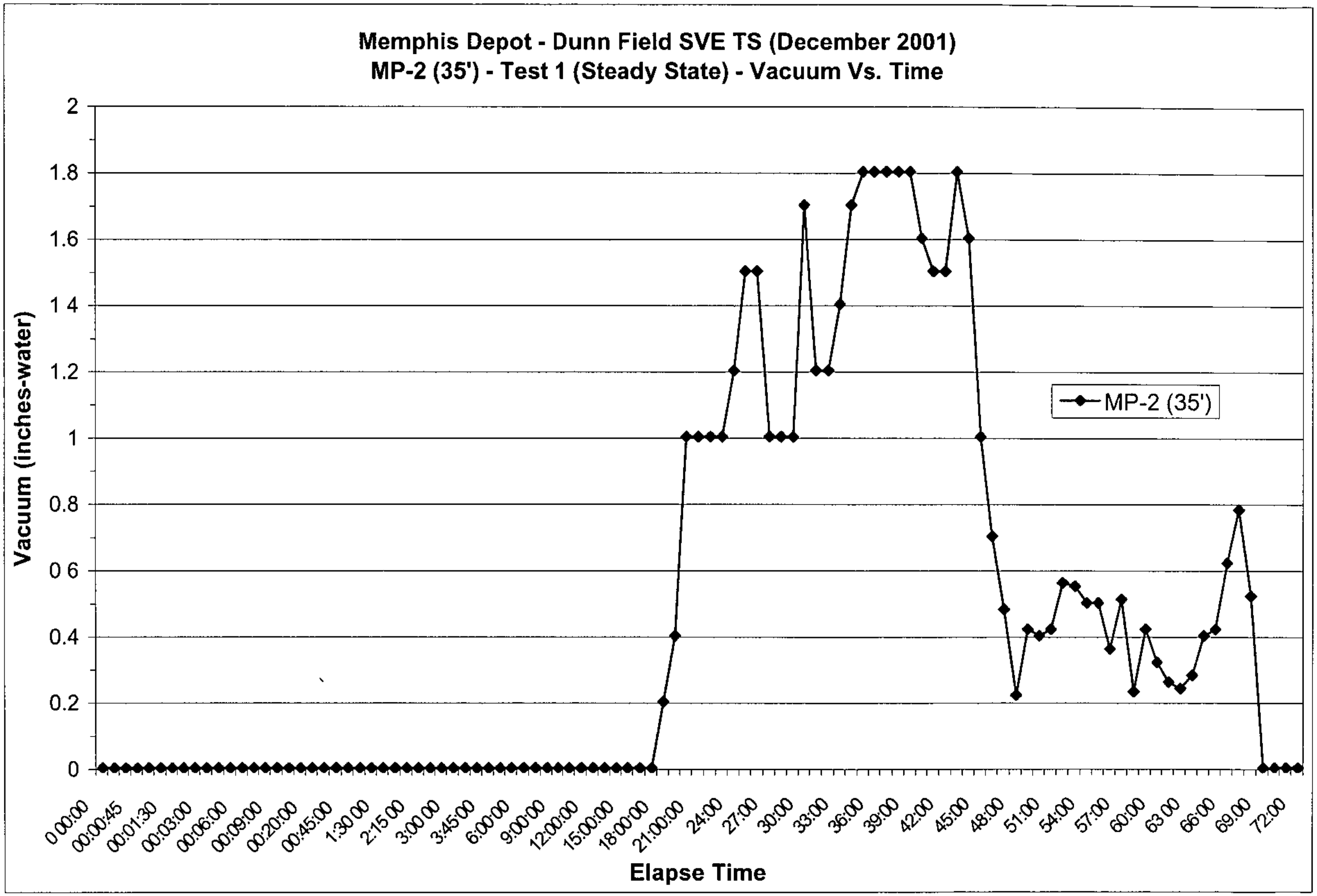

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-1 (35') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1 4
1 2
1
0 8
0 6
0 4
0 2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-1 (35')

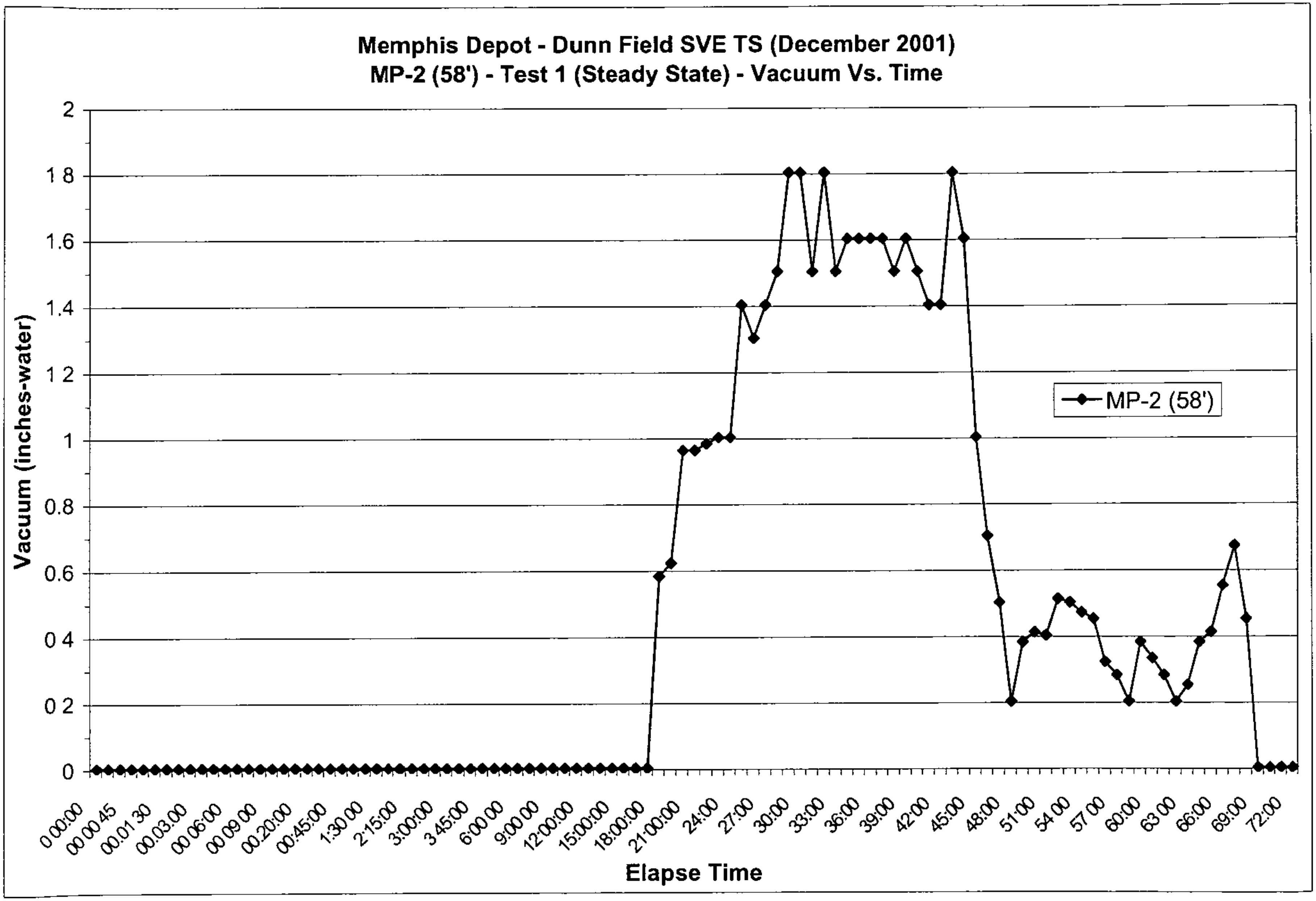
579 493


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-1 (58') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1 8
1.6
1.4
1.2
1
0 8
0 6
0 4
0 2
0
0:00:00
00 00 45
00:01 30
00:03.00
00:06 00
00:09.00
00:20:00
00:45:00
1:30:00
2 15:00
3:00:00
3:45:00
6:00:00
9 00:00
12:00:00
15:00:00
18:00.00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69 00
72:00
Elapse Time
MP-1 (58')


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-1 (71') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-1 (71')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

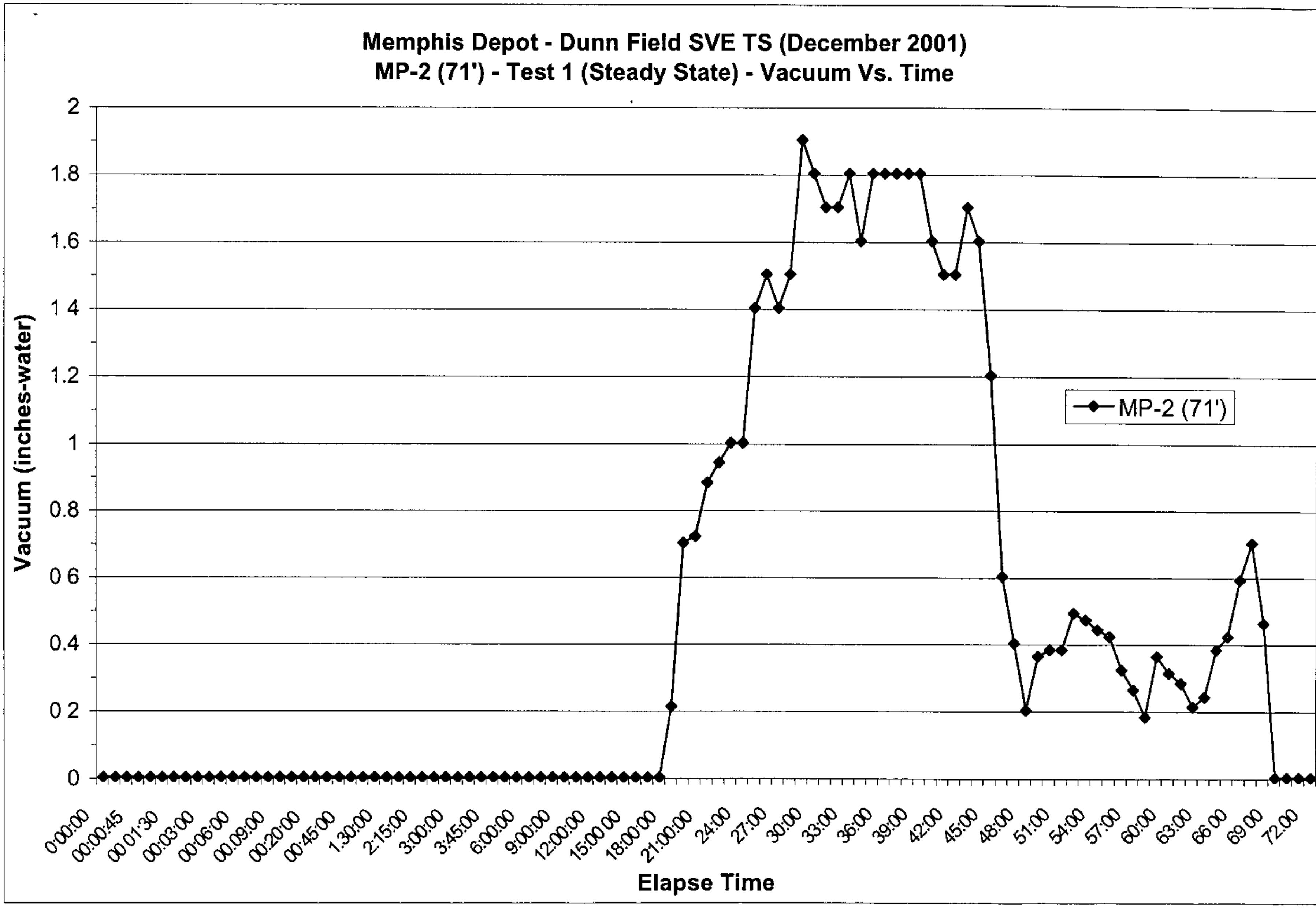

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-2 (22') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-2 (22')
0
0 2
0.4
0.6
0.8
1
1 2
1.4
1.6
1 8
2
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-2 (35') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-2 (35')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

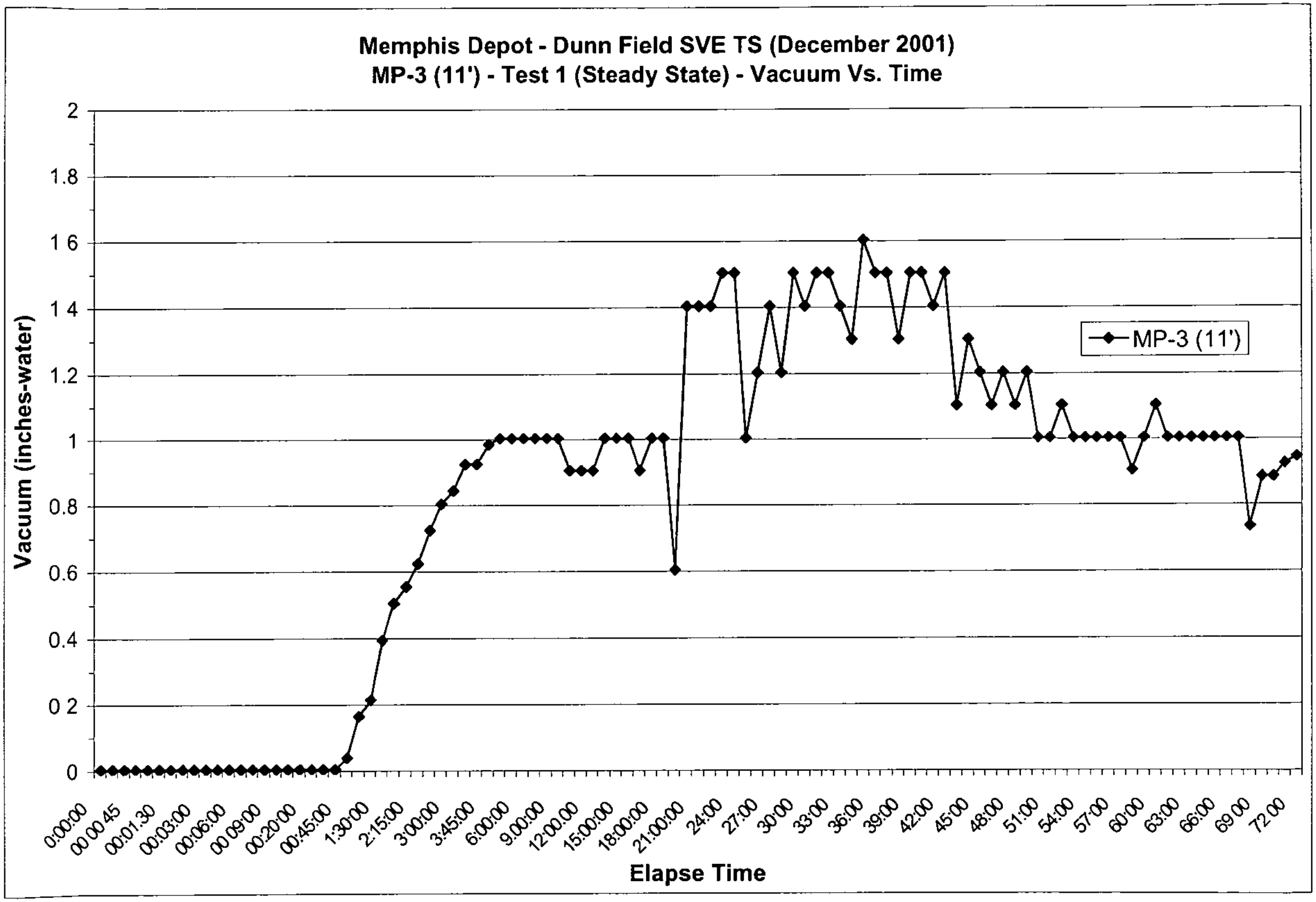


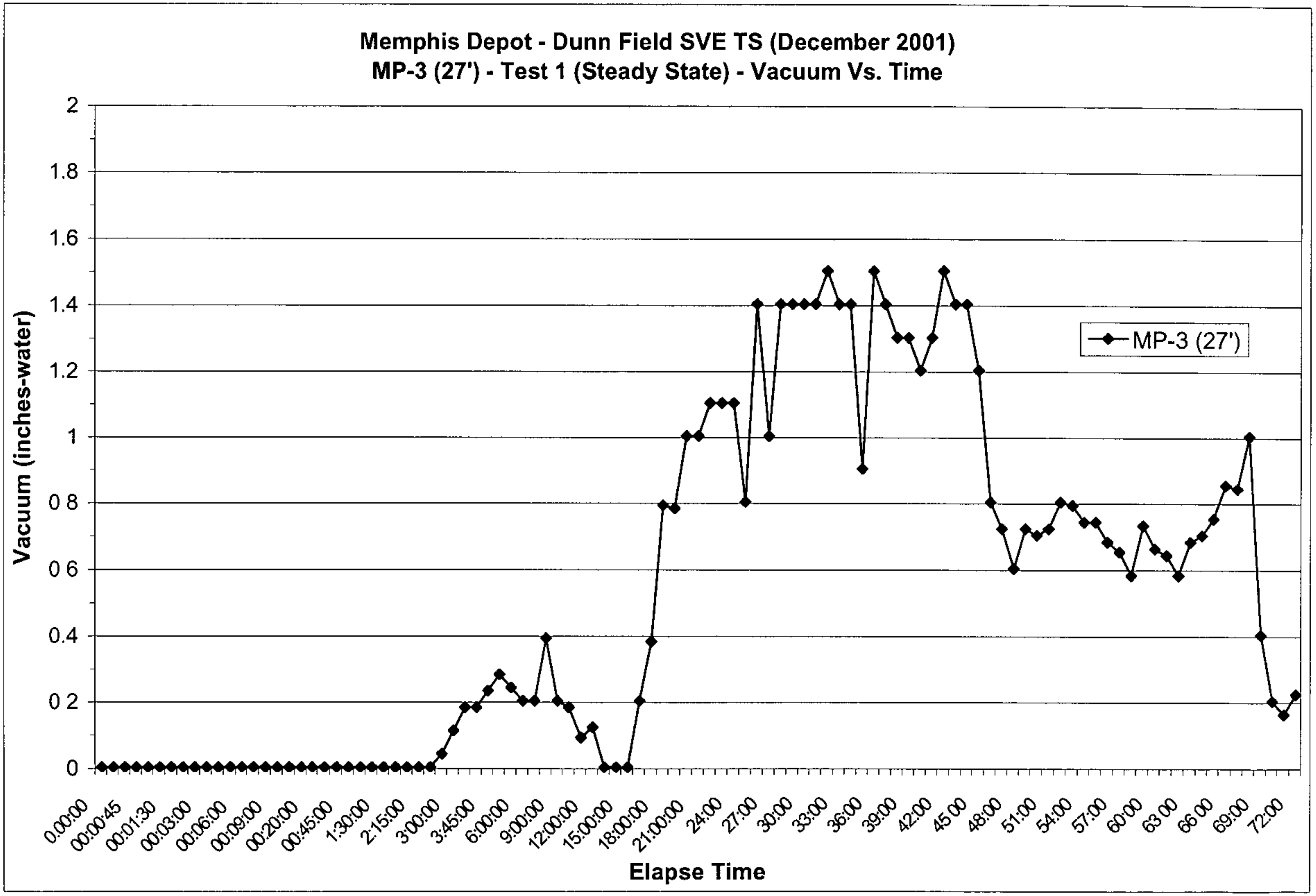
Memphis Depot - Dunn Field SVE TS (December 2001)
MP-2 (58') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-2 (58')

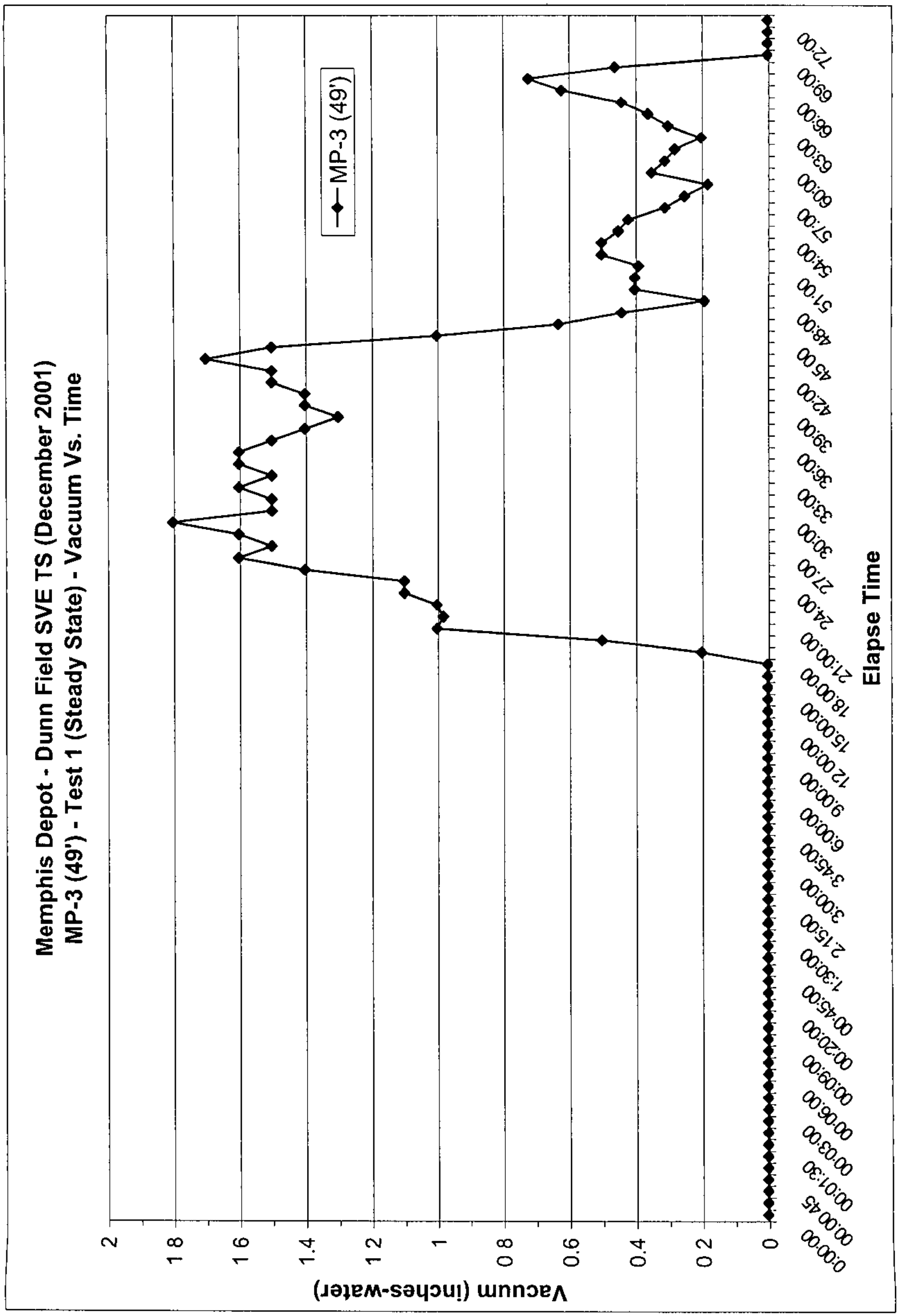
579 497

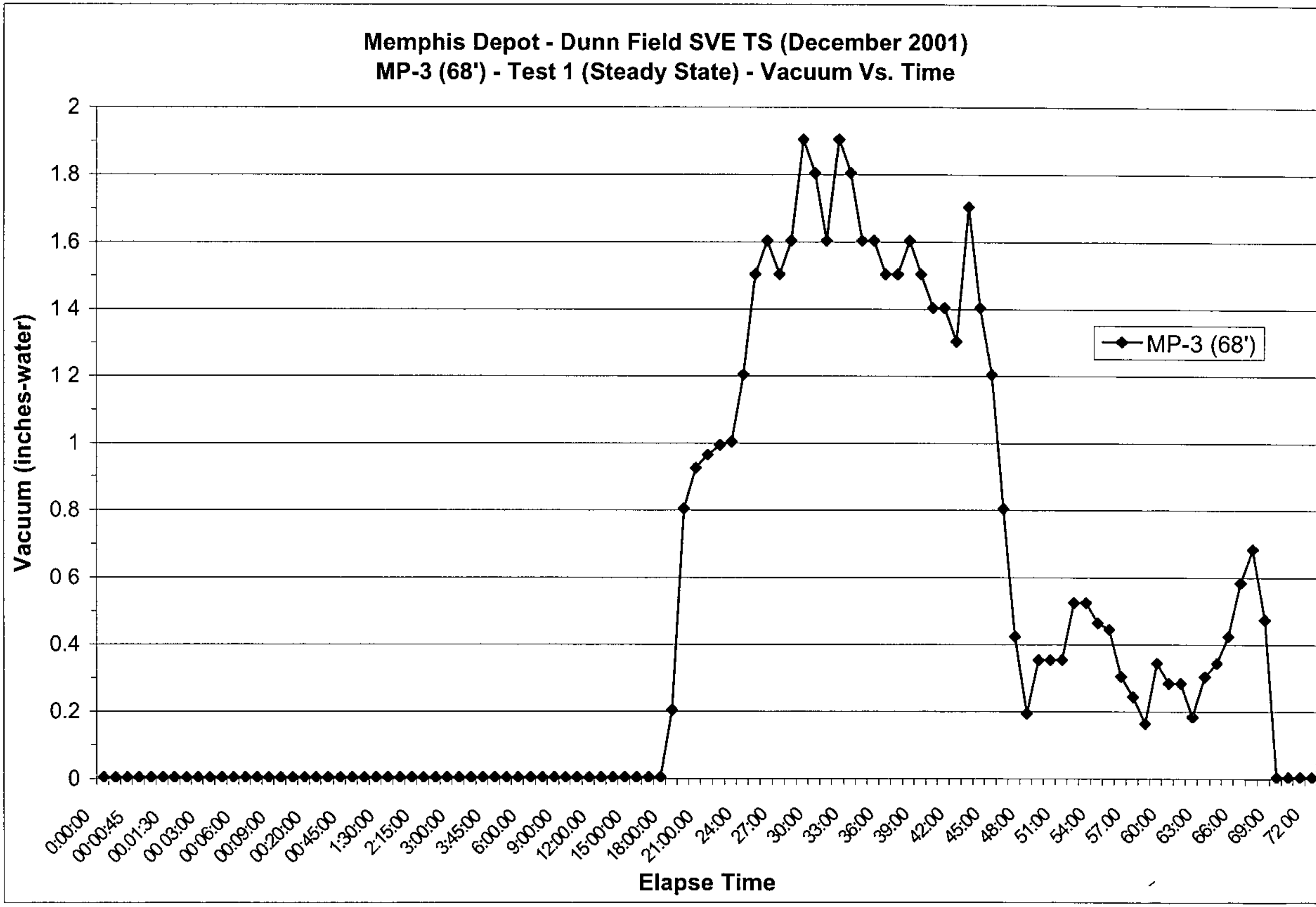


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-2 (71') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-2 (71')
0
0 2
0.4
0 6
0.8
1
1.2
1 4
1.6
1.8
2
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00

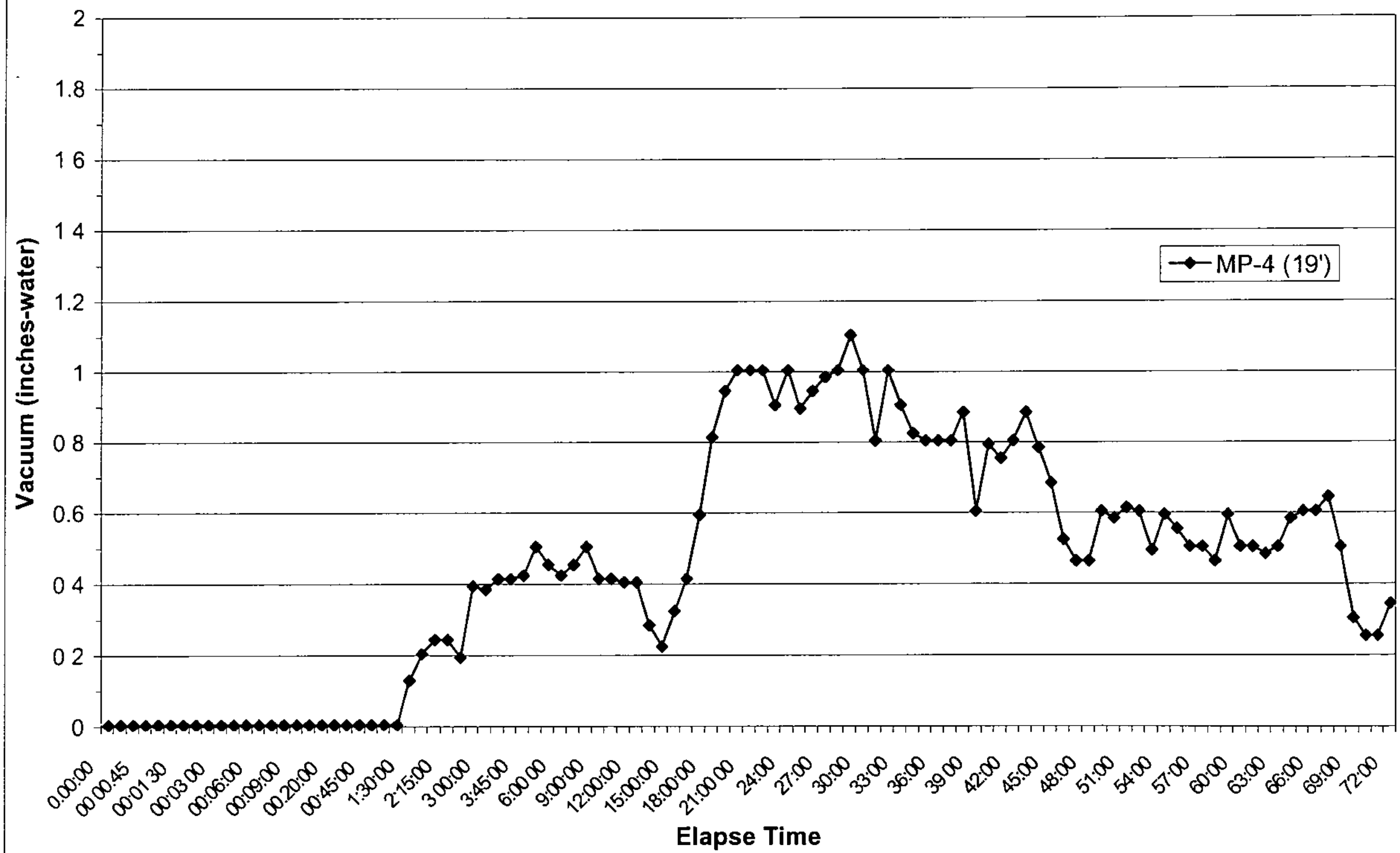

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-3 (11') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-3 (11')
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00

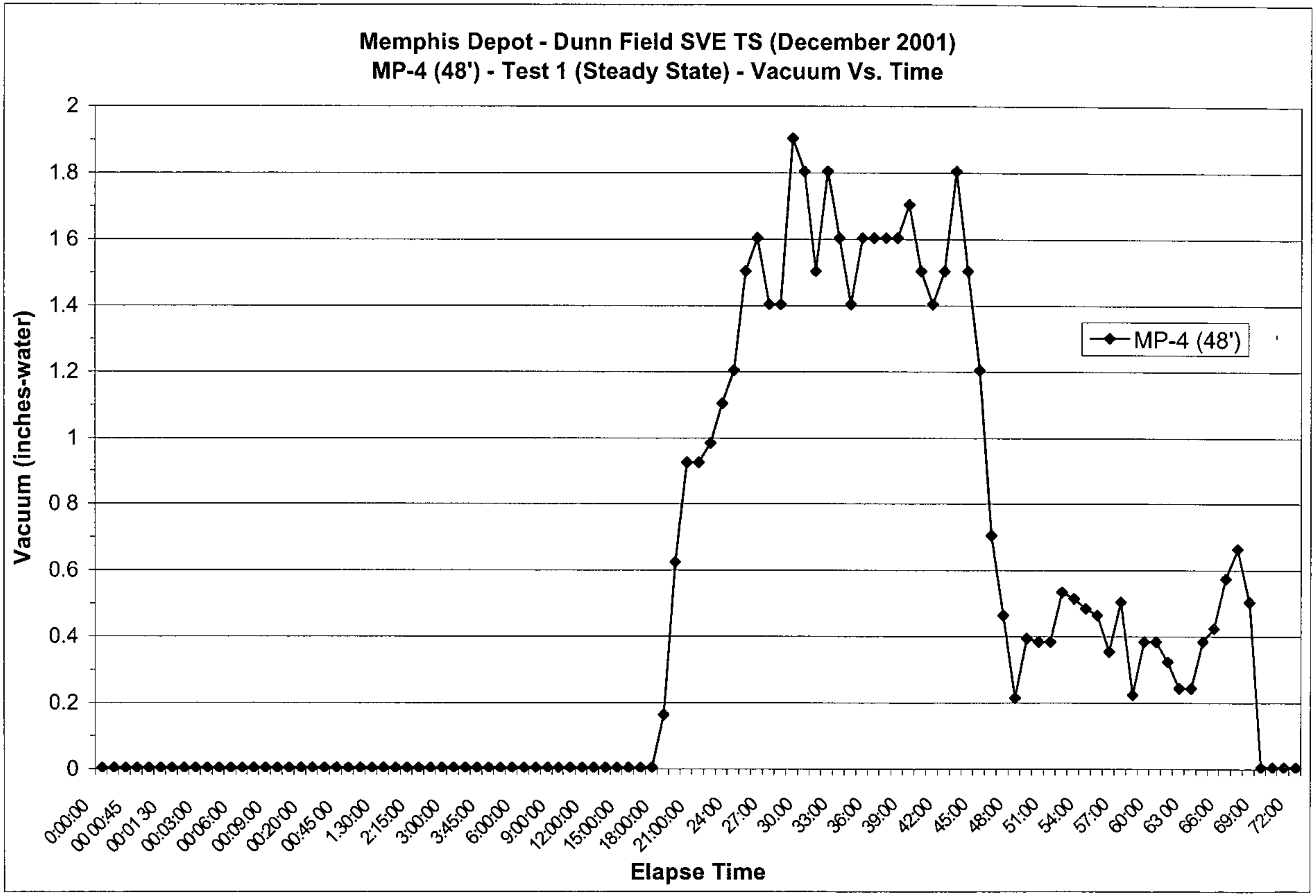

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-3 (27') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-3 (27')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

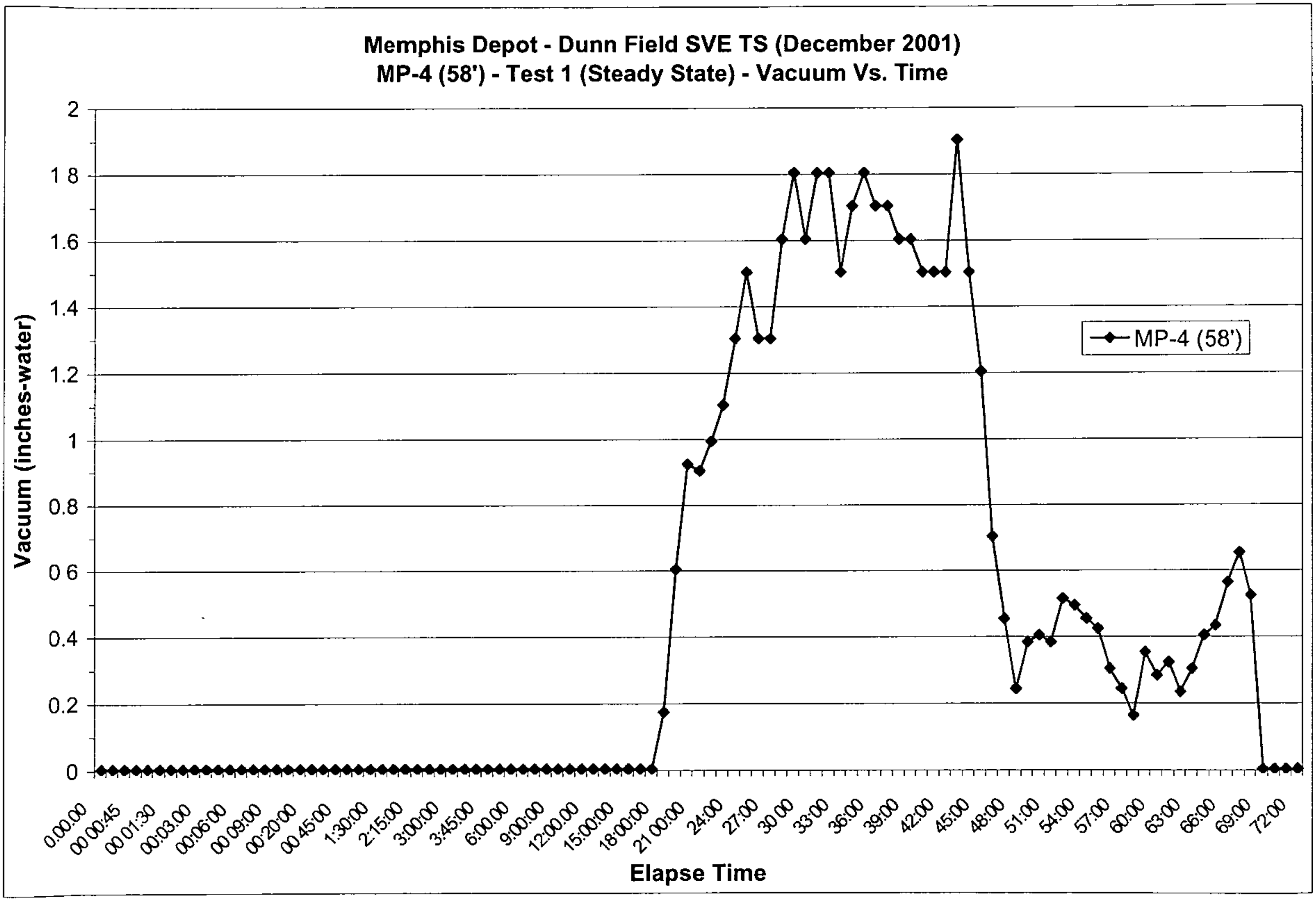

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-3 (49') - Test 1 (Steady State) - Vacuum Vs. Time
MP-3 (49')
Vacuum (inches-water)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-3 (68') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-3 (68')
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-4 (19') - Test 1 (Steady State) - Vacuum Vs. Time

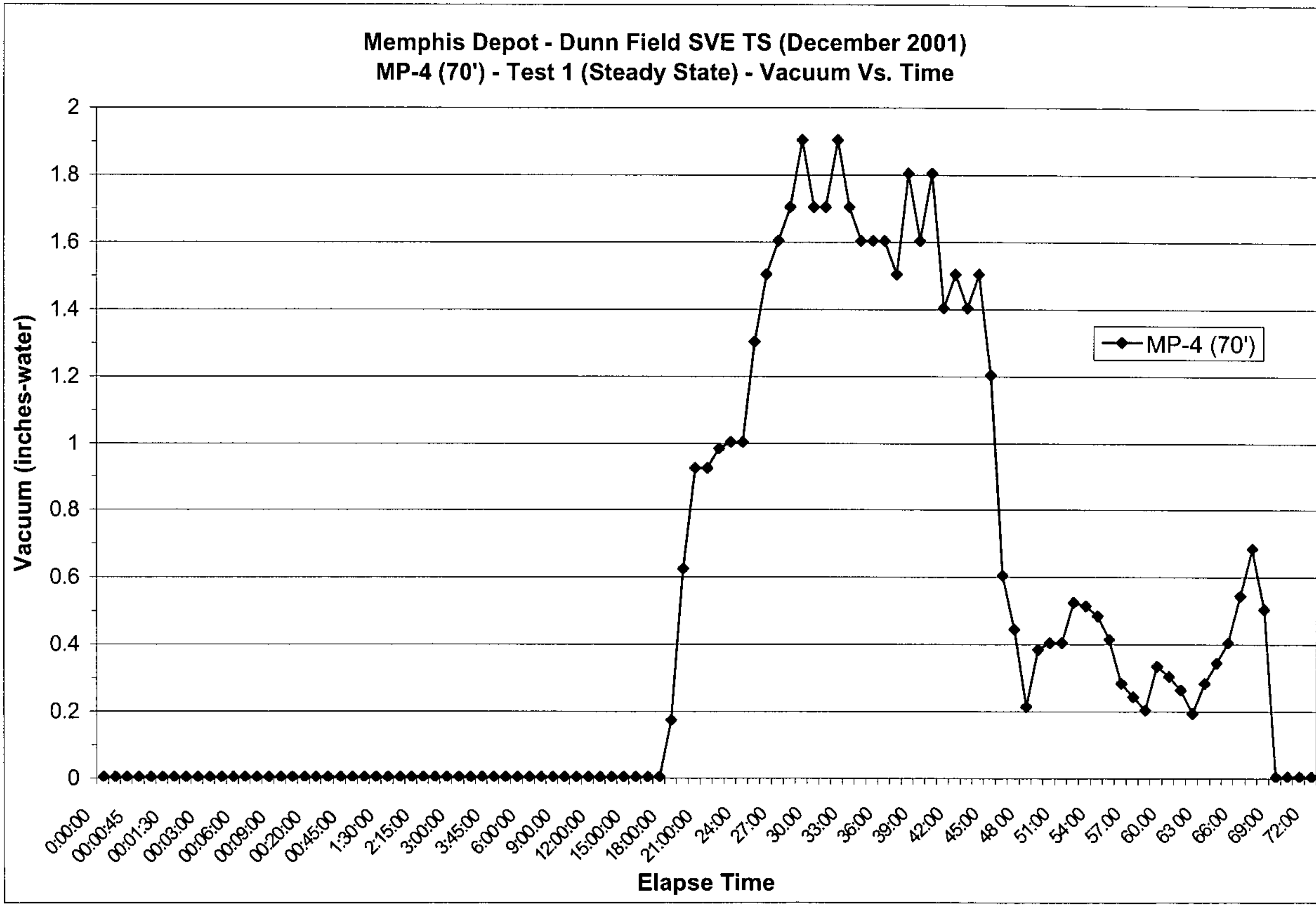



Memphis Depot - Dunn Field SVE TS (December 2001)
MP-4 (48') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-4 (48')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

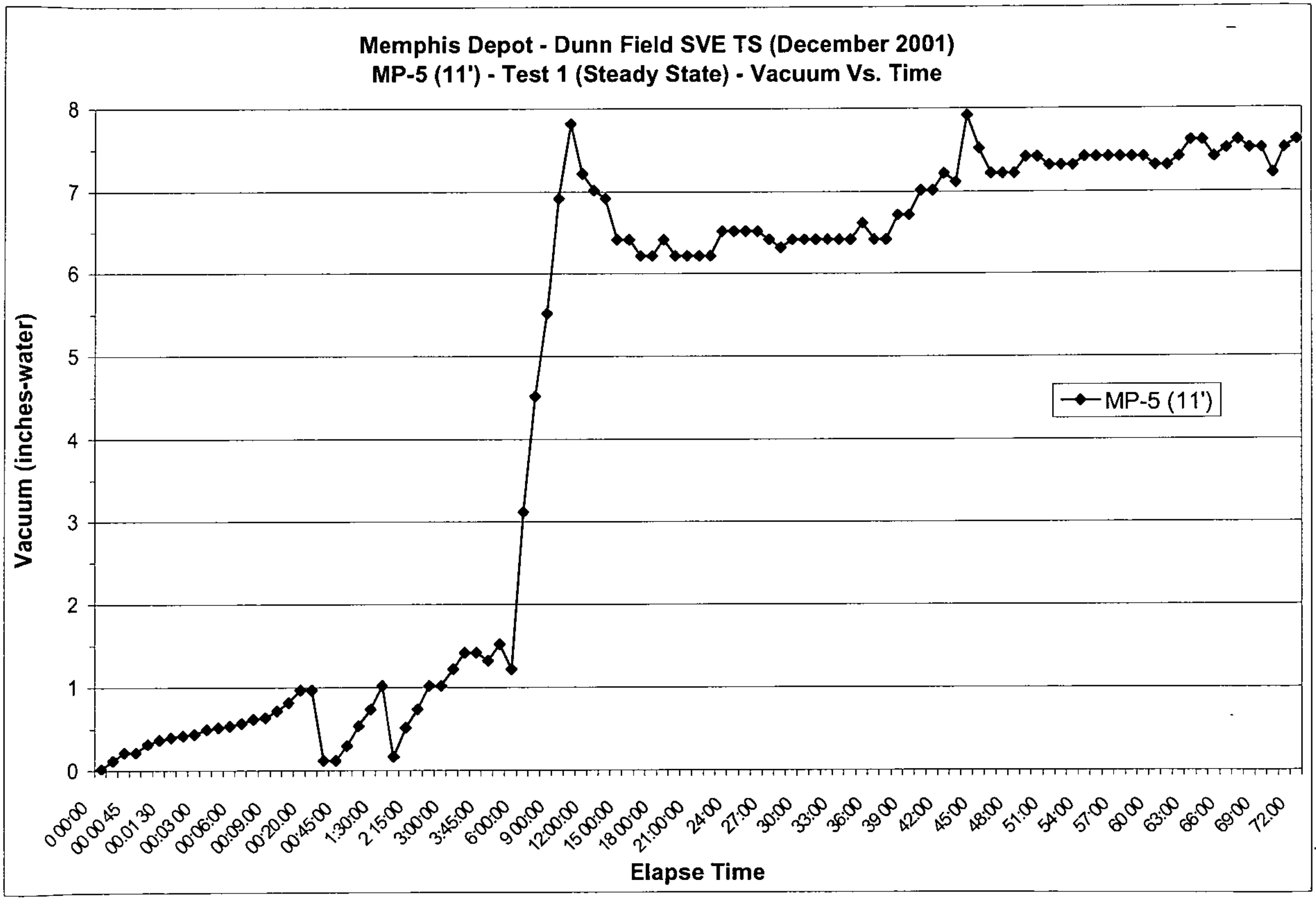


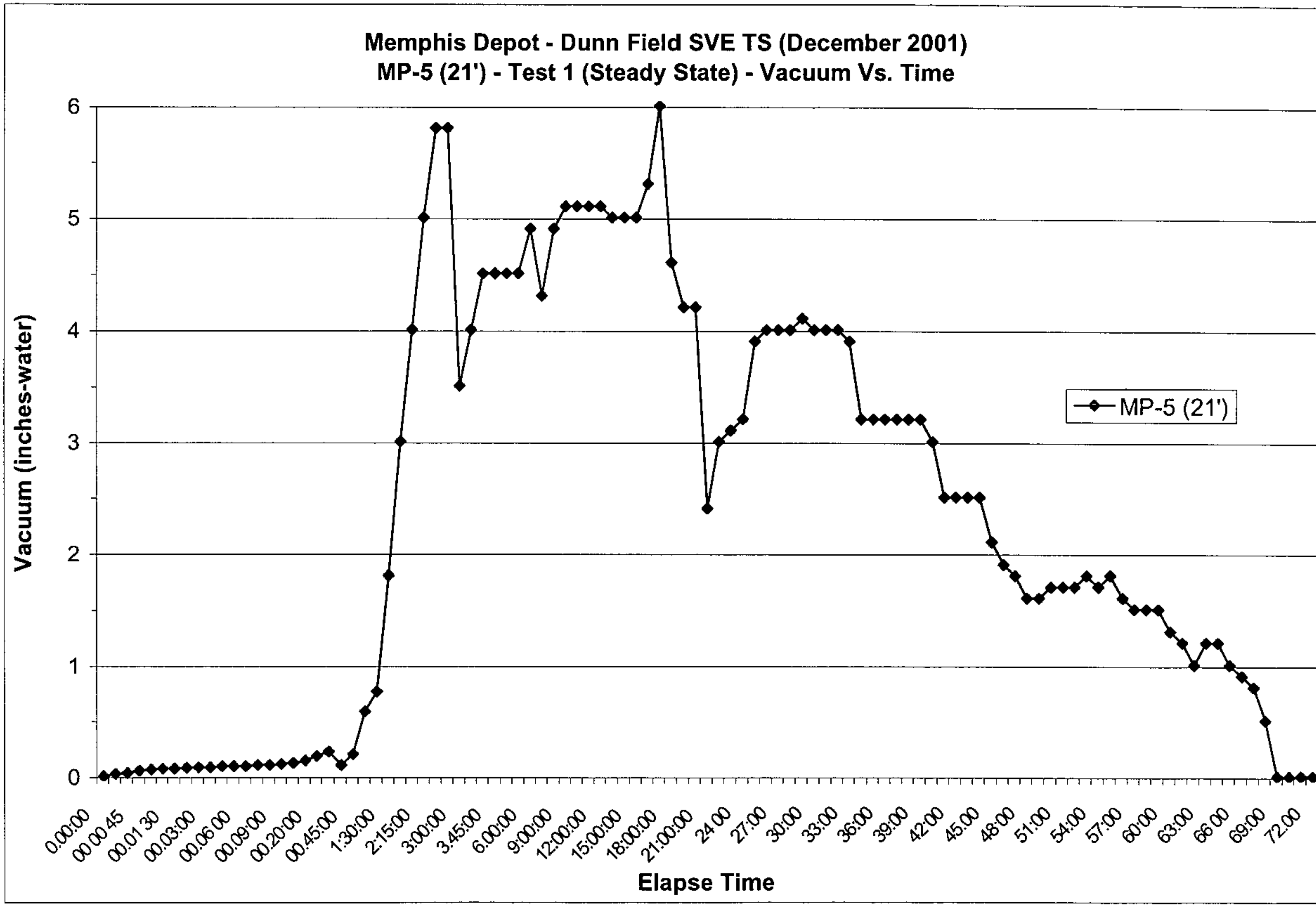
Memphis Depot - Dunn Field SVE TS (December 2001)
MP-4 (58') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-4 (58')
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00

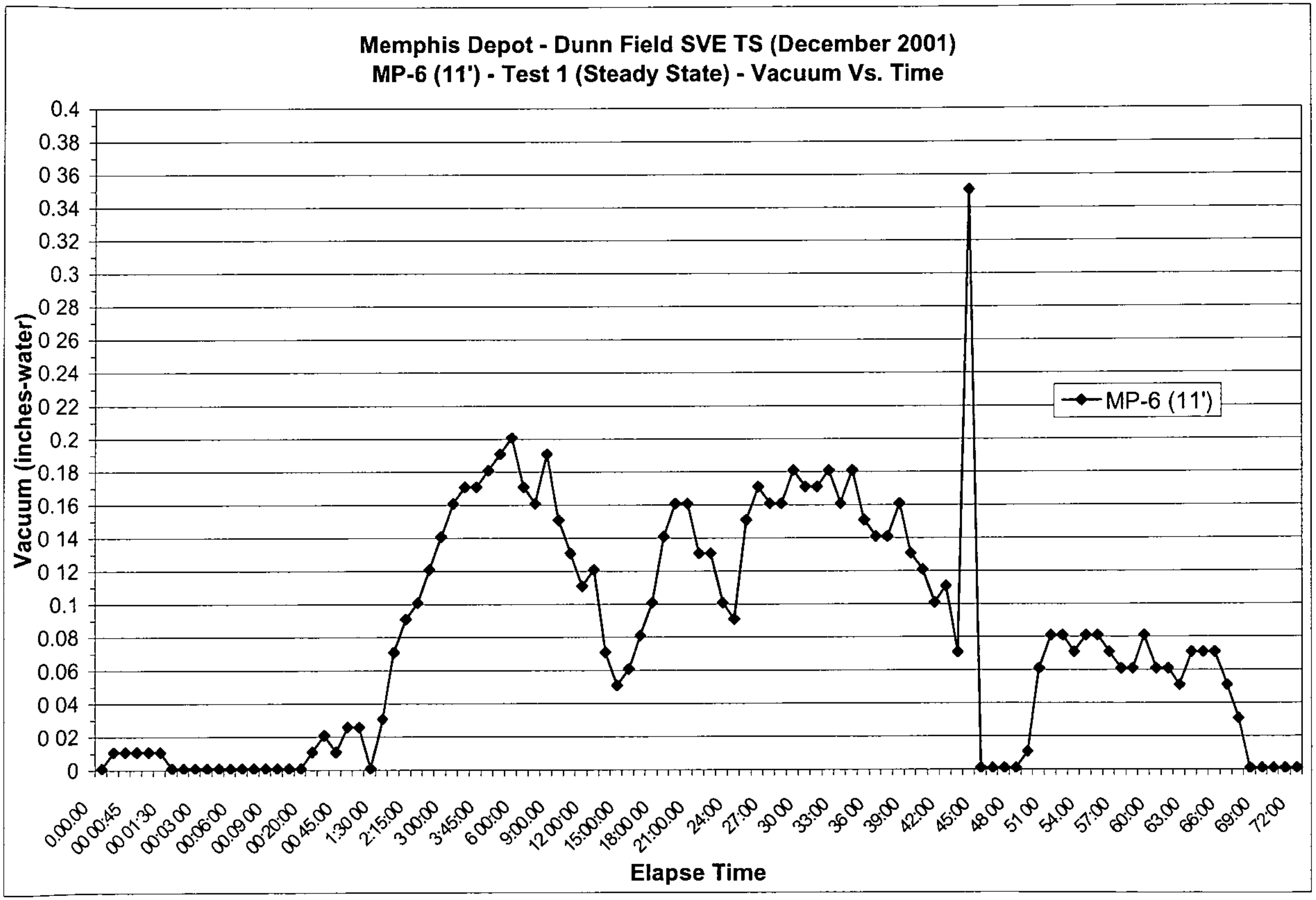
579 505

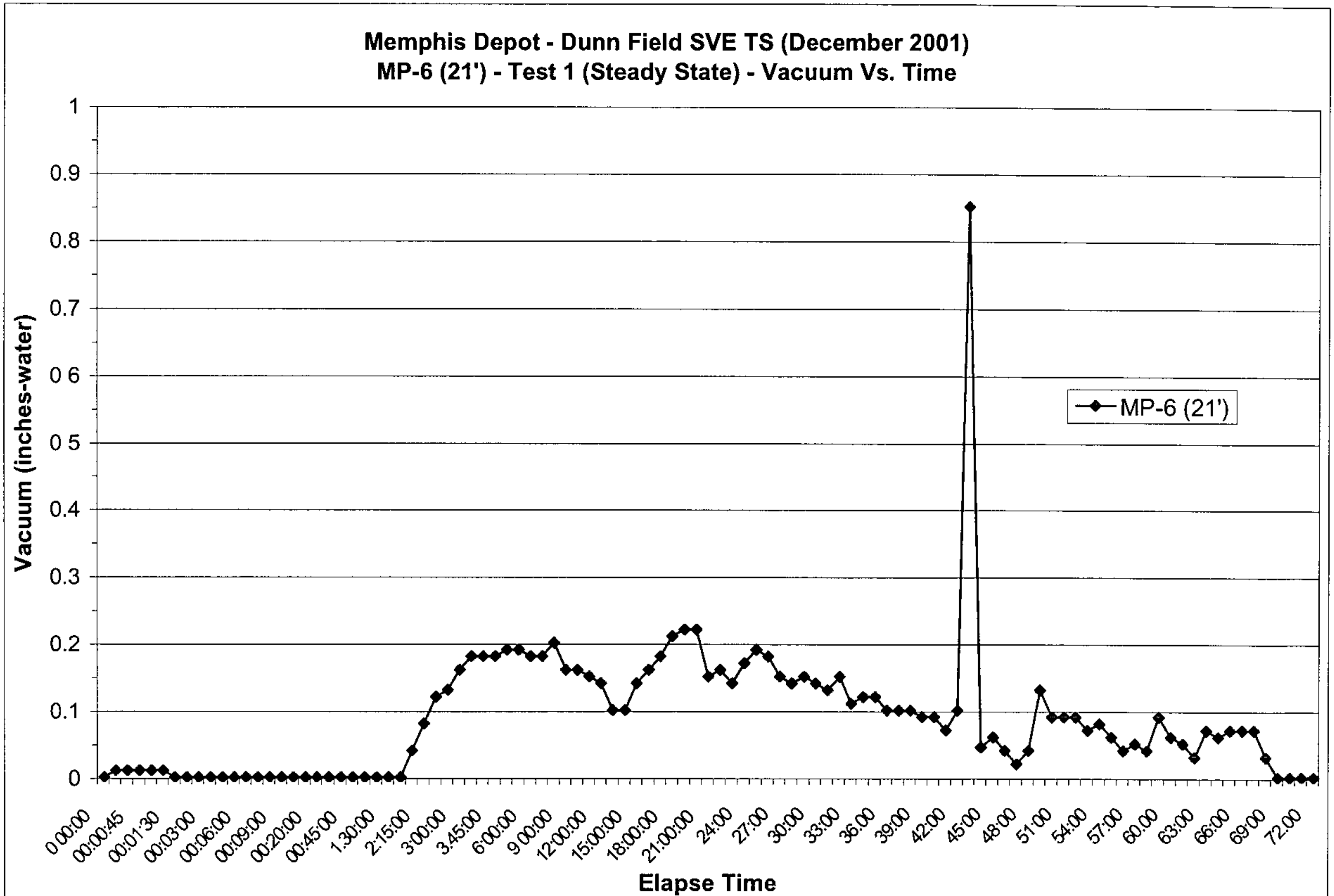


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-4 (70') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-4 (70')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

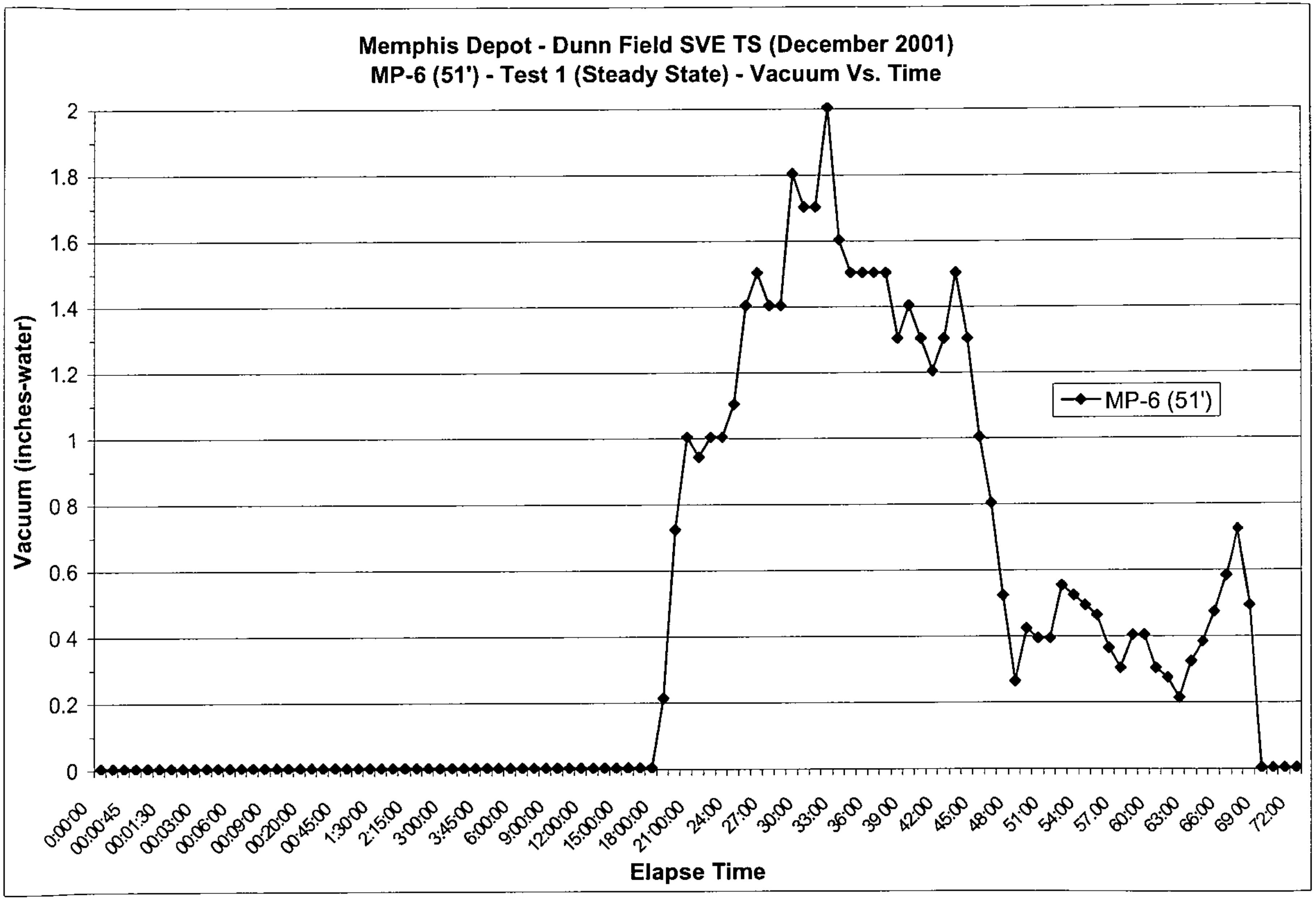

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-5 (11') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0
1
2
3
4
5
6
7
8
MP-5 (11')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-5 (21') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0
1
2
3
4
5
6
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-5 (21')

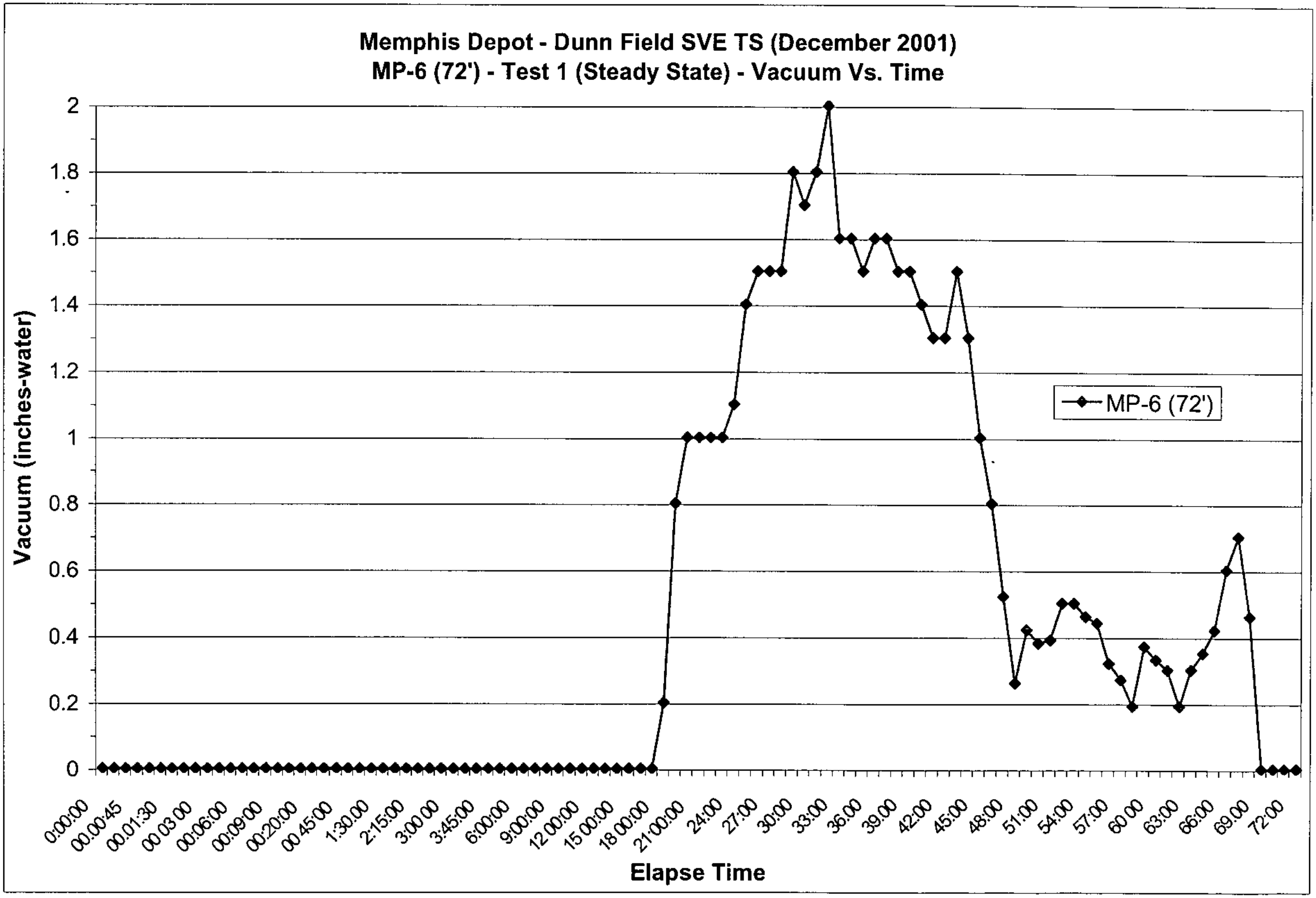

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-6 (11') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0.4
0.38
0 36
0.34
0.32
0.3
0 28
0 26
0.24
0 22
0.2
0.18
0.16
0 14
0 12
0.1
0.08
0.06
0 04
0 02
0
MP-6 (11')
0.00.00
00 00:45
00 01:30
00:03 00
00:06:00
00:09 00
00:20:00
00 45:00
1:30 00
2:15:00
3 00:00
3:45:00
6 00:00
9:00.00
12 00:00
15:00:00
18:00 00
21:00.00
24:00
27:00
30 00
33:00
36 00
39:00
42:00
45:00
48 00
51 00
54.00
57:00
60:00
63.00
66:00
69:00
72:00
Elapse Time

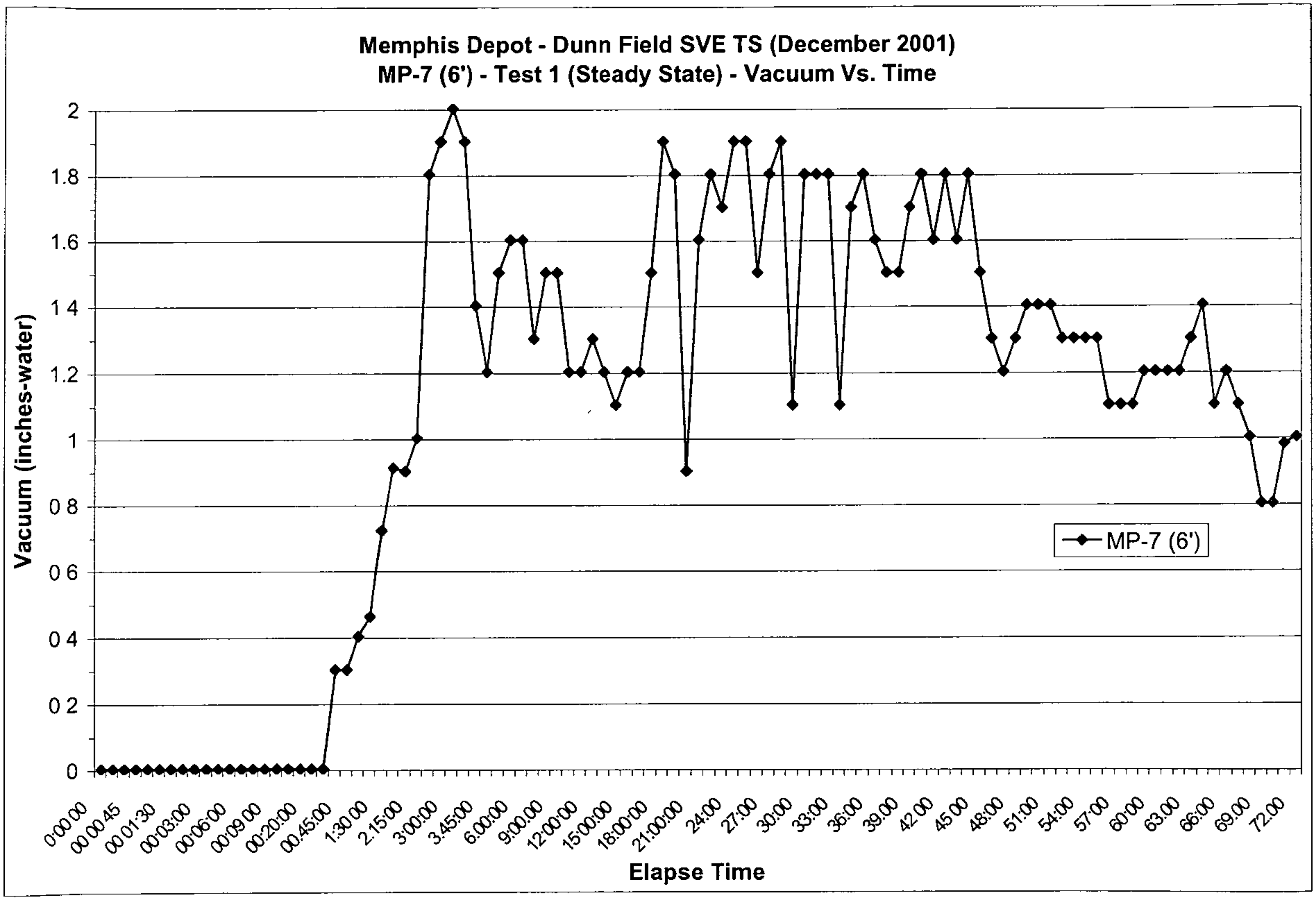


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-6 (21') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0
0.1
0.2
0.3
0.4
0 5
0 6
0.7
0.8
0.9
1
MP-6 (21')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-6 (51') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MP-6 (51')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

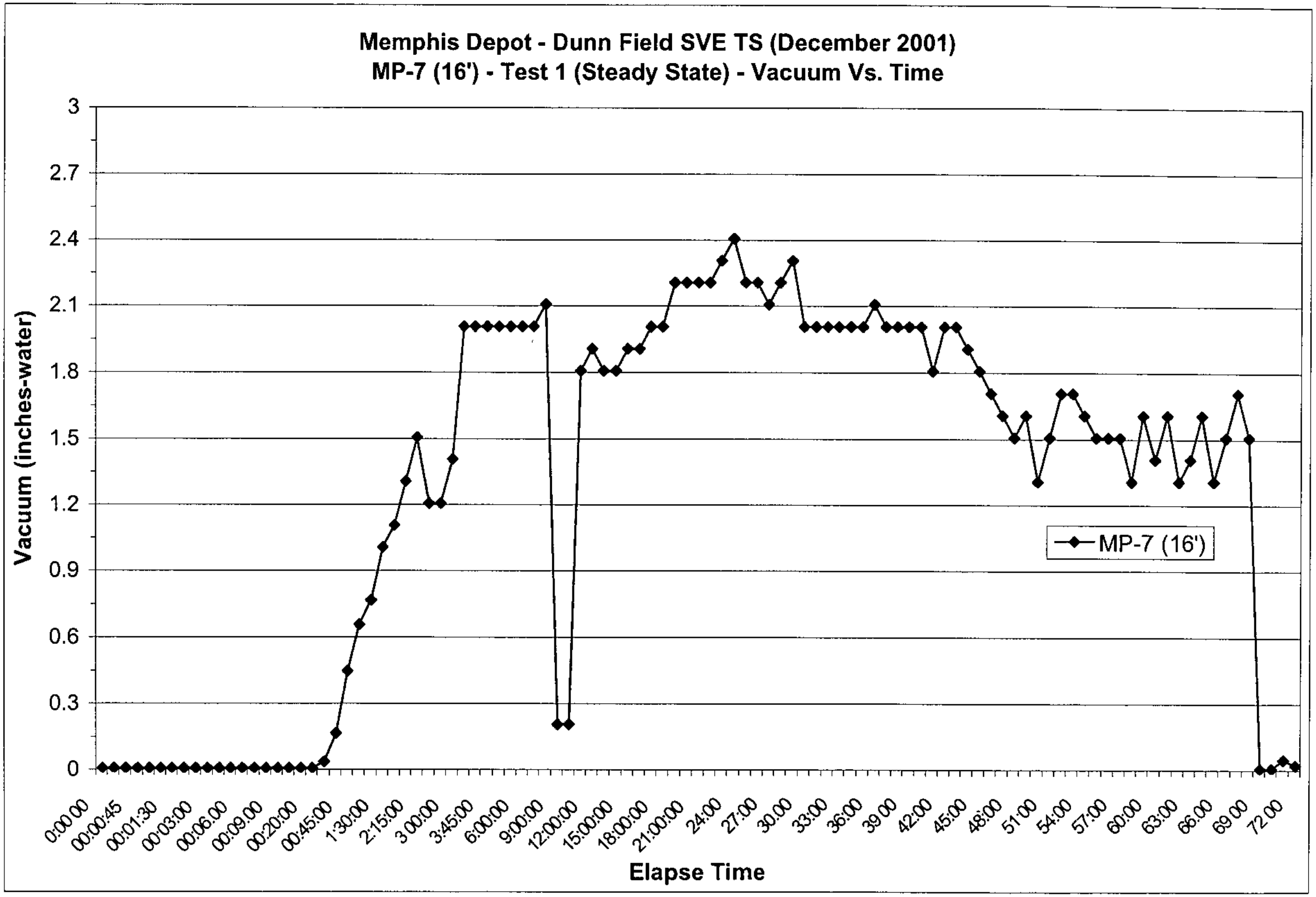
579 512

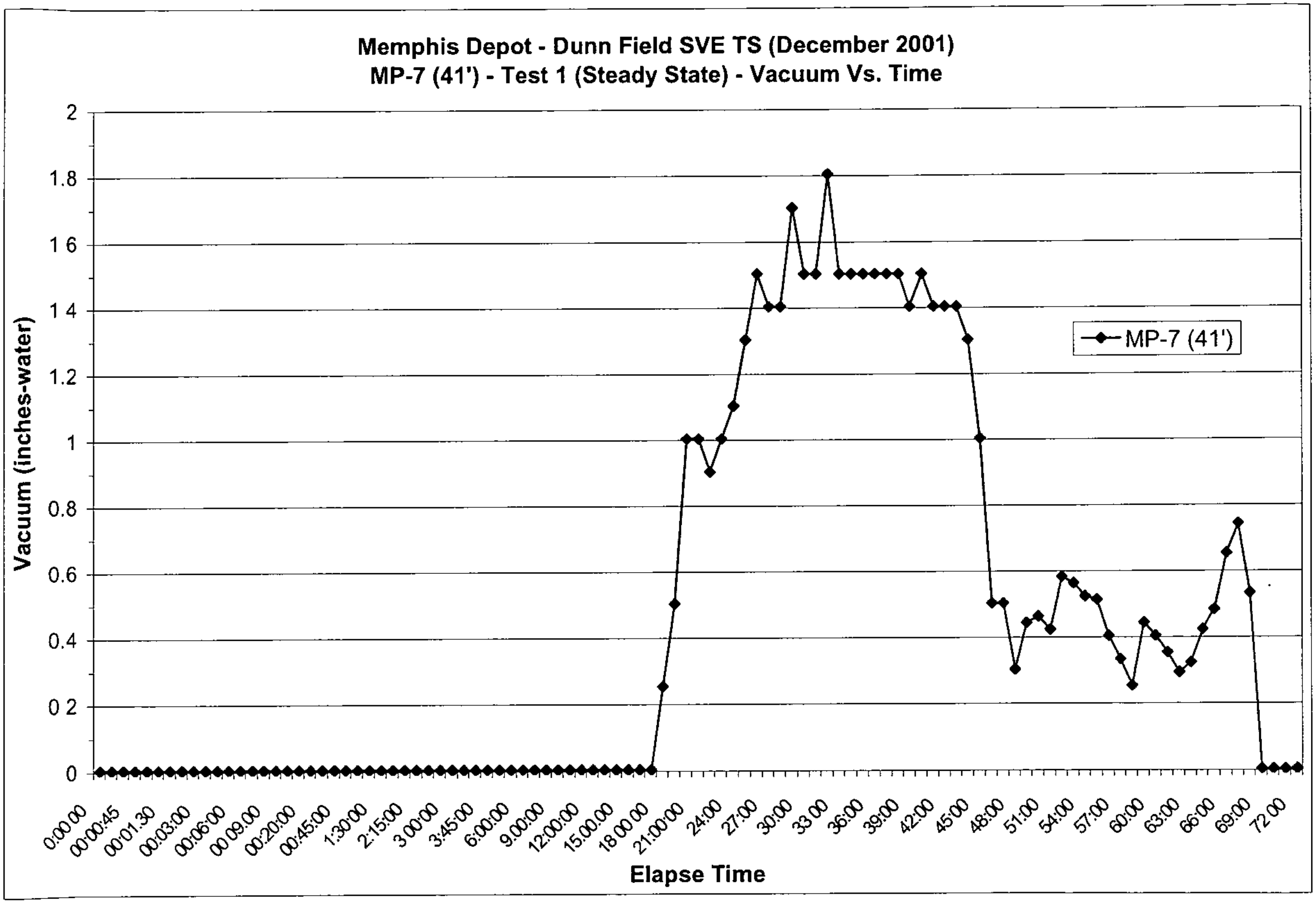

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-6 (72') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-6 (72')

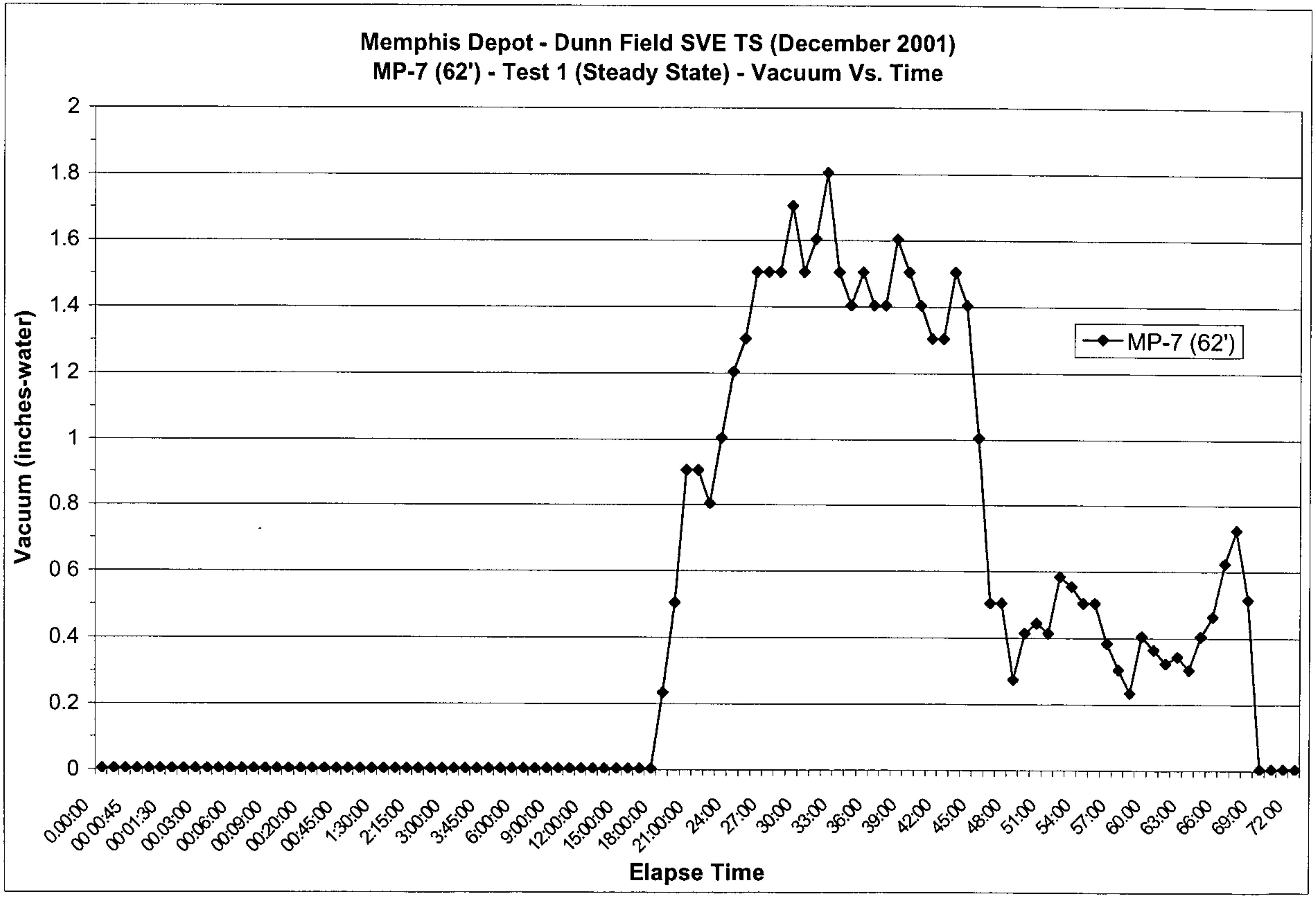


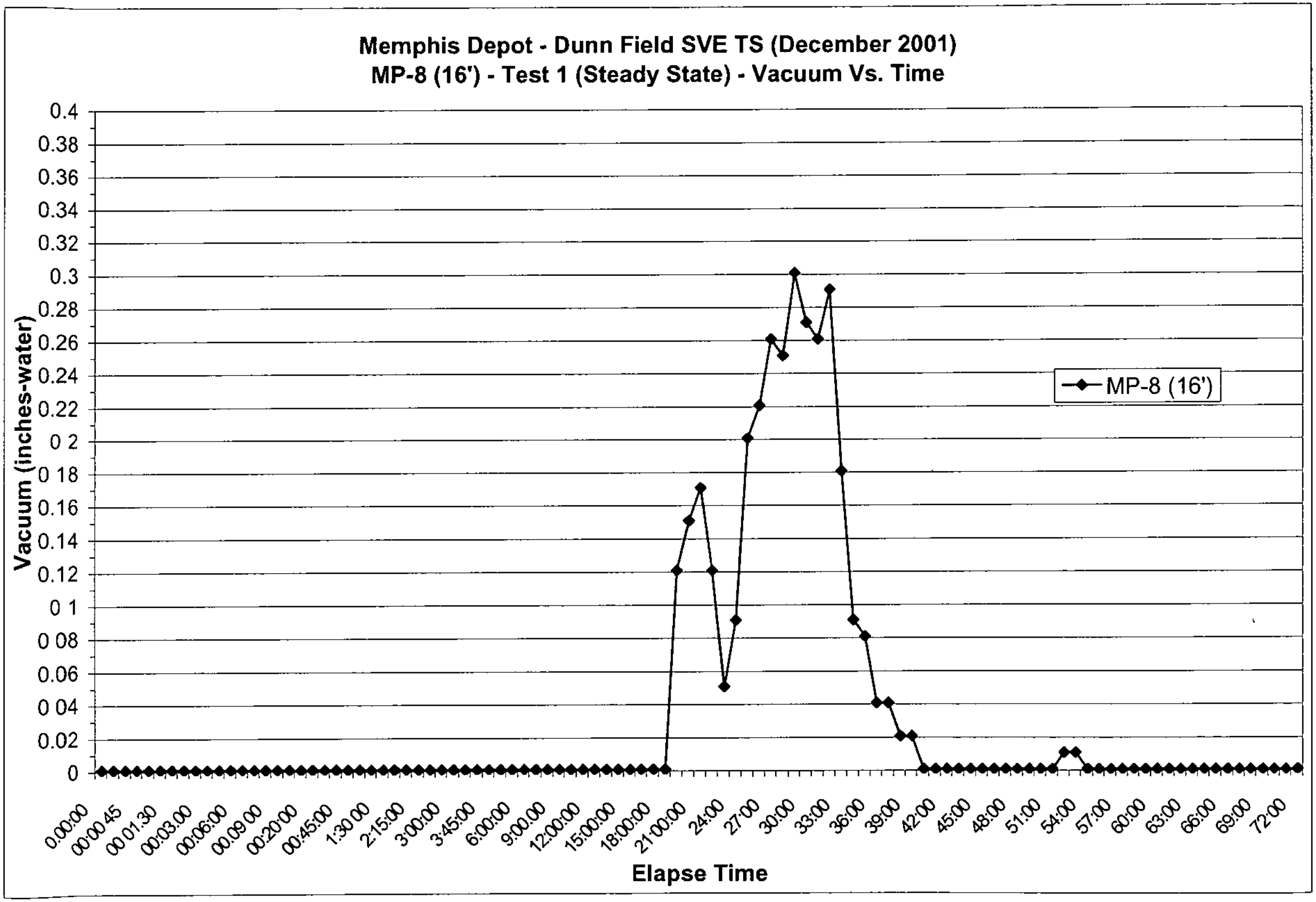
Memphis Depot - Dunn Field SVE TS (December 2001)
MP-7 (6') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1 4
1.2
1
0 8
0 6
0 4
0 2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-7 (6')

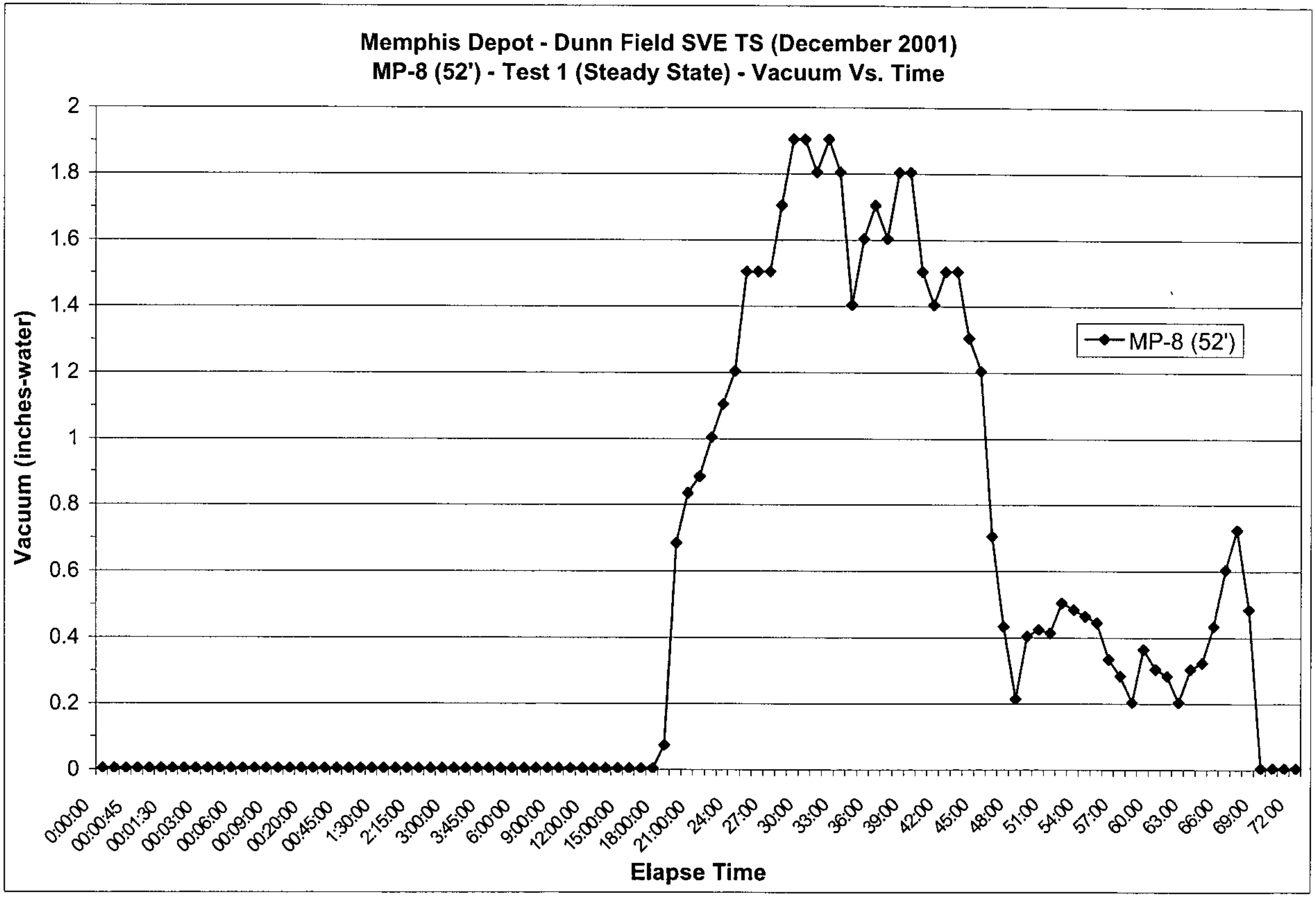
579 513

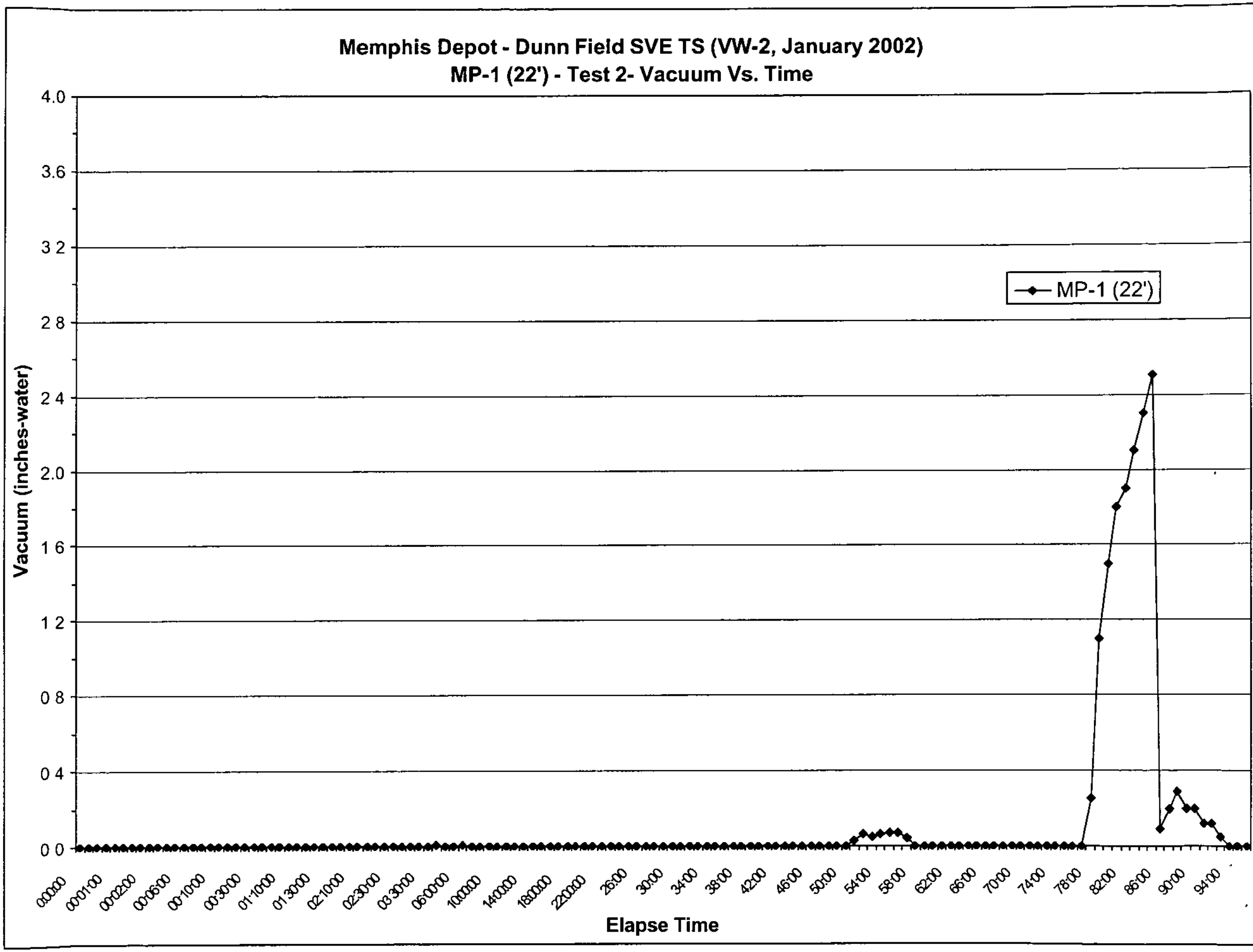

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-7 (16') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
3
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time
MP-7 (16')

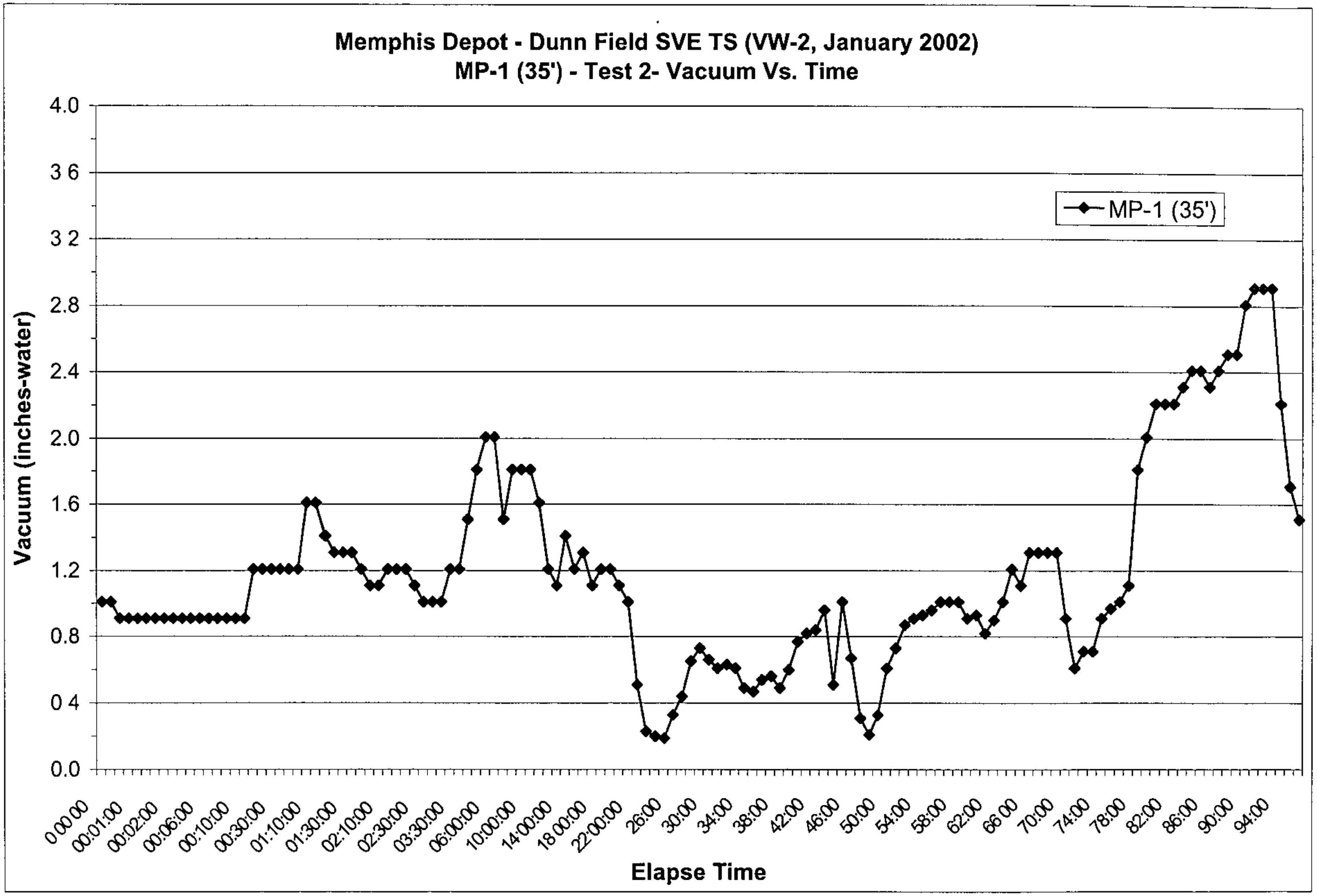

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-7 (41') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-7 (41')
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00

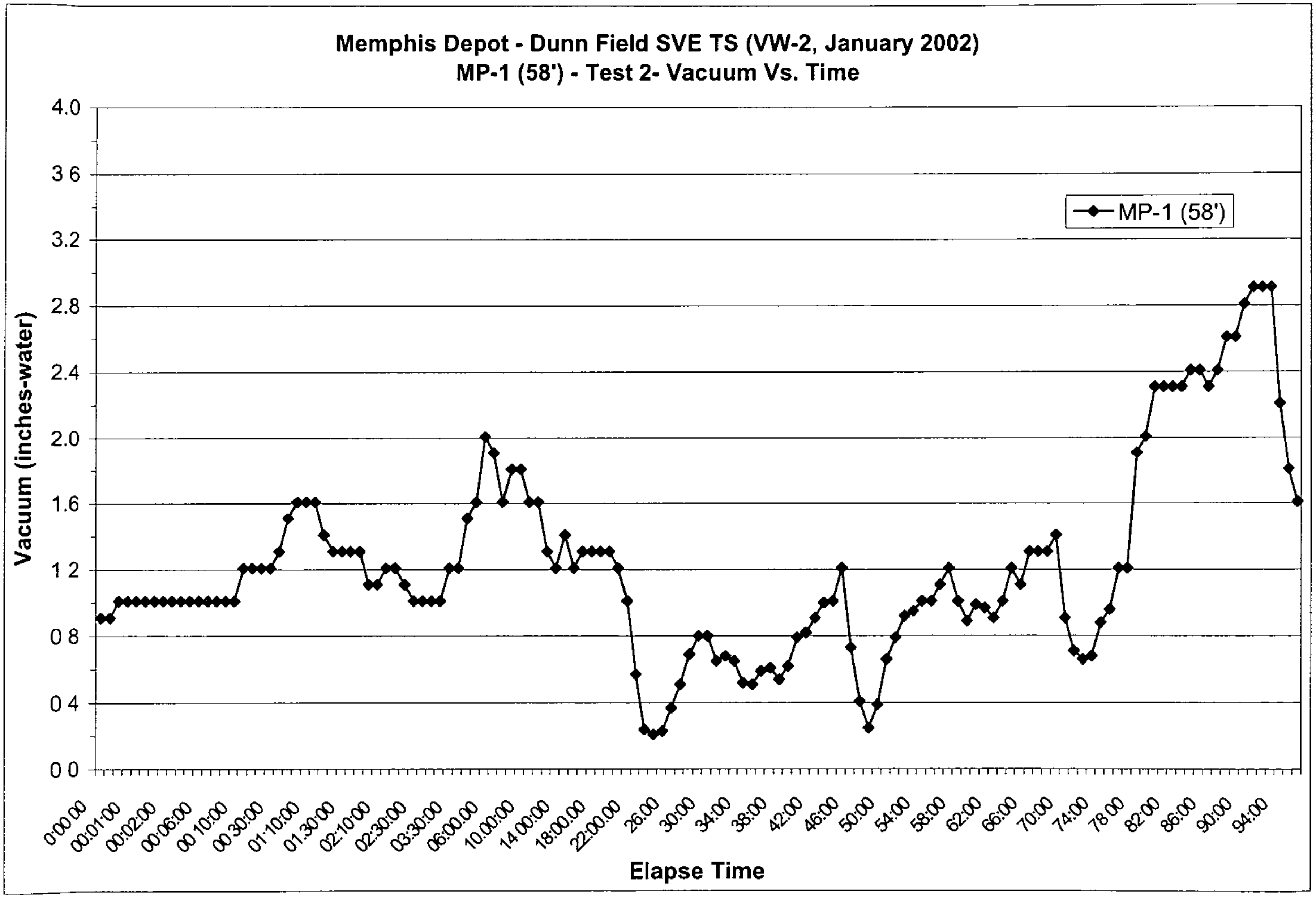

Memphis Depot - Dunn Field SVE TS (December 2001)
MP-7 (62') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
2
1.8
1.6
1.4
1 2
1
0.8
0 6
0.4
0.2
0
MP-7 (62')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-8 (16') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0.4
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
MP-8 (16')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (December 2001)
MP-8 (52') - Test 1 (Steady State) - Vacuum Vs. Time
Vacuum (inches-water)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
MP-8 (52')
0:00:00
00:00:45
00:01:30
00:03:00
00:06:00
00:09:00
00:20:00
00:45:00
1:30:00
2:15:00
3:00:00
3:45:00
6:00:00
9:00:00
12:00:00
15:00:00
18:00:00
21:00:00
24:00
27:00
30:00
33:00
36:00
39:00
42:00
45:00
48:00
51:00
54:00
57:00
60:00
63:00
66:00
69:00
72:00
Elapse Time

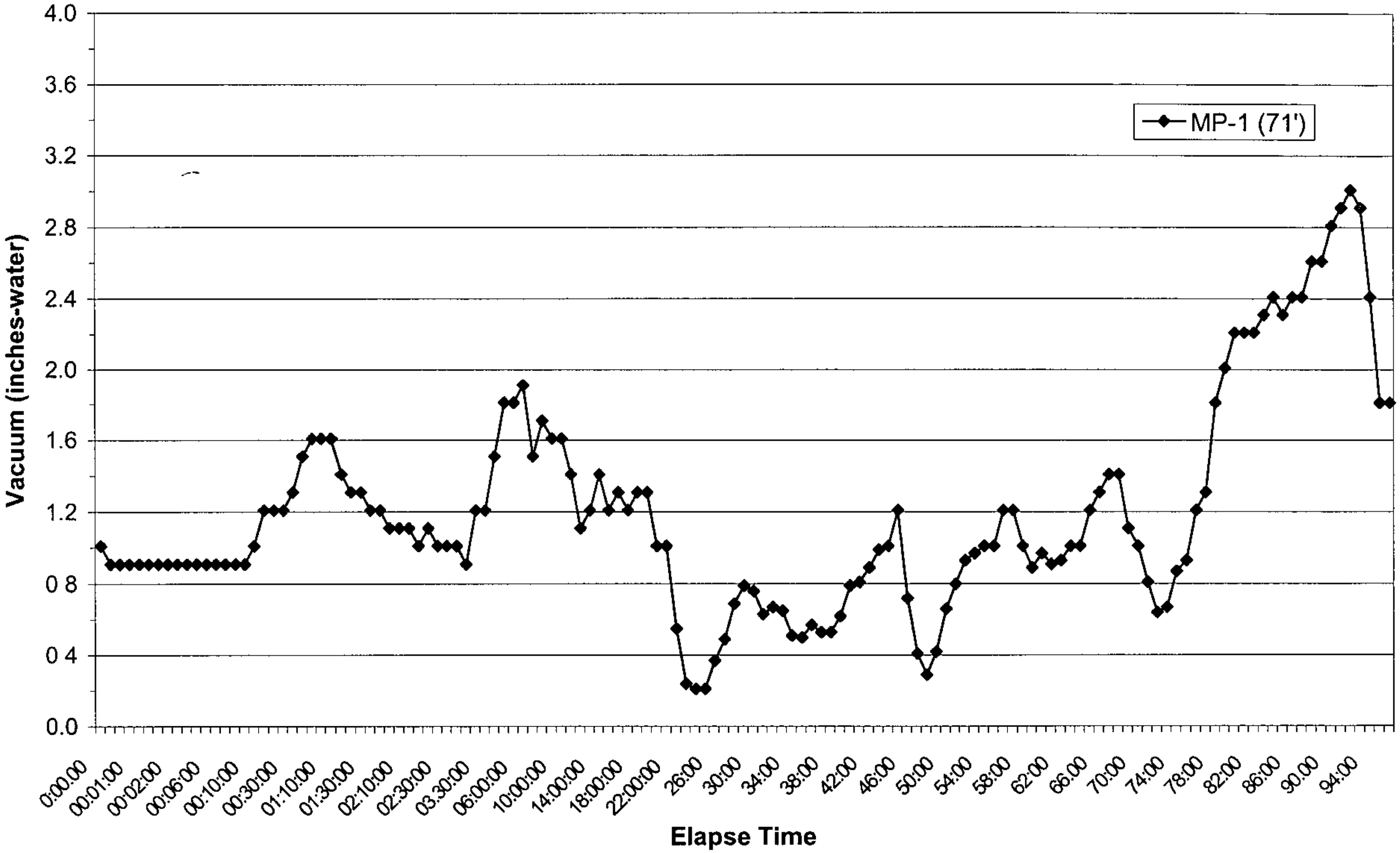

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-1 (22') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3 2
2 8
2 4
2.0
1 6
1 2
0 8
0 4
0 0
MP-1 (22')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

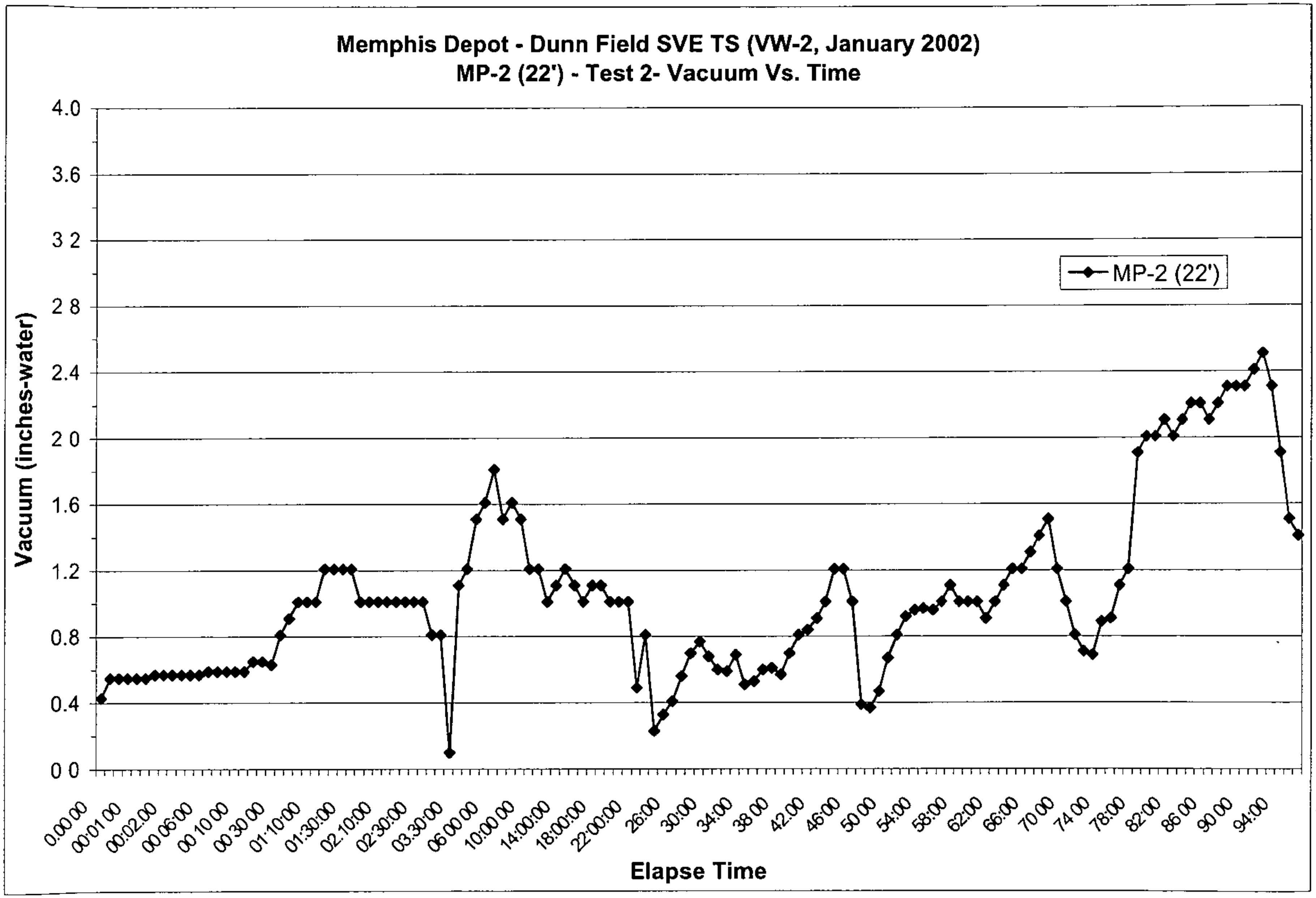

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-1 (35') - Test 2- Vacuum Vs. Time
MP-1 (35')
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-1 (58') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-1 (58')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

579 522

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-1 (71') - Test 2- Vacuum Vs. Time




Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-2 (22') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-2 (22')
4.0
3.6
3 2
2 8
2.4
2 0
1.6
1.2
0.8
0.4
0 0
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
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62:00
66:00
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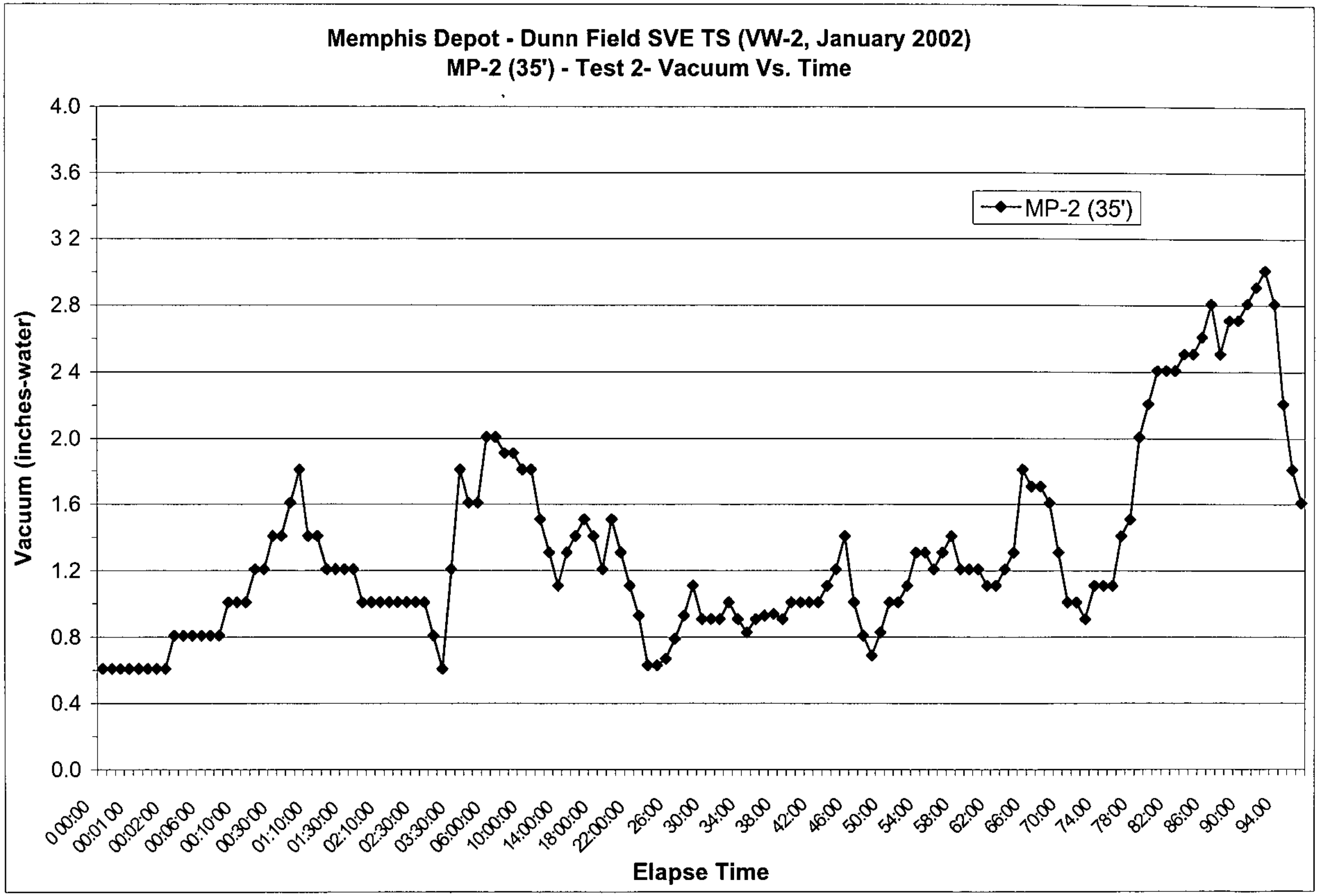
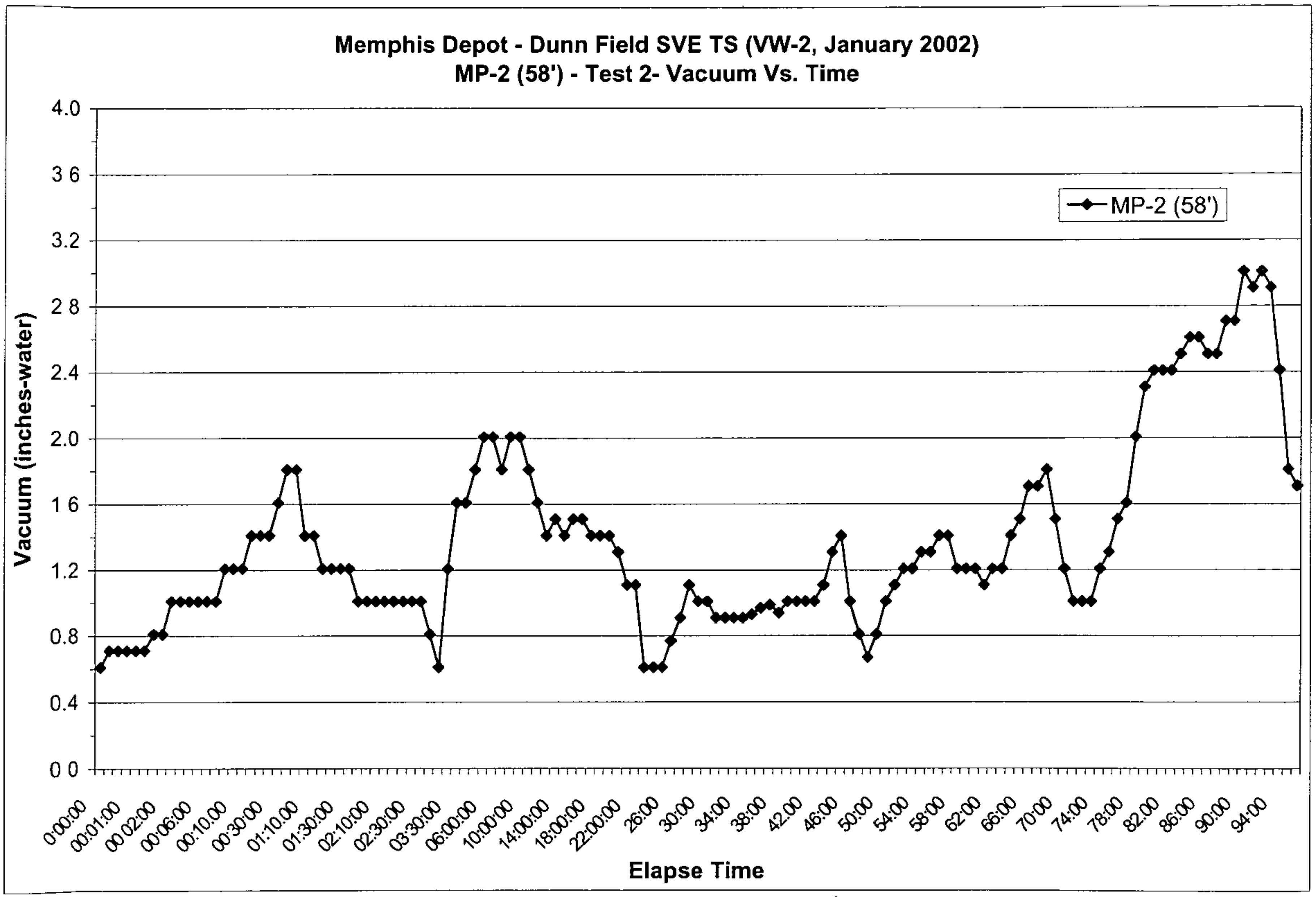
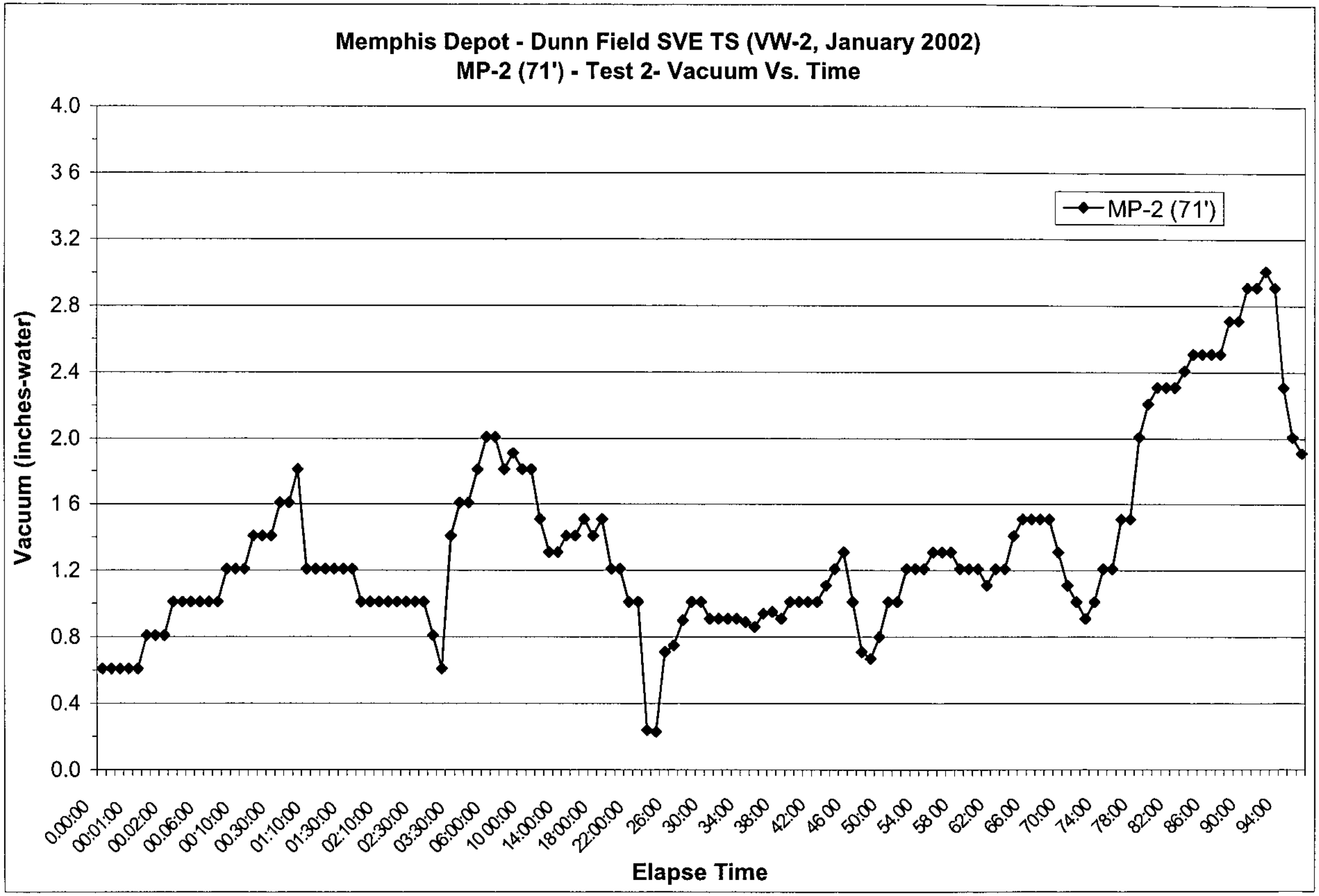
74:00
78:00
82:00
86:00
90:00
94:00

579 524

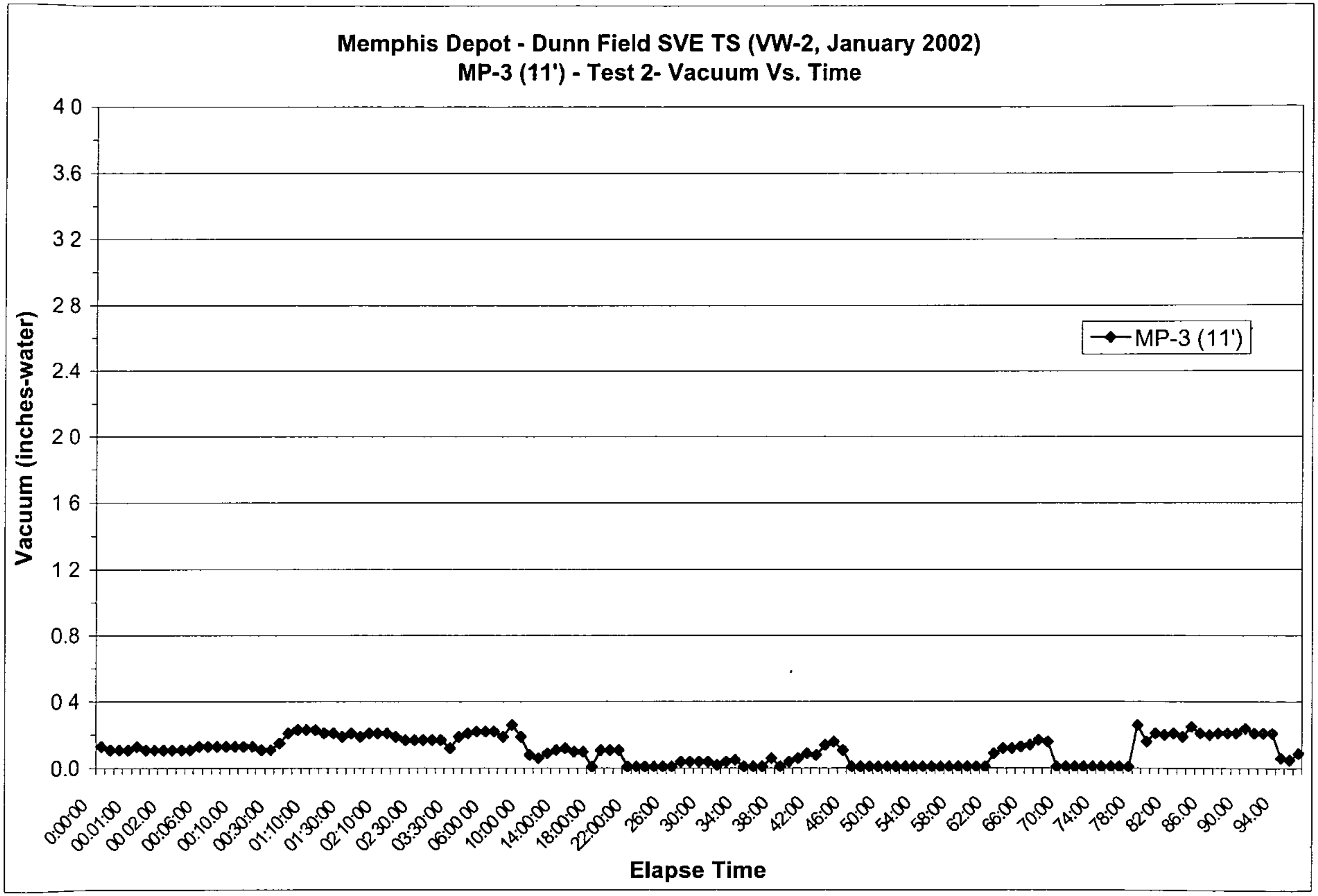

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-2 (35') - Test 2- Vacuum Vs. Time
MP-2 (35')
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

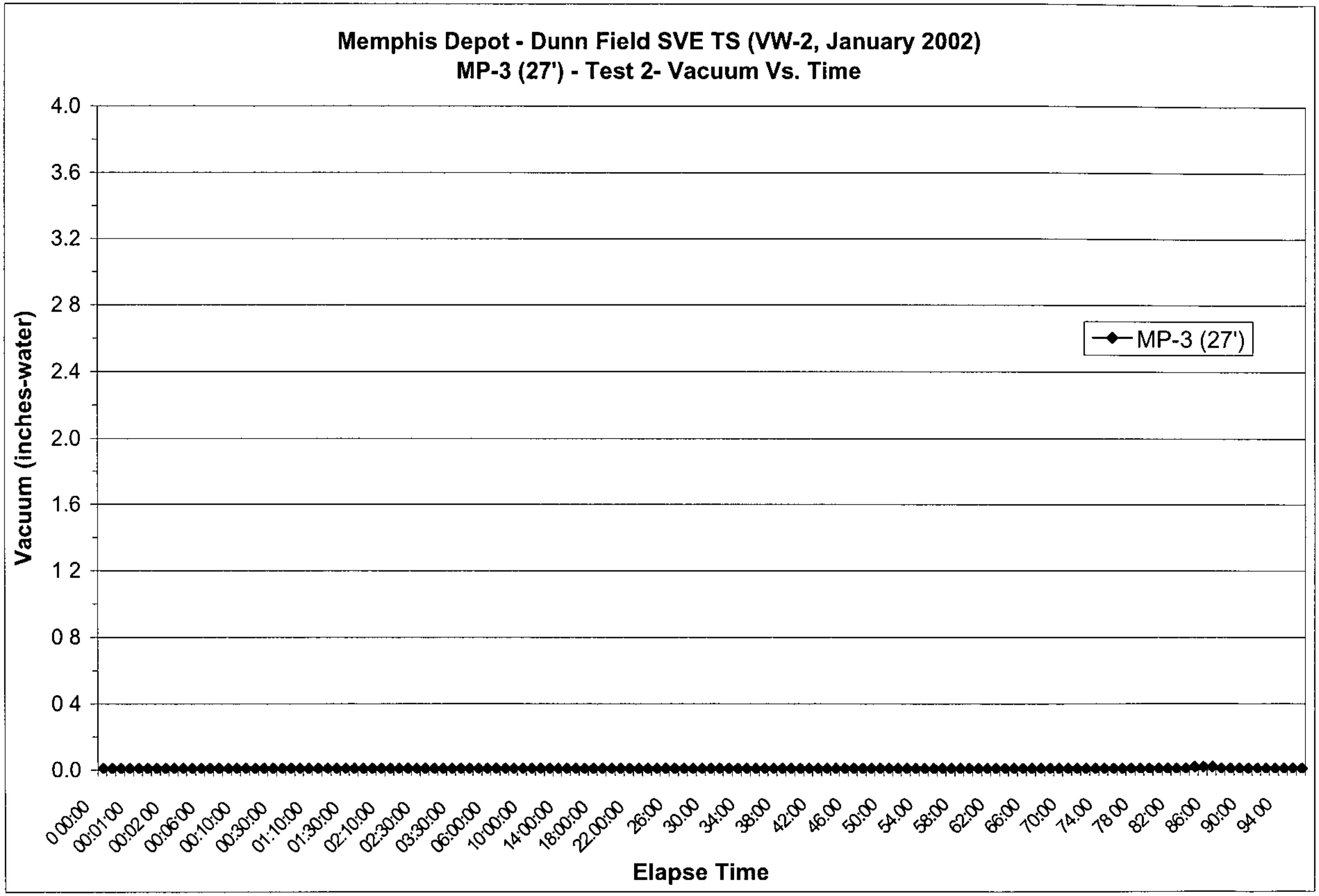


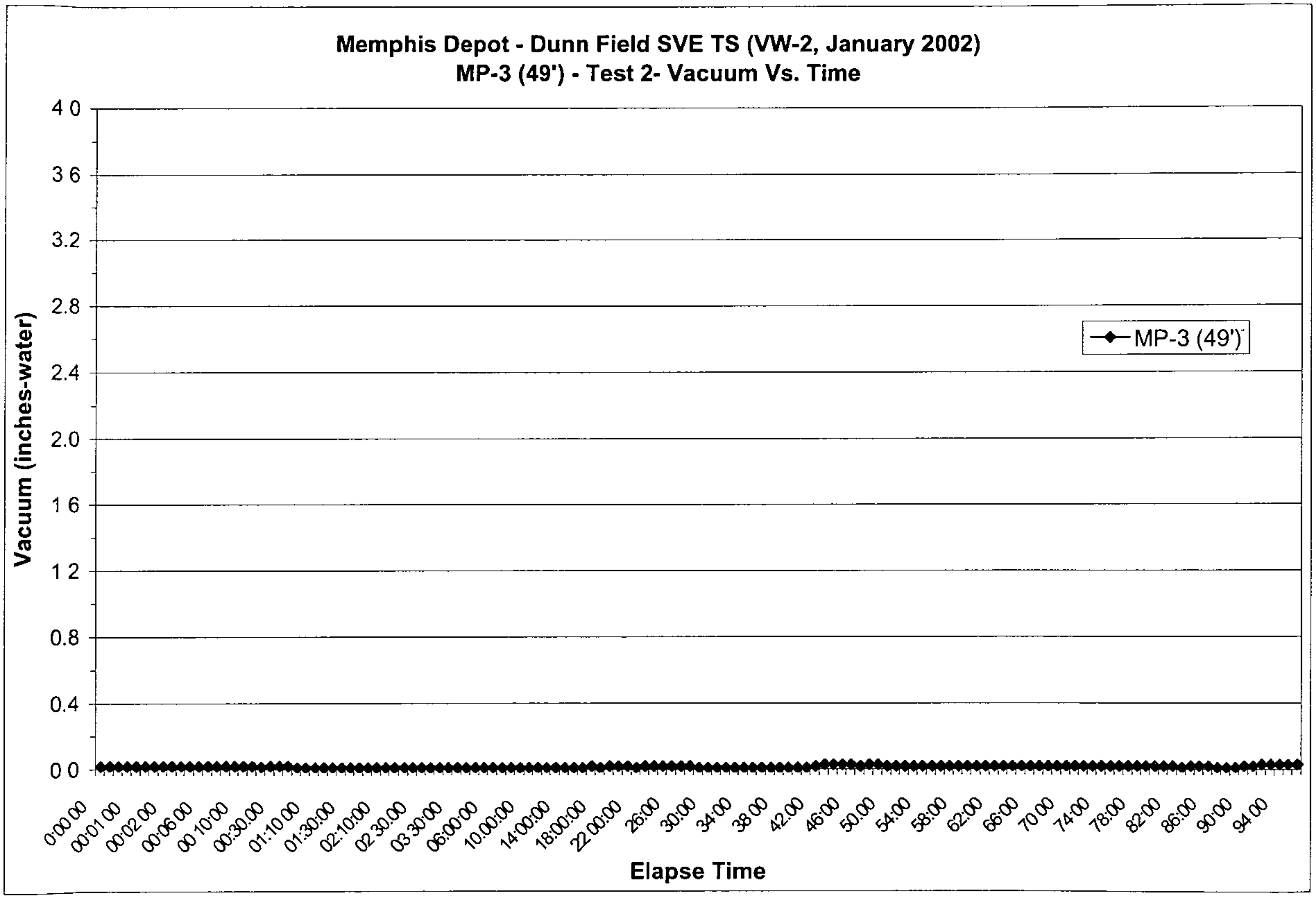
Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-2 (58') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-2 (58')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time



Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-2 (71') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-2 (71')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

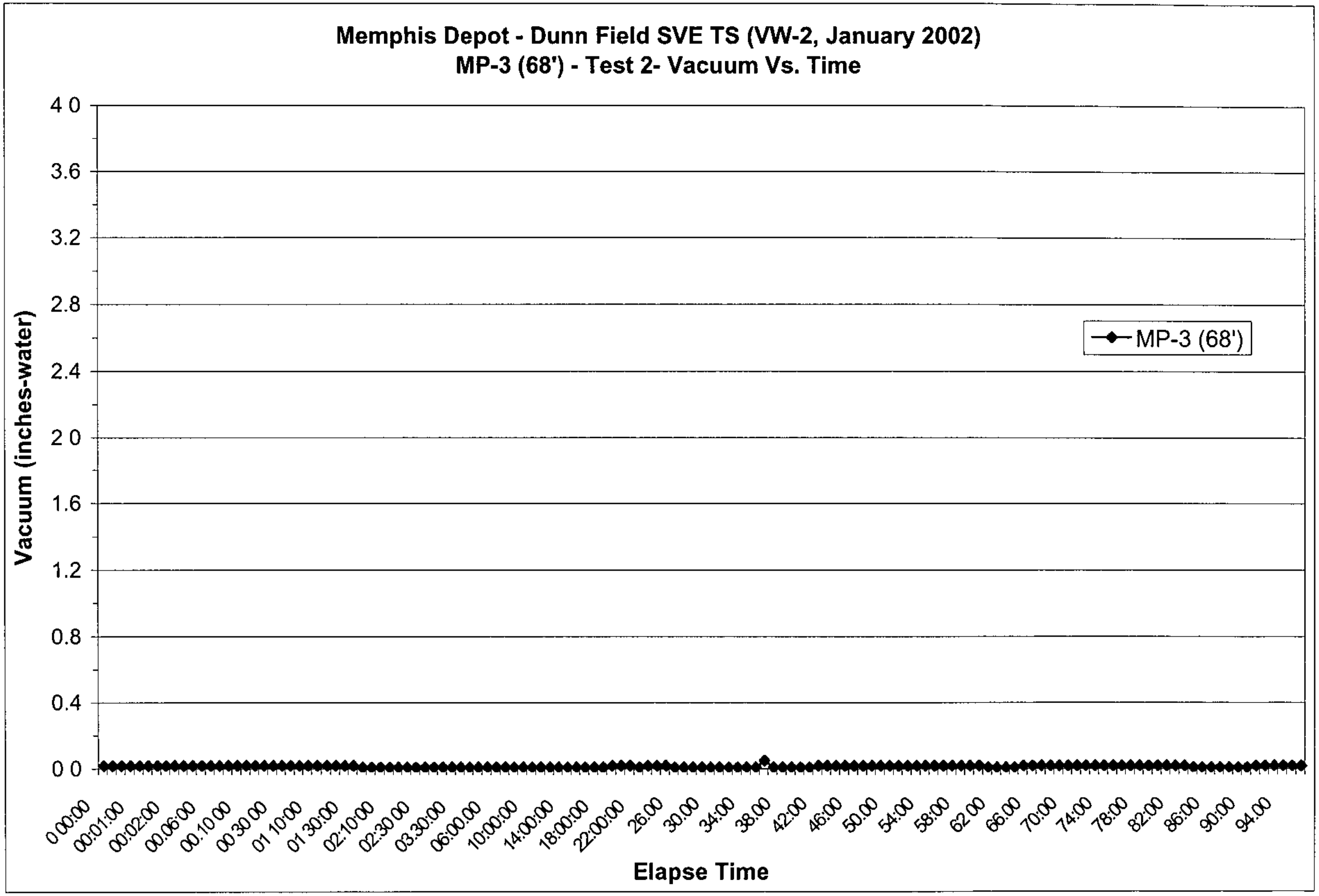

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-3 (11') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3.6
3 2
2 8
2.4
2 0
1 6
1 2
0.8
0 4
0.0
MP-3 (11')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

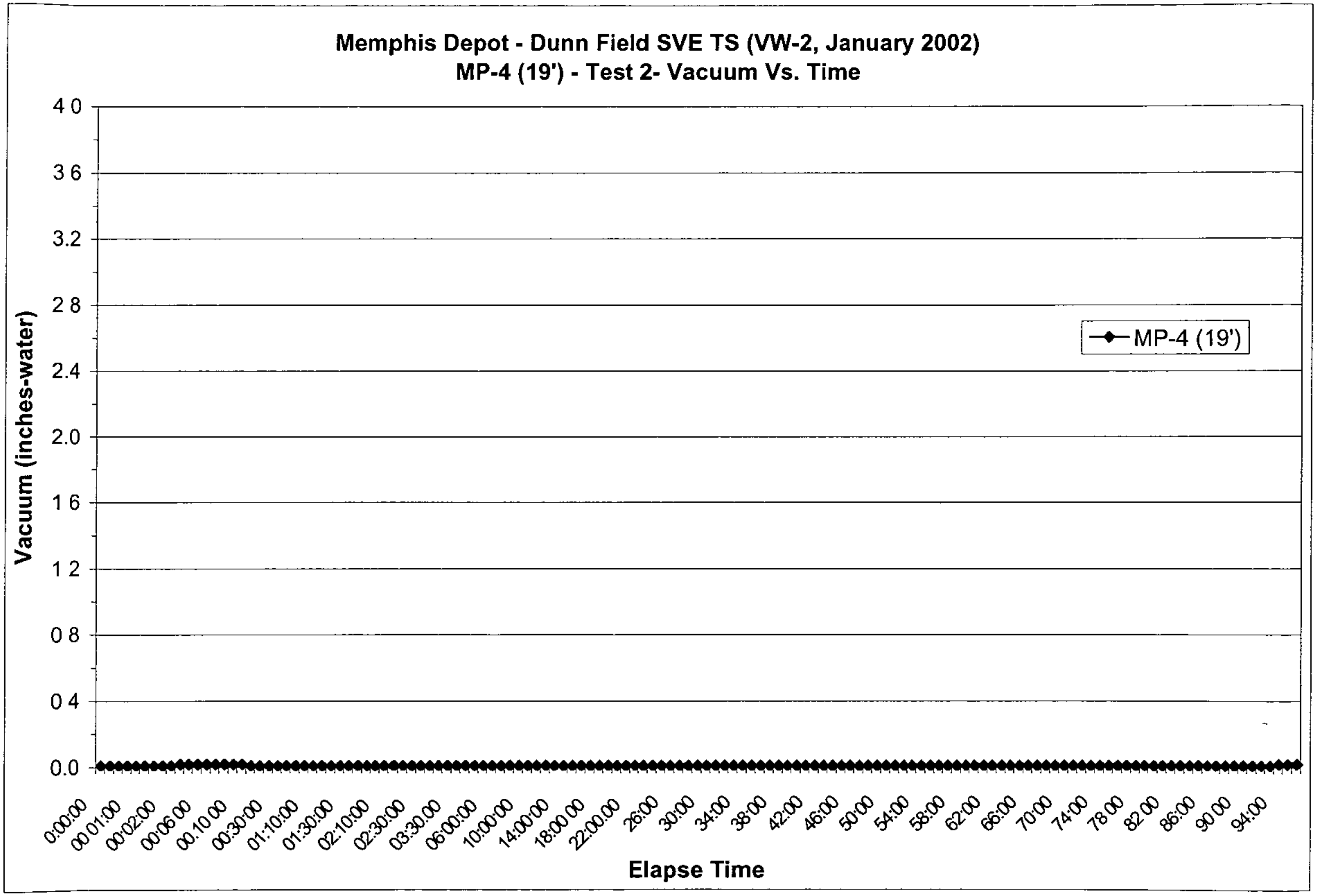

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-3 (27') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-3 (27')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time



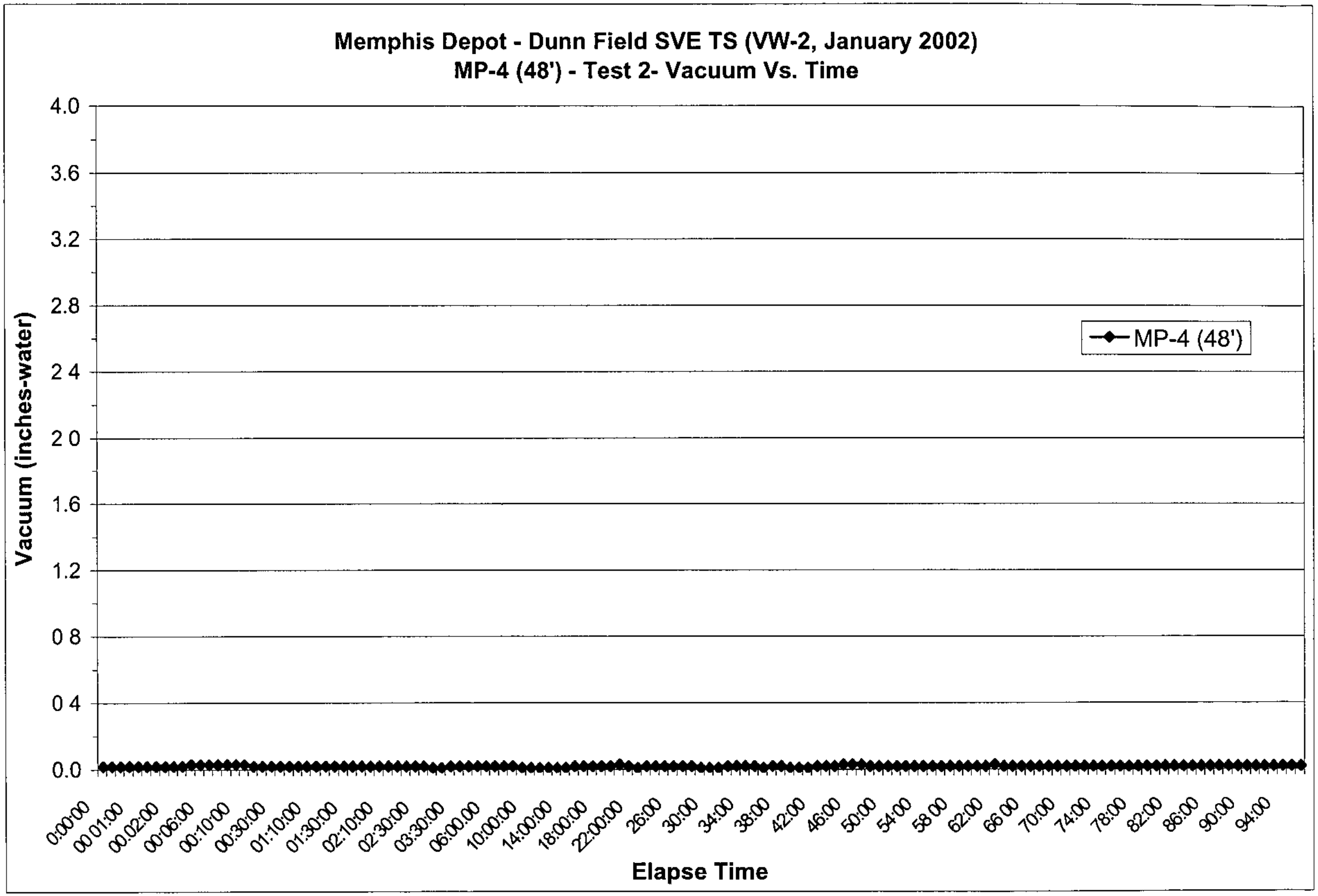
Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-3 (49') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-3 (49')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

579 529

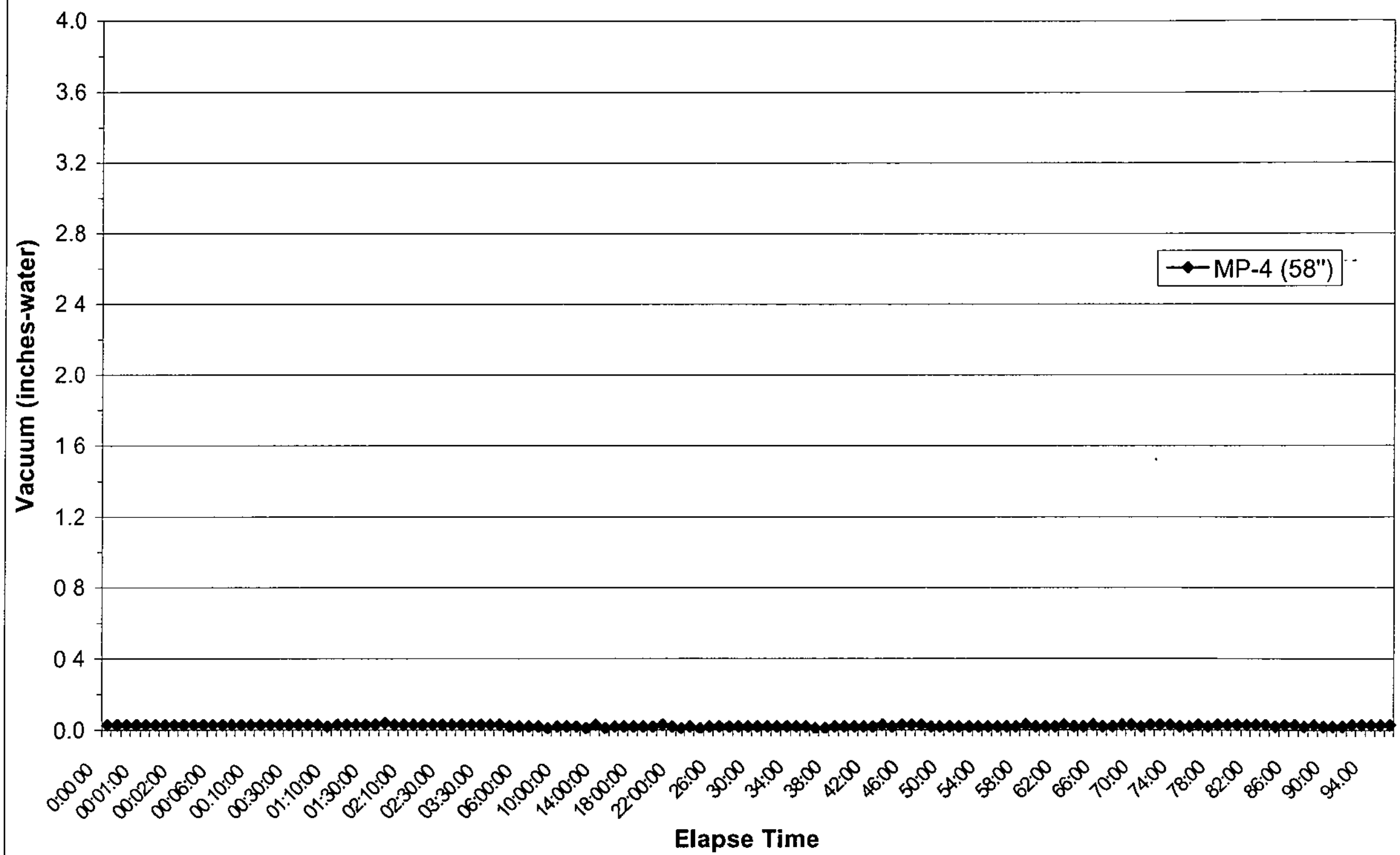

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-3 (68') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3.6
3.2
2.8
2.4
2 0
1.6
1.2
0.8
0.4
0 0
MP-3 (68')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

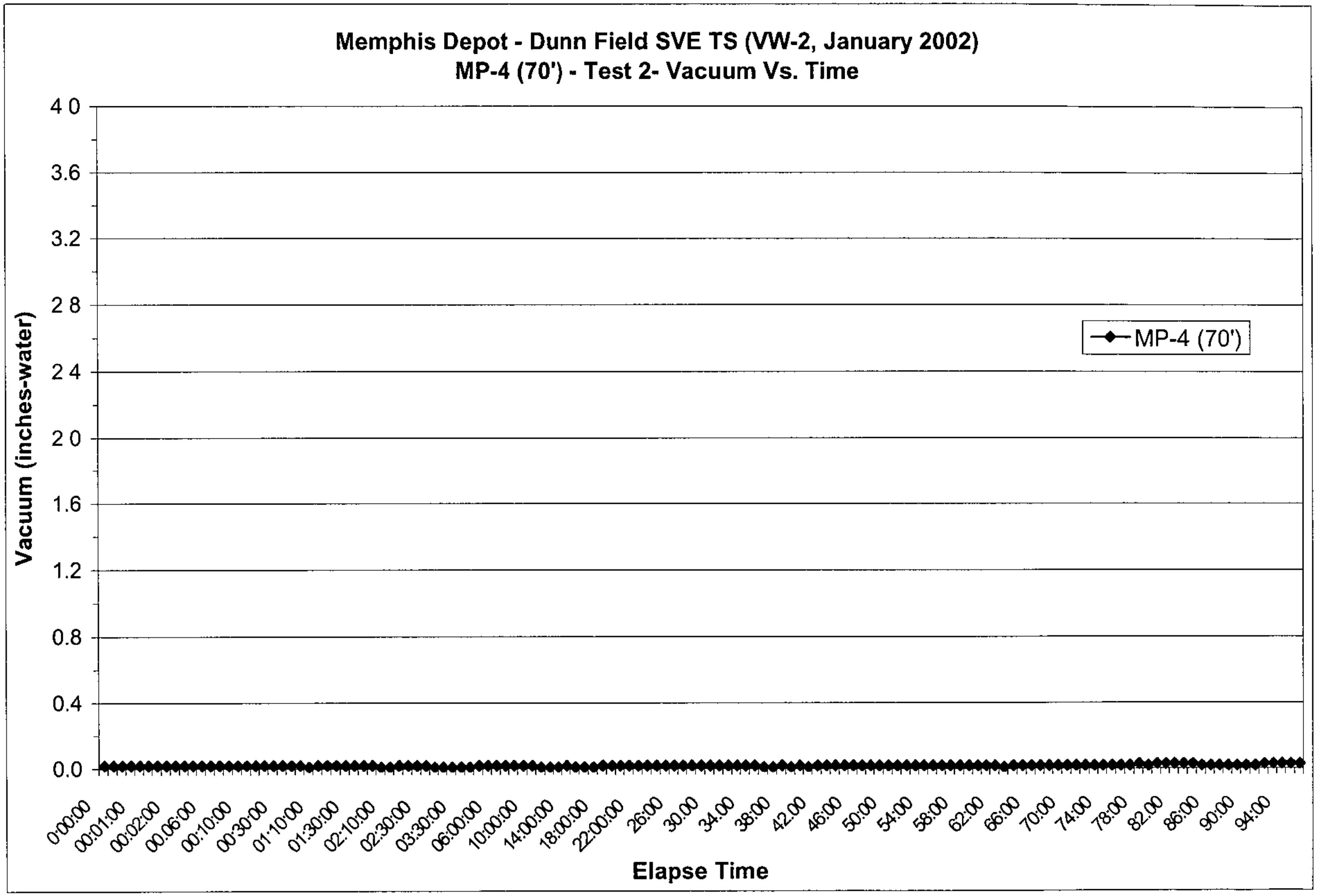

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-4 (19') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3 6
3.2
2 8
2.4
2.0
1 6
1 2
0 8
0 4
0.0
MP-4 (19')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

579 531

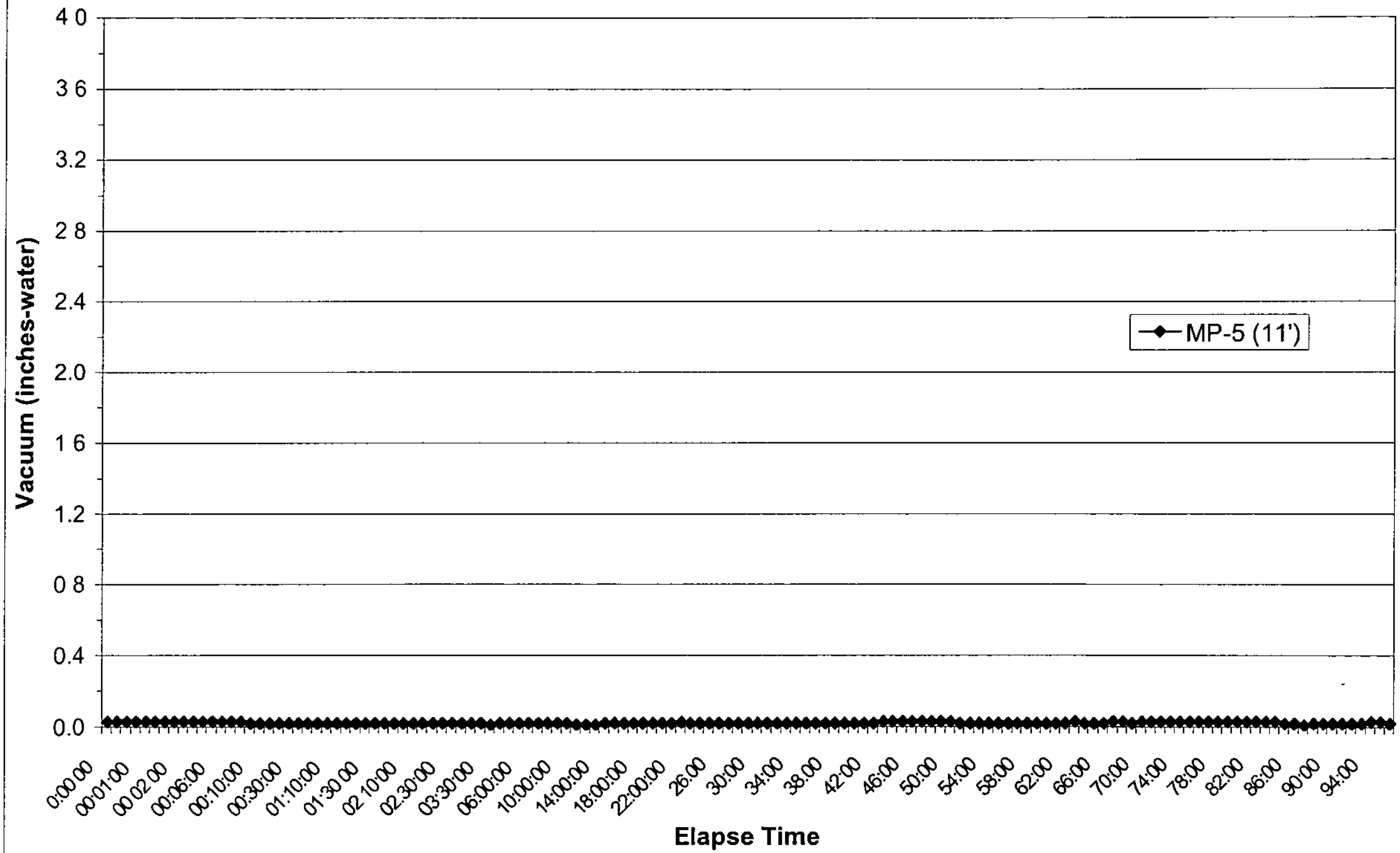

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-4 (48') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2 4
2 0
1.6
1.2
0 8
0 4
0.0
MP-4 (48')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

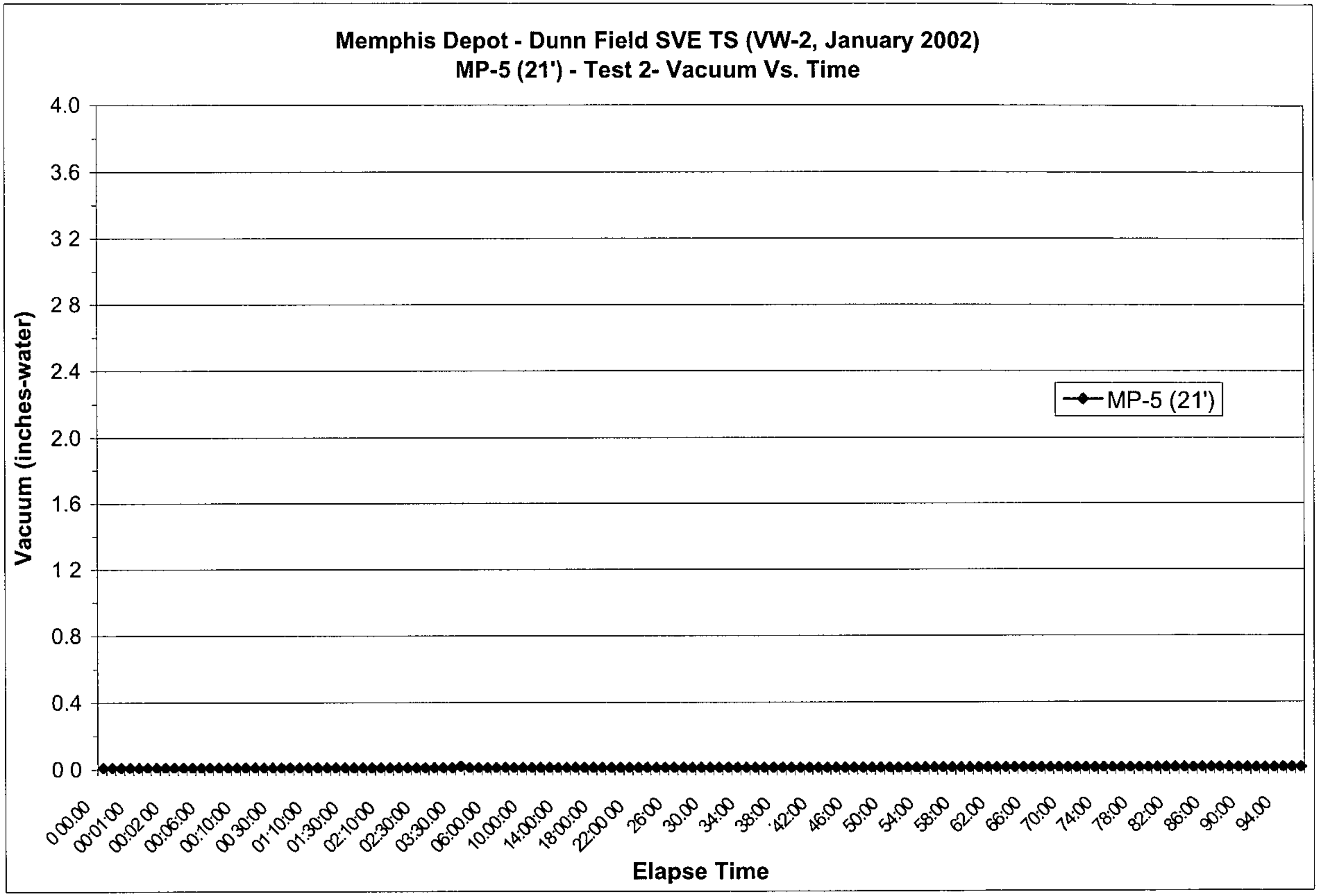
Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-4 (58') - Test 2- Vacuum Vs. Time

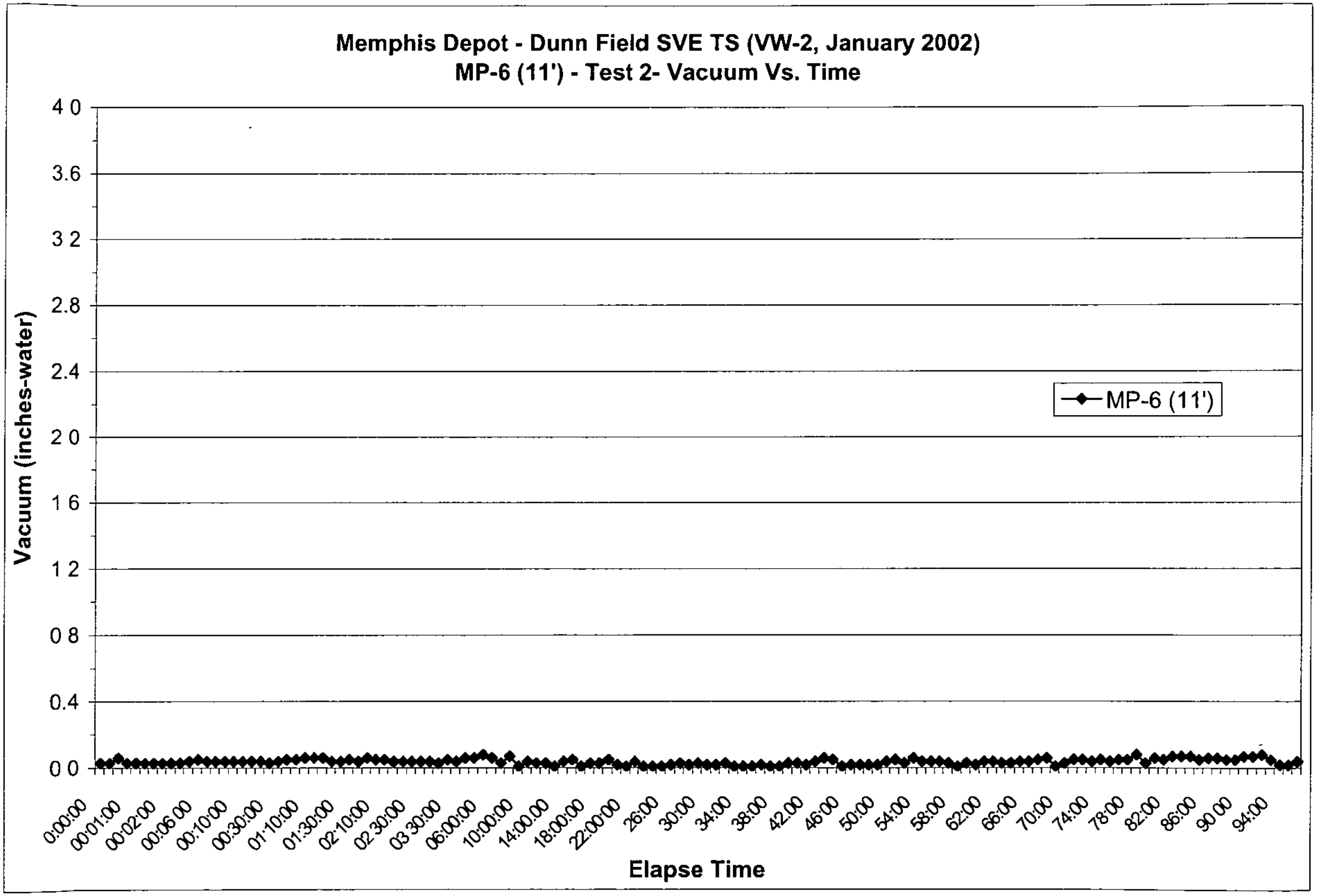


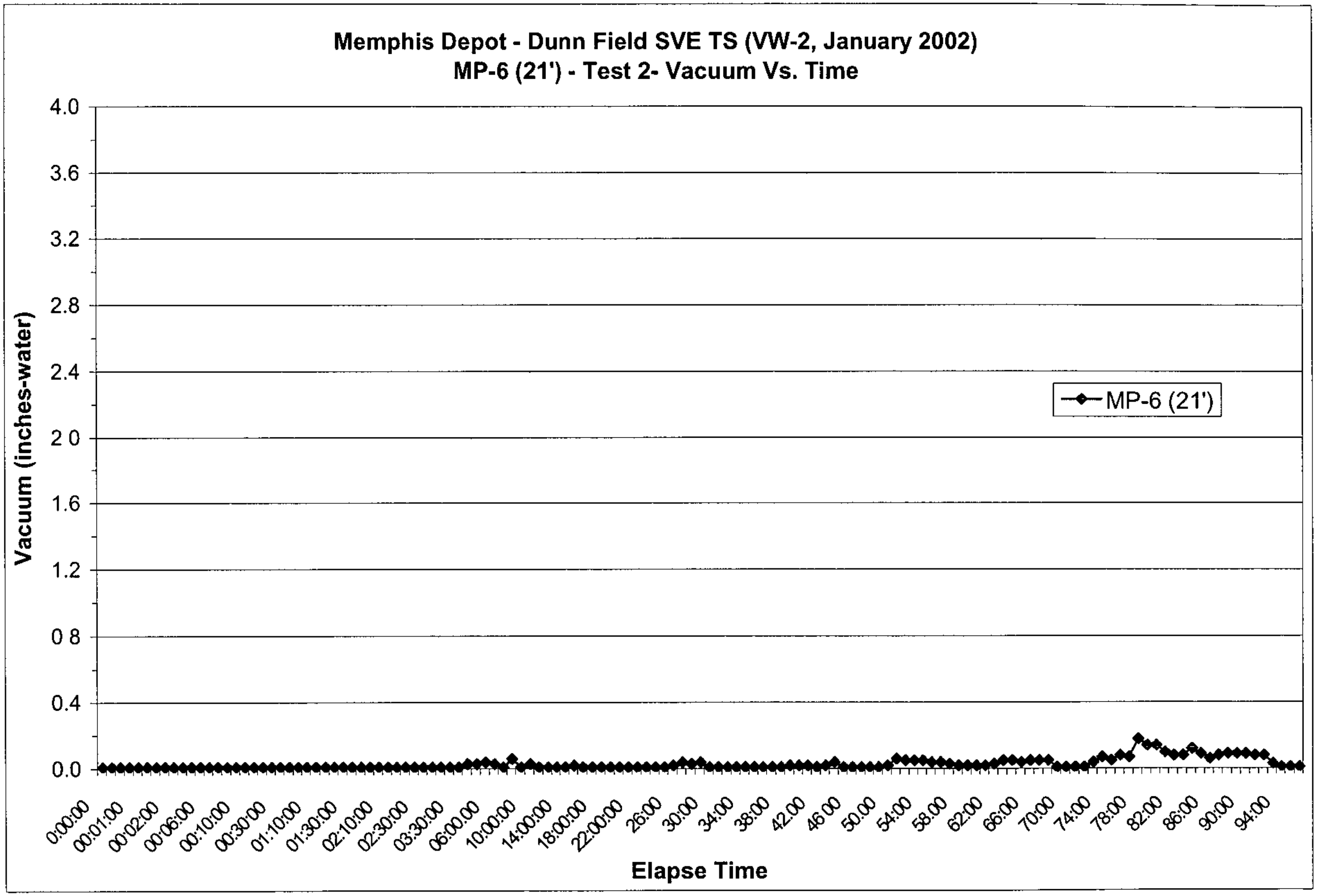

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-4 (70') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3.6
3.2
2 8
2 4
2 0
1.6
1.2
0.8
0.4
0.0
MP-4 (70')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

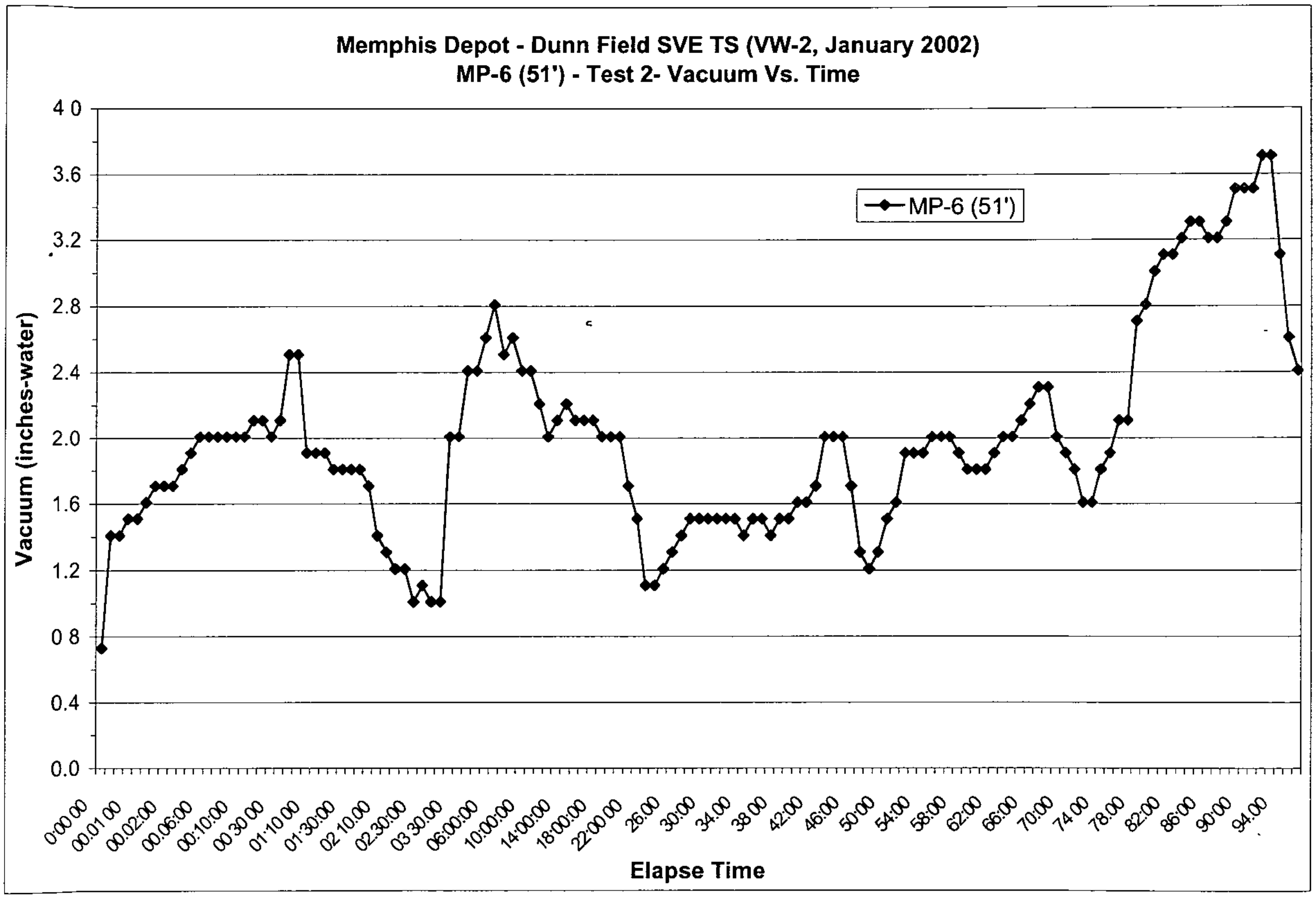
Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-5 (11') - Test 2- Vacuum Vs. Time

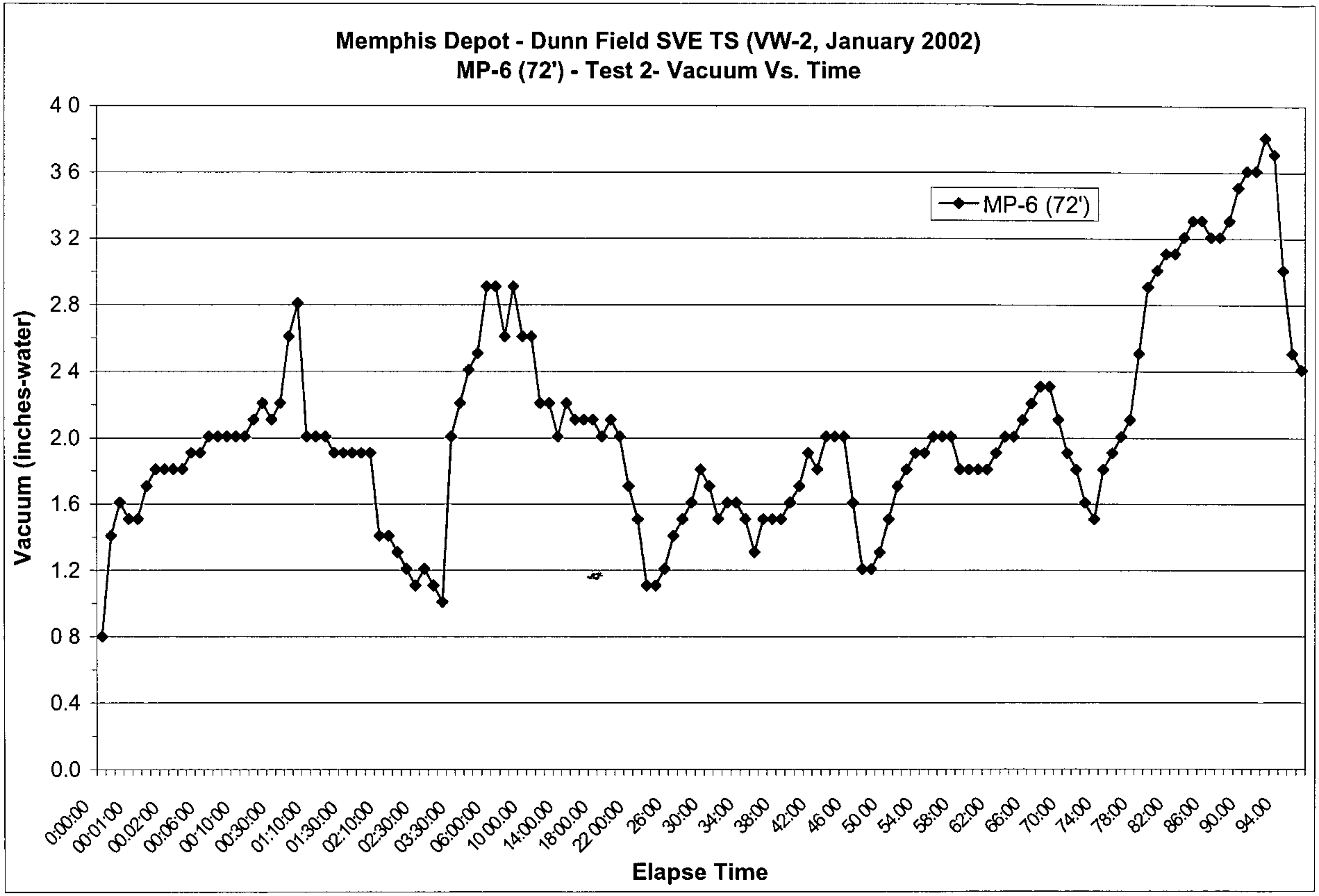



Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-5 (21') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3 2
2 8
2.4
2.0
1.6
1 2
0.8
0.4
0 0
MP-5 (21')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-6 (11') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3.6
3 2
2.8
2.4
2 0
1 6
1 2
0 8
0.4
0 0
MP-6 (11')
0:00:00
00:01:00
00:02:00
00:06 00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02 30:00
03 30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90 00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-6 (21') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2 0
1.6
1.2
0 8
0.4
0.0
MP-6 (21')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-6 (51') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4 0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0 8
0.4
0.0
MP-6 (51')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00 30 00
01:10:00
01:30:00
02 10:00
02:30:00
03 30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time



Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-6 (72') - Test 2- Vacuum Vs. Time
MP-6 (72')
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
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22:00:00
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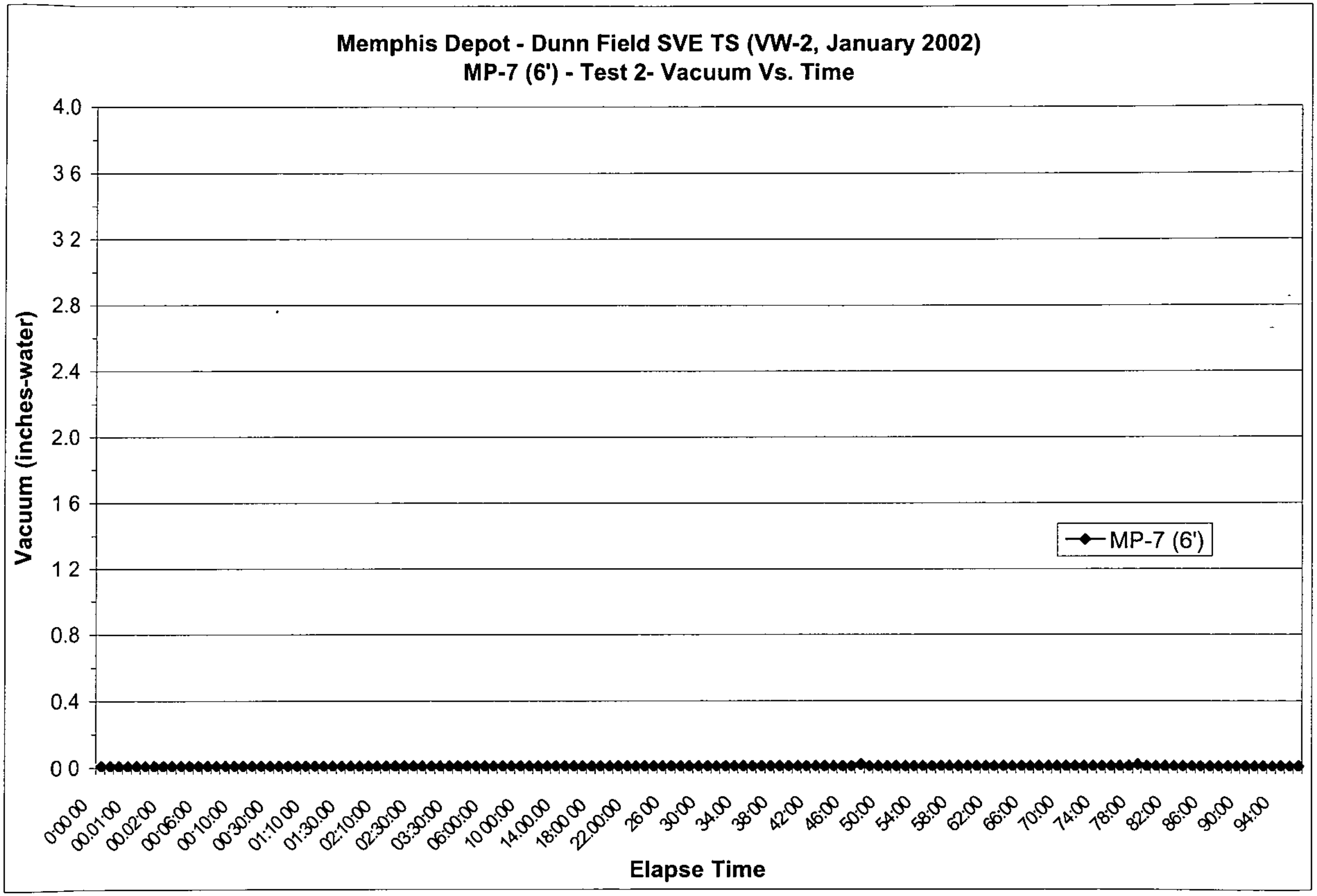
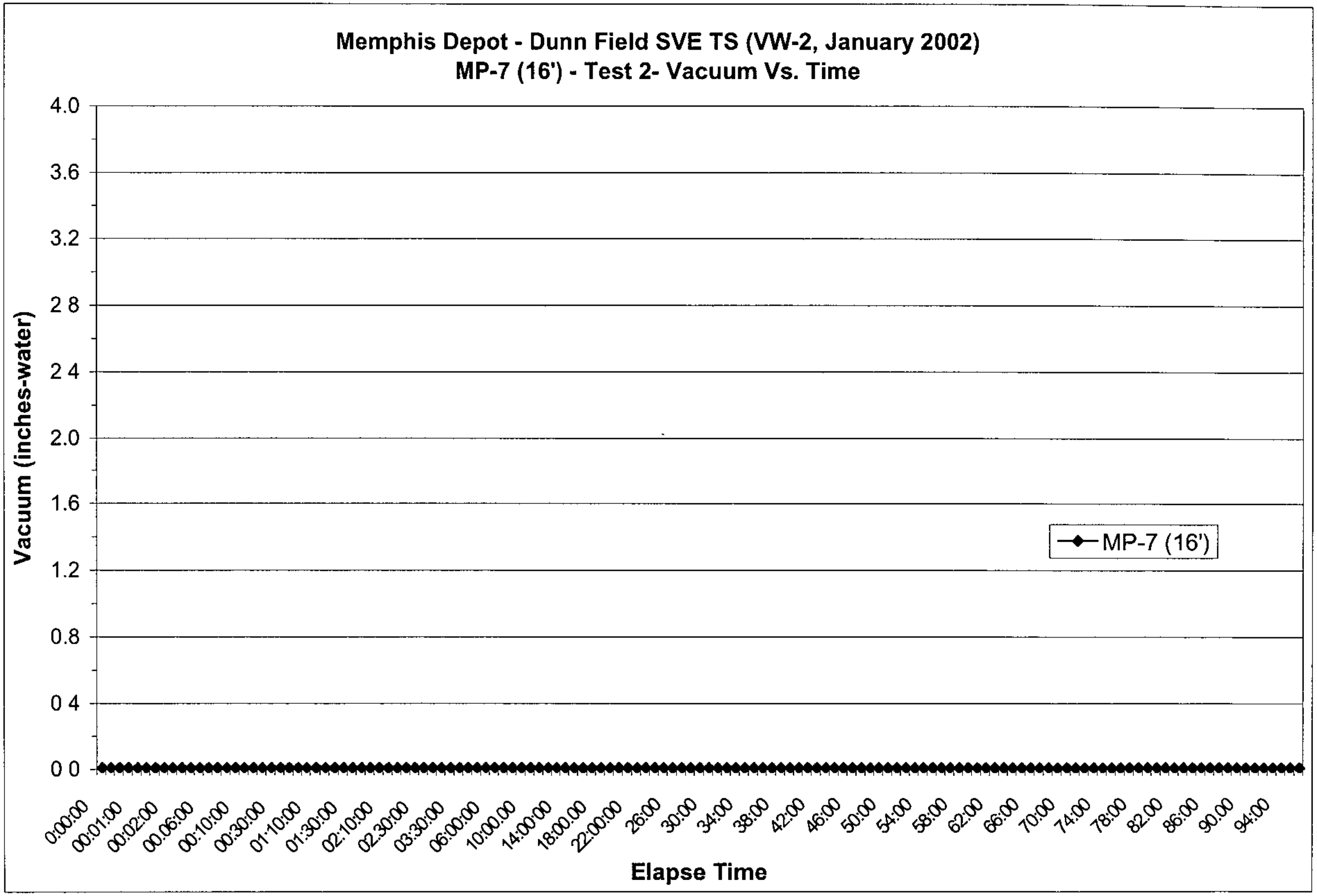
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-7 (6') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3 6
3 2
2.8
2.4
2.0
1 6
1 2
0.8
0.4
0 0
MP-7 (6')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

579 542



Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-7 (16') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-7 (16')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
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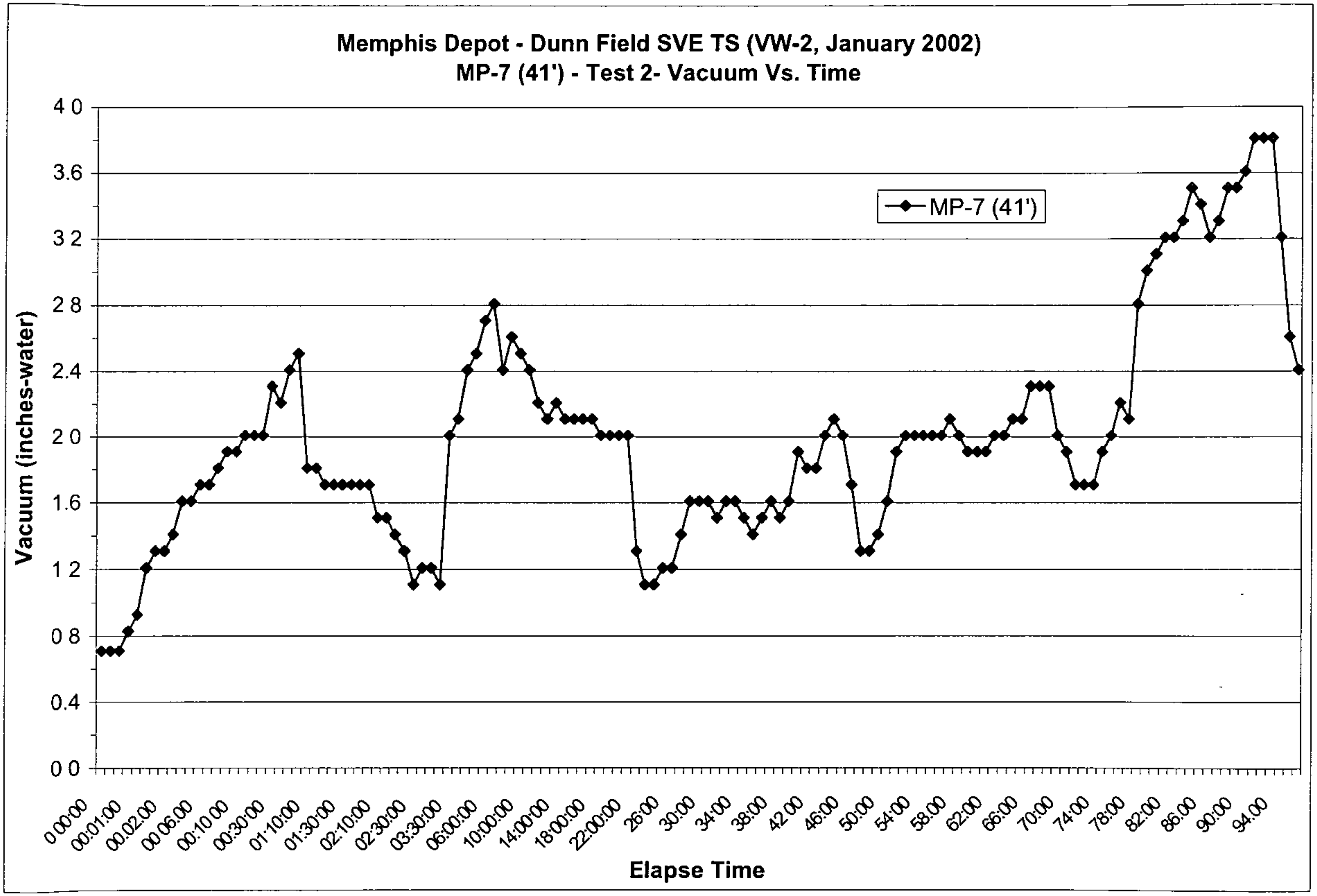
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-7 (41') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
Elapse Time
MP-7 (41')
4 0
3.6
3 2
2 8
2.4
2 0
1.6
1 2
0 8
0.4
0 0
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
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46:00
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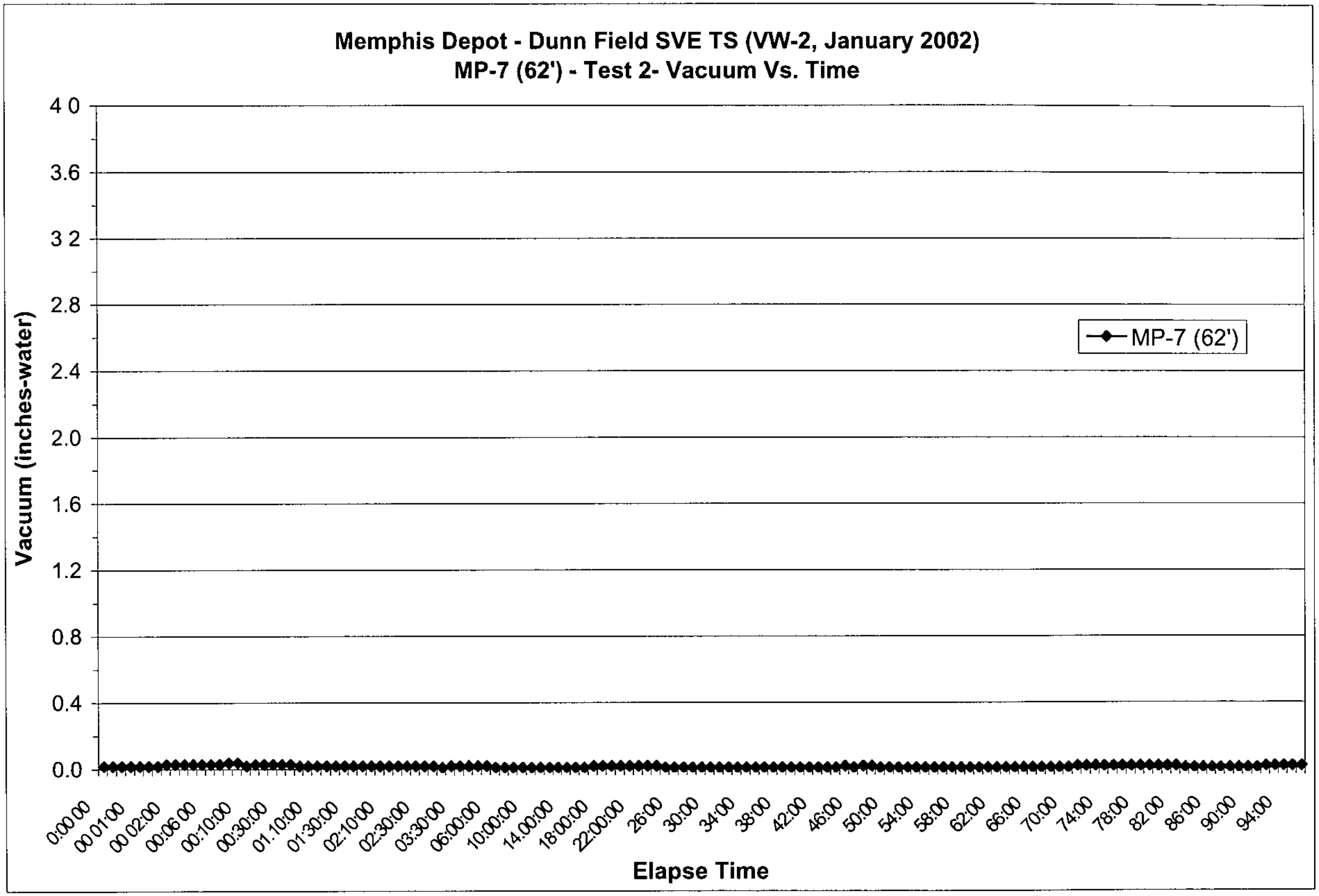
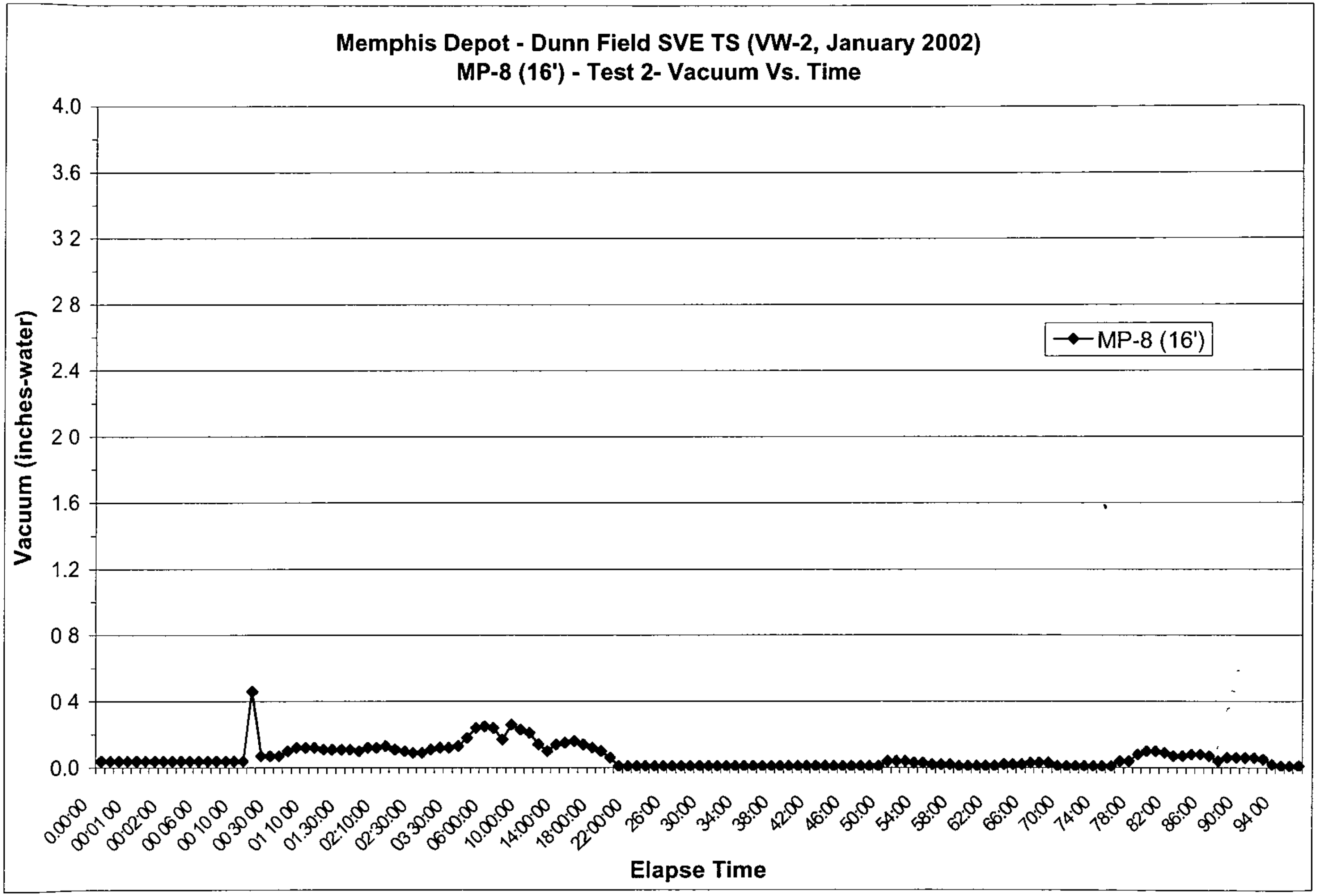
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00

579 543

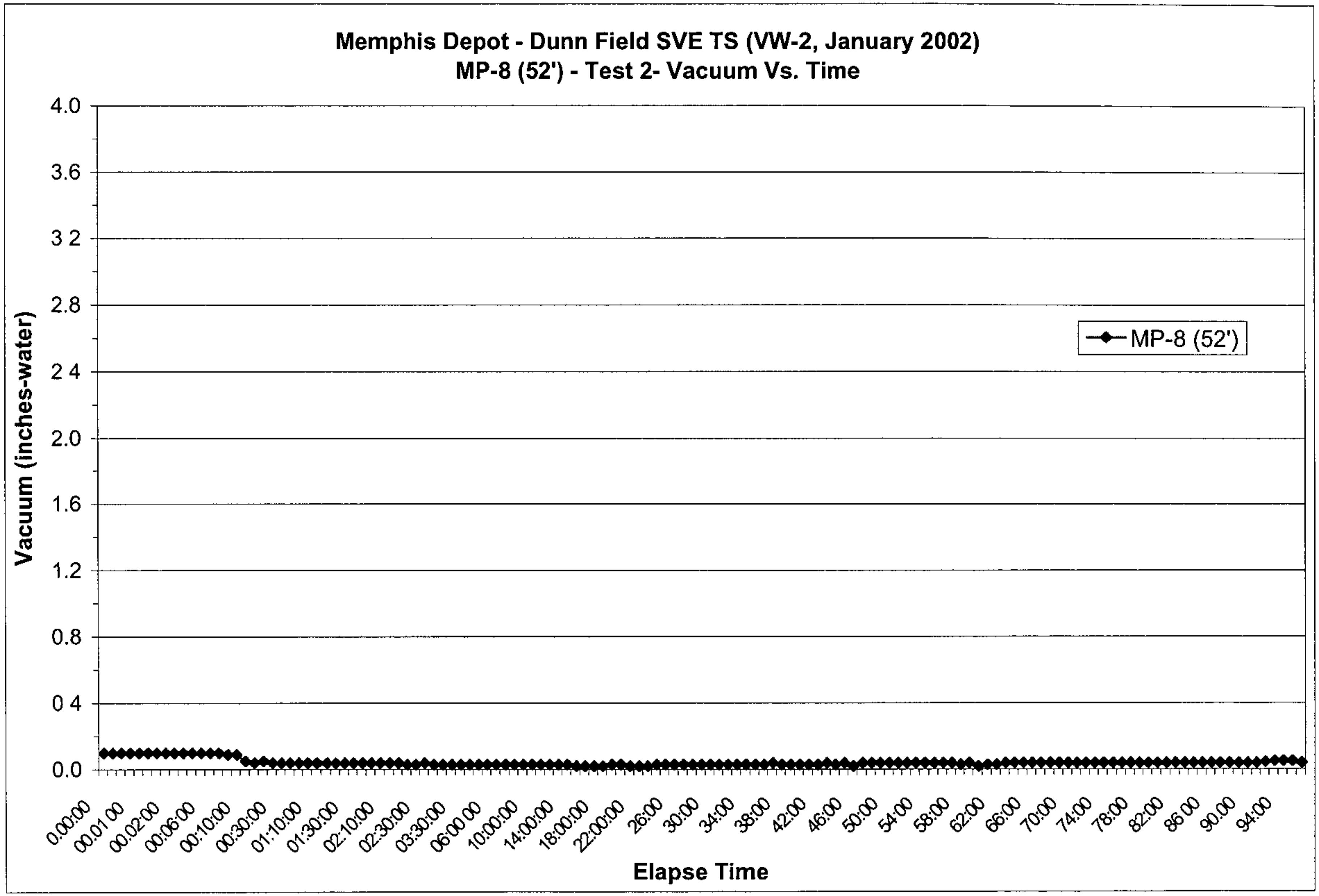

Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-7 (62') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-7 (62')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time



Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-8 (16') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3 2
2 8
2.4
2 0
1.6
1.2
0 8
0 4
0.0
MP-8 (16')
0:00:00
00:01 00
00:02:00
00 06 00
00 10.00
00 30 00
01 10.00
01.30:00
02:10:00
02:30:00
03 30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

579 545

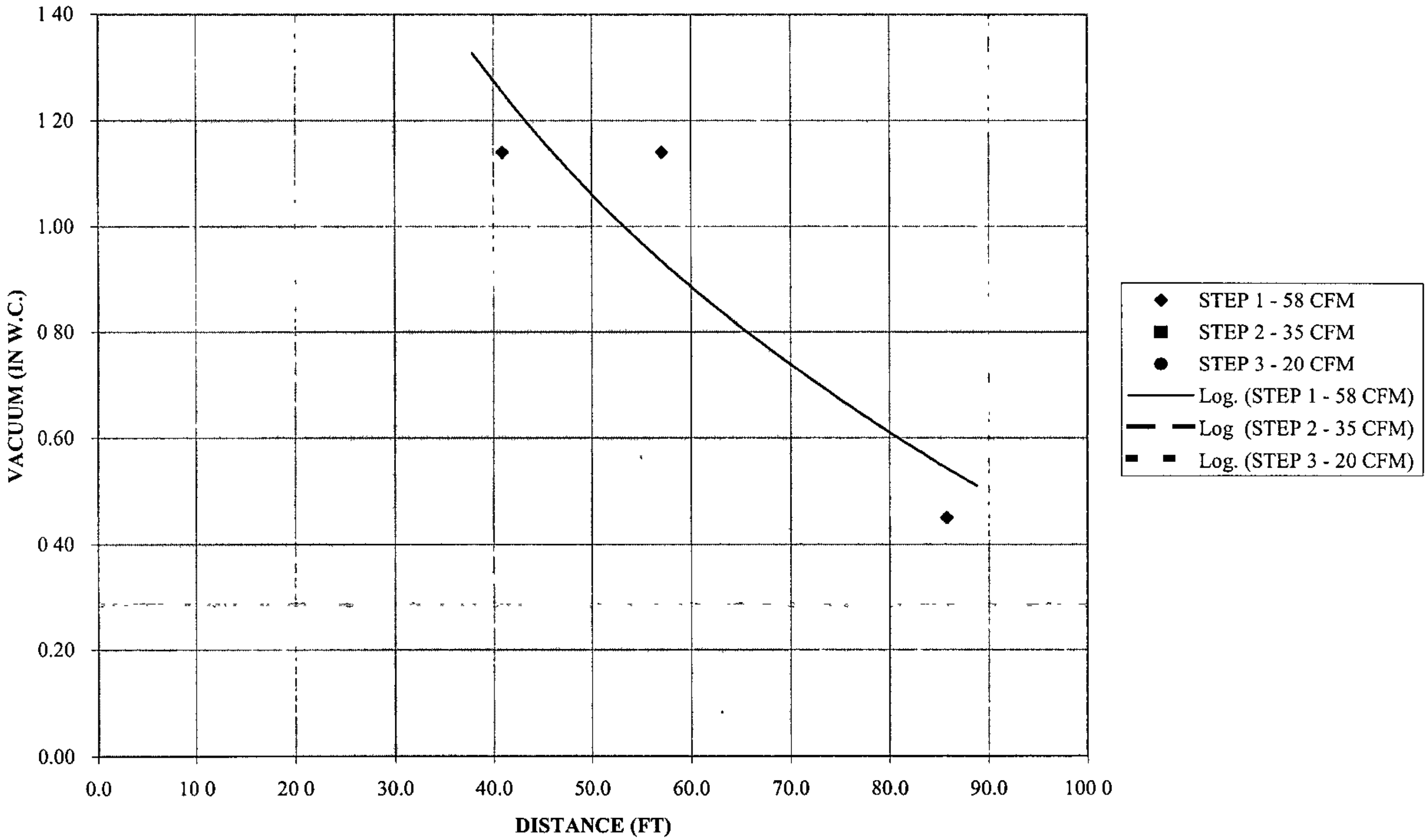
579 546


Memphis Depot - Dunn Field SVE TS (VW-2, January 2002)
MP-8 (52') - Test 2- Vacuum Vs. Time
Vacuum (inches-water)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
MP-8 (52')
0:00:00
00:01:00
00:02:00
00:06:00
00:10:00
00:30:00
01:10:00
01:30:00
02:10:00
02:30:00
03:30:00
06:00:00
10:00:00
14:00:00
18:00:00
22:00:00
26:00
30:00
34:00
38:00
42:00
46:00
50:00
54:00
58:00
62:00
66:00
70:00
74:00
78:00
82:00
86:00
90:00
94:00
Elapse Time

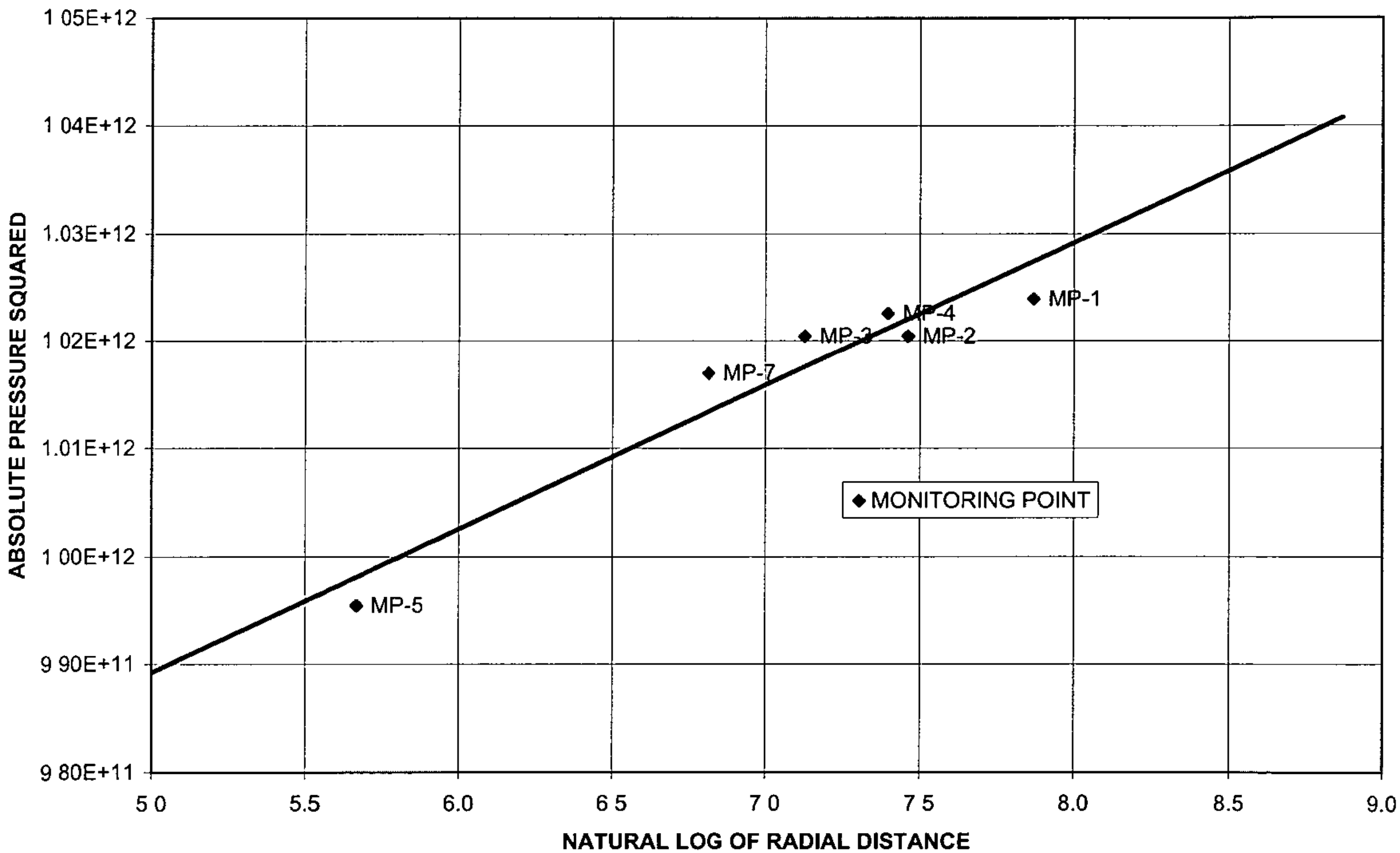
Attachment G

579 548

TEST 1 - SVE PILOT TEST LINEAR DATA PLOT

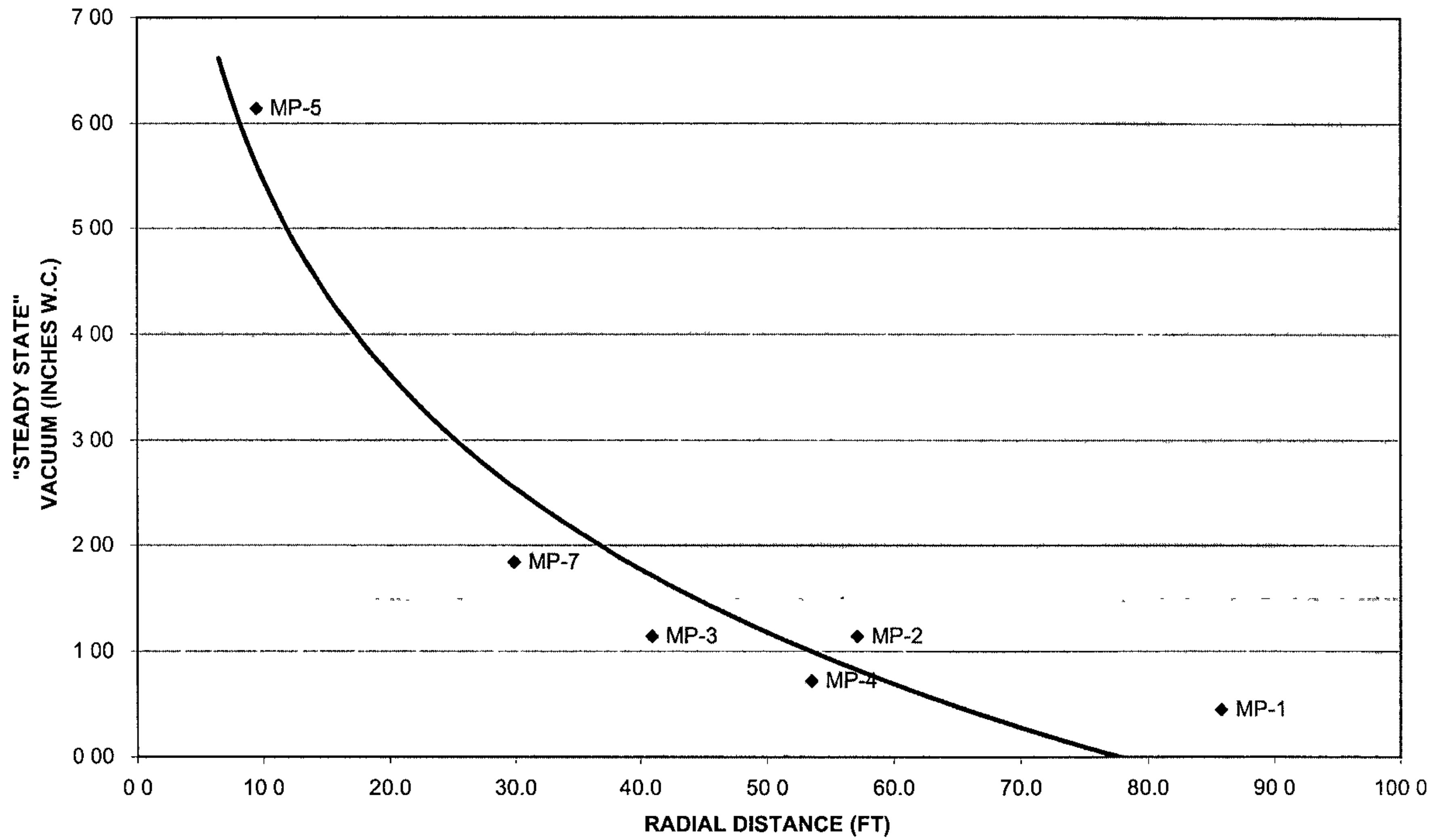


TEST 1 - REGRESSION SOLUTION PLOT



579 550

TEST 1 - LINEAR DATA PLOT



SOIL VAPOR EXTRACTION PILOT TEST DATA "STEADY STATE" SOLUTION - TEST 1

Location Memphis Depot, Dunn Fied
Client U S Army Engineering and Support Center, Huntsville
Test Date December 18-21, 2001
Vapor Extraction Well VW-1

Monitoring Point	Radial Distance (r) [ft]	Radial Distance (r) [cm]	ln(r)	Steady-State Vacuum [in H2O]	Absolute Pressure (P) [g/cm s^2]	P^2	Regrssn P^2
MP-1	85 8	2615 18	7 87	0 45	1011880 85	1 02E+12	1 03E+12
MP-2	57 1	1740 41	7 46	1 14	1010164 82	1 02E+12	1 02E+12
MP-3	40 9	1246 63	7 13	1 14	1010164 82	1 02E+12	1 02E+12
MP-4	53 5	1630 68	7 40	0 72	1011209 36	1 02E+12	1 02E+12
MP-5	9 5	289 56	5 67	6 14	997729 82	9 95E+11	9 98E+11
MP-7	29 9	911 35	6 81	1 84	1008423 92	1 02E+12	1 01E+12

P(r) = Pw [1 + (1/Pw^2)*(Pw^2-Patm^2)*ln(r/Rw)/ln(Rw/Ri)]^(1/2)
P(r) = absolute pressure at radius r
r = radial distance from extraction well
Pw = absolute pressure at the extraction well
= Patm - vacuum
Patm = absolute ambient atmospheric pressure
Rw = radius of extraction well
Ri = radius of influence of extraction well

$$P(r)^2 = \frac{(Pw^2 - Patm^2)\ln(r)}{\ln(Rw/Ri)} - \frac{\ln(Rw)(Pw^2-Patm^2)}{\ln(Rw/Ri)} + Pw^2$$

$$P(r)^2 = m * \ln(r) + b$$

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0 96
R Square	0 92
Adjusted R Square	0 90
Standard Error	3 34E+09
Observations	6 00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1 00	5 20E+20	5 20E+20	46 62	0 00
Residual	4 00	4 46E+19	1 12E+19		
Total	5 00	5 65E+20			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95 0%*	*Upper 95 0%*
Intercept	9 23E+11	1 38E+10	66 68	0 00	8 84E+11	9 61E+11	8 84E+11	9 61E+11
X Variable 1	1 33E+10	1 95E+09	6 83	0 00	7 91E+09	1 87E+10	7 91E+09	1 87E+10

Ri = 1629 2 cm
Ri = 53 5 ft

579 552

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEADY STATE" SOLUTION - TEST 1

Location Memphis Depot, Dunn Fied
Client U S Army Engineering and Support Center, Huntsville
Test Date December 18-21, 2001
Vapor Extraction Well VW-1

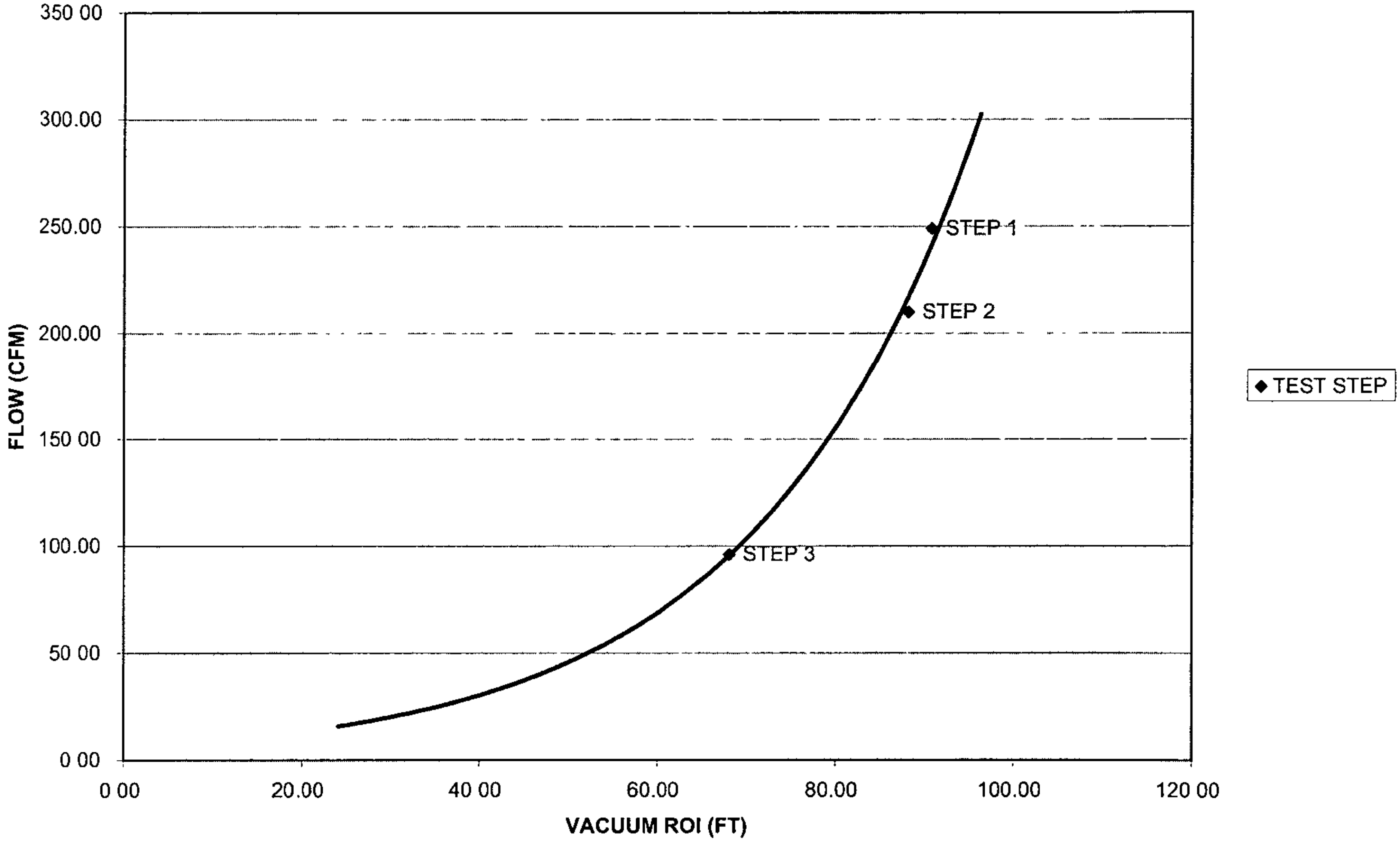
$$Q = \frac{H*Pi*(k/u)*Pw*[1-(patm/Pw)^2]}{ln(Rw/Ri)} \quad 2)$$

Q	= volumetric vapor flow rate from well
H	= well screen thickness
Pi	= 3 142
k	= soil permeability to air flow
u	= viscosity of extracted vapor
Pw	= absolute pressure at the extraction well
	= Patm - vacuum
Patm	= absolute ambient atmospheric pressure
Rw	= radius of extraction well
Ri	= radius of influence of extraction well

$$k = \frac{Q*u*ln(Rw/Ri)}{H*Pi*Pw*[1-(Patm/Pw)^2]}$$

H	=	457 2	[cm]
u	=	0 000180	[cm/gs]
Q	=	11443 6	[cm^3/s]
Pw	=	251480 6	[g/cm s^2]
Patm	=	1013000 0	[g/cm s^2]
Rw	=	2 54	[cm]
Ri	=	1629 2	[cm]
k	=	2 42E-09	[cm^2]
k	=	0 2	[darcy]

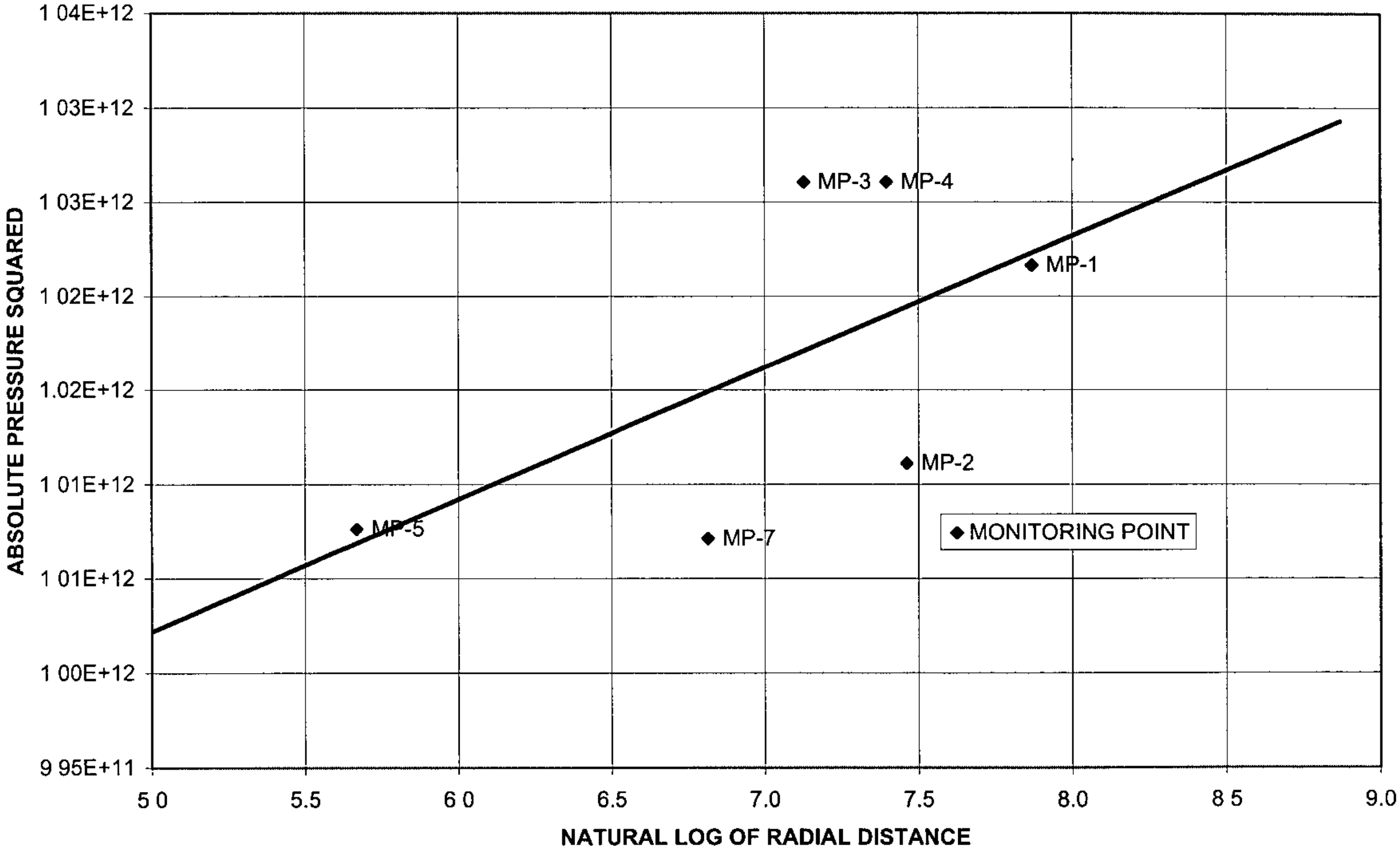
TEST 2 - VACUUM ROI VS. FLOW



579 553

579 554

TEST 2 - REGRESSION SOLUTION PLOT



TEST 2 - SVE PILOT TEST LINEAR DATA PLOT

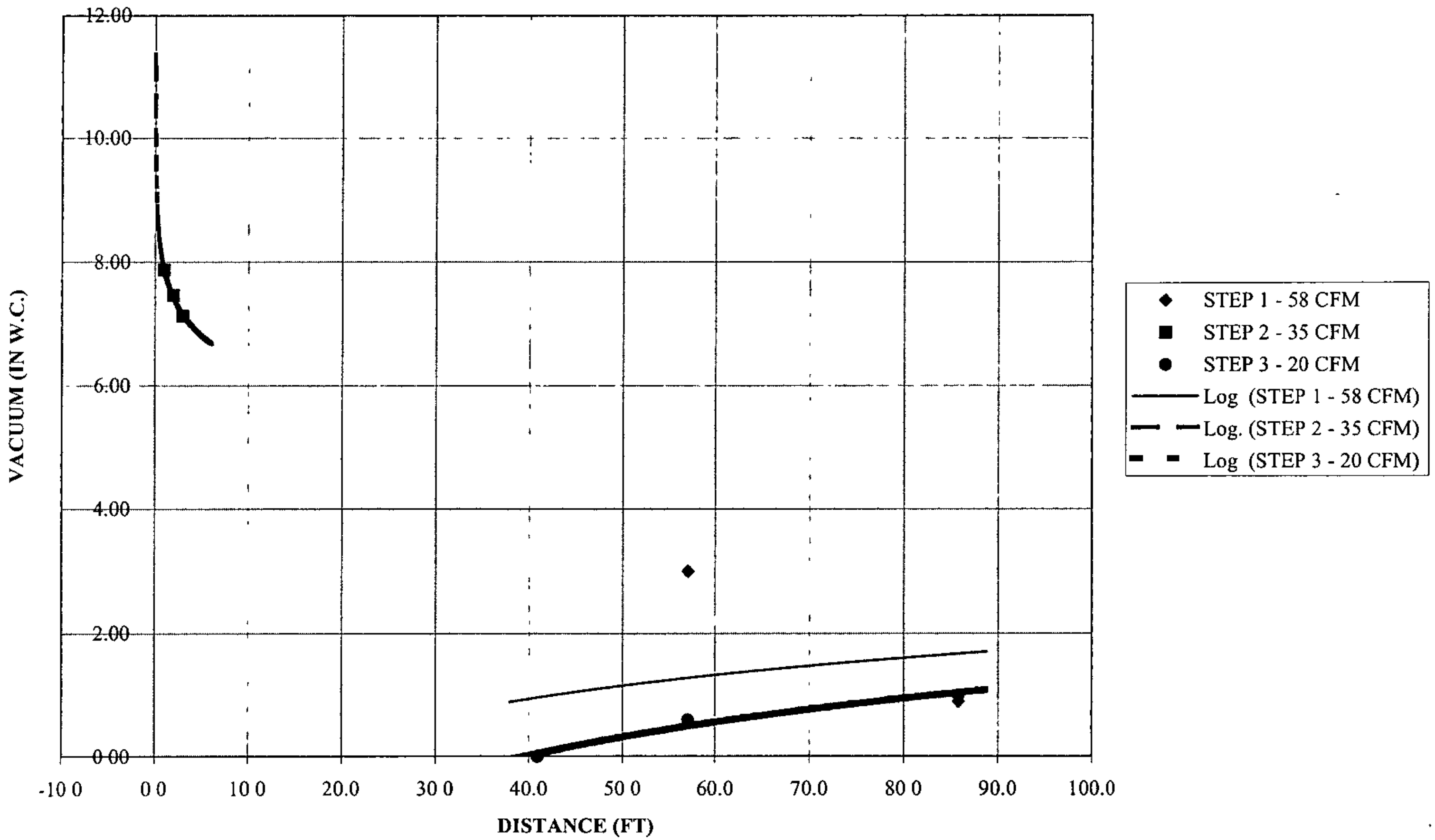


Chart 1 of 4

579 555

579 556

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEADY STATE" SOLUTION - TEST 2

Location Memphis Depot, Dunn Fied
Client U S Army Engineering and Support Center, Huntsville
Test Date January 7-11, 2002
Vapor Extraction Well VW-2

Monitoring Point	Radial Distance (r) [ft]	Radial Distance (r) [cm]	ln(r)	Steady-State Vacuum [in H2O]	Absolute Pressure (P) [g/cm s^2]	P^2	Regrssn P^2
MP-1	85 8	2615 18	7 87	0 90	1010761 70	1 02E+12	1 02E+12
MP-2	57 1	1740 41	7 46	3 00	1005539 00	1 01E+12	1 02E+12
MP-3	40 9	1246 63	7 13	0 02	1012950 26	1 03E+12	1 02E+12
MP-4	53 5	1630 68	7 40	0 02	1012950 26	1 03E+12	1 02E+12
MP-6	9 5	289 56	5 67	3 70	1003798 10	1 01E+12	1 01E+12
MP-7	29 9	911 35	6 81	3 80	1003549 40	1 01E+12	1 01E+12

P(r) = Pw [1 + (1/Pw^2)*(Pw^2-Patm^2)*ln(r/Rw)/ln(Rw/Ri)]^(1/2)
P(r) = absolute pressure at radius r
r = radial distance from extraction well
Pw = absolute pressure at the extraction well
= Patm - vacuum
Patm = absolute ambient atmospheric pressure
Rw = radius of extraction well
Ri = radius of influence of extraction well

P(r)^2 = (Pw^2 - Patm^2)ln(r) / ln(Rw/Ri) - ln(Rw)(Pw^2-Patm^2) / ln(Rw/Ri) +Pw^2

P(r)^2 = m * ln(r) + b

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0 60
R Square	0 35
Adjusted R Square	0 19
Standard Error	8 09E+09
Observations	6 00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1 00	1 44E+20	1 44E+20	2 20	0 21
Residual	4 00	2 62E+20	6 54E+19		
Total	5 00	4 06E+20			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95 0%*	*Upper 95 0%*
Intercept	9 67E+11	3 35E+10	28 87	0 00	8 74E+11	1 06E+12	8 74E+11	1 06E+12
X Variable 1	7 01E+09	4 73E+09	1 48	0 21	-6 11E+09	2 01E+10	-6 11E+09	2 01E+10

Ri = 3173 3 cm
Ri = 104 1 ft

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEADY STATE" SOLUTION - TEST 2

Location Memphis Depot, Dunn Fied

Client U S Army Engineering and Support Center, Huntsville

Test Date January 7-11, 2002

Vapor Extraction Well VW-2

$$Q = \frac{H*Pi*(k/u)*Pw*[1-(patm/Pw)^2]}{ln(Rw/Ri)} \quad 2)$$

Q	= volumetric vapor flow rate from well
H	= well screen thickness
Pi	= 3 142
k	= soil permeability to air flow
u	= viscosity of extracted vapor
Pw	= absolute pressure at the extraction well
	= Patm - vacuum
Patm	= absolute ambient atmospheric pressure
Rw	= radius of extraction well
Ri	= radius of influence of extraction well

$$k = \frac{Q*u*ln(Rw/Ri)}{H*Pi*Pw*[1-(Patm/Pw)^2]}$$

H	=	1219 2	[cm]
u	=	0 000180	[cm/gs]
Q	=	118918 8	[cm^3/s]
Pw	=	931675 1	[g/cm s^2]
Patm	=	1013000 0	[g/cm s^2]
Rw	=	2 54	[cm]
Ri	=	3173 3	[cm]
k	=	2 35E-07	[cm^2]
k	=	23 8	[darcy]

579 558

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEP TEST" - STEP 1

Location Memphis Depot, Dunn Fied

Client U S Army Engineering and Support Center, Huntsville

Test Date January 7, 2002

Vapor Extraction Well VW-2

Monitoring Point	Radial Distance (r) [ft]	Radial Distance (r) [cm]	ln(r)	Steady-State Vacuum [in H2O]	Absolute Pressure (P) [g/cm s^2]	P^2	Regrssn P^2
MP-1	85 8	2615 18	7 87	1 60	1009020 80	1 02E+12	1 02E+12
MP-2	57 1	1740 41	7 46	1 80	1008523 40	1 02E+12	1 02E+12
MP-3	40 9	1246 63	7 13	0 01	1012975 13	1 03E+12	1 02E+12
MP-4	53 5	1630 68	7 40	0 02	1012950 26	1 03E+12	1 02E+12
MP-6	9 5	289 56	5 67	2 50	1006782 50	1 01E+12	1 01E+12
MP-7	29 9	911 35	6 81	2 50	1006782 50	1 01E+12	1 02E+12

P(r) = Pw [1 + (1/Pw^2)*(Pw^2-Patm^2)*ln(r/Rw)/ln(Rw/Ri)]^(1/2)

P(r) = absolute pressure at radius r

r = radial distance from extraction well

Pw = absolute pressure at the extraction well

= Patm - vacuum

Patm = absolute ambient atmospheric pressure

Rw = radius of extraction well

Ri = radius of influence of extraction well

P(r)^2 = (Pw^2 - Patm^2)ln(r) / ln(Rw/Ri) - ln(Rw)(Pw^2-Patm^2) / ln(Rw/Ri) +Pw^2

P(r)^2 = m * ln(r) + b

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0 47
R Square	0 22
Adjusted R Square	0 02
Standard Error	5 64E+09
Observations	6 00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1 00	3 57E+19	3 57E+19	1 12	0 35
Residual	4 00	1 27E+20	3 18E+19		
Total	5 00	1 63E+20			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95 0%*	*Upper 95 0%*
Intercept	9 94E+11	2 34E+10	42 56	0 00	9 30E+11	1 06E+12	9 30E+11	1 06E+12
X Variable 1	3 49E+09	3 30E+09	1 06	0 35	-5 66E+09	1 26E+10	-5 66E+09	1 26E+10

Ri = 2768 9 cm

Ri = 90 8 ft

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEP TEST" - STEP 2

Location Memphis Depot, Dunn Fied
Client U S Army Engineering and Support Center, Huntsville
Test Date January 7, 2002
Vapor Extraction Well VW-2

Monitoring Point	Radial Distance (r) [ft]	Radial Distance (r) [cm]	ln(r)	Steady-State Vacuum [in H2O]	Absolute Pressure (P) [g/cm s^2]	P^2	Regrssn P^2
MP-1	85 8	2615 18	7 87	1 10	1010264 30	1 02E+12	1 02E+12
MP-2	57 1	1740 41	7 46	1 00	1010513 00	1 02E+12	1 02E+12
MP-3	40 9	1246 63	7 13	0 00	1013000 00	1 03E+12	1 02E+12
MP-4	53 5	1630 68	7 40	0 02	1012950 26	1 03E+12	1 02E+12
MP-6	9 5	289 56	5 67	1 70	1008772 10	1 02E+12	1 02E+12
MP-7	29 9	911 35	6 81	1 70	1008772 10	1 02E+12	1 02E+12

P(r) = Pw [1 + (1/Pw^2)*(Pw^2-Patm^2)*ln(r/Rw)/ln(Rw/Ri)]^(1/2)
P(r) = absolute pressure at radius r
r = radial distance from extraction well
Pw = absolute pressure at the extraction well
= Patm - vacuum
Patm = absolute ambient atmospheric pressure
Rw = radius of extraction well
Ri = radius of influence of extraction well

P(r)^2 = (Pw^2 - Patm^2)ln(r) / ln(Rw/Ri) - ln(Rw)(Pw^2-Patm^2) / ln(Rw/Ri) +Pw^2

P(r)^2 = m * ln(r) + b

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0 50
R Square	0 25
Adjusted R Square	0 06
Standard Error	3 71E+09
Observations	6 00

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1 00	1 85E+19	1 85E+19	1 34	0 31
Residual	4 00	5 52E+19	1 38E+19		
Total	5 00	7 36E+19			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95 0%*	*Upper 95 0%*
Intercept	1 00E+12	1 54E+10	65 27	0 00	9 61E+11	1 05E+12	9 61E+11	1 05E+12
X Variable 1	2 51E+09	2 17E+09	1 16	0 31	-3 51E+09	8 53E+09	-3 51E+09	8 53E+09

Ri = 2688 2 cm
Ri = 88 2 ft

579 560

SOIL VAPOR EXTRACTION PILOT TEST DATA "STEP TEST" - STEP 3

Location Memphis Depot, Dunn Fied

Client U S Army Engineering and Support Center, Huntsville

Test Date January 7, 2002

Vapor Extraction Well VW-2

Monitoring Point	Radial Distance (r) [ft]	Radial Distance (r) [cm]	ln(r)	Steady-State Vacuum [in H2O]	Absolute Pressure (P) [g/cm s^2]	P^2	Regrssn P^2
MP-1	85 8	2615 18	7 87	1 00	1010513 00	1 02E+12	1 02E+12
MP-2	57 1	1740 41	7 46	0 60	1011507 80	1 02E+12	1 02E+12
MP-3	40 9	1246 63	7 13	0 00	1013000 00	1 03E+12	1 02E+12
MP-4	53 5	1630 68	7 40	0 01	1012975 13	1 03E+12	1 02E+12
MP-6	9 5	289 56	5 67	1 00	1010513 00	1 02E+12	1 02E+12
MP-7	29 9	911 35	6 81	1 10	1010264 30	1 02E+12	1 02E+12

P(r) = Pw [1 + (1/Pw^2)*(Pw^2-Patm^2)*ln(r/Rw)/ln(Rw/Ri)]^(1/2)

P(r) = absolute pressure at radius r

r = radial distance from extraction well

Pw = absolute pressure at the extraction well

= Patm - vacuum

Patm = absolute ambient atmospheric pressure

Rw = radius of extraction well

Ri = radius of influence of extraction well

P(r)^2 = (Pw^2 - Patm^2)ln(r) / ln(Rw/Ri) - ln(Rw)(Pw^2-Patm^2) / ln(Rw/Ri) +Pw^2

P(r)^2 = m * ln(r) + b

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0 31
R Square	0 09
Adjusted R Square	-0 13
Standard Error	2 70E+09
Observations	6 00

ANOVA

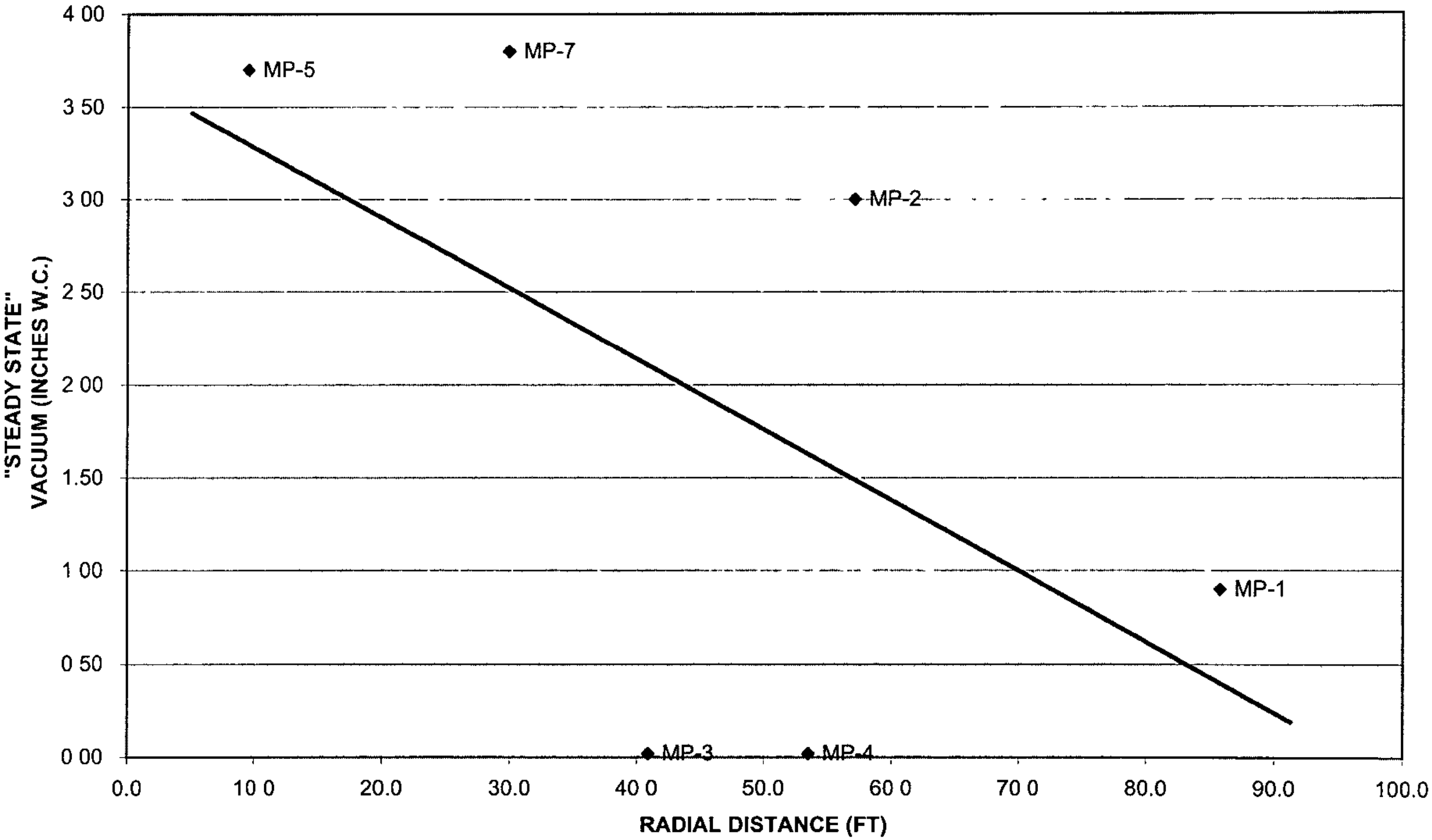
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1 00	3 06E+18	3 06E+18	0 42	0 55
Residual	4 00	2 93E+19	7 31E+18		
Total	5 00	3 23E+19			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95 0%*	*Upper 95 0%*
Intercept	1 02E+12	1 12E+10	90 68	0 00	9 85E+11	1 05E+12	9 85E+11	1 05E+12
X Variable 1	1 02E+09	1 58E+09	0 65	0 55	-3 37E+09	5 41E+09	-3 37E+09	5 41E+09

Ri = 2076 4 cm

Ri = 68 1 ft

TEST 2 - LINEAR DATA PLOT



579 561

Attachment H

ETC

ENVIRONMENTAL TESTING & CONSULTING, INC.
2924 Walnut Grove Road • Memphis, TN 38111 • (901) 327-2750 • FAX (901) 327-6334
Founded 1972

January 15, 2002

Mr. Kraig Smith
Sverdrup/Jacobs Eng.
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

SVERDRUP
JAN 17 2002
RECEIVED

Ref: Analytical Testing
ETC Order # 0201135
Project Description Dunn Field

Project Number C5X51108

The above referenced project has been analyzed per your instructions. The analyses were performed in our laboratory in accordance with Standard Methods, The Solid Waste Manual SW-846, EPA Methods for Chemical Analysis of Water and Wastes and/or 40 CFR part 136.

The analytical data has been validated using standard quality control measures performed as required by the analytical method. Quality Assurance, instrumentation maintenance and calibration were performed in accordance with guidelines established by the USEPA.

The results are shown on the attached analysis sheet(s).

Please do not hesitate to contact our office if you have any questions.

Sincerely,

Connie Bradberry

Connie Bradberry
Laboratory Project Manager

rt
Attachment

SVE_MHDDMTR

Certifications

Tennessee	*#TN02027*	*Mississippi*		*USDA*	*#S-46279*
Arkansas	*#40730*	*Oklahoma*	*#9311*		
Kentucky	*#90047*	*Virginia*	*#00106*		
North Carolina	*#415*	*Washington*	*#C248*		
South Carolina	*#84002002*	*US Army Corps of Engineers*			

Environmental Testing & Consulting, Inc.

Data Qualifiers for Organic Reporting

Within the attached report, some analytical data may be reported as "Qualified Data" as indicated by a "Data Qualifier" next to the result. This table summarizes the possible "Data Qualifiers" that may be associated with this report. These qualifiers do not apply for TIC reports.

Q	Surrogate Recovery Outside QC Limits
J	Estimated Value. Presence of the compound was confirmed but less than the
	reported detection limit.
E	Concentration exceeds the established method calibration range but is within
	the working range of the instrument.
B	Analyte detected in the associated Method Blank.
U	Reported result was unconfirmed. Refer to Case Narrative.
C	Result reported from GC/MS confirmation analysis.
M	Result reported represents a minimum value. Refer to Case Narrative.
NC	Result reported from Primary Column. Result did not confirm.
*	QC Data (percent recovery/RPD for a particular analyte was outside QC Limits)

Revision 03/01 Dataqual XLS

ENVIRONMENTAL TESTING & CONSULTING, INC.
2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

ANALYTICAL SUMMARY/CROSS REFERENCE TABLE

Client Name Sverdrup/Jacobs Eng.
Site ID Dunn Field

ETC Order #0201135
C5X51108

ETC Sample ID	Field ID	Matrix	Method	Method Description
020113501	Carbon-1	SOLID	1311	TCLP Extraction ZHE
020113501	Carbon-1	SOLID	8260B	TCLP Volatile Organics

1/10/02 JB

Environmental Testing & Consulting, Inc.

Login
Chain-of-Custody

CHAIN OF CUSTODY RECORD

Environmental Testing & Consulting, Inc.
2924 Walnut Grove Rd.
Memphis, TN 38111
(901)327-2750 FAX (901)327-6334

ETC Work Order : 0201135

Company Name	JACOBS ENG.
Project/Site	CSX51108 Dunn Field
Project #	CSX51108
Project Manager/Contact	KRAIG SMITH
Phone #	615 305 6437
Fax # :	615 833 8328
FID # :	
PO # .	
Fax Results	X
RUSH	X
Ice	X

Matrix: 1 Wastewater, 2 Aqueous, 3 Soil/Sediment, 4 Sludge, 5 Oil/Solvent, 6 Other

Analysis Requested (Note special detection limits or methods)

# of cont.	Sample ID/ Number	Depth	Sample Date	Sample Time	Matrix	Type Grab/Comp	TCLP VOCs	Comments
4	CARBON-1		1/8/02	13:00	CARBON	COMP	X	

Sampled By: KRAIG SMITH	Method of Shipment: HAND DELIVER	Blank/Cooler Temp: 4°C	Remarks: 3-DAY TAT

RELINQUISHED BY (sign)	DATE	TIME	RECEIVED BY (sign)	DATE	TIME
[signature]	1/8/02	1455			
			RECEIVED BY LAB (print/sign) [signature]	1/8/02	1455

Sample Delivery Group ID

Distribution · Original and Yellow accompany samples to the laboratory Pink copy for Field Crew
Original copy returned with results Yellow copy for ETC, Inc. files.

F:\QAQC\SLOP\COC0995.XLS

579 567

000004

Environmental Testing & Consulting, Inc.
Cooler Receipt Form

Date Received_1/8/02_______
Date/Time Checked In_1/8/02-14.55__
Carrier/Bill# ___Hand-Delivered___________

LIMS#_0201-135________
Project__Dunn Field____
____
By__Rebekah Barger__

1.	Custody Seals?/Location-	No
2.	Samples are non-radioactive?	Yes
3.	Chain of Custody in plastic?	No
4	Temperature at receipt (ok = 4 ± 2 °C) <4oC	OK
5	Ice & Packing- bags, ice	Yes
6.	Chain of Custody filled out properly?	Yes
7	All containers in separate bags?	No
8	Sample containers intact?	Yes
9.	Label(s) complete and in good condition?	Yes
10	Label(s) agree with Chain of Custody?	Yes
11.	Correct containers used?	Yes
12.	Sufficient sample?	Yes
13.	VOA vials bubble-free (H_2O) or no head space (soil)?	Yes
14.	Preservation OK? TM pH____; TRPH pH____; TOC pH____; TOX pH____; CN pH____; N/P pH____; Other pH____	Yes

Comments ____

*Validated Date and Time of Sample Receipt (VDTSR)

Environmental Testing & Consulting, Inc.

Sample Reports

ENVIRONMENTAL TESTING & CONSULTING, INC.

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Dunn Field

FID #

Date Arrived: 01/08/02
ETC Order Number: 0201135

ETC Lab ID: 0201135-01
Field ID : Carbon-1

Matrix : SOLID
Sample Date : 01/08/02

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
TCLP Extraction ZHE	Leachate	mg/L			01/08/02	TL	1311
TCLP Volatile Organics				01/09/02		LS	8260B 5030B
QC Batch	**V401091**						
Dilution Factor	**10**						
Benzene	ND	mg/L	0.010				
Carbon Tetrachloride	ND	mg/L	0.010				
Chlorobenzene	ND	mg/L	0.010				
Chloroform	ND	mg/L	0 010				
1,4-Dichlorobenzene	ND	mg/L	0.010				
1,2-Dichloroethane	ND	mg/L	0.010				
1,1-Dichloroethene	ND	mg/L	0.010				
2-Butanone (MEK)	ND	mg/L	1.00				
Tetrachloroethene	ND	mg/L	0.010				
Trichloroethene	ND	mg/L	0.010				
Vinyl Chloride	ND	mg/L	0.010				

Surrogate Standard	% Recovery	QC Limits	
S1 - Dibromofluoromethane	85	84	115
S2 - Toluene-d8	87	69	133
S3 - 4-Bromofluorobenzene	83	80	111
S4 - 1,2-Dichloroethane-d4	78	58	131

CB
Data Validator

ND - Not Detected

Q - Recovery Outside QC Limits

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level III
GC/MS Volatiles

579 572

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE
GC/MS VOLATILE COMPOUNDS – TCLP

Client Name	Sverdrup/Jacobs Eng
Project Name	Dunn Field
ETC Order #	0201-135

HOLDING TIMES

TCLP Extraction All samples extracted within 14 days
Sample Analysis All VOC extracts analyzed within 14days

METHOD

Preparation SW-846 1311
Analysis: SW-846 8260B

QUALITY CONTROL

QC Batch	Form 4 Summary
V401091	V401091LB

System Monitoring Compounds FORM 2
Surrogate recoveries within QC limits.*
*Surrogate Dibromofluoromethane was flagged for low recovery is samples V401091LB, V401091LCS and 0201-135-01MS/MSD Surrogate Bromoflourobenzene was flagged for low recovery in sample 0201-135-01MSD

Method Blank FORM 4
V401091LB
Target analytes were not detected in the method blank

Laboratory Control Sample FORM 3
V401091LCS
All acceptance criteria met

Matrix Spike / Matrix Spike Dup FORM 3
Batch V401091

0201-135-01	RPD	All analytes within QC limits.
Carbon-1	Spike Recovery	All analytes within QC limits.

Refer to Laboratory Control Sample(s) for system verification.

CALIBRATION

BFB Daily 12-Hour Tune	All criteria met FORM 5
Initial Calibration	All criteria met FORM 6
Calibration Verification	All criteria met FORM 7

Volatile Internal Standard Area and RT FORM 8
Daily Check Standard(s) Internal Standard Areas and Retention Times within QC limits

SAMPLE ANALYSIS

Instrumentation	HP 5890 Series II GC, 5971MSD
Dilutions Required	No dilutions required

Project Manager

FORM 2
WATER VOA-GCMS SYSTEM MONITORING COMPOUND RECOVERY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

	CLIENT SAMPLE NO.	SMC1 (DFM) #	SMC2 (TOL) #	SMC3 (BFB) #	OTHER (DCE) #	TOT OUT
01	V401091LB	81*	83	82	73	1
02	020113501	85	87	83	78	0
03	V401091LCS	84*	90	86	75	1
04	020113501MS	78*	80	81	70	1
05	020113501MSD	76*	79	78*	69	2
06						
07						
08						
09						
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29						
30						

		QC LIMITS
SMC1 (DFM)	= Dibromofluoromethane	(84-115)
SMC2 (TOL)	= Toluene-d8	(69-133)
SMC3 (BFB)	= Bromofluorobenzene	(80-111)
OTHER (DCE)	= 1,2-Dichloroethane-d4	(58-131)

Column to be used to flag recovery values

* Values outside of contract required QC limits

D System Monitoring Compound diluted out

FORM 4
VOA-GCMS METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

V401091LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Lab File ID: 0402005T Lab Prep Batch: V401091

Date Analyzed: 01/09/02 Time Analyzed: 1231

GC Column: ID: 2 (mm) Heated Purge: (Y/N) Y

Instrument ID: VOC4 Lab Sample ID: 1LB

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	CLIENT SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	020113501	020113501	0601007	1333
02	V401091LCS	1LCS	1701018TLCS	1923
03	020113501MS	MS	1901020	2025
04	020113501MSD	MSD	2001021	2056
05				
06				
07				
08				
09				
10				
11				
12				
13				
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COMMENTS:

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V401091LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Matrix: (soil/water) WATER Lab Prep Batch: V401091

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0402005T

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 01/09/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
71-43-2	Benzene	1.00	U
78-93-3	2-Butanone	20.00	U
56-23-5	Carbon Tetrachloride	1.00	U
108-90-7	Chlorobenzene	1.00	U
67-66-3	Chloroform	1.00	U
106-46-7	1,4-Dichlorobenzene	1.00	U
107-06-2	1,2-Dichloroethane	1.00	U
75-35-4	1,1-Dichloroethene	1.00	U
127-18-4	Tetrachloroethene	1.00	U
79-01-6	Trichloroethene	1.00	U
75-01-4	Vinyl Chloride	1.00	U

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

V401091LB

Lab Name: ETC, INC.   Contract:

Lab Code: Case No.:   SAS No.:   SDG No.: 0201135

Matrix: (soil/water) WATER   Lab Sample ID: 1LB

Sample wt/vol: 10.00 (g/mL) ML   Lab File ID: 0402005T

Level: (low/med) LOW   Date Received: ________

% Moisture: not dec. ________   Date Analyzed: 01/09/02

GC Column: ID: 2.00 (mm)   Dilution Factor: 1.0

Soil Extract Volume: ________ (uL)   Soil Aliquot Volume: ________ (uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
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30.				

FORM I VOA-GCMS-TIC

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC. Lab Prep Batch: V401091

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Matrix Spike - Sample No.: V401091LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Benzene	100.0		95.45	95	72-124
2-Butanone	100.0		92.91	93	55-151
Carbon Tetrachloride	100.0		88.39	88	64-123
Chlorobenzene	100.0		84.41	84	77-112
Chloroform	100.0		82.46	82	70-115
1,4-Dichlorobenzene	100.0		92.66	93	78-116
1,2-Dichloroethane	100.0		79.54	80	62-124
1,1-Dichloroethene	100.0		79.24	79	69-121
Tetrachloroethene	100.0		87.94	88	77-115
Trichloroethene	100.0		89.68	90	75-113
Vinyl Chloride	100.0		70.80	71	65-134

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 11 outside limits

COMMENTS: ______________________________

FORM III VOA-GCMS

FORM 3
WATER VOA-GCMS MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: ETC, INC. Lab Prep Batch: V401091

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Matrix Spike - Sample No.: 020113501

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	MS CONCENTRATION (ug/L)	MS % REC #	QC. LIMITS REC.
Benzene	100.0	0.000	108.6	109	72-124
2-Butanone	100.0	0.000	84.04	84	55-151
Carbon Tetrachloride	100.0	0.000	95.09	95	64-123
Chlorobenzene	100.0	0.000	90.55	90	77-112
Chloroform	100.0	0.000	83.01	83	70-115
1,4-Dichlorobenzene	100.0	0.000	95.84	96	78-116
1,2-Dichloroethane	100.0	0.000	77.05	77	62-124
1,1-Dichloroethene	100.0	0.000	79.43	79	69-121
Tetrachloroethene	100.0	0.000	86.14	86	77-115
Trichloroethene	100.0	0.000	94.58	94	75-113
Vinyl Chloride	100.0	0.000	66.49	66	65-134

COMPOUND	SPIKE ADDED (ug/L)	MSD CONCENTRATION (ug/L)	MSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Benzene	100.0	111.3	111	2	20	72-124
2-Butanone	100.0	85.07	85	1	20	55-151
Carbon Tetrachloride	100.0	94.62	95	0	20	64-123
Chlorobenzene	100.0	92.73	93	3	20	77-112
Chloroform	100.0	83.32	83	0	20	70-115
1,4-Dichlorobenzene	100.0	98.79	99	3	20	78-116
1,2-Dichloroethane	100.0	77.59	78	1	20	62-124
1,1-Dichloroethene	100.0	79.10	79	0	20	69-121
Tetrachloroethene	100.0	88.04	88	2	20	77-115
Trichloroethene	100.0	100.1	100	6	20	75-113
Vinyl Chloride	100.0	66.11	66	0	20	65-134

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 11 outside limits
Spike Recovery: 0 out of 22 outside limits

COMMENTS: ______________________________

FORM III VOA-GCMS

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level IV
GC/MS Volatiles

ENVIRONMENTAL TESTING & CONSULTING, INC
GC/MS VOC Method 8260B Sequence Check List (SW-846)

Sequence ID: V401091 Matrix: H2O HBN: ______
Date: 1-10-02
Analyst SS
Super [illegible]
Applicable ETC Order Nos. for this sequence:
0201-135-1 0201-055-1-4

	Validated
1. BFB Daily 12-Hour Tune Meets Criteria. No analyses begins until criteria are met. (SOP)	✓
2. Initial Calibration Verification Criteria - Method : V401041, 8260M	
a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene)	✓
b. CCC - RSD of RF for CCCs and Target Analytes MUST BE<= 30%	✓
c. RSD of analytes <=15% may use Average RF for quantitation	✓
d. Analytes w/RSD >15% use Linear Regression - correlation coefficient >=0.99	✓
3. Calibration Verification - Each 12-Hour Shift	
a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene)	✓
b. CCC - % Difference for Average RF Calibration - <=20%	✓
c. CCC - % Drift for Linear Regression Calibration - <=20%	✓
d. % Difference/% Drift for all other Target Analytes - <=30% — Acrolein	✓
e. Internal Standards - Retention Times within +/-30 seconds from Mid-Point ICAL STD	✓
f. Internal Standards - Areas within (-50% to +100%) form Mid-Point ICAL STD	✓
4. Method Blanks included in this sequence :	✓
Analyze daily or for each analytical batch (20 samples):	
List compounds identified in Method Blank w/concentration.	
Flag final result "B-Detected in Blank" — MeCl2 @ BDL	
TCLP BLK 0108-1	
5. Matrix Spike/Matrix Spike Duplicates included in this sequence :	✓
Analyze daily or for each matrix (ms/msd per 20 samples of same matrix)	
List MS/MSD(s) performed with any failures : 0201-13501 ms, msd	
6. Laboratory Control Samples included in this sequence : 0188	✓
Must contain all Target Analytes.	
7. Surrogate Recoveries within QC Limits	✓
8. All positive compounds within calibration range	✓

Narrative/Notes :

Form Date 09/13/01
P:\Organics\gcmsvol\8260\GCMS VOC 8260B Check List 091201.doc

FORM 5
VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK
BROMOFLUOROBENZENE (BFB)

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Lab File ID: 0101001 BFB Injection Date: 01/09/02

Instrument ID: VOC4 BFB Injection Time: 1028

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) N

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
50	15.0 - 40.0% of mass 95	17.1
75	30.0 - 60.0% of mass 95	46.1
95	Base Peak, 100% relative abundance	100.0
96	5.0 - 9.0% of mass 95	6.8
173	Less than 2.0% of mass 174	0.0 (0.0)1
174	Greater than 50.0% of mass 95	65.0
175	5.0 - 9.0% of mass 174	5.3 (8.2)1
176	95.0 - 101.0% of mass 174	62.5 (96.1)1
177	5.0 - 9.0% of mass 176	4.4 (7.0)2

1-Value is % mass 174 2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	EPA SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	DSC100PPB		0201002	01/09/02	1046
02	020113501	020113501	0601007	01/09/02	1333
03	020113501MS	MS	1901020	01/09/02	2025
04	020113501MSD	MSD	2001021	01/09/02	2056
05					
06					
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FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Instrument ID: VOC4 Calibration Date: 01/09/02 Time: 1046

Lab File ID: 0201002 Init. Calib. Date(s): 01/04/02 01/04/02

Heated Purge: (Y/N) Y Init. Calib. Times: 1614 2127

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
Acetone	96.29	100.0	AVRG	3.7	30.0	
Acetonitrile	1149	1000	AVRG	14.9	30.0	
Acrolein	37.02	100.0	AVRG	63.0	30.0	<-
Acrylonitrile	105.5	100.0	AVRG	5.5	30.0	
Allyl chloride	91.44	100.0	AVRG	8.6	30.0	
Benzene	100.2	100.0	AVRG	0.2	30.0	
Bromobenzene	90.48	100.0	AVRG	9.5	30.0	
Bromochloromethane	99.16	100.0	AVRG	0.8	30.0	
Bromodichloromethane	87.55	100.0	AVRG	12.4	30.0	
Bromoform	87.76	100.0	AVRG	12.2	30.0	
2-Butanone	97.72	100.0	AVRG	2.3	30.0	
Bromomethane	107.6	100.0	AVRG	7.6	30.0	
n-Butylbenzene	103.1	100.0	AVRG	3.1	30.0	
sec-Butylbenzene	82.34	100.0	AVRG	17.7	30.0	
tert-Butylbenzene	81.23	100.0	AVRG	18.8	30.0	
Carbon Disulfide	90.81	100.0	AVRG	9.2	30.0	
Carbon Tetrachloride	89.31	100.0	AVRG	10.7	30.0	
Chlorobenzene	86.08	100.0	AVRG	13.9	30.0	
Chlorodibromomethane	95.60	100.0	AVRG	4.4	30.0	
Chloroethane	90.41	100.0	AVRG	9.6	30.0	
2-Chloroethyl vinyl ether	94.73	100.0	AVRG	5.3	30.0	
Chloroform	83.28	100.0	AVRG	16.7	20.0	
Chloromethane	84.59	100.0	AVRG	15.4	30.0	
Chloroprene	82.53	100.0	AVRG	17.5	30.0	
2-Chlorotoluene	78.72	100.0	AVRG	21.3	30.0	
4-Chlorotoluene	80.64	100.0	AVRG	19.4	30.0	
1,2-Dibromo-3-chloropropane	96.12	100.0	AVRG	3.9	30.0	
1,2-Dibromoethane	102.2	100.0	AVRG	2.2	30.0	
Dibromomethane	82.84	100.0	AVRG	17.2	30.0	
1,2-Dichlorobenzene	106.6	100.0	AVRG	6.6	30.0	
1,3-Dichlorobenzene	109.3	100.0	AVRG	9.3	30.0	
1,4-Dichlorobenzene	101.9	100.0	AVRG	1.9	30.0	
cis-1,4-Dichloro-2-butene	91.17	100.0	AVRG	8.8	30.0	
trans-1,4-Dichloro-2-butene	107.6	100.0	AVRG	7.6	30.0	
Dichlorodifluoromethane	76.73	100.0	AVRG	23.3	30.0	
1,1-Dichloroethane	87.50	100.0	AVRG	12.5	30.0	
1,2-Dichloroethane	84.53	100.0	AVRG	15.5	30.0	

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Instrument ID: VOC4 Calibration Date: 01/09/02 Time: 1046

Lab File ID: 0201002 Init. Calib. Date(s): 01/04/02 01/04/02

Heated Purge: (Y/N) Y Init. Calib. Times: 1614 2127

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d
1,1-Dichloroethene	89.71	100.0	AVRG	10.3	20.0
cis-1,2-Dichloroethene	95.84	100.0	AVRG	4.2	30.0
trans-1,2-Dichloroethene	97.53	100.0	AVRG	2.5	30.0
1,2-Dichloropropane	91.05	100.0	AVRG	9.0	20.0
1,3-Dichloropropane	98.32	100.0	AVRG	1.7	30.0
2,2-Dichloropropane	90.23	100.0	AVRG	9.8	30.0
1,1-Dichloropropene	95.35	100.0	AVRG	4.6	30.0
cis-1,3-Dichloropropene	95.71	100.0	AVRG	4.3	30.0
trans-1,3-Dichloropropene	94.17	100.0	AVRG	5.8	30.0
Di isopropyl ether	94.43	100.0	AVRG	5.6	30.0
1,4-Dioxane	2336	2000	AVRG	16.8	30.0
Ethyl Acetate	104.4	100.0	AVRG	4.4	30.0
Ethylbenzene	85.15	100.0	AVRG	14.8	20.0
Ethyl methacrylate	197.5	200.0	AVRG	1.2	30.0
Furan	131.2	153.0	AVRG	14.2	30.0
Hexachlorobutadiene	105.5	100.0	AVRG	5.5	30.0
Hexane	106.2	117.0	AVRG	9.2	30.0
2-Hexanone	107.5	100.0	AVRG	7.5	30.0
Iodomethane	81.96	100.0	AVRG	18.0	30.0
Isobutyl Alcohol	2373	2000	AVRG	18.6	30.0
Isopropylbenzene	89.19	100.0	AVRG	10.8	30.0
4-Isopropyltoluene	76.42	100.0	AVRG	23.6	30.0
Methacrylonitrile	956.0	1000	AVRG	4.4	30.0
Methylene Chloride	101.2	100.0	LINR	1.2	30.0
Methyl methacrylate	193.0	200.0	AVRG	3.5	30.0
4-Methyl-2-Pentanone	103.2	100.0	AVRG	3.2	30.0
Methyl-tertbutyl-Ether	90.79	100.0	AVRG	9.2	30.0
Naphthalene	121.8	100.0	AVRG	21.8	30.0
Propionitrile	1022	1000	AVRG	2.2	30.0
n-Propyl Acetate	151.7	151.0	AVRG	0.5	30.0
n-Propylbenzene	87.36	100.0	AVRG	12.6	30.0
Styrene	92.16	100.0	AVRG	7.8	30.0
1,1,1,2-Tetrachloroethane	80.88	100.0	AVRG	19.1	30.0
1,1,2,2-Tetrachloroethane	121.5	100.0	AVRG	21.5	30.0
Tetrachloroethene	101.3	100.0	AVRG	1.3	30.0
Tetrahydrofuran	108.3	91.50	AVRG	18.4	30.0
1,2,3-Trichlorobenzene	120.4	100.0	AVRG	20.4	30.0

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Instrument ID: VOC4 Calibration Date: 01/09/02 Time: 1046

Lab File ID: 0201002 Init. Calib. Date(s): 01/04/02 01/04/02

Heated Purge: (Y/N) Y Init. Calib. Times: 1614 2127

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d
Toluene	94.56	100.0	AVRG	5.4	20.0
1,1,1-Trichloroethane	89.52	100.0	AVRG	10.5	30.0
1,1,2-Trichloroethane	100.5	100.0	AVRG	0.5	30.0
1,1,2-trichloro-1,2,2-triflu	94.63	100.0	AVRG	5.4	30.0
Trichloroethene	100.2	100.0	AVRG	0.2	30.0
Trichlorofluoromethane	73.63	100.0	AVRG	26.4	30.0
1,2,3-Trichloropropane	90.30	100.0	AVRG	9.7	30.0
1,2,4-Trimethylbenzene	79.07	100.0	AVRG	20.9	30.0
1,2,4-Trichlorobenzene	121.5	100.0	AVRG	21.5	30.0
1,3,5-Trimethylbenzene	81.60	100.0	AVRG	18.4	30.0
Vinyl Acetate	101.9	100.0	AVRG	1.9	30.0
Vinyl Chloride	83.00	100.0	AVRG	17.0	20.0
Xylene-mp	175.3	200.0	AVRG	12.4	30.0
Xylene-o	88.27	100.0	AVRG	11.7	30.0
Dibromofluoromethane	39.87	50.00	AVRG	20.3	30.0
Toluene-d8	46.44	50.00	AVRG	7.1	30.0
Bromofluorobenzene	39.71	50.00	AVRG	20.6	30.0
1,2-Dichloroethane-d4	37.16	50.00	AVRG	25.7	30.0

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Lab File ID (Standard): 0201002 Date Analyzed: 01/09/02

Instrument ID: VOC4 Time Analyzed: 1046

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS1 AREA #	RT #	IS2 (DFB) AREA #	RT #	IS3 (CBZ) AREA #	RT #
	12 HOUR STD	846271	6.92	1277286	7.50	1378510	9.70
	UPPER LIMIT	1692542	7.42	2554572	8.00	2757020	10.20
	LOWER LIMIT	423136	6.42	638643	7.00	689255	9.20
	CLIENT SAMPLE NO.						
01	020113501	813385	6.92	1275447	7.51	1074916	9.71
02	020113501MS	883916	6.92	1435681	7.51	1176896	9.71
03	020113501MSD	917663	6.92	1475407	7.51	1196338	9.71
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS1 = Pentafluorobenzene
IS2 (DFB) = 1,4-Difluorobenzene
IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0201135

Lab File ID (Standard): 0201002 Date Analyzed: 01/09/02

Instrument ID: VOC4 Time Analyzed: 1046

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS4 (DCB) AREA #	RT #	AREA #	RT #	AREA #	RT #
	12 HOUR STD	327534	11.52				
	UPPER LIMIT	655068	12.02				
	LOWER LIMIT	163767	11.02				
	CLIENT SAMPLE NO.						
01	020113501	267966	11.53				
02	020113501MS	303392	11.53				
03	020113501MSD	283146	11.53				
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS4 (DCB) = 1,4-Dichlorobenzene-d4

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

Lisa Savage 1-8-02
[initials] 1/8/02

QC REVIEWED 1-8-02

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 04-JAN-2002 16:14
End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Calibration File Names:
Level 1: \\ETCBDC\DD\chem\voc4.i\V401041.B\0301005.D
Level 2: \\ETCBDC\DD\chem\voc4.i\V401041.B\0401006.D
Level 3: \\ETCBDC\DD\chem\voc4.i\V401041.B\0601008.D
Level 4: \\ETCBDC\DD\chem\voc4.i\V401041.B\0701009.D
Level 5: \\ETCBDC\DD\chem\voc4.i\V401041.B\0801010.D
Level 6: \\ETCBDC\DD\chem\voc4.i\V401041.B\0901011.D
Level 7: \\ETCBDC\DD\chem\voc4.i\V401041.B\1001012.D
Level 8: \\ETCBDC\DD\chem\voc4.i\V401041.B\1101013.D
Level 9: \\ETCBDC\DD\chem\voc4.i\V401041.B\1201014.D
Level 10: \\ETCBDC\DD\chem\voc4.i\V401041.B\1301015.D

Compound	0.5000000 Level 1	1.0000 Level 2	5.0000 Level 3	20.0000 Level 4	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
	120 0000 Level 7	150 0000 Level 8	170 0000 Level 9	200 0000 Level 10							
1 Dichlorodifluoromethane	0 64464	0 73605	0.84463	0 86253	0.78129	0.80100					
	0 68037	0 65786	0.59036	0 59291			AVRG		0 71916		13 94235

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Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200.0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
2 Chloromethane	0.52202	0.39411	0.54041	0 47289	0 50453	0 44151					
	0 39634	0.38824	+++++	+++++			AVRG		0 45750		13 39704
3 Vinyl Chloride	+++++	0.57262	0 48281	0 54979	0 63108	0.51883					
	0 45186	0.44769	+++++	+++++			AVRG		0 52210		12 90094
4 Bromomethane	0 36242	0.33421	0 40954	0 35692	0 42887	0 38840					
	0 34529	0.35097	0.32675	0.34268			AVRG		0.36460		9 22244
5 Chloroethane	0 27728	0 33919	0.30204	0 29727	0 35974	0 30609					
	0.26303	0.26399	0.23875	0 24285			AVRG		0 28902		13.71688
6 Acrolein	+++++	+++++	+++++	0 03521	0 03263	0 03228					
	0.02675	0.02979	0 02821	0.03079			AVRG		0 03081		9 28264

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Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
7 Trichlorofluoromethane	0.95330	1.06944	1.08397	1 08993	1 21458	0 99319					
	0 85757	0 86086	0.76369	+++++			AVRG		0 98739		14.42477
8 Acetonitrile	+++++	+++++	0 03265	0 03033	0.03196	0.02988					
	0 02369	0.02691	0 02532	0.02838			AVRG		0 02864		11 04328
9 Acetone	+++++	+++++	+++++	0 16627	0 17899	0 15836					
	0.13098	0 15021	0.14025	0 14895			AVRG		0 15343		10 47737
10 Furan	+++++	1.27041	1 20232	1 18393	1 25854	1.11153					
	0 98490	1 00867	0.92480	0 92442			AVRG		1 09661		12 68620
11 1,1-Dichloroethene	0 49598	0 60376	0.53716	0 50486	0 54657	0 48411					
	0.42660	0.43826	0.41065	0 40756			AVRG		0 48555		13 42620

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Compound	0.5000000 Level 1 / 120.0000 Level 7	1.0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
12 Acrylonitrile	+++++	+++++	+++++	0.13855	0 13194	0 12994					
	0 10575	0 12161	0 11425	0 12587			AVRG		0 12399		9 00101
13 Iodomethane	+++++	0 73248	0 79261	0.78665	0 84651	0 74725					
	0 65199	0 67254	0 62133	0 60411			AVRG		0 71727		11 72641
14 Methylene Chloride	40172	43445	73795	179584	404256	776066					
	859996	1148871	1258780	1467972			LINR	-0 18014	0 48601		0 99220
15 1,1,2-trichloro-1,2,2-trifluo	0 47632	0 49377	0 52405	0.51266	0.53229	0 52094					
	0.53911	0.53070	0.51363	0 51917			AVRG		0.51626		3.65197
16 Allyl chloride	0 79161	0 92437	0 83369	0 83003	0 88173	0 78694					
	0.69806	0.72017	0.68220	0 67745			AVRG		0 78263		11 03014

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Compound	0.5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
17 Carbon Disulfide	3.35704 / 3.02286	3 87392 / 3.02736	3 61149 / 2.82323	3.39298 / 2.83551	3.70142	3.35149	AVRG		3 29973		11 04896
18 trans-1,2-Dichloroethene	0 51720 / 0 52431	0 59945 / 0 54680	0.54575 / 0 52393	0.54617 / 0.51719	0.58964	0.57143	AVRG		0 54819		5 43140
19 Methyl-tertbutyl-Ether	1.56383 / 1.33729	1 56180 / 1.42231	1 55698 / 1 39353	1.47227 / 1 43234	1.46460	1 45037	AVRG		1 46553		5.19508
20 Propionitrile	0 05388 / 0 03619	0.04865 / 0 04200	0 04894 / 0 03832	0.04796 / 0.04398	0 04632	0.04624	AVRG		0 04525		11.68130
21 1,1-Dichloroethane	1 00797 / 0.93803	1.04581 / 0.97842	1.09429 / 0.93952	1 09894 / 0 92149	1 17344	1 06431	AVRG		1.02622		8 10819

579 591

Environmental Testing and Consulting, Inc.

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Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
22 Vinyl Acetate	+++++	+++++	1 09814	1 03655	0.97348	0 98828					
	0 88459	0.95897	0 91342	0.97079			AVRG		0.97803		6 83678
23 Chloroprene	1 11706	1.10422	1.10659	1 07922	1 10117	1 05419					
	1.05775	1.03595	1 00721	0 95551			AVRG		1 06189		4 83605
24 2-Butanone	+++++	+++++	0 07167	0.06229	0 06147	0.06187					
	0 05322	0.06018	0.05641	0.06024			AVRG		0 06092		8 75973
25 Hexane	+++++	+++++	0 82111	0 81570	0 85076	0 83752					
	0 85884	0 83458	0 80560	0 78732			AVRG		0 82643		2 87025
26 Di isopropyl ether	+++++	1 83618	1 74130	1 71736	1 71822	1 77838					
	1.72261	1.83859	1 81882	1.81255			AVRG		1 77600		2 92220

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Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
27 Methacrylonitrile	0.33198	0 30965	0.29484	0 27767	0.26046	0 26259					
	0.22664	0 25926	0.24631	0 26870			AVRG		0 27381		11 32180
28 cis-1,2-Dichloroethene	0 57890	0 68209	0 60865	0 60304	0 63790	0.60197					
	0 53816	0 57652	0 55739	0 55252			AVRG		0 59371		7 26839
29 Ethyl Acetate	+++++	+++++	0.49359	0 43467	0 40667	0 42828					
	0.36685	0 41122	0 39573	0 43586			AVRG		0 42161		8 78343
30 Bromochloromethane	0 21714	0 26220	0 25311	0 24672	0.24766	0.24133					
	0 20771	0 22990	0 22223	0 22719			AVRG		0 23552		7.37663
31 Chloroform	1.44667	1.38240	1 28753	1.25329	1.31083	1 27006					
	1 14211	1 18803	1 14781	1 10820			AVRG		1 25369		8.72252

Environmental Testing and Consulting, Inc.

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Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
32 Isobutyl Alcohol	+++++	+++++	0.01983	0.01722	0.01639	0 01625					
	0.01260	0 01518	0 01423	0.01645			AVRG		0 01602		13 33758
33 2,2-Dichloropropane	1 11146	1 13781	1.06860	1.03185	1 03811	1 01077					
	1 01468	1 01514	1 01010	0.97074			AVRG		1 04093		4 89415
35 Tetrahydrofuran	+++++	+++++	0.14177	0 18053	0 15957	0 16074					
	0.13551	0.15299	0 14488	0 15385			AVRG		0 15373		9 05235
38 1,2-Dichloroethane	0 89836	1 01489	0 94160	0.93711	0.90067	0 97694					
	0 81016	0 85971	0.83552	0 86652			AVRG		0 90415		7 09445
39 1,1,1-Trichloroethane	1 07605	1.14852	1.20571	1 19358	1.15196	1 20426					
	1 12857	1 15089	1 24901	1 20602			AVRG		1 17146		4 24132

Environmental Testing and Consulting, Inc.

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Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
40 1,1-Dichloropropene	0.94444	0 98256	0.94313	0 94403	0 94360	0.95924					
	0.94200	0 99609	0 99149	0 95606			AVRG		0 96026		2 24778
41 Carbon Tetrachloride	0.85423	0 99118	0 97529	1 00749	0.99264	1.02468					
	1 03870	1 04539	1 04657	1 00797			AVRG		0.99841		5.62850
42 Benzene	2.49422	2.25750	2.12928	2.07795	2.24608	2 18626					
	2 17823	2.28546	2 35739	2 33649			AVRG		2 25489		5.39382
44 Dibromomethane	0.26891	0 28673	0.29257	0.27176	0 25891	0 25651					
	0 21836	0 23720	0.22798	0.22901			AVRG		0.25479		10 11250
45 1,2-Dichloropropane	+++++	0.54915	0.44417	0 37946	0.37661	0 39581					
	0 36877	0 40418	0.40862	0.40488			AVRG		0 41463		13 30511

Environmental Testing and Consulting, Inc.

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Compound	0 5000000 Level 1 / 120 0000 Level 7	1.0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
46 Trichloroethene	0.31489	0.36660	0 36553	0.36007	0 34495	0 36563					
	0.35236	0.37178	0.38824	0.38245			AVRG		0 36125		5 72550
47 Bromodichloromethane	0 67628	0.69502	0 76378	0 73321	0.69155	0 73073					
	0 66818	0 72356	0 73040	0 72733			AVRG		0 71400		4 18932
48 n-Propyl Acetate	+++++	0.81220	0 83251	0.77170	0.69307	0 75533					
	0.61934	0 71264	0.69263	0.75480			AVRG		0 73825		8 95395
49 Methyl methacrylate	0 27605	0 26873	0.28756	0 26955	0.24088	0 26282					
	0.21916	0.24786	0.24144	0 25709			AVRG		0 25711		7.82418
50 1,4-Dioxane	+++++	+++++	0.00207	0 00220	0 00239	0 00239					
	0 00169	0 00219	0.00210	0 00236			AVRG		0 00217		10 79875

Environmental Testing and Consulting, Inc.

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Compound	0.5000000 Level 1 / 120.0000 Level 7	1.0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
51 2-Chloroethyl vinyl ether	0.40493	0 39898	0 44424	0 38187	0 37682	0 39453					
	0 36568	0 40321	0.40665	0 40235			AVRG		0 39793		5.34615
52 cis-1,3-Dichloropropene	0.75500	0 75078	0 82879	0.79950	0 76328	0 81756					
	0 73951	0 80539	0 82360	0 82071			AVRG		0.79041		4 35995
53 4-Methyl-2-Pentanone	+++++	+++++	0 41199	0.38377	0.33910	0 36880					
	0 30229	0 34443	0 32651	0 35935			AVRG		0.35453		9.67552
54 trans-1,3-Dichloropropene	0 70937	0 74985	0.82277	0 80628	0.75783	0.82484					
	0 72432	0 79655	0 78816	0 79194			AVRG		0 77719		5 15089
55 1,1,2-Trichloroethane	0.24470	0 29273	0 30294	0 28870	0.26597	0 29858					
	0 25830	0.29165	0.28898	0.29812			AVRG		0.28307		6 94042

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 04-JAN-2002 16:14
End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
57 Ethyl methacrylate	0 25628	0.29423	0 33026	0 31548	0 28924	0 30495					
	0 25223	0 28024	0 26869	0 28165			AVRG		0.28733		8.69941
58 Toluene	1.25067	1 25627	1 16786	1 13372	1 11508	1 12344					
	0 98461	1.06517	1 09480	1 06631			AVRG		1.12579		7 41257
59 1,3-Dichloropropane	0 64223	0 66274	0 70759	0 70545	0 65640	0 72209					
	0 62720	0.70634	0.68786	0.70888			AVRG		0 68268		4 82550
60 2-Hexanone	+++++	+++++	0.27063	0.27959	0.25400	0 27396					
	0.20889	0.23989	0.21974	0.23822			AVRG		0 24811		10 45386
61 Chlorodibromomethane	0 44995	0 48345	0.51065	0 50193	0.49233	0 54464					
	0 46997	0 53078	0.52311	0.52460			AVRG		0.50314		5 86493

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 04-JAN-2002 16:14
End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
62 1,2-Dibromoethane	0 37227	0 38600	0 41954	0.41572	0 38676	0 42899					
	0 35774	0 40018	0 38627	0 39145			AVRG		0 39449		5 57527
63 Tetrachloroethene	0 30278	0 34746	0 34441	0.34024	0 33749	0.34875					
	0 31438	0 33743	0 34496	0 32994			AVRG		0 33478		4 51860
64 1,1,1,2-Tetrachloroethane	0 51197	0 47162	0 46101	0 45588	0 45691	0.48472					
	0 49981	0 52170	0.53792	0 53326			AVRG		0 49348		6 44174
66 Chlorobenzene	1 26639	1 25757	1 15024	1.11749	1 18480	1.13247					
	1.06669	1 14012	1.17752	1 16481			AVRG		1.16581		5 21056
67 Ethylbenzene	2 36101	2 52253	2 39424	2 33547	2.50862	2 38337					
	2.22441	2 31121	2 37033	2.26092			AVRG		2 36721		4 00740

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 04-JAN-2002 16:14
End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
68 Xylene-mp	0 69973	0 75203	0.66763	0 67660	0 72959	0.70335					
	0 65304	0.69092	0.71572	+++++			AVRG		0.69873		4.44285
69 Bromoform	0 30866	0.30528	0.32270	0.32788	0 33041	0 34769					
	0.31021	0.32441	0.30544	+++++			AVRG		0 32030		4 43800
70 trans-1,4-Dichloro-2-butene	0.12161	0 13521	0 15074	0.15807	0 16516	0.16884					
	0 13716	0.14065	0 12980	0 13935			AVRG		0.14466		10 71748
71 Styrene	1 13453	1.11910	1.06431	1.07832	1.19130	1.09533					
	0 99360	1 03918	1 04900	1.03643			AVRG		1.08011		5.28829
72 Xylene-o	0 64667	0 69676	0.62543	0 62909	0.68590	0 63675					
	0 58086	0 59867	0 61480	0 61052			AVRG		0 63254		5 74101

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 04-JAN-2002 16:14
End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
73 1,1,2,2-Tetrachloroethane	1 54460	1.42046	1.43875	1 34532	1 23280	1.44779					
	1 25874	1.24230	1 03991	1.05296			AVRG		1.30236		12 94114
74 cis-1,4-Dichloro-2-butene	+++++	0 13074	0 15504	0 15499	0.16538	0 15790					
	0.11886	0 11954	0 11391	0 12257			AVRG		0 13766		14 75727
75 1,2,3-Trichloropropane	+++++	0.14196	0 14419	0 14183	0.14207	0 14423					
	0 11501	0.11551	0 10687	0 11248			AVRG		0.12935		12 53998
76 Isopropylbenzene	1.85624	2.14976	1 99296	2.04291	2 24735	2 03921					
	1 83510	1 84460	1.84888	1.79939			AVRG		1 96564		7 77714
78 Bromobenzene	0.38054	0 42371	0 40925	0 41268	0 44549	0 39983					
	0 34564	0 35125	0 35309	0.35179			AVRG		0 38733		9.23182

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0.5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
79 n-Propylbenzene	2 34388	2 42195	2 25126	2 33252	2.63319	2 32672					
	2 05606	2 05763	2 14564	2 11725			AVRG		2 26861		8 01536
80 2-Chlorotoluene	1.68075	1 54201	1 53867	1 45738	1 68319	1 55858					
	1 23511	1 24829	1 29623	1 27721			AVRG		1 45174		12 06552
81 4-Chlorotoluene	1 72219	1 62478	1 61522	1 65395	1 81777	1 46066					
	1.36837	1 38610	1 46791	1 40825			AVRG		1 55252		9.99245
82 1,3,5-Trimethylbenzene	1.47319	1.51459	1 45660	1 48528	1.63138	1 42852					
	1 26116	1.27928	1 40332	1 38751			AVRG		1 43208		7 61508
83 1,2,4-Trimethylbenzene	1 63396	1 49410	1 44842	1 45191	1 60250	1.38586					
	1 23323	1.28264	2.41342	1.41189			AVRG		1 43579		8 65337

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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End Cal Date : 04-JAN-2002 21:27
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Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0.5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5.0000 Level 3 / 170.0000 Level 9	20.0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
85 tert-Butylbenzene	1.28265	1.25150	1 21517	1.25092	1 38257	1.17847					
	0.98960	1 00758	1 12234	1 13854			AVRG		1 18193		10 32140
86 sec-Butylbenzene	1 87369	1 83653	1.76438	1 86655	2 12653	1 75458					
	1.49900	1 57467	1.80255	1.80408			AVRG		1 79025		9 52315
87 4-Isopropyltoluene	1 36979	1 41888	1 30093	1 38523	1 54474	1 26340					
	1 14596	1 24298	1 44344	1 37733			AVRG		1 34927		8 44185
89 1,3-Dichlorobenzene	2 19989	2 03763	1 87202	1 84275	1 88513	1 77389					
	1 67750	1.75224	1 78727	1 69593			AVRG		1 85243		8.66950
90 1,4-Dichlorobenzene	2 14979	2 11049	1 84650	1.81034	1 84668	1 76380					
	1.67802	2 00933	2 06690	1 74093			AVRG		1 90228		8 81955

579 603

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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End Cal Date : 04-JAN-2002 21:27
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
91 1,2-Dichlorobenzene	1 71574	1 61401	1 52739	1 53514	1 56212	1 49545					
	1 46841	1.58147	1 59857	1 50821			AVRG		1 56065		4 58290
92 n-Butylbenzene	4 75997	4 58118	4 38107	4 41902	4 53399	4 20401					
	4 40073	4.59939	4 57859	3 95985			AVRG		4 44178		5 13069
93 1,2-Dibromo-3-chloropropane	+++++	+++++	0 22696	0 21046	0.20438	0 20190					
	0 23460	0.25087	0.19022	0.18605			AVRG		0.21318		10.55551
94 1,2,4-Trichlorobenzene	1.31167	1.11679	0.98410	0.93017	0 86282	1 00082					
	1.11452	0 99735	0.89210	0 93016			AVRG		1.01405		13 24670
95 Naphthalene	+++++	2.02799	1.75891	1.65133	1.52249	1 87980					
	1 90443	1.79783	1.70698	1.85638			AVRG		1 78957		8 40310

Environmental Testing and Consulting, Inc.

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Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
96 Hexachlorobutadiene	0 71233	0 68817	0.69845	0.70091	0.66050	0 69456					
	0 93759	0.81136	0.60840	0 63010			AVRG		0 71424		13 36302
97 1,2,3-Trichlorobenzene	1 04144	0.97627	0.82275	0.79806	0 73875	0.89793					
	0.92304	0.83102	0.81068	0 84054			AVRG		0.86805		10 50087
$ 34 Dibromofluoromethane	0.62174	0.66707	0.63070	0 61798	0 64800	0 62887					
	0.59661	0.61491	0.57628	0 58493			AVRG		0 61871		4 47457
$ 37 1,2-Dichloroethane-d4	0 75623	0.85245	0.77603	0.74218	0.74421	0 79843					
	0 72807	0.73600	0 69084	0 69355			AVRG		0 75180		6 42267
$ 56 Toluene-d8	1 43569	1 61083	1 59969	1 50323	1 57781	1.56405					
	1.47850	1 55237	1.45063	1 51931			AVRG		1.52921		4 01972

579 606

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V401041.B\v401041.8260.m
Cal Date : 07-Jan-2002 09:30 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
$ 77 Bromofluorobenzene	0.60036	0 61605	0 60108	0 56567	0 66149	0 57521					
	0 55060	0.53028	0 48225	0.50952			AVRG		0 56925		9 39288

Curve	Formula	Units
Averaged	Amt = Rsp/m1	Response
Linear	Amt = b + Rsp/m1	Response

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V401031

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V401031LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Isobutyl Alcohol	2000		1620	81	60-134
Isopropylbenzene	100.0		93.79	94	74-125
4-Isopropyltoluene	100.0		88.99	89	72-127
Methacrylonitrile	1000		779.0	78	70-125
Methylene Chloride	100.0		84.58	84	76-115
Methyl methacrylate	200.0		147.0	74	57-147
4-Methyl-2-Pentanone	100.0		73.20	73	42-144
Methyl-tertbutyl-Ether	100.0		85.05	85	62-122
Naphthalene	100.0		98.36	98	53-124
Propionitrile	1000		751.3	75	58-139
n-Propyl Acetate	100.0		120.2	120	88-170
n-Propylbenzene	100.0		94.74	95	75-125
Styrene	100.0		94.38	94	77-117
1,1,1,2-Tetrachloroetha	100.0		89.12	89	79-113
1,1,2,2-Tetrachloroetha	100.0		86.82	87	67-126
Tetrachloroethene	100.0		93.68	94	77-115
Tetrahydrofuran	100.0		80.47	80	76-181
1,2,3-Trichlorobenzene	100.0		105.3	105	62-132
Toluene	100.0		85.55	86	77-115
1,1,1-Trichloroethane	100.0		88.50	88	63-122
1,1,2-Trichloroethane	100.0		81.46	81	69-117
1,1,2-trichloro-1,2,2-t	100.0		104.8	105	70-130
Trichloroethene	100.0		90.70	91	75-113
Trichlorofluoromethane	100.0		72.51	72	55-130
1,2,3-Trichloropropane	100.0		78.87	79	62-130
1,2,4-Trimethylbenzene	100.0		85.88	86	69-126
1,2,4-Trichlorobenzene	100.0		110.4	110	68-132
1,3,5-Trimethylbenzene	100.0		87.74	88	69-128

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ____________________

579 608

ENVIRONMENTAL TESTING & CONSULTING, INC.
2924 Walnut Grove Road • Memphis, TN 38111 • (901) 327-2750 • FAX (901) 327-6334

Founded 1972

January 14, 2002

Mr. Kraig Smith
Sverdrup/Jacobs Eng.
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Ref: Analytical Testing
ETC Order # 0112602
Project Description Memphis Depot

Project Number C5X51106

The above referenced project has been analyzed per your instructions. The analyses were performed in our laboratory in accordance with Standard Methods, The Solid Waste Manual SW-846, EPA Methods for Chemical Analysis of Water and Wastes and/or 40 CFR part 136.

The analytical data has been validated using standard quality control measures performed as required by the analytical method. Quality Assurance, instrumentation maintenance and calibration were performed in accordance with guidelines established by the USEPA.

The results are shown on the attached analysis sheet(s).

Please do not hesitate to contact our office if you have any questions.

Sincerely,
Connie Bradberry

Connie Bradberry
Laboratory Project Manager

rt
Attachment

SVE_MHDDMT6

Certifications

Tennessee	*#TN02027*	*Mississippi*		*USDA*	*#S-46279*
Arkansas	*#40730*	*Oklahoma*	*#9311*		
Kentucky	*#90047*	*Virginia*	*#00106*		
North Carolina	*#415*	*Washington*	*#C248*		
South Carolina	*#84002002*	*US Army Corps of Engineers*			

Environmental Testing & Consulting, Inc.
Data Qualifiers for Organic Reporting

Within the attached report, some analytical data may be reported as "Qualified Data" as indicated by a "Data Qualifier" next to the result. This table summarizes the possible "Data Qualifiers" that may be associated with this report. These qualifiers do not apply for TIC reports

Q	Surrogate Recovery Outside QC Limits
J	Estimated Value. Presence of the compound was confirmed but less than the reported detection limit.
E	Concentration exceeds the established method calibration range but is within the working range of the instrument.
B	Analyte detected in the associated Method Blank
U	Reported result was unconfirmed. Refer to Case Narrative.
C	Result reported from GC/MS confirmation analysis.
M	Result reported represents a minimum value. Refer to Case Narrative.
NC	Result reported from Primary Column. Result did not confirm.
*	QC Data (percent recovery/RPD for a particular analyte was outside QC Limits)

579 610

ENVIRONMENTAL TESTING & CONSULTING, INC.

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

ANALYTICAL SUMMARY/CROSS REFERENCE TABLE

Client Name Sverdrup/Jacobs Eng.
Site ID Memphis Depot

ETC Order #0112602
C5X51106

ETC Sample ID	Field ID	Matrix	Method	Method Description
011260201	VW-1	AQUEOUS	150.1	pH
011260201	VW-1	AQUEOUS	160.2	Total Suspended Solids
011260201	VW-1	AQUEOUS	245.1	Mercury Dig. Batch/Diss
011260201	VW-1	AQUEOUS	200.7	Silver
011260201	VW-1	AQUEOUS	200.7	Silver - Dissolved
011260201	VW-1	AQUEOUS	200.7	Arsenic
011260201	VW-1	AQUEOUS	200.7	Arsenic - Dissolved
011260201	VW-1	AQUEOUS	200.7	Barium
011260201	VW-1	AQUEOUS	200.7	Barium - Dissolved
011260201	VW-1	AQUEOUS	200.7	Cadmium
011260201	VW-1	AQUEOUS	200.7	Cadmium - Dissolved
011260201	VW-1	AQUEOUS	200.7	Chromium
011260201	VW-1	AQUEOUS	200.7	Chromium - Dissolved
011260201	VW-1	AQUEOUS	200.7	Iron
011260201	VW-1	AQUEOUS	200.7	Iron - Dissolved
011260201	VW-1	AQUEOUS	245 1	Mercury
011260201	VW-1	AQUEOUS	245.1	Mercury - Dissolved
011260201	VW-1	AQUEOUS	200.7	Manganese
011260201	VW-1	AQUEOUS	200.7	Manganese - Dissolved
011260201	VW-1	AQUEOUS	200.7	Lead
011260201	VW-1	AQUEOUS	200.7	Lead - Dissolved
011260201	VW-1	AQUEOUS	200.7	Selenium
011260201	VW-1	AQUEOUS	200 7	Selenium - Dissolved
011260201	VW-1	AQUEOUS	8260B	GC/MS Volatile Organics
011260202	EFF-12-21	AQUEOUS	8260B	GC/MS Volatile Organics
011260202	EFF-12-21	AQUEOUS	8270C	GC/MS Base/Neutral & Acid

1/14/02 JS

Environmental Testing & Consulting, Inc.

Login
Chain-of-Custody

579 612

CHAIN OF CUSTODY RECORD

Environmental Testing & Consulting, Inc.
2924 Walnut Grove Rd.
Memphis, TN 38111
(901)327-2750 FAX (901)327-6334

ETC Work Order : 0112602

SVE_MHSDMTL

Company Name	JACOBS / Kraig Smith
Project/Site	Memphis Depot
Project #	CSXS1106
Project Manager/Contact	KRAIG SMITH
Phone #	615 305 6477
Fax #	615 823-8328
FID #	
PO #	
Fax Results	
RUSH	
Ice	X

Matrix: 1 Wastewater, 2 Aqueous, 3 Soil/Sediment, 4 Sludge, 5 Oil/Solvent, 6 Other

Analysis Requested (Note special detection limits or methods)

# of cont	Sample ID/ Number	Depth	Sample Date	Sample Time	Matrix	Type Grab/Comp	VOC	TOTAL RCRA met. + Fe, Mn	DISSOLVED RCRA MET. + Fe, Mn	TSS	PH	SVOC					Comments
6	IW-1		12/21	1000	Water	GRAB	X	X	X	X	X						
5	EFF-12-21		12/21	1030	Water	GRAB	X					X					

Sampled By: KRAIG SMITH	Method of Shipment: HAND DELIVER	Blank/Cooler Temp: 4°C GS	Remarks: Need E.D.D. Level IV. Send Copy to CHZMHill (W)

RELINQUISHED BY (sign)	DATE	TIME	RECEIVED BY (sign)	DATE	TIME
Kraig Smith	12-21	1:45			
RELINQUISHED BY (sign)	DATE	TIME	RECEIVED BY (sign)	DATE	TIME
RELINQUISHED BY (sign)	DATE	TIME	RECEIVED BY LAB (print/sign): S. HERRMANN / (signature)	12/21/01	1045

Sample Delivery Group ID

Distribution: Original and Yellow accompany samples to the laboratory. Pink copy for Field Crew. Original copy returned with results. Yellow copy for ETC, Inc. files.

F:\QAQC\SLOP\COC0895 XLS

000004

Environmental Testing & Consulting, Inc.
Cooler Receipt Form

Date Received_12/21/01
Date/Time Checked In_12/21/01-10.45
Carrier/Bill# __Hand-Delivered

LIMS#_0112-602
Project_Memphis Depot
By__Rebekah Barger

1.	Custody Seals?/Location-	No
2.	Samples are non-radioactive?	Yes
3	Chain of Custody in plastic?	Yes
4	Temperature at receipt (ok = 4 ± 2 °C) <4oC	OK
5.	Ice & Packing-bags, ice, bubble wrap	Yes
6	Chain of Custody filled out properly?	Yes
7.	All containers in separate bags?	No
8	Sample containers intact?	Yes
9.	Label(s) complete and in good condition?	Yes
10.	Label(s) agree with Chain of Custody?	Yes
11	Correct containers used?	Yes
12.	Sufficient sample?	Yes
13	VOA vials bubble-free (H_2O) or no head space (soil)?	Yes
14	Preservation OK? TM pH____; TRPH pH____; TOC pH____; TOX pH____; CN pH____; N/P pH____; Other pH____	Yes

Comments ______________________________

*Validated Date and Time of Sample Receipt (VDTSR)

579 614

Environmental Testing & Consulting, Inc.

Sample Reports

ENVIRONMENTAL TESTING & CONSULTING, INC.
2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID : 0112602-01
Field ID : VW-1

Matrix : AQUEOUS
Sample Date : 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	BY	METHOD	QC BATCH
pH	6.5	SU		12/21/01	RB	150.1	1330
Total Suspended Solids	177	mg/L	2	12/26/01	JM	160.2	T2122611

Data Validator

ND - Not Detected

579 616

ENVIRONMENTAL TESTING & CONSULTING, INC.

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID Memphis Depot

Date Arrived 12/21/01
ETC Order Number 0112602

ETC Lab ID . 0112602-01
Field ID : VW-1

Matrix : AQUEOUS
Sample Date : 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE PREPARED	BY	METHOD
Mercury Digestion Batch	V9-AQ-26				01/02/02	JF	245 1
Metals Dig Batch/Diss	V29-AQ-29				12/28/01	NR	3030K
Silver	ND	mg/L	0 0005	01/03/02	12/28/01	SH	200.7
Silver - Dissolved	ND	mg/L	0.0005	01/03/02	12/28/01	SH	200.7
Arsenic	0 003	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Arsenic - Dissolved	ND	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Barium	0.124	mg/L	0.001	01/03/02	12/28/01	SH	200.7
Barium - Dissolved	0.065	mg/L	0.001	01/03/02	12/28/01	SH	200.7
Cadmium	ND	mg/L	0.0003	01/03/02	12/28/01	SH	200.7
Cadmium - Dissolved	ND	mg/L	0.0003	01/03/02	12/28/01	SH	200.7
Chromium	0 014	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Chromium - Dissolved	ND	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Iron	11 1	mg/L	0 035	01/03/02	12/28/01	SH	200.7
Iron - Dissolved	ND	mg/L	0 035	01/03/02	12/28/01	SH	200.7
Mercury	ND	mg/L	0.0002	01/03/02	01/02/02	JF	245.1
Mercury - Dissolved	ND	mg/L	0.0002	01/03/02	01/02/02	JF	245.1
Manganese	2 39	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Manganese - Dissolved	2 12	mg/L	0.001	01/03/02	12/28/01	SH	200.7
Lead	0.049	mg/L	0 002	01/03/02	12/28/01	SH	200.7
Lead - Dissolved	ND	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Selenium	ND	mg/L	0.002	01/03/02	12/28/01	SH	200.7
Selenium - Dissolved	ND	mg/L	0.002	01/03/02	12/28/01	SH	200 7

Data Validator

ND - Not Detected

ENVIRONMENTAL TESTING & CONSULTING, INC.

579 617

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-01
Field ID: VW-1

Matrix: AQUEOUS
Sample Date: 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Volatile Organics				12/21/01		LS	8260B 5030B
QC Batch	V412211						
Dilution Factor	1						
Acetone	ND	ug/L	20.0				
Benzene	ND	ug/L	1.00				
Bromodichloromethane	ND	ug/L	1.00				
Bromoform	ND	ug/L	1 00				
Bromomethane	ND	ug/L	1.00				
2-Butanone (MEK)	57.3	ug/L	20.0				
Carbon Disulfide	0.64J	ug/L	1.00				
Carbon Tetrachloride	ND	ug/L	1.00				
Chlorobenzene	ND	ug/L	1.00				
Chlorodibromomethane	ND	ug/L	1 00				
Chloroethane	ND	ug/L	1.00				
Chloroform	1 36	ug/L	1.00				
Chloromethane	ND	ug/L	1.00				
1,1-Dichloroethane	ND	ug/L	1.00				
1,2-Dichloroethane	0.48J	ug/L	1.00				
1,1-Dichloroethene	ND	ug/L	1.00				
trans-1,2-Dichloroethene	7.91	ug/L	1.00				
1,2-Dichloropropane	ND	ug/L	1 00				
cis-1,3-Dichloropropene	ND	ug/L	1.00				
trans-1,3-Dichloropropene	ND	ug/L	1.00				
Ethylbenzene	ND	ug/L	1.00				
2-Hexanone (MBK)	ND	ug/L	5.00				
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.00				
Methylene Chloride	ND	ug/L	5.00				
Styrene	ND	ug/L	1.00				
1,1,2,2-Tetrachloroethane	311E	ug/L	1 00				
Tetrachloroethene	25 6	ug/L	1.00				
Toluene	ND	ug/L	2.00				
1,1,1-Trichloroethane	ND	ug/L	1 00				
1,1,2-Trichloroethane	3 20	ug/L	1 00				
Trichloroethene	606E	ug/L	1.00				
Vinyl Acetate	ND	ug/L	20.0				
Vinyl Chloride	ND	ug/L	1.00				
Xylenes-m,p	ND	ug/L	1.00				
Xylenes-o	ND	ug/L	1.00				
cis-1,2-Dichloroethene	26 0	ug/L	1.00				

Surrogate Standard	% Recovery	QC Limits	
S1 - Dibromofluoromethane	99	84	115
S2 - Toluene-d8	86	69	133
S3 - 4-Bromofluorobenzene	91	80	111
S4 - 1,2-Dichloroethane-d4	125	58	131

UB
Data Validator

ND - Not Detected   Q - Recovery Outside QC Limits

579 618

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

011260201

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: 011260201

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0701008

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 12/21/01

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.				
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ENVIRONMENTAL TESTING & CONSULTING, INC.

579 619

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-01
Field ID: VW-1-DIL1

Matrix: AQUEOUS
Sample Date: 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Volatile Organics				01/03/02		LS	8260B 5030B
QC Batch	V401031						
Dilution Factor	50						
1,1,2,2-Tetrachloroethane	16,400E	ug/L	50 0				
Trichloroethene	788	ug/L	50.0				

Surrogate Standard	% Recovery	QC Limits	
S1 - Dibromofluoromethane	104	84	115
S2 - Toluene-d8	93	69	133
S3 - 4-Bromofluorobenzene	102	80	111
S4 - 1,2-Dichloroethane-d4	104	58	131

CB
Data Validator

ND - Not Detected

Q - Recovery Outside QC Limits

579 620

ENVIRONMENTAL TESTING & CONSULTING, INC.
2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-01
Field ID : VW-1-DIL2

Matrix : AQUEOUS
Sample Date : 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Volatile Organics				01/03/02		LS	8260B 5030B
QC Batch	V401031						
Dilution Factor	1000						
1,1,2,2-Tetrachloroethane	18,000	ug/L	1000				

Surrogate Standard	% Recovery	QC Limits	
S1 - Dibromofluoromethane	104	84	115
S2 - Toluene-d8	103	69	133
S3 - 4-Bromofluorobenzene	101	80	111
S4 - 1,2-Dichloroethane-d4	104	58	131

CB
Data Validator

ND - Not Detected   Q - Recovery Outside QC Limits

ENVIRONMENTAL TESTING & CONSULTING, INC.

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-02
Field ID: EFF-12-21

Matrix: AQUEOUS
Sample Date: 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Volatile Organics				01/03/02		LS	8260B 5030B
QC Batch	V401031						
Dilution Factor	1						
Acetone	ND	ug/L	20.0				
Benzene	ND	ug/L	1.00				
Bromodichloromethane	ND	ug/L	1.00				
Bromoform	ND	ug/L	1.00				
Bromomethane	ND	ug/L	1.00				
2-Butanone (MEK)	ND	ug/L	20.0				
Carbon Disulfide	ND	ug/L	1.00				
Carbon Tetrachloride	6.11	ug/L	1.00				
Chlorobenzene	ND	ug/L	1.00				
Chlorodibromomethane	ND	ug/L	1.00				
Chloroethane	ND	ug/L	1.00				
Chloroform	52.1	ug/L	1.00				
Chloromethane	ND	ug/L	1.00				
1,1-Dichloroethane	0.53J	ug/L	1.00				
1,2-Dichloroethane	ND	ug/L	1.00				
1,1-Dichloroethene	16.4	ug/L	1.00				
trans-1,2-Dichloroethene	13.2	ug/L	1.00				
1,2-Dichloropropane	ND	ug/L	1.00				
cis-1,3-Dichloropropene	ND	ug/L	1.00				
trans-1,3-Dichloropropene	ND	ug/L	1.00				
Ethylbenzene	ND	ug/L	1.00				
2-Hexanone (MBK)	ND	ug/L	5.00				
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.00				
Methylene Chloride	ND	ug/L	10.0				
Styrene	ND	ug/L	1.00				
1,1,2,2-Tetrachloroethane	174	ug/L	1.00				
Tetrachloroethene	21.6	ug/L	1.00				
Toluene	ND	ug/L	2.00				
1,1,1-Trichloroethane	0.65J	ug/L	1.00				
1,1,2-Trichloroethane	1.32	ug/L	1.00				
Trichloroethene	173	ug/L	1.00				
Vinyl Acetate	ND	ug/L	20.0				
Vinyl Chloride	ND	ug/L	1.00				
Xylenes-m,p	ND	ug/L	1.00				
Xylenes-o	ND	ug/L	1.00				
cis-1,2-Dichloroethene	53.6	ug/L	1.00				

Surrogate Standard	% Recovery	QC Limits	
S1 - Dibromofluoromethane	107	84	115
S2 - Toluene-d8	94	69	133
S3 - 4-Bromofluorobenzene	102	80	111
S4 - 1,2-Dichloroethane-d4	118	58	131

CB
Data Validator

ND - Not Detected

Q - Recovery Outside QC Limits

579 622

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

011260202

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: 011260202

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0901011

Level: (low/med) LOW Date Received: ______

% Moisture: not dec. ______ Date Analyzed: 01/03/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-GCMS-TIC

ENVIRONMENTAL TESTING & CONSULTING, INC.

579 623

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-02
Field ID: EFF-12-21

Matrix: AQUEOUS
Sample Date: 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Base/Neutral & Acid				01/03/02		EM	8270C
QC Batch	P07012				12/27/01		3510C
Dilution Factor	1						
Acenaphthene	ND	ug/L	2.00				
Acenaphthylene	ND	ug/L	2 00				
Anthracene	ND	ug/L	2.00				
Benzo(a)anthracene	ND	ug/L	2.00				
Benzo(b)fluoranthene	ND	ug/L	2.00				
Benzo(k)fluoranthene	ND	ug/L	2.00				
Benzo(g,h,i)perylene	ND	ug/L	2.00				
Benzo(a)pyrene	ND	ug/L	2.00				
Benzoic Acid	ND	ug/L	50.0				
Benzyl Alcohol	ND	ug/L	10.0				
Bis(2-chloroethoxy)methane	ND	ug/L	5.00				
Bis(2-chloroethyl)ether	ND	ug/L	5.00				
Bis(2-chloroisopropyl)ether	ND	ug/L	5.00				
Bis(2-ethylhexyl)phthalate	ND	ug/L	10.0				
4-Bromophenyl phenyl ether	ND	ug/L	5.00				
Butyl benzyl phthalate	ND	ug/L	5.00				
4-Chloroaniline	ND	ug/L	5.00				
2-Chloronaphthalene	ND	ug/L	5.00				
4-Chloro-3-methylphenol	ND	ug/L	5 00				
2-Chlorophenol	ND	ug/L	5.00				
4-Chlorophenyl phenyl ether	ND	ug/L	5.00				
Chrysene	ND	ug/L	2.00				
Dibenzo(a,h)anthracene	ND	ug/L	2.00				
Dibenzofuran	ND	ug/L	5.00				
Di-n-butyl phthalate	ND	ug/L	5.00				
3,3'-Dichlorobenzidine	ND	ug/L	10 0				
2,4-Dichlorophenol	ND	ug/L	5.00				
Diethyl phthalate	ND	ug/L	5.00				
2,4-Dimethylphenol	ND	ug/L	5 00				
Dimethyl phthalate	ND	ug/L	5.00				
4,6-Dinitro-2-methylphenol	ND	ug/L	10 0				
2,4-Dinitrophenol	ND	ug/L	50.0				
2,4-Dinitrotoluene	ND	ug/L	5.00				
2,6-Dinitrotoluene	ND	ug/L	5 00				
Di-n-octyl phthalate	ND	ug/L	5 00				
Fluoranthene	ND	ug/L	2.00				
Fluorene	ND	ug/L	2.00				
Hexachlorobenzene	ND	ug/L	5.00				
Hexachlorobutadiene	ND	ug/L	5 00				
Hexachlorocyclopentadiene	ND	ug/L	5 00				
Hexachloroethane	ND	ug/L	5.00				
Indeno(1,2,3-cd)pyrene	ND	ug/L	2 00				
Isophorone	ND	ug/L	5.00				
2-Methylnaphthalene	ND	ug/L	2 00				
2-Methylphenol (o-cresol)	ND	ug/L	5.00				
4-Methylphenol (p-cresol)	ND	ug/L	5.00				
Naphthalene	ND	ug/L	2 00				

CB
Data Validator

ND - Not Detected   Q - Recovery Outside QC Limits

579 624

ENVIRONMENTAL TESTING & CONSULTING, INC.

2924 Walnut Grove Road - Memphis, TN 38111 - (901)327-2750

Client Name: Sverdrup/Jacobs Eng.
Memphis Depot, Dunn Field
3354 Perimeter Hill Drive,
Suite 310
Nashville, TN 37211

Site ID: Memphis Depot

FID #

Date Arrived: 12/21/01
ETC Order Number: 0112602

ETC Lab ID: 0112602-02
Field ID: EFF-12-21

Matrix: AQUEOUS
Sample Date: 12/21/01

TEST	RESULT	UNITS	DETECTION LIMIT	DATE ANALYZED	DATE EXTRACTED	BY	METHOD
GC/MS Base/Neutral & Acid				01/03/02		EM	8270C
Nitrobenzene	ND	ug/L	5.00		12/27/01		3510C
2-Nitroaniline	ND	ug/L	5.00				
3-Nitroaniline	ND	ug/L	10.0				
4-Nitroaniline	ND	ug/L	5.00				
2-Nitrophenol	ND	ug/L	5.00				
4-Nitrophenol	ND	ug/L	5.00				
N-Nitrosodiphenylamine	ND	ug/L	5.00				
N-Nitrosodipropylamine	ND	ug/L	5.00				
Pentachlorophenol	ND	ug/L	10.0				
Phenanthrene	ND	ug/L	2.00				
Phenol	ND	ug/L	5.00				
Pyrene	ND	ug/L	2.00				
2,4,5-Trichlorphenol	ND	ug/L	5 00				
2,4,6-Trichlorophenol	ND	ug/L	5.00				

Surrogate Standard	% Recovery	QC Limits	
S1 - Nitrobenzene-d5	51	29	110
S2 - 2-Fluorobiphenyl	51	38	107
S3 - 4-Terphenyl-d14	53	33	122
S4 - Phenol-d6	23	7	58
S5 - 2,4,6-Tribromophenol	54	16	138
S6 - 2-Fluorophenol	33	8	88

CB
Data Validator

ND - Not Detected

Q - Recovery Outside QC Limits

579 625

FORM 1
BNA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

011260202

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: 011260202

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 0601008

Level: (low/med) LOW Date Received: ________

% Moisture: ______ decanted: (Y/N)___ Date Extracted:

Concentrated Extract Volume: 1(mL) Date Analyzed: 01/03/02

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

Number TICs found: 9

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	3.72	0.820	J
2. 127-18-4	TETRACHLOROETHYLENE	3.79	3.30	NJ
3. 79-34-5	ETHANE, 1,1,2,2-TETRACHLORO-	4.45	39.58	NJ
4. 565-75-3	PENTANE, 2,3,4-TRIMETHYL-	4.57	1.06	NJ
5. 542-85-8	ETHANE, ISOTHIOCYANATO-	4.80	3.27	NJ
6.	UNKNOWN	5.50	1.07	J
7. 398-23-2	1,1'-BIPHENYL, 4,4'-DIFLUORO	6.12	1.64	NJ
8. 57-10-3	HEXADECANOIC ACID	7.50	0.932	NJ
9. 314-40-9	BROMACIL	7.58	2.39	NJ
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FORM I BNA-GCMS-TIC

579 626

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level III
Inorganics

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE
INORGANICS – AQUEOUS

Client Name Sverdrup/Jacobs Engineering
Project Name Memphis Depot

ETC Order# 0112-602

HOLDING TIMES

Sample Analysis — All samples analyzed within Method Specified Holding Times.

QUALITY CONTROL

QC Batch

T2122611 TSS

Duplicates

RPD — All analytes within QC limits

Project Manager

579 628

DUPLICATE
INORGANICS

Lab Name Environmental Testing and Consulting, Inc.

Analyte	QC Sample No.	QC Batch	SAMPLE Result	DUP Result	Units	% RPD	#	QC Limits		Method
TSS	01112-611-0 DUP	T2122611	344	308	mg/L	11		0	20	160.2

ND - Not Detected
Column to be used to flag recovery values with an asterisk
* Values outside of QC limits

Reviewed by

INORG DUP 0112-602.iqc

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level III
Metals (ICP/GFAA/CV)

579 630

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE
METALS – AQUEOUS

Client Name	Sverdrup/Jacobs Engineering
Project Name	Memphis Depot
ETC Order#	0112-602

PRESERVATION

All aqueous samples preserved to pH < 2

HOLDING TIMES

QC Batch(s) for this order	ICP Metals	V29-AQ-29
	Mercury	V9-AQ-26

Sample Preparation/Analysis	All samples digested/ analyzed within holding time.
Mercury Preparation/Analysis	All samples analyzed within 28 days of collection

METHOD

Preparation:	SM3030K/7470A
Analysis	EPA 200.7/7470A

CALIBRATION

Initial Calibration	All criteria met.
Continuing Calibration	All criteria met

SAMPLE ANALYSIS

Instrumentation	Thermo Jarrell Ash Enviro-I ICP
	CETAC M-6000A Mercury Analyzer
Dilutions Required	No dilutions required.

QUALITY CONTROL

0112-602.MQCBLANK

Method Blank

V29-AQ-29BLK	ICP Metals
V9-AQ-26BLK	Mercury

No target analytes detected in the method blank

0112-602.MQCLCS

Laboratory Control Sample(s)

V29-AQ-29LCS	ICP Metals
V9-AQ-26LCS	Mercury

All acceptance criteria met

0112-602.MQCMSMSD

Matrix Spike / Matrix Spike Dup - ICP Metals

0112-602-01	RPD	All analytes within QC limits.
VW-1	Spike Recovery	All analytes within QC limits *

*Iron was flagged for low recovery in the MS MSD recovery was within QC limits Refer to Laboratory Control Sample(s) for system verification.

Matrix Spike / Matrix Spike Dup - Hg

0112-602-01	RPD	All analytes within QC limits
VW-1	Spike Recovery	All analytes within QC limits.

Refer to Laboratory Control Sample(s) for system verification.

CB

Project Manager

FORM 3A
WATER METHOD BLANK
METALS

Lab Name: Environmental Testing and Consulting, Inc

Laboratory ID ICP/GFAA Metals	V29-AQ-29 BLK	QC Batch	V29-AQ-29
Laboratory ID Mercury	V9-AQ-26 BLK		V9-AQ-26

Date Sample Prepared 12/28/01 ICP/GFAA Metals
1/2/02 Mercury

Metals	Concentration mg/L	Detection Limit mg/L	Date Analyzed	Method
Silver	ND	0.0005	1/3/02	200.7
Arsenic	ND	0.002	1/3/02	200.7
Barium	ND	0.0005	1/3/02	200.7
Cadmium	ND	0.0003	1/3/02	200.7
Chromium	ND	0.002	1/3/02	200.7
Iron	ND	0.035	1/3/02	200.7
Manganese	ND	0.0005	1/3/02	200.7
Lead	ND	0.002	1/3/02	200.7
Selenium	ND	0.002	1/3/02	200.7
Mercury	ND	0.0002	1/3/02	245.1

ND - Not Detected

Reviewed by

FORM 7
WATER LABORATORY CONTROL SAMPLE
METALS

Lab Name Environmental Testing and Consulting, Inc

Laboratory Control ID

ICP/GFAA Metals V29-AQ-29 LCS
Mercury V9-AQ-26 LCS

QC Batch
V29-AQ-29
V9-AQ-26

Date Prepared

ICP/GFAA Metals 12/28/01
Mercury 1/2/02

Metals	Spike Added mg/L	Found mg/L	% R	#	QC Limits	
Silver	0.2500	0.2488	100		80	120
Arsenic	0.100	0.114	114		80	120
Barium	2.500	2.645	106		80	120
Cadmium	0 0200	0.0210	105		80	120
Chromium	0.500	0.544	109		80	120
Iron	2.50	2.78	111		80	120
Manganese	0.2500	0.2798	112		80	120
Lead	0.100	0.109	109		80	120
Selenium	0.100	0.106	106		80	120
Mercury	0.0050	0.0055	110		85	115

Column to be used to flag recovery values with an asterisk
* Values outside of QC limits

Reviewed by ________

0112-602.mqc LCS

FORM 6
WATER MATRIX SPIKE / MATRIX SPIKE DUPLICATE
METALS

Lab Name: Environmental Testing and Consulting, Inc

		QC Batch
Laboratory ID MS ICP/GFAA Metals	0112-602-01	V29-AQ-29
Laboratory ID MS Mercury	0112-602-01	V9-AQ-26

Date Sample Prepared	12/28/01	ICP/GFAA Metals
	1/2/02	Mercury

Metals	SPIKE Added mg/L	SAMPLE Conc mg/L	MS Conc mg/L	RPD <20% #	MS % Rec #	QC Limits	
Silver	0.2500	ND	0.2495	2	100	75	125
Arsenic	0.100	0.003	0.116	0	113	75	125
Barium	2.500	0.1235	2.799	2	107	75	125
Cadmium	0.0200	ND	0.0208	2	104	75	125
Chromium	0.500	0.014	0.554	2	108	75	125
Iron	2.50	11.1	12 4	5	52 *	75	125
Manganese	0.2500	2.393	2.648	0	102	75	125
Lead	0.100	0.049	0.157	1	108	75	125
Selenium	0.100	ND	0.106	0	106	75	125
Mercury	0 0050	ND	0.0053	0	106	80	120

ND - Not Detected
Column to be used to flag recovery values with an asterisk
* Values outside of QC limits

Reviewed by ____

0112-602.mqc MSMSD

FORM 6
WATER MATRIX SPIKE / MATRIX SPIKE DUPLICATE
METALS

Lab Name. Environmental Testing and Consulting, Inc

		QC Batch
Laboratory ID MS ICP/GFAA Metals	0112-602-01	V29-AQ-29
Laboratory ID MS Mercury	0112-602-01	V9-AQ-26

Date Sample Prepared	12/28/01	ICP/GFAA Metals
	1/2/02	Mercury

Metals	SPIKE Added mg/L	SAMPLE Conc mg/L	MSD Conc mg/L		MSD % Rec	#	QC Limits	
Silver	0.2500	ND	0.2448		98		75	125
Arsenic	0.100	0.003	0.116		113		75	125
Barium	2.500	0.1235	2.735		104		75	125
Cadmium	0.0200	ND	0.0203		102		75	125
Chromium	0.500	0.014	0.545		106		75	125
Iron	2.50	11.1	13.1		80		75	125
Manganese	0.2500	2.393	2.640		99		75	125
Lead	0.100	0.049	0.155		106		75	125
Selenium	0.100	ND	0.106		106		75	125
Mercury	0.0050	ND	0.0053		106		80	120

ND - Not Detected
Column to be used to flag recovery values with an asterisk
* Values outside of QC limits

Reviewed by ________

0112-602 mqc MSMSD

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level III
GC/MS Volatiles

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE -
GC/MS VOLATILE COMPOUNDS – AQUEOUS

Client Name Sverdrup/Jacobs Engineering
Project Name Memphis Depot

ETC Order# 0112-602

SAMPLE PRESERVATION (Verified at time of analysis)
All aqueous samples preserved to pH < 2 and maintained at 4 degrees C until analysis.

METHOD
Preparation SW-846 5030B
Analysis: SW-846 8260B

HOLDING TIMES
Sample Analysis All samples analyzed within 14 days of collection.

QUALITY CONTROL

QC Batch	Form 4 Summary
V412211	V412211LB
V401031	V401031LB

System Monitoring Compounds FORM 2
Surrogate recoveries within QC limits.

Method Blank FORM 4
V412211LB
V401031LB
Target analytes were not detected in the method blanks, except as listed below:
Methylene Chloride was identified in method blank V412211LB at 4 60J ug/L Per ETC, Inc. policy, sample concentrations less than 10 times the method blank value are flagged with "B – Detected in blank" and should be attributed to lab contamination.

Laboratory Control Sample FORM 3
V412211LCS/V412212LCS
V401031LCS
All target analyte acceptance criteria met
1,1,1,2-Tetrachloroethane was flagged for low recovery in V412211LCS. The LCS was re-analyzed for this analyte Recovery was within QC limits

Matrix Spike / Matrix Spike Dup FORM 3
Batch V412211

0112-623-02	RPD	All analytes within QC limits.
	Spike Recovery	All analytes within QC limits

The MS/MSD was performed on a sample not directly associated with this project Batch QC provided for information only. Refer to Laboratory Control Sample(s) for system verification

Batch V401031

0112-623-01	RPD	All analytes within QC limits
	Spike Recovery	All analytes within QC limits *

*Multiple analytes were flagged for high recoveries in the MS/MSD The MS/MSD was performed on a sample not directly associated with this project Batch QC provided for information only. Refer to Laboratory Control Sample(s) for system verification

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE
GC/MS VOLATILE COMPOUNDS – AQUEOUS

Client Name	Sverdrup/Jacobs Engineering
Project Name	Memphis Depot
ETC Order#	0112-602

CALIBRATION

BFB Daily 12-Hour Tune	All criteria met FORM 5
Initial Calibration	All criteria met. FORM 6
Calibration Verification	All criteria met FORM 7 Responses >30% do not affect the data

Sequence V401031

Calibration Verification (CV) Date 01/03/02 Time 0857

Multiple analytes were flagged as outside QC limits in this CV. Project samples were analyzed in this sequence to bring specific target analytes within calibration range. The analytes with responses >30% difference did not affect the data Samples in this sequence are listed on Form 5 (Instrument Performance Check). The CV passed SPCC/CCC evaluation criteria The CV is valid per SW-846 method 8000A/8260B

Volatile Internal Standard Area and RT FORM 8

Calibration Verification standard(s) Internal Standard Areas and Retention Times within QC limits

SAMPLE ANALYSIS

Instrumentation	HP 5890 Series II GC, 5971MSD
Dilutions Required	Dilutions were performed, as indicated on the result forms, to bring target analytes within calibration range.

CS

Project Manager

FORM 2
WATER VOA-GCMS SYSTEM MONITORING COMPOUND RECOVERY

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

	CLIENT SAMPLE NO.	SMC1 (DFM) #	SMC2 (TOL) #	SMC3 (BFB) #	OTHER (DCE) #	TOT OUT
01	V412211LCS	94	88	90	108	0
02	V412212LCS	94	91	80	114	0
03	V412211LB	97	95	89	113	0
04	011260201	99	86	91	125	0
05	V401031LCS	92	95	92	91	0
06	V401031LB	97	103	94	91	0
07	011260201	104	93	102	104	0
08	011260201	104	103	101	104	0
09	011260202	107	94	102	118	0
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		QC LIMITS
SMC1 (DFM)	= Dibromofluoromethane	(84-115)
SMC2 (TOL)	= Toluene-d8	(69-133)
SMC3 (BFB)	= Bromofluorobenzene	(80-111)
OTHER (DCE)	= 1,2-Dichloroethane-d4	(58-131)

Column to be used to flag recovery values

* Values outside of contract required QC limits

D System Monitoring Compound diluted out

FORM 4
VOA-GCMS METHOD BLANK SUMMARY

579 639

CLIENT SAMPLE NO.

V412211LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID: 0402005 Lab Prep Batch: V412211

Date Analyzed: 12/21/01 Time Analyzed: 1645

GC Column: ID: 2 (mm) Heated Purge: (Y/N) Y

Instrument ID: VOC4 Lab Sample ID: V412211LB

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	CLIENT SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	V412211LCS	1LCS	0201002LCS	1417
02	V412212LCS	2LCS	0202003LCS	1452
03	011260201	011260201	0701008	1818
04	011262302	011262302	1101012	2022
05	011262302MS	MS	2001021	0059
06	011262302MSD	MSD	2101022	0130
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COMMENTS:

579 640

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V412211LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: V412211

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0402005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 12/21/01

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
67-64-1	Acetone	20.00	U
75-05-8	Acetonitrile	20.00	U
107-02-8	Acrolein	20.00	U
107-13-1	Acrylonitrile	20.00	U
107-05-1	Allyl chloride	1.00	U
71-43-2	Benzene	1.00	U
108-86-1	Bromobenzene	1.00	U
74-97-5	Bromochloromethane	1.00	U
75-27-4	Bromodichloromethane	1.00	U
75-25-2	Bromoform	1.00	U
78-93-3	2-Butanone	20.00	U
74-83-9	Bromomethane	1.00	U
104-51-8	n-Butylbenzene	1.00	U
135-98-8	sec-Butylbenzene	1.00	U
98-06-6	tert-Butylbenzene	1.00	U
75-15-0	Carbon Disulfide	1.00	U
56-23-5	Carbon Tetrachloride	1.00	U
108-90-7	Chlorobenzene	1.00	U
124-48-1	Chlorodibromomethane	1.00	U
75-00-3	Chloroethane	1.00	U
110-75-8	2-Chloroethyl vinyl ether	20.00	U
67-66-3	Chloroform	1.00	U
74-87-3	Chloromethane	1.00	U
126-99-8	Chloroprene	1.00	U
95-49-8	2-Chlorotoluene	1.00	U
106-43-4	4-Chlorotoluene	1.00	U
96-12-8	1,2-Dibromo-3-chloropropane	1.00	U
106-93-4	1,2-Dibromoethane	1.00	U
74-95-3	Dibromomethane	1.00	U
95-50-1	1,2-Dichlorobenzene	1.00	U
541-73-1	1,3-Dichlorobenzene	1.00	U
106-46-7	1,4-Dichlorobenzene	1.00	U
1476-11-5	cis-1,4-Dichloro-2-butene	1.00	U

FORM 1 579 641

VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V412211LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: V412211

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0402005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 12/21/01

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
110-57-6	trans-1,4-Dichloro-2-butene	1.00	U
75-71-8	Dichlorodifluoromethane	1.00	U
75-34-3	1,1-Dichloroethane	1.00	U
107-06-2	1,2-Dichloroethane	1.00	U
75-35-4	1,1-Dichloroethene	1.00	U
156-59-2	cis-1,2-Dichloroethene	1.00	U
156-60-5	trans-1,2-Dichloroethene	1.00	U
78-87-5	1,2-Dichloropropane	1.00	U
142-28-9	1,3-Dichloropropane	1.00	U
594-20-7	2,2-Dichloropropane	1.00	U
563-58-6	1,1-Dichloropropene	1.00	U
10061-01-5	cis-1,3-Dichloropropene	1.00	U
10061-02-6	trans-1,3-Dichloropropene	1.00	U
108-20-3	Di isopropyl ether	1.00	U
123-91-1	1,4-Dioxane	100.0	U
141-78-6	Ethyl Acetate	5.00	U
100-41-4	Ethylbenzene	1.00	U
97-63-2	Ethyl methacrylate	1.00	U
110-00-9	Furan	1.00	U
87-68-3	Hexachlorobutadiene	1.00	U
110-54-3	Hexane	1.00	U
591-78-6	2-Hexanone	5.00	U
74-88-4	Iodomethane	1.00	U
78-83-1	Isobutyl Alcohol	100.0	U
98-82-8	Isopropylbenzene	1.00	U
99-87-6	4-Isopropyltoluene	1.00	U
126-98-7	Methacrylonitrile	10.00	U
75-09-2	Methylene Chloride	4.60	J
80-62-6	Methyl methacrylate	1.00	U
108-10-1	4-Methyl-2-Pentanone	5.00	U
1634-04-4	Methyl-tertbutyl-Ether	1.00	U
91-20-3	Naphthalene	1.00	U
107-12-0	Propionitrile	10.00	U

FORM I VOA-GCMS

579 642

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V412211LB

Lab Name: ETC, INC.

Contract:

Lab Code:

Case No.:

SAS No.:

SDG No.: 0112602

Matrix: (soil/water) WATER

Lab Prep Batch: V412211

Sample wt/vol: 10.00 (g/mL) ML

Lab File ID: 0402005

Level: (low/med) LOW

Date Received: ______

% Moisture: not dec. ______

Date Analyzed: 12/21/01

GC Column: ID: 2.00 (mm)

Dilution Factor: 1.0

Soil Extract Volume: ______ (uL)

Soil Aliquot Volume: ______ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
109-60-4	n-Propyl Acetate	1.00	U
103-65-1	n-Propylbenzene	1.00	U
100-42-5	Styrene	1.00	U
630-20-6	1,1,1,2-Tetrachloroethane	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane	1.00	U
127-18-4	Tetrachloroethene	1.00	U
109-99-9	Tetrahydrofuran	1.00	U
87-61-6	1,2,3-Trichlorobenzene	1.00	U
108-88-3	Toluene	1.00	U
71-55-6	1,1,1-Trichloroethane	1.00	U
79-00-5	1,1,2-Trichloroethane	1.00	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	1.00	U
79-01-6	Trichloroethene	1.00	U
75-69-4	Trichlorofluoromethane	1.00	U
96-18-4	1,2,3-Trichloropropane	1.00	U
95-63-6	1,2,4-Trimethylbenzene	1.00	U
120-82-1	1,2,4-Trichlorobenzene	1.00	U
108-67-8	1,3,5-Trimethylbenzene	1.00	U
108-05-4	Vinyl Acetate	20.00	U
75-01-4	Vinyl Chloride	1.00	U
108-38-3	Xylene-mp	1.00	U
95-47-6	Xylene-o	1.00	U

579 643

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

V412211LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: V412211LB

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0402005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 12/21/01

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-GCMS-TIC

579 644

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V412211

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V412211LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acetone	100.0		106.9	107	59-151
Acetonitrile	1000		1028	103	57-143
Acrolein	100.0		94.20	94	59-134
Acrylonitrile	100.0		99.07	99	60-146
Allyl chloride	100.0		87.62	88	74-120
Benzene	100.0		98.31	98	72-124
Bromobenzene	100.0		102.8	103	77-120
Bromochloromethane	100.0		97.16	97	74-120
Bromodichloromethane	100.0		93.54	94	68-119
Bromoform	100.0		105.1	105	66-136
2-Butanone	100.0		103.4	103	55-151
Bromomethane	100.0		86.79	87	40-134
n-Butylbenzene	100.0		94.38	94	69-129
sec-Butylbenzene	100.0		81.13	81	72-127
tert-Butylbenzene	100.0		103.5	104	73-126
Carbon Disulfide	100.0		102.0	102	60-133
Carbon Tetrachloride	100.0		98.14	98	64-123
Chlorobenzene	100.0		92.98	93	77-112
Chlorodibromomethane	100.0		92.18	92	72-118
Chloroethane	100.0		104.3	104	64-142
2-Chloroethyl vinyl eth	100.0		84.83	85	22-165
Chloroform	100.0		94.34	94	70-115
Chloromethane	100.0		100.1	100	58-139
Chloroprene	100.0		93.58	94	73-118
2-Chlorotoluene	100.0		109.8	110	65-132
4-Chlorotoluene	100.0		107.2	107	67-127
1,2-Dibromo-3-chloropro	100.0		89.22	89	56-134
1,2-Dibromoethane	100.0		90.92	91	74-118

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ____

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V412211

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V412211LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Dibromomethane	100.0		91.00	91	75-114
1,2-Dichlorobenzene	100.0		91.93	92	80-113
1,3-Dichlorobenzene	100.0		94.14	94	77-119
1,4-Dichlorobenzene	100.0		89.46	89	78-116
cis-1,4-Dichloro-2-bute	100.0		114.2	114	70-130
trans-1,4-Dichloro-2-bu	100.0		109.6	110	62-138
Dichlorodifluoromethane	100.0		101.1	101	48-145
1,1-Dichloroethane	100.0		91.57	92	76-118
1,2-Dichloroethane	100.0		100.5	100	62-124
1,1-Dichloroethene	100.0		86.25	86	69-121
cis-1,2-Dichloroethene	100.0		88.86	89	76-114
trans-1,2-Dichloroethen	100.0		85.04	85	72-121
1,2-Dichloropropane	100.0		96.34	96	64-133
1,3-Dichloropropane	100.0		88.94	89	68-128
2,2-Dichloropropane	100.0		102.0	102	67-132
1,1-Dichloropropene	100.0		100.4	100	76-117
cis-1,3-Dichloropropene	100.0		92.53	92	77-120
trans-1,3-Dichloroprope	100.0		101.8	102	73-124
Di isopropyl ether	100.0		96.44	96	62-160
1,4-Dioxane	2000		2110	106	56-131
Ethyl Acetate	100.0		100.9	101	52-151
Ethylbenzene	100.0		96.57	96	77-111
Ethyl methacrylate	200.0		166.4	83	57-140
Furan	100.0		150.1	150*	52-124
Hexachlorobutadiene	100.0		90.86	91	69-137
Hexane	100.0		103.6	104	70-130
2-Hexanone	100.0		86.26	86	53-144
Iodomethane	100.0		131.0	131	51-153

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________

579 646

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V412211

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V412211LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Isobutyl Alcohol	2000		1840	92	60-134
Isopropylbenzene	100.0		100.1	100	74-125
4-Isopropyltoluene	100.0		106.7	107	72-127
Methacrylonitrile	1000		979.2	98	70-125
Methylene Chloride	100.0		100.4	100	76-115
Methyl methacrylate	200.0		185.4	93	57-147
4-Methyl-2-Pentanone	100.0		92.82	93	42-144
Methyl-tertbutyl-Ether	100.0		103.8	104	62-122
Naphthalene	100.0		95.77	96	53-124
Propionitrile	1000		1026	103	58-139
n-Propyl Acetate	100.0		158.3	158	88-170
n-Propylbenzene	100.0		107.3	107	75-125
Styrene	100.0		99.10	99	77-117
1,1,1,2-Tetrachloroetha	100.0		74.52	74*	79-113
1,1,2,2-Tetrachloroetha	100.0		84.27	84	67-126
Tetrachloroethene	100.0		83.52	84	77-115
Tetrahydrofuran	100.0		87.40	87	76-181
1,2,3-Trichlorobenzene	100.0		98.34	98	62-132
Toluene	100.0		78.03	78	77-115
1,1,1-Trichloroethane	100.0		91.06	91	63-122
1,1,2-Trichloroethane	100.0		86.47	86	69-117
1,1,2-trichloro-1,2,2-t	100.0		91.22	91	70-130
Trichloroethene	100.0		82.95	83	75-113
Trichlorofluoromethane	100.0		102.5	102	55-130
1,2,3-Trichloropropane	100.0		103.2	103	62-130
1,2,4-Trimethylbenzene	100.0		105.1	105	69-126
1,2,4-Trichlorobenzene	100.0		99.34	99	68-132
1,3,5-Trimethylbenzene	100.0		105.0	105	69-128

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V412211

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V412211LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Vinyl Acetate	100.0		90.40	90	28-146
Vinyl Chloride	100.0		104.6	105	65-134
Xylene-mp	200.0		187.7	94	77-115
Xylene-o	100.0		94.80	95	77-115

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 2 out of 88 outside limits

COMMENTS: ______________________________

579 618

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC.   Lab Prep Batch: V412211

Lab Code: Case No.:   SAS No.:   SDG No.: 0112602

Matrix Spike - Sample No.: V412212LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
1,1,1,2-Tetrachloroetha	100.0		79.10	79	79-113

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 1 outside limits

COMMENTS: ______________________

FORM 3
WATER VOA-GCMS MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: ETC, INC. Lab Prep Batch: V412211

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: 011262302

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	MS CONCENTRATION (ug/L)	MS % REC #	QC. LIMITS REC.
Benzene	100.0	0.000	121.1	121	72-124
Chlorobenzene	100.0	0.000	100.3	100	77-112
1,1-Dichloroethene	100.0	0.000	95.99	96	69-121
Toluene	100.0	0.000	92.12	92	77-115
Trichloroethene	100.0	0.000	93.20	93	75-113

COMPOUND	SPIKE ADDED (ug/L)	MSD CONCENTRATION (ug/L)	MSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Benzene	100.0	104.4	104	15	20	72-124
Chlorobenzene	100.0	102.7	103	3	20	77-112
1,1-Dichloroethene	100.0	99.48	99	3	20	69-121
Toluene	100.0	90.81	91	1	20	77-115
Trichloroethene	100.0	94.96	95	2	20	75-113

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 5 outside limits
Spike Recovery: 0 out of 10 outside limits

COMMENTS: __________

579 650

FORM 4
VOA-GCMS METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

V401031LB

Lab Name: ETC,INC.

Contract:

Lab Code:

Case No.:

SAS No.:

SDG No.: 0112602

Lab File ID: 0303005

Lab Prep Batch: V401031

Date Analyzed: 01/03/02

Time Analyzed: 1103

GC Column:

ID: 2 (mm)

Heated Purge: (Y/N) Y

Instrument ID: VOC4

Lab Sample ID: 1LB

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	CLIENT SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	V401031LCS	1LCS	0201002LCS	0857
02	011262301	011262301	0501007	1210
03	011260201	011260201	0701009	1313
04	011260201	011260201	0801010	1345
05	011260202	011260202	0901011	1416
06	011262301MS	MS	1801020	1859
07	011262301MSD	MSD	1901021	1930
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COMMENTS:

FORM 1 579 651
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V401031LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: V401031

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0303005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 01/03/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
67-64-1	Acetone	20.00	U
75-05-8	Acetonitrile	20.00	U
107-02-8	Acrolein	20.00	U
107-13-1	Acrylonitrile	20.00	U
107-05-1	Allyl chloride	1.00	U
71-43-2	Benzene	1.00	U
108-86-1	Bromobenzene	1.00	U
74-97-5	Bromochloromethane	1.00	U
75-27-4	Bromodichloromethane	1.00	U
75-25-2	Bromoform	1.00	U
78-93-3	2-Butanone	20.00	U
74-83-9	Bromomethane	1.00	U
104-51-8	n-Butylbenzene	1.00	U
135-98-8	sec-Butylbenzene	1.00	U
98-06-6	tert-Butylbenzene	1.00	U
75-15-0	Carbon Disulfide	1.00	U
56-23-5	Carbon Tetrachloride	1.00	U
108-90-7	Chlorobenzene	1.00	U
124-48-1	Chlorodibromomethane	1.00	U
75-00-3	Chloroethane	1.00	U
110-75-8	2-Chloroethyl vinyl ether	20.00	U
67-66-3	Chloroform	1.00	U
74-87-3	Chloromethane	1.00	U
126-99-8	Chloroprene	1.00	U
95-49-8	2-Chlorotoluene	1.00	U
106-43-4	4-Chlorotoluene	1.00	U
96-12-8	1,2-Dibromo-3-chloropropane	1.00	U
106-93-4	1,2-Dibromoethane	1.00	U
74-95-3	Dibromomethane	1.00	U
95-50-1	1,2-Dichlorobenzene	1.00	U
541-73-1	1,3-Dichlorobenzene	1.00	U
106-46-7	1,4-Dichlorobenzene	1.00	U
1476-11-5	cis-1,4-Dichloro-2-butene	1.00	U

FORM I VOA-GCMS

579 652

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

V401031LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: V401031

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0303005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 01/03/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
110-57-6	trans-1,4-Dichloro-2-butene	1.00	U
75-71-8	Dichlorodifluoromethane	1.00	U
75-34-3	1,1-Dichloroethane	1.00	U
107-06-2	1,2-Dichloroethane	1.00	U
75-35-4	1,1-Dichloroethene	1.00	U
156-59-2	cis-1,2-Dichloroethene	1.00	U
156-60-5	trans-1,2-Dichloroethene	1.00	U
78-87-5	1,2-Dichloropropane	1.00	U
142-28-9	1,3-Dichloropropane	1.00	U
594-20-7	2,2-Dichloropropane	1.00	U
563-58-6	1,1-Dichloropropene	1.00	U
10061-01-5	cis-1,3-Dichloropropene	1.00	U
10061-02-6	trans-1,3-Dichloropropene	1.00	U
108-20-3	Di isopropyl ether	5.00	U
123-91-1	1,4-Dioxane	100.0	U
141-78-6	Ethyl Acetate	5.00	U
100-41-4	Ethylbenzene	1.00	U
97-63-2	Ethyl methacrylate	1.00	U
110-00-9	Furan	1.00	U
87-68-3	Hexachlorobutadiene	1.00	U
110-54-3	Hexane	1.00	U
591-78-6	2-Hexanone	5.00	U
74-88-4	Iodomethane	1.00	U
78-83-1	Isobutyl Alcohol	100.0	U
98-82-8	Isopropylbenzene	1.00	U
99-87-6	4-Isopropyltoluene	1.00	U
126-98-7	Methacrylonitrile	10.00	U
75-09-2	Methylene Chloride	5.00	U
80-62-6	Methyl methacrylate	1.00	U
108-10-1	4-Methyl-2-Pentanone	5.00	U
1634-04-4	Methyl-tertbutyl-Ether	5.00	U
91-20-3	Naphthalene	1.00	U
107-12-0	Propionitrile	10.00	U

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: V401031LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: V401031

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0303005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 01/03/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
109-60-4	n-Propyl Acetate	1.00	U
103-65-1	n-Propylbenzene	1.00	U
100-42-5	Styrene	1.00	U
630-20-6	1,1,1,2-Tetrachloroethane	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane	1.00	U
127-18-4	Tetrachloroethene	1.00	U
109-99-9	Tetrahydrofuran	1.00	U
87-61-6	1,2,3-Trichlorobenzene	1.00	U
108-88-3	Toluene	1.00	U
71-55-6	1,1,1-Trichloroethane	1.00	U
79-00-5	1,1,2-Trichloroethane	1.00	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	1.00	U
79-01-6	Trichloroethene	1.00	U
75-69-4	Trichlorofluoromethane	1.00	U
96-18-4	1,2,3-Trichloropropane	1.00	U
95-63-6	1,2,4-Trimethylbenzene	1.00	U
120-82-1	1,2,4-Trichlorobenzene	1.00	U
108-67-8	1,3,5-Trimethylbenzene	1.00	U
108-05-4	Vinyl Acetate	20.00	U
75-01-4	Vinyl Chloride	1.00	U
108-38-3	Xylene-mp	1.00	U
95-47-6	Xylene-o	1.00	U

579 654

FORM 1
VOA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

V401031LB

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: 1LB

Sample wt/vol: 10.00 (g/mL) ML Lab File ID: 0303005

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 01/03/02

GC Column: ID: 2.00 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-GCMS-TIC

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V401031

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V401031LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acetone	100.0		68.26	68	59-151
Acetonitrile	1000		746.2	75	57-143
Acrolein	100.0		99.73	100	59-134
Acrylonitrile	100.0		74.25	74	60-146
Allyl chloride	100.0		82.43	82	74-120
Benzene	100.0		99.31	99	72-124
Bromobenzene	100.0		87.62	88	77-120
Bromochloromethane	100.0		80.56	80	74-120
Bromodichloromethane	100.0		81.82	82	68-119
Bromoform	100.0		79.04	79	66-136
2-Butanone	100.0		79.18	79	55-151
Bromomethane	100.0		78.92	79	40-134
n-Butylbenzene	100.0		99.63	100	69-129
sec-Butylbenzene	100.0		109.0	109	72-127
tert-Butylbenzene	100.0		88.23	88	73-126
Carbon Disulfide	100.0		89.65	90	60-133
Carbon Tetrachloride	100.0		87.92	88	64-123
Chlorobenzene	100.0		91.89	92	77-112
Chlorodibromomethane	100.0		76.86	77	72-118
Chloroethane	100.0		82.94	83	64-142
2-Chloroethyl vinyl eth	100.0		88.49	88	22-165
Chloroform	100.0		83.76	84	70-115
Chloromethane	100.0		81.67	82	58-139
Chloroprene	100.0		88.78	89	73-118
2-Chlorotoluene	100.0		94.57	94	65-132
4-Chlorotoluene	100.0		88.32	88	67-127
1,2-Dibromo-3-chloropro	100.0		74.02	74	56-134
1,2-Dibromoethane	100.0		74.92	75	74-118

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________________

579 656

FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC.   Lab Prep Batch: V401031

Lab Code: Case No.:   SAS No.:   SDG No.: 0112602

Matrix Spike - Sample No.: V401031LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Dibromomethane	100.0		82.00	82	75-114
1,2-Dichlorobenzene	100.0		99.20	99	80-113
1,3-Dichlorobenzene	100.0		102.3	102	77-119
1,4-Dichlorobenzene	100.0		97.49	97	78-116
cis-1,4-Dichloro-2-bute	100.0		74.72	75	70-130
trans-1,4-Dichloro-2-bu	100.0		88.53	88	62-138
Dichlorodifluoromethane	100.0		59.17	59	48-145
1,1-Dichloroethane	100.0		84.13	84	76-118
1,2-Dichloroethane	100.0		76.34	76	62-124
1,1-Dichloroethene	100.0		87.14	87	69-121
cis-1,2-Dichloroethene	100.0		87.33	87	76-114
trans-1,2-Dichloroethen	100.0		92.86	93	72-121
1,2-Dichloropropane	100.0		87.29	87	64-133
1,3-Dichloropropane	100.0		80.58	80	68-128
2,2-Dichloropropane	100.0		92.94	93	67-132
1,1-Dichloropropene	100.0		99.78	100	76-117
cis-1,3-Dichloropropene	100.0		87.39	87	77-120
trans-1,3-Dichloroprope	100.0		82.77	83	73-124
Di isopropyl ether	100.0		96.43	96	62-160
1,4-Dioxane	2000		1524	76	56-131
Ethyl Acetate	100.0		78.55	78	52-151
Ethylbenzene	100.0		93.51	94	77-111
Ethyl methacrylate	200.0		134.6	67	57-140
Furan	100.0		119.7	120	52-124
Hexachlorobutadiene	100.0		102.5	102	69-137
Hexane	100.0		113.5	114	70-130
2-Hexanone	100.0		67.19	67	53-144
Iodomethane	100.0		88.86	89	51-153

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________________

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

579 657

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 01/03/02 Time: 0857

Lab File ID: 0201002 Init. Calib. Date(s): 12/27/01 12/27/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1552 2105

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
Acetone	68.26	100.0	LINR	31.7	30.0	<-
Acetonitrile	746.2	1000	LINR	25.4	30.0	
Acrolein	99.73	100.0	AVRG	0.3	30.0	
Acrylonitrile	74.25	100.0	LINR	25.8	30.0	
Allyl chloride	82.43	100.0	AVRG	17.6	30.0	
Benzene	99.31	100.0	AVRG	0.7	30.0	
Bromobenzene	87.62	100.0	AVRG	12.4	30.0	
Bromochloromethane	80.56	100.0	AVRG	19.4	30.0	
Bromodichloromethane	81.82	100.0	AVRG	18.2	30.0	
Bromoform	79.04	100.0	AVRG	21.0	30.0	
2-Butanone	79.18	100.0	AVRG	20.8	30.0	
Bromomethane	78.92	100.0	AVRG	21.1	30.0	
n-Butylbenzene	99.63	100.0	AVRG	0.4	30.0	
sec-Butylbenzene	109.0	100.0	AVRG	9.0	30.0	
tert-Butylbenzene	88.23	100.0	AVRG	11.8	30.0	
Carbon Disulfide	89.65	100.0	AVRG	10.4	30.0	
Carbon Tetrachloride	87.92	100.0	AVRG	12.1	30.0	
Chlorobenzene	91.89	100.0	AVRG	8.1	30.0	
Chlorodibromomethane	76.86	100.0	AVRG	23.1	30.0	
Chloroethane	82.94	100.0	AVRG	17.1	30.0	
2-Chloroethyl vinyl ether	88.49	100.0	AVRG	11.5	30.0	
Chloroform	83.76	100.0	AVRG	16.2	20.0	
Chloromethane	81.67	100.0	AVRG	18.3	30.0	
Chloroprene	88.78	100.0	AVRG	11.2	30.0	
2-Chlorotoluene	94.57	100.0	AVRG	5.4	30.0	
4-Chlorotoluene	88.32	100.0	AVRG	11.7	30.0	
1,2-Dibromo-3-chloropropane	74.02	100.0	AVRG	26.0	30.0	
1,2-Dibromoethane	74.92	100.0	AVRG	25.1	30.0	
Dibromomethane	82.00	100.0	LINR	18.0	30.0	
1,2-Dichlorobenzene	99.20	100.0	AVRG	0.8	30.0	
1,3-Dichlorobenzene	102.3	100.0	AVRG	2.3	30.0	
1,4-Dichlorobenzene	97.49	100.0	AVRG	2.5	30.0	
cis-1,4-Dichloro-2-butene	74.72	100.0	AVRG	25.3	30.0	
trans-1,4-Dichloro-2-butene	88.53	100.0	AVRG	11.5	30.0	
Dichlorodifluoromethane	59.17	100.0	AVRG	40.8	30.0	<-
1,1-Dichloroethane	84.13	100.0	AVRG	15.9	30.0	
1,2-Dichloroethane	76.34	100.0	AVRG	23.7	30.0	

579 658

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 01/03/02 Time: 0857

Lab File ID: 0201002 Init. Calib. Date(s): 12/27/01 12/27/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1552 2105

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
1,1-Dichloroethene	87.14	100.0	AVRG	12.9	20.0	
cis-1,2-Dichloroethene	87.33	100.0	AVRG	12.7	30.0	
trans-1,2-Dichloroethene	92.86	100.0	AVRG	7.1	30.0	
1,2-Dichloropropane	87.29	100.0	LINR	12.7	20.0	
1,3-Dichloropropane	80.58	100.0	AVRG	19.4	30.0	
2,2-Dichloropropane	92.94	100.0	AVRG	7.1	30.0	
1,1-Dichloropropene	99.78	100.0	AVRG	0.2	30.0	
cis-1,3-Dichloropropene	87.39	100.0	AVRG	12.6	30.0	
trans-1,3-Dichloropropene	82.77	100.0	AVRG	17.2	30.0	
Di isopropyl ether	96.43	100.0	AVRG	3.6	30.0	
1,4-Dioxane	1524	2000	AVRG	23.8	30.0	
Ethyl Acetate	78.55	100.0	AVRG	21.4	30.0	
Ethylbenzene	93.51	100.0	AVRG	6.5	20.0	
Ethyl methacrylate	134.6	200.0	AVRG	32.7	30.0	<-
Furan	119.7	153.0	AVRG	21.8	30.0	
Hexachlorobutadiene	102.5	100.0	AVRG	2.5	30.0	
Hexane	113.5	117.0	AVRG	3.0	30.0	
2-Hexanone	67.19	100.0	AVRG	32.8	30.0	<-
Iodomethane	88.86	100.0	AVRG	11.1	30.0	
Isobutyl Alcohol	1620	2000	LINR	19.0	30.0	
Isopropylbenzene	93.79	100.0	AVRG	6.2	30.0	
4-Isopropyltoluene	88.99	100.0	AVRG	11.0	30.0	
Methacrylonitrile	779.0	1000	AVRG	22.1	30.0	
Methylene Chloride	84.58	100.0	LINR	15.4	30.0	
Methyl methacrylate	147.0	200.0	AVRG	26.5	30.0	
4-Methyl-2-Pentanone	73.20	100.0	AVRG	26.8	30.0	
Methyl-tertbutyl-Ether	85.05	100.0	AVRG	15.0	30.0	
Naphthalene	98.36	100.0	AVRG	1.6	30.0	
Propionitrile	751.3	1000	LINR	24.9	30.0	
n-Propyl Acetate	120.2	151.0	LINR	20.4	30.0	
n-Propylbenzene	94.74	100.0	AVRG	5.3	30.0	
Styrene	94.38	100.0	AVRG	5.6	30.0	
1,1,1,2-Tetrachloroethane	89.12	100.0	AVRG	10.9	30.0	
1,1,2,2-Tetrachloroethane	86.82	100.0	AVRG	13.2	30.0	
Tetrachloroethene	93.68	100.0	AVRG	6.3	30.0	
Tetrahydrofuran	80.47	91.50	LINR	12.0	30.0	
1,2,3-Trichlorobenzene	105.3	100.0	AVRG	5.3	30.0	

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

579 659

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 01/03/02 Time: 0857

Lab File ID: 0201002 Init. Calib. Date(s): 12/27/01 12/27/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1552 2105

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
Toluene	85.55	100.0	AVRG	14.4	20.0	
1,1,1-Trichloroethane	88.50	100.0	AVRG	11.5	30.0	
1,1,2-Trichloroethane	81.46	100.0	AVRG	18.5	30.0	
1,1,2-trichloro-1,2,2-triflu	104.8	100.0	AVRG	4.8	30.0	
Trichloroethene	90.70	100.0	AVRG	9.3	30.0	
Trichlorofluoromethane	72.51	100.0	AVRG	27.5	30.0	
1,2,3-Trichloropropane	78.87	100.0	AVRG	21.1	30.0	
1,2,4-Trimethylbenzene	85.88	100.0	AVRG	14.1	30.0	
1,2,4-Trichlorobenzene	110.4	100.0	AVRG	10.4	30.0	
1,3,5-Trimethylbenzene	87.74	100.0	AVRG	12.3	30.0	
Vinyl Acetate	89.20	100.0	AVRG	10.8	30.0	
Vinyl Chloride	85.52	100.0	AVRG	14.5	20.0	
Xylene-mp	187.7	200.0	AVRG	6.2	30.0	
Xylene-o	93.92	100.0	AVRG	6.1	30.0	
Dibromofluoromethane	37.60	40.90	AVRG	8.1	30.0	
Toluene-d8	38.54	50.00	AVRG	22.9	30.0	
Bromofluorobenzene	37.54	40.80	AVRG	8.0	30.0	
1,2-Dichloroethane-d4	33.45	50.00	AVRG	33.1	30.0	<-

579 660

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID (Standard): 0201002 Date Analyzed: 01/03/02

Instrument ID: VOC4 Time Analyzed: 0857

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS1 AREA #	RT #	IS2 (DFB) AREA #	RT #	IS3 (CBZ) AREA #	RT #
	12 HOUR STD	941533	6.90	1456749	7.49	1019112	9.69
	UPPER LIMIT	1883066	7.40	2913498	7.99	2038224	10.19
	LOWER LIMIT	470767	6.40	728375	6.99	509556	9.19
	CLIENT SAMPLE NO.						
01	V401031LB	645571	6.90	921653	7.49	598556	9.69
02	011262301	583467	6.90	861331	7.49	499642*	9.69
03	011260201	569990	6.90	921637	7.49	553380	9.69
04	011260201	547406	6.90	822530	7.49	548967	9.69
05	011260202	509177	6.90	825611	7.49	516643	9.69
06	011262301MS	542363	6.90	893343	7.49	701406	9.69
07	011262301MSD	597075	6.90	953969	7.49	751542	9.69
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS1 = Pentafluorobenzene
IS2 (DFB) = 1,4-Difluorobenzene
IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

579, 661

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID (Standard): 0201002 Date Analyzed: 01/03/02

Instrument ID: VOC4 Time Analyzed: 0857

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS4 (DCB) AREA #	RT #	AREA #	RT #	AREA #	RT #
	12 HOUR STD	297425	11.51				
	UPPER LIMIT	594850	12.01				
	LOWER LIMIT	148713	11.01				
	CLIENT SAMPLE NO.						
01	V401031LB	175543	11.51				
02	011262301	158839	11.52				
03	011260201	164634	11.52				
04	011260201	166798	11.52				
05	011260202	166351	11.52				
06	011262301MS	183368	11.51				
07	011262301MSD	187816	11.51				
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS4 (DCB) = 1,4-Dichlorobenzene-d4

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

Report Date : 25-Oct-2001 09:01

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Gwen Savage 10-26-01
Nancy 7 Long 10/26/01
MM 10/26/01

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version 4.00
Integrator . HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date . 25-Oct-2001 08:59 lisa

Calibration File Names:
Level 1: \\ETCBDC\DD\chem\voc4.i\V410242.B\0301004.D
Level 2: \\ETCBDC\DD\chem\voc4.i\V410242.B\0401005.D
Level 3: \\ETCBDC\DD\chem\voc4.i\V410242.B\0601007.D
Level 4: \\ETCBDC\DD\chem\voc4.i\V410242.B\0701008.D
Level 5: \\ETCBDC\DD\chem\voc4.i\V410242.B\0801009.D
Level 6: \\ETCBDC\DD\chem\voc4.i\V410242.B\0901010.D
Level 7: \\ETCBDC\DD\chem\voc4.i\V410242.B\1001011.D
Level 8: \\ETCBDC\DD\chem\voc4.i\V410242.B\1101012.D
Level 9: \\ETCBDC\DD\chem\voc4.i\V410242.B\1201013.D
Level 10: \\ETCBDC\DD\chem\voc4.i\V410242.B\1301014.D

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
1 Dichlorodifluoromethane	0 97213	0 95013	0 94312	1 01738	1 00663	1 04224					
	1 04297	0 92814	0 82458	0 90914			AVRG		0 96365		7 04260

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
2 Chloromethane	0 70152	0.57801	0.61302	0 52598	0 53065	0 59540					
	0 58984	0 52870	0 45990	0 52673			AVRG		0 56497		11 67925
3 Vinyl Chloride	0 41504	0 55814	0 61838	0 56120	0 54778	0 57876					
	0 59121	0 53043	0 49026	0 51833			AVRG		0 54096		10 62800
4 Bromomethane	0 50805	0.52688	0 48448	0 47790	0 45649	0 49288					
	0 47705	0 48754	0 45601	0.49421			AVRG		0 48615		4 43967
5 Chloroethane	0 25529	0 25532	0 35699	0 31411	0 31534	0 32438					
	0 32833	0 30304	0.28265	0 30450			AVRG		0 30399		10 54341
6 Acrolein	+++++	+++++	+++++	0 03677	0 03069	0 02911					
	0 04131	0 03332	+++++	+++++			AVRG		0 03424		14 32308

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4 00
Integrator . HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 120 0000 Level 7	1 0000 Level 2 150 0000 Level 8	5 0000 Level 3 170.0000 Level 9	20 0000 Level 4 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
7 Trichlorofluoromethane	1 16026	1 21300	1.34269	1.31597	1 18371	1 18760					
	1.21715	1 05716	0 96331	1 00903			AVRG		1 16499		10 58693
8 Acetonitrile	+++++	0 02489	0 03313	0.03355	0 02717	0.02730					
	0 02743	+++++	+++++	+++++			AVRG		0 02891		12 30411
9 Acetone	+++++	+++++	0 03122	0 03297	0 02880	0.02763					
	0.02789	0 02716	0 02337	0 02588			AVRG		0 02811		10 62012
10 Furan	+++++	1.05748	1 16309	1 15498	1 02991	1 06795					
	1 08312	0 90945	0 85766	0 93897			AVRG		1 02918		10 35521
11 1,1-Dichloroethene	0 51648	0 52424	0.57495	0 55918	0 49645	0 50924					
	0 54784	0.48238	0 44463	0 47838			AVRG		0 51338		7 79658

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
12 Acrylonitrile	+++++	+++++	+++++	0 11016	0 09761	0 09877					
	0 09954	0 09308	0.08292	0 09200			AVRG		0 09630		8 66909
13 Iodomethane	+++++	+++++	0 47889	0 50565	0 58014	0.61396					
	0.65621	0 54686	0.53122	0 52399			AVRG		0 55461		10 59563
14 Methylene Chloride	12388	18829	44395	138765	302315	620602					
	812722	+++++	+++++	+++++			LINR	-0 01891	0 49236		0 99613
15 1,1,2-trichloro-1,2,2-trifluo	0 63380	0 69759	0.69775	0 69300	0 63935	0 63219					
	0 68628	0 62159	0.56081	0 60181			AVRG		0 64642		7 17477
16 Allyl chloride	0 91424	0 79900	0 89847	0 84670	0 78047	0 79042					
	0 80745	0.72903	0 66284	0 72632			AVRG		0 79549		9 78522

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	ml	m2	%RSD or R^2
17 Carbon Disulfide	1 58809	1 72791	1.79773	1 68785	1 53451	1 60071					
	1 65238	1 52032	1 37206	1 53677			AVRG		1 60183		7 57827
18 trans-1,2-Dichloroethene	0 62495	0 59923	0 60078	0 60037	0 57486	0 57152					
	0.58546	0 53954	0 52134	0.53596			AVRG		0 57540		5 84241
19 Methyl-tertbutyl-Ether	1 46529	1 37018	1 50544	1 52302	1 46321	1 44905					
	1 37186	1 33334	1 28365	1 28546			AVRG		1 40505		6 25164
20 Propionitrile	0 03267	0 03871	0 04101	0 04451	0 03763	0 03741					
	0 03421	0 03406	0 03258	0 03265			AVRG		0 03654		11 08086
21 1,1-Dichloroethane	1 01540	0 98146	1 07218	1 07143	1.02274	1 01481					
	1.00212	0 92096	0.90182	0 89500			AVRG		0 98979		6 52198

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1.0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
22 Vinyl Acetate	+++++	+++++	+++++	0 91967	0 83279	0 83793					
	0 77464	0.77773	0 73976	0 74507			AVRG		0 80394		7 95038
23 Chloroprene	1 13848	1 11913	1 19023	1 20699	1 09447	1 07124					
	1.08550	0 96022	0.92231	0 86828			AVRG		1 06568		10 63170
24 2-Butanone	+++++	+++++	0 04829	0 05271	0 04683	0 04482					
	0 04320	0 04153	0 03935	0 03766			AVRG		0 04430		11 15286
25 Hexane	+++++	+++++	0 82532	0 86931	0 73317	0 71114					
	0 74050	0 65795	0 61355	0.58994			AVRG		0 71761		13 54231
26 Di isopropyl ether	+++++	1 70469	1 66235	1.74529	1 58561	1 55028					
	1 50754	1 41871	1.40402	1.32184			AVRG		1 54448		9 38520

579 667

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
27 Methacrylonitrile	0 13099	0 13215	0 13417	0 14533	0 12259	0 11468					
	0 10945	0 10489	0.09973	0 09697			AVRG		0 11909		13 76472
28 cis-1,2-Dichloroethene	0 61891	0 62373	0 59315	0 61558	0 58087	0 57887					
	0 59543	0 53426	0 52811	0 51862			AVRG		0 57875		6 72712
29 Ethyl Acetate	+++++	+++++	0 36276	0 39953	0 35214	0 35736					
	0 33852	0 31951	0 30671	0 31191			AVRG		0 34355		9 02520
30 Bromochloromethane	0 26260	0.24962	0 26758	0 25728	0 24984	0 24783					
	0 23987	0 22434	0.21920	0 22442			AVRG		0 24426		6 90469
31 Chloroform	1.40516	1 34461	1.24725	1 27029	1 22669	1.20626					
	1 20723	1 10822	1 07769	1 05530			AVRG		1 21487		9 22697

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120.0000 Level 7	1.0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
32 Isobutyl Alcohol	+++++	+++++	0 01648	0 01804	0 01497	0 01476					
	0.01329	0 01329	0 01229	0 01231			AVRG		0 01443		14 17654
33 2,2-Dichloropropane	+++++	1 16393	1.13915	1 13707	1 06218	1 06665					
	1 07298	0 95887	0 90207	0 88359			AVRG		1 04294		9 99286
35 Tetrahydrofuran	+++++	+++++	0.13437	0 17794	0 15677	0 15526					
	0 14714	0 14481	0 13290	0.13867			AVRG		0 14848		9 97711
38 1,2-Dichloroethane	0 76306	0 78654	0 81471	0 86924	0.80172	0 81714					
	0 75840	0 71945	0 67702	0 66261			AVRG		0 76699		8 49138
39 1,1,1-Trichloroethane	1.26536	1 29468	1 33745	1 37830	1 30042	1 31740					
	1 29351	1 18332	1 12111	1 10889			AVRG		1 26004		7.25825

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
40 1,1-Dichloropropene	0 94782	0 90775	0 93531	0 95761	0 88909	0 91848					
	0 90292	0 82121	0 79693	0 77087			AVRG		0 88480		7 39962
41 Carbon Tetrachloride	0 98421	1.07996	1 09740	1 15293	1 14189	1 11366					
	1 09892	1 01175	1.03131	0 93397			AVRG		1 06460		6 72265
42 Benzene	2 08294	2.17245	2 17085	2 14551	2 34859	2 03843					
	1 94892	1 83684	2 09078	1 74782			AVRG		2 05831		8 52387
44 Dibromomethane	0 23977	0 23651	0 23816	0 25395	0 22710	0 21335					
	0 20689	0 20179	0 19453	0 18765			AVRG		0 21997		10 09605
45 1,2-Dichloropropane	6379	10500	36231	168357	393306	626886					
	719627	1088203	1239578	1240658			LINR	-0 10644	0 27757		0 99229

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
46 Trichloroethene	0.41359	0.41107	0 39005	0 41920	0 37123	0 36541					
	0 37528	0.33311	0 32971	0.34342			AVRG		0 37521		8.82993
47 Bromodichloromethane	0.60774	0 58635	0 57407	0.63991	0.56701	0 54888					
	0.54006	0.51100	0.50137	0.49164			AVRG		0 55680		8.57914
48 n-Propyl Acetate	+++++	16632	81492	437143	968262	1455441					
	1586182	2698993	2997696	+++++			LINR	-0 12532	0 45810		0 99078
49 Methyl methacrylate	0.21829	0 19108	0 18981	0.22751	0.18947	0 16621					
	0.15611	0 16519	0.15834	+++++			AVRG		0 18467		13 91905
50 1,4-Dioxane	+++++	+++++	0 00229	0 00282	0 00220	0 00215					
	0 00194	0 00207	0 00189	0 00186			AVRG		0 00215		14 38932

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
51 2-Chloroethyl vinyl ether	0 37993	0 40223	0 35477	0 40641	0 35154	0.30366					
	0 29488	0 29704	0.28766	+++++			AVRG		0 34201		13 92065
52 cis-1,3-Dichloropropene	0 60379	0 64653	0 56319	0.62128	0.56206	0 59882					
	0 59206	0 50691	0 49563	0 47426			AVRG		0 56645		10 12549
53 4-Methyl-2-Pentanone	+++++	+++++	0 23995	0.31555	0 26530	0 28205					
	0 26698	0 24374	0 23300	0 21473			AVRG		0 25766		12 31646
54 trans-1,3-Dichloropropene	0 53306	0 55093	0.52073	0 56825	0 50971	0 54475					
	0 53568	0 46008	0 44789	0.48467			AVRG		0 51558		7 72118
55 1,1,2-Trichloroethane	0 25715	0 26562	0.25436	0 25250	0 22240	0 24025					
	0 23516	0 20463	0 19627	0.21729			AVRG		0 23456		10 07904

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1.0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
57 Ethyl methacrylate	0 23549	0 24511	0 23353	0 22751	0.19157	0.20450					
	0 19698	0 16925	+++++	+++++			AVRG		0 21299		12 38532
58 Toluene	+++++	1 13442	1.02096	0 97034	0 84582	0 89935					
	0.89786	0 73726	+++++	+++++			AVRG		0 92943		13 74312
59 1,3-Dichloropropane	0 51136	0.54491	0 54212	0 53286	0 47559	0 50272					
	0 49645	0 42291	0 41352	0 44426			AVRG		0 48867		9 85225
60 2-Hexanone	+++++	+++++	0 10885	0 11477	0 09749	0.10672					
	0 10133	0.09150	0 08678	0 09400			AVRG		0 10018		9 48776
61 Chlorodibromomethane	0 38260	0 44295	0.42570	0 42460	0 38442	0 42338					
	0.41542	0.35595	0 35164	0 38464			AVRG		0 39913		7 89985

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
62 1,2-Dibromoethane	0 26653	0.28216	0 30433	0.30809	0 26944	0 29566					
	0 28951	0 25375	0 24326	0 27001			AVRG		0 27827		7 69154
63 Tetrachloroethene	0 32834	0 32924	0 31407	0 31393	0 27151	0 29834					
	0 30436	0.25277	0 24974	0 27577			AVRG		0 29381		10 04748
64 1,1,1,2-Tetrachloroethane	0 39561	0 40149	0.41996	0.43811	0 39994	0 39473					
	0.38140	0.38373	0 37664	0 35365			AVRG		0.39453		5 91706
66 Chlorobenzene	1 08681	1 02090	1.01229	1 02035	0.91309	0 86783					
	0 86366	0.86455	0 85425	0 79867			AVRG		0.93024		10.36095
67 Ethylbenzene	2 15167	2 20368	2.15854	2 12345	1 89612	1 87310					
	1 86540	1 81985	1 79431	1 68491			AVRG		1 95710		9 41421

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0.5000000 Level 1 / 120 0000 Level 7	1.0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
68 Xylene-mp	0 69841	0 68061	0.67498	0.64185	0 54562	0 54810					
	0 52147	0 51573	0 50571	0 47465			AVRG		0 58071		14 44875
69 Bromoform	0 20006	0 23056	0.24295	0 26063	0 23556	0.23267					
	0 22158	0 23163	0 22214	0 20789			AVRG		0 22857		7 49939
70 trans-1,4-Dichloro-2-butene	0 11456	0 10290	0 12906	0.13876	0 12198	0 11976					
	0.11198	0 11655	0 11093	0 10098			AVRG		0.11675		9 78409
71 Styrene	1 04862	1 07015	1 00769	1 02922	0 90267	0 92324					
	0 88879	0 87926	0 86827	0.81258			AVRG		0 94305		9 38864
72 Xylene-o	0.59357	0 63998	0 63686	0 60711	0 52354	0 52053					
	0 49288	0 48964	0 47802	0 44805			AVRG		0 54302		12 92937

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Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
73 1,1,2,2-Tetrachloroethane	0 91813	0 89035	0 91607	0.99578	0 95775	0 85428					
	0 82291	0.79800	0 76756	0.76549			AVRG		0.86863		9 19563
74 cis-1,4-Dichloro-2-butene	0 09923	0 11046	0 11496	0 12262	0.10968	0 10695					
	0 09953	0 10306	0 09600	0.08693			AVRG		0 10494		9 73515
75 1,2,3-Trichloropropane	+++++	0 10919	0.10641	0 11582	0 09968	0 09490					
	0 08855	0.09241	0 08572	0 08040			AVRG		0 09701		12 07833
76 Isopropylbenzene	1 87944	1 79679	1 81359	1 80981	1 60585	1 66882					
	1 60728	1 57853	1 57465	1 44859			AVRG		1 67834		8 28326
78 Bromobenzene	0 40113	0 38551	0.39572	0 39583	0 35093	0 35329					
	0 33729	0.33625	0 33510	0 30958			AVRG		0 36006		8 91376

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0.5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
79 n-Propylbenzene	2 32607	2 34673	2 33469	2 32867	2 01747	2 17805					
	2 07046	2 06029	2 01956	1 86048			AVRG		2 15425		8 02711
80 2-Chlorotoluene	1 54838	1 47921	1.39167	1 36433	1 27001	1 26612					
	1 20209	1 19203	1 18233	1 08142			AVRG		1 29776		11 23164
81 4-Chlorotoluene	1 75556	1 47249	1.60908	1 51940	1 32021	1 42120					
	1 28953	1 32981	1 29487	1 19608			AVRG		1 42082		12 00598
82 1,3,5-Trimethylbenzene	1 44013	1.44535	1.46019	1 43590	1 22452	1 30045					
	1.24583	1 23353	1 18899	1 11892			AVRG		1 30938		9 59902
83 1,2,4-Trimethylbenzene	1 44774	1 40562	1 47855	1 44169	1 22952	1 28360					
	1 23691	1.23798	1 18760	1 10202			AVRG		1 30512		9 87751

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Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
85 tert-Butylbenzene	1 19807	1 21315	1.19561	1 21673	1 03967	1.10777					
	1 08352	1.06752	1.03877	0.96642			AVRG		1 11272		7 93640
86 sec-Butylbenzene	1 87212	1.86483	1 88979	1 86617	1 60615	1 71002					
	1 65042	1 63597	1 59299	1 46354			AVRG		1 71520		8 71165
87 4-Isopropyltoluene	1 41196	1 43297	1 42166	1 38530	1 20060	1 25639					
	1 22112	1 20505	1 16767	1 08155			AVRG		1 27843		9 75204
89 1,3-Dichlorobenzene	1 87171	1 81694	1 66127	1 76811	1 72043	1 73848					
	1 75579	1 68055	1 67691	1 68313			AVRG		1 73733		3 91181
90 1,4-Dichlorobenzene	1 87269	1 76330	1 66127	1 70794	1 59897	1 65210					
	1 57405	1.61957	1 52048	1 52686			AVRG		1 64972		6 61410

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
91 1,2-Dichlorobenzene	1 52509	1 53316	1 49159	1 54576	1 44885	1 51042					
	1 50813	1 42484	1 40876	1 43671			AVRG		1 48333		3 32446
92 n-Butylbenzene	3 81309	3 85474	3 91226	4 04234	3 79198	3 96621					
	4 04727	3 76185	3.66299	3 73877			AVRG		3 85915		3 37108
93 1,2-Dibromo-3-chloropropane	0.20851	0.16211	0 16679	0 18100	0 16450	0 16306					
	0 15521	0 15884	0 15015	0.15091			AVRG		0 16611		10.43754
94 1,2,4-Trichlorobenzene	0 90420	0 86693	0.85270	0 82901	0 74162	0 79170					
	0 80746	0.81427	0 79715	0 81293			AVRG		0 82180		5.45952
95 Naphthalene	1 90618	1.73975	1 65414	1.70272	1.45301	1 58625					
	1 60575	1 65427	1.55601	1 60229			AVRG		1 64604		7 36512

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FORM 3
WATER VOA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC,INC. Lab Prep Batch: V401031

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: V401031LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Vinyl Acetate	100.0		89.20	89	28-146
Vinyl Chloride	100.0		85.52	86	65-134
Xylene-mp	200.0		187.7	94	77-115
Xylene-o	100.0		93.92	94	77-115

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 88 outside limits

COMMENTS: ______________________

FORM 3
WATER VOA-GCMS MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: ETC, INC. Lab Prep Batch: V401031

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: 011262301

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	MS CONCENTRATION (ug/L)	MS % REC #	QC. LIMITS REC.
Benzene	100.0	0.000	150.2	150*	72-124
Chlorobenzene	100.0	0.000	116.8	117*	77-112
1,1-Dichloroethene	100.0	0.000	115.4	115	69-121
Toluene	100.0	0.000	122.7	123*	77-115
Trichloroethene	100.0	0.000	134.4	134*	75-113

COMPOUND	SPIKE ADDED (ug/L)	MSD CONCENTRATION (ug/L)	MSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Benzene	100.0	128.3	128*	16	20	72-124
Chlorobenzene	100.0	115.2	115*	2	20	77-112
1,1-Dichloroethene	100.0	115.6	116	1	20	69-121
Toluene	100.0	117.7	118*	4	20	77-115
Trichloroethene	100.0	114.2	114*	16	20	75-113

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 5 outside limits
Spike Recovery: 8 out of 10 outside limits

COMMENTS: ______________________

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Environmental Testing & Consulting, Inc.

Quality Control Reports
Level III
GC/MS Semi-Volatiles

ENVIRONMENTAL TESTING AND CONSULTING, INC.
CASE NARRATIVE
GC/MS SEMI-VOLATILE COMPOUNDS - AQUEOUS

Client Name	Sverdrup/Jacobs Engineering
Project Name	Memphis Depot
ETC Order#	0112-602

SAMPLE PRESERVATION

All aqueous samples maintained at 4 degrees C until extraction

HOLDING TIMES

Sample Extraction — All aqueous samples extracted within 7 days.

METHOD

Preparation	SW-846 3510C
Analysis.	SW-846 8270C

QUALITY CONTROL

QC Batch	Form 4 Summary
P07012	P07012LB

System Monitoring Compounds FORM 2
Surrogate recoveries within QC limits.

Method Blank FORM 4
P07012LB
Target analytes were not detected in the method blank.

Laboratory Control Sample FORM 3
P07012LCS/LCSD
All target analyte acceptance criteria met, except as listed below.
Benzidine was flagged for low recoveries in the LCS/LCSD. 2,4-Dimethylphenol was flagged for low recovery in the LCSD.

RPDs for multiple analytes were flagged as outside QC limits due to lower recoveries in the LCSD.

Matrix Spike / Matrix Spike Dup FORM 3
Batch P07012
Due to the limited amount of sample available, no MS/MSD was extracted/analyzed. Refer to Laboratory Control Sample(s) for system verification.

CALIBRATION

DFTPP Daily 12-Hour Tune	All criteria met FORM 5
Initial Calibration	All criteria met FORM 6
Calibration Verification	All criteria met. FORM 7 Responses >30% do not affect the data.

Semi-Volatile Internal Standard Area and RT FORM 8
Calibration Verification standard(s) Internal Standard Areas and Retention Times within QC limits

SAMPLE ANALYSIS

Instrumentation	HP 5890 Series II GC, 5971MSD/HP 6890 GC, 5973MSD
Dilutions Required	No dilutions required

[signature]

Project Manager

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FORM 2
WATER BNA-GCMS SURROGATE RECOVERY

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

	CLIENT SAMPLE NO.	S1 (NBZ) #	S2 (FBP) #	S3 (TPH) #	S4 (PHL) #	S5 (TBP) #	S6 (2FP) #	S7 #	S8 #	TOT OUT
01	P07012LB	54	51	70	23	55	34			0
02	P07012LCS	65	67	82	25	76	36			0
03	P07012LCSD	71	69	80	28	71	40			0
04	011260202	51	51	53	23	54	33			0
05										
06										
07										
08										
09										
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		QC LIMITS
S1 (NBZ)	= Nitrobenzene-d5	(29-110)
S2 (FBP)	= 2-Fluorobiphenyl	(38-107)
S3 (TPH)	= Terphenyl-d14	(33-122)
S4 (PHL)	= Phenol-d6	(7- 58)
S5 (TBP)	= 2,4,6-Tribromophenol	(16-138)
S6 (2FP)	= 2-Fluorophenol	(8- 88)

Column to be used to flag recovery values
* Values outside of contract required QC limits
D Surrogate diluted out

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FORM 4
BNA-GCMS METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

P07012LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID: 0301005 Lab Prep Batch: P07012

Instrument ID: BNA1 Lab Sample ID: P07012LB

Matrix: (soil/water) WATER Date Analyzed: 01/03/02

Level:(low/med) LOW Time Analyzed: 1715

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	CLIENT SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED
01	P07012LCS	P07012LCS	0401006	01/03/02
02	P07012LCSD	P07012LCSD	0501007	01/03/02
03	011260202	011260202	0601008	01/03/02
04				
05				
06				
07				
08				
09				
10				
11				
12				
13				
14				
15				
16				
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22				
23				
24				
25				
26				
27				
28				
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30				

COMMENTS:

FORM IV BNA-GCMS

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FORM 1
BNA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

P07012LB

Lab Name: ETC, INC.   Contract:

Lab Code: Case No.:   SAS No.:   SDG No.: 0112602

Matrix: (soil/water) WATER   Lab Prep Batch: P07012

Sample wt/vol: 1000 (g/mL) ML   Lab File ID: 0301005

Level: (low/med) LOW   Date Received: ______

% Moisture: ______ decanted: (Y/N)___   Date Extracted:

Concentrated Extract Volume: 1(mL)   Date Analyzed: 01/03/02

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
83-32-9	Acenaphthene	2.00	U
208-96-8	Acenaphthylene	2.00	U
98-86-2	Acetophenone	5.00	U
62-53-3	Aniline	5.00	U
120-12-7	Anthracene	2.00	U
92-87-5	Benzidine	20.00	U
56-55-3	Benz(a)Anthracene	2.00	U
205-99-2	Benzo(b)fluoranthene	2.00	U
207-08-9	Benzo(k)fluoranthene	2.00	U
191-24-2	Benzo(ghi)perylene	2.00	U
50-32-8	Benzo(a)pyrene	2.00	U
65-85-0	Benzoic acid	50.00	U
100-51-6	Benzyl alcohol	5.00	U
111-91-1	Bis(2-chloroethoxy)methane	5.00	U
111-44-4	Bis(2-chloroethyl)ether	5.00	U
108-60-1	Bis(2-chloroisopropyl)ether	5.00	U
117-81-7	Bis(2-ethylhexyl)phthalate	5.00	U
101-55-3	4-Bromophenyl phenyl ether	5.00	U
85-68-7	Butyl benzyl phthalate	5.00	U
86-74-8	Carbazole	2.00	U
106-47-8	4-Chloroaniline	5.00	U
510-15-6	Chlorobenzilate	5.00	U
59-50-7	4-Chloro-3-methylphenol	5.00	U
91-58-7	2-Chloronaphthalene	2.00	U
95-57-8	2-Chlorophenol	5.00	U
7005-72-3	4-Chlorophenyl phenyl ether	5.00	U
218-01-9	Chrysene	2.00	U
53-70-3	Dibenz(a,h)anthracene	2.00	U
132-64-9	Dibenzofuran	5.00	U
84-74-2	Di-n-butyl phthalate	5.00	U
95-50-1	1,2-Dichlorobenzene	5.00	U
541-73-1	1,3-Dichlorobenzene	5.00	U
106-46-7	1,4-Dichlorobenzene	5.00	U

FORM 1 579 687
BNA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

P07012LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: P07012

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 0301005

Level: (low/med) LOW Date Received: ______

% Moisture: ______ decanted: (Y/N)___ Date Extracted:

Concentrated Extract Volume: 1(mL) Date Analyzed: 01/03/02

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
91-94-1	3,3'-Dichlorobenzidine	10.00	U
120-83-2	2,4-Dichlorophenol	5.00	U
87-65-0	2,6-Dichlorophenol	5.00	U
84-66-2	Diethyl phthalate	5.00	U
119-93-7	3,3-Dimethylbenzidine	10.00	U
105-67-9	2,4-Dimethyphenol	5.00	U
131-11-3	Dimethyl phthalate	5.00	U
534-52-1	4,6-Dinitro-2-methylphenol	10.00	U
51-28-5	2,4-Dinitrophenol	20.00	U
121-14-2	2,4-Dinitrotoluene	5.00	U
606-20-2	2,6-Dinitrotoluene	5.00	U
122-39-4	N-NitrsdiphylAm/Diphenylamin	5.00	U
117-84-0	Di-n-octyl phthalate	5.00	U
62-50-0	Ethyl methanesulfonate	5.00	U
206-44-0	Fluoranthene	2.00	U
86-73-7	Fluorene	2.00	U
118-74-1	Hexachlorobenzene	5.00	U
87-68-3	Hexachlorobutadiene	5.00	U
77-47-4	Hexachlorocyclopentadiene	5.00	U
67-72-1	Hexachloroethane	5.00	U
193-39-5	Indeno(1,2,3-cd)pyrene	2.00	U
78-59-1	Isophorone	5.00	U
66-27-3	Methyl methanesulfonate	5.00	U
91-57-6	2-Methylnaphthalene	2.00	U
95-48-7	2-Methylphenol	5.00	U
108-39-4	3&4-Methylphenol	5.00	U
91-20-3	Naphthalene	2.00	U
88-74-4	2-Nitroaniline	10.00	U
99-09-2	3-Nitroaniline	10.00	U
100-01-6	4-Nitroaniline	10.00	U
98-95-3	Nitrobenzene	5.00	U
88-75-5	2-Nitrophenol	10.00	U
100-02-7	4-Nitrophenol	5.00	U

FORM 1
BNA-GCMS ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

P07012LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Prep Batch: P07012

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 0301005

Level: (low/med) LOW Date Received: ______

% Moisture: ______ decanted: (Y/N)___ Date Extracted:

Concentrated Extract Volume: 1(mL) Date Analyzed: 01/03/02

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
924-16-3	N-Nitrosodibutylamine	5.00	U
55-18-5	N-Nitrosodiethylamine	5.00	U
62-75-9	N-Nitrosodimethylamine	5.00	U
621-64-7	N-Nitrosodi-n-propylamine	5.00	U
82-68-8	Pentachloronitrobenzene	10.00	U
87-86-5	Pentachlorophenol	10.00	U
62-44-2	Phenacetin	5.00	U
85-01-8	Phenanthrene	2.00	U
108-95-2	Phenol	5.00	U
129-00-0	Pyrene	2.00	U
110-86-1	Pyridine	5.00	U
95-94-3	1,2,4,5-Tetrachlorobenzene	5.00	U
58-90-2	2,3,4,6-Tetrachlorophenol	5.00	U
120-82-1	1,2,4-Trichlorobenzene	5.00	U
95-95-4	2,4,5-Trichlorophenol	5.00	U
88-06-2	2,4,6-Trichlorophenol	5.00	U
103-33-3	1,2-Dphnylhydrzine/Azobenzen	5.00	U

FORM 1 579 689
BNA-GCMS ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

P07012LB

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix: (soil/water) WATER Lab Sample ID: P07012LB

Sample wt/vol: 1000 (g/mL) ML Lab File ID: 0301005

Level: (low/med) LOW Date Received: ________

% Moisture: ______ decanted: (Y/N)___ Date Extracted:

Concentrated Extract Volume: 1(mL) Date Analyzed: 01/03/02

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: 7.0

Number TICs found: 3

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	3.73	1.21	J
2. 584-94-1	HEXANE, 2,3-DIMETHYL-	4.57	1.13	NJ
3. 102-82-9	TRIBUTYLAMINE	5.50	0.901	NJ
4.				
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579 690

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC.

Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acenaphthene	50.00		37.03	74	38-117
Acenaphthylene	50.00		39.46	79	37-114
Acetophenone	50.00		34.48	69	32-108
Aniline	50.00		29.44	59	16-133
Anthracene	50.00		37.54	75	34-128
Benzidine	50.00		7.31	15*	22-176
Benz(a)Anthracene	50.00		39.98	80	36-127
Benzo(b)fluoranthene	50.00		41.12	82	36-131
Benzo(k)fluoranthene	50.00		40.29	80	32-132
Benzo(ghi)perylene	50.00		37.62	75	26-123
Benzo(a)pyrene	50.00		39.57	79	34-131
Benzoic acid	50.00		17.77	36	11- 58
Benzyl alcohol	50.00		28.56	57	20-109
Bis(2-chloroethoxy)meth	50.00		35.24	70	20-126
Bis(2-chloroethyl)ether	50.00		31.67	63	16-122
Bis(2-chloroisopropyl)e	50.00		35.02	70	28-108
Bis(2-ethylhexyl)phthal	50.00		39.23	78	21-162
4-Bromophenyl phenyl et	50.00		37.02	74	31-124
Butyl benzyl phthalate	50.00		38.87	78	33-142
Carbazole	50.00		44.00	88	20-147
4-Chloroaniline	50.00		36.70	73	24-127
Chlorobenzilate	50.00		36.36	73	35-118
4-Chloro-3-methylphenol	50.00		37.84	76	35-117
2-Chloronaphthalene	50.00		39.08	78	29-137
2-Chlorophenol	50.00		28.72	57	27-102
4-Chlorophenyl phenyl e	50.00		36.89	74	39-110
Chrysene	50.00		41.19	82	30-124
Dibenz(a,h)anthracene	50.00		40.66	81	27-124

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

COMMENTS: ______________________________

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

579 691

Lab Name: ETC, INC. Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Dibenzofuran	50.00		37.09	74	40-108
Di-n-butyl phthalate	50.00		33.32	67	19-158
1,2-Dichlorobenzene	50.00		28.34	57	26-100
1,3-Dichlorobenzene	50.00		26.48	53	21-102
1,4-Dichlorobenzene	50.00		27.52	55	24- 99
3,3'-Dichlorobenzidine	50.00		57.64	115	6-192
2,4-Dichlorophenol	50.00		34.41	69	32-110
2,6-Dichlorophenol	50.00		36.02	72	31-112
Diethyl phthalate	50.00		37.48	75	36-130
3,3-Dimethylbenzidine	50.00		3.32	7	6-192
2,4-Dimethyphenol	50.00		26.59	53	34-105
Dimethyl phthalate	50.00		37.58	75	34-123
4,6-Dinitro-2-methylphe	50.00		34.06	68	27-128
2,4-Dinitrophenol	50.00		29.03	58	10-132
2,4-Dinitrotoluene	50.00		35.37	71	24-147
2,6-Dinitrotoluene	50.00		36.13	72	36-125
N-NitrsdiphylAm/Dipheny	100.0		78.99	79	35-116
Di-n-octyl phthalate	50.00		38.60	77	29-136
Ethyl methanesulfonate	50.00		31.47	63	20-121
Fluoranthene	50.00		34.00	68	28-127
Fluorene	50.00		37.51	75	41-116
Hexachlorobenzene	50.00		35.33	71	18-136
Hexachlorobutadiene	50.00		28.58	57	22-109
Hexachlorocyclopentadie	50.00		22.23	44	10-102
Hexachloroethane	50.00		24.68	49	16-107
Indeno(1,2,3-cd)pyrene	50.00		40.40	81	22-126
Isophorone	50.00		35.16	70	31-116
Methyl methanesulfonate	50.00		22.25	44	15- 82

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

COMMENTS: ______________________

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC. Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
2-Methylnaphthalene	50.00		34.49	69	34-108
2-Methylphenol	50.00		27.50	55	22- 97
3&4-Methylphenol	50.00		26.02	52	21- 96
Naphthalene	50.00		32.48	65	33-108
2-Nitroaniline	50.00		37.92	76	32-127
3-Nitroaniline	50.00		46.45	93	28-142
4-Nitroaniline	50.00		34.02	68	23-139
Nitrobenzene	50.00		33.22	66	27-117
2-Nitrophenol	50.00		32.55	65	25-114
4-Nitrophenol	50.00		13.54	27	1- 76
N-Nitrosodibutylamine	50.00		38.10	76	31-126
N-Nitrosodiethylamine	50.00		29.41	59	28-107
N-Nitrosodimethylamine	50.00		19.60	39	14- 84
N-Nitrosodi-n-propylami	50.00		36.17	72	29-114
Pentachloronitrobenzene	50.00		38.28	76	34-135
Pentachlorophenol	50.00		36.52	73	17-142
Phenacetin	50.00		37.07	74	29-141
Phenanthrene	50.00		36.84	74	40-120
Phenol	50.00		12.95	26	11- 55
Pyrene	50.00		34.96	70	20-154
Pyridine	50.00		12.76	26	10- 71
1,2,4,5-Tetrachlorobenz	50.00		32.97	66	28-110
2,3,4,6-Tetrachlorophen	50.00		39.50	79	28-118
1,2,4-Trichlorobenzene	50.00		28.78	58	23-106
2,4,5-Trichlorophenol	50.00		38.20	76	26-118
2,4,6-Trichlorophenol	50.00		37.39	75	26-115
1,2-Dphnylhydrzine/Azob	50.00		42.40	85	45-135

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

COMMENTS: ________________

579 693

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC. Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	LCSD CONCENTRATION (ug/L)	LCSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Acenaphthene	50.00	28.69	57	26*	20	38-117
Acenaphthylene	50.00	30.18	60	27*	20	37-114
Acetophenone	50.00	35.50	71	3	20	32-108
Aniline	50.00	27.90	56	5	20	16-133
Anthracene	50.00	29.56	59	24*	20	34-128
Benzidine	50.00	6.32	13*	14	20	22-176
Benz(a)Anthracene	50.00	38.82	78	2	20	36-127
Benzo(b)fluoranthene	50.00	43.31	87	6	20	36-131
Benzo(k)fluoranthene	50.00	45.51	91	13	20	32-132
Benzo(ghi)perylene	50.00	35.00	70	7	20	26-123
Benzo(a)pyrene	50.00	42.82	86	8	20	34-131
Benzoic acid	50.00	16.88	34	6	20	11- 58
Benzyl alcohol	50.00	33.21	66	15	20	20-109
Bis(2-chloroethoxy)meth	50.00	36.83	74	6	20	20-126
Bis(2-chloroethyl)ether	50.00	37.01	74	16	20	16-122
Bis(2-chloroisopropyl)e	50.00	40.96	82	16	20	28-108
Bis(2-ethylhexyl)phthal	50.00	39.58	79	1	20	21-162
4-Bromophenyl phenyl et	50.00	26.51	53	33*	20	31-124
Butyl benzyl phthalate	50.00	39.35	79	1	20	33-142
Carbazole	50.00	52.94	106	18	20	20-147
4-Chloroaniline	50.00	35.58	71	3	20	24-127
Chlorobenzilate	50.00	40.82	82	12	20	35-118
4-Chloro-3-methylphenol	50.00	36.02	72	5	20	35-117
2-Chloronaphthalene	50.00	30.72	61	24*	20	29-137
2-Chlorophenol	50.00	33.38	67	16	20	27-102
4-Chlorophenyl phenyl e	50.00	28.76	58	24*	20	39-110
Chrysene	50.00	38.90	78	5	20	30-124
Dibenz(a,h)anthracene	50.00	39.05	78	4	20	27-124

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

COMMENTS: ______________________________

FORM III BNA-GCMS

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC. Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	LCSD CONCENTRATION (ug/L)	LCSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Dibenzofuran	50.00	28.57	57	26*	20	40-108
Di-n-butyl phthalate	50.00	31.27	62	8	20	19-158
1,2-Dichlorobenzene	50.00	32.62	65	13	20	26-100
1,3-Dichlorobenzene	50.00	30.51	61	14	20	21-102
1,4-Dichlorobenzene	50.00	31.80	64	15	20	24- 99
3,3'-Dichlorobenzidine	50.00	43.61	87	28*	20	6-192
2,4-Dichlorophenol	50.00	34.51	69	0	20	32-110
2,6-Dichlorophenol	50.00	35.49	71	1	20	31-112
Diethyl phthalate	50.00	30.76	62	19	20	36-130
3,3-Dimethylbenzidine	50.00	3.47	7	0	20	6-192
2,4-Dimethyphenol	50.00	5.46	11*	131*	20	34-105
Dimethyl phthalate	50.00	29.55	59	24*	20	34-123
4,6-Dinitro-2-methylphe	50.00	27.11	54	23*	20	27-128
2,4-Dinitrophenol	50.00	24.05	48	19	20	10-132
2,4-Dinitrotoluene	50.00	29.89	60	17	20	24-147
2,6-Dinitrotoluene	50.00	30.54	61	16	20	36-125
N-NitrsdiphylAm/Dipheny	100.0	85.16	85	7	20	35-116
Di-n-octyl phthalate	50.00	44.51	89	14	20	29-136
Ethyl methanesulfonate	50.00	36.80	74	16	20	20-121
Fluoranthene	50.00	32.84	66	3	20	28-127
Fluorene	50.00	29.96	60	22*	20	41-116
Hexachlorobenzene	50.00	26.76	54	27*	20	18-136
Hexachlorobutadiene	50.00	29.76	60	5	20	22-109
Hexachlorocyclopentadie	50.00	15.06	30	38*	20	10-102
Hexachloroethane	50.00	27.48	55	12	20	16-107
Indeno(1,2,3-cd)pyrene	50.00	39.01	78	4	20	22-126
Isophorone	50.00	36.09	72	3	20	31-116
Methyl methanesulfonate	50.00	26.24	52	17	20	15- 82

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

COMMENTS: ______________________

FORM 3
WATER BNA-GCMS LAB CONTROL SAMPLE

Lab Name: ETC, INC. Lab Prep Batch: P07012

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Matrix Spike - Sample No.: P07012LCS

COMPOUND	SPIKE ADDED (ug/L)	LCSD CONCENTRATION (ug/L)	LCSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
2-Methylnaphthalene	50.00	35.17	70	1	20	34-108
2-Methylphenol	50.00	25.48	51	8	20	22- 97
3&4-Methylphenol	50.00	22.84	46	12	20	21- 96
Naphthalene	50.00	33.68	67	3	20	33-108
2-Nitroaniline	50.00	28.43	57	28*	20	32-127
3-Nitroaniline	50.00	33.08	66	34*	20	28-142
4-Nitroaniline	50.00	30.14	60	12	20	23-139
Nitrobenzene	50.00	34.45	69	4	20	27-117
2-Nitrophenol	50.00	33.91	68	4	20	25-114
4-Nitrophenol	50.00	11.48	23	16	20	1- 76
N-Nitrosodibutylamine	50.00	38.57	77	1	20	31-126
N-Nitrosodiethylamine	50.00	35.82	72	20	20	28-107
N-Nitrosodimethylamine	50.00	22.89	46	16	20	14- 84
N-Nitrosodi-n-propylami	50.00	40.13	80	10	20	29-114
Pentachloronitrobenzene	50.00	46.38	93	20	20	34-135
Pentachlorophenol	50.00	29.06	58	23*	20	17-142
Phenacetin	50.00	51.30	103	33*	20	29-141
Phenanthrene	50.00	29.34	59	22*	20	40-120
Phenol	50.00	14.72	29	11	20	11- 55
Pyrene	50.00	44.92	90	25*	20	20-154
Pyridine	50.00	7.14	14	60*	20	10- 71
1,2,4,5-Tetrachlorobenz	50.00	25.10	50	28*	20	28-110
2,3,4,6-Tetrachlorophen	50.00	30.33	61	26*	20	28-118
1,2,4-Trichlorobenzene	50.00	30.00	60	3	20	23-106
2,4,5-Trichlorophenol	50.00	28.34	57	28*	20	26-118
2,4,6-Trichlorophenol	50.00	26.32	53	34*	20	26-115
1,2-Dphnylhydrzine/Azob	50.00	43.34	87	2	20	45-135

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits

RPD: 25 out of 83 outside limits
Spike Recovery: 3 out of 166 outside limits

COMMENTS: ____________________

579 696

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level IV
Metals (ICP/GFAA/CV)

ENVIRONMENTAL TESTING & CONSULTING, INC
ICP Metals Sequence Check List

Sequence ID : 010302 System ID : ICP1 Date/Time: 1-3 0918

Analyst : SH
Supervisor: JF

1 Instrument Profile Intensity Check (Manganese) 9140

2 Initial Calibration
- a Initial Calibration Blank (STD1-Blank)
- b Initial Calibration Standard 1 (C1) 3 Exposures at less than 3% RSD
- c Initial Calibration Standard 2 (C2) 3 Exposures at less than 3% RSD
- d Initial Calibration Standard 3 (C3) 3 Exposures at less than 3% RSD
- e Initial Calibration Standard 4 (C4) 3 Exposures at less than 3% RSD
- f Standardization Report

3 Initial Calibration Readback (+/- 5% Difference Check Table)

			Failures
a	Initial Calibration Standard 1 (C1)	✓	
b	Initial Calibration Standard 2 (C2)	✓	
c	Initial Calibration Standard 3 (C3)	✓	
d	Initial Calibration Standard 4 (C4)	✓	

4 Initial Calibration Verification

e	Initial Calibration Blank (ICB) – All elements below MDL/MQL	✓	
f	Initial Calibration Verification (ICV1) – (5%) OK AT 10%	✓	Ca, K
g	Low Level Check (LLC1) – (20%)	✓	Ca
h	Low Level Check (LLC2) – (20%)	—	
i	Interelement Correction Standard – Initial (ICSAB) – (20%)	✓	
j	Interelement Correction Standard – Final (ICSAB) – (20%)	✓	

Comments

Applicable ETC Order Nos. for this sequence:

U29AQ29	0112621			
U1550-54	622			
0201001	597			
0112602	543			
0201026	U29AQ28			
027	0112623			
0112564	543			
552	496			
538	460			
571	U1550601			
584	0112545			
586				

\\SERVER\ETC_SOP\Metals\Analytical\ICP\ICP Metals 6010B 200 Check List 051000 doc

579 698

AutoSampler Report Table: PLASMA1 01/05/02 09:03:56 AM

Table Name: PLASMA1 Autosampler Type: TYPE TJA
Sample Positions: 42/192 QC Positions: 19/19 # Sets: 1
Rinse Station location is rack -1, pos. -1.

--- Racks ---

Rack #	Type	Usage	#Pos Left	Analyses/Pos
1	Aux. (L) Rack	STD/QC/BLANK	19	10
2	Sample (16mm)	Samples	0	1
3	Sample (16mm)	Samples	0	1
4	Sample (16mm)	Samples	0	1
5	Sample (16mm)	Samples	42	1

--- Sample Sets ---

Set#	Type	Prepare?	Description	Method	#Pos	Rack#	StartPos
1	Normal	No	010302	ICPT	150	2	1

--- Preparation Info ---

Set#	Uptake	Uptake#2	Final	Dil.Factor

No Samples Prepared.

Rack #1

Pos	Row	Col	Sample Name	Set #	#Used	Type
(1...19	Not Used)					

Rack #2

Pos	Row	Col	Sample Name	Set #	#Used	Type
1	1	1	V29AQ29 SB	1	-NA-	Sample
2	1	2	V15SO54 SB	1	-NA-	Sample
3	1	3	V29AQ29 LC	1	-NA-	Sample
4	1	4	V15SO54 LC	1	-NA-	Sample
5	1	5	020100101	1	-NA-	Sample
6	1	6	020100103	1	-NA-	Sample
7	1	7	011260201 D	1	-NA-	Sample
8	1	8	011260201	1	-NA-	Sample
9	1	9	011260201 MS	1	-NA-	Sample
10	1	10	011260201 MSD	1	-NA-	Sample
11	1	11	CCB1	1	-NA-	Sample
12	1	12	CCV1	1	-NA-	Sample
13	2	1	11260201 5	1	-NA-	Sample
14	2	2	11260201 D	1	-NA-	Sample
15	2	3	20102601	1	-NA-	Sample
16	2	4	20102701	1	-NA-	Sample
17	2	5	CCB2	1	-NA-	Sample
18	2	6	CCV2	1	-NA-	Sample
19	2	7	11256402 10	1	-NA-	Sample
20	2	8	11256406 10	1	-NA-	Sample
21	2	9	11256408 10	1	-NA-	Sample

AutoSampler Report Table: PLASMA1 01/05/02 09:03:56 AM

Rack #2

Pos	Row	Col	Sample Name	Set #	#Used	Type
22	2	10	11255201 PDS	1	-NA-	Sample
23	2	11	11253802 PDS	1	-NA-	Sample
24	2	12	11257101	1	-NA-	Sample
25	3	1	11258404	1	-NA-	Sample
26	3	2	11258406	1	-NA-	Sample
27	3	3	11258609	1	-NA-	Sample
28	3	4	11258609 5	1	-NA-	Sample
29	3	5	CCB3	1	-NA-	Sample
30	3	6	CCV3	1	-NA-	Sample
31	3	7	11258603 5	1	-NA-	Sample
32	3	8	11258613 PDS	1	-NA-	Sample
33	3	9	11258613 DT	1	-NA-	Sample
34	3	10	11255101 MSD	1	-NA-	Sample
35	3	11	11258614	1	-NA-	Sample
36	3	12	11258614 MS	1	-NA-	Sample
37	4	1	11258614 MSD	1	-NA-	Sample
38	4	2	11262101	1	-NA-	Sample
39	4	3	11262101 D	1	-NA-	Sample
40	4	4	11262101 MS	1	-NA-	Sample
41	4	5	CCB4	1	-NA-	Sample
42	4	6	CCV4	1	-NA-	Sample
43	4	7	11262201	1	-NA-	Sample
44	4	8	11262202	1	-NA-	Sample
45	4	9	11262203	1	-NA-	Sample
46	4	10	11262204	1	-NA-	Sample
47	4	11	11262205	1	-NA-	Sample
48	4	12	11262206	1	-NA-	Sample

Rack #3

Pos	Row	Col	Sample Name	Set #	#Used	Type
1	1	1	11262207	1	-NA-	Sample
2	1	2	11262208	1	-NA-	Sample
3	1	3	11262208 MS	1	-NA-	Sample
4	1	4	11262208 MSD	1	-NA-	Sample
5	1	5	CCB5	1	-NA-	Sample
6	1	6	CCV5	1	-NA-	Sample
7	1	7	11259701	1	-NA-	Sample
8	1	8	11259702	1	-NA-	Sample
9	1	9	11254303	1	-NA-	Sample
10	1	10	11254304	1	-NA-	Sample
11	1	11	V29AQ28 SB	1	-NA-	Sample
12	1	12	V29AQ28 LC	1	-NA-	Sample
13	2	1	11262301	1	-NA-	Sample
14	2	2	11262302	1	-NA-	Sample
15	2	3	11254302	1	-NA-	Sample
16	2	4	11254305	1	-NA-	Sample
17	2	5	CCB6	1	-NA-	Sample
18	2	6	CCV6	1	-NA-	Sample
19	2	7	11254306	1	-NA-	Sample
20	2	8	11249601	1	-NA-	Sample
21	2	9	11246001	1	-NA-	Sample

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AutoSampler Report Table: PLASMA1 01/05/02 09:03:56 AM

Rack #3

Pos	Row	Col	Sample Name	Set #	#Used	Type
22	2	10	11246001 MS	1	-NA-	Sample
23	2	11	11246001 MSD	1	-NA-	Sample
24	2	12	V15S061 SB	1	-NA-	Sample
25	3	1	V15S061 LC	1	-NA-	Sample
26	3	2	11254502	1	-NA-	Sample
27	3	3	11254504	1	-NA-	Sample
28	3	4	11254506	1	-NA-	Sample
29	3	5	CCB7	1	-NA-	Sample
30	3	6	CCV7	1	-NA-	Sample
31	3	7	11254509	1	-NA-	Sample
32	3	8	11254511	1	-NA-	Sample
33	3	9	11254513	1	-NA-	Sample
34	3	10	11254515	1	-NA-	Sample
35	3	11	11254518	1	-NA-	Sample
36	3	12	11254520	1	-NA-	Sample
37	4	1	11254522	1	-NA-	Sample
38	4	2	CCB8	1	-NA-	Sample
39	4	3	CCV8	1	-NA-	Sample
40	4	4	ICSA	1	-NA-	Sample
41	4	5	ICSAB	1	-NA-	Sample
42	4	6	(empty)	1	-NA-	-NA-
43	4	7	(empty)	1	-NA-	-NA-
44	4	8	(empty)	1	-NA-	-NA-
45	4	9	(empty)	1	-NA-	-NA-
46	4	10	(empty)	1	-NA-	-NA-
47	4	11	(empty)	1	-NA-	-NA-
48	4	12	(empty)	1	-NA-	-NA-

Rack #4

Pos	Row	Col	Sample Name	Set #	#Used	Type
1	1	1	(empty)	1	-NA-	-NA-
2	1	2	(empty)	1	-NA-	-NA-
3	1	3	(empty)	1	-NA-	-NA-
4	1	4	(empty)	1	-NA-	-NA-
5	1	5	(empty)	1	-NA-	-NA-
6	1	6	(empty)	1	-NA-	-NA-
7	1	7	(empty)	1	-NA-	-NA-
8	1	8	(empty)	1	-NA-	-NA-
9	1	9	(empty)	1	-NA-	-NA-
10	1	10	(empty)	1	-NA-	-NA-
11	1	11	(empty)	1	-NA-	-NA-
12	1	12	(empty)	1	-NA-	-NA-
13	2	1	(empty)	1	-NA-	-NA-
14	2	2	(empty)	1	-NA-	-NA-
15	2	3	(empty)	1	-NA-	-NA-
16	2	4	(empty)	1	-NA-	-NA-
17	2	5	(empty)	1	-NA-	-NA-
18	2	6	(empty)	1	-NA-	-NA-
19	2	7	(empty)	1	-NA-	-NA-
20	2	8	(empty)	1	-NA-	-NA-
21	2	9	(empty)	1	-NA-	-NA-

FORM 2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION
ICP METALS

Lab Name Environmental Testing and Consulting, Inc

Date/Time of Sequence 01/03/02 0918 Instrument ICPT

Initial Calibration Source C1 M6-28-10 C2 M6-29-01 C3 M6-32-09 C4 M6-33-03

Continuing Calibration Source ICV/CCV M6-32-16

	Initial Calibration Verification				Continuing CCV1				Continuing CCV2					
Analyte	True	Found	%Diff(1)	Flag	True	Found	%Diff(1)	Flag	Found	%Diff(1)	Flag	Found	%Diff(1)	Flag
Silver	100	98.1	2	<5	100	99	1	<5	100	0	<5			
Arsenic	500	522	4	<5	500	528	6	<10	538	8	<10			
Barium	1000	990	1	<5	1000	1000	0	<5	1020	2	<5			
Cadmium	100	98.6	1	<5	100	99.7	0	<5	102	2	<5			
Chromium	200	204	2	<5	200	206	3	<5	210	5	<10			
Iron	1000	1040	4	<5	1000	1050	5	<5	1070	7	<10			
Manganese	100	105	5	<10	100	106	6	<10	108	8	<10			
Lead	500	515	3	<5	500	523	5	<10	532	6	<10			
Selenium	500	497	1	<5	500	503	1	<5	511	2	<5			

(1) Percent difference from true value. ICP Method 6010B - 10% ICP Method 200.7 - 5%

FORM 3
INITIAL AND CONTINUING CALIBRATION BLANKS
ICP METALS

Lab Name Environmental Testing and Consulting, Inc

Date/Time of Sequence 01/03/02 0918 Instrument ICPT

Analyte	Initial Calibration Blank ug/L	Continuing Calibration Blank ug/L									
		CCB1	CCB2								
Silver	ND	ND	ND								
Arsenic	ND	ND	ND								
Barium	ND	ND	ND								
Cadmium	ND	ND	ND								
Chromium	ND	ND	ND								
Iron	ND	ND	ND								
Manganese	ND	ND	ND								
Lead	ND	ND	ND								
Selenium	ND	ND	ND								

FORM 4
INTERFERENCE CHECK SAMPLE
ICP METALS

Lab Name Environmental Testing and Consulting, Inc

Date/Time of Sequence 01/03/02 0918 Instrument ICPT

Concentration Units: ug/L

Analyte	True Sol AB	Initial Found Sol AB	Initial Found %REC	Final Found Sol AB	Final Found %REC
Silver	200	211	106	206	103
Aluminum	250000	251000	100	246000	98
Arsenic	200	204	102	201	101
Barium	200	209	105	204	102
Calcium	250000	252000	101	244000	98
Cadmium	200	195	98	193	97
Chromium	200	197	99	194	97
Iron	100000	101000	101	99000	99
Magnesium	250000	254000	102	246000	98
Manganese	200	205	103	200	100
Lead	200	202	101	196	98
Selenium	200	202	101	197	99

Analyte	True Sol A	Initial Found Sol A	Initial Found %REC	Final Found Sol A	Final Found %REC
Silver	0	ND	0	ND	0
Aluminum	250000	251000	100	248000	99
Arsenic	0	ND	0	ND	0
Barium	0	ND	0	ND	0
Calcium	250000	254000	102	247000	99
Cadmium	0	ND	0	ND	0
Chromium	0	ND	0	ND	0
Iron	100000	101000	101	99900	100
Magnesium	250000	254000	102	247000	99
Manganese	0	ND	0	ND	0
Lead	0	ND	0	ND	0
Selenium	0	ND	0	ND	0

%R - Recovery should be within 20%.

ENVIRONMENTAL TESTING & CONSULTING, INC
Mercury Sequence Check List

Sequence ID: L2010300,02,03DB Date/Time: 1/3/02 0949 Analyst: JF Supervisor: A

Instrument ID. CETAC M-6000A

1 General Maintenance Check — Action Taken
- a Lamp Warm-up [✓]
- b Pump Winding [✓]
- c Check GLS [✓]
- d Nafion Dryer [✓]

2 Sequence Check List
Initial Calibration
- a Initial Calibration Blank (STD1-Blank)
- b Initial Calibration Standard 1 0 20 ug/L
- c Initial Calibration Standard 2 1 0 ug/L
- d Initial Calibration Standard 3 2 0 ug/L
- e Initial Calibration Standard 4 5 0 ug/L
- f Initial Calibration Standard 5 10 0 ug/L

3 Regression coefficient (minimum = 0 995) ✓

4 Initial Calibration Blank (ICB) – All elements below MQL ✓
Water = 0 20 ug/L Soil = 0.02 mg/Kg ✓

5 Initial Calibration Verification (ICV) – 2cnd Source SRN: M-6-33-21
Concentration 5 0 ug/L +/- 10% Found: 5.34 %Difference: 7

6 Continuing Calibration Blank (CCB) – All elements below MQL indicate by √

Metal	CCB1	CCB2	CCB3	CCB4	CCB5	CCB6	CCB7	CCB8	CCB9	CCB10	CCB11	CCB12	CCB13	CCB14	CCB15
Hg	✓	✓	✓	F	✓										

7 Continuing Calibration Verification (CCV) – Range: EPA 90-110% SW-846 80-120%
All elements within QC limits indicate by √ (Concentration same as ICV) SRN: M-6-33-21

Metal	CCV1	CCV2	CCV3	CCV4	CCV5	CCV6	CCV7	CCV8	CCV9	CCV10	CCV11	CCV12	CCV13	CCV14	CCV15
Hg	✓	✓	✓	F	✓										

Applicable ETC Order Nos. for this sequence:

SBLC VC9AQ26	112551	112692	201001	
112602	112659	BLK DISS	112701	
112622	112691	112690	112660	

Thursday, January 03, 2002

Tube	Rack ID	Sample ID	Weight	Volume	Sampl
1		ICB	1	1	Unknow
2		ICV	1	1	Unknow
3		V09AQ26 SB	1	1	Unknow
4		V09AQ26 LC	1	1	Unknow
5		11260201B	1	1	Unknow
6		11260201C	1	1	Unknow
7		11260201C MS	1	1	Unknow
8		11260201C MSD	1	1	Unknow
9		11262201	1	1	Unknow
10		11262202	1	1	Unknow
11		11262203	1	1	Unknow
12		11262204	1	1	Unknow
13		CCB1	1	1	Unknow
14		CCV1	1	1	Unknow
15		11262205	1	1	Unknow
16		11262206	1	1	Unknow
17		11262207	1	1	Unknow
18		11262208	1	1	Unknow
19		11255101	1	1	Unknow
20		11265904	1	1	Unknow
21		11265904 MS	1	1	Unknow
22		11265904 MSD	1	1	Unknow
23		11265902	1	1	Unknow
24		11265903	1	1	Unknow
25		CCB2	1	1	Unknow
26		CCV2	1	1	Unknow
27		11265901	1	1	Unknow
28		11269101	1	1	Unknow
29		11269102	1	1	Unknow
30		11269201	1	1	Unknow
31		BLK DISS	1	1	Unknow
32		11269002	1	1	Unknow
33		11269002 MS	1	1	Unknow
34		11269002 MSD	1	1	Unknow
35		V09AQ27 SB	1	1	Unknow
36		V09AQ27 LC	1	1	Unknow
37		CCB3	1	1	Unknow
38		CCV3	1	1	Unknow
39		20100101	1	1	Unknow
40		20100103	1	1	Unknow
41		20100103 MS	1	1	Unknow
42		20100103 MSD	1	1	Unknow
43		11270101	1	1	Unknow
44		11270102	1	1	Unknow
45		11270103	1	1	Unknow
46		11270104	1	1	Unknow

Thursday, January 03, 2002

Tube	Rack ID	Sample ID	Weight	Volume	Sampl
48		11270106	1	1	Unknov
49		CCB4	1	1	Unknov
50		CCV4	1	1	Unknov
51		11266001	1	1	Unknov
52		11266002	1	1	Unknov
53		11260201C PDS	1	1	Unknov
54		20100103 PDS	1	1	Unknov
55		CCB5	1	1	Unknov
56		CCV5	1	1	Unknov

FORM 2A
INITIAL AND CONTINUING CALIBRATION VERIFICATION
MERCURY

Lab Name Environmental Testing and Consulting, Inc

Date/Time of Sequence 01/03/02 0949 Instrument M6000

Initial Calibration Source C1 M6-33-20

Continuing Calibration Source ICV/CCV M6-33-21

	Initial Calibration Verification				Continuing CCV1				Continuing CCV2			Continuing CCV3		
Analyte	True	Found	%Diff(1)	Flag	True	Found	%Diff(1)	Flag	Found	%Diff(1)	Flag	Found	%Diff(1)	Flag
Mercury	5.00	5.34	6.8	<10	5.00	5.31	6.2	<10	5.35	7.0	<10	5.35	7.0	<10

FORM 3
INITIAL AND CONTINUING CALIBRATION BLANKS
ICP METALS

Lab Name Environmental Testing and Consulting, Inc

Date/Time of Sequence 01/03/02 0949 Instrument M6000

Analyte	MDL ug/L	Initial Cal Blank (ICB) ug/L	Continuing Calibration Blank ug/L										
			CCB1	CCB2	CCB3								
Mercury	0.06	ND	ND	ND	ND								

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level IV
GC/MS Volatiles

ENVIRONMENTAL TESTING & CONSULTING, INC
GC/MS VOC Method 8260B Sequence Check List (SW-846)

Sequence ID: V41221 1 **Matrix:** ______ **HBN:** ______
Date: 12/26/01
Analyst ⊖
Super [initials]
Applicable ETC Order Nos. for this sequence:
0112-496 0112-623 ~~0112-512~~ 521
0112-602 -495 ~~-477~~ 570

Validated

1. **BFB Daily 12-Hour Tune Meets Criteria.** No analyses begins until criteria are met. (SOP) ✓
2. **Initial Calibration Verification Criteria - Method :** V410242.8260.M
   a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene) ✓
   b. CCC - RSD of RF for CCCs and Target Analytes MUST BE <= 30% ✓
   c. RSD of analytes <=15% may use Average RF for quantitation ✓
   d. Analytes w/RSD >15% use Linear Regression - correlation coefficient >=0.99 ✓
3. **Calibration Verification - Each 12-Hour Shift**
   a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene) ✓
   b. CCC - % Difference for Average RF Calibration - <=20% ✓
   c. CCC - % Drift for Linear Regression Calibration - <=20% ✓
   d. % Difference/% Drift for all other Target Analytes - <=30% ✓
   Iodomethane @31.0
   e. Internal Standards - Retention Times within +/-30 seconds from Mid-Point ICAL STD ✓
   f. Internal Standards - Areas within (-50% to +100%) form Mid-Point ICAL STD ✓
4. **Method Blanks included in this sequence :** ✓
   Analyze daily or for each analytical batch (20 samples): ______
   List compounds identified in Method Blank w/concentration.
   Flag final result "B-Detected in Blank"
   V4122111B MeCl2 @ 4.60ug/L
5. **Matrix Spike/Matrix Spike Duplicates included in this sequence :** ✓
   Analyze daily or for each matrix (ms/msd per 20 samples of same matrix)
   List MS/MSD(s) performed with any failures :
   0112-623-2
6. **Laboratory Control Samples included in this sequence :** ✓
   Must contain all Target Analytes.
   V4122111LCS
7. **Surrogate Recoveries within QC Limits** ✓
8. **All positive compounds within calibration range** ✓

Narrative/Notes :

Form Date 09/13/01
P:\0 ... gcms\8260\GCMS VOC 8260B Check List 091201.doc

FORM 5
VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK
BROMOFLUOROBENZENE (BFB)

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID: 0101001 BFB Injection Date: 12/21/01

Instrument ID: VOC4 BFB Injection Time: 1403

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) N

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
50	15.0 - 40.0% of mass 95	17.6
75	30.0 - 60.0% of mass 95	46.3
95	Base Peak, 100% relative abundance	100.0
96	5.0 - 9.0% of mass 95	6.9
173	Less than 2.0% of mass 174	0.0 (0.0)1
174	Greater than 50.0% of mass 95	65.4
175	5.0 - 9.0% of mass 174	4.8 (7.4)1
176	95.0 - 101.0% of mass 174	65.2 (99.7)1
177	5.0 - 9.0% of mass 176	4.3 (6.7)2

1-Value is % mass 174 2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	EPA SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	V412211LCS	1LCS	0201002LCS	12/21/01	1417
02	DSC100PPB		0201002	12/21/01	1417
03	V412212LCS	2LCS	0202003LCS	12/21/01	1452
04	DSC100PPB		0202003	12/21/01	1452
05	V412211LB	V412211LB	0402005	12/21/01	1645
06	011260201	011260201	0701008	12/21/01	1818
07	011262302	011262302	1101012	12/21/01	2022
08	011262302MS	MS	2001021	12/22/01	0059
09	011262302MSD	MSD	2101022	12/22/01	0130
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

579 712

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 12/21/01 Time: 1417

Lab File ID: 0201002 Init. Calib. Date(s): 10/24/01 10/24/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1433 1946

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d
Acetone	106.9	100.0	AVRG	6.9	30.0
Acetonitrile	1028	1000	AVRG	2.8	30.0
Acrolein	94.20	100.0	AVRG	5.8	30.0
Acrylonitrile	99.07	100.0	AVRG	0.9	30.0
Allyl chloride	87.62	100.0	AVRG	12.4	30.0
Benzene	98.31	100.0	AVRG	1.7	30.0
Bromobenzene	102.8	100.0	AVRG	2.8	30.0
Bromochloromethane	97.16	100.0	AVRG	2.8	30.0
Bromodichloromethane	93.54	100.0	AVRG	6.5	30.0
Bromoform	105.1	100.0	AVRG	5.1	30.0
2-Butanone	103.4	100.0	AVRG	3.4	30.0
Bromomethane	86.79	100.0	AVRG	13.2	30.0
n-Butylbenzene	94.38	100.0	AVRG	5.6	30.0
sec-Butylbenzene	81.13	100.0	AVRG	18.9	30.0
tert-Butylbenzene	103.5	100.0	AVRG	3.5	30.0
Carbon Disulfide	102.0	100.0	AVRG	2.0	30.0
Carbon Tetrachloride	98.14	100.0	AVRG	1.9	30.0
Chlorobenzene	92.98	100.0	AVRG	7.0	30.0
Chlorodibromomethane	92.18	100.0	AVRG	7.8	30.0
Chloroethane	104.3	100.0	AVRG	4.3	30.0
2-Chloroethyl vinyl ether	84.83	100.0	AVRG	15.2	30.0
Chloroform	94.34	100.0	AVRG	5.7	20.0
Chloromethane	100.1	100.0	AVRG	0.1	30.0
Chloroprene	93.58	100.0	AVRG	6.4	30.0
2-Chlorotoluene	109.8	100.0	AVRG	9.8	30.0
4-Chlorotoluene	107.2	100.0	AVRG	7.2	30.0
1,2-Dibromo-3-chloropropane	89.22	100.0	AVRG	10.8	30.0
1,2-Dibromoethane	90.92	100.0	AVRG	9.1	30.0
Dibromomethane	91.00	100.0	AVRG	9.0	30.0
1,2-Dichlorobenzene	91.93	100.0	AVRG	8.1	30.0
1,3-Dichlorobenzene	94.14	100.0	AVRG	5.9	30.0
1,4-Dichlorobenzene	89.46	100.0	AVRG	10.5	30.0
cis-1,4-Dichloro-2-butene	114.2	100.0	AVRG	14.2	30.0
trans-1,4-Dichloro-2-butene	109.6	100.0	AVRG	9.6	30.0
Dichlorodifluoromethane	101.1	100.0	AVRG	1.1	30.0
1,1-Dichloroethane	91.57	100.0	AVRG	8.4	30.0
1,2-Dichloroethane	100.5	100.0	AVRG	0.5	30.0

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 12/21/01 Time: 1417

Lab File ID: 0201002 Init. Calib. Date(s): 10/24/01 10/24/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1433 1946

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
1,1-Dichloroethene	86.25	100.0	AVRG	13.8	20.0	
cis-1,2-Dichloroethene	88.86	100.0	AVRG	11.1	30.0	
trans-1,2-Dichloroethene	85.04	100.0	AVRG	15.0	30.0	
1,2-Dichloropropane	96.34	100.0	LINR	3.7	20.0	
1,3-Dichloropropane	88.94	100.0	AVRG	11.1	30.0	
2,2-Dichloropropane	102.0	100.0	AVRG	2.0	30.0	
1,1-Dichloropropene	100.4	100.0	AVRG	0.4	30.0	
cis-1,3-Dichloropropene	92.53	100.0	AVRG	7.5	30.0	
trans-1,3-Dichloropropene	101.8	100.0	AVRG	1.8	30.0	
Di isopropyl ether	96.44	100.0	AVRG	3.6	30.0	
1,4-Dioxane	2110	2000	AVRG	5.5	30.0	
Ethyl Acetate	100.9	100.0	AVRG	0.9	30.0	
Ethylbenzene	96.57	100.0	AVRG	3.4	20.0	
Ethyl methacrylate	166.4	200.0	AVRG	16.8	30.0	
Furan	150.1	153.0	AVRG	1.9	30.0	
Hexachlorobutadiene	90.86	100.0	AVRG	9.1	30.0	
Hexane	103.6	117.0	AVRG	11.4	30.0	
2-Hexanone	86.26	100.0	AVRG	13.7	30.0	
Iodomethane	131.0	100.0	AVRG	31.0	30.0	<-
Isobutyl Alcohol	1840	2000	AVRG	8.0	30.0	
Isopropylbenzene	100.1	100.0	AVRG	0.1	30.0	
4-Isopropyltoluene	106.7	100.0	AVRG	6.7	30.0	
Methacrylonitrile	979.2	1000	AVRG	2.1	30.0	
Methylene Chloride	100.4	100.0	LINR	0.4	30.0	
Methyl methacrylate	185.4	200.0	AVRG	7.3	30.0	
4-Methyl-2-Pentanone	92.82	100.0	AVRG	7.2	30.0	
Methyl-tertbutyl-Ether	103.8	100.0	AVRG	3.8	30.0	
Naphthalene	95.77	100.0	AVRG	4.2	30.0	
Propionitrile	1026	1000	AVRG	2.6	30.0	
n-Propyl Acetate	158.3	151.0	LINR	4.8	30.0	
n-Propylbenzene	107.3	100.0	AVRG	7.3	30.0	
Styrene	99.10	100.0	AVRG	0.9	30.0	
1,1,1,2-Tetrachloroethane	98.49	100.0	AVRG	1.5	30.0	
1,1,2,2-Tetrachloroethane	84.27	100.0	AVRG	15.7	30.0	
Tetrachloroethene	83.52	100.0	AVRG	16.5	30.0	
Tetrahydrofuran	87.40	91.50	AVRG	4.5	30.0	
1,2,3-Trichlorobenzene	98.34	100.0	AVRG	1.7	30.0	

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 12/21/01 Time: 1417

Lab File ID: 0201002 Init. Calib. Date(s): 10/24/01 10/24/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1433 1946

GC Column: ID: 2.00 (mm)

COMPOUND	SAMPLE AMOUNT	CAL100 AMOUNT	CURVE	%D	MAX %d	
Toluene	78.03	100.0	AVRG	22.0	20.0	<-
1,1,1-Trichloroethane	91.06	100.0	AVRG	8.9	30.0	
1,1,2-Trichloroethane	86.47	100.0	AVRG	13.5	30.0	
1,1,2-trichloro-1,2,2-triflu	91.22	100.0	AVRG	8.8	30.0	
Trichloroethene	82.95	100.0	AVRG	17.0	30.0	
Trichlorofluoromethane	102.5	100.0	AVRG	2.5	30.0	
1,2,3-Trichloropropane	103.2	100.0	AVRG	3.2	30.0	
1,2,4-Trimethylbenzene	105.1	100.0	AVRG	5.1	30.0	
1,2,4-Trichlorobenzene	99.34	100.0	AVRG	0.7	30.0	
1,3,5-Trimethylbenzene	105.0	100.0	AVRG	5.0	30.0	
Vinyl Acetate	90.40	100.0	AVRG	9.6	30.0	
Vinyl Chloride	104.6	100.0	AVRG	4.6	20.0	
Xylene-mp	187.7	200.0	AVRG	6.2	30.0	
Xylene-o	94.80	100.0	AVRG	5.2	30.0	
Dibromofluoromethane	50.17	50.00	AVRG	0.3	30.0	
Toluene-d8	47.23	50.00	AVRG	5.5	30.0	
Bromofluorobenzene	55.68	50.00	AVRG	11.4	30.0	
1,2-Dichloroethane-d4	52.05	50.00	AVRG	4.1	30.0	

FORM 7
VOA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: VOC4 Calibration Date: 12/21/01 Time: 1452

Lab File ID: 0202003 Init. Calib. Date(s): 10/24/01 10/24/01

Heated Purge: (Y/N) Y Init. Calib. Times: 1433 1946

GC Column: ID: 2.00 (mm)

COMPOUND	$\overline{RRF}$	RRF100	MIN RRF	%D	MAX %D
Toluene	0.929	0.891		4.1	20.0
Dibromofluoromethane	0.653	0.654		0.2	30.0
Toluene-d8	1.306	1.281		1.9	30.0
Bromofluorobenzene	0.536	0.533		0.6	30.0
1,2-Dichloroethane-d4	0.690	0.761		10.3	30.0

579 716

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID (Standard): 0202003 Date Analyzed: 12/21/01

Instrument ID: VOC4 Time Analyzed: 1452

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS1 AREA #	RT #	IS2 (DFB) AREA #	RT #	IS3 (CBZ) AREA #	RT #
	12 HOUR STD	1150845	6.92	1896752	7.51	1912092	9.71
	UPPER LIMIT	2301690	7.42	3793504	8.01	3824184	10.21
	LOWER LIMIT	575423	6.42	948376	7.01	956046	9.21
	CLIENT SAMPLE NO.						
01	V412211LB	1082051	6.92	1653425	7.52	1492564	9.72
02	011260201	986876	6.92	1699657	7.52	1360729	9.71
03	011262302	939724	6.92	1613041	7.52	1285255	9.71
04	011262302MS	1021364	6.92	1826158	7.52	1683678	9.71
05	011262302MSD	1112557	6.92	1908306	7.52	1734938	9.72
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS1 = Pentafluorobenzene
IS2 (DFB) = 1,4-Difluorobenzene
IS3 (CBZ) = Chlorobenzene-d5

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

FORM 8
VOA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID (Standard): 0202003 Date Analyzed: 12/21/01

Instrument ID: VOC4 Time Analyzed: 1452

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) Y

		IS4 (DCB) AREA #	RT #	AREA #	RT #	AREA #	RT #
	12 HOUR STD	715184	11.53				
	UPPER LIMIT	1430368	12.03				
	LOWER LIMIT	357592	11.03				
	CLIENT SAMPLE NO.						
01	V412211LB	634402	11.53				
02	011260201	583986	11.54				
03	011262302	550098	11.54				
04	011262302MS	658638	11.54				
05	011262302MSD	651137	11.54				
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							

IS4 (DCB) = 1,4-Dichlorobenzene-d4

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag values outside QC limits with an asterisk.
* Values outside of QC limits.

579 718

ENVIRONMENTAL TESTING & CONSULTING, INC
GC/MS VOC Method 8260B Sequence Check List (SW-846)

Sequence ID V401031 Matrix: H_2O HBN: ________ Analyst [signature]
Date: 1-4-02 Super [signature] 1/4/02
Applicable ETC Order Nos. for this sequence: 0112-623-1-3 0112-602-1,2
0112-659-1-4 0201-037-1-3

Validated

1. BFB Daily 12-Hour Tune Meets Criteria. No analyses begins until criteria are met. (SOP) ✓
2. Initial Calibration Verification Criteria - Method : V412271.8260m
   a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene) ✓
   b. CCC - RSD of RF for CCCs and Target Analytes MUST BE <= 30% ✓
   c. RSD of analytes <=15% may use Average RF for quantitation ✓
   d. Analytes w/RSD >15% use Linear Regression - correlation coefficient >=0.99 ✓

3. Calibration Verification - Each 12-Hour Shift
   a. SPCC - Mean RF >=0.10 (>=0.30 for Chlorobenzene / 1122-Tetrachloroethene) ✓
   b. CCC - % Difference for Average RF Calibration - <=20% ✓
   c. CCC - % Drift for Linear Regression Calibration - <=20% ✓
   d. % Difference/% Drift for all other Target Analytes - <=30% ✓
      Acetone, DCDFM, Ethyl Meth, 2-Hexanone
   e. Internal Standards - Retention Times within +/-30 seconds from Mid-Point ICAL STD ✓
   f. Internal Standards - Areas within (-50% to +100%) form Mid-Point ICAL STD ✓

4. Method Blanks included in this sequence : ✓
   Analyze daily or for each analytical batch (20 samples): ________
   List compounds identified in Method Blank w/concentration.
   Flag final result "B-Detected in Blank"
   $MeCl_2$ @ BDL

5. Matrix Spike/Matrix Spike Duplicates included in this sequence : * ✓
   Analyze daily or for each matrix (ms/msd per 20 samples of same matrix)
   List MS/MSD(s) performed with any failures :
   0112-62301 MS, MSD
   * 8 out of 10 recoveries exceed limits.

6. Laboratory Control Samples included in this sequence : ✓
   Must contain all Target Analytes. 0/88

7. Surrogate Recoveries within QC Limits ✓

8. All positive compounds within calibration range ✓

Narrative/Notes :

FORM 5
VOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK
BROMOFLUOROBENZENE (BFB)

Lab Name: ETC,INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID: 0101001 BFB Injection Date: 01/03/02

Instrument ID: VOC4 BFB Injection Time: 0835

GC Column: ID: 2.00 (mm) Heated Purge: (Y/N) N

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
50	15.0 - 40.0% of mass 95	18.8
75	30.0 - 60.0% of mass 95	48.1
95	Base Peak, 100% relative abundance	100.0
96	5.0 - 9.0% of mass 95	7.0
173	Less than 2.0% of mass 174	0.0 (0.0)1
174	Greater than 50.0% of mass 95	57.6
175	5.0 - 9.0% of mass 174	5.0 (8.7)1
176	95.0 - 101.0% of mass 174	57.4 (99.6)1
177	5.0 - 9.0% of mass 176	3.7 (6.5)2

1-Value is % mass 174 2-Value is % mass 176

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	EPA SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	V401031LCS	1LCS	0201002LCS	01/03/02	0857
02	DSC100PPB		0201002	01/03/02	0857
03	V401031LB	1LB	0303005	01/03/02	1103
04	011262301	011262301	0501007	01/03/02	1210
05	011260201	011260201	0701009	01/03/02	1313
06	011260201	011260201	0801010	01/03/02	1345
07	011260202	011260202	0901011	01/03/02	1416
08	011262301MS	MS	1801020	01/03/02	1859
09	011262301MSD	MSD	1901021	01/03/02	1930
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20.0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
76 Fluoranthene CCC	57560	160874	315419	570921	1343258	1559018					
	2180271	2692179	+++++				LINR	-0 07693	0.68541		0 99578 *
77 Benzidine	+++++	33143	65727	81503	163777	202973					
	+++++	+++++	+++++				LINR	-0.16215	0.20632		0.99203
78 Pyrene	55165	160345	309864	550797	1316706	1517381					
	2132260	+++++	+++++				LINR	-0.05349	0 69737		0 99798
80 Chlorobenzilate	0 35034	0 36127	0.43132	0 46800	0 47062	0 46298					
	0 45019	0 47233	0 48521				AVRG		0 43914		11 31379
81 3,3-Dimethylbenzidine	+++++	+++++	59880	74605	204168	260538					
	503373	673094	+++++				QUAD	-0.08896	4.38243	-1.54802	0 99646

* %RSD = 16.6

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10 0000 Level 3 / 160.0000 Level 9	20 0000 Level 4	50.0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
82 Butyl benzyl phthalate	0 51366	0.55601	0 64541	0.66998	0 65395	0.67365					
	0 68134	0 68814	0 67193				AVRG		0.63934		9 62833
83 Benz(a)Anthracene	1 19601	1 06953	1.11969	1 05791	1 06009	1 09113					
	1 11576	1 12187	1 07025				AVRG		1.10025		4 01198
85 3,3'-Dichlorobenzidine	0.21108	0.21349	0 26296	0 24915	0.18053	0 18397					
	0 23001	0 24272	0 27172				AVRG		0 22729		14.32917
86 Chrysene	1 13830	1 00673	1.05767	0 99820	0 99434	1 01749					
	1 06144	1.04783	0 98465				AVRG		1 03407		4 67406
87 Bis(2-ethylhexyl)phthalate	+++++	0 61333	0 76926	0 76832	0 81233	0.85431					
	0 87194	0 88515	0.87573				AVRG		0.80630		11.26392

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bnal.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5.0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
88 Di-n-octyl phthalate CCC	+++++	54287	122636	217853	786101	1016991					
	1686684	2020444	3006537				QUAD	0 12598	0.80634	-0.00100	0.99781 *
89 Benzo(b)fluoranthene	1 16578	1.06994	1 20588	1 14980	1.15548	1.16893					
	1 18401	1 34654	+++++				AVRG		1 18079		6 58866
90 Benzo(k)fluoranthene	1 13549	1 03874	1 16146	1.18146	1.12186	1 20276					
	1.21892	1 30674	+++++				AVRG		1.17093		6 70120
91 Benzo(a)pyrene CCC	0 81166	0 77129	0.92529	0.90540	0.96492	1 01602					
	1 04154	1.09694	+++++				AVRG		0.94163		11 88456
93 Indeno(1,2,3-cd)pyrene	0 79263	0 71478	0.72775	0.75673	0.90865	0 91972					
	1 03537	0 91011	+++++				AVRG		0 84572		13.50767

* %RSD = 25.0

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

tart Cal Date : 29-DEC-2001 09:23
ǀnd Cal Date : 29-DEC-2001 12:17
ǀuant Method : ISTD
'arget Version : 4.00
ntegrator : HP RTE
ǀethod file : \\ETCBDC\DD\chem\bnal.i\B1122901.B\B1122901.M
'al Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100.0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50 0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
94 Dibenz(a,h)anthracene	0.63206	0 59255	0.59084	0.59901	0.73378	0 73546					
	0.83452	0 73742	+++++				AVRG		0 68195		13 29749
95 Benzo(ghi)perylene	0 68168	0 62070	0 61183	0.61076	0 72526	0.71720					
	0.80287	0.69411	0 67777				AVRG		0 68246		9 21500
; 4 2-Fluorophenol	1 41442	1 28454	1 43117	1 38787	1 36493	1 38229					
	1 39592	1.37609	1.31964				AVRG		1 37298		3 32560
; 7 Phenol-d6	1 84923	1.67028	1 83320	1.77994	1 78400	1 71912					
	1 73413	1 71261	1 62752				AVRG		1 74556		4.18058
; 23 Nitrobenzene-d5	0 52926	0.47176	0.49599	0.45959	0.46664	0 43213					
	0 42938	0 43052	0 38657				AVRG		0 45576		9.20780

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5.0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
$ 44 2-Fluorobiphenyl	1.47427	1.26262	1 38537	1 24358	1 26132	1.17394					
	1.12250	1.06281	+++++				AVRG		1.24830		10 74816
$ 65 2,4,6-Tribromophenol	3934	12607	28816	67949	198007	285393					
	395423	555840	764291				QUAD	0.08507	7.62342	-0 93256	0.99764
$ 79 Terphenyl-d14	+++++	1 11657	1 23388	1 30089	1 25577	1.17387					
	1.10858	1 21073	1 10840				AVRG		1.18858		6.19093

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

tart Cal Date : 29-DEC-2001 09:23
nd Cal Date : 29-DEC-2001 12:17
uant Method : ISTD
arget Version : 4.00
ntegrator : HP RTE
ethod file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
al Date : 30-Dec-2001 07:39 erica

Curve	Formula	Units
Averaged	Amt = Rsp/m1	Response
Linear	Amt = b + Rsp/m1	Response
Quad	Amt = b + m1*Rsp + m2*Rsp^2	Response

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	b	Coefficients m1	m2	%RSD or R^2
96 Hexachlorobutadiene	0 58251	0 56548	0 59938	0.60727	0 55408	0 58054					
	0 61329	0 61227	0 58522	0 62309			AVRG		0 59231		3 78629
97 1,2,3-Trichlorobenzene	0 78149	0.69318	0 72054	0 70894	0 62372	0 67216					
	0.71464	0 70617	0 68692	0 70062			AVRG		0 70084		5 66740
$ 34 Dibromofluoromethane	0 60801	0 64401	0 66936	0 67175	0 65981	0 66477					
	0.67110	0 63742	+++++	+++++			AVRG		0 65328		3 41252
$ 37 1,2-Dichloroethane-d4	0 63834	0 69243	0 70400	0 73776	0 69380	0 71780					
	0 68160	0 65064	+++++	+++++			AVRG		0.68955		4 76496
$ 56 Toluene-d8	1 29319	1 36271	1 35633	1 31140	1 17059	1 34760					
	1 41136	1 19201	+++++	+++++			AVRG		1 30565		6 47972

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 24-OCT-2001 14:33
End Cal Date : 24-OCT-2001 19:46
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\voc4.i\V410242.B\v410242.8260.m
Cal Date : 25-Oct-2001 08:59 lisa

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
$ 77 Bromofluorobenzene	0 53274	0 57475	0 56865	0 56015	0 49657	0 52419					
	0 51436	0 51673	+++++	+++++			AVRG		0 53602		5 32130

Curve	Formula	Units
Averaged	Amt = Rsp/m1	Response
Linear	Amt = b + Rsp/m1	Response

Report Date : 28-Dec-2001 08:55

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

QC REVIEWED 1-4-02

579 728

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Calibration File Names:
Level 1: M:\voc4.i\V412271.B\0301003.D
Level 2: M:\voc4.i\V412271.B\0402005.D
Level 3: M:\voc4.i\V412271.B\0501006.D
Level 4: M:\voc4.i\V412271.B\0601007.D
Level 5: M:\voc4.i\V412271.B\0701008.D
Level 6: M:\voc4.i\V412271.B\0801009.D
Level 7: M:\voc4.i\V412271.B\0901010.D
Level 8: M:\voc4.i\V412271.B\1001011.D
Level 9: M:\voc4.i\V412271.B\1101012.D
Level 10: M:\voc4.i\V412271.B\1201013.D

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
1 Dichlorodifluoromethane	2 00376	1 75176	1.43626	2.26754	2 11641	2 29171					
	2 03902	2 12873	2 08120	2 04195			AVRG		2 01583		12 52367

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
2 Chloromethane	+++++	0 20561	0.22832	0.24089	0 24363	0 26463					
SPCC	0 21484	0 24208	0 25727	0 21471			AVRG		0 23466		8 60122
3 Vinyl Chloride	0 40266	0 38435	0 41282	0 42263	0 50068	0 47286					
CCC	0 43731	0 46487	0 46166	0 42840			AVRG		0 43882		8 14938
4 Bromomethane	0 40235	0 34792	0 26632	0 33876	0 35489	0 36183					
	0 33948	0 36277	0 36793	0 35056			AVRG		0 34928		9 83862
5 Chloroethane	0 31514	0 26843	0 27135	0 31063	0 30807	0 28241					
	0.26135	0 27158	0 27263	0 25673			AVRG		0 28183		7 62473
6 Acrolein	+++++	+++++	+++++	0 04387	0 03872	0 03553					
	0 03299	0 03565	+++++	+++++			AVRG		0 03735		11 16710

579 729

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
7 Trichlorofluoromethane	1 07616	1 23779	1 20342	1 19710	1 24212	1 12523					
	1 06897	1 08958	1 09961	1 02494			AVRG		1 13649		6 80952
8 Acetonitrile	+++++	5147	18819	86540	175096	353395					
	390427	496680	530715	+++++			LINR	-0 64615	0 02754		0 99555
9 Acetone	+++++	+++++	3794	12343	23135	41566					
	47646	59198	63314	74102			LINR	-0 22854	0 03083		0 99643
10 Furan	+++++	1 22619	1.23138	1 23135	1 24904	1 16952					
	1 10525	1 13664	1.16452	1 09653			AVRG		1 17894		4 92311
11 1,1-Dichloroethene	0.49968	0 56429	0 49556	0 46557	0 47874	0 44415					
CCC	0 41684	0.43099	0 44284	0 41104			AVRG		0.46497		10 01055

Environmental Testing and Consulting, Inc

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
12 Acrylonitrile	+++++	+++++	+++++	41579	78178	150832					
	170283	217231	233107	266396			LINR	-0 24678	0 11109		0 99569
13 Iodomethane	+++++	0 64492	0 73698	0 82077	0 81621	0 75531					
	0 70804	0 72983	0 74195	0 67882			AVRG		0 73698		7 79534
14 Methylene Chloride	27855	26663	54744	162345	344589	643926					
	747135	930568	1050294	1185277			LINR	-0 10234	0.51229		0 99839
15 1,1,2-trichloro-1,2,2-trifluo	0 50750	0 60898	0 64171	0 64942	0 65747	0 66365					
	0.63857	0 71907	0 63994	0 66058			AVRG		0 63869		8 43727
16 Allyl chloride	1 13502	0 90468	0 83255	0 83872	0 84580	0 78784					
	0.74762	0.76236	0 77676	0.74071			AVRG		0 83721		13 92795

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
17 Carbon Disulfide	2 20075	2 11981	1.88277	1 79523	1 88022	1 76730					
	1 67343	1 74302	1 78882	1 64446			AVRG		1 84958		9 80937
18 trans-1,2-Dichloroethene	0 78555	0 56842	0 58340	0 56514	0 57398	0 55601					
	0 53183	0.55531	0 56421	0 53547			AVRG		0 58193		12 59538
19 Methyl-tertbutyl-Ether	2 28245	2 14903	1 91481	2 18307	1 89551	1 89007					
	1.84270	1 99114	1.81489	1 85944			AVRG		1 98231		8 26316
20 Propionitrile	+++++	7211	27311	137571	266196	513005					
	575968	737225	797201	921408			LINR	-0.91430	0 03996		0 99639
21 1,1-Dichloroethane	1 19219	1.18461	1.13140	1 15217	1 16733	1 08115					
SPCC	1 04834	1.06176	1 08656	1 04185			AVRG		1.11474 ✓		5 15971

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0.5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 000C Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
22 Vinyl Acetate	+++++	+++++	+++++	1 16663	0 97483	0 98209					
	0 91139	1 01019	0 91999	0.89843			AVRG		0 98051		9 37813
23 Chloroprene	1 61125	1 52289	1 39968	1.36119	1.38175	1 37581					
	1 33408	1 40442	1 29806	1 31349			AVRG		1 40026		6 91551
24 2-Butanone	+++++	+++++	0 06663	0 08200	0 06664	0 06760					
	0 06394	0 06471	0.06189	0 06231			AVRG		0 06696		9 58733
25 Hexane	+++++	+++++	1 10112	0 90278	0 87897	0.91777					
	0 85678	0 93909	0.88404	0 87087			AVRG		0 91893		8 51400
26 Di isopropyl ether	+++++	1 95993	2 00300	2.14124	2 01859	2.14966					
	2 08048	2 26011	2 13949	2 19542			AVRG		2.10532		4 63708

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
27 Methacrylonitrile	0 23359	0.20729	0 19319	0 23455	0 18650	0 19015					
	0.17933	0.19266	0 18063	0 18429			AVRG		0 19822		10 32909
28 cis-1,2-Dichloroethene	0 80976	0 67778	0 60731	0 61834	0 62234	0 58371					
	0.56775	0.58331	0 58879	0 56928			AVRG		0 62284		11 77140
29 Ethyl Acetate	+++++	+++++	0 50993	0.62095	0 48469	0 49652					
	0.46331	0 49626	0 46410	0.46647			AVRG		0 50028		10 34440
30 Bromochloromethane	0.31836	0 28607	0.25394	0 26470	0 25678	0 25194					
	0.23560	0 24426	0 25160	0 23783			AVRG		0 26011		9 61114
31 Chloroform	1 51683	1.55203	1 45438	1.49866	1 48146	1 42394					
CCC	1.36319	1 40411	1 42271	1 36895			AVRG		1 44863		4 35791

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1.0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
32 Isobutyl Alcohol	+++++	+++++	23413	114011	198506	391740					
	442144	575911	594159	706564			LINR	-2 89225	0 01500		0 99460
33 2,2-Dichloropropane	+++++	1.31032	1 37887	1 35423	1 34669	1 36457					
	1.32965	1 44527	1.34149	1.37835			AVRG		1 36105		2 83580
35 Tetrahydrofuran	+++++	5143	10920	53330	94602	184885					
	203372	258329	265848	314893			LINR	-0 12229	0 14874		0 99121
38 1,2-Dichloroethane	1 24921	1 11515	1 14250	1 28192	1 16162	1 18904					
	1 12710	1 19742	1 13528	1.09181			AVRG		1 16910		5 17177
39 1,1,1-Trichloroethane	1 39344	1 40195	1 41249	1 40532	1 45289	1 46608					
	1 44942	1 59038	1 49227	1 50028			AVRG		1 45645		4 14376

000122

579 735

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
40 1,1-Dichloropropene	0 78539	1 03347	1 07014	1 01623	1 07606	1 11313					
	1 09737	1 18493	1 11054	1 12931			AVRG		1 06166		10 20042
41 Carbon Tetrachloride	0 97561	1 22994	1 24340	1 22156	1 28722	1 30552					
	1.27958	1 38559	1 30473	1 30940			AVRG		1 25425		8 67767
42 Benzene	2 59514	2 41203	2 32159	2 35914	2 34827	2 56440					
	2 46750	2 69339	2 56099	2 62630			AVRG		2 49487		5 23450
44 Dibromomethane	+++++	0 35476	0 28376	0 29758	0.28363	0.25799					
	0 24944	0 24879	0 25399	0 24263			AVRG		0 27473		12 95917
45 1,2-Dichloropropane	7297	10623	38583	160933	348147	745024					
CCC	905115	1224880	1311472	1603968			LINR	0 03178	0 44088		0 99802 *

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0.5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20.0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
46 Trichloroethene	0.31903	0 38151	0 35613	0 34915	0 39549	0 38900					
	0 38826	0 41872	0 42159	0 42865			AVRG		0 38475		9 08655
47 Bromodichloromethane	0 89451	0 88106	0 72884	0 77406	0 83371	0 78902					
	0 76285	0 80018	0 81291	0 82013			AVRG		0 80972		6 31116
48 n-Propyl Acetate	+++++	0 90777	0 72879	0 91186	0 77493	0 73763					
	0 70481	0 72162	0 71432	+++++			AVRG		0 77522		11 04799
49 Methyl methacrylate	0 35778	0 29772	0 27226	0 31192	0 27570	0.26298					
	0 25066	0 25562	0 25442	+++++			AVRG		0.28212		12 41890
50 1,4-Dioxane	+++++	+++++	0 00213	0 00250	0 00212	0 00211					
	0 00163	0 00185	0 00189	0 00195			AVRG		0 00202		12 64790

579 737

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
51 2-Chloroethyl vinyl ether	0 46318	0 43932	0 40711	0 42489	0 41518	0 41236					
	0 40927	0.43683	0 43654	+++++			AVRG		0 42719		4 31357
52 cis-1,3-Dichloropropene	0 75249	0 74362	0.74201	0 78224	0 78754	0 77192					
	0 75908	0 78684	0 79784	0 80827			AVRG		0.77319		2 98331
53 4-Methyl-2-Pentanone	+++++	+++++	0 35179	0 44895	0.37317	0 35072					
	0.32949	0 32616	0 33053	0 31022			AVRG		0 35263		12 32745
54 trans-1,3-Dichloropropene	0 75208	0 74356	0 74225	0 78172	0 78818	0 77345					
	0 76036	0 78785	0 79909	0 80936			AVRG		0 77379		3 02569
55 1,1,2-Trichloroethane	0 30300	0 31762	0.26816	0 29007	0 27612	0 27746					
	0 26685	0 27587	0 27465	+++++			AVRG		0 28331		6 02039

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
57 Ethyl methacrylate	0 38603 0 26435	0.34188 0 26213	0 28251 +++++	0 33050 +++++	0 30630	0 28499	AVRG		0 30734		13 98490
58 Toluene CCC	+++++ 0 91111	1 00271 0.89894	0 90493 +++++	0 86658 +++++	1 03463	0.93028	AVRG		0 93560		6 47019
59 1,3-Dichloropropane	0.63725 0 66089	0 66591 0.67439	0 64153 0 68632	0 70454 0.65219	0 68861	0 69573	AVRG		0 67074		3 43633
60 2-Hexanone	+++++ 0.22576	+++++ 0.21712	0 25720 0 21428	0 31068 +++++	0 26247	0 24661	AVRG		0 24773		13 59865
61 Chlorodibromomethane	0 50203 0.52747	0.52890 0.53373	0 49010 0 55274	0 55313 0.52101	0.55746	0.54251	AVRG		0 53091		4 17921

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
62 1,2-Dibromoethane	0 39552 0 36790	0.39549 0.36305	0 37537 0 37583	0 41794 0 33774	0.40879	0 39651	AVRG		0 38341		6 24688
63 Tetrachloroethene	0.19233 0 29696	0 30325 0.29140	0.29176 0.32329	0 27120 0 30032	0.32742	0 30341	AVRG		0 29013		13 05700
64 1,1,1,2-Tetrachloroethane	+++++ 0 54182	0 54335 0 54883	0 58230 0.65558	0 52155 0 64874	0.53592	0 55279	AVRG		0 57010		8 64504
66 Chlorobenzene SPCC	1 05890 1.01007	1 25566 0.99428	1 17428 1 25318	0 99248 1 21050	1 12050	1 05930	AVRG		1 11291 ✓		9 39281
67 Ethylbenzene CCC	1 74969 2 13414	2 56861 2 05254	2 40716 2 60446	2 01587 2 47433	2 42833	2 21968	AVRG		2 26548		12 22237

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
68 Xylene-mp	0 60360	0 75785	0 67340	0 57146	0 68730	0 63820					
	0.61722	0 60609	0.77839	0.76653			AVRG		0 67000		11 24574
69 Bromoform	0 36943	0 39607	0.40389	0 41165	0 38148	0 38077					
	0.34227	0 31779	0.36001	0.33920			AVRG		0 37025		8 22824
70 trans-1,4-Dichloro-2-butene	0.14592	0 18709	0 17407	0.19092	0 17478	0 16392					
	0 14273	0 13051	0.14621	0 14369			AVRG		0 15998		13 08430
71 Styrene	0.81036	1 08909	1 04173	0 93641	1 10626	1 00111					
	0 91973	0.89650	1 12063	1 10483			AVRG		1 00266		10 70061
72 Xylene-o	0 50144	0 65308	0 62579	0 52625	0 64102	0 58383					
	0 54040	0 52615	0 66203	0.64818			AVRG		0 59082		10 54171

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5.0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
73 1,1,2,2-Tetrachloroethane	+++++	1 59624	1 45185	1 60788	1.37539	1 48269					
SPCC	1 19127	1 06849	+++++	+++++			AVRG		1 39626	✓	14 47894
74 cis-1,4-Dichloro-2-butene	0 19928	0 17842	0 16247	0 20635	0 19155	0.16723					
	0 13998	0 13724	0 15905	0 16510			AVRG		0 17067		13 66062
75 1,2,3-Trichloropropane	+++++	0.14772	0 16553	0 17729	0.15925	0.14515					
	0.12334	0 11355	0 12811	0 13230			AVRG		0 14358		14 69421
76 Isopropylbenzene	1 40794	2 18439	2 02261	1 74912	2 14397	1 88593					
	1 72477	1 65711	2 04836	2 04481			AVRG		1 88690		13 11885
78 Bromobenzene	0 32428	0 43247	0 40880	0 35072	0 41262	0 35664					
	0 32156	0.31000	0 38553	0 38589			AVRG		0 36885		11 53478

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170.0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
79 n-Propylbenzene	1.68468	2 43331	2.29228	1.97552	2 44480	2 08750					
	1 89285	1 89925	2 35420	2.41005			AVRG		2 14744		12 76753
80 2-Chlorotoluene	1 12855	1 51080	1 44798	1 34804	1 51636	1 31280					
	1 19329	1 20341	1 50704	1 52246			AVRG		1 36907		11 16736
81 4-Chlorotoluene	1 34676	1 84424	1.54293	1 31050	1 69607	1 40002					
	1 38036	1 38381	1.74914	1 75012			AVRG		1 54039		13 06099
82 1,3,5-Trimethylbenzene	1 15463	1 68178	1 52745	1 33067	1 61711	1 35826					
	1 28356	1 31779	1 65089	1.64547			AVRG		1 45676		12 96070
83 1,2,4-Trimethylbenzene	1 15463	1.68163	1 52672	1 33046	1.61316	1 35653					
	1 28329	1 31728	1 65089	1.64335			AVRG		1 45580		12 93714

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
85 tert-Butylbenzene	0.88345	1 32118	1 25739	1 10068	1 32638	1 06914					
	0 97760	1 02536	1 28607	1 29245			AVRG		1.15397		14 02882
86 sec-Butylbenzene	1.28241	1 63858	1 55179	1 32320	1 57622	1 31680					
	1 27939	1.34463	1 63575	1 64168			AVRG		1 45905		11 06080
87 4-Isopropyltoluene	1 02553	1.48552	1 39683	1 23142	1 48781	1 20241					
	1.24821	1 33876	1 50581	1 55013			AVRG		1 34724		12 50420
89 1,3-Dichlorobenzene	1 58074	1 82761	1 82239	1 66664	1 83163	1 78147					
	1.70187	1.70692	1.78911	1 69926			AVRG		1 74076		4 76556
90 1,4-Dichlorobenzene	1 57767	1 80135	1.70133	1 64271	1.81991	2 01347					
	1.77132	1.78304	1 84000	1.79476			AVRG		1 77456		6 67126

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0.5000000 Level 1 / 120.0000 Level 7	1 0000 Level 2 / 150.0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
91 1,2-Dichlorobenzene	1 23750	1 47416	1 48686	1 39324	1.54128	1.50371					
	1 52947	1 49325	1 46298	1.45396			AVRG		1 45764		6 02103
92 n-Butylbenzene	3.58801	4.66035	4 51314	4 16597	4 71826	4 48822					
	4 72781	4 47856	4.17029	4.17003			AVRG		4 36806		8 05022
93 1,2-Dibromo-3-chloropropane	+++++	0 31440	0 25562	0 28938	0 23961	0 25904					
	0.30954	0.22941	0 21761	+++++			AVRG		0 26433		13 78662
94 1,2,4-Trichlorobenzene	0.87541	1 14315	0 98734	0 95564	0.90561	1 03492					
	0 98720	0.87113	1 00133	0.94941			AVRG		0 97111		8.35577
95 Naphthalene	+++++	2 12450	1 84039	1 89714	1 58628	1 87569					
	1 81938	1.65011	1 77183	1 77037			AVRG		1 81508		8 49599

579 745

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200.0000 Level 10	50 0000 Level 5	100 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
96 Hexachlorobutadiene	0 67157	0 76412	0 78837	0.72793	0 73388	0.87648					
	0 87078	0 69055	0 84673	0.80509			AVRG		0 77755		9.34253
97 1,2,3-Trichlorobenzene	0 80133	1 02377	0 83089	0 86284	0 77550	0 89551					
	0 87515	0.79183	0 85755	0 84983			AVRG		0 85642		8 19909
$ 34 Dibromofluoromethane	0 80510	0 77296	0 79000	0 74821	0 75013	0.74329					
	0 71352	0 71483	0 71420	0.70336			AVRG		0 74556		4 69742
$ 37 1,2-Dichloroethane-d4	1 05576	1 01901	1 03513	1 08782	0 99974	1 01257					
	0 98882	1 03578	0 97850	0 95156			AVRG		1 01647		3 89081
$ 56 Toluene-d8	1 54328	1.64415	1 47182	1 35252	1 61240	1 50338					
	1 46015	1 36120	1 51921	1 43087			AVRG		1 48990		6 43868

Environmental Testing and Consulting, Inc.

. INITIAL CALIBRATION DATA

Start Cal Date : 27-DEC-2001 15:52
End Cal Date : 27-DEC-2001 21:05
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\CHEM\voc4.i\V412271.B\v412271.8260.m
Cal Date : 28-Dec-2001 08:45 mike

Compound	0 5000000 Level 1 / 120 0000 Level 7	1 0000 Level 2 / 150 0000 Level 8	5 0000 Level 3 / 170 0000 Level 9	20 0000 Level 4 / 200 0000 Level 10	50.0000 Level 5	100.0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
$ 77 Bromofluorobenzene	0 66422	0 76562	0.70296	0.59667	0 71372	0 63301					
	0.58695	0 53297	0.66750	0 68387			AVRG		0 65475		10 49105

Curve	Formula	Units
Averaged	Amt = Rsp/m1	Response
Linear	Amt = b + Rsp/m1	Response

579 748

Environmental Testing & Consulting, Inc.

Quality Control Reports
Level IV
GC/MS Semi-Volatiles

ENVIRONMENTAL TESTING & CONSULTING, INC
GC/MS BNA Sequence Check List (SW-846)

579 749

Sequence ID B1010301
Date 1/4/02
System ID BNA 1
Analyst ESM

Applicable ETC Order Nos. for this sequence:

0112600 0112638
0112602 0112623

Validated

1. DFTPP Daily 12-Hour Tune Meets Criteria. No analysis begins until criteria are met. (SOP) ✓
2. Degradation/Peak Tailing Check (may be combined with DFTPP Tune): ✓
   a. DDT to DDE/DDD <=20% Benzidine/PCP – Normal Response with no visible peak tailing. ✓

2. Initial Calibration Verification Criteria - Method : B1122901.M
   a. SPCC – Mean RF >=0.050 ✓
   b. CCC – RSD of RF for CCCs and Target Analytes MUST BE <=30% ✓
   c. RSD of analytes <=15% may use Average RF for quantitation ✓
   d. Analytes w/RSD >15% use Linear Regression – correlation coefficient >=0.99 ✓

3. Calibration Verification – Each 12-Hour Shift
   a. SPCC – RF >=0.050 ✓
   b. CCC - % Difference for Average RF Calibration - <=20% ✓
   c. CCC - % Drift for Linear Regression Calibration - <=20% ✓
   d. % Difference/% Drift for all other Target Analytes - <=30% ESM ~~✗~~ ✓
   * Benzidine, 3,3 Dimethylbenzidine, ~~Nitrobenzene~~, 4 Nitroaniline all high response
   e. Internal Standards – Retention Times within +/- 30 seconds from Mid-Point ICAL STD ✓
   f. Internal Standards – Areas within (-50% to +100%) from Mid-Point ICAL STD ✓

3. Method Blanks included in this sequence : ✓
   Analyze for each analytical batch (20 samples): ________
   List compounds identified in Method Blank w/concentration.
   Flag final result "B-Detected in Blank"
   V070122B – OK

4. Matrix Spike/Matrix Spike Duplicates included in this sequence :
   Analyze for each analytical batch (20 samples) . List MS/MSD(s) performed with any failures : NA

5. Laboratory Control Samples included in this sequence : ✓
   Must contain all Target Analytes.
   V07012 LCS/LCSD ⇒ 2 of 166 spike recoveries outside limits
   26 of 83 RPDS

6. Surrogate Recoveries within QC Limits ✓

7. All positive compounds within calibration range ✓

Narrative/Notes :

H:\QAQC\QCPACK\CHKLIST\GCBNA DOC

579 750

DFTPP TUNE/TAILING FACTOR/DEGRADATION SUMMARY RESULTS

DFTPP Ion Abundance/Ratio Criteria Chart

Ion	Abundance Criteria	Base Peak	Other	Test
198	Base Peak, 100% relative abundance	100.00		PASS
51	30 - 60% of mass 198	51.39		PASS
68	Less than 2% of mass 69	0.00	(0.00)	PASS
69	Mass 69 relative abundance	58.23		PASS
70	Less than 2% of mass 69	0.31	(0.52)	PASS
127	40 - 60% of mass 198	55.79		PASS
197	0 - 1% of mass 198	0.00		PASS
199	5 - 9% of mass 198	7.06		PASS
275	10 - 30% of mass 198	27.41		PASS
365	Greater than 1% of mass 198	3.50		PASS
441	Present, but less than mass 443	12.39	(78.76)	PASS
442	Greater than 40% of mass 198	78.30		PASS
443	17 - 23% of mass 442	15.73	(20.09)	PASS

TAILING ANALYSIS SUMMARY

Compound	Tail Factor	Max Allowed	Test
Pentachlorophenol	0.6489362	5.000	PASS
Benzidine	1.1582915	3.000	PASS

DDT DEGRADATION BREAKDOWN ANALYSIS SUMMARY

Compound	Response	%Breakdown	Max Allowed	Test
4,4-DDT	633398			N/A
4,4-DDE	0	0.0	15.0	PASS
4,4-DDD	26453	4.0	15.0	PASS
4,4-DDD + DDE	26453	4.0	15.0	PASS

****
Tuning Sample, //ETCBDC/DD/chem/bna1.i/B1010301.B/0101001.D/0101001.D,*** PASSED **
****

FORM 5
SEMIVOLATILE ORGANIC INSTRUMENT PERFORMANCE CHECK
DECAFLUOROTRIPHENYLPHOSPHINE (DFTPP)

579 751

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID: 0101001 DFTPP Injection Date: 01/03/02

Instrument ID: BNA1 DFTPP Injection Time: 1530

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
51	30.0 - 60.0% of mass 198	51.4
68	Less than 2.0% of mass 69	0.0 (0.0)1
69	Mass 69 relative abundance	58.2
70	Less than 2.0% of mass 69	0.3 (0.5)1
127	40.0 - 60.0% of mass 198	55.8
197	Less than 1.0% of mass 198	0.0
198	Base Peak, 100% relative abundance	100.0
199	5.0 to 9.0% of mass 198	7.1
275	10.0 - 30.0% of mass 198	27.4
365	Greater than 1.0% of mass 198	3.50
441	Present, but less than mass 443	12.4
442	Greater than 40.0% of mass 198	78.3
443	17.0 - 23.0% of mass 442	15.7 (20.1)2

1-Value is % mass 69 2-Value is % mass 442

THIS CHECK APPLIES TO THE FOLLOWING SAMPLES, MS, MSD, BLANKS, AND STANDARDS:

	EPA SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	DATE ANALYZED	TIME ANALYZED
01	8270 CV1		0202004	01/03/02	1653
02	P07012LB	P07012LB	0301005	01/03/02	1715
03	P07012LCS	P07012LCS	0401006	01/03/02	1737
04	P07012LCSD	P07012LCSD	0501007	01/03/02	1758
05	011260202	011260202	0601008	01/03/02	1820
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

579 752

FORM 7
BNA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: BNA1 Calibration Date: 01/03/02 Time: 1653

Lab File ID: 0202004 Init. Calib. Date(s): 12/29/01 12/29/01

Init. Calib. Times: 0923 1217

GC Column: DB-5MS ID: 0.25 (mm)

COMPOUND	SAMPLE AMOUNT	CAL50 AMOUNT	CURVE	%D	MAX %d	
Acenaphthene	51.27	50.00	AVRG	2.5	20.0	
Acenaphthylene	53.27	50.00	AVRG	6.5	30.0	
Acetophenone	54.14	50.00	AVRG	8.3	30.0	
Aniline	57.24	50.00	AVRG	14.5	30.0	
Anthracene	51.73	50.00	AVRG	3.5	30.0	
Benzidine	94.02	50.00	LINR	88.0	35.0	<-
Benz(a)Anthracene	50.93	50.00	AVRG	1.9	30.0	
Benzo(b)fluoranthene	53.12	50.00	AVRG	6.2	30.0	
Benzo(k)fluoranthene	54.45	50.00	AVRG	8.9	30.0	
Benzo(ghi)perylene	48.92	50.00	AVRG	2.2	30.0	
Benzo(a)pyrene	55.99	50.00	AVRG	12.0	20.0	
Benzoic acid	48.46	50.00	LINR	3.1	35.0	
Benzyl alcohol	55.05	50.00	AVRG	10.1	30.0	
Bis(2-chloroethoxy)methane	53.67	50.00	AVRG	7.3	30.0	
Bis(2-chloroethyl)ether	54.97	50.00	AVRG	9.9	30.0	
Bis(2-chloroisopropyl)ether	55.98	50.00	AVRG	12.0	30.0	
Bis(2-ethylhexyl)phthalate	48.54	50.00	AVRG	2.9	30.0	
4-Bromophenyl phenyl ether	55.45	50.00	AVRG	10.9	30.0	
Butyl benzyl phthalate	48.86	50.00	AVRG	2.3	30.0	
Carbazole	59.31	50.00	LINR	18.6	30.0	
4-Chloroaniline	51.57	50.00	AVRG	3.1	30.0	
Chlorobenzilate	44.92	50.00	AVRG	10.2	35.0	
4-Chloro-3-methylphenol	52.95	50.00	AVRG	5.9	20.0	
2-Chloronaphthalene	53.25	50.00	AVRG	6.5	30.0	
2-Chlorophenol	53.98	50.00	AVRG	8.0	30.0	
4-Chlorophenyl phenyl ether	49.73	50.00	AVRG	0.5	30.0	
Chrysene	51.22	50.00	AVRG	2.4	30.0	
Dibenz(a,h)anthracene	52.63	50.00	AVRG	5.3	30.0	
Dibenzofuran	50.90	50.00	AVRG	1.8	30.0	
Di-n-butyl phthalate	45.94	50.00	AVRG	8.1	30.0	
1,2-Dichlorobenzene	53.80	50.00	AVRG	7.6	30.0	
1,3-Dichlorobenzene	52.61	50.00	AVRG	5.2	30.0	
1,4-Dichlorobenzene	53.16	50.00	AVRG	6.3	20.0	
3,3'-Dichlorobenzidine	62.74	50.00	AVRG	25.5	30.0	
2,4-Dichlorophenol	53.38	50.00	AVRG	6.8	20.0	
2,6-Dichlorophenol	55.09	50.00	AVRG	10.2	30.0	
Diethyl phthalate	49.08	50.00	2ORDR	1.8	30.0	

FORM 7
BNA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: BNA1 Calibration Date: 01/03/02 Time: 1653

Lab File ID: 0202004 Init. Calib. Date(s): 12/29/01 12/29/01

Init. Calib. Times: 0923 1217

GC Column: DB-5MS ID: 0.25 (mm)

COMPOUND	SAMPLE AMOUNT	CAL50 AMOUNT	CURVE	%D	MAX %d	
3,3-Dimethylbenzidine	80.45	50.00	2ORDR	60.9	35.0	<-
2,4-Dimethyphenol	54.92	50.00	AVRG	9.8	30.0	
Dimethyl phthalate	48.59	50.00	AVRG	2.8	30.0	
4,6-Dinitro-2-methylphenol	48.02	50.00	LINR	4.0	30.0	
2,4-Dinitrophenol	47.42	50.00	2ORDR	5.2	30.0	
2,4-Dinitrotoluene	43.66	50.00	AVRG	12.7	30.0	
2,6-Dinitrotoluene	44.13	50.00	AVRG	11.7	30.0	
N-NitrsdiphylAm/Diphenylamin	57.83	50.00	AVRG	15.7	20.0	
Di-n-octyl phthalate	50.78	50.00	2ORDR	1.6	20.0	
Ethyl methanesulfonate	52.36	50.00	AVRG	4.7	30.0	
Fluoranthene	51.39	50.00	LINR	2.8	20.0	
Fluorene	50.04	50.00	AVRG	0.1	30.0	
Hexachlorobenzene	54.82	50.00	AVRG	9.6	30.0	
Hexachlorobutadiene	52.07	50.00	AVRG	4.1	20.0	
Hexachlorocyclopentadiene	49.53	50.00	AVRG	0.9	30.0	
Hexachloroethane	52.69	50.00	AVRG	5.4	30.0	
Indeno(1,2,3-cd)pyrene	51.85	50.00	AVRG	3.7	30.0	
Isophorone	54.00	50.00	AVRG	8.0	30.0	
Methyl methanesulfonate	52.50	50.00	AVRG	5.0	30.0	
2-Methylnaphthalene	52.54	50.00	AVRG	5.1	30.0	
2-Methylphenol	56.08	50.00	AVRG	12.2	30.0	
3&4-Methylphenol	55.00	50.00	AVRG	10.0	30.0	
Naphthalene	57.99	50.00	2ORDR	16.0	30.0	
2-Nitroaniline	50.24	50.00	AVRG	0.5	30.0	
3-Nitroaniline	43.56	50.00	2ORDR	12.9	30.0	
4-Nitroaniline	30.43	50.00	AVRG	39.1	30.0	<-
Nitrobenzene	52.64	50.00	AVRG	5.3	30.0	
2-Nitrophenol	52.02	50.00	AVRG	4.0	20.0	
4-Nitrophenol	42.65	50.00	AVRG	14.7	30.0	
N-Nitrosodibutylamine	53.89	50.00	AVRG	7.8	30.0	
N-Nitrosodiethylamine	53.70	50.00	AVRG	7.4	30.0	
N-Nitrosodimethylamine	53.58	50.00	AVRG	7.2	30.0	
N-Nitrosodi-n-propylamine	53.84	50.00	AVRG	7.7	30.0	
Pentachloronitrobenzene	53.59	50.00	AVRG	7.2	30.0	
Pentachlorophenol	47.27	50.00	LINR	5.5	20.0	
Phenacetin	47.47	50.00	AVRG	5.1	35.0	
Phenanthrene	51.32	50.00	AVRG	2.6	30.0	

579 754

FORM 7
BNA-GCMS CONTINUING CALIBRATION CHECK

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Instrument ID: BNA1 Calibration Date: 01/03/02 Time: 1653

Lab File ID: 0202004 Init. Calib. Date(s): 12/29/01 12/29/01

Init. Calib. Times: 0923 1217

GC Column: DB-5MS ID: 0.25 (mm)

COMPOUND	SAMPLE AMOUNT	CAL50 AMOUNT	CURVE	%D	MAX %d
Phenol	54.84	50.00	AVRG	9.7	20.0
Pyrene	50.32	50.00	LINR	0.6	30.0
Pyridine	56.01	50.00	AVRG	12.0	30.0
1,2,4,5-Tetrachlorobenzene	56.29	50.00	AVRG	12.6	30.0
2,3,4,6-Tetrachlorophenol	54.74	50.00	AVRG	9.5	30.0
1,2,4-Trichlorobenzene	51.94	50.00	AVRG	3.9	30.0
2,4,5-Trichlorophenol	53.68	50.00	AVRG	7.4	30.0
2,4,6-Trichlorophenol	54.10	50.00	AVRG	8.2	20.0
1,2-Dphnylhydrzine/Azobenzen	59.99	50.00	AVRG	20.0	30.0
Nitrobenzene-d5	51.58	50.00	AVRG	3.2	30.0
2-Fluorobiphenyl	52.64	50.00	AVRG	5.3	30.0
Terphenyl-d14	41.71	50.00	AVRG	16.6	30.0
Phenol-d6	54.49	50.00	AVRG	9.0	30.0
2,4,6-Tribromophenol	48.67	50.00	2ORDR	2.7	30.0
2-Fluorophenol	54.03	50.00	AVRG	8.1	30.0

FORM 8
BNA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC, INC.   Contract:

Lab Code: Case No.:   SAS No.:   SDG No.: 0112602

Lab File ID (Standard): 0202004   Date Analyzed: 01/03/02

Instrument ID: BNA1   Time Analyzed: 1653

		IS1 (DCB) AREA #	RT #	IS2 (NPT) AREA #	RT #	IS3 (ANT) AREA #	RT #
	12 HOUR STD	346727	4.92	1416790	5.62	711030	6.54
	UPPER LIMIT	693454	5.42	2833580	6.12	1422060	7.04
	LOWER LIMIT	173364	4.42	708395	5.12	355515	6.04
	CLIENT SAMPLE NO.						
01	P07012LB	376748	4.92	1469844	5.62	766544	6.54
02	P07012LCS	371537	4.92	1501251	5.62	799930	6.54
03	P07012LCSD	343126	4.92	1424814	5.62	775332	6.54
04	011260202	380079	4.92	1498039	5.61	800695	6.54
05							
06							
07							
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09							
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15							
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19							
20							
21							
22							

IS1 (DCB) = 1,4-Dichlorobenzene-d4
IS2 (NPT) = Naphthalene-d8
IS3 (ANT) = Acenaphthene-d10

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag internal standard area values with an asterisk.
* Values outside of QC limits.

FORM 8
BNA-GCMS INTERNAL STANDARD AREA AND RT SUMMARY

Lab Name: ETC, INC. Contract:

Lab Code: Case No.: SAS No.: SDG No.: 0112602

Lab File ID (Standard): 0202004 Date Analyzed: 01/03/02

Instrument ID: BNA1 Time Analyzed: 1653

		IS4 (PHN) AREA #	RT #	IS5 (CRY) AREA #	RT #	IS6 (PRY) AREA #	RT #
	12 HOUR STD	893683	7.34	429908	9.22	314353	11.32
	UPPER LIMIT	1787366	7.84	859816	9.72	628706	11.82
	LOWER LIMIT	446842	6.84	214954	8.72	157177	10.82
	CLIENT SAMPLE NO.						
01	P07012LB	1153015	7.33	568860	9.22	422035	11.32
02	P07012LCS	1052824	7.34	423850	9.22	305307	11.32
03	P07012LCSD	1240652	7.33	676327	9.22	467140	11.32
04	011260202	1318309	7.33	1146153*	9.22	879786*	11.32
05							
06							
07							
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21							
22							

IS4 (PHN) = Phenanthrene-d10
IS5 (CRY) = Chrysene-d12
IS6 (PRY) = Perylene-d12

AREA UPPER LIMIT = +100% of internal standard area
AREA LOWER LIMIT = - 50% of internal standard area
RT UPPER LIMIT = + 0.50 minutes of internal standard RT
RT LOWER LIMIT = - 0.50 minutes of internal standard RT

Column used to flag internal standard area values with an asterisk.
* Values outside of QC limits.

Report Date : 30-Dec-2001 07:49

M Huffman 12/30/01

12/30/01

QC REVIEWED 01-02-01

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Calibration File Names:
Level 1: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0301004.D
Level 2: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0401005.D
Level 3: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0501006.D
Level 4: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0601007.D
Level 5: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0701008.D
Level 6: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0801009.D
Level 7: \\ETCBDC\DD\chem\bna1.i\B1122901.B\0901010.D
Level 8: \\ETCBDC\DD\chem\bna1.i\B1122901.B\1001011.D
Level 9: \\ETCBDC\DD\chem\bna1.i\B1122901.B\1101012.D

Compound	2.0000 Level 1	5 0000 Level 2	10.0000 Level 3	20.0000 Level 4	50 0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
	100 0000 Level 7	120 0000 Level 8	160.0000 Level 9								
1 N-Nitrosodimethylamine	1 04884	0.93712	1.03457	1.00166	1 02904	1.02163					
	1 03766	1.05563	1 01488				AVRG		1 02012		3 45554

579 757

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160.0000 Level 9	20 0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
2 Pyridine	+++++	1 43280	1 72363	1 65532	1 76527	1 68137					
	1 69294	1 75408	1.61437				AVRG		1 66497		6 38243
3 Methyl methanesulfonate	1 04235	0 92294	0 97342	0 93460	0.95507	0 91024					
	0 88537	0.86474	0 84805				AVRG		0 92631		6 43696
5 N-Nitrosodiethylamine	0.70157	0.64117	0 69052	0.68019	0 69401	0 69838					
	0 69613	0 69405	0.69228				AVRG		0.68759		2 67559
6 Ethyl methanesulfonate	1.35135	1.18432	1 28599	1 22674	1.26063	1.22301					
	1.21156	1.17809	1.18516				AVRG		1 23410		4 60519
8 Phenol CCC	2.00719	1.80142	1 93396	1 84809	1.87267	1 79157					
	1.74344	1.70229	1 62486				AVRG		1.81394		6 47057

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Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10.0000 Level 3 / 160.0000 Level 9	20 0000 Level 4	50.0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
9 Aniline	0 89399	0.78565	0.87063	0.81094	0.85821	0 78543					
	0 77746	0 80010	0 75319				AVRG		0.81507		5 88484
10 Bis(2-chloroethyl)ether	1 42424	1.25116	1.32704	1.24316	1.19152	1.13644					
	1.12145	1.12037	1 02691				AVRG		1 20470		10 05076
11 2-Chlorophenol	1 39601	1.30045	1 41809	1 35297	1.40772	1.36910					
	1 36153	1.34933	1 34017				AVRG		1 36615		2.68892
12 1,3-Dichlorobenzene	1 70742	1.51783	1 60018	1 48482	1.47102	1 43137					
	1.43187	1.42023	1.29452				AVRG		1 48436		7 90640
14 1,4-Dichlorobenzene CCC	1 80844	1.54944	1.65176	1 51573	1 49167	1 45818					
	1 42334	1 42585	1 30099				AVRG		1 51393		9 68273

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Environmental Testing and Consulting, Inc.

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Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10.0000 Level 3 / 160.0000 Level 9	20 0000 Level 4	50 0000 Level 5	80.0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
15 Benzyl alcohol	0 84064 0 94389	0 78894 0.98926	0 89018 0.94588	0 89138	0 97853	0.93965	AVRG		0.91204		7 19630
16 1,2-Dichlorobenzene	1 59567 1.27472	1 43727 1 24664	1.51230 +++++	1 42184	1 39616	1 32228	AVRG		1.40086		8.44769
17 2-Methylphenol	1.22098 1.11133	1 15090 1.06411	1.19314 0.95048	1 16486	1.21476	1.15328	AVRG		1 13598		7.51071
18 Bis(2-chloroisopropyl)ether	2 41978 1.82823	2.08314 1.80768	2.16380 +++++	2 00510	1.96433	1 85531	AVRG		2 01592		10 21189
19 3&4-Methylphenol	1 29043 1.34404	1.22313 1.33131	1.34310 1 31450	1.30235	1.40962	1.37485	AVRG		1.32592		4.00533

Environmental Testing and Consulting, Inc.

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Compound	2.0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10.0000 Level 3 / 160.0000 Level 9	20 0000 Level 4	50 0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
20 Acetophenone	0.54981	0.49946	0.52929	0.49192	0 49351	0.47441					
	0.46648	0 44830	0 39916				AVRG		0 48359		9 14445
21 N-Nitrosodi-n-propylamine	0 30459	0 27732	0 30513	0 27898	0.27778	0 27564					
SPCC	0 27514	0.27014	0.23320				AVRG		0 27755		7 56393
22 Hexachloroethane	0.19336	0 16578	0 18154	0 16608	0.16167	0.16045					
	0.16149	0.15773	0.14180				AVRG		0.16555		8.83758
24 Nitrobenzene	0 50372	0 45587	0.47882	0.43615	0.42792	0.40623					
	0 40449	0.39892	0.34988				AVRG		0 42911		10 78159
25 Isophorone	0.72671	0.68767	0 75532	0 71231	0 69226	0 66542					
	0.67694	0 66139	0 59741				AVRG		0.68616		6 54943

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Report Date : 30-Dec-2001 07:49

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50 0000 Level 5	80 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
26 2-Nitrophenol CCC	0.17503	0 17395	0 19168	0.19807	0 19084	0.19467					
	0.19688	0 19378	0.18588				AVRG		0.18898		4.73772
27 2,4-Dimethyphenol	0 36335	0 32821	0.36590	0.34212	0 36280	0 35156					
	0.35139	0.33698	0.31524				AVRG		0.34640		4.99670
28 Bis(2-chloroethoxy)methane	0.49403	0 43305	0.46437	0 43086	0 42598	0 40812					
	0.40717	0 39512	0.35577				AVRG		0 42383		9.39735
29 Benzoic acid	+++++	14454	50244	144724	526754	965494					
	1194182	1371658	2005506				LINR	0.15137	0.29894		0 99888
30 2,4-Dichlorophenol CCC	0 23448	0.23402	0.25669	0 24651	0 26077	0.26834					
	0.26469	0 26257	0.24654				AVRG		0.25273		5.09097

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Compound	2 0000 Level 1 / 100.0000 Level 7	5.0000 Level 2 / 120.0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20.0000 Level 4	50 0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
31 1,2,4-Trichlorobenzene	0 33718	0.30132	0.31490	0.29308	0.29564	0.29511					
	0.29879	0 29048	0.26455				AVRG		0.29901		6 51572
33 Naphthalene	89650	220501	419481	842154	1973906	2894103					
	3281729	+++++	+++++				QUAD	0.03106	0 62124	0 34194	0 99892
34 4-Chloroaniline	0 53810	0.51524	0.54594	0.49563	0 49899	0.44028					
	0 42280	0.40879	+++++				AVRG		0 48322		10 89651
35 2,6-Dichlorophenol	0 25497	0 23499	0 25655	0.25010	0 25775	0.25053					
	0.25081	0.23893	0.21296				AVRG		0 24529		5 85233
36 Hexachlorobutadiene ccc	0 17964	0 15766	0 16557	0 15701	0 16093	0 16233					
	0 16419	0 16091	0 14253				AVRG		0 16120		5 99914

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Cal Date : 30-Dec-2001 07:39 erica

Compound	2.0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
37 N-Nitrosodibutylamine	0 25214	0 24384	0 27090	0 26072	0.26706	0.25452					
	0 25798	0 25625	0 24135				AVRG		0 25608		3 78105
38 4-Chloro-3-methylphenol	0 27489	0.26942	0.29961	0 29540	0 31222	0.29750					
CCC	0.30012	0 29674	0.27798				AVRG		0 29154		4 84159
39 2-Methylnaphthalene	0.74927	0.66329	0 71020	0.67054	0.66785	0 59177					
	0.58368	0.56821	+++++				AVRG		0.65060		9 87106
40 Hexachlorocyclopentadiene	0 21832	0.22081	0.23490	0 23726	0 25578	0 28690					
SPCC	0 27379	0.25944	0.25233				AVRG		0 24884		9.30494
41 1,2,4,5-Tetrachlorobenzene	0.53599	0 49378	0.52200	0.48346	0.50704	0 52969					
	0.51402	0.48653	0.46505				AVRG		0.50417		4 68589

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

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Cal Date : 30-Dec-2001 07:39 erica

Compound	2.0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
42 2,4,6-Trichlorophenol CCC	0 28768 0 36871	0 28640 0 35842	0.33669 0.35445	0.32272	0.35332	0 37002	AVRG		0.33760		9 55169
43 2,4,5-Trichlorophenol	0 30782 0 38863	0 31360 0 38581	0 35899 +++++	0.34343	0 38230	0.38661	AVRG		0.35840		9 32675
45 2-Chloronaphthalene	1 21608 1 01888	1 10443 0 98427	1 19520 +++++	1 10791	1 09396	1.06170	AVRG		1 09780		7 22657
46 2-Nitroaniline	+++++ 0.36819	0 34598 0 40365	0.40339 0 39128	0 39306	0 41293	0.35817	AVRG		0.38458		6.28858
47 Dimethyl phthalate	1 36985 1 06580	1.22283 1 09044	1.33941 +++++	1 23800	1.20336	1.06974	AVRG		1.19993		9.82260

Environmental Testing and Consulting, Inc.

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Compound	2 0000 Level 1 / 100.0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20.0000 Level 4	50 0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
48 2,6-Dinitrotoluene	+++++	+++++	0.20660	0 19009	0 18591	0.14532					
	0.15243	0 16904	+++++				AVRG		0.17490		13.46124
49 Acenaphthylene	1.69609	1.55646	1.69896	1 56630	1 49894	1.37528					
	1 32663	1.27253	+++++				AVRG		1 49890		10 78603
50 3-Nitroaniline	8229	24327	53924	111983	218557	372343					
	543347	793139	+++++				QUAD	-0 10013	5 98532	-2 80429	0 99571
52 Acenaphthene CCC	1 27094	1 10877	1 19092	1.08445	1 05220	0 97181					
	0.95799	0 92318	+++++				AVRG		1.07003		11 21308
53 2,4-Dinitrophenol SPCC	+++++	14340	32312	72265	193546	236053					
	308755	402256	530311				QUAD	-0 07037	7.34498	-0.96727	0.99125 *

$*\overline{RF} = 0.154$

Environmental Testing and Consulting, Inc.

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Compound	2 0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120 0000 Level 8	10 0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
54 4-Nitrophenol SPCC	+++++	0.16766	0 21551	0.21715	0.23653	0 17886					
	0 18833	0 21335	0 22398				AVRG		0 20517		11 70546
55 Dibenzofuran	1.69016	1 49716	1 66071	1 54207	1.53559	1 31761					
	1 28632	1 28118	+++++				AVRG		1 47635		11 08186
56 2,4-Dinitrotoluene	+++++	0 31470	0 37098	0.34184	0.35132	0.28599					
	0.30723	0.34970	0.34999				AVRG		0 33397		8 48796
57 2,3,4,6-Tetrachlorophenol	0 18958	0 21033	0.25521	0.25648	0.28376	0.24846					
	0 24468	0 24241	0.22356				AVRG		0.23939		11.63547
58 Diethyl phthalate	47606	126560	258262	539294	1297889	1654469					
	2019296	2419116	2762912				QUAD	0.02042	0 59505	0.20610	0.99608

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Environmental Testing and Consulting, Inc.

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Compound	2 0000 Level 1 / 100 0000 Level 7	5.0000 Level 2 / 120 0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
59 Fluorene	1.35747	1 21264	1 32510	1 23247	1.20985	1 04582					
	1 01658	1 00766	+++++				AVRG		1.17595		11 65705
60 4-Chlorophenyl phenyl ether	0 61946	0 54083	0.60236	0.56766	0.59045	0 54480					
	0 54390	0.56788	0 52236				AVRG		0.56663		5 66934
61 4-Nitroaniline	0 29500	0 33282	0 40178	0 34399	0 27432	+++++					
	+++++	+++++	+++++				AVRG		0 32958		14 92661
62 4,6-Dinitro-2-methylphenol	+++++	13468	32603	73585	218665	266900					
	363368	444941	+++++				LINR	0 02265	0.11894		0.99337
63 N-NitrsdiphylAm/Diphenylamine	0 52767	0 47854	0.51073	0.48944	0.50223	0 55036					
	0 53485	0.50832	0 44502				AVRG		0.50524		6 28014

ccc

Environmental Testing and Consulting, Inc.

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Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2 0000 Level 1 / 100 0000 Level 7	5.0000 Level 2 / 120.0000 Level 8	10 0000 Level 3 / 160.0000 Level 9	20.0000 Level 4	50.0000 Level 5	80 0000 Level 6	Curve	Coefficients b	Coefficients m1	Coefficients m2	%RSD or R^2
64 1,2-Dphnylhydrzine/Azobenzene	1.08326	0 97774	1.04007	0 97693	0 94297	1 02556					
	0.92820	0 82189	+++++				AVRG		0.97458		8 24345
66 Phenacetin	0.21878	0.26844	0 32831	0.30147	0.31126	0.28227					
	0 28779	0.29296	0.29426				AVRG		0 28728		10 73828
67 4-Bromophenyl phenyl ether	0.20844	0.18876	0 20204	0.19772	0.21190	0 23772					
	0 23692	0.23241	0.20543				AVRG		0.21348		8 40941
68 Hexachlorobenzene	0 24408	0 21190	0 22761	0.21791	0.23686	0.26006					
	0.25793	0 25612	0 22766				AVRG		0 23779		7.50802
69 Pentachlorophenol CCC	+++++	13332	32265	77784	242837	303727					
	425310	572174	765997				LINR	0.05832	0 14202		0 99748 *

* %RSD = 19.1

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000156

Environmental Testing and Consulting, Inc.

INITIAL CALIBRATION DATA

Start Cal Date : 29-DEC-2001 09:23
End Cal Date : 29-DEC-2001 12:17
Quant Method : ISTD
Target Version : 4.00
Integrator : HP RTE
Method file : \\ETCBDC\DD\chem\bna1.i\B1122901.B\B1122901.M
Cal Date : 30-Dec-2001 07:39 erica

Compound	2.0000 Level 1 / 100 0000 Level 7	5 0000 Level 2 / 120.0000 Level 8	10.0000 Level 3 / 160 0000 Level 9	20 0000 Level 4	50.0000 Level 5	80.0000 Level 6	Curve	Coefficients b	m1	m2	%RSD or R^2
70 Pentachloronitrobenzene	0 08183	0 07956	0 09042	0 08317	0 08483	0.08329					
	0 08139	0 07782	0 07026				AVRG		0 08140		6 73465
72 Phenanthrene	1 20967	1 04885	1.13383	1 01594	0 96868	0 94290					
	0.89258	0 81349	+++++				AVRG		1 00324		12 77563
73 Anthracene	1 07508	0 97889	1.05256	0 98344	0.93863	0 89787					
	0 86726	0 79504	+++++				AVRG		0 94860		9 90563
74 Carbazole	48159	137071	282271	546099	1191542	1196678					
	1659683	2303540	+++++				LINR	-0 11260	0.54979		0 99291
75 Di-n-butyl phthalate	1 16079	1 13999	1.25184	1 08524	0 99000	0 90114					
	0 87484	+++++	+++++				AVRG		1 05769		13 28025

Attachment I

TABLE I-1

HELP Model Input Parameters
Dunn Field, Memphis Depot

Weather Data

1 Evapotranspiration

Location·	Memphis, Tennessee
Evaporative Zone Depth	18 inches
Mximum leaf area index·	3.5

2. Precipitation

Default Precipitation:	Memphis, Tennessee

3. Temperature

Default Temperature:	Memphis, Tennessee

4. Solar Radiation Data

Default Radiation:	Memphis, Tennessee

Soil and Design Data

1. Dunn Field Area: 13 Acres

2 Percent of landfill area where runoff is possible: 95%

3. Method of initialization of moisture storage: No

4. Layer Data

Layer Type	Layer Thickness (inches)	Soil Texture Number
1	18	8
1	342	8
1	270	2
1	270	2

5 Runoff Curve

Slope·	50%	
Slope Length	1000	feet
Soil Texture:	8	
Vegetation:	4	

TABLE I-2

HELP Model Output Parameters
Dunn Field, Memphis Depot

	Inches	Std Deviations	Cu. Feet	Percent
Precipitation	54 52	7.39	2572799	100
Runoff	0.318	0.253	14991	0.58
Evapotranspiration	35.22	2.26	1662194	64.6
Percolation/Leakage thru layer 4	**7.50**	7.69	353713	13.75
Change in water storage	11.48	12 29	541902	21

TABLE I-3
Dilution Attenuation Factor (DAF) Parameters
Dunn Field FS

Parameter	Units	Value	Reference
Hydraulic Conductivity	(m/yr)	2460	Fluvial aquifer, Final Groundwater Characterization Data Report (CH2M HILL, 1997a)
Hydraulic Gradient	(m/m)	0.0124	Remedial Investigation Report for Dunn Field (CH2M HILL, 2002)
Aquifer Thickness	(m)	4 6	Remedial Investigation Report for Dunn Field (CH2M HILL, 2002)
Source Length	(m)	143	Based on Subsurface Soil VOCs Figures included in RI Report (CH2M HILL 2002), Direction of groundwater flow is assumed ot be east to west
Infiltration Rate	(m/yr)	0.1904	HELP model outout (see Table I-2)
Mixing Zone Thickness	(m)	4 6	Calculated using Equation 12 from SSL Guidance (EPA, 1996)
DAF		**6.1**	

TABLE I-4
Target Soil Concentrations
Dunn Field FS

Compound	DAF	Groundwater Criteria[a, b] (mg/L)	Target Soil Leachate Concentration[c] (mg/L)	Target Total Soil Concentration[c] (mg/kg)
Carbon Tetrachloride	6.1	0.0050	0.0305	0.0476
Chloroform	6.1	0.0790	0 4819	0 2267
Dichloroethane, 1,2-	6 1	0.0050	0 0305	0.0091
Dichloroethene, 1,1	6 1	0.0070	0 0427	0 0312
Dichloroethene, cis-1,2-	6 1	0 0700	0.4270	0 1890
Dichloroethene,1,2-trans-	6 1	0.1000	0.6100	0.3608
Methylene chloride	6 1	0 0050	0.0305	0.0081
Tetrachloroethane, 1,1,2,2-	6 1	0 0005	0 0031	0.0025
Tetrachloroethene	6.1	0 0050	0.0305	0.0415
Trichloroethane, 1,1,2-	6.1	0 0050	0 0305	0 0161
Trichloroethene	6.1	0 0050	0.0305	0 0424
Vinyl chloride	6.1	0 0020	0 0122	0 0055

[a] MCL for all parmeters except 1,1,2,2-Tetrachloroethane, in which the laboratory reporting limit was used
b MCL used for Chloroform is a proportion of the Total Trihalomethanes(TTHM) MCL of 0.08 mg/L TTHM is the sum of chloroform, Bromodichloromethane (BDCM), Dibromochloromethane (DBCM) and bromoform Based on Dunn Field Groundwater concentrations, chloroform, makes up 99% of TTHM concentrations Therefore, the MCL for TTHM was multiplied by 99% to determine the MCL for chloroform
c Target soil concentrations are assumed to be at the depth of the water table interface.

Target Soil Leachate Concentartion = DAF * Groundwater Criteria
Target Total Soil Concentartion = (Target Leachate Concentration * RL) / Bulk Density
Where, RL = (Bulk Density * Distribution Coefficient) + Water Content + (Air-filled Porosity * Henry's Law Constant)

TABLE I 5 Loess & Fluvial Deposits Model
Input Parameters for EMSOFT Model Runs
Dunn Field FS

Parameter	Description	Unit	Carbon Tetrachloride	Chloroform	Dichloroethane 1,2	Dichloroethene 1 1	Dichloroethene, cis-1 2	Dichloroethene,1,2-trans-	Methylene chloride	Tetrachloroethane 1 1 2 2-	Tetrachloroethene	Trichloroethane, 1,1 2	Trichloroethene	Vinyl Chloride	Reference
General															
Time	Time period for averaging and printing flux and soil concentration results	days	2805	8	2805	2805	2805	2805	2805	2805	2805	2805	2805	2805	Assume time for contaminated soil water to reach water table from bottom of fluvial deposit contamination
J	Porewater flux/infiltration rate	cm/day	0 052	6 038E-07	0 052	0 052	0 052	0 052	0 052	0 052	0 052	0 052	0 052	0 052	HELP model output = 19 04 in/year
D_{WVair}	Binary diffusion coefficient of water vapor in air	m^2/day	2	2	2	2	2	2	2	2	2	2	2	2	Reference 1
ρ_{WV}	Water vapor density	g/m³	23	23	23	23	23	23	23	23	23	23	23	23	Reference 5 Assume 25°C
ρ_{WL}	Liquid water density	g/m³	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	1 E+06	Reference 4 Appendix 14 Assume 25°C
RH	Relative humidity	dimensionless	0 5	0 5	0 5	0 5	0 5	0 5	0 5	0 5	0 5	0 5	0 5	0 5	Assume Mean value (0<RH<1)
E	Evaporation rate	m/day	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	0 002	HELP model output = 35 2 In/year
N	Number of contaminant layers per model	dimensionless	1	1	1	1	1	1	1	1	1	1	1	1	Assume 1 Layer due to lack of site specific data
Loess-Specific Model Parameters															
D1	Depth for averaging soil concentration results	cm	914	914	914	914	914	914	914	914	914	914	914	914	Assume Approximate Thickness of Loess at Dunn Field =30 ft, Reference 6
D2	Depth for printing soil concentration results	cm	914	914	914	914	914	914	914	914	914	914	914	914	Same as D1
foc	Fraction organic carbon	dimensionless	0 007	0 007	0 007	0 007	0 007	0 007	0 007	0 007	0 007	0 007	0 007	0 007	Based on Geotechnical Analyses above 30 ft depth Attachment B
ϕ	Soil porosity	dimensionless	0 45	0 45	0 45	0 45	0 45	0 45	0 45	0 45	0 45	0 45	0 45	0 45	Based on Geotechnical Analyses above 30 ft depth Attachment B
θ	Water content	dimensionless	0 25	0 25	0 25	0 25	0 25	0 25	0 25	0 25	0 25	0 25	0 25	0 25	Based on Geotechnical Analyses above 30 ft depth Attachment B
a	Volumetric air content, ($a = \phi - \theta$)	dimensionless	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	Based on Geotechnical Analyses above 30 ft depth Attachment B
ρ_b	dry soil bulk density	g/cm³	1 46	1 46	1 46	1 46	1 46	1 46	1 46	1 46	1 46	1.46	1 46	1 46	Based on Geotechnical Analyses above 30 ft depth Attachment B
h	Boundary layer thickness (D_{WVair} * ρ_{WV} (1 RH)/(2E * ρ_{WL}))	cm	4 71E-01	4 71E 01	4 71E 01	4 71E-01	4 71E-01	4 71E-01	4 71E-01	4 71E 01	4 71E-01	4 71E 01	4 71E-01	4 71E 01	Reference 2
Thickness of Clean Overburden	Depth from top of ground surface to soil contamination	cm	60 96	60 96	60 96	60 96	60 96	60 96	60 96	60 96	60 96	60 96	60 96	60 96	Assume 2 feet, based on historical vertical soil data (SBLCA and SBLEE)
Layer 1 Thickness	Thickness of contaminated layer	cm	853	853	853	853	853	853	853	853	853	853	853	853	Assume 28 feet, Average Loess Thickness - Clean Overburden
Fluvial Sand-Specific Model Parameters															
D1	Depth for averaging soil concentration results	cm	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	Depth to the water table is approximately 75 8 ft (SBLCA) D1 = distance between bottom of loess and water table = 75 8 ft 30 ft = 45 8 ft
D2	Depth for printing soil concentration results	cm	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	1396	Same as D1
foc	Fraction organic carbon	dimensionless	0 001	0 001	0 001	0 001	0 001	0 001	0 001	0 001	0 001	0 001	0 001	0 001	Based on Geotechnical Analyses below 30 ft depth Attachment B
ϕ	Soil porosity	dimensionless	0 44	0 44	0 44	0 44	0 44	0 44	0 44	0 44	0 44	0 44	0 44	0 44	Based on Geotechnical Analyses below 30 ft depth Attachment B
θ	Water content	dimensionless	0 07	0 07	0 07	0 07	0 07	0 07	0 07	0 07	0 07	0 07	0 07	0 07	Based on Geotechnical Analyses below 30 ft depth Attachment B
a	Volumetric air content ($a = \phi - \theta$)	dimensionless	0 37	0 37	0 37	0 37	0 37	0 37	0 37	0 37	0 37	0 37	0 37	0 37	Based on Geotechnical Analyses below 30 ft depth Attachment B
ρ_b	dry soil bulk density	g/cm³	1 47	1 47	1 47	1 47	1 47	1 47	1 47	1 47	1 47	1 47	1 47	1 47	Based on Geotechnical Analyses below 30 ft depth Attachment B
h	Boundary layer thickness (D_{WVair} * ρ_{WV} (1 RH)/(2E ρ_{WL}))	cm	0	0	0	0	0	0	0	0	0	0	0	0	Not exposed to atmosphere
Thickness of Clean Overburden	Depth from top of ground surface to soil contamination	cm	0	0	0	0	0	0	0	0	0	0	0	0	No clean layer between the Loess and the fluvial deposits
Layer 1 Thickness	Thickness of contaminated layer	cm	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	Assume depth of contamination is 71 feet based on historical vertical soil data (SBLCA and SBLEE) Thickness = 71 ft (depth of fluvial contamination) 30 ft (depth of loess) = 41 ft
Chemical Specific															
Koc	Soil organic carbon-water partition coefficient	mL/g	174	39 8	17 4	58 9	35 5	52 5	11 7	93 3	155	50 1	166	18 6	Reference 2 Attachment C
K_H	Henry's law constant	dimensionless	1 25	0 15	0 0401	1 07	0 167	0 385	0 0898	0 0141	0 754	0 0374	0 422	1 11	Reference 2 Attachment C
D_G	Air diffusion coefficient	cm2/day	6739 2	8985 6	8985 6	7776	6359 04	6108 48	8728 4	6134 4	6220 8	6739 2	6825 6	9158 4	Reference 2 Attachment C
D_L	Aqueous diffusion coefficient	cm2/day	0 760	0 864	0 855	0 899	0 976	1 028	1 011	0 683	0 708	0 760	0 786	0 106	Reference 2 Attachment C
$t_{1/2}$	Half-life	days	999 999	999 999	999 999	999 999	999 999	999 999	999 999	999 999	999 999	999 999	999 999	999 999	Assume no degradation
$C_{L\ (2x01)}$	Target soil leachate concentration	mg/L	3 05E-02	4 82E-01	3 05E-02	4 27E-02	4 27E-01	6 10E-01	3 05E 02	3 05E-03	3.05E 02	3 05E-02	3 05E-02	1 22E-02	MCL RBC or Reporting Limit * DAF
$C_{T\ (2x01)}$	**Target Total soil concentration at water table interface** ($C_{T,SOIL} = C_L R_L/\rho_b$)	mg/kg	**4 76E-02**	**2.27E-01**	**9.11E-03**	**3 12E-02**	**1 89E-01**	**3 61E-01**	**8.10E-03**	**2.52E-03**	**4.15E 02**	**1 61E-02**	**4.24E-02**	**5 53E-03**	Reference 1
R_L	Partitioning Factor ($R_L = \rho b K_D + \theta + a K_H$)	dimensionless	2 278	0 687	0 436	1 066	0 646	0 864	0 388	1 206	1 985	0 770	2 031	0 662	Reference 1
R_G	Partitioning Factor ($R_G = \rho b K_D/K_H + \theta/K_H + a$)	dimensionless	1 823	4 578	10 869	0 996	3 870	2 243	4 316	85 556	2 632	20 575	4 813	0 596	Reference 1
			2 330E 02	1 529E 01	7 595E-03	1 908E-02	1 313E-01	2 282E-01	7 272E 03	1 359E 03	2 047E-02	1 020E 02	2 047E-02	4 208E-03	

REFERENCES

1 Jury W A W F Spencer and W J Farmer 1983 Behavior Assessment Model for Trace Organics in Soil I Model Description J Environ Qual Vol 12 no 4 pp 558-564
2 US EPA. *Soil Screening Level Guidance, User's Guide* 1996 Office Of Solid Waste and Emergence Response Washington D C EPA540/R 96/018
3 USEPA 1997 EMSOFT User's Guide Office of Research and Development, Washington DC Report No NCEA-W-0073
4 Fetter C W 1994 *Applied Hydrogeology* New Jersey Prentice Hall, Inc
5 http://hyperphysics phy-astr gsu edu/hbase/kinetic/watvap html
6 CH2M HILL 2002 *Remedial Investigation Report for Dunn Field* Prepared for the U S Army Corps of Engineering and Support Center Huntsville

TABLE I-6
Summary of EMSOFT Output
Dunn Field FS

Parameter	Protective Groundwater Criteria[a] (mg/L)	Target Soil Leachate Concentration[b] (mg/L)	Disposal Area Concentrations (mg/kg)			Generic SSL Calculated from EPA Guidance[c,e]		EMSOFT Calculated SSL		Protective Soil Vapor Concentration[d]	
			Max	Mean	Detects	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)	Loess Specific Values (ppbv)	Fluvial Deposit Specific Values (ppbv)
Carbon Tetrachloride	0 0050	0 0305	6 8	0 52	16/155	0 04759	0 01636	0 2150	0 1086	28 14	14 22
Chloroform	0 0790	0 4819	14	0 94	37/154	0 22668	0 06032	0 9170	0 4860	61 57	32 63
Dichloroethane, 1,2-	0 0050	0 0305	0 046	0 016	5/155	0 00911	0 00229	0 0329	0 0189	1 12	0 64
Dichloroethene, 1,1	0 0070	0 0427	0 06	0 014	8/155	0 03118	0 01605	0 1500	0 0764	57 00	29 03
Dichloroethene, cis-1,2-	0 0700	0 4270	0 132	0 013	40/49	0 18899	0 05344	0 7550	0 4040	73 86	39 52
Dichloroethene,1,2-trans-	0 1000	0 6100	0 044	0 0054	22/49	0 36080	0 12018	1 5200	0 7910	256 53	133 50
Methylene chloride	0 0050	0 0305	0 039	0 0071	20/155	0 00810	0 00250	0 0305	0 0169	5 14	2 85
Tetrachloroethane, 1,1,2,2-	0 0005	0 0031	160	6 18	56/155	0 00252	0 00044	0 0112	0 0066	0 03	0 55
Tetrachloroethene	0 0050	0 0305	4 4	0 16	56/155	0 04147	0 01197	0 1806	0 0920	15 18	0 99
Trichloroethane, 1,1,2-	0 0050	0 0305	2 2	0 18	25/155	0 01608	0 00327	0 0627	0 0355	0 84	2 03
Trichloroethene	0 0050	0 0305	460	7 89	92/155	0 04243	0 00976	0 1820	0 0932	10 56	2 06
Vinyl chloride	0 0020	0 0122	7 0	0 64	15/155	0 00553	0 00422	0 0294	0 0150	28 94	14 77

[a] Protective groundwater criteria assumed to be MCL for all compounds except 1,1,2,2-Tetrachloroethane, in which the laboratory reporting limit was used The MCL for Chloroform is 99% of the MCL for Total Trihalomethanes, which is 0 08 mg/L, based on Dunn Field groundwater concentration

[b] Target Soil Leachate Concentration = protective groundwater criteria times a DAF of 6 1

[c] SSL Calculated from Equation 10 in SSL Guidance (EPA, 1996)

[d] Soil Vapor concentration is in equilibrium with EMSOFT calculated SSL

[e] Does not account for thickness of layers or that Loess exists on top of fluvial deposits

SSL = Soil Screening Level
MCL = Maximum Contaminant Level
DAF = Dilution Attenuation Factor

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APPENDIX D-1

Cost Estimates for the Disposal Sites Alternatives

Table D1-3a
Capital Cost Estimate: Alternative 3, Soil Containment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Institutional Controls (Deed Restrictions)					Deed restrictions would prohibit redevelopment of property to residential standards
	1 1 Attorney Fees	40	hr	$200 /hr	$8,000	CH2M HILL. American Scrap Metal Site, Panama City: Order of Magnitude Cost Estimate
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	Includes recording the location of the Disposal Sites
2	Fencing along Perimeter of Disposal Area					
	2 1 Fencing	2,100	ft	$23 /ft	$48,300	Estimate from RS Means Environmental Remediation Cost Data (2001)
	2 2 Gate	8	hr	$807 /hr	$6,456	Estimate from RS Means Environmental Remediation Cost Data (2001)
3	Signs					
	3 1 Signs	32	ea	$69 ea	$2,208	Estimate from RS Means Environmental Remediation Cost Data (2001)
	3 3 Labor	8	hr	$50 hr	$400	
4	Plans for Implementation	100	hr	$85 /hr	$8,500	Based on CH2M HILL's professional judgement Plans to develop include Site Safety and Health Plan and Environmental Protection Plan
5	Pre-Design Engineering/Investigation					
	5 1 Pre-Design Planning	120	hr	$85 /hr	$10,200	Assume it will include RA Workplan development with engineering design, bidding, permitting, and as-built drawings
	5 2 Geophysical Locating of Sites	1	ea	$12,000 /ea	$12,000	Reichhold Kensington,GA site $3270 per day, plus $1500 mobilization and $500 per report.
	5 3 Test-Pitting of Disposal Sites	1	ea	$42,550 /ea	$42,550	Use of excavator to conduct test pits in Level B
	5 4 Field Oversight of Test Pitting	1	ea	$23,500 /ea	$23,500	Assumes 1 person in field for 6 days at 10 hrs per day, plus field equipment (meters, sample kits.) expenses.

Table D1-3a
Capital Cost Estimate: Alternative 3, Soil Containment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5 5	Analytical Costs for Analysis of Disposal Site Soils and Waste	1	ea	$64,560 /ea	$64,560	Assumes comprehensive soil samples (plus QA/QC samples) from test pits in each disposal site 54 samples analyzed for TCL/TAL and 16 samples analyzed for disposal characterization
5 6	Misc Field Costs	1	LS	$7,500 /each	$7,500	Estimated
6	Soil Cover of Disposal Sites					
6 1	Mobilization/Demobilization	1	LS	$6,000 /ea	$6,000	
6 2	Prepare staging areas	1	LS	$2,500 /ea	$2,500	Order of magnitude cost estimate from CH2M
6 3	Site Setup	1	LS	$1,500 /ea	$1,500	HILL Constructors, Inc
6 4	Site Clearing & Grubbing	1	LS	$5,000 /ea	$5,000	
6 5	Silt fence	1,000	L F	$1 /L F	$1,100	Local Memphis, TN vendor
6 6	Hay bales	350	ea	$4 /each	$1,278	Local Memphis, TN vendor
6 7	Low Permeability Soil Cover	757	yd^3	$30 /$yd^3$	$22,700	Soil cover will have a 24-inch compacted thickness. This covers a 10,215-sq ft area over the disposal sites. This cost includes transport and placement of the cover material
6 8	Vegetative Cover - Hydroseed	0 5	acre	$2,700 /acre	$1,400	Michael L. Hatcher & Associates Landscaping, Memphis, TN
6 9	Clean Backfill Lab Analysis - TAL/TCL	2	ea	$770 /each	$1,500	Kemron Laboratory , based on 7-day TAT
6 10	Field Labor Oversight	120	hr	$75 /hr	$9,000	Oversight labor
6 11	Misc Supplies	1	lumpsum	$1,500 /hr	$1,500	Estimated
6 12	Remedial Action Report	1	ea	$15,000 /ea	$15,000	This cost includes the preparation of a technical report, where all field data will be presented with interpretation analysis Estimated
Total Capital Costs					**$303,652**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent

Table D1-3b
O&M Cost Estimate Alternative 3, Soil Containment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
7	Maintenance of Site (Year 2-30)						Assumes that property will be available for redevelopment but not for larger building requiring excavation into stabilized masses Would require signage to alert property owners/leases to hazards
	7 1 Signage (six over 30 years)						Assumes signs will be replaced every 5 years Signs will be replaced 6 times over 30 years
	7 1 1 Signs	2	ea/yr	$69 /ea	$140 ($28 averaged over 5 years)	$500	Estimated
	7 1 2 Posts	2	ea/yr	$25 /ea	$50 ($10 averaged over 5 years)	$200	Assumes 12-ft post
	7 1 3 Labor	10	hr/yr	$75 /hr	$750 ($150 averaged over 5 years)	$2,200	Estimated
	7 2 Fencing (three over 30 years)						
	7 2 1 Fencing	40	ft/yr	$23 /ft	$920 ($92 averaged over 10 years)	$2,700	
	7 2 2 Labor	20	hr/yr	$75 /hr	$1500 ($150 averaged over 10 years)	$4,400	Assumes 2 field people on-site for 10 hours for 1 day
	7 3 Soil Cover Maintenance	24	hr/yr	$75 /hr	$1,800	$27,300	These costs assume locaal labor will be available to repair soil cover due to erosion and intrusion
	7 4 Landscaping of Soil Covers	192	hr/yr	$75 /hr	$14,400	$218,000	Assumes 16 hours (2 days) per month for 30 years
8	Annual Evaluation (Year 2-30)						
	8 1 Inspection	8	hr/yr	$75 /hr	$600	$9,100	Annual inspection required
	8 2 Annual Report	32	hr/yr	$75 /hr	$2,400	$36,300	Assume 1 report per year
9	5-Year Review (six over 30 years)	40	hr/yr	$100 /hr	$4000 ($800 averaged over 5 years)	$11,700	Remedial alternative will need to be reviewed every 5 years to ensure adequate protection
Total O&M Costs (2-30 years)[d,e]					**$20,230**	**$312,000**	

typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 30 years

Table D1-3c
Capital Cost Estimate: Alternative 3, Soil Containment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Institutional Controls (Deed Restrictions)	$9,000	NA	NA	$9,000
2	Perimeter Fencing	$54,756	NA	NA	$54,756
3	Signs	$2,608	NA	NA	$2,608
4	Plans for Implementation	$8,500	NA	NA	$8,500
5	Pre-Design Engineering/Investigation	$160,310	NA	NA	$160,310
6	Soil Cover of Disposal Sites	$68,478	NA	NA	$68,478
7	Maintenance of Site (Year 2-30)	NA	$16,630	$255,300	$255,300
8	Annual Evaluation (Year 2-30)	NA	$3,000	$45,400	$45,400
9	5-year Review	NA	$800	$11,700	$11,700
Total Costs		**$304,000**	**$20,000**	**$312,000**	**$616,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1.

[c] Total PW cost includes capital plus PW O&M costs over 30 years

Note: The annual total O&M costs consist of cost for annual evaluation and an average of other costs over time period they occur
NA = Not applicable

Table D1-5a
Capital Cost Estimate. Alternative 5, Ex-Situ Soil Treatment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Institutional Controls (Deed Restrictions)					Deed restrictions would prohibit redevelopment of property to residential standards
	1.1 Attorney Fees	40	hr	$200 /hr	$8,000	CH2M HILL: American Scrap Metal Site, Panama City: Order of Magnitude Cost Estimate
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	Includes recording the location of the Disposal Sites
2	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement Plans to develop include Site Safety and Health Plan and Environmental Protection Plan
3	Pre-Design Engineering/Investigation					
	5 1 Pre-Design Planning	120	hr	$85 /hr	$10,200	Assume it will include RA Workplan development with engineering design, bidding, permitting, and as-built drawings
	5.2 Geophysical Locating of Sites	1	ea	$12,000 /ea	$12,000	Reichhold Kensington,GA site $3270 per day, plus $1500 mobilization and $500 per report
	5 3 Test-Pitting of Disposal Sites	1	ea	$42,550 /ea	$42,550	Use of excavator to conduct test pits in Level B
	5 4 Field Oversight of Test Pitting	1	ea	$23,500 /ea	$23,500	Assumes 1 person in field for 6 days at 10 hrs per day, plus field equipment (meters, sample kits) expenses.
	5 5 Analytical Costs for Analysis of Disposal Site Soils and Waste	1	ea	$64,560 /ea	$64,560	Assumes comprehensive soil samples (plus QA/QC samples) from test pits in each disposal site. 54 samples analyzed for TCL/TAL and 16 samples analyzed for disposal characterization
	5.6 Misc Field Costs	1	LS	$7,500 /each	$7,500	Estimated
4	Buried Mat'ls Solidification Bench-Scale Testing	1	ea	$15,000 /ea	$15,000	Estimate based on RS Means *2001 Environmental Remediation Cost Data - Unit Price* for laboratory testing Assume 10 bulk samples for solidification

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Table D1-5a
Capital Cost Estimate: Alternative 5, Ex-Situ Soil Treatment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	4 1 Labor (sampling for bench scale testing)	40	hr	$75 /hr	$3,000	Assumes that 4 persons will be present at site to collect representative samples from a portion of the 16 disposal sites
	4 2 Mobilization/ Demobilization	64	hr	$75 /hr	$4,800	Assumes it will take 4 field person 8 hours for mobilization and 8 hours for demobilization
	4 3 Rental Equipment	1	day	$1,000 /day	$1,000	Assumes backhoe rental with blast shield to collect samples
	4 4 Supplies	1	event	$1,000 /event	$1,000	Estimated
	4 5 Summary TM	60	hr	$75 /hr	$4,500	A summary Technical Memorandum will be written after the bench scale testing
5	Ex-Situ Soil Treatment					The total volume for the 16 disposal sites is 13,620 cubic feet (approx 5100 cubic yards). Assuming that 75% of the disposal sites will require treatment Assuming that this action is run with excavator and to a waste pile in Level B
	5 1 Mobilization/Demobilization	1	ea	$50,000 /ea	$50,000	Estimated
	5 2 Project Management, workplan and HASP Preparation	1	ea	$40,000 /ea	$40,000	CH2M HILL Professional estimate
	5 3 On site Management by Subcontractor	1	ea	$112,500 /ea	$112,500	Management on site during remedial action CH2M HILL Professional estimate
	5 4 Control Bldgs	1	ea	$5,000 /ea	$5,000	Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for Air pollution control
	5 5 Cement Batch Plant Rental and Operation of Plant	5	mo	$16,000 /mo	$80,000	Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for Stabilization Includes additional cost for setup and operation of plant
	5 6 Grouting Material, Reagent, and Water	8190	tn	$85 /tn	$696,200	Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for stabilization, fixation

Table D1-5a
Capital Cost Estimate: Alternative 5, Ex-Situ Soil Treatment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5.7	Heavy Equipment Rental - Loader, Excavator, Forklift, Screening Unit, 10cy Mixer, Belt Feeder	5	mo	$155,000 /mo	$775,000	Assumes 40' x 150' x 25' bldg, setup and breakdown Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for solidification/stabilization in Level B
5 8	Decontamination including waste tank	1	ea	$25,000 /ea	$25,000	Includes decontamination and waste holding tank of 2500 gallons CH2M HILL estimate 375 hrs x $60/hr
5 9	Receptacle/Residual Waste Hauling and Disposal	50	tn	$700 /tn	$35,000	Assumed to be hazardous waste requiring incineration Costs includes characterization of materials and rolloff for transport.
5 10	Decon Materials and Solid Waste Disposal	1	ea	$4,000 /ea	$4,000	Estimated Assuming non-hazardous waste characterization.
5 11	Confirmation Sampling	24	ea	$955 /ea	$22,900	TCLP analyses of stabilized masses and characterization analyses from bottom of pits
5 12	Remedial Action Report	1	ea	$15,000 /ea	$15,000	This cost includes the preparation of a technical report, where all field data will be presented with interpretation analysis Estimated.
Total Capital Costs					**$2,069,410**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent

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Table D1-5b
O&M Cost Estimate: Alternative 5, Ex-Situ Soil Treatment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
6	Maintenance of Site (Year 2-30)						Assumes that property will be available for redevelopment but not for larger building requiring excavation into stabilized masses Would require signage to alert property owners/leases to hazards
	6 1 Signage (six over 30 years)						Assumes signs will be replaced every 5 years Signs will be replaced 6 times over 30 years
	6 1 1 Signs	2	ea/yr	$69 /ea	$140 ($28 averaged over 5 years)	$500	Estimated
	6 1 2 Posts	2	ea/yr	$25 /ea	$50 ($10 averaged over 5 years)	$200	Assumes 12-ft post
	6 1.3 Labor	10	hr/yr	$75 /hr	$750 ($150 averaged over 5 years)	$2,200	Estimated
7	Annual Evaluation (Year 2-30)						
	7 1 Inspection	8	hr/yr	$75 /hr	$600	$9,100	Annual inspection required to determine if institutional controls are acceptable.
	7 2 Annual Report	32	hr/yr	$75 /hr	$2,400	$36,300	Assume 1 report per year
8	5-Year Review (six over 30 years)	40	hr/yr	$100 /hr	$4000 ($800 averaged over 5 years)	$11,700	Remedial alternative will need to be reviewed every 5 years to ensure adequate protection
Total O&M Costs (2-30 years)[d, e]					**$3,988**	**$60,000**	

typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 30 years.

Table D1-5c
Capital Cost Estimate: Alternative 5, Ex-Situ Soil Treatment
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Institutional Controls (Deed Restrictions)	$9,000	NA	NA	$9,000
2	Plans for Implementation	$10,200	NA	NA	$10,200
3	Pre-Design Engineering/Investigation	$160,310	NA	NA	$160,310
4	Buried Mat'ls Solidification Bench-Scale Testing	$29,300	NA	NA	$29,300
5	Ex-Situ Soil Treatment	$1,860,600	NA	NA	$1,860,600
6	Maintenance of Site	NA	$188	$2,900	$2,900
7	Annual Evaluation	NA	$3,000	$45,400	$45,400
8	5-year Review	NA	$800	$11,700	$11,700
Total Costs		**$2,069,000**	**$4,000**	**$60,000**	**$2,129,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] Total PW cost includes capital plus PW O&M costs over 30 years.

Note The annual total O&M costs consist of cost for annual evaluation and an average of other costs over time period they occur.

NA = Not applicable

Table D1-6a
Capital Cost Estimate: Alternative 6, Excavation, Transportation, and Off-site Disposal
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Institutional Controls (Deed Restrictions)					Deed restrictions would prohibit redevelopment of property to residential standards
	1 1 Attorney Fees	32	hr	$200 /hr	$6,400	CH2M HILL American Scrap Metal Site, Panama City Order of Magnitude Cost Estimate
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement
						Plans to develop include Site Safety and Health Plan and Environmental Protection Plan
3	Pre-Design Engineering/Investigation					
	5 1 Pre-Design Planning	120	hr	$85 /hr	$10,200	Assume it will include RA Workplan development with engineering design, bidding, permitting, and as-built drawings
	5 2 Geophysical Locating of Sites	1	ea	$12,000 /ea	$12,000	Reichhold Kensington,GA site. $3270 per day, plus $1500 mobilization and $500 per report
	5 3 Test-Pitting of Disposal Sites	1	ea	$42,550 /ea	$42,550	Use of excavator to conduct test pits in Level B
	5 4 Field Oversight of Test Pitting	1	ea	$23,500 /ea	$23,500	Assumes 1 person in field for 6 days at 10 hrs per day, plus field equipment (meters, sample kits) expenses
	5 5 Analytical Costs for Analysis of Disposal Site Soils and Waste	1	ea	$64,560 /ea	$64,560	Assumes comprehensive soil samples (plus QA/QC samples) from test pits in each disposal site 54 samples analyzed for TCL/TAL and 16 samples analyzed for disposal characterization
	5 6 Misc Field Costs	1	LS	$7,500 /each	$7,500	Estimated

Table D1-6a

Capital Cost Estimate: Alternative 6, Excavation, Transportation, and Off-site Disposal
Disposal Sites and Associated Subsurface Soil Alternatives

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
4	Excavation					The total volume for the 16 disposal sites is 13,620 cubic feet (approx 5100 cubic yards). Assume that 75% of the disposal sites will require excavation and 25% of the soil will characterized as nonhazardous Assuming that this action is run with rolloff boxes in Level B
	4 1 Mobilization/Demobilization	1	ea	$10,000 /ea	$10,000	Estimated
	4 2 On site Management by Subcontractor	1	ea	$25,000 /ea	$25,000	Management on site during remedial action CH2M HILL Professional estimate
	4 3 Control Bldgs	1	ea	$5,000 /ea	$5,000	Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for temporary offices
	4 4 Heavy Equipment Rental - Loader, Excavator, Forklift incl operators personnel	1	mo	$150,000 /mo	$150,000	Estimate from RS Means *2001 Environmental Remediation Cost Data - Unit Price* for equipment rental in Level B
5	Transportation and Disposal					Transport of materials from site 12 sites with 25% of the total cubic yards characterized as non-hazardous
	5.1 Chemical Oxidation Treatment for Pesticide contaminated hazardous waste					
	5 1 1 Transport and Disposal	1974	tn	$240 tn	$473,800	1223 cy to dispose Estimate $240 per ton
	5 2 Incineration of Hazardous Waste Soils					
	5 2 1 Transport and Disposal	389	tn	$700 tn	$272,300	91 cy to dispose Estimated $700 per ton
	5 3 "C" Listed Hazardous Waste Soils					
	5 3 1 Transported and Disposal	2226	tn	$157 tn	$349,500	1403 cy to dispose Estimated $157 per ton
	5 4 Non-hazardous Soils					
	5 4 1 Transport and Disposal	1814	tn	$32 tn	$58,000	1109 cy to dispose Estimated $32 per ton
	5 5 Clean Backfill for Each Pit	3,900	cy	$25 /cy	$97,500	Placed and compacted clean backfill

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Table D1-6a

Capital Cost Estimate: Alternative 6, Excavation, Transportation, and Off-site Disposal Disposal Sites and Associated Subsurface Soil Alternatives

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5.6	Decontamination including waste tank	1	ea	$25,000 /ea	$25,000	Includes decontamination and waste holding tank of 2500 gallons CH2M HILL estimate 375 hrs x $60/hr
5 7	Decon Materials and Solid Waste Disposal	1	ea	$4,000 /ea	$4,000	Estimated Assuming non-hazardous waste characterization.
5.8	Confirmation Sampling	30	ea	$1,725 /ea	$51,800	Characterization analyses from bottom of pits.
5 9	Remedial Action Report	1	ea	$15,000 /ea	$15,000	This cost includes the preparation of a technical report, where all field data will be presented with interpretation analysis Estimated
Total Capital Costs					**$1,714,810**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.

Table D1-6b
O&M Cost Estimate: Alternative 6, Excavation, Transportation, and Off-site Disposal
Disposal Sites and Associated Subsurface Soil Alternatives
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
6	Annual Evaluation (Year 2-30)						
	6 1 Inspection	8	hr/yr	$75 /hr	$600	$9,100	Annual inspection required to determine if institutional controls are acceptable
	6 2 Annual Report	32	hr/yr	$75 /hr	$2,400	$36,300	Assume 1 report per year.
7	5-Year Review (six over 30 years)	40	hr/yr	$100 /hr	$4000 ($800 averaged over 5 years)	$11,700	Remedial alternative will need to be reviewed every 5 years to ensure adequate protection
Total O&M Costs (2-30 years)[d]					**$3,800**	**$57,000**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1.

[d] The Total Annual O&M Costs are equal to an average of the annual cost for a year with semi-annual monitoring and a year with annual monitoring

Table D1-6c
O&M Cost Estimate: Alternative 6, Excavation, Transportation, and Off-site Disposal
Disposal Sites and Associated Subsurface Soil Alternatives
Rev. 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Institutional Controls (Deed Restrictions)	$7,400	NA	NA	$7,400
2	Plans for Implementation	$10,200	NA	NA	$10,200
3	Pre-Design Engineering/Investigation	$160,310	NA	NA	$160,310
5	Excavation	$190,000	NA	NA	$190,000
6	Transportation and Disposal	$1,346,900	NA	NA	$1,346,900
7	Annual Evaluation (Year 2-30)	NA	$3,000	$45,400	$45,400
8	5-Year Review	NA	$800	$11,700	$11,700
Total Costs		**$1,715,000**	**$3,800**	**$57,000**	**$1,772,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.
[b] Present worth cost calculated using an interest rate of 5 percent over 30 years
[c] Total PW cost includes capital plus PW O&M costs over 30 years
Note The annual total O&M costs consist of cost for annual evaluation and an average of other costs over time period they occur
NA = Not applicable

APPENDIX D-2

Cost Estimates for the VOC Soil Presumptive Remedy

Table D2-2a
Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Institutional Controls (Deed Restrictions)					Deed restrictions would prohibit installation and use of production and consumptive use wells and access to the Disposal Area of Dunn Field
	1 1 Attorney Fees	40	hr	$200 /hr	$8,000	CH2M HILL. American Scrap Metal Site, Panama City Order of Magnitude Cost Estimate for Alternative 2A
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Fencing along Perimeter of Disposal Area					
	2 1 Fencing	2,200	ft	$23 /ft	$50,600	Use of existing fence and additional fence, Estimate from RS Means Environmental Remediation Cost Data (2001). Order of magnitude costs
	2 2 Gate	2	ea	$807 /hr	$1,614	Assumes two field people will be on site for 10 hours per day for 5 days
3	Signs					
	3 1 Signs	6	ea	$69 ea	$414	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs.
	3 3 Labor	4	hr	$50 hr	$200	
4	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement Plans to develop include Site Safety and Health Plan, Environmental Protection Plan, Quality Assurance Project Plan, and Sampling and Analysis Plan

Table D2-2a

Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5	Soil Investigation and Soil Monitoring Points					Assumes 56 soil monitoring points (2 horizons) for the loess and 42 (2 horizons) soil monitoring points for the fluvial sand will be installed to monitor full-scale soil vapor extraction. Screens will be set at multiple depths in each borehole (2 horizons in the loess and 2 horizons in the fluvial sand) Soil samples will be collected from 20 locations
	5 1 Mobilization/Demobilization	1	ea	$8,500 /ea	$8,500	Assume Rotasonic drill rig and equipment will not be local.
	5 2 Soil Monitoring Point Drilling	2640	ft	$62 /ft	$163,680	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear (2002) Bore holes will be drilled and continuously sampling using Rotasonic drilling methods Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
	5 3 Labor (Contractor oversight)	150	hr	$75 /hr	$11,300	Assumes one field person will be on-site for overseeing and soil sampling for 10 hours a day for 41 days
	5 4 Laboratory Analyses (VOCs)	106	analysis	$192 /analysis	$20,400	Assumes 4 samples from each sampling locations will be sent to Test America in TN The price includes QA/QC samples
	5.5 Laboratory Analyses (TCLP)	1	analysis	$955 /analysis	$1,000	Kemron Laboratory , based on 14-day TAT
	5 6 Rental Equipment	18	day	$90 /day	$1,600	MicroFID - quote from Pine Environmental Services, Inc.
	5 7 Mobilization/Demobilization (Oversight and soil sampling)	32	hr	$75 /hr	$2,400	Assumes it will take one field person 8 hours for mobilization and 8 hours for demobilization for each trip Two trips will be needed
	5 8 Supplies	2	event	$500 /event	$1,000	CH2M HILL professional judgement

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Table D2-2a

Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
6	Vertical SVE Wells Installation					54 vertical SVE wells for loess (total depth=25 feet) and 24 vertical SVE wells for fluvial sand (total depth=65 feet) will be installed at the site
	6 1 Mobilization	0	ea	$0 /ea	$0	Assume Mobilization will be at the same time that soil monitoring points are installed, therefore no costs are presented
	6 2 SVE Wells Drilling and Preparation for Loess	1568	ft	$72 /ft	$112,860	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear (2002)
	6 3 SVE Wells Drilling and Preparation for fluvial sand	1740	ft	$72 /ft	$125,280	Bore holes will be drilled and continuously sampling using Rotasonic drilling methods Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
	6 4 Labor (Oversight)	160	hr	$75 /hr	$12,000	Assumes one field person will be on-site for overseeing for 10 hours a day for 42 days
	6 5 Laboratory Analyses (TCLP)	2	analysis	$955 /analysis	$1,900	Kemron Laboratory , based on 14-day TAT
	6 6 Mobilization/Demobilization (Oversight)	32	hr	$75 /hr	$2,400	Assumes it will take one field person 8 hours for mobilization and 8 hours for demobilization for each trip Two trips will be needed
7	Capital Equipment and Construction					
	7 1 Vacuum Pumps for loess	3	ea	$32,693 /ea	$98,079	Quoted by EPG/Catalytic Combustion 3 HYVAC 25 HP MPE Systems Nominal 400 ACFM @ 26" Hg each. The cost includes MPE, Vapor/Liquid Separator (VSL), Controls, Wiring panel to skid
	7 2 Vacuum Pump for sand	1	ea	$13,500 /ea	$13,500	Quoted by EPG/Catalytic Combustion Low Vac 15 HP Regenerative System 500 ACFM @ 2 3" Hg The cost includes MPE, VLS, Controls, Wiring panel to skid
	7 3 Trenching	10,000	LF	$6 50 /LF	$65,000	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for 3 feet deep trenching Assumes soil will be placed back in trench.

Table D2-2a
Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	7 4 Piping Cost	10,000	LF	$1 46 /LF	$14,600	Quoted by Michigan Pipe Supply, LLC The cost includes 4" SDR 11 HDPE pipes x 500' coil.
	7.5 Miscellaneous	1	ea	$29,000 /ea	$29,000	The price includes 4" HDPE SDR 11 MPT transitions, flange adapters, ductile iron back up rings, reducing couplings, throttling valves, air flow meters, vacuum gauges, and well vaults
	7 6 Piping Assembling	1	ea	$183,400 /ea	$183,400	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for piping assembling, well vaults installation, and other pipe fitting
	7 7 Equipment Storage Building	1	ea	$19,800 /ea	$19,800	Quoted by Engineering Management Construction, Inc Butler building package 15'x20'x15'
	7 8 Building Heater	1	ea	$500 /ea	$500	
	7 9 Auto Dialer	1	ea	$4,000 /ea	$4,000	
	7 10 Capping	360,000	sq ft.	$2 /sq ft	$720,000	Based on CH2M HILL's professional judgement The cost includes 3 person crew, grading, putting 20 mm liner down and fill with 6" cover of gravel and stones
8	Startup					Project Manager and an engineer will have a kick off meeting and a safety meeting with subcontractors Assumes Startup will take 10 hours a day for 14 days
	8 1 Labor (Startup)	560	hr	$85 /hr	$47,600	Assumes 4 people (2 engineers and 2 technicians) will oversee the system startup It will take 10 hours per day for 14 days.
	8 2 Mobilization/ Demobilization (Startup)	64	hr	$85 /hr	$5,400	Assumes it will take 4 people 8 hours for mobilization and 8 hours for demobilization for the startup
	8 3 Summary TM	60	hr	$85 /hr	$5,100	A summary Technical Memorandum will be written after the startup

Table D2-2a

Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
9	Offgas Treatment					
	9 1 Chlorinated Catalytical Oxidizer	1	ea	$85,000 /ea	$85,000	Quoted by Catalytic Combustion Base system price for Model HD-CATOX 750G
	9 2 Scrubber for HCl emissions	1	ea	$61,000 /ea	$61,000	Quoted by Catalytic Combustion Base system price for Model 1000 HCl Scrubber Module
	9 3 Miscellaneous	1	ea	$13,200 /ea	$13,200	The price was quoted by Catalytic Combustion plus 20% contingency The cost includes freight (SVE & Offgas Treatment equipment) to the job site, subcontractor's start-up cost, and spare parts package for the oxidizer and scrubber
	9 4 NaOH Required to Neutralize HCl for the first year	66,600	gal	$0 31 /gal	$20,700	Assumes 7 52 gallons per hour of 25% NaOH solution (freeze at 10 degrees F) or 3 13 gallons per hour of 50% NaOH solution (freeze at 45 degrees F) is needed to neutralize HCl generated from the system 25% NaOH will be $0 31 per gallon and 50% NaOH will
10	Utilities (Year 1)					
	10 1 Electricity for vacuum pumps	587,910	kw-hr	$0 06 /kw-hr	$35,275	Assumes vacuum pumps (total of 90 HP) will run 24 hours a day for 365 days for the first year
	10 2 Electricity for heater	7,200	kw-hr	$0 06 /kw-hr	$432	Assumes a heater (2 kw) will run 5 months during the winter season for the first year
	10 3 Electricity for Offgas Treatment	32,662	kw-hr	$0 06 /kw-hr	$1,960	Assumes a fan (5 HP) for offgas treatment will run 24 hours a day for 365 days for the first year
	10 4 Fuel Consumption for Offgas Treatment	21,024	therms	$1 00 /therm	$21,024	Fuel consumption will be 2 4 therms/hr based on Catalytic Combustion's estimation The system will consume natural gas 24 hours a day for 365 days for the first year Assumes natural gas will cost $1 00 per therm Gasoline connection fee is included

Table D2-2a
Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	10.5 Water Usage for Offgas Treatment	1,436,640	gal	$0.08 /gal	$115,239	Water usage will be 164 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days for the first year Public water will cost $0 60 per cubic foot Water line connection fee is included
	10 6 Sewerage for Offgas Treatment	1,174	1000 gal	$0 59 /1000 gal	$693	Water discharge rate will be 134 gal/hr based on Catalytic Combustion's estimation The system will discharge water 24 hours a day for 365 days for the first year. The sewerage charge will be $0 587 per 1000 gallon Sewerage connection fee is included
	10 7 Sewerage for Groundwater Recovered by SVE Systems	105	1000 gal	$0 59 /1000 gal	$62	Water purging rate from SVE systems will be 0.2 gpm (or 12 gal/hr) based on the SVE feasibility study conducted at the site in December 2001 The system will purge water 24 hours a day for 365 days for the first year The sewerage charge will be $0.587
	10 8 Electricity Hookup	1	ea	$30,000 /ea	$30,000	Three-Phase 460-volt AC Supplies at 100-amp is needed at the site. The cost includes transformers, poles, and subcontractor's labor
11	Air Sampling for VOCs, Air Monitoring, and SVE O&M					Assume first year of air sampling, air monitoring and SVE O&M is a capital expense. Air samples will be collected from discharge stack out of offgas treatment and scrubber, daily for first 3 days and weekly for first 4 weeks for the Startup and monthly thereafter
	11.1 Labor	2080	hr	$75 /hr	$156,000	Assumes one full time field person will be on-site to conduct O&M, collect air samples, and perform air monitoring for 8 hours a day during the first year SVE operation
	11 2 Laboratory Analyses (VOCs)	28	analysis	$300 /analysis	$8,400	Quoted by Test America Inc TN
	11.3 Laboratory Analyses (HCL)	28	analysis	$35 /analysis	$1,000	Quoted by Test America Inc. TN

Table D2-2a

Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	11 4 Rental Equipment	56	day	$90 /day	$5,000	MicroFID - quote from Pine Environmental Services, Inc
	11 5 Mobilization/Demobilization	0				Assumes one field person will already be local
	11 6 Temp Field Office Trailer & Storage Trailer	12	month	$338 /month	$4,100	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
	11 7 Supplies	12	month	$500 /month	$6,000	Based on CH2M HILL's professional judgement
12	Industrial Discharge Monitoring (Year 1), 12 Events					Assumes 4 samples and QC samples will be collected, discharge effluent to sewer line, from remediation system This sample will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot.
	12 1 Labor					Assumes 1 field person will be on-site full time for system O&M
	12 2 Laboratory Analyses (VOCs)	56	analysis	$198 /analysis	$11,100	Quoted by Test America Inc. TN.
	12.3 Rental Equipment	12	day	$210 /day	$2,500	Based on CH2M HILL's professional judgement This cost includes field measurement probes (Conductivity, pH, temp, turbidity, DO) and water level indicator.
	12 4 Mobilization/Demobilization	0				Assumes sampling events will be performed while conducting monthly air sampling
	12 5 Supplies	12	month	$200 /month	$2,400	Based on CH2M HILL's professional judgement
13	Confirmatory Soil Vapor Sampling from existing points (Year 3-4)					Soil vapor samples will be collected and analyzed to confirm soil cleanup at the site at the completion of the SVE remediation
	13 5 Sampling Labor	200	hr	$75 /hr	$15,000 [PW $12400]	Assumes 2 field persons will be on-site for soil vapor sampling for 10 hours a day for 10 days

Table D2-2a

Capital Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	13 6 Laboratory Analyses (VOCs)	245	analysis	$300 /analysis	$73,500 [PW $60500]	Assumes 4 samples from each boring will be sent to Test America in TN The price includes 3 encores for each sample.
	13 7 Rental Equipment	10	day	$90 /day	$900 [PW $800]	MicroFID - quote from Pine Environmental Services, Inc.
	13 8 Mobilization/Demobilization	24	hr	$75 /each	$1,800 [PW $1500]	Assumes 2 field persona will be on-site for soil vapor sampling
	13 9 Supplies	1	event	$2,000 /event	$2,000 [PW $1700]	CH2M HILL Professional judgement
14	Abandonment of Wells (Year 4-5)					Assumes 54 vertical SVE wells for loess (total depth=25 feet) and 24 vertical SVE wells for fluvial sand (total depth=65 feet) and 20 confirmatory wells (80 ft) will be abandoned at the completion of remedial alternative This cost will occur in year 5
	14 1 Mobilization/Demobilization	1	ea	$1,200 /ea	$1,200 [PW $1000]	Local driller
	14 2 Abandon Wells	5950	ft	$4 ft	$23,800 [PW $19600]	Costs from Boart Longyear (2002)
15	Equipment Removal and Site Restoration (Year 4-5)	1	ea	$25,000 /ea	$25,000 [PW $20600]	
16	Annual Report (Year 1)	120	hr	$85 /hr	$10,200	A summary O&M report will be produced annually Assume will take approximately 2 weeks and a half to complete.
Capital Costs					$2,451,712	Assume first year is a capital expense
	Project Management & Support				$122,586	5% of Capital Costs
					$2,574,298	
	Contingency				$257,430	10% Contingency Costs
Total Capital Costs					**$2,831,727**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.

Table D2-2b
O&M Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
17	Utilities						The SVE system will run 3 years
	17 1 Electricity for vacuum pumps	587,910	kw-hr	$0 06 /kw-hr	$35,275	$96,100	Assumes vacuum pumps (total of 90 HP) will run 24 hours per day for 365 days each year
	17 2 Electricity for heater	7,200	kw-hr	$0 06 /kw-hr	$432	$1,200	Assumes a heater (2 kw) will run 5 months during the winter season each year
	17 3 Electricity for Offgas Treatment	32,662	kw-hr	$0 06 /kw-hr	$1,960	$5,400	Assumes a fan (5 HP) for offgas treatment will run 24 hours per day for 365 days each year
	17 4 Fuel Consumption for Offgas Treatment	21,024	therms	$1 00 /therm	$21,024	$57,300	Fuel consumption will be 2 4 therms/hr based on Catalytic Combustion's estimation The system will consume natural gas 24 hours a day for 365 days each year Assumes natural gas will cost $1 00 per therm
	17 5 Water Usage for Offgas Treatment	1,436,640	gal	$0 08 /gal	$115,239	$313,900	Water usage will be 164 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year Public water will cost $0 60 per cubic foot
	17 6 Sewerage for Offgas Treatment	1,174	1000 gal	$0 59 /1000 gal	$693	$1,900	Water discharge rate will be 134 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year. The sewerage charge will be $0 587 per 1000 gallon
	17 7 Sewerage for groundwater recovered by SVE systems	105	1000 gal	$0 59 /1000 gal	$62	$200	Water purging rate from SVE systems will be 0 2 gpm (or 12 gal/hr) based on the SVE feasibility study conducted at the site in December 2001 The system will purge water 24 hours a day for 365 days for the first year The sewerage charge will be $0 587
	17 8 Miscellaneous (NaOH Required to Neutralize HCl)	66,600	gal	$0 31 /gal	$20,700	$56,300	Assumes 7 52 gallons per hour of 25% NaOH solution (freeze at 10 degrees F) or 3 13 gallons per hour of 50% NaOH solution (freeze at 45 degrees F) is needed to neutralize HCl generated from the system 25% NaOH will be $0 31 per gallon and 50% NaOH will

Table D2-2b
O&M Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
18 .	Air Sampling for VOCs, air monitoring, and SVE O&M						Air samples will be collected from discharge stack out of offgas treatment and scrubber monthly for VOCs analysis QA samples (duplicate, ambient, and equipment blank) will be also collected and analyzed Air monitoring at the site and SVE O&M will be c
	18 1 Labor	2080	hr	$75 /hr	$156,000	$424,900	Assumes one full time field person (1 FTE) will be on-site to conduct O&M, collect air samples, and perform air monitoring for 8 hours a day during each year of SVE operation
	18 2 Laboratory Analyses (VOCs)	28	analysis	$300 /analysis	$8,400	$22,900	Quoted by Test America Inc TN
	18 3 Laboratory Analyses (HCL)	28	analysis	$35 /analysis	$1,000	$2,700	Quoted by Test America Inc TN
	18 4 Laboratory Analyses (VOCs)	64	analysis	$300 /analysis	$19,200	$52,300	Periodic sampling and testing from soil vapor points Assumes 32 samples semi-annually
	18 5 Rental Equipment	56	day	$90 /day	$5,000	$13,800	MicroFID - quote from Pine Environmental Services, Inc
	18 6 Mobilization/Demobilization	0					Assumes one field person will be local
	18 7 Supplies	12	event	$500 /event	$6,000	$16,400	Based on CH2M HILL's professional judgement
19	Industrial Discharge Monitoring (Year 2-4), 36 Events						Assumes 4 samples will be collected, discharge effluent to sewer line and QC samples, from remediation system This sample will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot
	19 1 Labor						Assumes 1 field person will be on-site for 8 hours for one day for each event
	19 2 Laboratory Analyses (VOCs)	56	analysis/yr	$198 /analysis	$11,100	$30,200	Quote from Columbia Analytical Services, Redding, CA
	19 3 Rental Equipment	12	day/yr	$210 /day	$2,500	$6,900	CH2M HILL Eglin AFB, FL AAS System Cost Estimate - Capital Costs
	19 4 Mobilization/Demobilization	0					Assume samples will be collected while conducting system O&M
	19 5 Supplies	12	event/yr	$200 /event	$2,400	$6,600	Based on CH2M HILL Reichhold-Summary Invoice of Site Operations Reduce cost to $200 due to less intensive sampling event

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Table D2-2b
O&M Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
20	Annual Report	120	hr/yr	$85 /hr	$10,200	$27,800	A summary O&M report will be produced annually Assume will take approximately 2 weeks and a half to complete
Total O&M Costs (2-4 years)					**$417,185**	**$1,137,000**	
	Project Management & Support				$20,859	$56,850	5% of O&M Costs
Total O&M Costs (2-4 years)					**$438,044**	**$1,193,850**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 3-4 years Year 1 of O&M is included in Capital Costs

Table D2-2c

Capital Cost and O&M Cost Estimate: Subsurface Soil - Vertical SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Total PW Cost[c]
1	Institutional Controls	$9,000	NA	NA	$9,000
2	Fencing along Perimeter of Disposal Area	$52,214	NA	NA	$52,214
3	Signs	$614	NA	NA	$614
4	Plans for Implementation	$10,200	NA	NA	$10,200
5	Soil Investigation and Soil Monitoring Points	$209,880	NA	NA	$209,880
6	SVE Wells Installation	$254,440	NA	NA	$254,440
7	Capital Equipment and Construction	$1,147,879	NA	NA	$1,147,879
8	Startup	$58,100	NA	NA	$58,100
9	Offgas Treatment	$179,900	NA	NA	$179,900
10	Utilities (Year 1)	$204,685	NA	NA	$204,685
11	Air Sampling for VOCs, air monitoring, and SVE O&M	$180,500	NA	NA	$180,500
12	Industrial Discharge Monitoring (Year 1), 12 Events	$16,000	NA	NA	$16,000
13	Confirmatory Soil Vapor Sampling from existing points (Ye	$76,900	NA	NA	$76,900
14	Abandonment of Wells (Year 4)	$20,600	NA	NA	$20,600
15	Equipment Removal and Site Restoration (Year 4)	$20,600	NA	NA	$20,600
16	Annual Report (Year 1)	$10,200	NA	NA	$10,200
--	Project Management & Support	$122,586	NA	NA	$122,586
--	Contingency (Year 1)	$257,430	NA	NA	$257,430
17	Utilities	NA	$195,385	$532,300	$532,300
18	Air Sampling for VOCs, air monitoring, and SVE O&M	NA	$195,600	$533,000	$533,000
19	Industrial Discharge Monitoring (Year 2-4), 36 Events	NA	$16,000	$43,700	$43,700
20	Annual Report	NA	$10,200	$27,800	$27,800
--	Project Management & Support		$20,859	$56,850	$56,850
Total Costs		**$2,832,000**	**$438,000**	**$1,194,000**	**$4,025,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] Total PW cost includes capital plus PW O&M costs over 3 years

NA = Not applicable

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Table D2-2a1
Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Institutional Controls (Deed Restrictions)					Deed restrictions would prohibit installation and use of production and consumptive use wells and access to the Disposal Area of Dunn Field
	1.1 Attorney Fees	40	hr	$200 /hr	$8,000	CH2M HILL American Scrap Metal Site, Panama City Order of Magnitude Cost Estimate for Alternative 2A
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Fencing along Perimeter of Disposal Area					
	2 1 Fencing	2,200	ft	$23 /ft	$50,600	Use of existing fence and additional fence, Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
	2.2 Gate	2	ea	$807 /hr	$1,614	Assumes two field people will be on site for 10 hours per day for 5 days
3	Signs					
	3 1 Signs	6	ea	$69 ea	$414	Estimate from RS Means Environmental Remediation Cost Data (2001). Order of magnitude costs.
	3 3 Labor	4	hr	$50 hr	$200	
4	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement
						Plans to develop include Site Safety and Health Plan, Environmental Protection Plan, Quality Assurance Project Plan, and Sampling and Analysis Plan
						Plans to develop include Site Safety and Health Plan and Environmental Protection Plan.

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5	Soil Investigation and Soil Monitoring Points					Assumes 52 soil monitoring points (2 horizons) for the loess and 48 (2 horizons) soil monitoring points for the fluvial sand will be installed to monitor full-scale soil vapor extraction Screens will be set at multiple depths in each borehole (2 horizons in the loess and 2 horizons in the fluvial sand). Soil samples will be collected from 20 locations
	5.1 Mobilization/Demobilization	1	ea	$8,500 /ea	$8,500	Assume Rotasonic drill rig and equipment will not be local.
	5 2 Soil Monitoring Point Drilling	3084	ft	$62 /ft	$191,208	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear (2002). Bore holes will be drilled and continuously sampling using Rotasonic drilling methods. Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
	5 3 Labor (Contractor oversight)	170	hr	$75 /hr	$12,800	Assumes one field person will be on-site for overseeing and soil sampling for 10 hours a day for 17 days.
	5 4 Laboratory Analyses (VOCs)	106	analysis	$192 /analysis	$20,400	Assumes 4 samples from each sampling locations will be sent to Test America in TN The price includes QA/QC samples.
	5 5 Laboratory Analyses (TCLP)	1	analysis	$955 /analysis	$1,000	Kemron Laboratory , based on 14-day TAT
	5 6 Rental Equipment	19	day	$90 /day	$1,700	MicroFID - quote from Pine Environmental Services, Inc.
	5 7 Mobilization/Demobilization (Oversight and soil sampling)	32	hr	$75 /hr	$2,400	Assumes it will take one field person 8 hours for mobilization and 8 hours for demobilization for each trip. Two trips will be needed.
	5 8 Supplies	2	event	$500 /event	$1,000	CH2M HILL professional judgement

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Table D2-2a1
Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
6	Horizontal SVE Wells Installation					Three horizontal SVE wells for loess (15-20 feet in depth and 705 to 840 feet in length) and two horizontal SVE wells for fluvial sand (50-55 feet in depth and 730 to 820 feet in length) will be installed at the site. Both riser casing and screen will be 6-inch SDR-11 HDPE Slotted screen is 3 rows of 0.020-inch slots
	6 1 Mobilization	1	ea	$75,760 /ea	$75,760	Quoted by Longbore, Inc. The price includes drill rig, pipe trailer, mud system, generator trailer, support truck, steam cleaner, fork lift, back hoe, initial and final decon, surveying, PVC liner material, water PPE, water truck, drilling fluid and additives, vacuum truck services, and etc
	6 2 Drilling and Well Construction	6325	ft	$59 /ft	$373,175	Quoted by Longbore, Inc
	6 3 Materials					Quoted by Longbore, Inc.
	6 3 1 Sacks Portland cement	100	ea	$16 /ea	$1,600	Quoted by Longbore, Inc.
	6 3 2 SDR 11 HDPE screen	5100	ft	$12 /ft	$61,200	Quoted by Longbore, Inc.
	6.3.3 SDR 11 HDPE riser	1696	ea	$8 /ea	$13,600	Quoted by Longbore, Inc
	6.4 Development	100	hr	$500 /hr	$50,000	Quoted by Longbore, Inc.
	6 5 Laboratory Analyses (TCLP)	4	analysis	$955 /analysis	$3,800	Kemron Laboratory , based on 14-day TAT
	6 6 Soil Disposal	8	roll-off	$2,000 /roll-off	$16,000	The cost includes roll-off rental, transportation and disposal for non-hazardous soil bore cuttings Assumes a roll-off is 17 cubic yards and 123 cubic yard soil will be generated (estimated by Longbore, Inc.)
	6.7 Labor (Oversight)	500	hr	$75 /hr	$37,500	Assumes one field person will be on-site for overseeing for 10 hours a day for 50 days
	6.8 Mobilization/Demobilization (Oversight)	64	hr	$75 /hr	$4,800	Assumes it will take one field person 8 hours for mobilization and 8 hours for demobilization for each trip (4 trips is needed)

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
7	Vertical SVE Wells Installation					24 vertical SVE wells for loess (total depth=25-30 feet) and 10 vertical SVE wells for fluvial sand (total depth=70-75 feet) will be installed at the site.
	7 1 Mobilization	0	ea	$0 /ea	$0	Assume Mobilization will be at the same time that soil monitoring points are installed, therefore no costs are presented.
	7 2 SVE Wells Drilling and Preparation for Loess	648	ft	$72 /ft	$46,656	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear
	7.3 SVE Wells Drilling and Preparation for fluvial sand	720	ft	$72 /ft	$51,840	Bore holes will be drilled and continuously sampling using Rotasonic drilling methods Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
	7 4 Labor (Oversight)	170	hr	$75 /hr	$12,800	Assumes one field person will be on-site for overseeing for 10 hours a day for 17 days.
	7.5 Laboratory Analyses (TCLP)	1	analysis	$955 /analysis	$1,000	Kemron Laboratory , based on 14-day TAT
	7 6 Mobilization/Demobilization (Oversight)	16	hr	$75 /hr	$1,200	Assumes it will take one field person 8 hours for mobilization and 8 hours for demobilization for each trip. Two trips will be needed
8	Capital Equipment and Construction					
	8 1 Vacuum Pumps for loess	1	ea	$63,500 /ea	$63,500	Quoted by EPG/Catalytic Combustion A HYVAC 75 HP MPE Systems Nominal 1200 ACFM @ 26" Hg will be used. The cost includes MPE, Vapor/Liquid Separator (VSL), Controls, Wiring panel to skid.
	8.2 Vacuum Pump for sand	1	ea	$13,500 /ea	$13,500	Quoted by EPG/Catalytic Combustion. Low Vac 15 HP Regenerative System 500 ACFM @ 2 3" Hg The cost includes MPE, VLS, Controls, Wiring panel to skid.
	8 3 Trenching	4,500	LF	$6.50 /LF	$29,250	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for 3 feet deep trenching Assumes soil will be placed back in trench.

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	8.4 Piping Cost	4,500	LF	$1.46 /LF	$6,570	Quoted by Michigan Pipe Supply, LLC. The cost includes 4" SDR 11 HDPE pipes x 500' coil.
	8.5 Miscellaneous	1	ea	$13,000 /ea	$13,000	The price includes 4" HDPE SDR 11 MPT transitions, flange adapters, ductile iron back up rings, reducing couplings, throttling valves, air flow meters, vacuum gauges, and well vaults.
	8 6 Piping Assembling	1	ea	$81,000 /ea	$81,000	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for piping assembling, well vaults installation, and other pipe fitting.
	8.7 Equipment Storage Building	1	ea	$19,800 /ea	$19,800	Quoted by Engineering Management Construction, Inc Butler building package 15'x20'x15'.
	8 8 Building Heater	1	ea	$500 /ea	$500	
	8.9 Auto Dialer	1	ea	$4,000 /ea	$4,000	
	8 10 Capping	360,000	sq. ft.	$1 75 /sq ft	$630,000	Based on CH2M HILL's professional judgement The cost includes 3 person crew, grading, putting 20 mm liner down and fill with 6" cover of gravel and stones. There will be less stick-ups through the cap with the horizontal wells
9	Startup					Project Manager and an engineer will have a kick off meeting and a safety meeting with subcontractors Assumes Startup will take 10 hours a day for 14 days
	9.1 Labor (Startup)	560	hr	$85 /hr	$47,600	Assumes 4 people (2 engineers and 2 technicians) will oversee the system startup It will take 10 hours per day for 14 days
	9.2 Mobilization/ Demobilization (Startup)	64	hr	$85 /hr	$5,400	Assumes it will take 4 people 8 hours for mobilization and 8 hours for demobilization for the startup
	9 3 Summary TM	60	hr	$85 /hr	$5,100	A summary Technical Memorandum will be written after the startup.

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
10	Offgas Treatment					
	10.1 Chlorinated Catalytical Oxidizer	1	ea	$85,000 /ea	$85,000	Quoted by Catalytic Combustion Base system price for Model HD-CATOX 750G
	10 2 Scrubber for HCl emissions	1	ea	$61,000 /ea	$61,000	Quoted by Catalytic Combustion Base system price for Model 1000 HCl Scrubber Module
	10 3 Miscellaneous	1	ea	$13,200 /ea	$13,200	The price was quoted by Catalytic Combustion plus 20% contingency. The cost includes freight (SVE & Offgas Treatment equipment) to the job site, subcontractor's start-up cost, and spare parts package for the oxidizer and scrubber.
	10.4 NaOH Required to Neutralize HCl for the first year	66,600	gal	$0.31 /gal	$20,700	Assumes 7.52 gallons per hour of 25% NaOH solution (freeze at 10 degrees F) or 3 13 gallons per hour of 50% NaOH solution (freeze at 45 degrees F) is needed to neutralize HCl generated from the system 25% NaOH will be $0 31 per gallon and 50% NaOH will
11	Utilities (Year 1)					
	11 1 Electricity for vacuum pumps	685,895	kw-hr	$0 06 /kw-hr	$41,154	Assumes vacuum pumps (total of 105 HP) will run 24 hours a day for 365 days for the first year
	11 2 Electricity for heater	7,200	kw-hr	$0 06 /kw-hr	$432	Assumes a heater (2 kw) will run 5 months during the winter season for the first year
	11 3 Electricity for Offgas Treatment	32,662	kw-hr	$0.06 /kw-hr	$1,960	Assumes a fan (5 HP) for offgas treatment will run 24 hours a day for 365 days for the first year
	11.4 Fuel Consumption for Offgas Treatment	21,024	therms	$1 00 /therm	$21,024	Fuel consumption will be 2.4 therms/hr based on Catalytic Combustion's estimation The system will consume natural gas 24 hours a day for 365 days for the first year Assumes natural gas will cost $1 00 per therm Gasoline connection fee is included.

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Table D2-2a1
Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	11 5 Water Usage for Offgas Treatment	1,436,640	gal	$0.08 /gal	$115,239	Water usage will be 164 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days for the first year Public water will cost $0 60 per cubic foot Water line connection fee is included
	11 6 Sewerage for Offgas Treatment	1,174	1000 gal	$0.59 /1000 gal	$693	Water discharge rate will be 134 gal/hr based on Catalytic Combustion's estimation The system will discharge water 24 hours a day for 365 days for the first year. The sewerage charge will be $0.587 per 1000 gallon. Sewerage connection fee is included.
	11.7 Sewerage for Groundwater Recovered by SVE Systems	105	1000 gal	$0 59 /1000 gal	$62	Water purging rate from SVE systems will be 0.2 gpm (or 12 gal/hr) based on the SVE feasibility study conducted at the site in December 2001. The system will purge water 24 hours a day for 365 days for the first year. The sewerage charge will be $0 587
	11 8 Electricity Hookup	1	ea	$30,000 /ea	$30,000	Three-Phase 460-volt AC Supplies at 100-amp is needed at the site The cost includes transformers, poles, and subcontractor's labor.
12	Air Sampling for VOCs, Air Monitoring, and SVE O&M					Assume first year of air sampling, air monitoring and SVE O&M is a capital expense. Air samples will be collected from discharge stack out of offgas treatment and scrubber, daily for first 3 days and weekly for first 4 weeks for the Startup and monthly thereafter
	12 1 Labor	2080	hr	$75 /hr	$156,000	Assumes one full time field person will be on-site to conduct O&M, collect air samples, and perform air monitoring for 8 hours a day during the first year SVE operation.
	12.2 Laboratory Analyses (VOCs)	28	analysis	$300 /analysis	$8,400	Quoted by Test America Inc. TN
	12 3 Laboratory Analyses (HCL)	28	analysis	$35 /analysis	$1,000	Quoted by Test America Inc. TN
	12 4 Rental Equipment	56	day	$90 /day	$5,000	MicroFID - quote from Pine Environmental Services, Inc.
	12 5 Mobilization/Demobilization	0				Assumes one field person will be local

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	12 6 Temp. Field Office Trailer & Storage Trailer	12	month	$338 /month	$4,100	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs.
	12 7 Supplies	12	month	$1,000 /month	$12,000	Based on CH2M HILL's professional judgement.
13	Industrial Discharge Monitoring (Year 1), 12 Events					Assumes 4 samples and QC samples will be collected, discharge effluent to sewer line, from remediation system This sample will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot.
	13.1 Labor	0				Assumes 1 field person will be on-site full time for system O&M.
	13 2 Laboratory Analyses (VOCs)	56	analysis	$198 /analysis	$11,100	Quoted by Test America Inc TN.
	13 3 Rental Equipment	12	day	$210 /day	$2,500	CH2M HILL Eglin AFB, FL AAS System Cost Estimate - Capital Costs This cost includes field measurement probes (Conductivity, pH, temp, turbidity, DO) and water level indicator
	13 4 Mobilization/Demobilization	0				Assumes sampling events will be performed while conducting monthly air sampling.
	13 5 Supplies	12	month	$200 /month	$2,400	Based on CH2M HILL's professional judgement.
14	Confirmatory Soil Vapor Sampling from existing points (Year 3-4)					Soil vapor samples will be collected and analyzed to confirm soil cleanup at the site at the completion of the SVE remediation
	14.1 Sampling Labor	200	hr	$75 /hr	$15,000 [PW $12400]	Assumes 2 field persons will be on-site for soil vapor sampling for 10 hours a day for 10 days
	14 2 Laboratory Analyses (VOCs)	245	analysis	$300 /analysis	$73,500 [PW $60500]	Assumes 4 samples from each boring will be sent to Test America in TN The price includes 3 encores for each sample
	14 3 Rental Equipment	10	day	$90 /day	$900 [PW $800]	MicroFID - quote from Pine Environmental Services, Inc
	14 4 Mobilization/Demobilization	24	hr	$75 /each	$1,800 [PW $1500]	Assumes 2 field persona will be on-site for soil vapor sampling.
	14 5 Supplies	1	event	$2,000 /event	$2,000 [PW $1700]	CH2M HILL Professional judgement

Table D2-2a1

Capital Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
15	Abandonment of Wells (Year 4-5)					Assumes 54 vertical SVE wells for loess (total depth=25 feet) and 24 vertical SVE wells for fluvial sand (total depth=65 feet) and 20 confirmatory wells (80 ft) will be abandoned at the completion of remedial alternative This cost will occur in year 5
	15.1 Mobilization/Demobilization	1	ea	$1,200 /ea	$1,200 [PW $1000]	Local driller
	15.2 Abandon Wells	10777	ft	$4 ft	$43,108 [PW $72800]	Costs from Boart Longyear (2002)
16	Equipment Removal and Site Restoration (Year 4-5)	1	ea	$25,000 /ea	$25,000 52,500	
17	Annual Report (Year 1)	100	hr	$85 /hr	$8,500	A summary O&M report will be produced annually Assume will take approximately 2 weeks and a half to complete.
Capital Costs					$2,753,951	Assume first year is a capital expense.
	Project Management & Support				$137,698	5% of Capital Costs
					$2,891,649	
	Contingency				$289,165	10% Contingency Costs
Total Capital Costs					**$3,180,813**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations. The estimate is typically accurate within plus 50 to minus 30 percent.

Table D2-2b1
O&M Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
18	Utilities						The SVE system will run 3-4 years
	18 1 Electricity for vacuum pumps	685,895	kw-hr	$0 06 /kw-hr	$41,154	$112,100	Assumes vacuum pumps (total of 105 HP) will run 24 hours per day for 365 days each year
	18 2 Electricity for heater	7,200	kw-hr	$0 06 /kw-hr	$432	$1,200	Assumes a heater (2 kw) will run 5 months during the winter season each year
	18 3 Electricity for Offgas Treatment	32,662	kw-hr	$0 06 /kw-hr	$1,960	$5,400	Assumes a fan (5 HP) for offgas treatment will run 24 hours per day for 365 days each year
	18 4 Fuel Consumption for Offgas Treatment	21,024	therms	$1 00 /therm	$21,024	$57,300	Fuel consumption will be 2 4 therms/hr based on Catalytic Combustion's estimation The system will consume natural gas 24 hours a day for 365 days each year Assumes natural gas will cost $1 00 per therm
	18 5 Water Usage for Offgas Treatment	1,436,640	gal	$0 08 /gal	$115,239	$313,900	Water usage will be 164 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year Public water will cost $0 60 per cubic foot
	18 6 Sewerage for Offgas Treatment	1,174	1000 gal	$0 59 /1000 gal	$693	$1,900	Water discharge rate will be 134 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year The sewerage charge will be $0 587 per 1000 gallon
	18 7 Sewerage for groundwater recovered by SVE systems	105	1000 gal	$0 59 /1000 gal	$62	$200	Water purging rate from SVE systems will be 0 2 gpm (or 12 gal/hr) based on the SVE feasibility study conducted at the site in December 2001 The system will purge water 24 hours a day for 365 days for the first year The sewerage charge will be $0 587
	18 8 Miscellaneous (NaOH Required to Neutralize HCl)	66,600	gal	$0 31 /gal	$20,700	$56,300	Assumes 7 52 gallons per hour of 25% NaOH solution (freeze at 10 degrees F) or 3 13 gallons per hour of 50% NaOH solution (freeze at 45 degrees F) is needed to neutralize HCl generated from the system 25% NaOH will be $0 31 per gallon and 50% NaOH will

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Table D2-2b1
O&M Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
19	Air Sampling for VOCs, air monitoring, and SVE O&M						Air samples will be collected from discharge stack out of offgas treatment and scrubber monthly for VOCs analysis QA samples (duplicate, ambient, and equipment blank) will be also collected and analyzed Air monitoring at the site and SVE O&M will be conducted at the same time
	19 1 Labor	2080	hr	$75 /hr	$156,000	$424,900	Assumes one full time field person (1 FTE) will be on-site to conduct O&M, collect air samples, and perform air monitoring for 8 hours a day during each year of SVE operation
	19 2 Laboratory Analyses (VOCs)	28	analysis	$300 /analysis	$8,400	$22,900	Quoted by Test America Inc TN
	19 3 Laboratory Analyses (HCL)	28	analysis	$35 /analysis	$1,000	$2,700	Quoted by Test America Inc TN
	Laboratory Analyses (VOCs)	64	analysis	$300 /analysis	$19,200	$52,300	Periodic sampling and testing from soil vapor points Assumes 32 samples semi-annually
	19 4 Rental Equipment	56	day	$90 /day	$5,000	$13,800	MicroFID - quote from Pine Environmental Services, Inc
	19 5 Mobilization/Demobilization						Assumes one field person will be local
	19 6 Supplies	12	event	$1,000 /event	$12,000	$32,700	Based on CH2M HILL's professional judgement
20	Industrial Discharge Monitoring (Year 2-4), 36 Events						Assumes 4 samples will be collected, discharge effluent to sewer line and QC samples, from remediation system This sample will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot
	20 1 Labor						Assumes 1 field person will be on-site for 8 hours for one day for each event
	20 2 Laboratory Analyses (VOCs)	56	analysis/yr	$198 /analysis	$11,100	$30,200	Quote from Columbia Analytical Services, Redding, CA
	20 3 Rental Equipment	12	day/yr	$210 /day	$2,500	$6,900	CH2M HILL Eglin AFB, FL AAS System Cost Estimate - Capital Costs
	20 4 Mobilization/Demobilization	0					Assume samples will be collected while conducting system O&M
	20 5 Supplies	12	event/yr	$200 /event	$2,400	$6,600	Based on CH2M HILL Reichhold-Summary Invoice of Site Operations Reduce cost to $200 due to less intensive sampling event

Table D2-2b1
O&M Cost Estimate. Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil
Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
21	Annual Report	120	hr/yr	$85 /hr	$10,200	$27,800	A summary O&M report will be produced annually Assume will take approximately 2 weeks and a half to complete
Total O&M Costs (2-4 years)					$429,064	$1,169,000	
	Project Management & Support				$21,453	$58,450	5% of O&M Costs
Total O&M Costs (2-4 years)					$450,517	$1,227,450	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 3-4 years Year 1 of O&M is included in Capital Costs

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Table D2-2c1

Capital Cost and O&M Cost Estimate: Subsurface Soil - Horizontal SVE Presumptive Remedy for VOCs in Soil

Rev 0 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Total PW Cost[c]
1	Institutional Controls	$9,000	NA	NA	$9,000
2	Fencing along Perimeter of Disposal Area	$52,214	NA	NA	$52,214
3	Signs	$614	NA	NA	$614
4	Plans for Implementation	$10,200	NA	NA	$10,200
5	Soil Investigation and Soil Monitoring Points	$239,008	NA	NA	$239,008
6	Horizontal SVE Wells Installation	$637,435	NA	NA	$637,435
7	Vertical SVE Wells Installation	$113,496	NA	NA	$113,496
8	Capital Equipment and Construction	$861,120	NA	NA	$861,120
9	Startup	$58,100	NA	NA	$58,100
10	Offgas Treatment	$179,900	NA	NA	$179,900
11	Utilities (Year 1)	$210,564	NA	NA	$210,564
12	Air Sampling for VOCs, Air Monitoring, and SVE O&M	$186,500	NA	NA	$186,500
13	Industrial Discharge Monitoring (Year 1), 12 Events	$16,000	NA	NA	$16,000
14	Confirmatory Soil Vapor Sampling from existing points (Ye	$76,900	NA	NA	$76,900
15	Abandonment of Wells (Year 4)	$73,800	NA	NA	$73,800
16	Equipment Removal and Site Restoration (Year 4)	$20,600	NA	NA	$20,600
17	Annual Report (Year 1)	$10,200	NA	NA	$10,200
--	Project Management & Support	$137,698	NA	NA	$137,698
--	Contingency (Year 1)	$289,165	NA	NA	$289,165
18	Utilities	NA	$201,264	$548,300	$548,300
19	Air Sampling for VOCs, air monitoring, and SVE O&M	NA	$201,600	$549,300	$549,300
20	Industrial Discharge Monitoring (Year 2-4), 36 Events	NA	$16,000	$43,700	$43,700
21	Annual Report	NA	$10,200	$27,800	$27,800
--	Project Management & Support	NA	$21,453	$58,450	$58,450
Total Costs		**$3,183,000**	**$451,000**	**$1,228,000**	**$4,410,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] Total PW cost includes capital plus PW O&M costs over 3 years

APPENDIX D-3

Cost Estimates for the Groundwater Alternatives

TABLE D3-2a

Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior

Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Deed Restrictions					Deed restrictions would prohibit installation and use of production and consumptive use wells They would also permit regulator access to all monitoring wells for the10-year life of this remedy
	1 1 Attorney Fees	32	hr	$200 /hr	$6,400	CH2M HILL American Scrap Metal Site, Panama City Order of Magnitude Cost Estimate
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement
						Plans to develop include Site Safety and Health Plan and Environmental Protection Plan.
3	ZVI Injection Procedures					
	3 1 Injection Bench-Scale & Pilot Test	1	ea	$231,600 /ea	$231,600	Quote from ARS Technologies, Inc Assumes 4 well pilot test using new wells
	3 2 Full-Scale Implementation	1	ea	$3,098,021 /ea	$3,098,021	Quote from ARS Technologies, Inc Assumes 43 wells using pneumatic fracturing and atomized liquid injection. Assumes 40 foot radius of influence per well. Includes subcontractor PM labor, reporting, permitting, electricity, and water
	3 3 Oversight of Pilot Test	80	hr	$75 /hr	$6,000	Assume 2 weeks for pilot test
	3 4 Oversight of Full Scale	1,040	hr	$75 /hr	$78,000	Assume 6 months for implementation
	3 5 Waste Disposal	2	ea	$2,000 /ea	$4,000	Includes rolloff rental, dropoff/pickup Assume soils and other waste is nonhazardous.
	3 6 Temp Field Office, Trailer, and Storage Trailer	7	mn	$338 mn	$2,366	Estimate from RS Means Environmental Remediation Cost Data (2001). Order of magnitude costs
	3 7 Initial/Confirmatory Pilot Test GW Sampling					
	3 7 1 Labor	96	hr	$75 /hr	$7,200	Assumes 2 field people will be on-site for 12 hours for 4 days for both events

TABLE D3-2a
Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	3 7 2 Laboratory Analyses (VOCs)	24	analysis	$104 /analysis	$2,500	Quote from GEL Labs
	3 7 3 Laboratory Analyses (MNA Parameters)	24	analysis	$300 /analysis	$7,200	Quote from GEL Labs
	3 7 4 Rental Equipment	8	day	$330 /day	$2,600	CH2M HILL Professional estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	3 7 5 Supplies	1	event	$500 /event	$500	CH2M HILL Professional estimate
4	Installation of 10 Recovery Wells					Assume wells will be stainless steel, 100 feet deep, with 10-foot screens Wells will be installed using Rotasonic drilling method. Assume wells will yield approximately 30 gpm
	4 1 Typical Recovery Well	10	ea	$25,116 /ea	$251,160	OHM costs for installation of four recovery wells on Dunn Field. These costs include material, labor, equipment, and other government costs for drill, set, and development of well casing and screen, concrete base, well pumps, piping to effluent line, decontamination of equipment, disposal IDW, centralizers, miscellaneous piping and fittings, and flowmeters
	4 2 Conveyance System Construction	1	ea	$1,921,215 /ea	$1,921,215	Includes plumbing of new recovery wells to existing system Based on costs from Jacobs Engineering to install four new recovery wells at south end of system.
5	Full Scale Bioremediation (Year 1)					Electron donors will be injected into 100 injection wells (spacing=40') for 90 days 10 more monitoring wells will be installed to monitor full-scale enhanced bioremediation. Sampling from 18 wells, 3 times for the startup and quarterly thereafter Startup will be 14 days O&M: weekly for the first 6 months and bi-weekly thereafter

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TABLE D3-2a

Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior

Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
5 1	Electron Donor Fluids	3,171,000	lbs	$0.35 /lb	$1,109,850	Based on quotations for MI EBT Treatability Study
5 2	Water Mix Costs	320,000	cu ft.	$0 54 /cu ft	$172,800	Purchase of water from City of Memphis Utilities
5 3	Drilling Mobilization/Demobilization	1	ea	$8,500 00 /ea	$8,500	Assume rotosonic drilling mobilization
5 4	Installation 100 Injection Wells - Rotasonic	8,500	ft	$62 /ft	$527,000	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear (2002) Bore holes will be drilled and continuously sampling using Rotasonic drilling methods. Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
5 5	Installation 15 Monitoring Wells - Rotasonic	1,350	ft	$62 /ft	$83,700	Defense Depot - Groundwater Remedial Act, U S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field)
5 6	Labor (well installation oversight)	1,320	hr	$75 /hr	$99,000	Assume 1 field person will be required to oversee and prepare site for well installation Assume it will take approximately 12 hours per day for 100 days
5 7	Mobilization/ Demobilization (well installation oversight)	88	hr	$75 /hr	$6,600	Assumes it will take one field person 4 hours for mobilization and 4 hours for demobilization for each trip 11 trips is needed
5 8	Injection Pumps	3	ea	$20,000 /ea	$60,000	Based on costs for a Watson-Marlow SPX80 Pump (estimate from Paxson Eng. Equip)
5.9	Storage Tanks	6	ea	$32,000 /ea	$192,000	Based on estimate from ASME Pressure Tanks for 10,000 gallon and 5,000 gallon carbon stell tanks for storage and batch mixing service
5.10	Trenching and Pipe Assembly	2,575	ft	$27 /ft	$68,238	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for piping assembling, well vaults installation, and other pipe fitting
5 11	Equipment Storage Building	3	ea	$29,700 /ea	$89,100	Quoted by Engineering Management Construction, Inc Butler building package 30'x25'x12'
5 12	Building Heater	1	ea	$500 /ea	$500	CH2M HILL Professional Estimate

TABLE D3-2a
Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	5 13 Utilities -Electricity	100000	ea	$0 06 /ea	$6,000	CH2M HILL Professional Estimate
	5 14 Labor - Installation and Oversight	6,600	hr	$75 /hr	$495,000	Assume 5 person work/oversight crew to work 6 months to setup piping, pumps, and startup of system.
	5.15 Labor (O&M, weekly for first 6 months & bi-weekly thereafter)	390	ea	$75 /hr	$29,300	Assume 1 field person will perform O&M on-site for 10 hours for each event
	5 16 Mobilization/ Demobilization (O&M; weekly and bi-weekly)	624	hr	$75 /hr	$46,800	Assumes it will take 1 field person 8 hours for mobilization and 8 hours for demobilization for each event
	5 17 Summary TM	60	hr	$75 /hr	$4,500	A summary Technical Memorandum will be written after the installation
6	Groundwater Monitoring (Year 1), 4 Events					Assume first year of groundwater monitoring is a capital expense This includes 4 quarterly sampling events Groundwater monitoring will entail the sampling of 43 wells An additional 15 percent (of groundwater samples) will be collected as QC samples
	6 1 Labor	640	hr	$75 /hr	$48,000	Assumes 2 field people will be on-site for 10 hours for 8 days for each event.
	6 2 Laboratory Analyses (VOCs)	200	analysis	$104 /analysis	$20,800	Quote from GEL Labs
	6 3 Laboratory Analyses (MNA Parameters)	200	analysis	$300 /analysis	$60,000	Price list from Microseeps Labs and GEL
	6 4 Rental Equipment	32	day	$330 /day	$10,600	CH2M HILL Professional Estimate. This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae.
	6 5 Mobilization/Demobilization					Assumes groundwater monitoring will be performed while conducting O&M
	6 6 Supplies	4	event	$1,000 /event	$4,000	CH2M HILL Professional Estimate

TABLE D3-2a
Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
7	Abandonment of Wells (Year 15)					Assume 62 100-foot 2-inch monitoring wells and 11 100-foot 4-inch recovery wells (all are existing wells), and 6 new 4-inch recovery wells, and 192 injection wells will be abandoned at the completion of the remedial alternative This cost will occur in year 10
	7 1 Mobilization/Demobilization	1	ea	$1,200 /ea	$1,200 [PW $800]	
	7 2 Abandon Monitoring Wells (2-inch)	62	ea	$1,000 /ea	$62,000 [PW $40000]	CH2M HILL. American Scrap Metal Site, Panama City: Remedy Implementation Cost Estimate - Capital Costs
	7 3 Abandon Extraction Wells (4-inch)	21	ea	$2,000 /ea	$42,000 [PW $27100]	
	7 4 Abandon injection wells	99	ea	$1,000 /ea	$99,000 [PW $63900]	Assume this cost includes removal of protective covers, grouting to the surface, and removing the concrete surface pad
8	POTW Fees	53,400	1000 gal/yr	$0 59 /1000 gal	$31,500	Quote from Mr Akil Al-Chokhachi, Division of Public works with the City of Memphis, TN Will need to pay a fee to local POTW for groundwater discharged into sewer line Annual discharge volume was calculated based on monthly discharge rate of 2,225,000 gallons on December 2001 with 100% additional volume (for 10 more recovery wells and more conservative consideration)
9	Industrial Discharge Monitoring (Year 1), 4 Events					Assumes 4 samples will be collected, discharge effluent to sewer line and QC samples, from remediation system This sample will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot
	9 1 Labor	24	hr	$75 /hr	$1,800	Assumes 1 field person will be on-site for 6 hours for one day for each event.
	9 2 Laboratory Analyses (VOCs)	4	analysis	$104 /analysis	$400	Quote from Columbia Analytical Services, Redding, CA

TABLE D3-2a

Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior

Rev. 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	9 3 Rental Equipment	4	day	$210 /day	$800	CH2M HILL Eglin AFB, FL: AAS System Cost Estimate - Capital Costs This cost includes field measurement probes (Conductivity, pH, temp, turbidity, DO) water level indicator, and Multirae
	9.4 Supplies	4	event	$200 /event	$800	Based on: CH2M HILL Reichold-Summary Invoice of Site Operations Reduce cost to $200 due to less intensive sampling event
10	Pump Operation Maintenance	208	hr/yr	$75 /hr	$15,600	Assumes local Depot labor will be available Bi-weekly maintenance checks will be performed an average of 8 hours per 2 weeks for the first year.
11	Extraction Well Maintenance					Assume extraction well maintenance (for 17 recovery wells) will occur annually and will include cleaning and well head repairs
	11.1 Cleaning	21	ea	$125 /ea	$2,625	Bid tables for Stone Container project, Panama City, FL Assume costs to clean well are similar to costs to develop well
	11 2 Miscellaneous Repairs	21	ea	$8,000 /ea	$168,000	Defense Depot - Groundwater Remedial Act, U S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field) Based on Section 1 08 Typical Recovery Well These costs include material, labor, equipment, and other costs for centralizers, miscellaneous piping and fittings, and flowmeters
12	Annual Report (Year 1)	120	hr	$85 /hr	$10,200	A summary monitoring report will be produced annually They will include a potentioemtric surface map, a plume map, summary tables, interpretative text. Asume will take approximately a week and a half to complete. Assume first year is a capital expense.

TABLE D3-2a

Capital Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediatior

Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
Subtotal Capital Costs					**$9,135,775**	
13	Contingency - Capital Costs (10%)	10%	ea	$9,135,775 /ea	$913,577	
14	Contingency - Project Management (5%)	5%	ea	$9,135,775 /ea	$456,789	
Total Capital Costs					**$10,507,000**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

TABLE D3-2b
O&M Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
15	Bioremediation (Year 2 to 15)						Bi-weekly O&M and quarterly sampling from 18 wells
	15 1 Labor (O&M; bi-weekly)	260	ea	$75 /hr	$19,500	$138,600	Assume 1 field person will perform O&M on-site for 10 hours for each event
	15 2 Electricity	100,000	kwh	$0 06 /kwh	$6,000	$42,600	Estimated.
	15 3 Miscellaneous Repairs	2	ea	$10,000 /event	$20,000	$142,200	Estimated.
	15 4 Reinjection of Fluids	2	event	$1,109,850 /event	$158,550 00	$2,114,000	Estimated 2 reinjection events in 14 years
16	Groundwater Pump and Treat						The existing pump and discharge system will be used and enhanced The groundwater extraction system will be operated for 10 years.
	16 1 Industrial Discharge Monitoring (Year 2-10),						Assumes 4 samples will be collected, discharge effluent to sewer line and QC samples, from remediation system Samples will be collected monthly according to the industrial discharge agreement between the city of Memphis and the Depot
	16 2 Labor	24	hr/yr	$75 /hr	$1,800	$12,800	Assumes 1 field person will be on-site for 6 hours for one day for each event
	16 3 Laboratory Analyses (VOCs)	4	analysis/yr	$104 /analysis	$400	$3,000	Quote from GEL Labs
	16 4 Rental Equipment	4	day/yr	$210 /day	$800	$6,000	CH2M HILL Eglin AFB, FL AAS System Cost Estimate - Capital Costs This cost includes field measurement probes (Conductivity, pH, temp, turbidity, DO) water level indicator, and Multirae
	16 5 Supplies	4	event/yr	$200 /event	$800	$5,700	CH2M HILL Professional Estimate
	16 6 Pump Operation Maintenance	468	hr/yr	$75 /hr	$35,100	$249,500	Assumes local Depot labor will be available

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TABLE D3-2b
O&M Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
16 7	Extraction Well Maintenance						Weekly maintenance checks will be performed an average of 2 hours biweekly for 9 years Assume extraction well maintenance (for 21 recovery wells) will occur annually and will include cleaning and well head repairs
16 8	Cleaning	21	ea	$125 /ea	$2,600	$18,700	Bid tables for Stone Container project, Panama City, FL. Assume costs to clean well are similar to costs to develop well
16 9	Miscellaneous Repairs	1	ea	$8,000 /ea	$8,000	$56,900	Defense Depot - Groundwater Remedial Act, U.S. Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field) Based on Section 1 08 Typical Recovery Well These costs include material, labor, equipment, and other costs for centralizers, miscellaneous piping and fittings, and flowmeters
16 10	POTW Fees (Year 2-10)	53,400	1000 gal/yr	$0.59 /1000 gal	$31,506	$223,900	Quote from Mr. Akil Al-Chokhachi, Division of Public works with the City of Memphis, TN Annual discharge volume was calculated based on monthly discharge rate of 2,225,000 gallons on December 2001 with 60% additional volume (for 6 more recovery wells and more conservative consideration)

TABLE D3-2b
O&M Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation
Rev. 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
17	Groundwater Monitoring (Year 2-15), 23 Events						Groundwater samples will be collected semiannually from years 2 through 10, and annually for years 11 through 15 This includes 23 events Groundwater monitoring will entail the sampling of 28 wells An additional 15 percent (of groundwater samples) will be collected as QC samples.
	17 1 Labor (sampling)	315	hr/yr	$75 /hr	$23,625	$233,900	Assumes 43 wells (including QC samples) will be sampled semiannually 4 field people will be on-site for 12 hours for 4 days
	17 2 Laboratory Analyses (VOCs)	100	analysis/yr	$104 /analysis	$10,400	$102,900	Quote from GEL Labs
	17 3 Laboratory Analyses (MNA Parameters)	100	analysis/yr	$300 /analysis	$30,000	$297,000	Price list from Microseeps Labs and GEL Labs
	17.4 Rental Equipment	56	day/yr	$330 /day	$18,500	$182,900	CH2M HILL Professional Estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	17 5 Supplies	2	event /yr	$500 /event	$800	$7,900	CH2M HILL Professional Estimate
18	Annual Report (Year 2-15)	80	hr/yr	$85 /hr	$6,800	$67,300	A summary monitoring report will be produced annually. They will include a potentioemtric surface map, a plume map, summary tables, interpretative text Assume will take approximately a week and a half to complete.

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TABLE D3-2b

O&M Cost Estimate: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation

Rev. 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
19	5-Year Review (six over 30 years)	80	hr/yr	$100 /hr	$8000 ($800 averaged over 5 years)	$23,400	Remedial alternative at site will need to be reviewed every 5 years to ensure that institutional controls are providing adequate protection Assume will take approximately a week to complete
Total O&M Costs (2-15 years)					**$375,981**	**$3,929,000**	
	Project Management & Support				$37,598	$392,900	10% of O&M Costs
Total O&M Costs (2-15 years)[d, e]					**$414,000**	**$4,322,000**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 10 years

[d] The Total Annual O&M Costs are equal to an average of the annual cost for a year with semi-annual monitoring and a year with annual monitoring

[e] The annual O&M costs for monitoring well costs and 5 year review are an average of total cost over time period item occurs occur For example, the annual cost for 5-year review is total $4000 averaged over 5 years ($800)

TABLE D3-2c
Cost Estimate Summary: Alternative 2, ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field Groundwater FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Deed Restrictions	$7,400	NA	NA	$7,400
2	Plans for Implementation	$10,200	NA	NA	$10,200
3	ZVI Injection Procedures	$3,439,987	NA	NA	$3,439,987
4	Installation of 10 Recovery Wells	$2,172,375	NA	NA	$2,172,375
5	Full Scale Bioremediation (Year 1)	$2,998,888	NA	NA	$2,998,888
6	Groundwater Monitoring (Year 1), 4 Events	$143,400	NA	NA	$143,400
7	Abandonment of Wells (Year 15)	$131,800	NA	NA	$131,800
8	POTW Fees	$31,500	NA	NA	$31,500
9	Industrial Discharge Monitoring (Year 1), 4 Events	$3,000	NA	NA	$3,000
10	Pump Operation Maintenance	$15,600	NA	NA	$15,600
11	Extraction Well Maintenance	$170,625	NA	NA	$170,625
12	Annual Report (Year 1)	$10,200	NA	NA	$10,200
13	Contingency - Capital Costs (10%)	$913,577	NA	NA	$913,577
14	Contingency - Project Management (5%)	$456,789	NA	NA	$456,789
15	Bioremediation (Year 2 to 15)	NA	$204,050 [e]	$2,437,400	$2,437,400
16	Groundwater Pump and Treat	NA	$81,006	$576,500	$576,500
17	Groundwater Monitoring (Year 2-15), 23 Events	NA	$83,325 [e]	$824,600	$824,600
18	Annual Report (Year 2-15)	NA	$6,800	$67,300	$67,300
19	5-Year Review (six over 30 years)	NA	$800	$23,400	$23,400
--	Project Management and Support	NA	$37,598	$392,900	$392,900
Total Costs		**$10,506,000**	**$414,000**	**$4,322,000**	**$14,827,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost calculated using an interest rate of 5 percent over 10 years.

[c] Total PW cost includes capital plus PW O&M costs

[e] The annual O&M costs are an average of total cost over time period item occurs occur. For example, the annual cost for 5-year review is total $4000 averaged over 5 years ($800)

NA = Not applicable

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TABLE D3-3a
Capital Cost Estimate: Alternative 3, ZVI Injection, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Deed Restrictions					Deed restrictions would prohibit installation and use of production and consumptive use wells They would also permit regulator access to all monitoring wells for the 3-year life of this remedy
	1 1 Attorney Fees	32	hr	$200 /hr	$6,400	CH2M HILL· American Scrap Metal Site, Panama City: Order of Magnitude Cost Estimate for Alternative 2A
	1 2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgetment. Plans to develop include Site Safety and Health Plan and Environmental Protection Plan
3	ZVI Injection Procedures					
	3 1 Injection Bench-Scale & Pilot Test	1	ea	$231,600 /ea	$231,600	Quote from ARS Technologies, Inc. Assumes 4 well pilot test using new wells
	3.2 Full-Scale Implementation	1	ea	$4,051,957 /ea	$4,051,957	Quote from ARS Technologies, Inc. Assumes 53 wells using pneumatic fracturing and atomized liquid injection Assumes 40 foot radius of influence per well Includes subcontractor PM labor, reporting, permitting, electricity, and water
	3 3 Oversight of Pilot Test	80	hr	$75 /hr	$6,000	Assume 2 weeks for pilot test
	3 4 Oversight of Full Scale	1,040	hr	$75 /hr	$78,000	Assume 6 months for implementation
	3 5 Waste Disposal	2	ea	$2,000 /ea	$4,000	Includes rolloff rental, dropoff/pickup Assume soils and other waste is nonhazardous
	3 6 Temp Field Office, Trailer, and Storage Trailer	7	mn	$338 mn	$2,366	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
	3 7 Initial/Confirmatory Pilot Test GW Sampling					
	3 7 1 Labor	96	hr	$75 /hr	$7,200	Assumes 2 field people will be on-site for 12 hours for 4 days for both events
	3 7 2 Laboratory Analyses (VOCs)	24	analysis	$104 /analysis	$2,500	Quote from Columbia Analytical Services, Redding, CA

TABLE D3-3a

Capital Cost Estimate: Alternative 3, ZVI Injection, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
3 7.3	Laboratory Analyses (MNA Parameters)	24	analysis	$300 /analysis	$7,200	Price list from Microseeps Labs
3 7.4	Rental Equipment	8	day	$330 /day	$2,600	CH2M HILL. Professional estimate. This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae.
3 7 5	Supplies	1	event	$500 /event	$500	CH2M HILL· Professional estimate
4	Permeable Reactive Barriers - Iron					
4 1	Bench Scale Testing	1	ea	$20,000 /ea	$20,000	Quote from ETI
4 2	Full-Scale Implementation	1	ea	$1,922,500 /ea	$1,922,500	Quote from Eviron Tech , Inc Assumes 1050 feet of PRB Includes subcontractor field visits, design, and implementation through jetting
4 4	Oversight of Full Scale	1,040	hr	$75 /hr	$78,000	Assume 6 months for implementation
4 5	Waste Disposal	2	ea	$2,000 /ea	$4,000	Includes rolloff rental, dropoff/pickup Assume soils and other waste is nonhazardous
4 6	Temp Field Office, Trailer, and Storage Trailer	7	mn	$338 mn	$2,366	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
4 7	Initial/Confirmatory Pilot Test GW Sampling					
4 7 1	Labor	96	hr	$75 /hr	$7,200	Assumes 2 field people will be on-site for 12 hours for 4 days for both events.
4 7.2	Laboratory Analyses (VOCs)	24	analysis	$104 /analysis	$2,500	Quote from Columbia Analytical Services, Redding, CA
4 7 3	Laboratory Analyses (MNA Parameters)	24	analysis	$300 /analysis	$7,200	Price list from Microseeps Labs

TABLE D3-3a

Capital Cost Estimate: Alternative 3, ZVI Injection, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	4 7 4 Rental Equipment	8	day	$330 /day	$2,600	CH2M HILL Professional estimate. This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae.
	4 7 5 Supplies	1	event	$500 /event	$500	CH2M HILL Professional estimate
	4 8 Clearing and Grubbing	2	ac	$1,620 /ac	$3,200	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
5	Additional Monitoring Wells					
	5 3 Drilling Mobilization/Demobilization	1	ea	$2,500 00 /ea	$2,500	Assume rotosonic drilling mobilization
	5 5 Installation 15 Monitoring Wells - Rotasonic	1,350	ft	$62 /ft	$83,700	Defense Depot - Groundwater Remedial Act, U S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field)
	5 6 Labor (well installation oversight)	150	hr	$75 /hr	$11,300	Assume 1 field person will be required to oversee and prepare site for well installation Assume it will take approximately 12 hours per day for 85 days
	5 7 Mobilization/ Demobilization (well installation oversight)	40	hr	$75 /hr	$3,000	Assumes it will take one field person 4 hours for mobilization and 4 hours for demobilization for each trip 8 trips is needed
6	Groundwater Monitoring (Year 1), 4 Events					Assume first year of groundwater monitoring is a capital expense. This includes 4 quarterly sampling events Groundwater monitoring will entail the sampling of 43 wells An additional 15 percent (of groundwater samples) will be collected as QC samples
	6 1 Labor	640	hr	$75 /hr	$48,000	Assumes 2 field people will be on-site for 10 hours for 8 days for each event

TABLE D3-3a

Capital Cost Estimate: Alternative 3, ZVI Injection, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	6 2 Laboratory Analyses (VOCs)	200	analysis	$104 /analysis	$20,800	Quote from GEL Labs
	6 3 Laboratory Analyses (MNA Parameters)	200	analysis	$300 /analysis	$60,000	Price list from Microseeps Labs and GEL
	6 4 Rental Equipment	32	day	$330 /day	$10,600	CH2M HILL Professional Estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	6 5 Mobilization/Demobilization					Assumes groundwater monitoring will be performed while conducting O&M
	6 6 Supplies	4	event	$1,000 /event	$4,000	CH2M HILL Professional Estimate
7	Abandonment of Wells (Year 15)					Assume 62 100-foot 2-inch monitoring wells and 11 100-foot 4-inch recovery wells (all are existing wells), and 6 new 4-inch recovery wells, and 192 injection wells will be abandoned at the completion of the remedial alternative This cost will occur in year 10
	7 1 Mobilization/Demobilization	1	ea	$1,200 /ea	$1,200 [PW $800]	
	7 2 Abandon Monitoring Wells (2-inch)	62	ea	$1,000 /ea	$62,000 [PW $40000]	CH2M HILL American Scrap Metal Site, Panama City Remedy Implementation Cost Estimate - Capital Costs
	7 3 Abandon Extraction Wells (4-inch)	21	ea	$2,000 /ea	$42,000 [PW $27100]	
	7 4 Abandon injection wells	99	ea	$1,000 /ea	$99,000 [PW $63900]	Assume this cost includes removal of protective covers, grouting to the surface, and removing the concrete surface pad
8	Annual Report (Year 1)	160	hr	$85 /hr	$13,600	A summary monitoring report will be produced annually They will include a potentioemtric surface map, a plume map, summary tables, interpretative text Asume will take approximately a week and a half to complete Assume first year is a capital expense
Subtotal Capital Costs					**$6,805,789**	
9	Contingency - Capital Costs (10%)	10%	ea	$6,805,789 /ea	$680,579	
10	Contingency - Project Management (5%)	5%	ea	$6,805,789 /ea	$340,289	

TABLE D3-3a

Capital Cost Estimate: Alternative 3, ZVI Injection, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
Total Capital Costs					$7,826,657	

TABLE D3-3b
O&M Cost Estimate: Alternative 3, ZVI Injection, PRB Installation, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
11	Groundwater Monitoring (Year 2-15), 23 Events						Groundwater samples will be collected semiannually from years 2 through 10, and annually for years 11 through 15 This includes 23 events Groundwater monitoring will entail the sampling of 28 wells An additional 15 percent (of groundwater samples) will be collected as QC samples
	11.1 Labor (sampling)	400	hr/yr	$75 /hr	$30,000	$297,000	Assumes 43 wells (including QC samples) will be sampled semiannually for years 2 - 10 and annually for years 11-15 4 field people will be on-site for 12 hours for 4 days
	11 2 Laboratory Analyses (VOCs)	110	analysis/yr	$104 /analysis	$11,440	$113,200	Quote from GEL Labs
	11 3 Laboratory Analyses (MNA Parameters)	110	analysis/yr	$300 /analysis	$33,000	$326,700	Price list from Microseeps Labs and GEL Labs
	11 4 Rental Equipment	12	day/yr	$330 /day	$4,000	$39,200	CH2M HILL Professional Estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	11 5 Supplies	2	event /yr	$500 /event	$800	$7,900	CH2M HILL Professional Estimate
12	Annual Report (Year 2-15)	100	hr/yr	$85 /hr	$8,500	$84,100	A summary monitoring report will be produced annually They will include a potentiometric surface map, a plume map, summary tables, interpretative text Assume will take approximately a week and a half to complete

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TABLE D3-3b
O&M Cost Estimate: Alternative 3, ZVI Injection, PRB Installation, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Source/ Comments
13	5-Year Review (six over 30 years)	80	hr/yr	$100 /hr	$8000 ($800 averaged over 5 years)	$23,400	Remedial alternative at site will need to be reviewed every 5 years to ensure that institutional controls are providing adequate protection Assume will take approximately a week to complete
Total O&M Costs (2-15 years)					**$87,740**	**$892,000**	
	Project Management & Support				$8,774	$89,200	10% of O&M Costs
Total O&M Costs (2-15 years)					**$97,000**	**$981,200**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1

[c] The duration of O&M will be 3 years

TABLE D3-3c
Cost Estimate Summary: Alternative 3, ZVI Injection, PRB Installation, and Enhanced Bioremediation
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Deed Restrictions	$7,400	NA	NA	$7,400
2	Plans for Implementation	$10,200	NA	NA	$10,200
3	ZVI Injection Procedures	$4,393,923	NA	NA	$4,393,923
4	Permeable Reactive Barriers - Iron	$2,050,066	NA	NA	$2,050,066
5	Additional Monitoring Wells	$100,500	NA	NA	$100,500
6	Groundwater Monitoring (Year 1), 4 Events	$143,400	NA	NA	$143,400
7	Abandonment of Wells (Year 15)	$86,700	NA	NA	$86,700
8	Annual Report (Year 1)	$13,600	NA	NA	$13,600
9	Contingency - Capital Costs (10%)	$680,579	NA	NA	$680,579
10	Contingency - Project Management (5%)	$340,289	NA	NA	$340,289
11	Groundwater Monitoring (Year 2-15), 23 Events	NA	$79,240	$784,000	$784,000
12	Annual Report (Year 2-15)	NA	$8,500	$84,100	$84,100
13	5-Year Review (six over 30 years)	NA	$800	$23,400	$23,400
--	Project Management and Support	NA	$8,774	$89,200	$89,200
Total Costs		**$7,827,000**	**$98,000**	**$981,000**	**$8,807,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1.

[c] Total PW cost includes capital plus PW O&M costs

NA = Not applicable

Note The annual O&M costs are an average of total cost over time period item occurs occur For example, the annual cost for 5-year review is total $4000 averaged over 5 years ($800)

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TABLE D3-4a
Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
1	Deed Restrictions					Deed restrictions would prohibit installation and use of production and consumptive use wells They would also permit regulator access to all monitoring wells for the10-year life of this remedy.
	1 1 Attorney Fees	32	hr	$200 /hr	$6,400	CH2M HILL American Scrap Metal Site, Panama City Order of Magnitude Cost Estimate for Alternative 2A
	1.2 Recording of the Deed	2	ea	$500 /ea	$1,000	
2	Plans for Implementation	120	hr	$85 /hr	$10,200	Based on CH2M HILL's professional judgement. Plans to develop include Site Safety and Health Plan and Environmental Protection Plan
3	Pilot Study - Air Sparge					A pilot study will be performed to determine the design parameters required for an air sparging system under site conditions. In order to perform this study, five 2-inch diameter schedule 40 PVC injection well will be installed to a depth of 95 feet, con
	3 1 Drill Well - Rotasonic	475	ft	$62 /ft	$29,450	Defense Depot - Groundwater Remedial Act, U.S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field) Well will be installed using Rotasonic drilling method.
	3 2 Labor (drilling oversight)	72	hr	$75 /hr	$5,400	Assume 1 field person will be required to oversee and prepare site for well installation Assume it will take approximately 10 hours per day for 5 days.
	3 3 Mobilization/ Demobilization (well installation oversight)	8	hr	$75 /hr	$600	Assumes it will take one field person 4 hours for mobilization and 4 hours for demobilization.
	3 4 Air Flowmeter & Pressure gauges	5	ls	$1,000 /ls	$5,000	Defense Depot - Groundwater Remedial Act, U S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field)

TABLE D3-4a

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
						Based on a 1-inch magnetic flowmeter
3 5	Air Sparging System	1	ea	$2,250 /ea	$2,300	Based on phone quotes for Pro-Act Services of Ludington, MI This price is based on 20 psi and 150 sCFM air sparging system Assume wells will be set in coarse sand, approximately 100-feet deep, with a 20-foot water column. Each well should achieve a 15-ft radius of influence
3.6	Labor (pilot test startup)	144	hr	$75 /hr	$10,800	Assumes 2 field persons will be on-site for 12 hours for 6 days
3.7	Mobilization/ Demobilization (pilot test start up)	32	hr	$75 /hr	$2,400	Assumes it will take 2 people 8 hours for mobilization and 8 hours for demobilization
3.8	Summary TM	120	hr	$85 /hr	$10,200	A summary Technical Memorandum will be written after pilot test. Assume will take approximately a week and a half to complete
3 9	Groundwater Sampling/System Operation	1	ea	$2,500 /ea	$2,500	Groundwater sampling and analysis of 8 monitoring wells at the site prior to test beginning, includes labor Also, assumes 2 hours will be required per event to check on well maintenance and system operation.
4	Installation of 364 Sparging Wells					It is assumed that to totally involve the plume, approximately 200 onsite and 134 offsite air sparging wells will be required. Assumes wells will be set in coarse sand, 100-feet deep (95-foot casing, 5-foot screen), with a 20-foot water column. Each well should achieve a 15-ft radius of influence Thus, wells will be placed approximately 30 feet apart
4 1	Mobilization/Demobilization	1	ea	$8,500 /ea	$8,500	Assume Rotasonic drill ng and equipment will not be local.
4 2	Drill Well - Rotasonic	33,335	ft	$62 /ft	$2,066,770	Defense Depot - Dunn Field RI Well will be installed using Rotasonic drilling method

TABLE D3-4a

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
4 3	Labor (drilling oversight)	3,276	hr	$75 /hr	$245,700	Assume 1 field person will be required to oversee and prepare site for well installation Assume it will take approximately 12 hours per day for 273 days
4 4	Trenching	12,000	ft	$27 /ft	$324,000	Based on CH2M HILL's professional judgement The cost includes construction equipment and labor for piping assemblage from each well back to blower unit, well vaults installation, and other pipe fitting
4.5	Clearing and Grubbing	2	ac	$1,650 /ac	$3,300	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
5	Air Sparging System					Based on Phone Quote for Pro-Act Services
5 1	Air Sparge/Blower Unit	6	ea	15,000 /ea	$90,000	Assume 6 Positive Displacement blowers will be required Assumes cost also includes system manifold and control panel for blowers This price is based on 20 psi and 300 SCFM air sparging system
5 2	Temp Field Office, Trailer, and Storage Trailer	6	mn	$338 mn	$2,028	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
5 3	Equipment Storage Building	1	ea	$29,700 /ea	$29,700	Estimate from RS Means Environmental Remediation Cost Data (2001). Butler building package 25'x30'x12'
5 4	Electrical, Instrumentation, and Controls	1	ea	$250,000 /ea	$250,000	Defense Depot - Groundwater Remedial Act, U.S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field) Based on Section 1.13 Power and Control Wiring Assumes a high-technology system Also assumes most electrical wiring and distribution panels are already in place and system does not require new transformer

TABLE D3-4a
Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	5 5 Start Up and Testing					Defense Depot - Groundwater Remedial Act, U.S Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field)
	5 5 1 Initial Start Up and Testing and Annual Operations	1600	hr	$75 /hr	$120,000	Assumes 2 weeks of startup time for subcontractor and oversight 3 persons at 12 hrs per day over 10 days Includes manhours for 2 field people to perform full time start-up for 10 hours per day for 12 days.
6	Utilities (Year 1)					
	6 1 Electricity for vacuum pumps	391,572	kw-hr	$0.06 /kw-hr	$23,494	Assumes vacuum pumps (total of 60 HP) will run 24 hours a day for 365 days for the first year
	6.2 Electricity for SVE unit	98,000	kw-hr	$0 06 /kw-hr	$5,880	Assumes vacuum pump (total of 15 HP) will run 24 hours a day for 365 days for the first year
	6 3 Electricity for Enhanced Bio Unit	100,000	kw-hr	$0.06 /kw-hr	$6,000	Assumes pump and mixers (total of 15 HP) will run 24 hours a day for 365 days for the first year
7	Soil Monitoring Points					Assumes 31 soil monitoring points will be installed to monitor full-scale soil vapor extraction Screens will be set at multiple depths in each borehole (2 horizons in the loess and 2 horizons in the fluvial sand) Soil samples will be collected from 20 locations
	7 1 Soil Monitoring Point Drilling	1860	ft	$62 /ft	$115,320	Defense Depot - EBT Treatability Study at the Main Installation Costs from Boart Longyear (2002). Bore holes will be drilled and continuously sampling using Rotasonic drilling methods. Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem Labor included with installation of air sparge points
	7 2 Rental Equipment	14	day	$90 /day	$1,300	MicroFID - quote from Pine Environmental Services, Inc.

TABLE D3-4a

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	7 3 Supplies	1	event	$500 /event	$500	CH2M HILL professional judgement
8	Vertical SVE Wells Installation					31 vertical SVE wells for fluvial sand (total depth=65 feet) will be installed at the site
	8 1 Mobilization	0	ea	$0 /ea	$0	Assume Mobilization will be at the same time that soil monitoring points are installed, therefore no costs are presented
	8 2 SVE Wells Drilling and Preparation for fluvial sand	2015	ft	$72 /ft	$145,080	Bore holes will be drilled and continuously sampling using Rotasonic drilling methods Costs per ft are inclusion of all drilling, materials, supplies, T&D of cuttings (assume non-hazardous waste), per diem
9	Captial Equipment and Construction					
	9 1 Vacuum Pump for sand	1	ea	$13,500 /ea	$13,500	Quoted by EPG/Catalytic Combustion Low Vac 15 HP Regenerative System 500 ACFM @ 2 3" Hg The cost includes MPE, VLS, Controls, Wiring panel to skid Trenching will be included with air sparging system
	9 2 Piping Cost	3,020	LF	$1.46 /LF	$4,409	Quoted by Michigan Pipe Supply, LLC. The cost includes 4" SDR 11 HDPE pipes x 500' coil.
	9 3 Miscellaneous	1	ea	$10,000 /ea	$10,000	The price includes 4" HDE SDR 11 MPT transitions, flange adapters, ductile iron back up rings, reducing couplings, throttling valves, air flow meters, vacuum gauges, and well vaults

TABLE D3-4a
Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	9 4 Piping Assemblage	1	ea	$62,000 /ea	$62,000	Based on CH2M HILL's professional judgement. The cost includes construction equipment and labor for piping assembling, well vaults installation, and other pipe fitting
10	Permeable Reactive Barriers - Iron					
	10 1 Bench Scale Testing	1	ea	$20,000 /ea	$20,000	Quote from ETI
	10 2 Full-Scale Implementation	1	ea	$1,922,500 /ea	$1,922,500	Quote from Eviron Tech , Inc Assumes 1050 feet of PRB Includes subcontractor field visits, design, and implementation through jetting.
	10 3 Oversight of Full Scale	1,040	hr	$75 /hr	$78,000	Assume 6 months for implementation
	10 4 Waste Disposal	2	ea	$2,000 /ea	$4,000	Includes rolloff rental, dropoff/pickup Assume soils and other waste is nonhazardous
	10 5 Temp Field Office, Trailer, and Storage Trailer	7	mn	$338 mn	$2,366	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs
	10 6 Initial/Confirmatory Pilot Test GW Sampling					
	10 7 1 Labor	96	hr	$75 /hr	$7,200	Assumes 2 field people will be on-site for 12 hours for 4 days for both events
	10 7 2 Laboratory Analyses (VOCs)	24	analysis	$104 /analysis	$2,500	Quote from Columbia Analytical Services, Redding, CA
	10 7 3 Laboratory Analyses (MNA Parameters)	24	analysis	$300 /analysis	$7,200	Price list from Microseeps Labs.
	10 7 4 Rental Equipment	8	day	$330 /day	$2,600	CH2M HILL: Professional estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	10 7 5 Supplies	1	event	$500 /event	$500	CH2M HILL: Professional estimate
	10.8 Clearing and Grubbing	2	ac	$1,620 /ac	$3,200	Estimate from RS Means Environmental Remediation Cost Data (2001) Order of magnitude costs.
11	Additional Monitoring Wells					
	11 1 Drilling Mobilization/Demobilization	1	ea	$2,500 00 /ea	$2,500	Assume rotosonic drilling mobilization

TABLE D3-4a

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
	11 2 Installation 15 Monitoring Wells - Rotasonic	1,350	ft	$62 /ft	$83,700	Defense Depot - Groundwater Remedial Act, U S. Army Corps of Engineers, Groundwater Interim Remedial, (Dunn Field)
	11 3 Labor (well installation oversight)	150	hr	$75 /hr	$11,300	Assume 1 field person will be required to oversee and prepare site for well installation Assume it will take approximately 12 hours per day for 85 days
	11 4 Mobilization/ Demobilization (well installation oversight)	40	hr	$75 /hr	$3,000	Assumes it will take one field person 4 hours for mobilization and 4 hours for demobilization for each trip. 8 trips is needed
12	Groundwater Monitoring (Year 1), 4 Events					Assume first year of groundwater monitoring is a capital expense This includes 4 quarterly sampling events. Groundwater monitoring will entail the sampling of 43 wells An additional 15 percent (of groundwater samples) will be collected as QC samples.
	12 1 Labor	640	hr	$75 /hr	$48,000	Assumes 2 field people will be on-site for 10 hours for 8 days for each event
	12 2 Laboratory Analyses (VOCs)	200	analysis	$104 /analysis	$20,800	Quote from GEL Labs
	12.3 Laboratory Analyses (MNA Parameters)	200	analysis	$300 /analysis	$60,000	Price list from Microseeps Labs and GEL.
	12 4 Rental Equipment	32	day	$330 /day	$10,600	CH2M HILL Professional Estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
	12 5 Mobilization/Demobilization					Assumes groundwater monitoring will be performed while conducting O&M
	12 6 Supplies	4	event	$1,000 /event	$4,000	CH2M HILL Professional Estimate

TABLE D3-4a
Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Capital Cost[a]	Source/ Comments
13	Abandonment of Wells (Years 4 and 30)					Assume 62 100-foot 2-inch monitoring wells and 11 100-foot 4-inch recovery wells (all are existing wells), 6 new 4-inch recovery wells and 20 new 2-inch monitoring wells, and 273 air sparging wells will be abandoned at the completion of the remedial alter This cost will occur in year 10
	13 1 Mobilization/Demobilization	2	ea	$1,200 /ea	$2,400 [PW $2100]	
	13 2 Abandon Monitoring Wells (2-inch)	82	ea	$1,000 /ea	$82,000 [PW $19000]	CH2M HILL Professional estimate
	13 3 Abandon Wells (4-inch)	11	ea	$2,000 /ea	$22,000 [PW $18100]	
	13 4 Abandon air sparging wells	364	ea	$1,000 /ea	$364,000 [PW $299500]	Assume this cost includes removal of protective covers, grouting to the surface, and removing the concrete surface pad
14	Annual Report (Year 1)	120	hr	$85 /hr	$10,200	A summary monitoring report will be produced annually. They will include a potentioemtric surface map, a plume map, summary tables, interpretative text. Asume will take approximately a week and a half to complete Assume first year is a capital expense.
Subtotal Capital Costs					**$6,256,597**	
15	Contingency - Capital Costs (10%)	10%	ea	$6,256,597 /ea	$625,660	
16	Contingency - Project Management (5%)	5%	ea	$6,256,597 /ea	$312,830	
Total Capital Costs					**$7,195,000**	

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent

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TABLE D3-4b
Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs
Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Source/ Comments
17	Groundwater Monitoring (Year 2-15), 23 Events						Groundwater samples will be collected semiannually from years 2 through 10, and annually for years 11 through 15 This includes 23 events. Groundwater monitoring will entail the sampling of 28 wells An additional 15 percent (of groundwater samples) will be collected as QC samples
17 1	Labor (sampling)	400	hr/yr	$75 /hr	$30,000	$297,000	Assumes 43 wells (including QC samples) will be sampled semiannually for years 2 - 10 and annually for years 11-15 4 field people will be on-site for 12 hours for 4 days
17 2	Laboratory Analyses (VOCs)	110	analysis/yr	$104 /analysis	$11,440	$113,200	Quote from GEL Labs
17 3	Laboratory Analyses (MNA Parameters)	110	analysis/yr	$300 /analysis	$33,000	$326,700	Price list from Microseeps Labs and GEL Labs
17 4	Rental Equipment	12	day/yr	$330 /day	$4,000	$39,200	CH2M HILL Professional Estimate This cost includes Grundfos pump and controller, Field measurement probes (Conductivity, pH, temp, turbidity, DO), generator, water level indicator, and Multirae
17 5	Supplies	2	event /yr	$500 /event	$800	$7,900	CH2M HILL Professional Estimate
18	Air Sparging System Maintenance						
18 1	Maintenance Checks (Year 2-5)	1040	hr/yr	$75 /hr	$78,000	$276,600	Weekly maintenance checks will be performed an average of 5 hours per week for 5 years
18 2	Miscellaneous Equipment Repair (5 over 5 years)	1	ea/yr	$25,000 /ea	$25,000	$108,200	Assumes that if PD-type blowers are used to introduce air to groundwater, less maintenance will be required and they will last approximately 35,000 hours of continuous operation

TABLE D3-4b

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Source/ Comments
							Based on 5 years of operation, assume each blower will need to be repaired/replaced once. (Catalytic Combustion Corporation). Cost is based on unit cost and assumptions listed for Item 5, Air Sparging System (Capital Costs).
18 3	Electricity for vacuum pumps	391,572	kw-hr	$0 06 /kw-hr	$23,494	$83,300	Assumes vacuum pumps (total of 60 HP) will run 24 hours a day for 365 days for the first year.
18 4	Electricity for SVE unit	98,000	kw-hr	$0 06 /kw-hr	$5,880	$20,900	Assumes vacuum pump (total of 15 HP) will run 24 hours a day for 365 days for the first year
19	Utilities for SVE System for 1 year						The SVE system will run 1 extra year
19 1	Electricity for vacuum pumps	587,910	kw-hr	$0 06 /kw-hr	$35,275	$35,275	Assumes vacuum pumps (total of 90 HP) will run 24 hours per day for 365 days each year
19 2	Electricity for heater	7,200	kw-hr	$0 06 /kw-hr	$432	$432	Assumes a heater (2 kw) will run 5 months during the winter season each year.
19 3	Electricity for Offgas Treatment	32,662	kw-hr	$0 06 /kw-hr	$1,960	$1,960	Assumes a fan (5 HP) for offgas treatment will run 24 hours per day for 365 days each year
19 4	Fuel Consumption for Offgas Treatment	21,024	therms	$1 00 /therm	$21,024	$21,024	Fuel consumption will be 2.4 therms/hr based on Catalytic Combustion's estimation. The system will consume natural gas 24 hours a day for 365 days each year Assumes natural gas will cost $1.00 per therm.

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TABLE D3-4b

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost		Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Source/ Comments
	19 5 Water Usage for Offgas Treatment	1,436,640	gal	$0 08	/gal	$115,239	$115,239	Water usage will be 164 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year Public water will cost $0 60 per cubic foot
	19.6 Sewerage for Offgas Treatment	1,174	1000 gal	$0.59	/1000 gal	$693	$693	Water discharge rate will be 134 gal/hr based on Catalytic Combustion's estimation The system will consume water 24 hours a day for 365 days each year The sewerage charge will be $0 587 per 1000 gallon
	19 7 Sewerage for groundwater recovered by SVE systems	105	1000 gal	$0 59	/1000 gal	$62	$62	Water purging rate from SVE systems will be 0 2 gpm (or 12 gal/hr) based on the SVE feasibility study conducted at the site in December 2001 The system will purge water 24 hours a day for 365 days for the first year The sewerage charge will be $0.587
	19 8 Miscellaneous (NaOH Required to Neutralize HCl)	66,600	gal	$0 31	/gal	$20,700	$20,700	Assumes 7 52 gallons per hour of 25% NaOH solution (freeze at 10 degrees F) or 3 13 gallons per hour of 50% NaOH solution (freeze at 45 degrees F) is needed to neutralize HCl generated from the system 25% NaOH will be $0 31 per gallon and 50% NaOH will
20	Air Sampling for VOCs, air monitoring, and SVE O&M for 1 Year							Air samples will be collected from discharge stack out of offgas treatment and scrubber monthly for VOCs analysis QA samples (duplicate, ambient, and equipment blank) will be also collected and analyzed

TABLE D3-4b

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Quantity	Unit	Unit Cost	Annual O&M Cost[a]	Present Worth O&M Cost[a,b]	Source/ Comments
	20 1 Labor	2080	hr	$75 /hr	$156,000	$156,000	Assumes one full time field person (1 FTE) will be on-site to conduct O&M, collect air samples, and perform air monitoring for 8 hours a day during each year of SVE operation
	20 2 Laboratory Analyses (VOCs)	28	analysis	$300 /analysis	$8,400	$8,400	Quoted by Test America Inc TN
	20 3 Laboratory Analyses (HCL)	28	analysis	$35 /analysis	$1,000	$1,000	Quoted by Test America Inc TN
	20 4 Laboratory Analyses (VOCs)	64	analysis	$300 /analysis	$19,200	$19,200	Periodic sampling and testing from soil vapor points Assumes 32 samples semi-annually
	20 5 Rental Equipment	56	day	$90 /day	$5,000	$5,000	MicroFID - quote from Pine Environmental Services, Inc.
	20 6 Mobilization/Demobilization	0				$0	Assumes one field person will be local
	20 7 Supplies	12	event	$500 /event	$6,000	$6,000	Based on CH2M HILL's professional judgement.
21	Annual Report (Year 2-15)	100	hr/yr	$85 /hr	$8,500	$84,100	A summary monitoring report will be produced annually They will include a potentiometric surface map, a plume map, summary tables, interpretative text Assume will take approximately a week and a half to complete
22	5-Year Review (six over 30 years)	80	hr/yr	$100 /hr	$8000 ($800 averaged over 5 years)	$23,400	Remedial alternative at site will need to be reviewed every 5 years to ensure that institutional controls are providing adequate protection. Assume will take approximately a week to complete
Total O&M Costs (2-15 years)					**$611,899**	**$1,771,000**	
	Project Management & Support				$61,190	$177,100	10% of O&M Costs
Total O&M Costs (2-15 years)					**$673,089**	**$1,948,000**	

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TABLE D3-4c

Capital Cost Estimate: Alternative 4, Air Sparging with SVE, PRB Installation with MNA and ICs

Rev 1 Memphis Depot Dunn Field FS

Item	Activity/Component	Capital Cost[a]	Annual O&M Cost[a]	Present Worth O&M Cost[a,b,c]	Total PW Cost[c]
1	Deed Restrictions	$7,400	NA	NA	$7,400
2	Plans for Implementation	$10,200	NA	NA	$10,200
3	Pilot Study - Air Sparge	$68,650	NA	NA	$68,650
4	Installation of 364 Sparging Wells	$2,648,270	NA	NA	$2,648,270
5	Air Sparging System	$491,728	NA	NA	$491,728
6	Utilities (Year 1)	$35,374	NA	NA	$35,374
7	Soil Monitoring Points	$117,120	NA	NA	$117,120
8	Vertical SVE Wells Installation	$145,080	NA	NA	$145,080
9	Captial Equipment and Construction	$89,909	NA	NA	$89,909
10	Permeable Reactive Barriers - Iron	$2,050,066	NA	NA	$2,050,066
11	Additional Monitoring Wells	$100,500	NA	NA	$100,500
12	Groundwater Monitoring (Year 1), 4 Events	$143,400	NA	NA	$143,400
13	Abandonment of Wells (Years 4 and 30)	$338,700	NA	NA	$338,700
14	Annual Report (Year 1)	$10,200	NA	NA	$10,200
15	Contingency - Capital Costs (10%)	$625,660	NA	NA	$625,660
16	Contingency - Project Management (5%)	$312,830	NA	NA	$312,830
17	Groundwater Monitoring (Year 2-15), 23 Events	NA	$79,240	$784,000	$784,000
18	Air Sparging System Maintenance	NA	$132,374	$489,000	$489,000
19	Utilities for SVE System for 1 year	NA	$195,385	$195,385	
20	Air Sampling for VOCs, air monitoring, and SVE O&M for 1 Year	NA	$195,600	$195,600	
21	Annual Report (Year 2-15)	NA	$8,500	$84,100	$84,100
22	5-Year Review (six over 30 years)	NA	$800	$23,400	$23,400
--	Project Management & Support	NA	$61,190	$177,100	$177,100
Total Costs		**$7,195,000**	**$674,000**	**$1,949,000**	**$8,753,000**

[a] Estimates include remedial action, construction, and O&M costs that are expected to differ between alternatives. Planning and engineering costs are typically estimated to be a percentage of remedy cost and therefore, do not factor in comparative cost evaluations The estimate is typically accurate within plus 50 to minus 30 percent.

[b] Present worth cost is calculated by using an interest rate of 5 percent for all costs beyond year 1.

[c] Total PW cost includes capital plus PW O&M costs

NA = Not applicable

Present Worth Costs for Groundwater Alternatives

Rev. 1 Memphis Depot Dunn Field Feasibility Study

Alternative	Capital Cost	Present Worth O&M	Total Costs
2 - ZVI Injection, Extraction Enhancement, and Enhanced Bioremediation with MNA and ICs	$10,506,000	$4,322,000	$14,828,000
3 - ZVI Injection, PRB Installation with MNA and ICs	$7,827,000	$981,000	$8,807,000
4 - Air Sparging with SVE, PRB Installation with MNA and ICs	$7,195,000	$1,949,000	$8,753,000

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APPENDIX E

VOC (PCE, TCE & 1,1,2,2-PCA) Total Mass Calculations and Cleanup Time Estimations

Total Mass of PCE in loess (0-30 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Conc. (mg/kg)	Ave. Conc. @ interval (mg/kg)	Bulk Density (lbs/ft^3)	Total Mass (lbs)
SBLEE*	A	8-10	400	10	4,000	4 4	N/A	91.35	1 6078
SBLCA*	A	8-10	400	10	4,000	1 9	N/A	91.35	0.6943
SBLCB	A	8-10		10		0.015		91 35	
SBLCD	A	8-10		10		0 007		91.35	
SBLEA	A	8-10	219,200	10	2,192,000	0.005	0.00598	91 35	1 1974
SBLDE	A	8-10		10		0.002		91 35	
SBLDC	A	8-10		10		0 0009		91.35	
SBLCA	A	28-30		10		0.31		91.35	
SBLCB	A	28-30		10		0.013		91.35	
SBLDC	A	28-30		10		0.008		91.35	
SBLCD	A	28-30	220,000	10	2,200,000	0.007	0.04425	91.35	8.8929
SBLCF	A	28-30		10		0 006		91.35	
SBLDA	A	28-30		10		0.005		91.35	
SBLDE	A	28-30		10		0.003		91.35	
SBLDF	A	28-30		10		0.002		91.35	
SBLCA*	A	14-16	400	10	4,000	1 9	N/A	91 35	0.6943
SBLEE	A	14-16		10		0.056		91.35	
SBLCD	A	14-16		10		0.025		91.35	
SBLCB	A	14-16		10		0.017		91.35	
SBLDC	A	14-16		10		0.006		91.35	
SBLEA	A	14-16	219,600	10	2,192,000	0.006	0.01276	91.35	2.5542
SBLDE	A	14-16		10		0.003		91.35	
SBLDB	A	14-16		10		0.0008		91.35	
SBLDF	A	14-16		10		0.0006		91.35	
SBLDD	A	14-16		10		0.0004		91 35	
SBLBC	E	28-30	10,000	10	100,000	0.0005	N/A	91 35	0.0046
SBLAB	F	8-10	14,400	10	144,000	0 041	N/A	91.35	0.5393
SBLAB	F	28-30	14,400	10	144,000	0 089	0 04475	91 35	0.5887
SBLBD	F	28-30		10		0.0005		91 35	
SBLAB	F	14-16		10		0.14		91.35	
SBLBD	F	14-16	14,400	10	144,000	0 0008	0.04707	91.35	0 6191
SBLAA	F	14-16		10		0 0004		91.35	
SBLFE	G	8-10	22,500	10	225,000	0.031	0 028	91.35	0.5755
SBLFG	G	8-10		10		0.025		91.35	
SBLFE	G	28-30	22,500	10	225,000	0.006	N/A	91.35	0 1233
SBLFE	G	14-16	22,500	10	225,000	0.018	0.010	91 35	0.2055
SBLFG	G	14-16		10		0.002		91.35	
SBLFD	N/A	14-16	0	10	0	0 005	N/A	91.35	0.0000
								Total	18 2969

579 856

Note:

1. Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc.in soil
   Reference Book: Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J , 1998)
2. SVE areas were divided into four zones (A, E, F, and G), refer to attached figure
3 Soil analytical results were obtained from the 1999 investigation.
4. Three vertical intervals (0-10', 10-20', and 20-30') were used to calculate total mass of the contaminant in loess
5 Assumes the contaminant concentration detected in the 2 feet interval represents conc.in the 10 feet interval
6. * Hot soil analytical results, therefore 400 square feet soil around the sampling point was calculated for the interval.
   Soil concentrations other than hot spots were averaged for treatment zones
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were
   averaged since the data obtained from the test were not continually decrease
9. The Average Mass Removal Rate for PCE was obtained from the pilot test 1: 0.00411 (lbs/hr)
10. Remediation time: 185 (day) = **0.5** year
11 Dry Bulk Density Calculation:

Station ID	Depth (ft)		Dry Unit Weight (lbs/ft^3)
MP-5	14-16		104.1
MP-5	14-16		97.3
MP-5	4-6		81
MP-5	4-6		88.5
MP-6	49-51		76 7
MP-6	49-51		82.4
MP-6	65-67		92 1
MP-6	65-67		90 3
MP-6	9-11		93 9
MP-6	9-11		96.3
MP-7	19-21		76.9
MP-7	19-21		91 3
MP-7	39-41		99 1
MP-7	39-41		105.8
MP-7	59-61		90.7
MP-7	59-61		95 2
	Ave:		**91.35**

Total Mass of TCE in loess (0-30 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Conc (mg/kg)	Ave Conc. @ interval (mg/kg)	Bulk Density (lbs/ft^3)	Total Mass (lbs)
SBLEE*	A	14-16	400	10	4,000	210	N/A	91.35	76.734
SBLCA*	A	14-16	400	10	4,000	9.5	N/A		3 4713
SBLCD*	A	14-16	400	10	4,000	4.9	N/A		1.79046
SBLCB	A	14-16	218,800	10	2,188,000	0.96	0.14867		29 7158
SBLDC	A	14-16		10		0 47			
SBLDG	A	14-16		10		0.11			
SBLEF	A	14-16		10		0 033			
SBLCF	A	14-16		10		0 025			
SBLDE	A	14-16		10		0.021			
SBLDB	A	14-16		10		0.007			
SBLCC	A	14-16		10		0.006			
SBLDD	A	14-16		10		0.002			
SBLCE	A	14-16		10		0.0008			
SBLEA	A	14-16		10		0 0006			
SBLCA*	A	28-30	400	10	4,000	18	N/A		6.5772
SBLCD*	A	28-30	400	10	4,000	3 9	N/A		1 42506
SBLCB*	A	28-30	400	10	4,000	1 3	N/A		0.47502
SBLCF*	A	28-30	400	10	4,000	1.1	N/A		0.40194
SBLDC	A	28-30	218,400	10	2,184,000	0.59	0.10384		20.7165
SBLDF	A	28-30		10		0.093			
SBLDG	A	28-30		10		0.071			
SBLDE	A	28-30		10		0 043			
SBLEE	A	28-30		10		0 027			
SBLEF	A	28-30		10		0.004			
SBLDA	A	28-30		10		0.002			
SBLDD	A	28-30		10		0.0007			
SBLEE*	A	8-10	400	10	4,000	460	N/A		168.084
SBLCA*	A	8-10	400	10	4,000	6.8	N/A		2.48472
SBLCD*	A	8-10	400	10	4,000	1.9	N/A		0 69426
SBLCB	A	8-10	218,800	10	2,188,000	0.68	0.1105		22.0861
SBLDC	A	8-10		10		0.073			
SBLDE	A	8-10		10		0 009			
SBLCF	A	8-10		10		0 006			
SBLDG	A	8-10		10		0.003			
SBLCC	A	8-10		10		0 002			
SBLDF	A	8-10		10		0.0005			
SBLBC	E	14-16	400	10	4,000	0.023	N/A		0 0084042
SBLBC	E	28-30	400	10	4,000	0.031	N/A		0.0113274
SBLAB	F	14-16	14,400	10	144,000	0 47	0.2435		3 2031
SBLBD	F	14-16		10		0 017			
SBLAB	F	28-30	14,400	10	144,000	0.33	0 1735		2.2823
SBLBD	F	28-30		10		0 017			
SBLAB	F	8-10	14,400	10	144,000	0.10	N/A		1 31544
SBLFG	G	14-16	22,500	10	225,000	0 006	N/A		0.1233225
SBLFG	G	8-10	22,500	10	225,000	0 005	N/A		0.0000
								Total:	341 6004

579 858

Note:

1 Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc in soil
Reference Book: Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J., 1998)
2. SVE areas were divided into four zones (A, E, F, and G), refer to attached figure
3. Soil analytical results were obtained from the 1999 investigation.
4. Three vertical intervals (0-10', 10-20', and 20-30') were used to calculate total mass of the contaminant in loess
5. Assumes the contaminant concentration detected in the 2 feet interval represents conc.in the 10 feet interval
6. * Hot soil analytical results, therefore 400 square feet soil around the sampling point was calculated for the interval. Soil concentrations other than hot spots were averaged for treatment zones.
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were averaged since the data obtained from the test were not continually decrease
9. The Average Mass Removal Rate for TCE was obtained from the pilot test 1: 0 01292 (lbs/hr)
10 Remediation time: 1,102 (day) = **3.0** year
11. Dry Bulk Density Calculation:

Station ID	Depth (ft)		Dry Unit Weight (lbs/ft^3)
MP-5	14-16		104.1
MP-5	14-16		97.3
MP-5	4-6		81
MP-5	4-6		88 5
MP-6	49-51		76.7
MP-6	49-51		82 4
MP-6	65-67		92.1
MP-6	65-67		90.3
MP-6	9-11		93.9
MP-6	9-11		96.3
MP-7	19-21		76.9
MP-7	19-21		91.3
MP-7	39-41		99.1
MP-7	39-41		105.8
MP-7	59-61		90 7
MP-7	59-61		95 2
	Ave:		**91.35**

Total Mass of 1,1,2,2-PCA in loess (0-30 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Conc. (mg/kg)	Ave. Conc @ interval (mg/kg)	Bulk Density (lbs/ft^3)	Total Mass (lbs)
SBLEE	A	14-16	400	10	4,000	46	N/A	91 35	16.8084
SBLCA	A	14-16	400	10	4,000	8.6	N/A	91.35	3.1424
SBLCD	A	14-16	400	10	4,000	2.5	N/A	91.35	0.9135
SBLEF	A	14-16		10		0.032		91.35	
SBLCC	A	14-16		10		0.007		91.35	
SBLDG	A	14-16	218,800	10	2,176,000	0.003	0.0096	91.35	1.9083
SBLDB	A	14-16		10		0.003		91.35	
SBLCB	A	14-16		10		0.003		91.35	
SBLCA	A	28-30	400	10	4,000	33	N/A	91.35	12.0582
SBLCD	A	28-30		10		0.91		91.35	
SBLCB	A	28-30		10		0.027		91.35	
SBLEE	A	28-30	219,600	10	2,192,000	0.009	0.1908	91.35	38.2056
SBLEF	A	28-30		10		0 004		91 35	
SBLDA	A	28-30		10		0.004		91 35	
SBLEE	A	8-10	400	10	4,000	160	N/A	91 35	58.4640
SBLCD	A	8-10	400	10	4,000	1.6	N/A	91 35	0.5846
SBLCA	A	8-10	219,200	10	2,184,000	0 24	N/A	91 35	47.882016
SBLBC	E	28-30	10,000	10	100,000	0.055	N/A	91.35	0 5024
SBLAB	F	28-30	14,400	10	144,000	0 009	0.007	91 35	0.0921
SBLBD	F	28-30		10		0.005		91 35	
								Total·	180.5616

Note·

1. Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc.in soil
   Reference Book Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J., 1998)
2. SVE areas were divided into four zones (A, E, F, and G), refer to attached figure
3. Soil analytical results were obtained from the 1999 investigation.
4. Three vertical intervals (0-10', 10-20', and 20-30') were used to calculate total mass of the contaminant in loess
5. Assumes the contaminant concentration detected in the 2 feet interval represents conc in the 10 feet interval
6. * Hot soil analytical results, therefore 400 square feet soil around the sampling point was calculated for the interval.
   Soil concentrations other than hot spots were averaged for treatment zones
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were averaged since the data obtained from the test were not continually decrease
9. The Average Mass Removal Rate for 1,1,2,2-PCA was obtained from the pilot test 1: 0.00676 (lbs/hr)
10. Remediation time: 1,114 (day) = **3.1** year
11. Dry Bulk Density Calculation:

Station ID	Depth (ft)	Dry Unit Weight (lbs/ft^3)	
MP-5	14-16		104.1
MP-5	14-16		97.3
MP-5	4-6		81
MP-5	4-6		88.5
MP-6	49-51		76.7
MP-6	49-51		82.4
MP-6	65-67		92.1
MP-6	65-67		90 3
MP-6	9-11		93 9
MP-6	9-11		96 3
MP-7	19-21		76.9
MP-7	19-21		91.3

579 860

MP-7	39-41		99.1
MP-7	39-41		105 8
MP-7	59-61		90.7
MP-7	59-61		95 2
	Ave:		**91.35**

Total Mass of PCE in fluvial (30 ~ 80 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Conc. (mg/kg)	Ave. Conc. @ interval (mg/kg)	Dry Bulk Density (lbs/ft^3)	Total Mass (lbs)
SBLCA-SB1	A	33	220,000	10	2,200,000	0 006	N/A	91.35	1.2058
SBLCA-SB4	A	42	220,000	10	2,200,000	0 0012	0.00207		0.4153
SBLCA-SB3	A	44				0.001			
SBLCA-SB2	A	44				0 004			
SBLCA-SB8	A	52	220,000	10	2,200,000	0.002	0.0015		0.3015
SBLCA-SB3	A	53				0.001			
SBLCA-SB3	A	67	220,000	10	2,200,000	0 0009	N/A		0.1809
SBLCA-SB8	A	72	220,000	10	2,200,000	0.066	0.0175		3 5170
SBLCA-SB2	A	73				0.001			
SBLCA-SB4	A	75				0.001			
SBLCA-SB5	A	77				0 002			
								Total:	5.6205

Note:

1 Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc.in soil
Reference Book: Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J , 1998)
2. Calculations were based on area A (250' X 880')
3. Soil analytical results were obtained from the 2000 investigation
4. Five vertical intervals (30-40', 40-50', 50-60', 60'-70', & 70-80') were used in the calculation
5. Assumes the contaminant concentrations detected in the interval represent conc.in the 10 feet interval
6. Soil concentrations in the same intervals were averaged for the area
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were averaged since the data obtained from the test were not continually decrease
9. The Average Mass Removal Rate for PCE was obtained from the pilot test 2: 0.08901 (lbs/hr)
10. Remediation time: 3 (day) = **0.007** year
11. Dry Bulk Density Calculation:

Station ID	Depth (ft)	Dry Unit Weight (lbs/ft^3)
MP-5	14-16	104 1
MP-5	14-16	97 3
MP-5	4-6	81
MP-5	4-6	88.5
MP-6	49-51	76 7
MP-6	49-51	82 4
MP-6	65-67	92 1
MP-6	65-67	90 3
MP-6	9-11	93.9
MP-6	9-11	96 3
MP-7	19-21	76 9
MP-7	19-21	91 3
MP-7	39-41	99 1
MP-7	39-41	105.8
MP-7	59-61	90 7
MP-7	59-61	95 2
	Ave:	**91.35**

Total Mass of TCE in fluvial (27-81 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft²)	Thickness (ft)	Volume (ft³)	Conc. (mg/kg)	Ave. Conc @ interval (mg/kg)	Bulk Density (lbs/ft³)	Total Mass (lbs)
SBLCA-SB11	A	27 5	220,000	2 5	550,000	0.009	N/A	91.35	0.4522
SBLCA-SB1	A	33	220,000	10	2,200,000	0.132	0 0830		16 6805
SBLCA-SB11	A	37.5				0 059			
SBLCA-SB10	A	37.5				0.058			
SBLCA-SB4	A	42	220,000	10	2,200,000	0.089	0 0713		14 3359
SBLCA-SB9	A	42				0.021			
SBLCA-SB2	A	44				0 176			
SBLCA-SB3	A	44				0.075			
SBLCA-SB5	A	44				0.061			
SBLCA-SB8	A	47				0.006			
SBLCA-SB8	A	52	220,000	10	2,200,000	0.161	0 0710		14.2689
SBLCA-SB4	A	52				0 055			
SBLCA-SB3	A	53				0 054			
SBLCA-SB5	A	54				0 099			
SBLCA-SB9	A	56				0.012			
SBLCA-SB10	A	57.5				0 045			
SBLCA-SB1	A	64	220,000	10	2,200,000	0.075	0 0475		9 5461
SBLCA-SB3	A	67				0 063			
SBLEE-SB1	A	67				0.011			
SBLCA-SB2	A	68				0.041			
SBLCA-SB8	A	72	220,000	11	2,420,000	0.322	0.2225		49.1874
SBLCA-SB10	A	72.5				0.008			
SBLCA-SB2	A	73				0.145			
SBLCA-SB1	A	74				0.009			
SBLCA-SB4	A	75				0.164			
SBLCA-SB5	A	77				0.179			
SBLCA-SB9	A	77				0.065			
SBLCA-SB11	A	81				0.888			
								Total:	104.4712

Note:

1. Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc.in soil
   Reference Book: Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J., 1998)
2. Calculations were based on area A (250' X 880')
3. Soil analytical results were obtained from the 2000 investigation.
4. Six vertical intervals (27 5-30', 30-40', 40-50', 50-60', 60'-70', & 70-81') were used in the calculation
5. Assumes the contaminant concentrations detected in the interval represent conc.for the entire interval
6. Soil concentrations in the same intervals were averaged for the area
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were averaged since the data obtained from the test were not continually decrease
9. The Average Mass Removal Rate for TCE was obtained from the pilot test 2: 0 45311 (lbs/hr)
10. Remediation time: 10 (day) = **0.0** year
11. Dry Bulk Density Calculation:

Station ID	Depth (ft)		Dry Unit Weight (lbs/ft³)
MP-5	14-16		104.1
MP-5	14-16		97.3

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MP-5	4-6		81
MP-5	4-6		88.5
MP-6	49-51		76.7
MP-6	49-51		82 4
MP-6	65-67		92.1
MP-6	65-67		90 3
MP-6	9-11		93 9
MP-6	9-11		96.3
MP-7	19-21		76.9
MP-7	19-21		91 3
MP-7	39-41		99 1
MP-7	39-41		105.8
MP-7	59-61		90 7
MP-7	59-61		95 2
	Ave:		**91.35**

Total Mass of 1,1,2,2-PCA in fluvial (40-81 feet) and Clean-up Time Estimation

Station ID	Treatment Zones	Depth (ft)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Conc (mg/kg)	Ave. Conc @ interval (mg/kg)	Bulk Density (lbs/ft^3)	Total Mass (lbs)
SBLCA-SB2*	A	44	400	10	4,000	22 6	N/A	91.35	8.2580
SBLCA-SB5	A	44	219,600	10	2,192,000	0.914	0.4655		93.2113
SBLCA-SB3	A	44				0.017			
SBLCA-SB5*	A	54	400	10	4,000	3 42	N/A		1 2497
SBLCA-SB10	A	57.5	219,600	10	2,192,000	0.265	0.09875		19.7736
SBLCA-SB3	A	53				0.087			
SBLCA-SB4	A	52				0.022			
SBLCA-SB8	A	52				0.021			
SBLCA-SB2*	A	68	400	10	4,000	15 1	N/A		5 5175
SBLCA-SB3*	A	67	400	10	4,000	1 07	N/A		0.3910
SBLEE-SB1	A	67	219,200	10	2,184,000	0 153	0.0825		16.4594
SBLCA-SB1	A	64				0.012			
SBLCA-SB2*	A	73	400	11	4,400	13.6	N/A		5.4664
SBLCA-SB11*	A	81	400	11	4,400	5 98	N/A		2.4036
SBLCA-SB4*	A	75	400	11	4,400	2.03	N/A		0.8159
SBLCA-SB8	A	72	218,800	11	2,393,600	0.399	0.1578		34.5038
SBLCA-SB5	A	77				0.159			
SBLCA-SB9	A	77				0.124			
SBLCA-SB10	A	72.5				0 099			
SBLCA-SB1	A	74				0 008			
			880,000					Total:	188.0504

Note:

1. Total mass of the contaminant = soil volume * soil dry bulk density * the contaminant conc.in soil
   Reference Book: Practical Design Calculations for Groundwater and Soil Remediation (Kuo, J., 1998)
2. Calculations were based on area A (250' X 880')
3. Soil analytical results were obtained from the 2000 investigation
4. Five vertical intervals (30-40', 40-50', 50-60', 60'-70', & 70-81') were used in the calculation
5. Assumes the contaminant concentrations detected in the interval represent conc.for the entire interval
6. * Hot soil analytical results, therefore 400 square feet soil around the sampling point was calculated for the interval. Soil concentrations other than hot spots were averaged for the treatment zone.
7. N/A - Not Applicable
8. SVE recovery rate will decrease over the operation time, mass removal rates from the pilot test were averaged since the data obtained from the test were not continually decrease

5. The Average Mass Removal Rate for 1,1,2,2-PCA was obtained from the pilot test 2: 0.14305 (lbs/hr)
6. Remediation time: 55 (day) = **0.2** year
7. Dry Bulk Density Calculation.

Station ID	Depth (ft)	Dry Unit Weight (lbs/ft^3)	
MP-5	14-16		104 1
MP-5	14-16		97 3
MP-5	4-6		81
MP-5	4-6		88.5
MP-6	49-51		76 7
MP-6	49-51		82 4
MP-6	65-67		92.1
MP-6	65-67		90.3
MP-6	9-11		93.9
MP-6	9-11		96.3
MP-7	19-21		76 9
MP-7	19-21		91 3

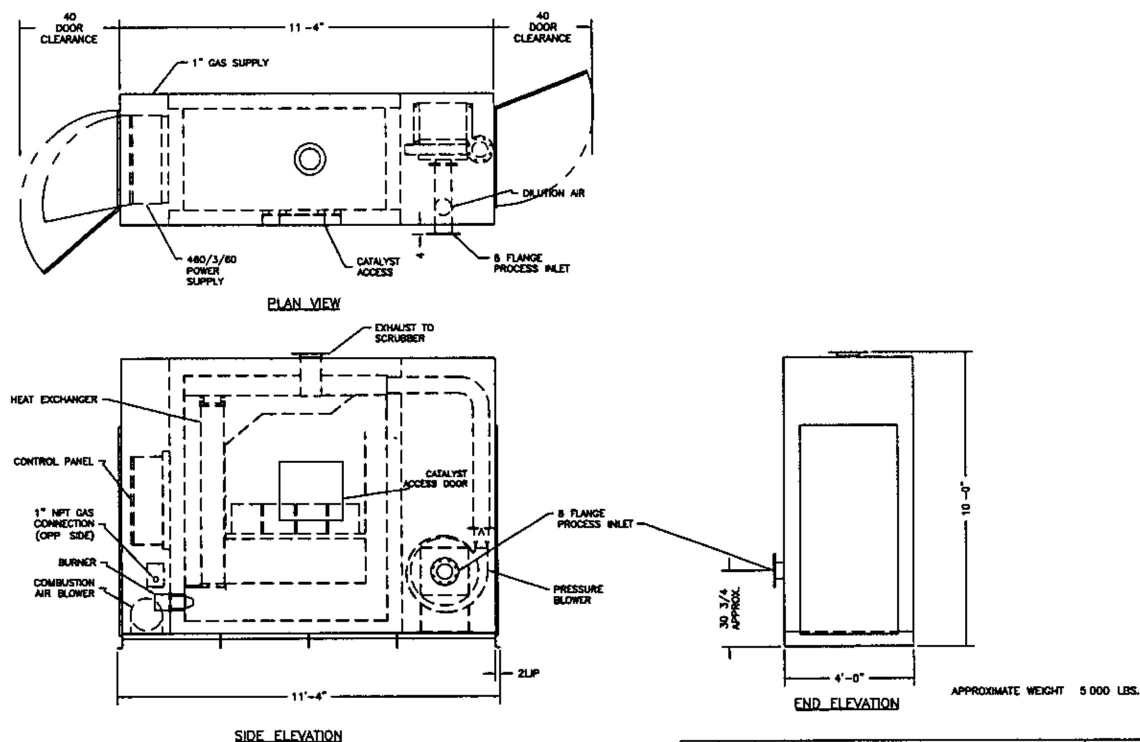
579 866

MP-7	39-41		99.1
MP-7	39-41		105 8
MP-7	59-61		90.7
MP-7	59-61		95.2
	Ave:		**91.35**

APPENDIX F

SVE Treatment System P&ID

579 868



APPROXIMATE WEIGHT 5 000 LBS.

ITEM	QTY	UNIT	DESCRIPTION	MATERIAL	ITEM MASTER	DRAWING NUMBER
2						
1						

BILL OF MATERIAL

DRAWING STATUS	DATE	BY
PRELIMINARY		
FOR APPROVAL	.	.
. APPROVED FOR FAB		
. AS BUILT		
AS FIELD MODIFIED		

MAT'L SEE BOM
WEIGHT N/A
TOLERANCES .X = 0.06 .XX = 0.03 .XXX = 0.015 ∠ = 0.5°

CATALYTIC COMBUSTION
709 – 21st Avenue Bloomer Wisconsin 54724
Telephone 715-568-2882 FAX 715-568-2884

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THIRD ANGLE PROJECTION
INCH [mm]
DO NOT SCALE THIS DRAWING

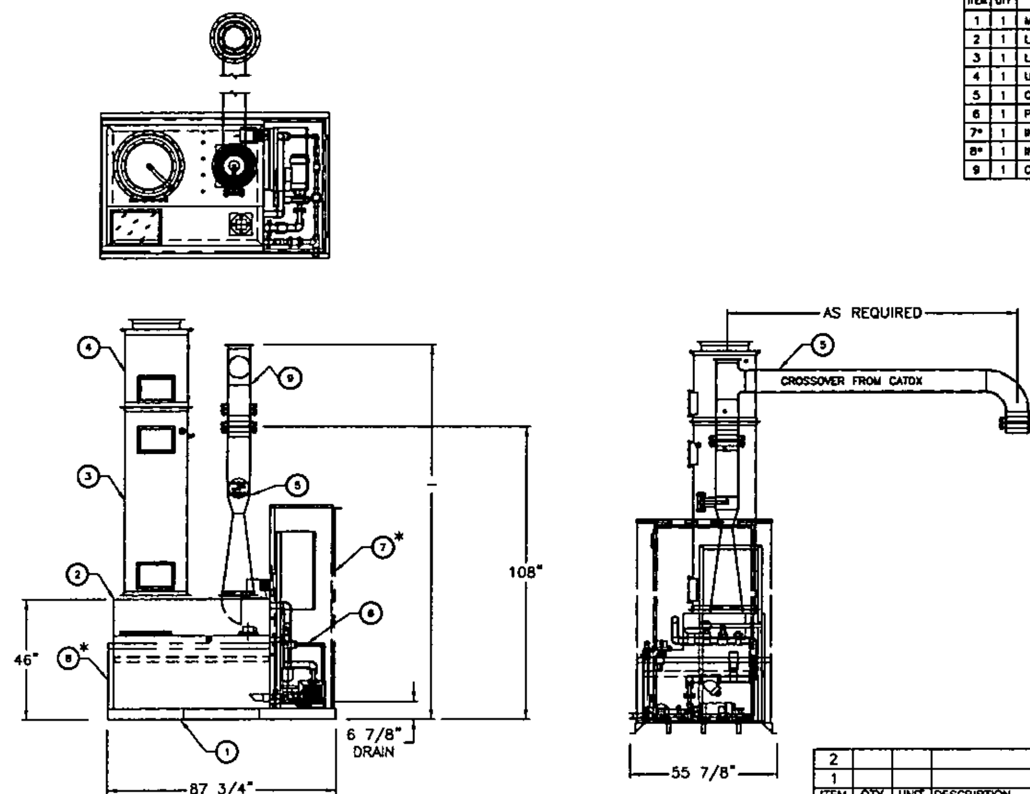
DATE: 5-8-02
SCALE: NONE
DRAWN BY: GU
CHECKED BY:
CUSTOMER: CH2M HILL
TITLE: 750 HD CATALYTIC OXIDIZER GENERAL ARRANGEMENT

PROJECT/PRODUCT	DRAWING	REV	SIZE
020130	100	0	B

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	REF DWG. #
1	1	MAIN BASE ASSEMBLY	G1-F1000
2	1	LOWER SYSTEM/ RECYCLE TANK ASSEMBLY	J3-A
3	1	LOWER SCRUBBER ASSEMBLY	J3-B
4	1	UPPER SCRUBBER ASSEMBLY	J3-C
5	1	QUENCH ASSEMBLY	J3-D
6	1	PIPING ASSEMBLY	J3-E
7*	1	INSULATED ENCLOSURE ASSEMBLY	J3-F
8*	1	INSULATED PANEL ASSEMBLY	J3-G
9	1	CROSSOVER ASSEMBLY	J3-H

* – INDICATES OPTIONAL ASSEMBLY



ITEM	QTY	UNIT	DESCRIPTION	MATERIAL	ITEM MASTER	DRAWING NUMBER
2						
1						

BILL OF MATERIAL

DRAWING STATUS	DATE	BY
PRELIMINARY		
FOR APPROVAL		
APPROVED FOR FAB		
AS BUILT		
AS FIELD MODIFIED		

MAT'L: SEE BOM
WEIGHT: N/A
TOLERANCES: .X = 0.06, .XX = 0.03, .XXX = 0.015, ∠ = 0.5°

CATALYTIC COMBUSTION
709 - 21st Avenue Bloomer, Wisconsin 54724
Telephone 715-568-2882 FAX 715-568-2884

THIRD ANGLE PROJECTION — INCH [mm]

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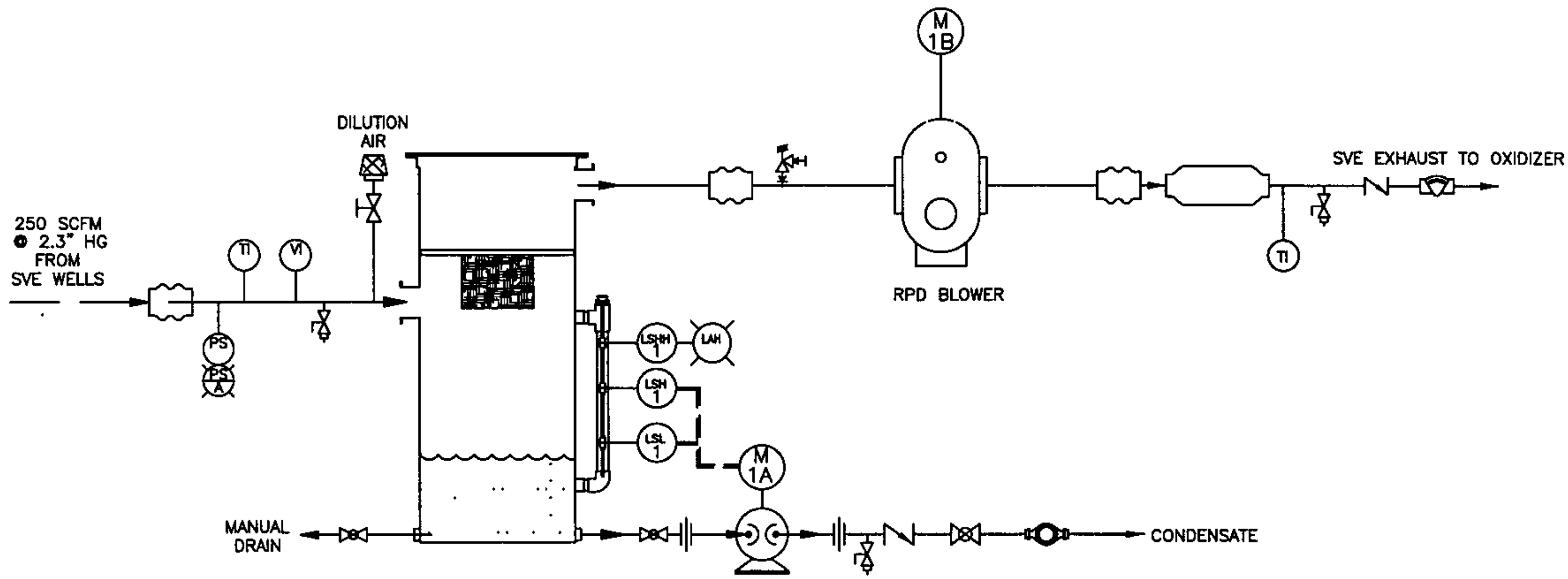
DO NOT SCALE THIS DRAWING

DATE: 5-8-02
SCALE: NONE
DRAWN BY: GU
CHECKED BY:

CUSTOMER: CH2M HILL
TITLE: 750 HCL SCRUBBER GENERAL ARRANGEMENT

PROJECT/PRODUCT	DRAWING	REV	SIZE
020130	110	0	B



REV	DESCRIPTION	DATE	BY
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MAT'L: SEE BOM

WEIGHT N/A

TOLERANCES
.X = 0.06
.XX = 0.03
.XXX = 0.015
∠ = 0.5°

CATALYTIC COMBUSTION

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THIRD ANGLE PROJECTION

INCH [mm]

DO NOT SCALE THIS DRAWING

DATE: 5-6-02

SCALE: NONE

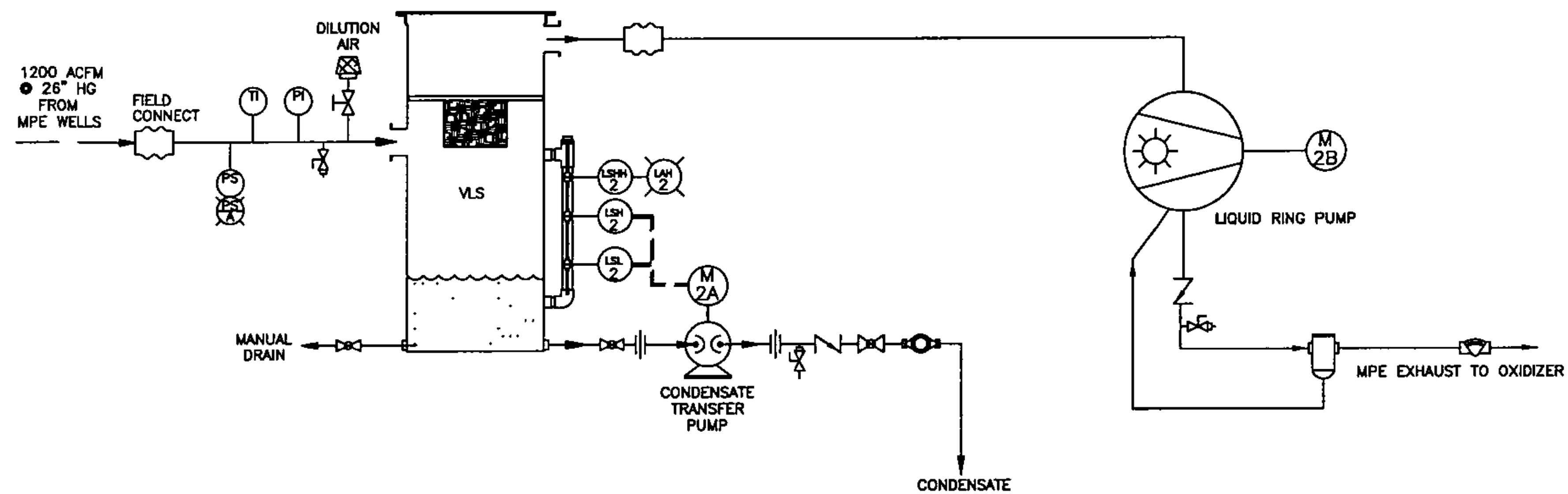
DRAWN BY: GU

CHECKED BY:

CUSTOMER: CH2M HILL

TITLE: LOW VAC RPD SYSTEM P&ID

PROJECT/PRODUCT	DRAWING	REV	SIZE
020130	520	0	A



REV	DESCRIPTION	DATE	BY
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.			
.			
.			

MAT'L: SEE BOM

WEIGHT N/A

TOLERANCES
.X = 0.06
.XX = 0.03
.XXX = 0.015
∠ = 0.5°

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THIRD ANGLE PROJECTION

INCH [mm]

DO NOT SCALE THIS DRAWING

DATE: 5-6-02

SCALE: NONE

DRAWN BY: GU

CHECKED BY.

CUSTOMER: CH2M HILL

TITLE: HYVAC MPE P&ID

PROJECT/PRODUCT	DRAWING	REV	SIZE
020130	510	0	A

579 871

579 872

SCRUBBER–OXIDIZER OPERATION

1) THE SCRUBBER MUST MUST BE IN THE AUTO MODE AND OPERATING PRIOR TO STARTING THE OXIDIZER

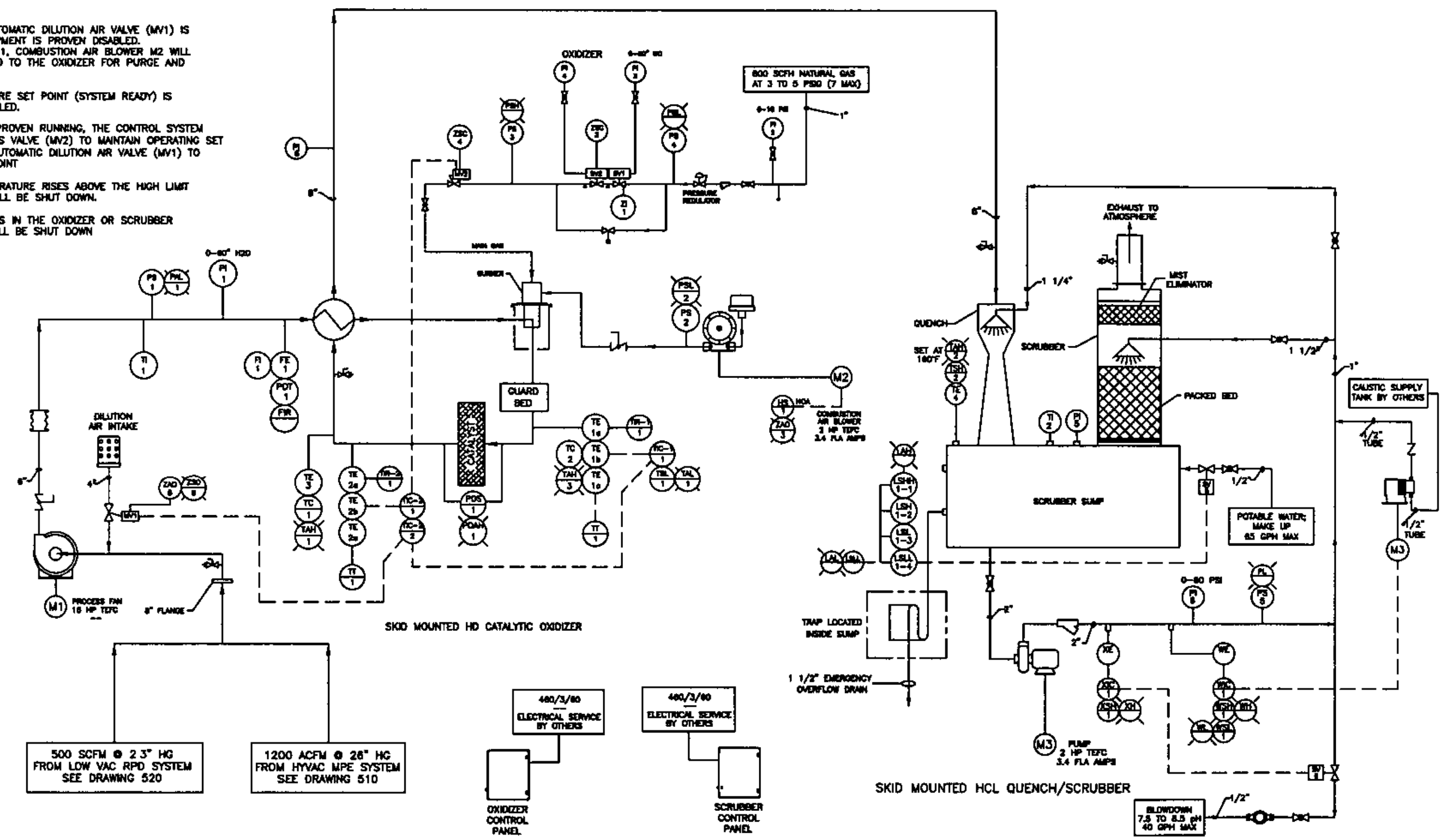
2) UPON OXIDIZER START, THE AUTOMATIC DILUTION AIR VALVE (MV1) IS PROVEN OPEN AND THE SVE EQUIPMENT IS PROVEN DISABLED.
THE OXIDIZER PROCESS BLOWER M1, COMBUSTION AIR BLOWER M2 WILL START AND FRESH AIR IS PROVIDED TO THE OXIDIZER FOR PURGE AND WARM–UP

3) AFTER THE BURNER TEMPERATURE SET POINT (SYSTEM READY) IS THE SVE EQUIPMENT MAY BE ENABLED.

4) ONCE THE SVE EQUIPMENT IS PROVEN RUNNING, THE CONTROL SYSTEM WILL MODULATE THE AUTOMATIC GAS VALVE (MV2) TO MAINTAIN OPERATING SET POINT AND ALSO MODULATE THE AUTOMATIC DILUTION AIR VALVE (MV1) TO CONTROL TO AN EXOTHERM SET POINT

5) IF THE OXIDIZER OUTLET TEMPERATURE RISES ABOVE THE HIGH LIMIT SET POINT, THE ENTIRE SYSTEM WILL BE SHUT DOWN.

6) IF AN ALARM CONDITION OCCURS IN THE OXIDIZER OR SCRUBBER CONTROLS, THE ENTIRE SYSTEM WILL BE SHUT DOWN



REV	DESCRIPTION	DATE	BY
.			
.			

DRAWING STATUS	DATE	BY
. PRELIMINARY	.	.
. FOR APPROVAL	.	.
APPROVED FOR FAB	.	.
AS BUILT	.	.
AS FIELD MODIFIED	.	.

MAT'L

WEIGHT

TOLERANCES
X = 0.06
XX = 0.03
.XXX = 0.015
∠ = 0.5°

THIRD ANGLE PROJECTION

INCH [mm]

CATALYTIC COMBUSTION CORPORATION

709 – 21st Avenue Bloomer, Wisconsin 54724
Telephone 715–568–2882 FAX 715–568–2884

DO NOT SCALE THIS DRAWING

DATE: 5–6–02
SCALE: NONE
DRAWN BY: gu
CHECKED BY:

CUSTOMER: CH2M HILL

TITLE: HD CATALYTIC OXIDIZER & SCRUBBER P&ID

PROJECT	DRAWING	REV	SIZE
020130	500		B

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE