Dunn Field West Vapor Intrusion Sampling and Analysis Plan

Defense Depot Memphis, Tennessee
U.S. EPA I.D. Number TN4210020570

Revision 1
January 2024

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Department of the Army

Prepared for:

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Acronyms and Abbreviations

AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	chloroform
cm/sec	centimeters per second
COC	constituent of concern
COPC	constituent of potential concern
CVOC	chlorinated volatile organic compound
CY	cubic yard
DDMT	Defense Depot Memphis, Tennessee
DFW	Dunn Field West
DoD	Department of Defense
DPT	direct push technology
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
ELCR	excessive lifetime cancer risk
EPC	exposure point concentration
ET&D	excavation, transportation, and off-site disposal
FDAQ	Fluvial Deposits Aquifer
ft	foot/feet
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IDW	investigation derived waste
ISTD	in situ thermal desorption
LOD	limit of detection
LOQ	limit of quantitation
LTM	long-term monitoring
MCL	maximum contaminant level
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
MI	Main Installation
min	minute
ml	milliliter
MLGW	Memphis Light, Gas and Water
OSWER	Office of Solid Waste and Emergency Response

PCE	tetrachloroethene
PID	photoionization detector
ppm	parts per million
QC	quality control
RA	remedial action
RG	remediation goal
ROD	Record of Decision
ROE	right of entry
SAP	Sampling and Analysis Plan
SCHD	Shelby County Health Department
SDG	sample delivery group
SOP	standard operating procedure
SVE	soil vapor extraction
TC	target concentration
TCA	1,1,2- trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TCR	target cancer risk
TDEC	Tennessee Department of Environment and Conservation
TeCA	1,1,2,2-tetrachloroethane
THQ	target hazard quotient
UCL	upper confidence limit
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VMP	vapor monitoring point
VOC	volatile organic compound
ZVI	zero-valent iron

1 Introduction

This Dunn Field West Vapor Intrusion Sampling and Analysis Plan (DFW VI SAP; HDR, 2023) for the former Defense Depot Memphis, Tennessee (DDMT) has been prepared under Contract W91278-16-D-0061, Task Order W9127819F0090 to the United States Army Corps of Engineers (USACE), Mobile District. The environmental restoration program at DDMT is directed by the Department of the Army (Army), Office of the Deputy Chief of Staff, G9, Environmental Division, Base Realignment and Closure (BRAC) Field Branch. The regulatory oversight agencies are United States Environmental Protection Agency (USEPA), Region 4 and Tennessee Department of Environment and Conservation (TDEC). DDMT's USEPA Identification Number is TN4210020570.

An investigation was conducted in the west-central section of Dunn Field due to increasing chlorinated volatile organic compound (CVOC) concentrations in groundwater. Soil, soil vapor and groundwater samples were collected from May 2020 to August 2021, and analytical results were evaluated through a human health risk assessment (HHRA). The *Dunn Field West Post-ROD Supplemental Investigation Report, Revision 1* (DFW Investigation; HDR, 2023a) was submitted to USEPA and TDEC on April 20, 2023.

The investigation identified volatile organic compound (VOC) concentrations greater than vapor intrusion screening levels (VISLs) in soil vapor and groundwater on Dunn Field and in groundwater in the residential area along Rozelle Street west of Dunn Field. The HHRA identified the potential for unacceptable risks and hazards from exposure to contaminants of potential concern (COPCs) in groundwater and soil vapor to future on-site commercial/industrial workers and to future off-site residents. The HHRA determined that pathways for current exposure on-site were incomplete but pathways for current off-site residents were potentially complete (see Section 2.3.5). Further investigation is required to determine whether current off-site residents will be potentially exposed to unacceptable VI risk and hazard using soil vapor data.

This DFW VI SAP presents methods to characterize the potential VI risk and hazard to off-site residents west of Dunn Field. An outline of the planned investigation was prepared by Army and discussed in a conference call with USEPA and TDEC on 21 February 2023. The outline was approved and has been used in preparing this SAP. The methods presented in this SAP are in accordance with *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, Office of Solid Waste and Emergency Response (OSWER) Publication 9200.2-154 (USEPA, 2015) and *DOD Vapor Intrusion Guidance* (TSERAW, 2009). Applicable content from the *DDMT Uniform Federal Policy Quality Assurance Project Plan* (HDR, 2018) has been updated for inclusion in this SAP.

Responses to agency comments and correspondence with USEPA and TDEC are included in Appendix A.

1.1 Site Location and Description

DDMT is located in southeastern Memphis, Tennessee, and consists of approximately 634 acres at the Main Installation (MI) and Dunn Field (Figure 1). DDMT originated as a military facility in the early 1940s to provide stock control, materiel storage, and maintenance services for the U.S. Army. DDMT was selected for closure under BRAC in 1995; storage and distribution activities ceased in September 1997.

Dunn Field, which is located across Dunn Avenue from the northwest section of the MI, contains approximately 67 acres with former mineral storage and waste disposal areas. Approximately two-thirds of Dunn Field is grassed, and the remaining area is covered with crushed rock and paved surfaces. Dunn Field is zoned for light industrial use but is currently undeveloped. Land use controls for Dunn Field were established to limit use to light industrial uses, to prevent residential use and to prevent exposure to contaminated groundwater (CH2MHILL, 2008).

The surrounding area has mixed residential, commercial and industrial land uses. Dunn Field is bordered on the south by Dunn Avenue and the MI, on the east by Hayes Road and residential property, on the north by a railroad line and East Person Avenue with residential property and commercial-industrial uses, and on the west by commercial warehouses with residential property and an electrical substation further west.

1.2 Project Organization

Project personnel and contact information are listed on Table 1; qualifications of HDR and subcontractor personnel are listed on Table 2. The project schedule is listed on Table 3.

2 Background Information

2.1 Geology and Hydrogeology

The geologic units on Dunn Field relevant to this VI study are loess and the fluvial deposits. The loess consists of wind-blown and deposited brown to reddish-brown, low-plasticity clayey silt to silty clay. The loess deposits on Dunn Field are present from the ground surface to approximately 20 feet (ft) below ground surface (bgs). The fluvial (terrace) deposits consist of two general layers. The upper layer of silty, sandy clay to clayey sand is approximately 10 ft thick. The lower layer is composed of interlayered sand, sandy gravel, and gravelly sand, and is 40 to 50 ft thick. The unit thicknesses were taken from boring logs for long-term monitoring (LTM) wells in the investigation area: MW-06, MW-71, MW-87, MW-328 and MW-329.

The fine-grained soil in the loess and upper fluvial deposits at DDMT have low permeability values with test results at 5x10-8 to 2x10-7 centimeters per second (cm/sec). The coarse-grained soil in the lower fluvial deposits have moderate permeability values with test results at 2x10-4 to 7x10-3 cm/sec (HDR, 2021).

The uppermost aquifer is the unconfined Fluvial Deposits Aquifer (FDAQ) in the saturated section of the lower fluvial deposits. The lower fluvial deposits are underlain by a clay layer in the upper Claiborne Group, which is present throughout Dunn Field and forms the base of the FDAQ. Depth to FDAQ groundwater at Dunn Field West ranges from approximately 55 to 65 ft bgs (HDR, 2023b).

2.2 Remedial Investigation, Response Actions and Remedial Actions

Dunn Field was divided into three areas for the remedial investigation (CH2MHILL, 2002), based on similar historical use and proposed reuse: Northeast Open Area, Stockpile Area, and Disposal Area. These areas are shown on Figure 2 with the locations of the interim remedial action and removal actions conducted prior to completion of the Dunn Field Record of Decision (ROD; CH2MHILL, 2004). A groundwater extraction system was installed for the interim remedial action (CH2MHILL, 1996) in 2001, and removal actions were conducted for chemical warfare material in 2001 (UXB International, Inc., 2001) and lead-contaminated soil in the former pistol range in 2003 (Jacobs Federal Programs, 2003a). The groundwater removal interim action operated from 2001 to 2009; the equipment was removed, and the wells abandoned in 2010 (HDR, 2010).

Remedial actions for disposal sites and source areas in the Disposal Area of Dunn Field were conducted from 2005 to 2012 in accordance with the Dunn Field ROD (CH2MHILL, 2004) and ROD Amendment (e²M, 2009). The locations are shown on Figure 3.

The Disposal Sites remedial action (RA) required removal of potential principal threat wastes (primarily drums and glass bottles) from five disposal sites. Soil and debris were excavated and transported for off-site disposal (ET&D) in 2005 and 2006. Approximately 2,700 cubic yards (CY) of non-hazardous materials were transported off-site and disposed at the BFI South

Shelby County Landfill. Approximately 234 CY of hazardous materials from Disposal Site 3 were disposed at the Clean Harbors Lambton Secure Landfill in Canada. The *Disposal Sites Remedial Action Completion Report* (MACTEC, 2006) was approved by USEPA in August 2006.

The Source Areas RA included conventional soil vapor extraction (SVE) in the coarse-grained fluvial soils; ET&D for two shallow areas containing waste materials (TA-1F) and buried drums with residual petroleum hydrocarbons (TA-3); in situ thermal desorption (ISTD) in the fine-grained loess; and zero-valent iron (ZVI) injection in the FDAQ. Confirmation samples met criteria for remedial action objectives for each action. The *Source Areas Interim Remedial Action Completion Report* (HDR|e²M, 2009) was approved by USEPA and TDEC in November 2009. The RAs are summarized below:

- The Fluvial SVE system was installed to remove CVOCs from the fluvial sands at Dunn Field with screened intervals for the SVE wells at approximately 30 to 70 ft bgs. The system operated from July 2007 to July 2012 and removed approximately 4,000 pounds of VOCs.
- The initial excavations at TA-1F and TA-3 were performed October 2007 to January 2008; the excavations were completed in February to June 2009 after construction and operation of the ISTD system. Approximately 7,400 CY of waste material were disposed as non-hazardous waste at the Waste Management Inc. landfill in Tunica, MS.
- ISTD treatment was performed in four areas with a total area of about 1.25 acres and a treatment interval of approximately 5 to 30 ft bgs. The thermal conduction wells operated from May to November 2008, and the vapor extraction system operated from May to December 2008. Approximately 12,500 pounds of VOCs were removed during treatment.
- ZVI injections were not required because groundwater objectives were achieved through the subsurface soil remedies.

2.3 DFW Investigation

The DFW investigation (HDR, 2023a) was conducted to evaluate increasing concentrations of CVOCs in samples from LTM wells MW-06 and MW-87 in the west-central portion of Dunn Field (Figure 3). These wells are located west of Source Areas RA Treatment Area 3 (TA-3) and south of TA-2. CVOC concentrations were reduced by the SVE and ISTD RAs and decreased below both maximum contaminant levels (MCLs) and target concentrations (TCs) in the Dunn Field ROD in April 2011. Increased concentrations were observed in 2013 and the trichloroethene (TCE) concentration at MW-87 increased above the MCL in 2017.

Residual CVOC concentrations in soil are likely present in the fine-grained soils (loess and upper fluvial deposits) near MW-87. Prior to RA, contaminants in the loess on Dunn Field leached through the soil and impacted groundwater. The SVE system halted contaminant migration through the fluvial deposits and ISTD removed CVOCs from the loess in the treatment areas. The radius of influence of the SVE system apparently included MW-06 and MW-87 and halted contaminant migration through the lower fluvial deposits in that area; removal of contaminants from the loess by ISTD was likely limited to the extent of the conductive heater wells. After shutdown of the SVE system in 2012, contaminant migration from the loess through the lower fluvial deposits resumed, as evident from increased CVOC concentrations in LTM samples.

Soil, soil vapor and groundwater samples for the DFW investigation were collected from May 2020 to August 2021. Comparison of the analytical results to VISLs are summarized below. Soil vapor analytical results collected on Rozelle Street for the 2009 vapor intrusion study are also discussed.

2.3.1 Soil Samples

In 2020 and 2021, soil samples were collected from 28 borings advanced to a maximum depth of 60 ft bgs. Soil sample depths and photoionization detector (PID) measurements are shown on Table 4. The laboratory analytical results summary is provided on Table 5, and CVOC concentrations above remediation goals (RGs) established in the Dunn Field ROD (CH2MHILL, 2004) are shown on Figure 4. An area of residual soil contamination by 1,1,2,2-tetrachloroethane (TeCA), 1,1,2-trichloroethane (TCA), vinyl chloride (VC) and other VOCs was observed in soil samples from borings SB-06, SB-07, SB-07D and SB-18. The vertical extent of contamination was delineated by the deeper soil samples in these borings and the lateral extent was delineated by adjacent borings. The vertical extent of CVOCs above RGs was 22 ft bgs at SB-06, 31 ft bgs at SB-07D and 12 ft bgs at SB-18. Soil with CVOCs above RGs is limited to the fine-grained soil (loess and upper fluvial deposits) located approximately 75 ft east of the Dunn Field boundary.

2.3.2 Soil Vapor Samples

Vapor monitoring points (VMPs) for the DFW investigation were installed in 2020 and 2021 with 12-inch long, 0.25-inch inside diameter stainless steel wire-mesh screens; eight shallow VMPs in the loess have screens at approximately 5 ft bgs, and eight deep VMPs in the lower fluvial deposits sand have screens between 25 and 30 ft bgs. VMPs VP-7A and VP-7B were constructed in 2007 for the Dunn Field SVE system in TA-3; the VMPs have 5-ft screens in the lower fluvial deposits at depths of 53 and 32 ft bgs, respectively. VMP construction data is provided on Table 6.

Soil vapor samples were collected in 2020 and 2021. Laboratory analytical results for the VMPs are presented on Table 7 for shallow VMPs and on Table 8 for deep VMPs, including VP-7A/B, in micrograms per cubic meter (μg/m^3).

- Multiple samples were collected from most VMPs to evaluate concentrations over time. CVOC and VOC concentrations varied up to three orders of magnitude when comparing results over the multiple sampling events. In general, CVOC concentrations were greatest in samples collected after VMP installation and decreased over time.
- During multiple sampling events, saturated soil prevented the collection of soil vapor samples from shallow VMP-18S, VMP-25S, and deep VMP-6D and VMP-10D. Saturated soil inhibits the migration of soil vapor and therefore may be partly responsible for the orders of magnitude difference between the initial and subsequent sample results.

Shallow soil vapor results are discussed below:

- Shallow soil vapor samples collected from VMP-6S, 7S and 14S were the only samples which contained CVOCs above the commercial VISL at a target cancer risk of $1x10^{-6}$ and target hazard quotient of 0.1 (TCR of 1E-06, THQ of 0.1). The CVOCs are chloroform (CF), TCE and VC.
- Multiple, Other VOCs, generally associated with petroleum hydrocarbons, were also detected above commercial VISLs in VMP-6S and 7S. Acrolein was detected above the commercial VISL (0.292 $\mu g/m^3$) in VMP-7S, 10S, 11S, 14S, 17S and 25S.

Deep soil vapor sample results are discussed below:

- Deep soil vapor samples collected from VP-7A/B and VMP-7D and 15D were the only samples which contained CVOCs above the commercial VISL (TCR of 1E-06, THQ of 0.1). The CVOCs are TCA, CF and TCE in VP-7A/B; TCE and VC in VMP-7D; and CF in VMP-15D.
- As in shallow vapor samples, multiple, Other VOCs, generally associated with petroleum hydrocarbons, were also detected above VISLs in VMP-6D, 7D and 18D. A few Other VOCs (1,3-butadiene, acrolein and naphthalene) were also detected above VISLs in samples collected from VP-7A/B and VMP-10D, 13D, 15D and 17D.

As illustrated on Figure 5, the lateral extent of CVOCs in soil vapor is generally delineated to the north and south; however, CVOC concentrations above VISLs were detected in VMP-6S and VMP-7S approximately 75 ft east of the Dunn Field boundary. Soil vapor samples were not collected west of VMP-6S and VMP-7S; therefore, the extent of CVOCs in shallow soil vapor west of VMP-6S and VMP-7D is not known.

2.3.3 Groundwater Samples

Fluvial aquifer LTM wells in the project area are shown on Figure 6, and construction data are provided on Table 9. LTM analytical results for April 2021 to April 2023 are shown on Table 10 for on-site wells and Table 11 for off-site wells. Only primary CVOCs listed in the Dunn Field ROD and acetone were reported above the limits of detection. The maximum concentration for acetone (13 micrograms per liter [µg/L]) was below commercial and residential VISLs and is not shown.

MCLs and TCs are also shown with commercial VISLs on Table 10 and residential VISLs on Table 11. Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

Commercial VISLs were exceeded in one or more samples from on-site wells MW-06, MW-87 and MW-328 for TCA, CF and TCE. Residential VISLs were exceeded for the same three CVOCs in one or more samples from off-site wells MW-71 and MW-184. These CVOCs also exceeded VISLs in shallow soil vapor samples and deep soil vapor samples.

Groundwater elevation contours and analytical results indicate the approximate centerline of the plume extends from MW-06 to MW-184.

2.3.4 2009 Vapor Intrusion Study

A nested VMP, VI-1A/B, was installed in 2009 on an asphalt pad in an abandoned lot on Rozelle Street west of Dunn Field (Figure 5). The VMP screens were 6-inch long, 0.5-inch diameter stainless steel wire mesh; VI-1A was screened at 14.5 ft bgs and VI-1B at 4.5 ft bgs. Soil samples collected at 6, 11 and 16 ft bgs were classified as clay or clayey silt (loess). Soil vapor samples were collected In September 2009 and March 2010. Tetrachloroethene (PCE) at 1.2 to 5 $\mu g/m^3$ and methylene chloride at 4.2 to 7.3 $\mu g/m^3$ were the only CVOCs detected above laboratory reporting limits (HDR|e²M, 2009); the concentrations were below residential VISLs (TCR of 1E-06, THQ of 0.1). The concrete pad was left in place and the manhole was filled with concrete after the sample tubes had been cut off about 8 inches bgs.

2.3.5 Risk Assessment

The DFW Investigation HHRA (HDR, 2023a) identified potential for unacceptable risks and hazards from exposure to COPCs in groundwater and soil vapor to future on-site commercial/industrial workers and to future off-site residents. Applicable guidance (USEPA, 1991) requires that human health risks and hazards incorporate any potential exposure without consideration of engineering or institutional controls. However, under current land use conditions, there are no known human receptors being exposed to soil, groundwater, and soil vapor as DFW is not in active use, groundwater is not being used as a source of drinking water, and there are no on-site buildings.

Exposure pathways for current off-site residents are considered to be potentially complete due to groundwater concentrations above VISLs at off-site wells and the lack of current soil vapor samples in the Rozelle Street area. However, the potential for exposure is limited based on the following: soil contamination is limited to Dunn Field; potable groundwater is provided by Memphis Light, Gas and Water (MLGW); CVOCs have been detected at relatively low levels above the groundwater resident VISL in MW-71 and MW-184 located west of Dunn Field; and the 2009 VI study indicated the loess and upper fluvial deposits provide an effective barrier to vertical migration of soil vapor from groundwater. In addition, a VI sensitivity analysis was performed in the HHRA with the groundwater analytical data in off-site well MW-71 to determine the potential risks and hazards to current off-site residents if they were exposed to indoor air impacted by groundwater COPCs. MW-71 is located in the groundwater flow path between Dunn Field West and the closest residence; its depth to water was 62 ft in 2021. Review of potential current off-site resident exposure to groundwater contamination via VI showed risk within the USEPA acceptable cancer risk range and hazard below the USEPA acceptable noncancer threshold.

Land use controls have been implemented on DFW to prevent future residential land use, daycare facilities, well installation and groundwater use, and to control site access. These controls limit potential future exposure on-site. Future exposure of off-site residents to groundwater is prevented through the supply of potable water by MLGW. Local regulations which prohibit the installation of drinking water wells within 0.5 miles of the designated boundaries of a listed federal Superfund site, including areas of groundwater contamination, and where municipal water supply is available.

3 Project and Data Quality Objectives

The data quality objectives (DQOs) were established in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006). Work Sheets from the DDMT QAPP (HDR, 2018) have been updated to provide additional information and are provided in Appendix B. The Work Sheets are:

- WS 6, Communication Pathways
- WS 23, Analytical SOPs
- WS 24, Analytical Instrument Calibration
- WS 25, Analytical Instrument and Equipment Maintenance, Testing, and Inspection
- WS 31, 32 & 33, Assessments and Corrective Action
- WS 34, Data Verification and Validation Inputs
- WS 35, Data Verification Procedures
- WS 36, Data Validation Procedures
- WS 37, Data Usability Assessment

3.1 Problem Statement

The DFW investigation (HDR, 2023a) documented VOC concentrations greater than VISLs in soil vapor and groundwater on Dunn Field and in groundwater in the residential area along Rozelle Street west of Dunn Field. Pathways for current exposure on-site are considered to be incomplete but are considered to be potentially complete for current off-site residents (Section 2.3.5). Further investigation is required to determine whether current off-site residents will be potentially exposed to unacceptable VI risk and hazard using soil vapor data.

3.2 Goals of the Study

The goals of this study are to collect soil vapor samples along the approximate centerline of the plume extending from MW-06 to MW-184. VMPs will be installed at three locations along the groundwater flow path beginning near MW-06 (Figure 7). Paired VMPs will be installed at each location with 12-inch long, 0.25-inch inside diameter stainless steel wire-mesh screens in the loess at 5 ft bgs and in the lower fluvial deposits at approximately 30 ft bgs.

The newly constructed VMPs and four existing VMPs (two deep and two shallow) will be sampled for VOCs by an analytical laboratory during two events approximately four months apart. Vapor analytical results from the DFW investigation, these additional vapor samples, and groundwater results from recent LTM sample events, will be used to evaluate whether VOCs in subsurface vapor and groundwater present an unacceptable VI risk to current off-site residents.

3.3 Information Inputs

The following information inputs will be used to achieve the goals of this study.

- Laboratory analysis of soil vapor samples from four existing VMPs (VMP-6S, VMP-6D, VMP-7S, and VMP-7D) on Dunn Field and six new VMPs (26A/B, 27A/B and 28A/B).
- VMPs will be sampled twice to evaluate temporal variability in CVOC concentrations.
- Laboratory analytical results from LTM groundwater samples and soil vapor samples will be compared to the VISLs (Table 12) to evaluate whether contaminants migrating west of Dunn Field present a VI concern to current off-site residential receptors.

3.4 Study Boundaries

The study boundary includes the west-central portion of Dunn Field and extends off-site to the west past Rozelle Street (Figure 3).

The proposed schedule for this investigation is shown on Table 3. This investigation is limited to the collection of soil vapor samples from up to six newly constructed VMPs and four existing VMPs during two sample events, laboratory analysis, data validation, a VI risk assessment, and completion of a report in 2025.

3.5 Analytical Approach

Soil vapor samples will be analyzed at Department of Defense (DoD) environmental laboratory accreditation program laboratory for VOCs by Method TO-15. Laboratory analytical limits of quantitation (LOQ) and limits of detection (LOD) are listed on Table 13 with the VISLs. The LOQs and LODs were compared to VISLs to confirm the screening level criteria could be met. LOQs and LODs were available for the VOCs for method TO-15, except for six analytes, of which only two had VISLs for comparison. Initial review of LOQs and LODs indicates they are below the VISLs in soil vapor except for 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, and acrolein.

Soil lithology for VMP borings will be described using the Unified Soil Classification System (USCS; American Society for Testing and Materials [ASTM] D2487-83). Field observations (e.g., odor and staining) and PID measurements will be noted in the field log.

3.6 Performance or Acceptance Criteria

Laboratory analytical results must meet USEPA method-specified laboratory quality control (QC) criteria and be shown to be useful for the intended purpose through data verification and validation. Performance criteria for analytical data are presented on Table 14.

A Tennessee-registered land surveyor will establish horizontal and vertical control for each VMP. Vertical control will be established to 0.01 ft and will be based on the North American Vertical Datum of 1988. Horizontal control will be based on the Tennessee State Plane Coordinate System.

Field activities including VMP installation and soil vapor sampling, laboratory analysis, and data validation will be conducted in accordance with:

- this SAP
- ASTM D7758-17 Standard Practice for Passive Soil Gas Sampling in the Vadose Zone for Source Identification, Spatial Variability Assessment, Monitoring, and Vapor Intrusion Evaluations (ASTM, 2017)
- OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (USEPA, 2015)
- DoD Vapor Intrusion Handbook Fact Sheet Update No. 010 (TSERAW, 2020)
- DoD Vapor Intrusion Guidance (TSERAW, 2009)
- DoD General Data Validation Guidelines (DOD, 2018)
- Environmental Quality Guidance for Evaluating Performance-Based Chemical Data, EM 200-1-10 (USACE, 2005)
- Vapor Intrusion Investigation Process and Flowchart (TDEC, 2016)
- Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.4, (DOD/DOE, 2021).

3.7 Plan for Obtaining Data

A project schedule is provided on Table 3; the planned activities are listed below. Additional information on investigation activities is provided in Section 4.

Phase 1. VMP Construction and Initial Sampling

- Obtain right of entry (ROE) for VMPs installed on private property and encroachment permit(s) for VMPs installed on public property.
- Obtain permits from the Shelby County Health Department (SCHD), mark locations in white paint, and notify Tennessee 811.
- Advance six direct push technology (DPT) soil borings up to 35 ft bgs. Construct three deep VMPs near the top of the fluvial sand and three shallow VMPs in the loess at 5 ft bgs. Shallow and deep VMPs will be constructed in adjacent borings.
- Collect pressure and PID measurements and soil vapor samples from VMP-6S, VMP-6D, VMP-7S and VMP-7D and the six new VMPs. Purge and sample each of these VMPs. Analyze soil vapor samples for VOCs by Method TO-15.
- Compare soil vapor results to VISLs shown on Table 12 and prepare a data summary report for Army review.

Phase 2. Follow-up VMP Sampling

- No more than six months after the initial sampling, collect pressure and PID measurements and soil vapor samples from VMP-6S, VMP-6D, VMP-7S and VMP-7D and the six new VMPs. Analyze soil vapor samples for VOCs by Method TO-15.
- Prepare a technical memorandum with validated soil vapor results and calculation of the VI risk and hazard for a current off-site resident for submittal to TDEC, USEPA, and Army.

4 Vapor Intrusion Investigation

Sampling, laboratory analysis and data validation will be performed in accordance with updated Standard Operating Procedures (SOPs) from the DDMT UFP QAPP (HDR, 2018) provided in Appendix C. Laboratory analyses will be conducted in accordance with SOPs in Appendix D. Field activities will be performed in accordance with the *Site Safety and Health Plan Update* (HDR, 2022b) prepared for this task order. The investigation activities are summarized below.

4.1 Access, Permitting and Utility Clearance

Army will request ROE from the off-site property owner west of Dunn Field to install two VMPs (VMP-27S and VMP-27D) located in the cleared path approximately 100 ft north of MW-71 to LTM well MW-71 (Figure 7). Previous attempts to obtain ROE for monitoring well installation have not been successful; therefore, these two VMPs may not be installed.

An encroachment permit will be requested from the City of Memphis for two VMPs (VMP-28S and VMP-28D) in the public right-of-way along Rozelle Street. A performance bond will be obtained per city requirements.

Prior to drilling, each boring location will be marked, and Tennessee 811 will be notified so that underground utilities can be located and marked. SCHD permits for the VMPs will be acquired by the driller.

4.2 VMP Construction and Sampling

Six DPT borings will be advanced to depths up to 35 ft bgs for single-screen completion VMPs. Three VMPs are to be screened in the loess, at approximately 5 ft bgs, and three VMPs are planned to be screened in the lower fluvial deposits at approximately 30 ft bgs. VMP IDs will have a letter added to denote the depth, “S” for shallow and “D” for deep.

The borings will be continuously cored, VMPs constructed, and sampled in accordance with Appendix C, SOP 2. The soil core will be described using the USCS and screened for VOCs with a PID. Soil samples will be collected for laboratory analysis where PID readings exceed 25 parts per million (ppm). Boring logs and VMP diagrams will be prepared for each location.

Soil vapor samples will be collected from VMPs at least 48 hours after construction. Prior to soil vapor sampling, atmospheric and vadose zone pressure differential will be measured in each VMP to determine vertical gradients with a manometer.

After pressure measurement, each VMP will be purged of three casing volumes at a flow rate of 200 milliliters per minute (ml/min). If low soil permeability prevents a minimum flow rate of 100 ml/min, at a maximum vacuum of 100 inches of water, a sample will not be collected as the soil is not sufficiently permeable to facilitate advective VI. Sampling under excessive vacuum may desorb VOCs from low permeability soil and may cause short circuiting through the annular seal. Both conditions would result in unrepresentative results.

After purging three casing volumes, the VMP will be sampled at 200 ml/min using a 1-liter summa canister in accordance with Appendix C, SOP 5. The soil vapor sample will be shipped to a DOD Environmental Laboratory Accreditation Program (ELAP) laboratory for analysis of VOCs listed on Table 13 by Method TO-15.

4.2.1 Surveying

A Tennessee-registered land surveyor will establish horizontal and vertical control for new VMPs. Vertical control will be established to 0.01 ft and will be based on the North American Vertical Datum of 1988. Horizontal control will be established to 0.1 ft and will be based on the Tennessee State Plane Coordinate System.

4.3 Equipment Decontamination

The purpose of decontamination and cleaning procedures during drilling, VMP installation, and sampling is to prevent foreign contamination of the samples and cross-contamination between sampling sites. Before use, drilling and reusable sampling equipment will be decontaminated by steam cleaning or pressure washing, or alternatively by washing with a non-phosphate detergent such as Liquinox or equivalent followed by a potable water rinse. Specific decontamination procedures are described in Appendix C, SOP 9.

4.4 Management of Investigation Derived Waste

Investigation derived waste (IDW), consisting of soil cuttings from the borings and wastewater from equipment decontamination, will be stored for analysis prior to disposal. Soil cuttings from borings will be stored on Dunn Field; the soil will be placed on plastic sheeting in piles not to exceed 5 CY; the cuttings will be covered by plastic sheeting held in place by perimeter weights. Soil cuttings with suspected contamination (e.g., stained soil or hydrocarbon or solvent odor) will be drummed or placed in piles separate from other soil cuttings. Upon completion of drilling, one soil sample will be collected from the central section of each soil pile. At each sample location, approximately 6 inches of surface soil will be removed, and samples will be collected for VOC analysis by standard extraction and by toxicity characteristic leaching procedure (TCLP) extraction. IDW soil samples will be submitted to a DOD ELAP laboratory for analysis of VOCs by SW-846 Method 8260B following preparation by Method 5035A for standard analysis and by and Methods 5030C and 1311 ZHE for TCLP analyses.

Soil samples for standard extraction will be collected with a Terracore sampler. Soil samples for TCLP extraction, which requires greater sample volume, will be collected by completely filling a 4-ounce jar for each location. If standard analysis demonstrates the VOC concentrations are less than the Dunn Field RGs, the soil cuttings will be spread on Dunn Field. If the soil concentrations exceed the RGs, TCLP VOC results will be reviewed to confirm the soil meets requirements for disposal as non-hazardous waste at a facility approved to receive waste from a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site.

Water IDW will be stored in an aboveground storage tank (AST) on Dunn Field. As the AST approaches capacity, water samples will be collected for analysis in accordance with guidance from TDEC. The water will be discharged to the storm sewer on Dunn Field if analytical results meet TDEC criteria. If criteria are not met, the water will be disposed at a facility approved to receive waste from a CERCLA site. Documentation of sample analyses and discharge will be provided in a technical memorandum.

4.5 Quality Control and Data Validation

A description of methods to identify constructed field locations, identify samples, conduct quality control, and perform data validation is presented below.

4.5.1 Sample Identification

Individual samples will be identified by a unique alphanumeric code (sample ID) which will be written on the sample label and recorded on the chain of custody form. The sample ID for vapor samples will be the VMP ID (e.g., VMP-27B). The sample ID for soil samples from VMP boring will be the prefix (SO), the boring ID and the depth in ft bgs to the top of the sample (e.g., SO-27B-25).

IDW sample IDs will include the source (IDW), medium (S for soil and W for water) and the sample sequence and project identifier (DFW) (e.g., IDW-S02-DFW).

Additional information is provided in Appendix C, SOP 7, *Sample Control and Documentation*.

4.5.2 Quality Control Samples

Field duplicate samples will be collected for soil vapor samples at a frequency of one for every ten field samples. Duplicate samples will be collected with a tee to split samples collected in Summa cannisters. Trip blanks, matrix spike/matrix spike duplicates, and rinse blanks are not planned to be collected for vapor samples.

4.5.3 Data Validation

Laboratories will verify that required analytical data are complete for samples within each sample delivery group (SDG). Electronic data deliverables will be reviewed to confirm requirements established in this SAP and Appendix C, SOP 10, *Data Verification* are met. Data will be reviewed by the HDR project chemist in accordance with guidance documents listed in Section 3.6 (DoD, 2018 and USACE, 2005). Achievement of project-specific measurement performance criteria and data validation criteria will be evaluated, and the analytical measurement error will be assessed. Performance criteria for analytical data are presented on Table 14. A data validation report will be prepared for each SDG.

5 Data Evaluation and Reporting

5.1 Data Evaluation

Validated soil vapor analytical results will be compared to the applicable VISLs, shown on Table 12. These criteria were calculated using the USEPA VISL Calculator (USEPA, 2022b) (TCR of 1E-06, THQ of 0.1). Default parameters were applied in the soil vapor VISL calculations. Soil samples will be collected to assess potential residual contamination and for IDW management; soil analytical results will be compared to Dunn Field ROD RGs.

Although groundwater samples will not be collected as part of this investigation, groundwater analytical results from recent LTM events will be compared to site-specific groundwater VISLs as an additional line of evidence. The groundwater VISLs (Table 12) were calculated using the USEPA VISL Calculator (USEPA, 2022b) (TCR of 1E-06, THQ of 0.1). Default parameters were applied in the calculations, except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius, instead of the default value of 25 degrees Celsius. These site-specific VISLs were initially calculated for the MI VI SAP (HDR, 2023c).

The attenuation factor was chosen based on the extensive low permeability surface soil on the (e.g., range of 4.50x10-8 to 1.60x10-7 cm/sec in the loess and upper fluvial deposits) (USEPA, 2015) encountered on the MI (HDR, 2022a). Field observations during drilling on Dunn Field have also encountered laterally continuous low permeability soil which is consistent with the loess on the MI. The groundwater temperature was chosen based on the average groundwater temperature from previous LTM events in 2020 and 2021. The average groundwater temperature for measurements during low-flow and bailer sampling of MI LTM wells in 2020 and 2021 was 20.3 degrees Celsius. Dunn Field wells from the same period had an average of 17.4 degrees Celsius but the VISLs were not recalculated to maintain consistency with MI VI study. The supporting documentation for the calculation of the VISLs is provided in Appendix E. VISLs will be recalculated to be current when the analytical results are evaluated.

5.2 Data Reporting

The results from each soil vapor sampling phase will be summarized in data reports consisting primarily of tables and figures illustrating areas where concentrations are greater than VISLs. After VMP construction and initial sampling, a data report will be prepared for Army review. The data report will include VMP installation, sampling methods and analytical results.

A detailed report will be prepared after completion of the second round of soil vapor samples. The report will describe the field activities noting deviations from this SAP; data quality evaluation; analytical results with final data validation flags; a VI risk assessment; and recommendations for further action if warranted.

The complete laboratory reports will be included with electronic copies of the report. The report will be submitted for internal review by Army and USACE and, following resolution of internal comments, the report will be submitted to USEPA and TDEC for review.

5.3 VI Risk Assessment

A VI risk assessment will be performed after the second round of soil vapor samples to determine whether current off-site residents will be potentially exposed to unacceptable VI risk and hazard using soil vapor data. The VI risk assessment will be conducted in accordance with USEPA *Risk Assessment Guidance for Superfund* (USEPA, 1989), DoD *Vapor Intrusion Guidance* (TSERAW, 2009), USEPA Region 4 *Human Health Risk Assessment Supplemental Guidance* (USEPA, 2018), and USEPA *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA, 2015). The most recent version of the USEPA *Vapor Intrusion Screening Level Calculator* (USEPA, 2023) will be used to calculate cumulative excessive lifetime cancer risk (ELCR) and noncancer hazard index (HI) values for the current off-site residential exposure scenario. The approach will consist of these steps:

- Conduct a screening-level data assessment.
  - Compile the off-site soil vapor analytical data. Refine the analytical data set for the risk assessment to consider only data associated with the VI pathway.
  - Screen the maximum detected concentrations in soil vapor analytical data using the Residential VISLs presented in Table 12.
  - Identify the constituents that have maximum detected concentrations greater than the Residential VISLs as COPCs in soil vapor.
- Conduct an exposure assessment.
  - The DFW Investigation HHRA (HDR, 2023a) describes the source pathways and identifies potential receptors and potentially complete exposure pathways. The CSM is a dynamic tool that may change over the course of the investigation as new information becomes available. An updated version of the CSM will be provided that includes the current off-site resident exposure scenario for the VI pathway via soil vapor.
  - Develop exposure point concentrations (EPCs) for each COPC in soil vapor. USEPA ProUCL software (USEPA, 2022a), or most recent version, will be used to calculate 95% upper confidence limits (UCLs) on the arithmetic mean, if there is sufficient number of samples. The EPC will be the lower value of the 95% UCL and maximum detected concentration. If the 95% UCL on the arithmetic mean is determined to be unreliable, or if it is greater than all values in the data set, the maximum detected concentration will be used as the EPC.
- Conduct a toxicity assessment.
  - The toxicity values will be selected in accordance with USEPA's OSWER Directive 9285.7-53, *Human Health Toxicity Values in Superfund Risk Assessments* (USEPA, 2003). COPC-specific adjustments will be made, such as evaluating chloroform as a threshold carcinogen, in which only the noncarcinogenic toxicity endpoint will be evaluated initially; if the hazard is greater than one, then the cancer toxicity endpoint will be evaluated.
- Conduct a risk characterization.

  - Calculate cancer risks and noncancer HQs for each COPC and exposure pathway using the EPCs and toxicity values. Compare the results to the acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$ for the ELCR and threshold of 1 for the overall HI. An analysis of separating the hazards by target organ will be performed for HI values that are greater than 1 and are based on more than one COPC. Constituents of concern (COCs) contributing to unacceptable risks and hazards for the current off-site resident exposure to soil vapor via VI, if any, will be identified.

- Conduct an uncertainty evaluation.
  - Evaluate the uncertainties associated with the site investigation, the likelihood of exposures, and the toxicity of the COPCs.

6 References

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Tables

TABLE 1
PROJECT PERSONNEL AND CONTACT INFORMATION
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis Tennessee

Name	Organization	Role	Email	Office	Mobile
James Foster	DAIN-ISE	BRAC Program Manager	james.c.foster10.civ@mail.mil	703-545-2541	
Bill Millar	CALIBRE Systems	BRAC Environmental Coordinator	william.w.millar.ctr@army.mil	703-819-0100	
Fernando Martinez-Torres	USEPA	Remedial Project Manager	martinez-torres.fernando@epa.gov	404-695-4991	
Jamie Woods	TDEC	Remedial Project Manager	jamie.woods@tn.gov	901-371-3041	
Melissa Shirley	USACE-SAM	Contracting Officer’s Representative	melissa.l.shirley@usace.army.mil	251-690-2616	
Bob Beacham	USACE-SAM	Project Manager	robert.p.beacham@usace.army.mil	251-690-3077	251-581-2787
Laura Roebuck	USACE-SAM	Technical Manager	laura.w.roebuck@usace.army.mil	251-690-3480	251-455-5340
Glen Turney	HDR	Managing Principal	glen.turney@hdrinc.com	210-253-6503	210-317-5448
Tom Holmes	HDR	Project Manager	thomas.holmes@hdrinc.com	404-295-3279	404-295-3279
Brian Vessels	HDR	Southeast Area Safety Manager	brian.vessels@hdrinc.com	704-449-5315	704-449-5315
Clayton Mokri	HDR	Task Manager	clayton.mokri@hdrinc.com	916-679-8726	530-902-7106
Lynn Lutz	HDR	Project Chemist	lynn.lutz@hdrinc.com	303-754-4266	720-633-2380
Travis Ritter	HDR	Project Database/ GIS Manager	warren.ritter@hdrinc.com	850-429-8946	210-464-8679
Denise Cooper	HDR	Community Relations	denise.cooper@hdrinc.com	901-268-2478	901-268-2478
Mayble Abraham	EHS Support	Risk Assessor	mayble.abraham@ehs-support.com	862-248-4560	
-	Surveyor TBD	Survey Manager	-	-	
-	Driller TBD	Drilling Manager	-	-	
-	Vapor Analytical Lab TBD	Soil Vapor Analytical Manager	-	-	
-	Soil Analytical Lab TBD	Soil Analytical Manager	-	-	

TABLE 2
PERSONNEL QUALIFICATIONS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis Tennessee

Name	Organization	Role	Education/Experience	Specialized Training/Certifications
Glen Turney	HDR	Managing Principal	MBA, 35 Years	Board Certified Environmental Engineer AR, CO, FL, GA, MT, NM, OK, TN, TX, WA, WY
Tom Holmes	HDR	Project Manager	MS Geophysics, 45 Years	Registered Professional Geologist, Georgia
Brian Vessels	HDR	Southeast Area Safety Manager	MS Safety Sciences, 24 Years	Certified Safety Professional, LEED Accredited Professional
Clayton Mokri	HDR	Task Manager	BS Environmental Science, 20 Years	HAZWOPER, Registered Environmental Manager, OSHA 30Hr
Lynn Lutz	HDR	Project Chemist	BA Chemistry, 37 Years	-
Travis Ritter	HDR	Project Database/ GIS Manager	MES Environmental Science; 22 Years	HAZWOPER
Denise Cooper	HDR	Community Relations	BA Journalism, 28 Years	-
-	Surveyor TBD	-	-	-
-	Driller TBD	-	-	-
-	Vapor Analytical Lab TBD	-	-	-
-	Soil Analytical Lab TBD	-	-	-

TABLE 3
PROJECT SCHEDULE
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis Tennessee

Phase Name	Start[1]	Finish
Soil Vapor Sampling	1-Feb-24	5-Jun-24
ROE and Permitting	1-Feb-24	25-Mar-24
Field Preparation	25-Mar-24	1-Apr-24
Install VMPs	8-Apr-24	12-Apr-24
Sample VMPs	14-Apr-24	16-Apr-24
Laboratory Analysis	17-Apr-24	8-May-24
Data Quality Evaluation	8-May-24	15-May-24
VISL Review and Data Report	15-May-24	5-Jun-24
Follow-up Soil Vapor Sampling	25-Jul-24	3-Sep-24
Field Preparation	25-Jul-24	1-Aug-24
Sample VMPs	4-Aug-24	6-Aug-24
Laboratory Analysis	6-Aug-24	27-Aug-24
Data Quality Evaluation	27-Aug-24	3-Sep-24
Reporting	3-Sep-24	9-Feb-25
Internal Draft Report	3-Sep-24	24-Sep-24
Government Review	24-Sep-24	24-Oct-24
Revision 0 Report	24-Oct-24	7-Nov-24
EPA/TDEC Review	7-Nov-24	6-Jan-25
Revision 1 Report	5-Feb-25	9-Feb-25

1) The schedule assumes this SAP is approved by February 1, 2024.

TABLE 4
SOIL SAMPLE DEPTHS AND PID READINGS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

Boring ID	Date	Depth (ft, bgs)	PID Result [3] (ppm)	Soil Sample ID
SB-01	5/12/2020	1	0.0	SB-01-01-DFW
	5/12/2020	6	0.0	SB-01-06-DFW
	5/12/2020	18	0.0	SB-01-18-DFW
	5/12/2020	24	0.0	SB-01-24-DFW
	Top of Sand	26	-	-
	Total Depth	45	-	-
SB-02 [1]	5/13/2020	1	0.0	SB-02-01-DFW
	5/13/2020	6	0.0	SB-02-06-DFW
	5/13/2020	15	0.0	SB-02-15-DFW
	5/13/2020	25	0.0	SB-02-25-DFW
	Top of Sand	26	-	-
	Total Depth	64	-	-
SB-03	5/13/2020	1	0.0	SB-03-01-DFW
	5/13/2020	6	0.0	SB-03-06-DFW
	5/13/2020	12	0.0	SB-03-12-DFW
	5/13/2020	22	0.0	SB-03-22-DFW
	Top of Sand	27	-	-
	Total Depth	32	-	-
SB-04	5/12/2020	1	0.0	SB-04-01-DFW
	5/12/2020	6	0.0	SB-04-06-DFW
	5/12/2020	18	0.0	SB-04-18-DFW
	5/12/2020	29	0.0	SB-04-29-DFW
	Top of Sand	27	-	-
	Total Depth	32	-	-
SB-05	5/12/2020	1	0.0	SB-05-01-DFW
	5/12/2020	6	0.0	SB-05-06-DFW
	5/12/2020	15	0.0	SB-05-15-DFW
	5/12/2020	25	0.0	SB-05-25-DFW
	Top of Sand	28	-	-
	Total Depth	32	-	-
SB-06	5/12/2020	1	0.0	SB-06-01-DFW
	5/12/2020	6	0.0	SB-06-06-DFW
	5/12/2020	16	19.1	SB-06-16-DFW
	5/12/2020	22	0.0	SB-06-22-DFW
	Top of Sand	25	-	-
	Total Depth	45	-	-
SB-07	5/11/2020	1	0.3	SB-07-01-DFW
	5/11/2020	4	99.0	SB-07-04-DFW
	5/11/2020	14	55.3	SB-07-14-DFW
	5/11/2020	25	2.6	SB-07-25-DFW
	Top of Sand	25	-	-
	Total Depth	45	-	-
SB-07D	6/11/2021	22.5	0.9	SB-07D-22.5-DFW
	6/11/2021	23.8	83.9	SB-07D-23.75-DFW
	6/11/2021	30	10.9	SB-07D-30-DFW
	6/11/2021	31	3.4	SB-07D-31-DFW
	Top of Sand	25	-	-
	Total Depth[4]	31	-	-

TABLE 4
SOIL SAMPLE DEPTHS AND PID READINGS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

Boring ID	Date	Depth (ft, bgs)	PID Result [3] (ppm)	Soil Sample ID
SB-08	5/11/2020	1	0.0	SB-08-01-DFW
	5/11/2020	6	0.0	SB-08-06-DFW
	5/11/2020	20	0.0	SB-08-20-DFW
	5/11/2020	43	5.9	SB-08-43-DFW
	Top of Sand	25	-	-
	Total Depth	45	-	-
SB-09	5/11/2020	1	0.4	SB-09-01-DFW
	5/11/2020	6	0.0	SB-09-06-DFW
	5/11/2020	14	10.0	SB-09-14-DFW
	5/11/2020	22	8.2	SB-09-22-DFW
	Top of Sand	24	-	-
	Total Depth	45	-	-
SB-10 [2]	5/14/2020	1	0.0	SB-10-01-DFW
	5/14/2020	6	0.0	SB-10-06-DFW
	5/14/2020	15	0.0	SB-10-15-DFW
	5/14/2020	28	0.0	SB-10-28-DFW
	Top of Sand	23	-	-
	Total Depth	60	-	-
SB-11	6/15/2020	1	0.0	SB-11-1-DFW
	6/15/2020	7	15.2	SB-11-7-DFW
	6/15/2020	15	0.0	SB-11-15-DFW
	6/15/2020	24	0.0	SB-11-24-DFW
	Top of Sand	26	-	-
	Total Depth	32	-	-
SB-12	6/15/2020	1	0.0	SB-12-1-DFW
	6/15/2020	6	0.0	SB-12-6-DFW
	6/15/2020	12	0.0	SB-12-12-DFW
	6/15/2020	22	0.0	SB-12-22-DFW
	Top of Sand	24	-	-
	Total Depth	32	-	-
SB-13	6/15/2020	1	0.0	SB-13-1-DFW
	6/15/2020	6	0.0	SB-13-6-DFW
	6/15/2020	15	0.0	SB-13-15-DFW
	6/15/2020	21	0.0	SB-13-21-DFW
	Top of Sand	23	-	-
	Total Depth	30	-	-
SB-14	6/15/2020	2	0.0	SB-14-2-DFW
	6/15/2020	6	0.0	SB-14-6-DFW
	6/15/2020	16	0.0	SB-14-16-DFW
	6/15/2020	22	0.0	SB-14-22-DFW
	Top of Sand	27	-	-
	Total Depth	32	-	-
SB-15	6/16/2020	1	0.0	SB-15-1-DFW
	6/16/2020	6	0.0	SB-15-6-DFW
	6/16/2020	16	0.0	SB-15-16-DFW
	6/16/2020	24	0.0	SB-15-24-DFW
	Top of Sand	29	-	-
	Total Depth	32	-	-

TABLE 4
SOIL SAMPLE DEPTHS AND PID READINGS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

Boring ID	Date	Depth (ft, bgs)	PID Result [3] (ppm)	Soil Sample ID
SB-16	6/16/2020	1	0.0	SB-16-1-DFW
	6/16/2020	6	0.0	SB-16-6-DFW
	6/16/2020	15	0.0	SB-16-15-DFW
	6/16/2020	25	0.0	SB-16-25-DFW
	Top of Sand	29.5	-	-
	Total Depth	32	-	-
SB-18	6/10/2021	2	5.6	SB-18-2-DFW
	6/10/2021	4	725	SB-18-4-DFW
	6/10/2021	12	651	SB-18-12-DFW
	6/10/2021	18	7.2	SB-18-18-DFW
	6/10/2021	28	2.3	SB-18-28-DFW
	6/10/2021	40	0.0	SB-18-40-DFW
	Top of Sand	28	-	-
	Total Depth	40	-	-
SB-19	6/10/2021	2	0.0	SB-19-2-DFW
	6/10/2021	4	304	SB-19-4-DFW
	6/10/2021	5	82.7	SB-19-5-DFW
	6/10/2021	13	60.0	SB-19-13-DFW
	6/10/2021	32	2.3	SB-19-32-DFW
	Top of Sand	25	-	-
	Total Depth[4]	32	-	-
SB-20	6/10/2021	2	18.2	SB-20-2-DFW
	6/10/2021	4	31.4	SB-20-4-DFW
	6/10/2021	15	40.0	SB-20-15-DFW
	6/10/2021	32	0.0	SB-20-32-DFW
	Top of Sand	24.5	-	-
	Total Depth[4]	32	-	-
SB-21	6/11/2021	2	0.0	SB-21-2-DFW
	6/11/2021	6	0.0	SB-21-6-DFW
	6/11/2021	17	0.0	SB-21-17-DFW
	6/11/2021	36	0.0	SB-21-36-DFW
	Top of Sand	27	-	-
	Total Depth	36	-	-
SB-22	6/9/2021	2	0.7	SB-22-2-DFW
	6/9/2021	6	0.1	SB-22-6-DFW
	6/9/2021	22	0.3	SB-22-22-DFW
	6/9/2021	30	1.4	SB-22-30-DFW
	Top of Sand	24	-	-
	Total Depth[4]	30	-	-
SB-23	6/11/2021	2	0.0	SB-23-2-DFW
	6/11/2021	6	0.0	SB-23-6-DFW
	6/11/2021	17	0.0	SB-23-17-DFW
	6/11/2021	32	0.0	SB-23-32-DFW
	Top of Sand	26	-	-
	Total Depth[4]	32	-	-

TABLE 4
SOIL SAMPLE DEPTHS AND PID READINGS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

Boring ID	Date	Depth (ft, bgs)	PID Result [3] (ppm)	Soil Sample ID
SB-24	6/9/2021	2	0.0	SB-24-2-DFW
	6/9/2021	6	0.0	SB-24-6-DFW
	6/9/2021	20	0.0	SB-24-20-DFW
	6/9/2021	26	0.0	SB-24-26-DFW
	Top of Sand	25	-	-
	Total Depth	30	-	-
SB-25	6/9/2021	2	0.0	SB-25-2-DFW
	6/9/2021	8	2.8	SB-25-8-DFW
	6/9/2021	17	0.1	SB-25-17-DFW
	6/9/2021	29	0.0	SB-25-29-DFW
	Top of Sand	26	-	-
	Total Depth	29	-	-
SB-26	6/11/2021	1	2.9	SB-26-1-DFW
	6/11/2021	5	0.3	SB-26-5-DFW
	6/11/2021	17	0.0	SB-26-17-DFW
	6/11/2021	28	0.0	SB-26-28-DFW
	Top of Sand	26	-	-
	Total Depth[4]	28	-	-
SB-27	7/13/2021	2	0.0	SB-27-2-DFW
	7/13/2021	6	0.0	SB-27-6-DFW
	7/13/2021	17	0.0	SB-27-17-DFW
	7/13/2021	28	0.0	SB-27-28-DFW
	Top of Sand	28	-	-
	Total Depth[4]	32	-	-

Notes:

1) SB-02 advanced to 64 ft bgs and groundwater sample collected
2) SB-10 advanced to 60 ft bgs and groundwater sample collected
3) PID measurements made with a MiniRae 2000 (10.6 ev lamp)
4) Boring refusal at total depth

PID: photoionization detector
ppm: parts per million
ft, bgs: feet below ground surface
ID: identification
SB: soil boring

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-01-01-DFW	SB-01-06-DFW	SB-01-18-DFW	SB-01-24-DFW	SB-02-01-DFW	SB-02-06-DFW	SB-02-15-DFW
	Lab ID				M0E0882-01	M0E0882-03	M0E0882-04	M0E0882-05	M0E0993-06	M0E0993-07	M0E0993-08
	Date				5/12/2020	5/12/2020	5/12/2020	5/12/2020	5/13/2020	5/13/2020	5/13/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.26 U	5.54 U	5.29 U	4.19 U	4.84 U	4.85 U	4.55 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.26 U	5.54 U	5.29 U	4.19 U	4.84 U	4.85 U	4.55 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Chloroform	µg/Kg	917	486	1,400	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	3.06 J	6.94	6.6	4.5	5.08	7.12	4.82
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.41 U	4.43 U	4.23 U	3.36 U	3.87 U	3.88 U	3.64 U
Total CVOCs	µg/Kg	-	-	-	3.1	6.9	6.6	4.5	5.1	7.1	4.8
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
2-Hexanone	µg/Kg	-	-	130,000	8.52 U	11.1 U	10.6 U	8.39 U	9.68 U	9.69 U	9.09 U
Acetone	µg/Kg	-	-	67,000,000	17 U	22.2 U	21.2 U	16.8 U	19.4 U	19.4 U	18.2 U
Benzene	µg/Kg	-	-	5,100	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Carbon disulfide	µg/Kg	-	-	350,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Ethylbenzene	µg/Kg	-	-	25,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Naphthalene	µg/Kg	-	-	8,600	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
o-Xylene	µg/Kg	-	-	280,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.7 U	2.22 U	2.12 U	1.68 U	1.94 U	1.94 U	1.82 U
Toluene	µg/Kg	-	-	4,700,000	1.29 J	1.44 J	1.25 J	1.16 J	0.636 J	0.757 J	0.465 J
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-02-25-DFW	SB-03-01-DFW	SB-03-06-DFW	SB-03-12-DFW	SB-03-22-DFW	SB-04-01-DFW	SB-04-06-DFW
	Lab ID				M0E0993-09	M0E0993-01	M0E0993-02	M0E0993-03	M0E0993-04	M0E1111-04	M0E0882-06
	Date				5/13/2020	5/13/2020	5/13/2020	5/13/2020	5/13/2020	5/14/2020	5/12/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.39 U	4.78 U	4.48 U	4.74 U	4.35 U	5.38 U	5.33 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.39 U	4.78 U	4.48 U	4.74 U	4.35 U	5.38 U	5.33 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Chloroform	µg/Kg	917	486	1,400	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	4.96	3.85	4.98	5.14	4.32	6.17	6.54
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.51 U	3.83 U	3.59 U	3.79 U	3.48 U	4.31 U	4.27 U
Total CVOCs	µg/Kg	-	-	-	5.0	3.9	5.0	5.1	4.3	6.2	6.5
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
2-Hexanone	µg/Kg	-	-	130,000	8.78 U	9.56 U	8.96 U	9.48 U	8.71 U	10.8 U	10.7 U
Acetone	µg/Kg	-	-	67,000,000	17.6 U	19.1 U	17.9 U	19 U	17.4 U	21.5 U	21.3 U
Benzene	µg/Kg	-	-	5,100	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Carbon disulfide	µg/Kg	-	-	350,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Ethylbenzene	µg/Kg	-	-	25,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Naphthalene	µg/Kg	-	-	8,600	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
o-Xylene	µg/Kg	-	-	280,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.76 U	1.91 U	1.79 U	1.9 U	1.74 U	2.15 U	2.13 U
Toluene	µg/Kg	-	-	4,700,000	0.496 J	0.737 J	0.654 J	0.632 J	0.674 J	1.29 J	1.01 J
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-04-18-DFW	SB-04-29-DFW	SB-05-01-DFW	SB-05-06-DFW	SB-05-15-DFW	SB-05-25-DFW	SB-06-01-DFW
	Lab ID				M0E0882-07	M0E0882-08	M0E0882-09	M0E0882-10	M0E0882-11	M0E0882-12	M0E0882-14
	Date				5/12/2020	5/12/2020	5/12/2020	5/12/2020	5/12/2020	5/12/2020	5/12/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.97 U	4.08 U	4.61 U	4.86 U	5.57 U	4.38 U	5.23 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.97 U	4.08 U	4.61 U	4.86 U	5.57 U	4.38 U	5.23 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Chloroform	µg/Kg	917	486	1,400	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	5.24	3.27 U	5.63	5.42	6.2	3.67	4.64
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.99 U	1.63 U	1.28 J	1.94 U	2.23 U	1.75 U	2.09 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.98 U	3.27 U	3.69 U	3.89 U	4.46 U	3.51 U	4.19 U
Total CVOCs	µg/Kg	-	-	-	5.2	0.0	5.6	5.4	6.2	3.7	4.6
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
2-Hexanone	µg/Kg	-	-	130,000	9.94 U	8.17 U	9.22 U	9.72 U	11.1 U	8.77 U	10.5 U
Acetone	µg/Kg	-	-	67,000,000	19.9 U	16.3 U	18.4 U	19.4 U	22.3 U	17.5 U	20.9 U
Benzene	µg/Kg	-	-	5,100	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Carbon disulfide	µg/Kg	-	-	350,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Ethylbenzene	µg/Kg	-	-	25,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Naphthalene	µg/Kg	-	-	8,600	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
o-Xylene	µg/Kg	-	-	280,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.99 U	1.63 U	1.84 U	1.94 U	2.23 U	1.75 U	2.09 U
Toluene	µg/Kg	-	-	4,700,000	1.08 J	0.718 J	0.896 J	0.807 J	1.12 J	0.663 J	0.658 J
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
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µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
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FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-06-06-DFW	SB-06-16-DFW	SB-06-22-DFW	SB-07-01-DFW	SB-07-04-DFW	SB-07-14-DFW	SB-07-25-DFW
	Lab ID				M0E0882-15	M0E0882-16RE1	M0E0882-17	M0E0777-05	M0E0777-06RE1	M0E0777-03	M0E0777-04
	Date				5/12/2020	5/12/2020	5/12/2020	5/11/2020	5/11/2020	5/11/2020	5/11/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	5 U	**1160**	3.99 U	4.67 U	**7650**	3.22 J	1.91 J
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	5 U	**99.6 J**	3.99 U	4.67 U	**1520 J**	4.86 U	4.9 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	2 U	208 U	1.59 U	1.87 U	1060 U	2.1	1.96 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
Chloroform	µg/Kg	917	486	1,400	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	2 U	208 U	1.59 U	1.87 U	1060 U	32.7	82.9 J
Methylene chloride	µg/Kg	30.5	16.9	320,000	4.94	416 U	4.07	8.04	2110 U	10.4	7.39
Tetrachloroethene	µg/Kg	180.6	92	39,000	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
Trichloroethene	µg/Kg	182	93.2	1,900	2 U	208 U	1.59 U	1.87 U	1060 U	1.94 U	1.96 U
Vinyl chloride	µg/Kg	29.4	15	1,700	4 U	416 U	3.19 U	3.73 U	2110 U	**46.9**	**42 J**
Total CVOCs	µg/Kg	-	-	-	4.9	1260	4.1	8.0	9170	95.3	134
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	2 U	1740	1.59 U	1.87 U	56900	9.14	1.96 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	2 U	1500	1.59 U	1.87 U	22100	3.74	1.96 U
2-Hexanone	µg/Kg	-	-	130,000	9.99 U	1160	7.97 U	9.34 U	9000	11	4.11 J
Acetone	µg/Kg	-	-	67,000,000	7.55 J	2080 U	8.71 J	18.7 U	10600 U	25.9	22.2
Benzene	µg/Kg	-	-	5,100	2 U	208 U	4.55	1.87 U	297 J	80	11.7 J
Carbon disulfide	µg/Kg	-	-	350,000	2 U	208 U	1.59 U	1.87 U	356 J	1.94 U	1.96 U
Ethylbenzene	µg/Kg	-	-	25,000	2 U	412	1.59 U	1.87 U	**<u>28900</u>**	16	1.96 U
Isopropylbenzene	µg/Kg	-	-	990,000	2 U	414	1.59 U	1.87 U	4430	2.89	1.96 U
m-,p-Xylene	µg/Kg	-	-	240,000	2 U	244	0.807 J	1.87 U	89500	14.6	1.96 U
Naphthalene	µg/Kg	-	-	8,600	2 U	2350	1.59 U	1.87 U	**<u>61400</u>**	8.1	1.96 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	2 U	2150	1.59 U	1.87 U	11900	2.8	1.96 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	2 U	1080	1.59 U	1.87 U	7950	2.29	1.96 U
o-Xylene	µg/Kg	-	-	280,000	2 U	208 U	1.59 U	1.87 U	11300	2.35	1.96 U
p-Isopropyltoluene	µg/Kg	-	-	-	2 U	995	1.59 U	1.87 U	5310	1.24 J	1.96 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	0.538 J	754	1.59 U	1.87 U	3640	2.36	1.96 U
Toluene	µg/Kg	-	-	4,700,000	0.616 J	208 U	0.697 J	0.54 J	622 J	2.6	1.7 J
Total Other VOCs	mg/Kg	-	-	-	0.0	12.8	0.0	0.0	314	0.2	0.0

<u>Notes:</u>
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **<u>bold</u>**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

<u>DQE Flags:</u>
U: Not Detected
J: Estimated

<u>Method:</u>
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-07D-22.5	SB-07D-23.75	SB-07D-30	SB-07D-31	SB-08-01-DFW	SB-08-06-DFW	SB-08-20-DFW
	Lab ID				D2106012-011A	D2106012-012A	D2106012-013A	D2106012-014A	M0E0777-10	M0E0777-11	M0E0777-12
	Date				6/11/2021	6/11/2021	6/11/2021	6/11/2021	5/11/2020	5/11/2020	5/11/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	5.27 U	5520 UJ	5.75 U	6.13 U	4.37 U	4.88 U	4.61 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	5.27 U	5520 UJ	5.75 U	6.13 U	4.37 U	4.88 U	4.61 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Chloroform	µg/Kg	917	486	1,400	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	112	5520 UJ	14.1	10.4 J	1.75 U	1.95 U	1.85 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	5.27 U	5520 UJ	5.75 U	6.13 U	5.19	6.81	8.7
Tetrachloroethene	µg/Kg	180.6	92	39,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Trichloroethene	µg/Kg	182	93.2	1,900	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Vinyl chloride	µg/Kg	29.4	15	1,700	**50.6**	5520 UJ	**29.4**	9.13 J	3.49 U	3.9 U	3.69 U
Total CVOCs	µg/Kg	-	-	-	163	0.0	43.5	19.5	5.2	6.8	8.7
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	5.27 U	10400 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	5.27 U	5780 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
2-Hexanone	µg/Kg	-	-	130,000	5.27 U	5520 UJ	5.75 U	6.13 U	8.73 U	9.75 U	9.23 U
Acetone	µg/Kg	-	-	67,000,000	5.27 U	5520 UJ	5.75 U	6.13 U	17.5 U	19.5 U	18.5 U
Benzene	µg/Kg	-	-	5,100	33.7 U	22100 UJ	41.4 U	48.6 U	1.75 U	1.95 U	1.85 U
Carbon disulfide	µg/Kg	-	-	350,000	6.95 J	5520 UJ	3.15 J	6.13 U	1.75 U	1.95 U	1.85 U
Ethylbenzene	µg/Kg	-	-	25,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Isopropylbenzene	µg/Kg	-	-	990,000	5.92 J	9800 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
m-,p-Xylene	µg/Kg	-	-	240,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Naphthalene	µg/Kg	-	-	8,600	5.27 U	13300 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	5.27 UJ	5650 J	5.75 UJ	6.13 UJ	1.75 U	1.95 U	1.85 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	5.27 U	5520 UJ	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
o-Xylene	µg/Kg	-	-	280,000	5.27 U	5150 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
p-Isopropyltoluene	µg/Kg	-	-	-	5.27 U	7600 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	5.27 U	6730 J	5.75 U	6.13 U	1.75 U	1.95 U	1.85 U
Toluene	µg/Kg	-	-	4,700,000	5.27 U	5520 UJ	5.75 U	6.13 U	0.498 J	0.821 J	0.696 J
Total Other VOCs	mg/Kg	-	-	-	0.0	64.4	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-08-43-DFW	SB-09-01-DFW	SB-09-06-DFW	SB-09-14-DFW	SB-09-22-DFW	SB-10-01-DFW	SB-10-06-DFW
	Lab ID				M0E0777-13	M0E0777-08	M0E0777-07	M0E0777-01	M0E0777-02	M0E1111-01	M0E1111-02
	Date				5/11/2020	5/11/2020	5/11/2020	5/11/2020	5/11/2020	5/14/2020	5/14/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.59 U	4.73 U	4.58 U	4.65 U	4.47 U	5.18 U	5.24 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.59 U	4.73 U	4.58 U	4.65 U	4.47 U	5.18 U	5.24 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Chloroform	µg/Kg	917	486	1,400	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	17.7	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	8.24	5.77	4.04	7.31	4.82	4.29	4.89
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.67 U	3.78 U	3.67 U	3.72 U	3.57 U	4.14 U	4.19 U
Total CVOCs	µg/Kg	-	-	-	25.9	5.8	4.0	7.3	4.8	4.3	4.9
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
2-Hexanone	µg/Kg	-	-	130,000	9.17 U	9.46 U	9.17 U	9.29 U	8.94 U	10.4 U	10.5 U
Acetone	µg/Kg	-	-	67,000,000	18.3 U	18.9 U	18.3 U	18.6 U	17.9 U	20.7 U	32.4
Benzene	µg/Kg	-	-	5,100	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Carbon disulfide	µg/Kg	-	-	350,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Ethylbenzene	µg/Kg	-	-	25,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Naphthalene	µg/Kg	-	-	8,600	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
o-Xylene	µg/Kg	-	-	280,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.83 U	1.89 U	1.83 U	1.86 U	1.79 U	2.07 U	2.1 U
Toluene	µg/Kg	-	-	4,700,000	0.637 J	0.741 J	1.83 U	0.911 J	1.79 U	0.947 J	1.07 J
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-10-15-DFW	SB-10-28-DFW	SB-11-1-DFW	SB-11-7-DFW	SB-11-15-DFW	SB-11-24-DFW	SB-12-1-DFW
	Lab ID				M0E1111-03	M0E1111-13	M0F1296-01RE2	M0F1296-02RE2	M0F1296-03RE2	M0F1296-04RE2	M0F1296-05RE2
	Date				5/14/2020	5/14/2020	6/15/2020	6/15/2020	6/15/2020	6/15/2020	6/15/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.87 U	4.49 U	5.42 U	4.57 U	4.91 U	4.69 U	5.01 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.87 U	4.49 U	5.42 U	4.57 U	4.91 U	4.69 U	5.01 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Chloroform	µg/Kg	917	486	1,400	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	0.549 J	2 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	4.7	3.59 U	4.34 U	3.66 U	3.93 U	3.75 U	4 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.89 U	3.59 U	4.34 U	3.66 U	3.93 U	3.75 U	4 U
Total CVOCs	µg/Kg	-	-	-	4.7	0.0	0.0	0.0	0.0	0.5	0.0
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
2-Hexanone	µg/Kg	-	-	130,000	9.73 U	8.97 U	10.8 U	3.32 J	9.83 U	9.38 U	10 U
Acetone	µg/Kg	-	-	67,000,000	24.8	17.9 U	13.5 J	62.1	13.9 J	18.8 U	62.4
Benzene	µg/Kg	-	-	5,100	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Carbon disulfide	µg/Kg	-	-	350,000	1.95 U	1.79 U	2.17 U	4.32	0.944 J	1.88 U	3.3
Ethylbenzene	µg/Kg	-	-	25,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.95 U	1.79 U	0.614 J	1.83 U	1.97 U	1.88 U	2 U
Naphthalene	µg/Kg	-	-	8,600	1.95 U	1.79 U	0.555 J	0.47 J	1.97 U	1.88 U	7.42
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
o-Xylene	µg/Kg	-	-	280,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.95 U	1.79 U	2.17 U	55.2	1.97 U	1.88 U	2 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.95 U	1.79 U	2.17 U	1.83 U	1.97 U	1.88 U	2 U
Toluene	µg/Kg	-	-	4,700,000	1.08 J	0.58 J	1.01 J	0.903 J	1.97 U	1.88 U	2 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.1	0.0	0.0	0.1

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-12-6-DFW	SB-12-12-DFW	SB-12-22-DFW	SWB-13-1-DFW	SB-13-6-DFW	SB-13-15-DFW
	Lab ID				M0F1296-06RE2	M0F1296-07RE2	M0F1296-08RE2	M0F1296-09RE2	M0F1296-10RE2	M0F1296-11RE2
	Date				6/15/2020	6/15/2020	6/15/2020	6/15/2020	6/15/2020	6/15/2020
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	5.18 U	4.83 U	4.56 U	4.94 U	5.21 U	4.67 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	5.18 U	4.83 U	4.56 U	4.94 U	5.21 U	4.67 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Chloroform	µg/Kg	917	486	1,400	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	1.39 J	0.987 J	3.65 U	1.2 J	4.17 U	3.73 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Trichloroethene	µg/Kg	182	93.2	1,900	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Vinyl chloride	µg/Kg	29.4	15	1,700	4.15 U	3.86 U	3.65 U	3.95 U	4.17 U	3.73 U
Total CVOCs	µg/Kg	-	-	-	1.4	1.0	0.0	1.2	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
2-Hexanone	µg/Kg	-	-	130,000	10.4 U	9.65 U	9.13 U	9.87 U	10.4 U	9.34 U
Acetone	µg/Kg	-	-	67,000,000	60.7	19.3 U	18.3 U	19.9	19.3 J	17.7 J
Benzene	µg/Kg	-	-	5,100	2.07 U	1.93 U	1.83 U	0.699 J	2.08 U	1.87 U
Carbon disulfide	µg/Kg	-	-	350,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Ethylbenzene	µg/Kg	-	-	25,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Isopropylbenzene	µg/Kg	-	-	990,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
m-,p-Xylene	µg/Kg	-	-	240,000	2.07 U	1.93 U	1.83 U	0.664 J	2.08 U	1.87 U
Naphthalene	µg/Kg	-	-	8,600	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
o-Xylene	µg/Kg	-	-	280,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
p-Isopropyltoluene	µg/Kg	-	-	-	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	2.07 U	1.93 U	1.83 U	1.97 U	2.08 U	1.87 U
Toluene	µg/Kg	-	-	4,700,000	2.07 U	1.93 U	1.83 U	1.49 J	2.08 U	1.87 U
Total Other VOCs	mg/Kg	-	-	-	0.1	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed
DQE Flags:
U: Not Detected
J: Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-13-21-DFW	SB-14-2-DFW	SB-14-6-DFW	SB-14-16-DFW	SB-14-22-DFW	SB-15-1-DFW	SB-15-6-DFW
	Lab ID				M0F1296-12RE2	M0F1296-13RE1	M0F1296-14	M0F1296-15RE2	M0F1296-16	M0F1296-20	M0F1296-21
	Date				6/15/2020	6/15/2020	6/15/2020	6/15/2020	6/15/2020	6/16/2020	6/16/2020
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.45 U	328 U	4.98 U	4.53 U	4.67 U	6.82 U	4.82 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.45 U	328 U	4.98 U	4.53 U	4.67 U	6.82 U	4.82 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Chloroform	µg/Kg	917	486	1,400	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	3.56 U	262 U	3.98 U	3.62 U	3.74 U	5.45 U	3.86 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	2.63
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.56 U	262 U	3.98 U	3.62 U	3.74 U	5.45 U	3.86 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.78 U	33.1 J	1.99 U	1.81 U	1.87 U	1.89 J	1.93 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	1.06 J	1.93 U
2-Hexanone	µg/Kg	-	-	130,000	8.91 U	656 U	9.95 U	9.06 U	9.34 U	13.6 U	9.65 U
Acetone	µg/Kg	-	-	67,000,000	19.2	1310 U	24.5	16.9 J	12.1 J	133	96.1
Benzene	µg/Kg	-	-	5,100	1.78 U	131 U	1.99 U	1.81 U	1.87 U	1.9 J	0.916 J
Carbon disulfide	µg/Kg	-	-	350,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	20.5	0.854 J
Ethylbenzene	µg/Kg	-	-	25,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	0.798 J	1.93 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.78 U	39.4 J	1.99 U	1.81 U	1.87 U	3.45	1.93 U
Naphthalene	µg/Kg	-	-	8,600	1.78 U	1150	1.99 U	1.81 U	1.87 U	29.9	1.93 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
o-Xylene	µg/Kg	-	-	280,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	1.11 J	1.93 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.78 U	131 U	1.99 U	1.81 U	1.87 U	2.73 U	1.93 U
Toluene	µg/Kg	-	-	4,700,000	1.78 U	33.8 J	1.99 U	1.81 U	1.87 U	5.74	2.04
Total Other VOCs	mg/Kg	-	-	-	0.0	1.3	0.0	0.0	0.0	0.2	0.1

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-15-16-DFW	SB-15-24-DFW	SB-16-1-DFW	SB-16-6-DFW	SB-16-15-DFW	SB-16-25-DFW	SB-18-2
	Lab ID				M0F1296-22	M0F1296-23	M0F1296-24	M0F1296-25	M0F1296-26	M0F1296-27	D2106012-002A
	Date				6/16/2020	6/16/2020	6/16/2020	6/16/2020	6/16/2020	6/16/2020	6/10/2021
Primary CVOCs	Units	LSV	FDSV								
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.95 U	4.42 U	5.47 U	5.54 U	5.17 U	4.67 U	4.2 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.95 U	4.42 U	5.47 U	5.54 U	5.17 U	4.67 U	4.2 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Chloroform	µg/Kg	917	486	1,400	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	3.96 U	3.53 U	4.38 U	4.43 U	4.13 U	3.74 U	4.2 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Trichloroethene	µg/Kg	182	93.2	1,900	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.96 U	3.53 U	4.38 U	4.43 U	4.13 U	3.74 U	4.2 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other VOCs											
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
2-Hexanone	µg/Kg	-	-	130,000	9.91 U	8.83 U	10.9 U	11.1 U	10.3 U	9.34 U	14.4 U
Acetone	µg/Kg	-	-	67,000,000	13.5 J	49.8	85.4	67.6	23.1	17.4 J	4.2 U
Benzene	µg/Kg	-	-	5,100	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	184 U
Carbon disulfide	µg/Kg	-	-	350,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Ethylbenzene	µg/Kg	-	-	25,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Isopropylbenzene	µg/Kg	-	-	990,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
m-,p-Xylene	µg/Kg	-	-	240,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Naphthalene	µg/Kg	-	-	8,600	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 UJ
n-Propylbenzene	µg/Kg	-	-	2,400,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
o-Xylene	µg/Kg	-	-	280,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
p-Isopropyltoluene	µg/Kg	-	-	-	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Toluene	µg/Kg	-	-	4,700,000	1.98 U	1.77 U	2.19 U	2.21 U	2.07 U	1.87 U	4.2 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.1	0.1	0.0	0.0	0.0

Notes:

1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.

2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.

3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-18-4	SB-18-12	SB-18-18	SB-18-28	SB-18-40	SB-19-2
	Lab ID				D2106012-003A	D2106012-005A	D2106012-006A	D2106012-007A	D2106012-008A	D2106011-015A
	Date				6/10/2021	6/10/2021	6/10/2021	6/10/2021	6/10/2021	6/10/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Chloroform	µg/Kg	917	486	1,400	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	**10300 J**	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Trichloroethene	µg/Kg	182	93.2	1,900	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Vinyl chloride	µg/Kg	29.4	15	1,700	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Total CVOCs	µg/Kg	-	-	-	10300	0.0	0.0	0.0	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	**540000 J**	101000	5.02 U	4.87 U	3.1 U	2.64 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	**158000 J**	36100	5.02 U	4.87 U	3.1 U	2.64 U
2-Hexanone	µg/Kg	-	-	130,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	17.4 U
Acetone	µg/Kg	-	-	67,000,000	21300 U	3140 U	5.02 UJ	4.87 UJ	3.1 UJ	2.64 U
Benzene	µg/Kg	-	-	5,100	85400 U	12600 U	75 U	33.7 U	12.4 U	180 J
Carbon disulfide	µg/Kg	-	-	350,000	21300 U	2110 J	5.02 U	4.87 U	3.1 U	2.64 U
Ethylbenzene	µg/Kg	-	-	25,000	21300 U	3140 U	5.02 U	4.87 U	3.1 U	2.64 U
Isopropylbenzene	µg/Kg	-	-	990,000	145000	50000	3 J	4.87 U	3.1 U	2.64 U
m-,p-Xylene	µg/Kg	-	-	240,000	51400 J	10300	5.02 U	4.87 U	3.1 U	2.64 U
Naphthalene	µg/Kg	-	-	8,600	**504000**	169000	6.06 J	4.87 U	3.1 U	2.64 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	205000 J	91800	5.02 U	4.87 U	3.1 U	2.64 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	123000 J	21900	5.02 U	4.87 U	3.1 U	2.64 U
o-Xylene	µg/Kg	-	-	280,000	83700 J+	15900	5.02 U	4.87 U	3.1 U	2.64 U
p-Isopropyltoluene	µg/Kg	-	-	-	255000 J	73000	2.55 J	4.87 U	3.1 U	2.64 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	52900 J	9230	5.02 U	4.87 U	3.1 U	2.64 U
Toluene	µg/Kg	-	-	4,700,000	51000	7930	2.04 J	4.87 U	3.1 U	2.64 U
Total Other VOCs	mg/Kg	-	-	-	2169	451	0.0	0.0	0.0	0.2

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-19-4	SB-19-5	SB-19-13	SB-19-32	SB-20-2	SB-20-4
	Lab ID				D2106011-016A	D2106011-017A	D2106011-018A	D2106012-001A	D2106012-009A	D2106012-010A
	Date				6/10/2021	6/10/2021	6/10/2021	6/10/2021	6/10/2021	6/10/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Chloroform	µg/Kg	917	486	1,400	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Trichloroethene	µg/Kg	182	93.2	1,900	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3070 U	2.76 U	249 U	7.85 J	5.46 U	424 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	7.9	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	3070 U	2.76 U	249 U	2.56 U	3.01	424 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
2-Hexanone	µg/Kg	-	-	130,000	3070 U	2.76 U	249 U	2.56 U	26.2 U	424 U
Acetone	µg/Kg	-	-	67,000,000	3070 U	2.76 U	249 U	2.56 UJ	5.46 UJ	424 U
Benzene	µg/Kg	-	-	5,100	12300 U	11.1 U	995 U	12.9 U	223 U	1690 UJ
Carbon disulfide	µg/Kg	-	-	350,000	3070 U	4.16 J	154 J	9.16	5.46 U	424 UJ
Ethylbenzene	µg/Kg	-	-	25,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 U
Isopropylbenzene	µg/Kg	-	-	990,000	4040 J	13.2	517	2.56 U	5.46 U	1560 J
m-,p-Xylene	µg/Kg	-	-	240,000	4850 J	2.63 J	445 J	2.56 U	5.46 U	1310 J
Naphthalene	µg/Kg	-	-	8,600	3070 U	2.76 U	249 U	2.56 U	3.92 J	687 J
n-Butylbenzene	µg/Kg	-	-	5,800,000	7490	15.1	516 U	2.56 U	5.46 U	3910 J
n-Propylbenzene	µg/Kg	-	-	2,400,000	5310 J	2.36 J	561	2.56 U	5.46 U	3750 J
o-Xylene	µg/Kg	-	-	280,000	4180 J	3.89 J	514	2.56 U	5.46 U	2560 J+
p-Isopropyltoluene	µg/Kg	-	-	-	3070 U	2.76 U	249 U	2.56 U	1.63 J	680 J
sec-Butylbenzene	µg/Kg	-	-	12,000,000	5020 J	2.27	507	2.56 U	5.46 U	2360 J
Toluene	µg/Kg	-	-	4,700,000	3070 U	2.76 U	249 U	2.56 U	5.46 U	424 UJ
Total Other VOCs	mg/Kg	-	-	-	30.9	0.0	2.7	0.0	0.0	16.8

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-20-15	SB-20-32	SB-21-2	SB-21-6	SB-21-17	SB-21-36
	Lab ID				D2106013-010A	D2106013-011A	D2106013-001A	D2106013-002A	D2106013-003A	D2106013-004A
	Date				6/10/2021	6/10/2021	6/11/2021	6/11/2021	6/11/2021	6/11/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Chloroform	µg/Kg	917	486	1,400	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Trichloroethene	µg/Kg	182	93.2	1,900	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Vinyl chloride	µg/Kg	29.4	15	1,700	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	3.66 J	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
2-Hexanone	µg/Kg	-	-	130,000	4.83 U	5.65 UJ	6.82 U	6.64 U	6.02 U	5.28 U
Acetone	µg/Kg	-	-	67,000,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Benzene	µg/Kg	-	-	5,100	29.7	15.2 J	66.1 U	72.8 U	25.7 U	17 U
Carbon disulfide	µg/Kg	-	-	350,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Ethylbenzene	µg/Kg	-	-	25,000	4.83 U	5.65 UJ	4.46 U	6.64 U	13.3	5.28 U
Isopropylbenzene	µg/Kg	-	-	990,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
m-,p-Xylene	µg/Kg	-	-	240,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Naphthalene	µg/Kg	-	-	8,600	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	7.53 U	5.65 UJ	5.09 U	6.64 U	6.02 U	5.28 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	4.83 U	4.41 J	4.46 U	6.64 UJ	6.02 U	5.28 U
o-Xylene	µg/Kg	-	-	280,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
p-Isopropyltoluene	µg/Kg	-	-	-	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	4.83 U	5.65 UJ	1.44 J	6.64 U	6.02 U	5.28 U
Toluene	µg/Kg	-	-	4,700,000	4.83 U	5.65 UJ	4.46 U	6.64 U	6.02 U	5.28 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-22-2	SB-22-6	SB-22-22	SB-22-30	SB-23-2	SB-23-6
	Lab ID				D2106011-010A	D2106011-011A	D2106011-012A	D2106011-014A	D2106013-005A	D2106013-006A
	Date				6/9/2021	6/9/2021	6/9/2021	6/9/2021	6/11/2021	6/11/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Chloroform	µg/Kg	917	486	1,400	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	3.38 U	17.1	14 J	12.1	4.65 U	5.66 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	5.28 J	1.31 J	0.809 J	2.74 U	4.65 U	5.66 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Trichloroethene	µg/Kg	182	93.2	1,900	33.3	11	14.7 J	8.25	4.65 U	5.66 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Total CVOCs	µg/Kg	-	-	-	38.6	29.4	29.5	20.4	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
2-Hexanone	µg/Kg	-	-	130,000	13 U	3.15 U	2.54 U	2.74 U	18 U	5.66 U
Acetone	µg/Kg	-	-	67,000,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Benzene	µg/Kg	-	-	5,100	209	46.5 U	19.4 U	11 U	201 U	26.6 U
Carbon disulfide	µg/Kg	-	-	350,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Ethylbenzene	µg/Kg	-	-	25,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Isopropylbenzene	µg/Kg	-	-	990,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
m-,p-Xylene	µg/Kg	-	-	240,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Naphthalene	µg/Kg	-	-	8,600	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	2.51 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
o-Xylene	µg/Kg	-	-	280,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
p-Isopropyltoluene	µg/Kg	-	-	-	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Toluene	µg/Kg	-	-	4,700,000	3.38 U	3.15 U	2.54 U	2.74 U	4.65 U	5.66 U
Total Other VOCs	mg/Kg	-	-	-	0.2	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-23-17	SB-23-32	SB-24-2	SB-24-6	SB-24-20	SB-24-26
	Lab ID				D2106013-007A	D2106013-008A	D2106011-005A	D2106011-006A	D2106011-007A	D2106011-008A
	Date				6/11/2021	6/11/2021	6/9/2021	6/9/2021	6/9/2021	6/9/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Chloroform	µg/Kg	917	486	1,400	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	5.19 U	5.08 U	3.39 U	2.74 U	4.29 J	3.07 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Trichloroethene	µg/Kg	182	93.2	1,900	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Vinyl chloride	µg/Kg	29.4	15	1,700	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	0.0	4.3	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	2.22 J
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
2-Hexanone	µg/Kg	-	-	130,000	5.19 U	5.08 U	7.24 U	2.74 U	2.3 U	3.07 U
Acetone	µg/Kg	-	-	67,000,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Benzene	µg/Kg	-	-	5,100	47.6 U	26.7 U	116 U	63.4 U	34.3 U	20.4 U
Carbon disulfide	µg/Kg	-	-	350,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Ethylbenzene	µg/Kg	-	-	25,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Isopropylbenzene	µg/Kg	-	-	990,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
m-,p-Xylene	µg/Kg	-	-	240,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Naphthalene	µg/Kg	-	-	8,600	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	2.37 J
n-Propylbenzene	µg/Kg	-	-	2,400,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	2.52 J
o-Xylene	µg/Kg	-	-	280,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
p-Isopropyltoluene	µg/Kg	-	-	-	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Toluene	µg/Kg	-	-	4,700,000	5.19 U	5.08 U	3.39 U	2.74 U	2.3 U	3.07 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-25-2	SB-25-8	SB-25-17	SB-25-29	SB-26-1	SB-26-5
	Lab ID				D2106011-001A	D2106011-002A	D2106011-003A	D2106011-004A	D2106012-015A	D2106012-017A
	Date				6/9/2021	6/9/2021	6/9/2021	6/9/2021	6/11/2021	6/11/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	3.27 U	6.2 UJ	2.92 U	2.49 U	4.97 U	5.46 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 UJ
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	3.27 U	6.2 U	2.92 U	2.49 UJ	4.97 U	5.46 U
Chloroform	µg/Kg	917	486	1,400	3.27 U	24.8	2.92 U	2.49 U	4.97 U	5.46 UJ
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 UJ
Methylene chloride	µg/Kg	30.5	16.9	320,000	3.27 U	10.4 J	2.92 U	2.49 U	4.97 U	5.46 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	3.27 U	2.15 J	2.92 U	2.49 U	4.97 U	5.46 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 UJ
Trichloroethene	µg/Kg	182	93.2	1,900	3.27 U	5.64 J	2.92 U	2.49 U	4.97 U	5.46 U
Vinyl chloride	µg/Kg	29.4	15	1,700	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 U
Total CVOCs	µg/Kg	-	-	-	0.0	43.0	0.0	0.0	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	3.27 U	44.8 J	2.92 U	2.49 U	4.97 U	5.46 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	3.27 U	22.3 J	2.92 U	2.49 U	4.97 U	5.46 U
2-Hexanone	µg/Kg	-	-	130,000	3.27 U	68.2 U	2.92 U	2.49 U	150 U	5.46 U
Acetone	µg/Kg	-	-	67,000,000	3.27 U	6.2 U	2.92 U	2.49 U	31.3 J	5.46 UJ
Benzene	µg/Kg	-	-	5,100	112 U	403	12.7 U	28 U	833 J	71.5 U
Carbon disulfide	µg/Kg	-	-	350,000	3.27 U	14.7	2.92 U	2.49 U	4.97 U	5.46 U
Ethylbenzene	µg/Kg	-	-	25,000	3.27 U	6.2 UJ	2.92 U	2.49 UJ	4.97 U	5.46 U
Isopropylbenzene	µg/Kg	-	-	990,000	3.27 U	6.2 UJ	2.92 U	2.49 U	4.97 U	5.46 U
m-,p-Xylene	µg/Kg	-	-	240,000	3.27 U	6.2 J	2.92 U	2.49 U	4.97 U	5.46 U
Naphthalene	µg/Kg	-	-	8,600	3.27 U	19 J	2.92 U	2.49 U	4.97 U	5.46 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	3.47 U	36.5 J	2.23 U	1.99 U	4.97 UJ	5.46 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	3.27 UJ	6.2 UJ	2.92 U	2.49 U	4.97 U	5.46 U
o-Xylene	µg/Kg	-	-	280,000	3.27 U	6.2 UJ	2.92 U	2.49 U	4.97 U	5.46 U
p-Isopropyltoluene	µg/Kg	-	-	-	3.27 U	15.6 J	2.92 U	2.49 U	4.97 U	5.46 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	3.27 U	6.2 U	2.92 U	2.49 U	4.97 U	5.46 U
Toluene	µg/Kg	-	-	4,700,000	3.27 U	27.2	2.92 U	2.49 U	4.97 U	5.46 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.6	0.0	0.0	0.9	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 5
SOIL ANALYTICAL RESULTS SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	Project Action Limit [1]		USEPA Industrial Soil Regional Screening Level	SB-26-17	SB-26-28	SB-27-2	SB-27-6	SB-27-17	SB-27-28
	Lab ID				D2106012-018A	D2106013-015A	D2107013-001A	D2107013-002A	D2107013-003A	D2107013-004A
	Date				6/11/2021	6/11/2021	7/13/2021	7/13/2021	7/13/2021	7/13/2021
Primary CVOCs	Units	LSV	FDSV							
1,1,2,2-Tetrachloroethane	µg/Kg	11.2	6.6	2,700	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
1,1,2-Trichloroethane	µg/Kg	62.7	35.5	630	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
1,1-Dichloroethene	µg/Kg	150	76.4	100,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
1,2-Dichloroethane	µg/Kg	32.9	18.9	2,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Carbon tetrachloride	µg/Kg	215	108.6	2,900	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Chloroform	µg/Kg	917	486	1,400	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
cis-1,2-Dichloroethene	µg/Kg	755	404	230,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Methylene chloride	µg/Kg	30.5	16.9	320,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Tetrachloroethene	µg/Kg	180.6	92	39,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
trans-1,2-Dichloroethene	µg/Kg	1520	791	30,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Trichloroethene	µg/Kg	182	93.2	1,900	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Vinyl chloride	µg/Kg	29.4	15	1,700	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Total CVOCs	µg/Kg	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
Other VOCs										
1,2,4-Trimethylbenzene	µg/Kg	-	-	180,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
1,3,5-Trimethylbenzene	µg/Kg	-	-	150,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
2-Hexanone	µg/Kg	-	-	130,000	4.76 U	4.67 U	64 J+	6.15 UJ	6.05 UJ	5.75 UJ
Acetone	µg/Kg	-	-	67,000,000	4.76 U	4.67 U	9.76 J	6.15 UJ	6.05 UJ	5.75 UJ
Benzene	µg/Kg	-	-	5,100	37.1 U	23.8 U	23.8 UJ	24.6 UJ	24.2 UJ	23 UJ
Carbon disulfide	µg/Kg	-	-	350,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Ethylbenzene	µg/Kg	-	-	25,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Isopropylbenzene	µg/Kg	-	-	990,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
m-,p-Xylene	µg/Kg	-	-	240,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Naphthalene	µg/Kg	-	-	8,600	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
n-Butylbenzene	µg/Kg	-	-	5,800,000	4.76 UJ	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
n-Propylbenzene	µg/Kg	-	-	2,400,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
o-Xylene	µg/Kg	-	-	280,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
p-Isopropyltoluene	µg/Kg	-	-	-	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
sec-Butylbenzene	µg/Kg	-	-	12,000,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Toluene	µg/Kg	-	-	4,700,000	4.76 U	4.67 U	5.95 U	6.15 U	6.05 U	5.75 U
Total Other VOCs	mg/Kg	-	-	-	0.0	0.0	0.1	0.0	0.0	0.0

Notes:
1) Project Action Limits are Site-Specific Soil Screening Levels to be Protective of Groundwater from the Dunn Field ROD, Table 2-21G.
2) Results above LSV or FDSV are in **bold** and results above RSLs are in **bold**.
3) Analytical results, whether non-detect or detected above or below the LOQ, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOQ in at least one sample.

µg/kg: micrograms per kilogram
LOQ: Limit of Quantitation
LSV: Loess Specific Values
FDSV: Fluvial Deposit Specific Values.
- : Not Listed

DQE Flags:
U: Not Detected
J: Estimated

Method:
8260B: Volatile Organic Compounds

TABLE 6
VMP CONSTRUCTION SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

VMP ID	Date Completed	Northing	Easting	Top Lid Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Depth to Sand (ft, bgs)	Total Boring Depth (ft, bgs)	Riser Length (ft)	Top of Screen Elevation (ft, NAVD)	Screen Length (ft)	Total Depth (ft, btoc)
VP-7A	6/11/2007	280602	802203	295.9	293.3	26.0	58.0	55.5	240.4	5	60.5
VP-7B	6/14/2007	280603	802206	296.1	293.5	26.0	38.0	34.8	261.3	5	39.8
VMP-6S	7/13/2021	280683	802071	290.5	290.1	--	6.0	4.0	286.6	1	5.0
VMP-6D	7/14/2021	280678	802071	290.4	290.0	27.0	32.0	30.0	262.1	1	31.0
VMP-7S	7/8/2020	280644	802058	289.5	289.2	--	5.5	4.0	285.2	1	5.0
VMP-7D	7/8/2020	280642	802058	289.5	289.5	25.0	29.0	26.5	263.0	1	27.5
VMP-10S	7/8/2020	280672	802127	290.5	290.2	--	5.5	4.0	286.2	1	5.0
VMP-10D	7/9/2020	280668	802126	290.5	290.2	23.0	27.0	25.5	264.7	1	26.5
VMP-11S	7/8/2020	280630	802122	290.3	290.1	--	5.5	4.0	286.1	1	5.0
VMP-13D	7/8/2020	280621	802161	291.4	291.1	23.0	27.0	25.5	265.6	1	26.5
VMP-14S	7/8/2020	280638	802214	294.3	294.2	--	5.5	4.0	290.2	1	5.0
VMP-15D	7/9/2020	280625	802256	298.4	298.2	29.0	32.0	30.5	267.7	1	31.5
VMP-17S	7/8/2020	280689	802193	295.1	294.9	--	5.5	4.0	290.9	1	5.0
VMP-17D	7/9/2020	280685	802192	294.9	294.6	29.0	32.0	30.5	264.1	1	31.5
VMP-18S	7/13/2021	280691	802112	291.1	290.9	--	6.0	4.0	287.4	1	5.0
VMP-18D	7/13/2021	280685	802110	291.1	290.6	28.0	30.0	28.5	262.1	1	29.5
VMP-25S	7/13/2021	280593	802079	289.5	289.2	--	6.0	3.5	285.7	1	5.0
VMP-25D	7/13/2021	280590	802080	289.6	289.1	26.5	30.0	27.0	262.1	1	28.0

Notes:
ft: feet
NAVD: North American Vertical Datum of 1988
bgs: below ground surface
btoc: below top of casing
VMP: vapor monitoring point
VP: vapor point

TABLE 7
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, SHALLOW VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-6S	VMP-6S	VMP-7S	VMP-7S	VMP-7S	VMP-7S
	Lab ID	Commercial	Residential	P2103824-009	P2104163-003	P2003915-012	P2005847-009	P2103824-007	P2104163-002
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/16/2021	8/4/2021	7/14/2020	10/14/2020	7/15/2021	8/4/2021
Primary CVOCs	Units								
1,1,2,2-Tetrachloroethane	µg/m^3	7.05	1.61	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
1,1,2-Trichloroethane	µg/m^3	2.92	0.695	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
1,1-Dichloroethene	µg/m^3	2920	695	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
1,2-Dichloroethane	µg/m^3	15.7	3.6	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
Carbon Tetrachloride	µg/m^3	68.1	15.6	540 U	31 U	37 U	0.14 J	0.68 U	0.73 U
Chloroform	µg/m^3	17.8	4.07	540 U	**20 J**	37 U	0.25 J	1.3 J	1.1 J
cis-1,2-Dichloroethene	µg/m^3	-	-	540 U	31 U	37 U	0.55 J	0.68 U	0.73 U
Methylene Chloride	µg/m^3	8760	2090	1000 U	59 U	70 U	0.26 J	1.3 U	1.4 U
Tetrachloroethene	µg/m^3	584	139	540 U	34 J-	27 J	5	14	11 J-
trans-1,2-Dichloroethene	µg/m^3	584	139	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
Trichloroethene	µg/m^3	29.2	6.95	**260 J**	**30 J**	37 U	0.49 J	1.1 J	0.73 U
Vinyl Chloride	µg/m^3	92.9	5.59	**2200**	71 J	**160**	0.81	0.35 J	0.73 U
Total Primary CVOCs	µg/m^3	-	-	2460	155	187	7.5	16.8	12.1
Other VOCs									
1,1,2-Trichlorotrifluoroethane	µg/m^3	73000	17400	540 U	31 U	37 U	0.41 J	0.47 J	0.47 J
1,1-Dichloroethane	µg/m^3	256	58.5	1100 U	61 U	72 U	0.49 U	--	--
1,2,4-Trimethylbenzene	µg/m^3	876	209	**50000**	**8000**	**2300**	2.9	2.9	1.3 J
1,2-Dichloropropane	µg/m^3	58.4	13.9	540 U	31 U	44 J	2.3	0.4 J	0.52 J
1,3,5-Trimethylbenzene	µg/m^3	876	209	**22000**	**3800**	**1100**	1.4	0.83 J	0.36 J
1,3-Butadiene	µg/m^3	13.6	3.12	1000 U	59 U	70 U	0.47 U	1.3 U	1.4 U
1,3-Dichlorobenzene	µg/m^3	-	-	540 U	31 U	37 U	0.25 U	--	--
1,4-Dioxane	µg/m^3	81.8	18.7	540 U	31 U	37 U	0.25 U	0.68 U	0.38 J
2-Butanone (MEK)	µg/m^3	73000	17400	1000 U	30 J	70 U	1.1 J	2.1 J	4.8
2-Hexanone	µg/m^3	438	104	540 U	31 U	37 U	0.25 U	0.68 U	1.1 J
2-Propanol (Isopropyl Alcohol)	µg/m^3	2920	695	1200 J	120 UJ	140 U	0.93 U	2.5 U	2.7 UJ
4-Ethyltoluene	µg/m^3	-	-	19000	2200	1600	1.1	1.1 J	0.51 J
4-Methyl-2-pentanone	µg/m^3	43800	10400	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
Acetone	µg/m^3	451000	-	8600 U	500 U	590 U	4 U	17 J	22 J
Acetonitrile	µg/m^3	876	209	1000 U	59 U	70 U	0.47 U	1.3 U	0.94 J
Acrolein	µg/m^3	0.292	0.0695	990 U	57 U	68 U	0.46 U	**1.2 J**	**2.2 J**
alpha-Pinene	µg/m^3	-	-	1000 U	62 J	200	0.47 U	1.3 U	1.4 U
Benzene	µg/m^3	52.4	12	**38000**	**1200**	**510**	9.5	0.87 J	0.41 J
Bromomethane	µg/m^3	73	17.4	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
Carbon Disulfide	µg/m^3	10200	2430	1700 U	100 U	120 U	1.1 J	8.4	3.9 J
Chloroethane	µg/m^3	146000	-	1000 U	59 U	70 U	0.47 U	1.3 U	1.4 U
Chloromethane	µg/m^3	1310	313	1000 U	59 U	70 U	0.47 U	1.3 U	1.4 U
Cumene	µg/m^3	5840	1390	**9600**	930	640	1.1	0.32 J	0.73 U
Cyclohexane	µg/m^3	87600	20900	**130000**	10000	10000	41	1.4 U	1.5 U
Dichlorodifluoromethane (CFC 12)	µg/m^3	1460	348	1000 U	59 U	70 U	2	1.8 J	2.1 J
d-Limonene	µg/m^3	-	-	1000 U	59 U	120 J	0.47 U	0.74 J	1.4 U
Ethanol	µg/m^3	-	-	2700 U	90 J	180 U	4 J	5.1 J	5.2 J
Ethyl Acetate	µg/m^3	1020	243	2100 UJ	120 U	140 U	1.1 J	2.6 UJ	2.8 U
Ethylbenzene	µg/m^3	164	37.4	**120000**	**7600**	**5100**	3.8	1.5 J	0.8 J
Hexane	µg/m^3	10200	2430	**320000**	**16000**	9300	32	0.58 J	1.4 U
m,p-Xylenes	µg/m^3	1460	348	**360000**	**26000**	**3500**	4.4	4.9	1.6 J
Naphthalene	µg/m^3	12	2.75	990 U	57 U	**38 J**	0.46 U	1.2 U	1.3 U
n-Butyl Acetate	µg/m^3	-	-	540 U	31 U	37 U	0.25 U	0.68 U	0.73 U
n-Heptane	µg/m^3	5840	1390	**280000**	**19000**	**16000**	12	1.3 J	0.78 J
n-Nonane	µg/m^3	292	69.5	**180000**	**13000**	**6700**	4	4.2	2.2 J
n-Octane	µg/m^3	-	-	220000	12000 J-	11000	2.7	2.4	1.4 J-
n-Propylbenzene	µg/m^3	14600	3480	**17000**	1700	860	0.25 U	0.46 J	0.35 J
o-Xylene	µg/m^3	1460	348	**110000**	**11000**	330	1	0.48 J	0.73 U
Propene	µg/m^3	43800	10400	1000 U	37 J	39 J	2.7	1.3 U	1.4 J
Styrene	µg/m^3	14600	3480	520 J	27 J-	43 J	0.47 U	1.3 U	1.4 UJ
Tetrahydrofuran (THF)	µg/m^3	29200	6950	540 U	31 U	37 U	0.25 U	0.68 U	0.31 J
Toluene	µg/m^3	73000	17400	**84000**	2100 J-	93 J	0.93	0.73 J	0.33 J-
Trichlorofluoromethane	µg/m^3	-	-	1000 U	59 U	70 U	0.92	1.3 J	1.1 J
Vinyl Acetate	µg/m^3	2920	695	8600 U	500 U	590 U	4 U	6.4 J	10 J
Total Other VOCs	µg/m^3	-	-	1889320	122976	69517	133	64.6	66.5

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.
LOD: Limit of Detection
µg/m^3: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 7
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, SHALLOW VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-10S	VMP-10S	VMP-10S	VMP-11S	VMP-11S	VMP-11S
	Lab ID	Commercial	Residential	P2003915-006	P2005847-004	P2104163-001	P2003915-008	P2005847-005	P2103824-005
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/14/2020	10/14/2020	8/4/2021	7/14/2020	10/14/2020	7/15/2021
Primary CVOCs	Units								
1,1,2,2-Tetrachloroethane	μg/m³	7.05	1.61	0.71 U	0.26 U	0.78 U	0.72 U	0.26 U	0.7 U
1,1,2-Trichloroethane	μg/m³	2.92	0.695	0.71 U	0.26 U	0.78 U	0.72 U	0.26 U	0.7 U
1,1-Dichloroethene	μg/m³	2920	695	0.71 U	0.26 U	0.78 U	0.72 U	0.16 J	0.7 U
1,2-Dichloroethane	μg/m³	15.7	3.6	0.71 U	0.26 U	0.78 U	0.72 U	0.26 U	0.7 U
Carbon Tetrachloride	μg/m³	68.1	15.6	0.42 J	0.35 J	0.78 U	0.72 U	0.26 U	0.62 J
Chloroform	μg/m³	17.8	4.07	7.9	2.4	4.3	3.4	0.6 J	3.8
cis-1,2-Dichloroethene	μg/m³	-	-	0.71 U	0.26 U	0.78 U	11	2.5	0.7 U
Methylene Chloride	μg/m³	8760	2090	1.3 U	0.49 U	1.5 U	1.4 U	0.48 U	1.3 U
Tetrachloroethene	μg/m³	584	139	19	1.4	11 J-	3.9	0.32 J	9.2 J
trans-1,2-Dichloroethene	μg/m³	584	139	0.71 U	0.26 U	0.78 U	0.72 U	0.54 J	0.7 U
Trichloroethene	μg/m³	29.2	6.95	3.2	0.21 J	0.75 J	3.3	2.2	0.7 U
Vinyl Chloride	μg/m³	92.9	5.59	0.27 J	0.26 U	0.78 U	0.28 J	5.7	0.7 U
Total Primary CVOCs	μg/m³	-	-	30.8	4.4	16.1	21.9	12.0	13.6
Other VOCs									
1,1,2-Trichlorotrifluoroethane	μg/m³	73000	17400	1 J	0.46 J	0.46 J	0.9 J	0.12 J	0.48 J
1,1-Dichloroethane	μg/m³	256	58.5	1.4 U	0.51 U	--	1.4 U	0.5 U	--
1,2,4-Trimethylbenzene	μg/m³	876	209	3.8	0.27 J	0.43 J	2.3	0.26 U	0.35 J
1,2-Dichloropropane	μg/m³	58.4	13.9	0.71 U	0.26 U	0.78 U	0.72 U	0.26 U	0.7 U
1,3,5-Trimethylbenzene	μg/m³	876	209	1.1 J	0.26 U	0.78 U	0.66 J	0.26 U	0.7 U
1,3-Butadiene	μg/m³	13.6	3.12	1.3 U	0.49 U	1.5 U	0.41 J	0.48 U	1.3 U
1,3-Dichlorobenzene	μg/m³	-	-	0.71 U	0.26 U	--	0.72 U	0.26 U	--
1,4-Dioxane	μg/m³	81.8	18.7	0.71 U	0.26 U	0.9 J	6	0.26 U	0.7 U
2-Butanone (MEK)	μg/m³	73000	17400	2.6 J	0.87 J	10	9.4	0.28 J	70 J
2-Hexanone	μg/m³	438	104	0.8 J	0.26 U	1.6 J	2.9	0.26 U	3.4 J
2-Propanol (Isopropyl Alcohol)	μg/m³	2920	695	2.6 U	0.47 J	2.1 J	3.5 J	0.95 U	3.2 J
4-Ethyltoluene	μg/m³	-	-	0.96 J	0.49 U	1.5 U	0.8 J	0.48 U	1.3 U
4-Methyl-2-pentanone	μg/m³	43800	10400	0.71 U	0.26 U	0.58 J	0.74 J	0.26 U	3.6 J
Acetone	μg/m³	451000	-	18 J	3.2 J	49	68	4.1 U	430 J
Acetonitrile	μg/m³	876	209	1.3 U	0.49 U	2.8	1.4 U	0.48 U	8.3 J
Acrolein	μg/m³	0.292	0.0695	**1.6 J**	**0.47 J**	**4.3 J**	**4.7**	0.47 U	**50 J**
alpha-Pinene	μg/m³	-	-	3.5	0.49 U	1.6 J	5.7	0.48 U	1.3 U
Benzene	μg/m³	52.4	12	1.5 J	0.25 J	1.6 J	3.2	2.3	2.4
Bromomethane	μg/m³	73	17.4	0.71 U	0.26 U	0.78 U	0.72 U	0.26 U	3.6 J
Carbon Disulfide	μg/m³	10200	2430	18	0.6 J	22	15	0.8 J	12 J
Chloroethane	μg/m³	146000	-	1.3 U	0.49 U	1.5 U	1.4 U	0.48 U	2.9 J
Chloromethane	μg/m³	1310	313	0.66 J	0.49 U	0.71 J	0.78 J	0.48 U	2.4 J
Cumene	μg/m³	5840	1390	1.6 J	0.26 U	0.78 U	2.5	0.26 U	0.7 U
Cyclohexane	μg/m³	87600	20900	1.5 J	0.52 U	1.6 U	34	11	1.4 U
Dichlorodifluoromethane (CFC 12)	μg/m³	1460	348	2.2	2.1	2.1 J	2 J	1.3	1.5 J
d-Limonene	μg/m³	-	-	2.1 J	0.51 J	0.75 J	3.8	0.48 U	1.3 U
Ethanol	μg/m³	-	-	18 J	4.3 J	14 J	73	1.8 J	13 J
Ethyl Acetate	μg/m³	1020	243	2.7 U	1.7	3 U	91	0.98 U	2.7 UJ
Ethylbenzene	μg/m³	164	37.4	2.4	0.26 U	0.51 J	1.4 J	0.26 U	0.48 J
Hexane	μg/m³	10200	2430	1.5 J	0.38 J	0.88 J	26	0.84	1.3 U
m,p-Xylenes	μg/m³	1460	348	9.2	0.32 J	1 J	3 J	0.23 J	0.84 J
Naphthalene	μg/m³	12	2.75	1.3 U	0.48 U	0.8 J	**16**	0.47 U	1.3 U
n-Butyl Acetate	μg/m³	-	-	0.71 U	0.26 U	0.68 J	0.72 U	0.26 U	1.6 J
n-Heptane	μg/m³	5840	1390	0.63 J	0.49 U	0.71 J	3.5	0.48 U	0.66 J
n-Nonane	μg/m³	292	69.5	1.3 U	0.49 U	0.49 J	1.4 U	0.48 U	0.8 J
n-Octane	μg/m³	-	-	0.56 J	0.49 U	1.5 UJ	0.68 J	0.48 U	0.75 J
n-Propylbenzene	μg/m³	14600	3480	1 J	0.26 U	0.54 J	1.5 J	0.26 U	0.7 U
o-Xylene	μg/m³	1460	348	4.5	0.18 J	0.48 J	1.5 J	0.15 J	0.41 J
Propene	μg/m³	43800	10400	3.8	0.52 J	3.3	16	8.4	12 J
Styrene	μg/m³	14600	3480	1.3 U	0.49 U	1.5 UJ	1.4 U	0.48 U	4.2 J+
Tetrahydrofuran (THF)	μg/m³	29200	6950	0.69 J	0.26 U	0.74 J	0.72 U	0.26 U	1.4 J
Toluene	μg/m³	73000	17400	8.5	0.57 J	2.6 J-	3.6	0.31 J	2.6
Trichlorofluoromethane	μg/m³	-	-	1.5 J	1.1	0.92 J	1.2 J	0.26 J	1.1 J
Vinyl Acetate	μg/m³	2920	695	6.6 J	4.2 U	21 J	11 U	4.1 U	130 J
Total Other VOCs	μg/m³	-	-	120	18.3	150	406	27.8	764

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.
LOD: Limit of Detection
μg/m³: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 7
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, SHALLOW VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-14S	VMP-14S	VMP-14S	VMP-17S	VMP-17S	VMP-17S
	Lab ID	Commercial	Residential	P2003915-002	P2005847-001	P2103824-003	P2003915-004	P2005847-003	P2103824-004
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/14/2020	10/14/2020	7/15/2021	7/14/2020	10/14/2020	7/15/2021
Primary CVOCs	Units								
1,1,2,2-Tetrachloroethane	$\mu g/m^3$	7.05	1.61	0.68 U	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
1,1,2-Trichloroethane	$\mu g/m^3$	2.92	0.695	0.68 U	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
1,1-Dichloroethene	$\mu g/m^3$	2920	695	0.68 U	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
1,2-Dichloroethane	$\mu g/m^3$	15.7	3.6	0.68 U	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
Carbon Tetrachloride	$\mu g/m^3$	68.1	15.6	1.7 J	0.37 J	0.77 J	0.7 U	0.25 U	0.69 U
Chloroform	$\mu g/m^3$	17.8	4.07	**18**	3.8	9.4	0.73 J	0.47 J	0.82 J
cis-1,2-Dichloroethene	$\mu g/m^3$	-	-	1.5 J	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
Methylene Chloride	$\mu g/m^3$	8760	2090	1 J	7.7	1.3 U	1.3 U	0.48 U	1.3 U
Tetrachloroethene	$\mu g/m^3$	584	139	350	120	220	13	12	17
trans-1,2-Dichloroethene	$\mu g/m^3$	584	139	0.43 J	0.1 J	0.69 U	0.7 U	0.25 U	0.69 U
Trichloroethene	$\mu g/m^3$	29.2	6.95	13	1.3	4.9	0.7 U	0.25 U	0.3 J
Vinyl Chloride	$\mu g/m^3$	92.9	5.59	0.54 J	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
Total Primary CVOCs	$\mu g/m^3$	-	-	386	133	235	13.7	12.5	18.1
Other VOCs									
1,1,2-Trichlorotrifluoroethane	$\mu g/m^3$	73000	17400	0.7 J	0.43 J	0.48 J	0.56 J	0.42 J	0.61 J
1,1-Dichloroethane	$\mu g/m^3$	256	58.5	1.3 U	0.45 U	--	1.4 U	0.49 U	--
1,2,4-Trimethylbenzene	$\mu g/m^3$	876	209	16	0.61 J	0.47 J	0.37 J	0.12 J	0.69 U
1,2-Dichloropropane	$\mu g/m^3$	58.4	13.9	0.68 U	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
1,3,5-Trimethylbenzene	$\mu g/m^3$	876	209	3.7	0.18 J	0.69 U	0.7 U	0.25 U	0.69 U
1,3-Butadiene	$\mu g/m^3$	13.6	3.12	1.3 U	0.44 U	1.3 U	1.3 U	0.48 U	1.3 U
1,3-Dichlorobenzene	$\mu g/m^3$	-	-	0.68 U	0.23 U	--	0.7 U	0.25 U	--
1,4-Dioxane	$\mu g/m^3$	81.8	18.7	0.46 J	0.23 U	1.2 J	22	0.25 U	0.69 U
2-Butanone (MEK)	$\mu g/m^3$	73000	17400	8.8	3.1	3 J	3.2 J	0.48 U	1.2 J
2-Hexanone	$\mu g/m^3$	438	104	1 J	0.23 U	1.1 J	0.57 J	0.25 U	0.69 U
2-Propanol (Isopropyl Alcohol)	$\mu g/m^3$	2920	695	1.9 J	20	1.5 J	1.2 J	0.94 U	1.2 J
4-Ethyltoluene	$\mu g/m^3$	-	-	7.3	0.18 J	1.3 U	1.3 U	0.48 U	1.3 U
4-Methyl-2-pentanone	$\mu g/m^3$	43800	10400	1.8 J	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
Acetone	$\mu g/m^3$	451000	-	41	13	18 J	6.7 J	4 U	11 J
Acetonitrile	$\mu g/m^3$	876	209	1.1 J	0.44 U	1.3 J	1.3 U	0.48 U	1.3 U
Acrolein	$\mu g/m^3$	0.292	0.0695	**4.2**	**1.1 J**	**2.4 J**	**4.5**	0.46 U	**0.85 J**
alpha-Pinene	$\mu g/m^3$	-	-	1 J	0.6 J	1.3 U	0.69 J	0.48 U	1.3 U
Benzene	$\mu g/m^3$	52.4	12	2.6	1.1	0.5 J	0.78 J	0.25 U	6.2
Bromomethane	$\mu g/m^3$	73	17.4	1.9 J	0.23 U	0.69 U	0.7 U	0.25 U	0.69 U
Carbon Disulfide	$\mu g/m^3$	10200	2430	20	1.1 J	7.4	37	0.37 J	6.5
Chloroethane	$\mu g/m^3$	146000	-	1.1 J	0.44 U	1.3 U	1.3 U	0.48 U	1.3 U
Chloromethane	$\mu g/m^3$	1310	313	5	0.44 U	1.3 U	1.3 U	0.48 U	1.3 U
Cumene	$\mu g/m^3$	5840	1390	2.5	0.11 J	0.69 U	0.7 U	0.25 U	0.69 U
Cyclohexane	$\mu g/m^3$	87600	20900	0.81 J	1.2 J	1.4 U	1.4 U	0.51 U	1.4 U
Dichlorodifluoromethane (CFC 12)	$\mu g/m^3$	1460	348	2.2	2.2	1.8 J	2.3	2.2	1.9 J
d-Limonene	$\mu g/m^3$	-	-	4.3	2.5	1.3 U	1.3 U	0.48 U	1.3 U
Ethanol	$\mu g/m^3$	-	-	17 J	56	11 J	13 J	2.1 J	15 J
Ethyl Acetate	$\mu g/m^3$	1020	243	2.4 J	230	2.6 UJ	2 J	0.97 U	1.9 J+
Ethylbenzene	$\mu g/m^3$	164	37.4	7.2	0.98	0.38 J	0.7 U	0.25 U	0.69 U
Hexane	$\mu g/m^3$	10200	2430	2.1 J	3	1.3 U	1.3 U	0.48 U	1.3 U
m,p-Xylenes	$\mu g/m^3$	1460	348	24	2.1	0.91 J	0.62 J	0.28 J	0.7 J
Naphthalene	$\mu g/m^3$	12	2.75	**23**	0.42 U	1.3 U	0.87 J	0.46 U	1.3 U
n-Butyl Acetate	$\mu g/m^3$	-	-	0.47 J	1.1 J	2.7 J	0.52 J	0.25 U	0.69 U
n-Heptane	$\mu g/m^3$	5840	1390	1.2 J	1.6	1.3 U	1.3 U	0.48 U	1.3 U
n-Nonane	$\mu g/m^3$	292	69.5	0.61 J	1	0.36 J	1.3 U	0.48 U	1.3 U
n-Octane	$\mu g/m^3$	-	-	1.3 U	0.58 J	1.3 U	1.3 U	0.48 U	1.3 U
n-Propylbenzene	$\mu g/m^3$	14600	3480	4.6	0.17 J	0.69 U	0.7 U	0.25 U	0.69 U
o-Xylene	$\mu g/m^3$	1460	348	8.7	0.98	0.51 J	0.32 J	0.21 J	0.69 U
Propene	$\mu g/m^3$	43800	10400	5.7	3.5	0.61 J	1.8 J	0.48 U	1.3 U
Styrene	$\mu g/m^3$	14600	3480	1.3 U	1.5	1.3 U	1.3 U	0.48 U	1.3 U
Tetrahydrofuran (THF)	$\mu g/m^3$	29200	6950	2.4	0.45 J	0.69 U	0.94 J	0.25 U	0.69 U
Toluene	$\mu g/m^3$	73000	17400	18	16	1.1 J	0.94 J	0.39 J	2.4
Trichlorofluoromethane	$\mu g/m^3$	-	-	2.3	1.4	2.3	1.4 J	1.2	1.5 J
Vinyl Acetate	$\mu g/m^3$	2920	695	14 J	3.7 U	11 U	11 U	4 U	11 U
Total Other VOCs	$\mu g/m^3$	-	-	263	368	59.0	102	7.3	51.0

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.
LOD: Limit of Detection
$\mu g/m^3$: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 7
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, SHALLOW VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-25S
	Lab ID	Commercial	Residential	P2103824-011
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/16/2021
Primary CVOCs	Units			
1,1,2,2-Tetrachloroethane	µg/m3	7.05	1.61	0.71 U
1,1,2-Trichloroethane	µg/m3	2.92	0.695	0.71 U
1,1-Dichloroethene	µg/m3	2920	695	0.71 U
1,2-Dichloroethane	µg/m3	15.7	3.6	0.71 U
Carbon Tetrachloride	µg/m3	68.1	15.6	0.89 J
Chloroform	µg/m3	17.8	4.07	0.4 J
cis-1,2-Dichloroethene	µg/m3	-	-	0.71 U
Methylene Chloride	µg/m3	8760	2090	39
Tetrachloroethene	µg/m3	584	139	0.71 U
trans-1,2-Dichloroethene	µg/m3	584	139	0.71 U
Trichloroethene	µg/m3	29.2	6.95	0.71 U
Vinyl Chloride	µg/m3	92.9	5.59	0.71 U
Total Primary CVOCs	µg/m3	-	-	40.3
Other VOCs				
1,1,2-Trichlorotrifluoroethane	µg/m3	73000	17400	1.1 J
1,1-Dichloroethane	µg/m3	256	58.5	--
1,2,4-Trimethylbenzene	µg/m3	876	209	1 J
1,2-Dichloropropane	µg/m3	58.4	13.9	0.71 U
1,3,5-Trimethylbenzene	µg/m3	876	209	0.38 J
1,3-Butadiene	µg/m3	13.6	3.12	1.3 U
1,3-Dichlorobenzene	µg/m3	-	-	--
1,4-Dioxane	µg/m3	81.8	18.7	0.71 U
2-Butanone (MEK)	µg/m3	73000	17400	16
2-Hexanone	µg/m3	438	104	0.71 U
2-Propanol (Isopropyl Alcohol)	µg/m3	2920	695	10
4-Ethyltoluene	µg/m3	-	-	0.35 J
4-Methyl-2-pentanone	µg/m3	43800	10400	0.71 U
Acetone	µg/m3	451000	-	130
Acetonitrile	µg/m3	876	209	9.7
Acrolein	µg/m3	0.292	0.0695	**2.1 J**
alpha-Pinene	µg/m3	-	-	2.4
Benzene	µg/m3	52.4	12	0.86 J
Bromomethane	µg/m3	73	17.4	0.71 U
Carbon Disulfide	µg/m3	10200	2430	0.76 J
Chloroethane	µg/m3	146000	-	1.3 U
Chloromethane	µg/m3	1310	313	0.4 J
Cumene	µg/m3	5840	1390	0.71 U
Cyclohexane	µg/m3	87600	20900	2.5 J
Dichlorodifluoromethane (CFC 12)	µg/m3	1460	348	3.4
d-Limonene	µg/m3	-	-	7.4
Ethanol	µg/m3	-	-	100
Ethyl Acetate	µg/m3	1020	243	3.1 J+
Ethylbenzene	µg/m3	164	37.4	0.89 J
Hexane	µg/m3	10200	2430	3
m,p-Xylenes	µg/m3	1460	348	2.6 J
Naphthalene	µg/m3	12	2.75	1.3 U
n-Butyl Acetate	µg/m3	-	-	0.45 J
n-Heptane	µg/m3	5840	1390	13
n-Nonane	µg/m3	292	69.5	0.53 J
n-Octane	µg/m3	-	-	0.62 J
n-Propylbenzene	µg/m3	14600	3480	0.32 J
o-Xylene	µg/m3	1460	348	0.93 J
Propene	µg/m3	43800	10400	1.3 U
Styrene	µg/m3	14600	3480	0.37 J+
Tetrahydrofuran (THF)	µg/m3	29200	6950	1.2 J
Toluene	µg/m3	73000	17400	5.6
Trichlorofluoromethane	µg/m3	-	-	2.3
Vinyl Acetate	µg/m3	2920	695	11 U
Total Other VOCs	µg/m3	-	-	323

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.
LOD: Limit of Detection
µg/m^3: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 8
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, DEEP VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VP-7A	VP-7A	VP-7A	VP-7B	VP-7B	VP-7B	VMP-6D
	Lab ID	Commercial	Residential	P2003915-014	P2005847-010	P2103824-002	P2003915-013	P2005847-011	P2103824-001	P2103824-010
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/14/2020	10/14/2020	7/15/2021	7/14/2020	10/14/2020	7/15/2021	7/16/2021
Primary CVOCs	Units									
1,1,2,2-Tetrachloroethane	µg/m^3	7.05	1.61	0.78 U	0.25 U	57 U	0.84 U	0.26 U	0.7 U	110 U
1,1,2-Trichloroethane	µg/m^3	2.92	0.695	**6.9**	**26**	**42 J**	**4**	0.82	**3.6**	110 U
1,1-Dichloroethene	µg/m^3	2920	695	0.78 U	0.5 J	57 U	1.2 J	0.26 U	2.6	110 U
1,2-Dichloroethane	µg/m^3	15.7	3.6	3.1	5.5	57 U	0.46 J	0.26 U	0.43 J	110 U
Carbon Tetrachloride	µg/m^3	68.1	15.6	6.5	4.4	56 J	7	0.38 J	4.9	110 U
Chloroform	µg/m^3	17.8	4.07	**4400**	**2300**	**29000**	**1900**	**290**	**1600**	110 U
cis-1,2-Dichloroethene	µg/m^3	-	-	540	310	2200	64	8.7	51	110 U
Methylene Chloride	µg/m^3	8760	2090	5.8	3.6	110 U	22	4.3	21	210 U
Tetrachloroethene	µg/m^3	584	139	14	16	**640**	56	5.7	82	110 U
trans-1,2-Dichloroethene	µg/m^3	584	139	13	13	170 J	6.2	0.9	7.7	110 U
Trichloroethene	µg/m^3	29.2	6.95	**440**	**390**	**6700**	**120**	10	**130**	110 U
Vinyl Chloride	µg/m^3	92.9	5.59	0.68 J	2.5	52 J	2.6 J	0.13 J	8.5	56 J
Total Primary CVOCs	µg/m^3	-	-	5430	3072	38860	2183	321	1912	56.0
Other VOCs										
1,1,2-Trichlorotrifluoroethane	µg/m^3	73000	17400	12	11	140 J	8.1	0.44 J	14	110 U
1,1-Dichloroethane	µg/m^3	256	58.5	3.3	2.2	--	1.2 J	0.19 J	--	--
1,2,4-Trimethylbenzene	µg/m^3	876	209	0.56 J	0.25 U	57 U	1.3 J	0.25 J	0.5 J	**30000**
1,2-Dichloropropane	µg/m^3	58.4	13.9	4.4	3.3	36 J	2.3 J	0.4 J	2.4	110 U
1,3,5-Trimethylbenzene	µg/m^3	876	209	0.78 U	0.25 U	57 U	0.84 U	0.26 U	0.7 U	**11000**
1,3-Butadiene	µg/m^3	13.6	3.12	1.5 U	0.47 U	110 U	5.2	1.4	3.6	**97 J**
1,3-Dichlorobenzene	µg/m^3	-	-	0.87 J	0.99	--	0.84 U	0.26 U	--	--
1,4-Dioxane	µg/m^3	81.8	18.7	0.78 U	0.25 U	57 U	1.3 J	0.26 U	0.7 U	110 U
2-Butanone (MEK)	µg/m^3	73000	17400	4.8 J	1.2 J	110 U	18	2.1	11	210 U
2-Hexanone	µg/m^3	438	104	1.9 J	0.25 U	57 U	1.9 J	0.47 J	0.7 U	110 U
2-Propanol (Isopropyl Alcohol)	µg/m^3	2920	695	2.3 J	0.93 U	110 J	2.3 J	0.95 U	1.7 J	180 J
4-Ethyltoluene	µg/m^3	-	-	1.5 U	0.47 U	110 U	1.6 U	0.48 U	1.3 U	10000
4-Methyl-2-pentanone	µg/m^3	43800	10400	0.41 J	0.25 U	57 U	0.82 J	0.26 U	0.7 U	110 U
Acetone	µg/m^3	451000	-	27	4 U	910 U	260	13	31	1800 U
Acetonitrile	µg/m^3	876	209	1.5 U	0.47 U	110 U	2 J	0.69 J	1.1 J	210 U
Acrolein	µg/m^3	0.292	0.0695	**65**	0.46 U	100 U	**5.4**	**0.45 J**	**2.9 J**	200 U
alpha-Pinene	µg/m^3	-	-	1.5 U	0.47 U	110 U	1.6 U	0.24 J	1.3 U	380
Benzene	µg/m^3	52.4	12	0.49 J	0.89	57 U	0.86 J	0.51 J	0.39 J	**43000**
Bromomethane	µg/m^3	73	17.4	0.78 U	0.25 U	57 U	0.84 U	0.26 U	0.7 U	110 U
Carbon Disulfide	µg/m^3	10200	2430	2.1 J	0.58 J	180 U	110	22	120	350 U
Chloroethane	µg/m^3	146000	-	1.5 U	0.47 U	110 U	1.6 U	0.48 U	1.3 U	210 U
Chloromethane	µg/m^3	1310	313	1.5 U	0.47 U	110 U	1.6 U	0.21 J	1.3 U	210 U
Cumene	µg/m^3	5840	1390	0.78 U	0.25 U	57 U	0.84 U	0.26 U	0.7 U	**6400**
Cyclohexane	µg/m^3	87600	20900	1.6 U	0.38 J	110 U	1 J	0.32 J	0.63 J	20000
Dichlorodifluoromethane (CFC 12)	µg/m^3	1460	348	2.4 J	2.2	110 U	2.5 J	2	2 J	210 U
d-Limonene	µg/m^3	-	-	0.71 J	1.6	110 U	1.6 U	0.41 J	1.3 U	210 U
Ethanol	µg/m^3	-	-	28	8.3	280 U	12 J	2 J	40	540 U
Ethyl Acetate	µg/m^3	1020	243	3 U	0.96 U	220 UJ	3.5 J	0.98 U	2.7 UJ	430 UJ
Ethylbenzene	µg/m^3	164	37.4	0.78 U	0.25 U	57 U	0.91 J	0.18 J	0.38 J	**56000**
Hexane	µg/m^3	10200	2430	0.88 J	1.6	110 U	1.4 J	0.8	1.3 U	**23000**
m,p-Xylenes	µg/m^3	1460	348	1.6 U	0.28 J	110 U	2 J	0.59 J	0.83 J	92000
Naphthalene	µg/m^3	12	2.75	**13**	0.46 U	100 U	2.2 J	0.65 J	1.3 J	**600**
n-Butyl Acetate	µg/m^3	-	-	0.78 U	0.25 U	57 U	0.53 J	0.26 U	0.7 U	110 U
n-Heptane	µg/m^3	5840	1390	1.5 U	0.47 U	110 U	2 J	0.45 J	0.54 J	**24000**
n-Nonane	µg/m^3	292	69.5	1.5 U	0.47 U	110 U	1.8 J	0.2 J	1.3 U	**87000**
n-Octane	µg/m^3	-	-	1.5 U	0.47 U	110 U	1.9 J	0.24 J	1.3 U	51000
n-Propylbenzene	µg/m^3	14600	3480	0.78 U	0.25 U	57 U	0.84 U	0.26 U	0.54 J	11000
o-Xylene	µg/m^3	1460	348	0.78 U	0.19 J	57 U	0.8 J	0.25 J	0.37 J	**24000**
Propene	µg/m^3	43800	10400	1.5 U	0.72 J	110 U	8.1	2.4	4.9	7900
Styrene	µg/m^3	14600	3480	1.5 U	0.47 U	110 U	0.59 J	0.2 J	1.3 U	130 J
Tetrahydrofuran (THF)	µg/m^3	29200	6950	0.78 U	0.51 J	57 U	11	3.7	8.3	110 U
Toluene	µg/m^3	73000	17400	0.61 J	1.4	57 U	2.2 J	1.1	0.94 J	24000
Trichlorofluoromethane	µg/m^3	-	-	1.3 J	1.1	110 U	1.2 J	1	1.3 J	210 U
Vinyl Acetate	µg/m^3	2920	695	11 J	4 U	910 U	18 J	4.1 U	11 U	1800 U
Total Other VOCs	µg/m^3	-	-	134	38.4	286	494	58.8	231	480687

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.

LOD: Limit of Detection
µg/m^3: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 8
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, DEEP VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-7D	VMP-7D	VMP-10D	VMP-13D	VMP-13D	VMP-15D	VMP-15D
	Lab ID	Commercial	Residential	P2003915-010	P2005847-008	P2003915-007	P2003915-009	P2005847-007	P2003915-001	P2005847-012
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/14/2020	10/14/2020	7/14/2020	7/14/2020	10/14/2020	7/14/2020	10/15/2020
Primary CVOCs	Units									
1,1,2,2-Tetrachloroethane	μg/m^3	7.05	1.61	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
1,1,2-Trichloroethane	μg/m^3	2.92	0.695	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
1,1-Dichloroethene	μg/m^3	2920	695	220 J	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
1,2-Dichloroethane	μg/m^3	15.7	3.6	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
Carbon Tetrachloride	μg/m^3	68.1	15.6	99 U	0.38 J	2.8 U	5 U	0.35 J	6.4 U	0.38 J
Chloroform	μg/m^3	17.8	4.07	99 U	0.25 U	2.8 U	5 U	0.14 J	**23**	1
cis-1,2-Dichloroethene	μg/m^3	-	-	10000	2.1	2.8 U	5 U	0.27 U	6.4 U	0.28 U
Methylene Chloride	μg/m^3	8760	2090	190 U	0.29 J	5.2 U	9.4 U	0.3 J	12 U	0.26 J
Tetrachloroethene	μg/m^3	584	139	99 U	0.56 J	29	52	2.1	52	0.28 U
trans-1,2-Dichloroethene	μg/m^3	584	139	150 J	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
Trichloroethene	μg/m^3	29.2	6.95	**190 J**	1	2.8 U	16 J	0.59 J	6.4 U	0.27 J
Vinyl Chloride	μg/m^3	92.9	5.59	**51000**	53	2.5 J	7.3 J	0.27 U	6.4 U	0.28 U
Total Primary CVOCs	μg/m^3	-	-	61560	57.3	31.5	75.3	3.5	75.0	1.9
Other VOCs										
1,1,2-Trichlorotrifluoroethane	μg/m^3	73000	17400	99 U	0.51 J	2.8 U	5 U	0.54 J	6.4 U	0.45 J
1,1-Dichloroethane	μg/m^3	256	58.5	190 U	0.49 U	5.4 U	9.7 U	0.51 U	12 U	0.54 U
1,2,4-Trimethylbenzene	μg/m^3	876	209	170 J	1	20	110	0.61 J	32	0.71 J
1,2-Dichloropropane	μg/m^3	58.4	13.9	**110 J**	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
1,3,5-Trimethylbenzene	μg/m^3	876	209	**1100**	0.34 J	9.7	71	0.16 J	11 J	0.14 J
1,3-Butadiene	μg/m^3	13.6	3.12	190 U	0.47 U	**22**	**58**	0.5 U	**79**	0.52 U
1,3-Dichlorobenzene	μg/m^3	-	-	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
1,4-Dioxane	μg/m^3	81.8	18.7	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
2-Butanone (MEK)	μg/m^3	73000	17400	190 U	1.2 J	3.5 J	9.4 U	2.2	12 U	1.4 J
2-Hexanone	μg/m^3	438	104	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
2-Propanol (Isopropyl Alcohol)	μg/m^3	2920	695	370 U	0.93 U	10 U	18 U	0.67 J	24 U	1.1 J
4-Ethyltoluene	μg/m^3	-	-	2600	0.57 J	4.9 J	73	0.2 J	15 J	0.19 J
4-Methyl-2-pentanone	μg/m^3	43800	10400	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
Acetone	μg/m^3	451000	-	1600 U	16	44 U	79 U	13	100 U	34
Acetonitrile	μg/m^3	876	209	190 U	0.47 U	5.2 U	9.4 U	0.5 U	12 U	0.52 U
Acrolein	μg/m^3	0.292	0.0695	180 U	**0.64 J**	5.1 U	9.1 U	**1.2 J**	12 U	**0.49 J**
alpha-Pinene	μg/m^3	-	-	1000	1.3	11	74	0.27 J	3200	0.62 J
Benzene	μg/m^3	52.4	12	**8800**	6.3	15	20	0.34 J	14 J	0.84 J
Bromomethane	μg/m^3	73	17.4	99 U	0.24 J	2.8 U	5 U	0.27 U	6.4 U	0.28 U
Carbon Disulfide	μg/m^3	10200	2430	320 U	3.2	45	54	3.2	21 J	0.88 U
Chloroethane	μg/m^3	146000	-	280 J	0.19 J	5.2 U	9.4 U	0.5 U	12 U	0.52 U
Chloromethane	μg/m^3	1310	313	190 U	0.57 J	1.4 J	9.4 U	0.36 J	12 U	0.25 J
Cumene	μg/m^3	5840	1390	360	0.53 J	4.4 J	30	0.27 U	7.1 J	0.28 U
Cyclohexane	μg/m^3	87600	20900	51000	57	18 J	180	0.53 U	90	0.33 J
Dichlorodifluoromethane (CFC 12)	μg/m^3	1460	348	190 U	2.2	2.3 J	2.7 J	2.3	12 U	2.2
d-Limonene	μg/m^3	-	-	330	1.3	29	80	0.6 J	75	0.52 U
Ethanol	μg/m^3	-	-	260 J	5.7 J	14 U	24 U	7.4 J	31 U	8.3 J
Ethyl Acetate	μg/m^3	1020	243	380 U	0.66 J	11 U	19 U	0.8 J	24 U	1.5 J
Ethylbenzene	μg/m^3	164	37.4	**14000**	8.1	14	140	0.39 J	38	0.68 J
Hexane	μg/m^3	10200	2430	**31000**	25	92	450	0.34 J	250	1.4
m,p-Xylenes	μg/m^3	1460	348	2300	4.5	17 J	160	0.93 J	95	2.4
Naphthalene	μg/m^3	12	2.75	180 U	0.26 J	5.1 U	5 J	0.29 J	12 U	0.51 U
n-Butyl Acetate	μg/m^3	-	-	99 U	0.25 U	2.8 U	5 U	0.27 U	6.4 U	0.28 U
n-Heptane	μg/m^3	5840	1390	**40000**	19	33	780	0.61 J	380	0.87
n-Nonane	μg/m^3	292	69.5	**33000**	18	3.9 J	41	2.6	12 U	0.41 J
n-Octane	μg/m^3	-	-	34000	20	4.6 J	42	1.5	12 U	0.49 J
n-Propylbenzene	μg/m^3	14600	3480	330	0.52 J	8.3 J	51	0.15 J	14 J	0.14 J
o-Xylene	μg/m^3	1460	348	690	0.54 J	8.5 J	41	0.37 J	33	0.95
Propene	μg/m^3	43800	10400	1500	2.1	1300	2300	0.57 J	2000	1.8
Styrene	μg/m^3	14600	3480	190 U	0.47 U	5.2 U	9.4 U	0.5 U	12 U	0.52 U
Tetrahydrofuran (THF)	μg/m^3	29200	6950	99 U	0.25 U	2.6 J	2.9 J	0.27 U	6.4 U	0.28 U
Toluene	μg/m^3	73000	17400	460	1.4	20	110	0.88	190	3.5
Trichlorofluoromethane	μg/m^3	-	-	190 U	1.1	5.2 U	9.4 U	1	12 U	1.1
Vinyl Acetate	μg/m^3	2920	695	1600 U	4 U	44 U	79 U	4.8 J	100 U	4.4 U
Total Other VOCs	μg/m^3	-	-	223290	200	1690	4876	48.3	6544	66.3

Notes:
1) Results above commercial VISL shown in **red bold**.
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.
VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.

LOD: Limit of Detection
μg/m^3: micrograms per cubic meter
- : Not Listed
VISL: Vapor Intrusion Screening Level
TCR: Target Cancer Risk
THQ: Target Hazard Quotient
DQE Flags:
U: Not Detected at LOD
J: Estimated
Method:
TO-15

TABLE 8
SOIL VAPOR ANALYTICAL RESULTS SUMMARY, DEEP VMPS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	Sample ID	VISL Criteria	VISL Criteria	VMP-17D	VMP-17D	VMP-18D	VMP-18D
	Lab ID	Commercial	Residential	P2003915-003	P2005847-002	P2103824-008	P2104163-004
	Date	(TCR=1E-06, THQ=0.1)	(TCR=1E-06, THQ=0.1)	7/14/2020	10/14/2020	7/16/2021	8/4/2021
Primary CVOCs	Units						
1,1,2,2-Tetrachloroethane	µg/m^3	7.05	1.61	5.4 U	0.25 U	13 U	20 U
1,1,2-Trichloroethane	µg/m^3	2.92	0.695	5.4 U	0.25 U	13 U	20 U
1,1-Dichloroethene	µg/m^3	2920	695	5.4 U	0.25 U	13 U	20 U
1,2-Dichloroethane	µg/m^3	15.7	3.6	5.4 U	0.25 U	13 U	20 U
Carbon Tetrachloride	µg/m^3	68.1	15.6	5.4 U	0.25 U	13 U	20 U
Chloroform	µg/m^3	17.8	4.07	5.4 U	0.32 J	13 U	20 U
cis-1,2-Dichloroethene	µg/m^3	-	-	5.4 U	0.25 U	96	96
Methylene Chloride	µg/m^3	8760	2090	10 U	0.48 U	25 U	37 U
Tetrachloroethene	µg/m^3	584	139	42	32	13 U	20 UJ
trans-1,2-Dichloroethene	µg/m^3	584	139	5.4 U	0.25 U	43	16 J
Trichloroethene	µg/m^3	29.2	6.95	5.4 U	0.13 J	13 U	20 U
Vinyl Chloride	µg/m^3	92.9	5.59	5.4 U	0.25 U	65	16 J
Total Primary CVOCs	µg/m^3	-	-	42.0	32.5	204	128
Other VOCs							
1,1,2-Trichlorotrifluoroethane	µg/m^3	73000	17400	5.4 U	1	13 U	20 U
1,1-Dichloroethane	µg/m^3	256	58.5	11 U	0.49 U	--	--
1,2,4-Trimethylbenzene	µg/m^3	876	209	16 J	0.25 U	13 U	11 J
1,2-Dichloropropane	µg/m^3	58.4	13.9	5.4 U	0.25 U	13 U	20 U
1,3,5-Trimethylbenzene	µg/m^3	876	209	5.1 J	0.25 U	13 U	20 U
1,3-Butadiene	µg/m^3	13.6	3.12	**52**	0.48 U	**72**	37 U
1,3-Dichlorobenzene	µg/m^3	-	-	5.4 U	0.25 U	--	--
1,4-Dioxane	µg/m^3	81.8	18.7	5.4 U	0.25 U	13 U	20 U
2-Butanone (MEK)	µg/m^3	73000	17400	10 U	0.48 U	25 U	37 U
2-Hexanone	µg/m^3	438	104	5.4 U	0.25 U	13 U	20 U
2-Propanol (Isopropyl Alcohol)	µg/m^3	2920	695	20 U	1.1 J	49 U	73 UJ
4-Ethyltoluene	µg/m^3	-	-	7.7 J	0.48 U	25 U	37 U
4-Methyl-2-pentanone	µg/m^3	43800	10400	5.4 U	0.25 U	13 U	20 U
Acetone	µg/m^3	451000	-	86 U	4 U	210 U	310 U
Acetonitrile	µg/m^3	876	209	10 U	0.48 U	25 U	37 U
Acrolein	µg/m^3	0.292	0.0695	9.9 U	0.46 U	24 U	36 U
alpha-Pinene	µg/m^3	-	-	6.1 J	0.48 U	25 U	88
Benzene	µg/m^3	52.4	12	13 J	0.25 U	**100**	**100**
Bromomethane	µg/m^3	73	17.4	5.4 U	0.25 U	13 U	20 U
Carbon Disulfide	µg/m^3	10200	2430	62	2.7	85	20 J
Chloroethane	µg/m^3	146000	-	10 U	0.48 U	25 U	37 U
Chloromethane	µg/m^3	1310	313	10 U	0.48 U	25 U	37 U
Cumene	µg/m^3	5840	1390	4.8 J	0.25 U	1100	730
Cyclohexane	µg/m^3	87600	20900	15 J	0.51 U	1000	1400
Dichlorodifluoromethane (CFC 12)	µg/m^3	1460	348	10 U	2.4	25 U	37 U
d-Limonene	µg/m^3	-	-	29	0.48 U	25 U	37 U
Ethanol	µg/m^3	-	-	14 J	3.3 J	65 U	96 U
Ethyl Acetate	µg/m^3	1020	243	21 U	0.51 J	51 UJ	75 U
Ethylbenzene	µg/m^3	164	37.4	13 J	0.25 U	**660**	**480**
Hexane	µg/m^3	10200	2430	200	0.48 U	500	180
m,p-Xylenes	µg/m^3	1460	348	22 J	0.51 U	27 U	39 U
Naphthalene	µg/m^3	12	2.75	**21**	0.46 U	**75**	**240**
n-Butyl Acetate	µg/m^3	-	-	5.4 U	0.25 U	13 U	20 U
n-Heptane	µg/m^3	5840	1390	80	0.48 U	370	180
n-Nonane	µg/m^3	292	69.5	10 U	0.48 U	**460**	37 U
n-Octane	µg/m^3	-	-	10 U	0.48 U	280	150 J-
n-Propylbenzene	µg/m^3	14600	3480	6.5 J	0.25 U	1900	1300
o-Xylene	µg/m^3	1460	348	8.2 J	0.25 U	13 U	16 J
Propene	µg/m^3	43800	10400	2600	0.48 U	4000	360
Styrene	µg/m^3	14600	3480	10 U	0.48 U	25 U	37 UJ
Tetrahydrofuran (THF)	µg/m^3	29200	6950	5.4 U	0.25 U	13 U	20 U
Toluene	µg/m^3	73000	17400	33	0.21 J	130	40 J-
Trichlorofluoromethane	µg/m^3	-	-	10 U	1.3	25 U	37 U
Vinyl Acetate	µg/m^3	2920	695	86 U	4 U	210 U	310 U
Total Other VOCs	µg/m^3	-	-	3208	12.5	10660	5295

Notes:

1) Results above commercial VISL shown in **red bold**.

2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

VISL: USEPA Vapor intrusion screening level calculated with default parameters, 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.

LOD: Limit of Detection

µg/m^3: micrograms per cubic meter

- : Not Listed

VISL: Vapor Intrusion Screening Level

TCR: Target Cancer Risk

THQ: Target Hazard Quotient

DQE Flags:

U: Not Detected at LOD

J: Estimated

Method:

TO-15

TABLE 9
WELL CONSTRUCTION SUMMARY
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

Well	Aquifer	Area	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Top of Clay Depth (ft, bgs)	Top of Clay Elevation (ft, NAVD)	Total Boring Depth (ft, bgs)	Riser Length (ft)	Screen Length (ft)	Total Well Depth (ft, btoc)
MW-06	Fluvial	DF West	280605	802069	288.66	288.78	-	-	70.0	51.0	20	71.0
MW-32[1]	Fluvial	Off Depot	280834	801616	285.38	285.60	66.5	219.1	71.5	52.7	15	67.7
MW-71	Fluvial	DF West	280585	801805	294.40	291.90	76.0	215.9	77.7	65.5	10	75.5
MW-87	Fluvial	DF West	280696	802039	294.93	292.80	78.0	214.8	81.0	63.0	15	78.0
MW-91	Fluvial	DF West	280475	802014	291.99	289.30	69.5	219.8	70.0	55.0	15	70.0
MW-164	Fluvial	Off Depot	280998	801497	287.48	287.71	72.0	215.7	86.0	55.3	20	75.5
MW-175[1]	Fluvial	DF West	280618	802175	291.63	291.93	77.0	214.9	86.0	67.5	10	77.7
MW-176	Fluvial	DF West	280824	802032	299.68	299.92	86.5	213.4	96.0	76.0	10	86.0
MW-184	Fluvial	Off Depot	280903	801442	283.12	283.34	68.0	215.3	86.0	58.0	10	68.0
MW-187	Fluvial	Background	280563	802348	302.74	303.21	87.0	216.2	97.0	76.0	10	86.0
MW-233[1]	Fluvial	Off Depot	280953	801629	289.53	289.68	68.7	221.0	90.0	57.8	10	68.0
MW-328	Fluvial	MW-87 Area	280591	802012	288.58	288.92	70.0	218.9	80.0	58.4	10	68.6
MW-329	Fluvial	MW-87 Area	280662	802255	298.80	299.17	-	-	80.0	66.6	10	76.8

Notes:
MW: monitoring well
ft: feet
bgs: below ground surface
btoc: below top of casing
NAVD: North American Vertical Datum of 1988
DF: Dunn Field
IAQ: Intermediate Aquifer
1) MW-233 was abandoned in July 2009; MWs 32, 37, 175, 231, 234 were abandoned in March 2013.

TABLE 10
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ON-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Commercial Groundwater VISL [3] 1x10-6, 0.1	MW-06	MW-06-DFW	MW-06-DFW-RE	MW-06	MW-06	MW-06	MW-06
		Lab ID				M1D1327-03RE1	M1F0926-11	M1F0926-12	M1J1150-01	22D0489-02	22J0565-01	22J0565-02
		Date				4/18/2021	6/12/2021	6/12/2021	10/17/2021	4/9/2022	10/15/2022	10/15/2022
Primary CVOCs	cas	Units	MCL	TC								
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	36.9	23.6	18.4	11.5	15.1	2.37	16.7	19.9
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	6.61	**7.14**	4.69	3.93	4.93	1.41	**8.29**	**11.3**
1,1-Dichloroethene	75-35-4	µg/L	7	7	192	2.00 U	1.00 U	1.00 U	1.00 U	0.200 U	0.200 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	24.2	0.470 J	0.500 U	0.500 U	0.300 J	0.300 U	0.590 J	0.670
Carbon tetrachloride	56-23-5	µg/L	5	3	4.4	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	8.56	**142**	**93.1**	**75.7**	**95.8**	**29.75**	**120**	**141**
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	5,090	11.5	6.41	5.65	7.81	2.46	10.3	10.6
Tetrachloroethene	127-18-4	µg/L	5	2.5	61.5	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.250 J+
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	2,190	0.290 J	0.500 U	0.500 U	0.500 U	0.200 U	0.320 J	0.200 U
Trichloroethene	79-01-6	µg/L	5	5	5.36	**14.3**	**9.64**	**6.16**	**9.40**	3.06	**9.32**	**10.5**
Vinyl chloride	75-01-4	µg/L	2	-	5.47	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	199	132	103	133	39.1	166	194

Notes:
1) Results above commercial VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
RL: Reporting Limit
- : Not Listed
DQE Flags:
J: Estimated
J+: Estimated, biased high
U: Not Detected
UJ: Not Detected, RL Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 10
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ON-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Commercial Groundwater VISL [3]	MW-06	MW-87	MW-87-DFW	MW-87-DFW-RE	MW-87	MW-87	MW-87
		Lab ID				23D0301-02	M1D1327-24	M1F0926-09RE1	M1F0926-10	M1J1150-03	22D0489-10	23D0301-16
		Date				4/8/2023	4/18/2021	6/12/2021	6/12/2021	10/17/2021	4/9/2022	4/8/2023
Primary CVOCs	cas	Units	MCL	TC	1x10-6, 0.1							
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	36.9	3.82	0.800 U	0.400 U	0.400 U	0.400 U	0.200 U	0.200 U
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	6.61	1.33	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U
1,1-Dichloroethene	75-35-4	µg/L	7	7	192	0.200 U	2.00 U	1.00 U	1.00 U	1.00 U	0.200 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	24.2	0.300 U	1.00 U	0.500 U	0.500 U	0.500 U	0.300 U	0.300 U
Carbon tetrachloride	56-23-5	µg/L	5	3	4.4	0.200 U	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	8.56	**19.5 J**	**9.16**	6.47	6.8	5.12	**28.49**	4.51
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	5,090	1.93	0.489 J	0.283 J	0.323 J	0.500 U	1.26	0.250 J
Tetrachloroethene	127-18-4	µg/L	5	2.5	61.5	0.500 UJ	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	2,190	0.200 U	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U
Trichloroethene	79-01-6	µg/L	5	5	5.36	2.77	1.14	0.726 J	0.732 J	0.520 J	1.75	0.200 J
Vinyl chloride	75-01-4	µg/L	2	-	5.47	0.500 U	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	29.4	10.8	7.5	7.9	5.6	31.5	5.0

Notes:
1) Results above commercial VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
RL: Reporting Limit
- : Not Listed
DQE Flags:
J: Estimated
J+: Estimated, biased high
U: Not Detected
UJ: Not Detected, RL Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 10
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ON-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Commercial Groundwater VISL [3] 1x10-6, 0.1	MW-91	MW-91	MW-176	MW-176	MW-187	MW-187
		Lab ID				M1D1327-25RE1	23D0301-17	M1D1337-08RE1	23D0301-45	M1D1337-12RE1	23D0301-48
		Date				4/18/2021	4/8/2023	4/18/2021	4/8/2023	4/18/2021	4/9/2023
Primary CVOCs	cas	Units	MCL	TC							
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	36.9	0.335 J	0.640	0.800 U	0.200 U	0.800 U	0.200 U
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	6.61	1.00 U	0.200 U	1.00 U	0.200 U	1.00 U	0.200 U
1,1-Dichloroethene	75-35-4	µg/L	7	7	192	2.00 U	0.200 U	2.00 U	0.200 U	2.00 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	24.2	1.00 U	0.300 U	1.00 U	0.300 U	1.00 U	0.300 U
Carbon tetrachloride	56-23-5	µg/L	5	3	4.4	1.00 U	0.200 U	1.00 U	0.200 U	1.00 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	8.56	0.289 J	0.310 J	0.500 U	0.180 J	0.136 J	0.180 J
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	5,090	1.00 U	0.300 U	1.00 U	0.300 U	1.00 U	0.300 U
Tetrachloroethene	127-18-4	µg/L	5	2.5	61.5	1.00 U	0.500 U	0.275 J	0.500 U	1.00 U	0.500 U
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	2,190	1.00 U	0.200 U	1.00 U	0.200 U	1.00 U	0.200 U
Trichloroethene	79-01-6	µg/L	5	5	5.36	1.00 U	0.220 J	1.00 U	0.200 U	1.00 U	0.200 U
Vinyl chloride	75-01-4	µg/L	2	-	5.47	1.00 U	0.500 U	1.00 U	0.500 U	1.00 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	0.6	1.2	0.3	0.2	0.1	0.2

Notes:
1) Results above commercial VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
RL: Reporting Limit
- : Not Listed
DQE Flags:
J: Estimated
J+: Estimated, biased high
U: Not Detected
UJ: Not Detected, RL Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 10
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ON-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Commercial Groundwater VISL [3]	MW-328	MW-328-DFW	MW-328-DFW-RE	MW-328	MW-328	MW-328	MW-328
		Lab ID				M1D1341-11	M1F0926-07	M1F0926-08	M1J1150-09	22D0489-45	22J0565-12	23D0301-69
		Date				4/19/2021	6/13/2021	6/13/2021	10/17/2021	4/9/2022	10/14/2022	4/8/2023
Primary CVOCs	cas	Units	MCL	TC	1x10-6, 0.1							
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	36.9	2.31	2.33	2.35	1.67	0.82	1.44	7.94
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	6.61	1.33	1.34	1.45	1.02	0.68	3.09	**8.17**
1,1-Dichloroethene	75-35-4	µg/L	7	7	192	2.00 U	1.00 U	1.00 U	1.00 U	0.200 U	0.200 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	24.2	1.00 U	0.500 U	0.500 U	0.500 U	0.300 U	0.250 J	0.530 J
Carbon tetrachloride	56-23-5	µg/L	5	3	4.4	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	8.56	**54.3**	**75.8**	**81.4**	**52.1**	**45.9**	**81.6**	**117**
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	5,090	3.66	4.81	5.19	3.51	3.05	5.57	9.22
Tetrachloroethene	127-18-4	µg/L	5	2.5	61.5	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.280 J+	0.240 J
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	2,190	1.00 U	0.500 U	0.500 U	0.500 U	0.200 U	0.230 J	0.220 J
Trichloroethene	79-01-6	µg/L	5	5	5.36	4.19	**5.49**	**6.22**	3.47	3.91	**5.38**	**7.34**
Vinyl chloride	75-01-4	µg/L	2	-	5.47	1.00 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	65.8	89.8	96.6	61.8	54.4	97.6	151

Notes:
1) Results above commercial VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a "semi site-specific" value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
RL: Reporting Limit
- : Not Listed
DQE Flags:
J: Estimated
J+: Estimated, biased high
U: Not Detected
UJ: Not Detected, RL Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 10
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ON-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Commercial Groundwater VISL [3]	MW-329-DFW	MW-329	MW-329	MW-329	MW-329
		Lab ID				M1F0926-05	M1J1150-10	22D0489-46	22J0565-13	23D0301-70
		Date				6/14/2021	10/17/2021	4/9/2022	10/14/2022	4/8/2023
Primary CVOCs	cas	Units	MCL	TC	1x10-6, 0.1					
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	36.9	0.400 U	0.400 U	0.200 U	0.200 U	0.200 U
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	6.61	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
1,1-Dichloroethene	75-35-4	µg/L	7	7	192	1.00 U	1.00 U	0.200 U	0.200 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	24.2	0.500 U	0.500 U	0.300 U	0.300 U	0.300 U
Carbon tetrachloride	56-23-5	µg/L	5	3	4.4	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	8.56	0.25 U	0.250 U	0.300 U	0.300 U	0.370 J
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	5,090	0.500 U	0.500 U	0.300 U	0.300 U	0.300 U
Tetrachloroethene	127-18-4	µg/L	5	2.5	61.5	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	2,190	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
Trichloroethene	79-01-6	µg/L	5	5	5.36	0.500 U	0.500 U	0.200 U	0.200 U	0.200 U
Vinyl chloride	75-01-4	µg/L	2	-	5.47	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	0	0	0	0	0.4

Notes:
1) Results above commercial VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
RL: Reporting Limit
- : Not Listed
DQE Flags:
J: Estimated
J+: Estimated, biased high
U: Not Detected
UJ: Not Detected, RL Estimated
Method:
8260B: Volatile Organic Compounds

TABLE 11
GROUNDWATER ANALYTICAL RESULTS SUMMARY, OFF-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Resident	MW-71	MW-71	MW-71	MW-157	MW-157
		Lab ID			Groundwater	M1D1327-18	22D0489-08	23D0301-12	M1D1336-16	23D0301-30
		Date			VISL [3]	4/19/2021	4/10/2022	4/8/2023	4/19/2021	4/8/2023
Primary CVOCs	cas	Units	MCL	TC	1x10-6, 0.1					
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	8.46	4.52	7.41	5.44	0.800 U	0.200 U
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	1.57	0.533 J	1.00	**2.30**	1.00 U	0.200 U
1,1-Dichloroethene	75-35-4	µg/L	7	7	45.7	2.00 U	0.200 U	0.200 U	2.00 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	5.53	1.00 U	0.300 U	0.300 J	1.00 U	0.300 U
Carbon tetrachloride	56-23-5	µg/L	5	3	1.01	1.00 U	0.200 U	0.200 U	1.00 U	0.200 U
Chloroform	67-66-3	µg/L	80	12	1.96	**5.78**	**7.14**	**17.9**	0.267 J	0.170 J
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	1,210	0.893 J	0.99	1.38	1.00 U	0.300 U
Tetrachloroethene	127-18-4	µg/L	5	2.5	14.7	1.00 U	0.500 U	0.500 U	1.00 U	0.500 U
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	521	1.00 U	0.200 U	0.200 U	1.00 U	0.200 U
Trichloroethene	79-01-6	µg/L	5	5	1.28	1.23	**2.68**	**3.60**	1.00 U	0.130 J
Vinyl chloride	75-01-4	µg/L	2	-	0.329	1.00 U	0.500 U	0.500 U	1.00 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	13.0	19.2	30.9	0.3	0.3

Notes:
1) Results above resident VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a “semi site-specific” value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
- : Not Listed
DQE Flags:
J: Estimated
U: Not Detected
Method:
8260B: Volatile Organic Compounds

TABLE 11
GROUNDWATER ANALYTICAL RESULTS SUMMARY, OFF-SITE WELLS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Well ID			Resident	MW-164	MW-164	MW-164	MW-184	MW-184	MW-184
		Lab ID			Groundwater	M1D1336-22	22D0489-23	23D0301-36/RE1	M1D1337-11RE1	22D0489-28	23D0301-47
		Date			VISL [3]	4/19/2021	4/9/2022	4/8/2023	4/19/2021	4/9/2022	4/8/2023
Primary CVOCs	cas	Units	MCL	TC	1x10-6, 0.1						
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	-	2.2	8.46	0.800 U	0.200 U	0.200 U	3.35	6.02	2.43
1,1,2-Trichloroethane	79-00-5	µg/L	5	1.9	1.57	1.00 U	0.200 U	0.200 U	0.539 J	1.49	0.960
1,1-Dichloroethene	75-35-4	µg/L	7	7	45.7	2.00 U	0.200 U	0.200 U	2.00 U	0.200 U	0.200 U
1,2-Dichloroethane	107-06-2	µg/L	5	-	5.53	1.00 U	0.300 U	0.300 U	1.00 U	0.300 U	0.300 U
Carbon tetrachloride	56-23-5	µg/L	5	3	1.01	1.00 U	0.200 U	0.200 U	0.822 J	0.200 U	0.880
Chloroform	67-66-3	µg/L	80	12	1.96	0.635	0.300 U	0.570 J	**6.59**	**11.88**	**14.9**
cis-1,2-Dichloroethene	156-59-2	µg/L	70	35	1,210	1.00 U	0.300 U	0.230 J	1.16	1.37	1.56
Tetrachloroethene	127-18-4	µg/L	5	2.5	14.7	1.00 U	0.500 U	0.500 U	1.00 U	0.500 U	0.200 J
trans-1,2-Dichloroethene	156-60-5	µg/L	100	50	521	1.00 U	0.200 U	0.200 U	1.00 U	0.200 U	0.100 J
Trichloroethene	79-01-6	µg/L	5	5	1.28	0.488 J	0.200 U	0.660	**1.86**	**2.91**	**2.22**
Vinyl chloride	75-01-4	µg/L	2	-	0.329	1.00 U	0.500 U	0.500 U	1.00 U	0.500 U	0.500 U
Total Primary CVOCs	-	µg/L	-	-	-	1.1	0	1.5	14.3	23.7	23.0

Notes:
1) Results above resident VISL shown in **bold**
2) Analytical results, whether non-detect or detected above or below the LOD, are shown for the Primary CVOCs and for any Other VOCs (non-primary) that are detected above the LOD in at least one sample.

3) Default parameters were applied in the VISL calculations (TCR of 1E-06, THQ of 0.1), except for adjusting the groundwater to indoor air attenuation factor to a "semi site-specific" value of 0.0005 (USEPA, 2015) and adjusting the groundwater temperature to 20.3 degrees Celsius.

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
TC: Target Concentration from Dunn Field ROD
- : Not Listed
DQE Flags:
J: Estimated
U: Not Detected
Method:
8260B: Volatile Organic Compounds

TABLE 12
SCREENING LEVELS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

		Groundwater Screening Levels [1,2,3,4]		**Soil Vapor Screening Levels** [2,3,4]	
	CAS #	Commercial Groundwater VISL 1x10-6, 0.1	Resident Groundwater VISL 1x10-6, 0.1	Commercial Soil Vapor VISL 1x10-6, 0.1	Resident Soil Vapor VISL 1x10-6, 0.1
		μg/L	μg/L	$\mu g/m^3$	$\mu g/m^3$
Primary CVOCs					
Carbon tetrachloride	56-23-5	4.4	1.01	68.1	15.6
Chloroform	67-66-3	8.56	1.96	17.8	4.07
cis-1,2-Dichloroethene [2]	156-59-2	5,090	1,210	11,700	2,780
Tetrachloroethene	127-18-4	61.5	14.7	584	139
Trichloroethene	79-01-6	5.36	1.28	29.2	6.95
Vinyl chloride	75-01-4	5.47	0.329	92.9	5.59
Other VOCs					
1,1,1-Trichloroethane	71-55-6	7,560	1,800	73,000	17,400
1,1,2,2-Tetrachloroethane	79-34-5	36.9	8.46	7.05	1.61
1,1,2-Trichloroethane	79-00-5	6.61	1.57	2.92	0.695
1,1-Dichloroethane	75-34-3	80.1	18.3	256	58.5
1,1-Dichloroethene	75-35-4	192	45.7	2,920	695
1,2,3-Trichloropropane	96-18-4	24.6	5.85	4.38	1.04
1,2,4-Trichlorobenzene	120-82-1	42.4	10.1	29.2	6.95
1,2,4-Trimethylbenzene	95-63-6	281	66.9	876	209
1,2-Dibromo-3-chloropropane	96-12-8	0.934	0.0772	0.0681	0.00563
1,2-Dibromoethane	106-93-4	1.96	0.448	0.681	0.156
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114)	76-14-2	NE	NE	NE	NE
1,2-Dichlorobenzene	95-50-1	2,980	710	2,920	695
1,2-Dichloroethane	107-06-2	24.2	5.53	15.7	3.6
1,2-Dichloropropane	78-87-5	37.6	8.96	58.4	13.9
1,3,5-Trimethylbenzene	108-67-8	197	46.9	876	209
1,3-Butadiene	106-99-0	0.307	0.0702	13.6	3.12
1,3-Dichlorobenzene	541-73-1	NE	NE	NE	NE
1,4-Dichlorobenzene	106-46-7	30.2	6.93	37.2	8.51
1,4-Dioxane	123-91-1	31,500	7,220	81.8	18.7
2,2,4-Trimethylpentane	540-84-1	NE	NE	NE	NE
2-Butanone (MEK)	78-93-3	2,320,000	552,000	73,000	17,400
2-Hexanone	591-78-6	8,990	2,140	438	104
2-Propanol	67-63-0	700,000	167,000	2,920	695
3-Chloro-1-propene (Allyl Chloride)	107-05-1	2.33	0.555	14.6	3.48
4-Ethyltoluene	622-96-8	NE	NE	NE	NE
4-Methyl-2-Pentanone	108-10-1	596,000	142,000	43,800	10,400
Acetone [4]	67-64-1	22,800,000	5,440,000	453,000	108,000
Acetonitrile	75-05-8	45,400	10,800	876	209
Acrolein	107-02-8	4.2	1	0.292	0.0695
Acrylonitrile	107-13-1	79.4	18.2	6.01	1.38
alpha-Pinene	80-56-8	NE	NE	NE	NE
Benzene	71-43-2	16.9	3.88	52.4	12
Benzyl Chloride	100-44-7	39	8.93	8.34	1.91
Bromodichloromethane	75-27-4	9.49	2.17	11	2.53
Bromoform	75-25-2	1,350	308	372	85.1
Bromomethane	74-83-9	16.7	3.97	73	17.4
Carbon Disulfide	75-15-0	1,230	292	10,200	2,430
Chlorobenzene	108-90-7	441	105	730	174
Chloroethane	75-00-3	8,890	2,120	58,400	13,900
Chloromethane	74-87-3	244	58.1	1,310	313
cis-1,3-Dichloropropene [3]	10061-01-5	53.3	12.2	102	23.4
Cyclohexane	110-82-7	1,040	249	87,600	20,900
Dibromochloromethane	124-48-1	NE	NE	NE	NE
Dichlorodifluoromethane (CFC 12)	75-71-8	6.87	1.64	1,460	348
d-Limonene	5989-27-5	NE	NE	NE	NE
Ethanol	64-17-5	NE	NE	NE	NE
Ethyl Acetate	141-78-6	13,900	3,300	1,020	243
Ethyl Benzene	100-41-4	39.3	9	164	37.4
Heptane	142-82-5	5.35	1.27	5,840	1,390
Hexachlorobutadiene	87-68-3	3.67	0.84	18.6	4.25
Hexane	110-54-3	10.1	2.4	10,200	2,430
Isopropylbenzene	98-82-8	1,030	245	5,840	1,390

TABLE 12
SCREENING LEVELS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Dunn Field, Defense Depot Memphis, Tennessee

	CAS #	**Groundwater Screening Levels** [1,2,3,4] Commercial Groundwater VISL 1x10-6, 0.1	**Groundwater Screening Levels** [1,2,3,4] Resident Groundwater VISL 1x10-6, 0.1	**Soil Vapor Screening Levels** [2,3,4] Commercial Soil Vapor VISL 1x10-6, 0.1	**Soil Vapor Screening Levels** [2,3,4] Resident Soil Vapor VISL 1x10-6, 0.1
		µg/L	µg/L	µg/m³	µg/m³
Methyl Methacrylate	80-62-6	60,700	14,500	10,200	2,430
Methyl tert-Butyl Ether	1634-04-4	4,700	1,080	1,570	360
Methylene Chloride	75-09-2	4,700	1,120	8,760	2,090
Naphthalene	91-20-3	55.7	12.8	12	2.75
n-Butyl Acetate	123-86-4	NE	NE	NE	NE
n-Butylbenzene	104-51-8	NE	NE	NE	NE
n-Nonane	111-84-2	0.168	0.04	292	69.5
n-Octane	111-65-9	NE	NE	NE	NE
n-propylbenzene	103-65-1	2,710	646	14,600	3,480
p-Isopropyltoluene	99-87-6	NE	NE	NE	NE
Propene	115-07-1	355	84.5	43,800	10,400
sec-Butylbenzene	135-98-8	NE	NE	NE	NE
Styrene	100-42-5	10,300	2,460	14,600	3,480
tert-Butyl alcohol	75-65-0	15,600,000	3,710,000	73,000	17,400
Tetrahydrofuran	109-99-9	736,000	175,000	29,200	6,950
Toluene	108-88-3	20,300	4,830	73,000	17,400
trans-1,2-Dichloroethene [2]	156-60-5	2,190	521	11,700	2,780
trans-1,3-Dichloropropene [3]	10061-02-6	53.3	12.2	102	23.4
Trichlorofluoromethane (CFC 11)	75-69-4	NE	NE	NE	NE
Trichlorotrifluoroethane	76-13-1	241	57.4	73,000	17,400
Vinyl Acetate	108-05-4	10,600	2,520	2,920	695
Xylene, o-	95-47-6	538	128	1,460	348
Xylenes, m,p-	179601-23-1	386	92	1,460	348

Notes:
µg/L: microgram per liter
µg/m³: microgram per cubic meter
ATSDR: Agency for Toxic Substances and Disease Registry
CAS: Chemical Abstract Service
CVOC: chlorinated volatile organic compound
MRL: minimal risk level
NE: not established
USEPA: United States Environmental Protection Agency
VISL: USEPA Vapor intrusion screening level calculated with default parameters (except as noted below), 1x10-6 target cancer risk, 0.1 noncancer target hazard quotient. May 2022.
1) The groundwater VISLs were calculated using a 0.0005 groundwater to indoor air attenuation factor and 20.3 degree Celsius groundwater temperature. May 2022.
2) For inhalation route exposure to cis- and trans-1,2-dichloroethene, the VISLs were calculated by using the trans-1,2-dichloroethene inhalation Minimal Risk Level (ATSDR) of 0.2 parts per million (converted to 0.8 milligram per cubic meter using a standard temperature of 25 degrees Celsius and standard pressure of 1 atmosphere in the USEPA's Indoor Air Unit Conversion calculator [USEPA, 2021]) as the noncancer chronic reference concentration. This methodology was requested by USEPA for the Dunn Field Post-ROD Supplemental Investigation Report (HDR, 2022).
3) The levels for 1,3-dichloropropene's were applied to its isomers.
4) Acetone's May 2021 levels, based on a MRL of 31 mg/m³, were retained for comparison to the analytical data to reduce uncertainty. These SLs are no longer provided in the May 2022 sources.

References:
HDR, 2022. Dunn Field West Post-ROD Supplemental Investigation Report, Revision 1. Former Defense Depot Memphis, Tennessee. Prepared for U.S. Army Corps of Engineers, Mobile District. September.
USEPA, 2021. Indoor Air Unit Conversion, EPA On-line Tools for Site Assessment Calculation. Last Updated August 31. Available online: https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/ia_unit_conversion.html
USEPA, 2022. Vapor Intrusion Screening Levels (VISL) Calculator. May. Available online:

TABLE 13
LABORATORY ANALYTICAL LIMITS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Soil Vapor			
		Screening Levels		Soil Vapor (Method TO-15)	
	CAS #	Commercial Soil Vapor VISL 1x10-6, 0.1	Resident Soil Vapor VISL 1x10-6, 0.1	LOQ[2]	LOD[2]
		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
Primary CVOCs					
Carbon tetrachloride	56-23-5	68.1	15.6	1.25	0.425
Chloroform	67-66-3	17.8	4.07	1.35	0.425
cis-1,2-Dichloroethene	156-59-2	11,700	2,780	1.3	0.425
Tetrachloroethene	127-18-4	584	139	1.3	0.425
Trichloroethene	79-01-6	29.2	6.95	1.3	0.425
Vinyl chloride	75-01-4	92.9	5.59	1.3	0.425
Other VOCs					
1,1,1-Trichloroethane	71-55-6	73,000	17,400	1.3	0.425
1,1,2,2-Tetrachloroethane	79-34-5	7.05	1.61	1.3	0.425
1,1,2-Trichloroethane	79-00-5	2.92	0.695	1.3	0.425
1,1-Dichloroethane	75-34-3	256	58.5	1.325	0.825
1,1-Dichloroethene	75-35-4	2,920	695	1.35	0.425
1,2,3-Trichloropropane	96-18-4	4.38	1.04	NA	NA
1,2,4-Trichlorobenzene	120-82-1	29.2	6.95	2.75	0.8
1,2,4-Trimethylbenzene	95-63-6	876	209	1.3	0.425
1,2-Dibromo-3-chloropropane	96-12-8	0.0681	0.00563	2.5	0.8
1,2-Dibromoethane	106-93-4	0.681	0.156	1.3	0.425
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114)	76-14-2	NE	NE	1.35	0.8
1,2-Dichlorobenzene	95-50-1	2,920	695	1.325	0.425
1,2-Dichloroethane	107-06-2	15.7	3.6	1.325	0.425
1,2-Dichloropropane	78-87-5	58.4	13.9	1.25	0.425
1,3,5-Trimethylbenzene	108-67-8	876	209	1.3	0.425
1,3-Butadiene	106-99-0	13.6	3.12	1.3	0.8
1,3-Dichlorobenzene	541-73-1	NE	NE	1.3	0.425
1,4-Dichlorobenzene	106-46-7	37.2	8.51	1.3	0.8
1,4-Dioxane	123-91-1	81.8	18.7	1.3	0.425
2,2,4-Trimethylpentane	540-84-1	NE	NE	NA	NA
2-Butanone (MEK)	78-93-3	73,000	17,400	2.5	0.8
2-Hexanone	591-78-6	438	104	2.75	0.425
2-Propanol	67-63-0	2,920	695	2.5	1.575
3-Chloro-1-propene (Allyl Chloride)	107-05-1	14.6	3.48	1.325	0.425
4-Ethyltoluene	622-96-8	NE	NE	1.325	0.8
4-Methyl-2-Pentanone	108-10-1	43,800	10,400	2.75	0.425
Acetone	67-64-1	453,000	108,000	13	6.75
Acetonitrile	75-05-8	876	209	2.5	0.8
Acrolein	107-02-8	0.292	0.0695	2.5	0.775
Acrylonitrile	107-13-1	6.01	1.38	2.5	0.8
alpha-Pinene	80-56-8	NE	NE	1.35	0.8
Benzene	71-43-2	52.4	12	1.25	0.425
Benzyl Chloride	100-44-7	8.34	1.91	2.75	0.8
Bromodichloromethane	75-27-4	11	2.53	1.325	0.425
Bromoform	75-25-2	372	85.1	1.3	0.8
Bromomethane	74-83-9	73	17.4	1.275	0.425
Carbon Disulfide	75-15-0	10,200	2,430	2.75	1.35
Chlorobenzene	108-90-7	730	174	1.3	0.425
Chloroethane	75-00-3	58,400	13,900	1.275	0.8
Chloromethane	74-87-3	1,310	313	1.275	0.8
cis-1,3-Dichloropropene	10061-01-5	102	23.4	1.25	0.425
Cyclohexane	110-82-7	87,600	20,900	2.75	0.85
Dibromochloromethane	124-48-1	NE	NE	1.325	0.425
Dichlorodifluoromethane (CFC 12)	75-71-8	1,460	348	1.325	0.8
d-Limonene	5989-27-5	NE	NE	1.25	0.8
Ethanol	64-17-5	NE	NE	12.5	2.075
Ethyl Acetate	141-78-6	1,020	243	5.25	1.625
Ethyl Benzene	100-41-4	164	37.4	1.3	0.425
Heptane	142-82-5	5,840	1,390	1.325	0.8
Hexachlorobutadiene	87-68-3	18.6	4.25	1.3	0.8
Hexane	110-54-3	10,200	2,430	1.325	0.8
Isopropylbenzene	98-82-8	5,840	1,390	1.3	0.425
Methyl Methacrylate	80-62-6	10,200	2,430	2.75	1.625
Methyl tert-Butyl Ether	1634-04-4	1,570	360	1.325	0.425
Methylene Chloride	75-09-2	8,760	2,090	1.3	0.8
Naphthalene	91-20-3	12	2.75	1.3	0.775
n-Butyl Acetate	123-86-4	NE	NE	2.75	0.425
n-Butylbenzene	104-51-8	NE	NE	NA	NA
n-Nonane	111-84-2	292	69.5	1.3	0.8
n-Octane	111-65-9	NE	NE	1.325	0.8
n-propylbenzene	103-65-1	14,600	3,480	1.325	0.425
p-Isopropyltoluene	99-87-6	NE	NE	NA	NA
Propene	115-07-1	43,800	10,400	1.3	0.8

TABLE 13
LABORATORY ANALYTICAL LIMITS
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis, Tennessee

		Soil Vapor			
		Screening Levels		Soil Vapor (Method TO-15)	
	CAS #	Commercial Soil Vapor VISL 1x10-6, 0.1	Resident Soil Vapor VISL 1x10-6, 0.1	LOQ[2]	LOD[2]
		μg/m^3	μg/m^3	μg/m^3	μg/m^3
sec-Butylbenzene	135-98-8	NE	NE	NA	NA
Styrene	100-42-5	14,600	3,480	1.25	0.8
tert-Butyl alcohol	75-65-0	73,000	17,400	NA	NA
Tetrahydrofuran	109-99-9	29,200	6,950	2.5	0.425
Toluene	108-88-3	73,000	17,400	1.3	0.425
trans-1,2-Dichloroethene	156-60-5	11,700	2,780	1.325	0.425
trans-1,3-Dichloropropene	10061-02-6	102	23.4	1.275	0.8
Trichlorofluoromethane (CFC 11)	75-69-4	NE	NE	1.3	0.8
Trichlorotrifluoroethane	76-13-1	73,000	17,400	1.35	0.425
Vinyl Acetate	108-05-4	2,920	695	12.5	6.75
Xylene, o-	95-47-6	1,460	348	1.3	0.425
Xylenes, m,p-	179601-23-1	1,460	348	2.75	0.85

Notes
1) LOQ and LOD assuming 14-day deployment.
2) LOQ and LOD assuming 1-liter volume for soil vapor and 6-liter volume for indoor air.
μg/m^3 microgram per cubic meter
CAS: Chemical Abstract Service
CVOC: chlorinated volatile organic compound
LOD: limit of detection
LOQ: limit of quantitation
NA: not analyzed
NE: not established
USEPA: United States Environmental Protection Agency
VISL: USEPA vapor intrusion screening level calculated with default parameters (except as noted below), 1x10-6 target cancer risk, and 0.1 noncancer target hazard quotient. May 2022.

For inhalation route exposure to cis- and trans-1,2-dichloroethene, the VISLs were calculated by using the trans-1,2-dichloroethene inhalation Minimal Risk Level (ATSDR) of 0.2 parts per million (converted to 0.8 milligram per cubic meter using a standard temperature of 25 degrees Celsius and standard pressure of 1 atmosphere in the USEPA's Indoor Air Unit Conversion calculator [USEPA, 2021]) as the noncancer chronic reference concentration. This methodology was requested by USEPA for the Dunn Field Post-ROD Supplemental Investigation Report (HDR, 2022).
The levels for 1,3-dichloropropene's were applied to its isomers.

References

HDR, 2022. Dunn Field West Post-ROD Supplemental Investigation Report, Revision 1. Former Defense Depot Memphis, Tennessee. Prepared for U.S. Army Corps of Engineers, Mobile District. September.
USEPA, 2021. Indoor Air Unit Conversion, EPA On-line Tools for Site Assessment Calculation. Last Updated August 31. Available online: https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/ia_unit_conversion.html
USEPA, 2022. Vapor Intrusion Screening Levels (VISL) Calculator. May. Available online: https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator

TABLE 14
MEASUREMENT AND PERFORMANCE CRITERIA
DFW VAPOR INTRUSION SAMPLING AND ANALYSIS PLAN
Defense Depot Memphis Tennessee

Matrix	Active Soil Vapor
Analytical Group	VOCs
Concentration Level	Low/medium

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 5	Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Compendium Method TO-15 / ALS SOP VOA-TO15 (*Add SOP Reference*)	Precision-lab	<30% RPD	LCS/LCSD RPDs	A
		Precision-overall	<30% RPD	Field duplicate RPDs	S&A
		Accuracy/bias	Lab control limits	Surrogate spike recoveries	S&A
		Accuracy/bias	Lab control limits, or limits in table C-43 of QSM 5.4	LCS/LCSD recoveries	A
		Accuracy/bias-contamination	No analyte detected at >1/2 LOQ or > 10% sample concentration or regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Method blanks	A

Matrix	Soil / IDW Soil / TCLP Soil
Analytical Group	VOCs
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and / or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
SOP 2	SW-846 Method 8260B/C / CTL SOP VO 004 (*Add SOP Reference*)	Precision-field	≤20% RPD	MS/MSD RPDs	S&A
		Accuracy/bias	Lab control limits, or limits in table C-23 or C-24 of QSM 5.4	MS/MSD recoveries	S&A
		Precision-lab	≤20% RPD	LCS/LCSD RPDs	A
		Accuracy/bias	Lab control limits	Surrogate spike recoveries	S&A
		Accuracy/bias	Lab control limits, or limits in table C-23 or C-24 of QSM 5.4	LCS/LCSD recoveries	A
		Accuracy/bias-contamination	No analyte detected at ≥1/2 LOQ or > 10% sample concentration or regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Method blanks	A
		Accuracy/bias-contamination	No analyte detected at ≥1/2 LOQ or > 10% sample concentration or regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Trip blanks	S&A

RPD: relative percent difference
LOQ: limit of quantitation
LCS: laboratory control spike
LCSD: laboratory control spike duplicate
QSM: Department of Defense Quality Systems Manual for Environmental Laboratories (DoD, 2019)
VOCs: volatile organic compounds

Figures

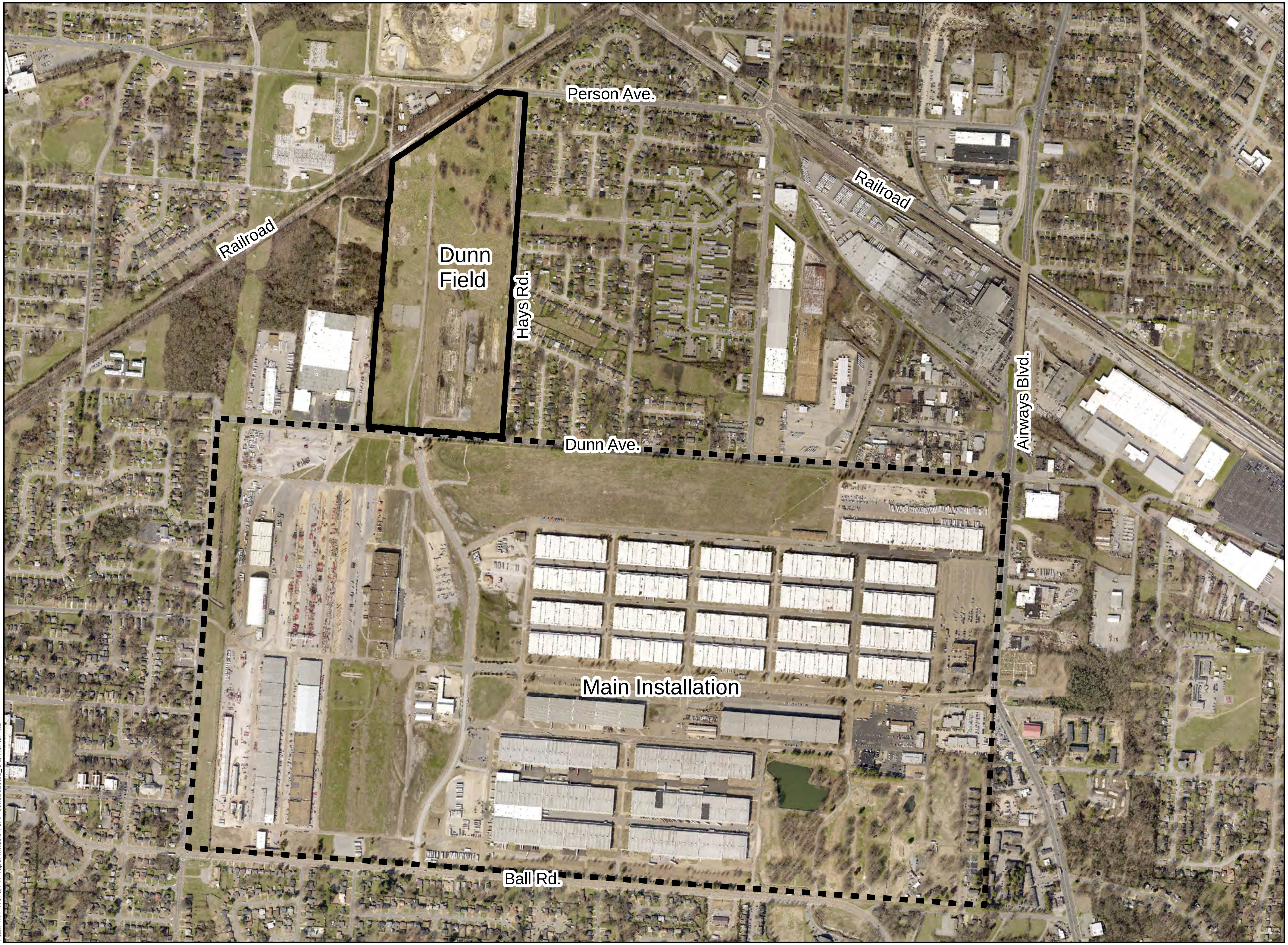


Figure 1

Site Aerial Photograph

DFW Vapor Intrusion
Sampling and Analysis Plan

Defense Depot
Memphis, Tennessee

Legend

Main Installation Perimeter

Dunn Field Perimeter

Notes:
1. Aerial date: 2019.
2. Source: Shelby County TN Regional GIS Department.

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/23/2023
Edition: Rev 0

Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\01_Site Aerial.mxd

Figure 2

Dunn Field Area Designations, Removal Actions and Interim Remedial Action

DFW Vapor Intrusion Sampling and Analysis Plan

Defense Depot Memphis, Tennessee

Legend

- Original Dunn Field Boundary
- IRA Recovery Well
- IRA Discharge Conveyance Line
- Area Designations
- Removal Actions
- Paved Area
- Roads
- Railroad

N W E S

0 250 500

Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/22/2023
Edition: Rev 0

HDR

Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\02_DF Areas and Actions.mxd

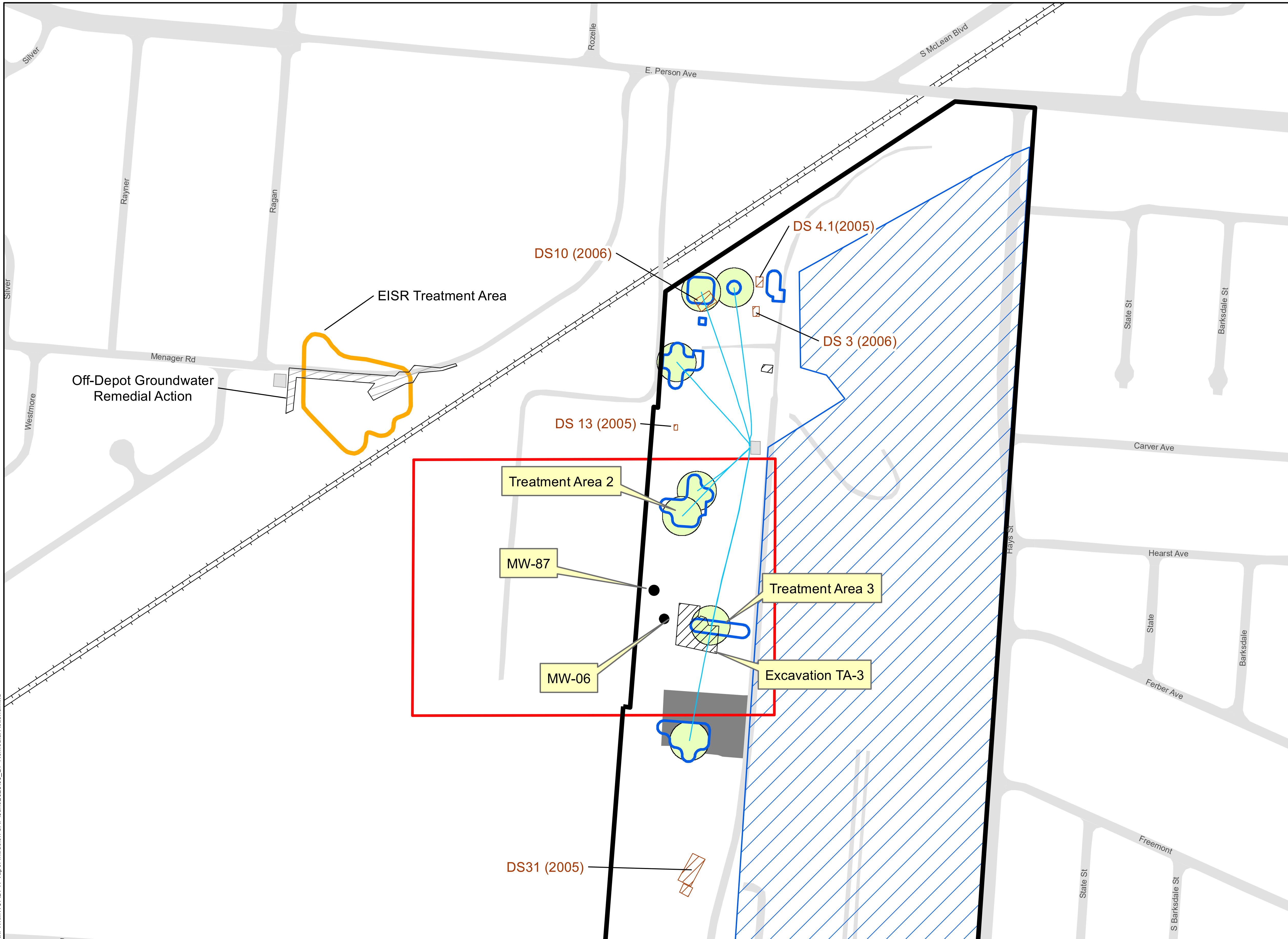


Figure 3

Remedial Actions and Unrestricted Use Area

DFW Vapor Intrusion Sampling and Analysis Plan

Defense Depot Memphis, Tennessee

Legend

- Original Dunn Field Boundary
- Fluvial SVE Conveyance Line
- Project Area Boundary
- Disposal Sites Excavation Area
- Off Depot Air Sparge Area
- EISR Treatment Area
- Loess Excavation Areas
- ISTD Treatment Areas
- Fluvial SVE Well 60-foot radius of influence
- Unrestricted Use Area from ROD
- Buildings
- Paved Area
- Roads
- Railroad

TA: Treatment Area
DS: Disposal Site
EISR: Early Implementation-Selected Remedy

N W E S

0 250 500
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/23/2023
Edition: Rev 0

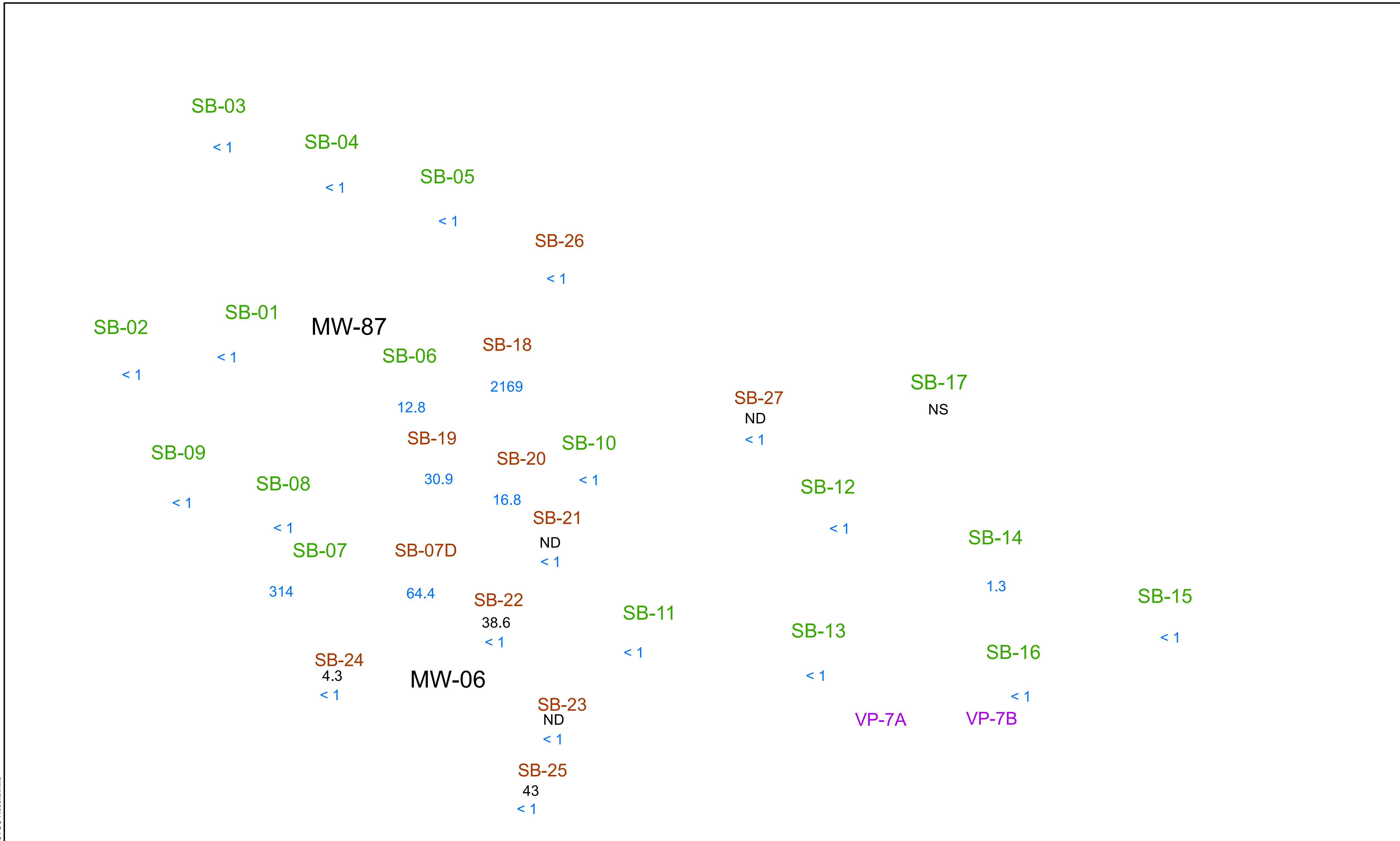
Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\03_DF Remedial Actions.mxd

Figure 4

CVOC and Other VOC Concentrations in Soil

DFW Vapor Intrusion
Sampling and Analysis Plan

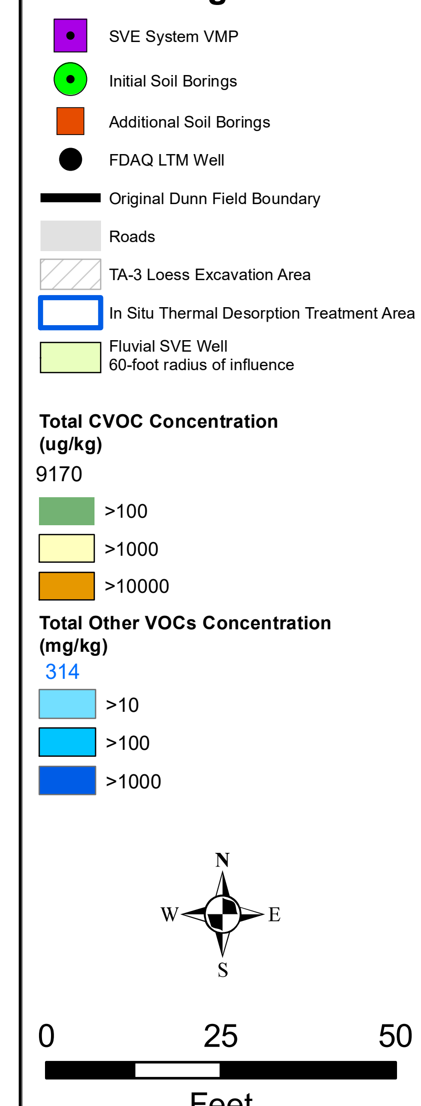
Defense Depot
Memphis, Tennessee



Note:
The highest total concentration of CVOCs (micrograms per kilogram) and of Other VOCs in (milligrams per kilogram) for the samples from each boring is shown.

ND: CVOCs not detected
NS: not sampled

Legend



Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/26/2023
Edition: Rev 0

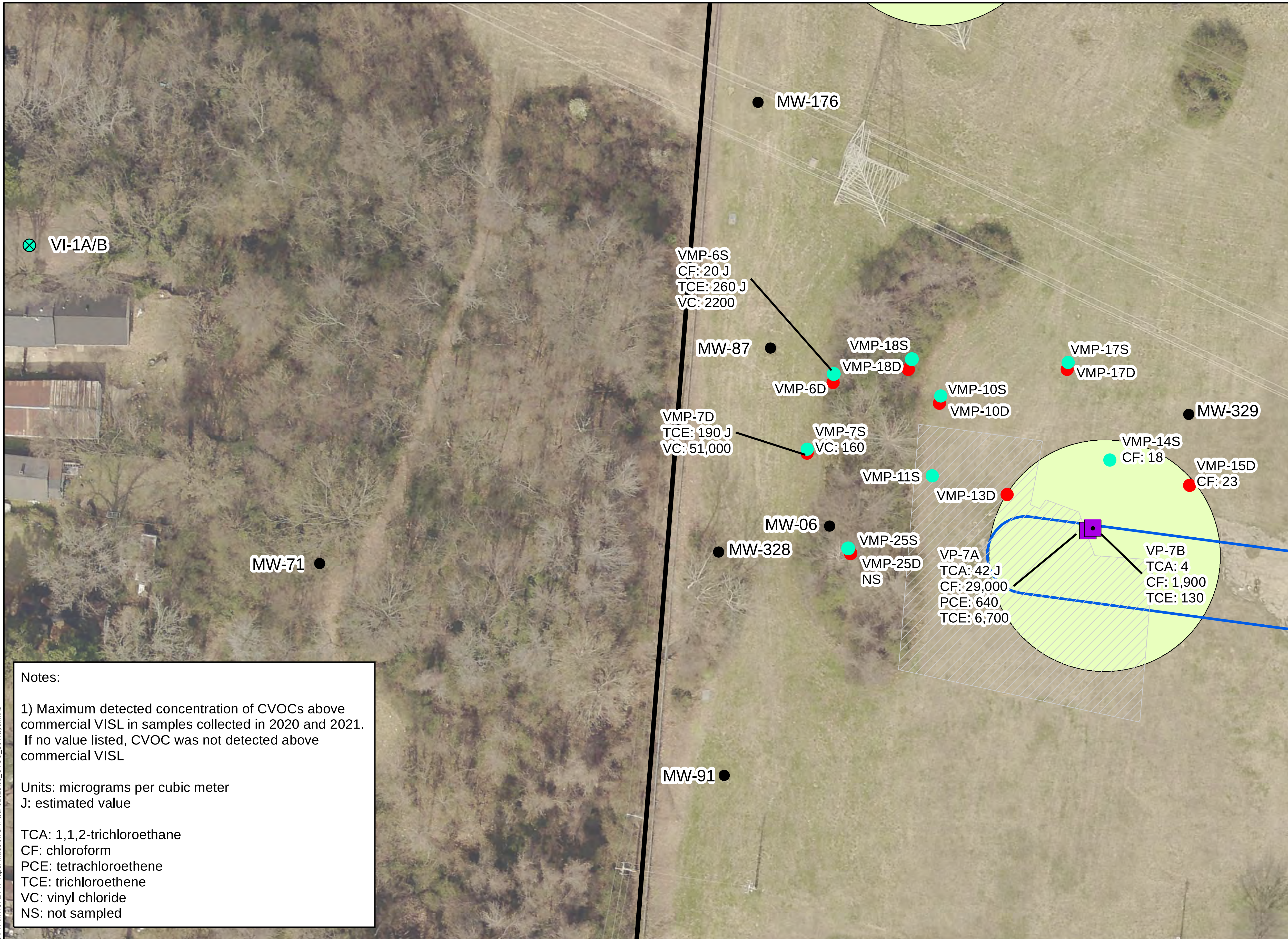
Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\04_CVOC Results.mxd

Figure 5

CVOC Concentrations in Soil Vapor

DFW Vapor Intrusion Sampling and Analysis Plan

Defense Depot Memphis, Tennessee



Notes:

1) Maximum detected concentration of CVOCs above commercial VISL in samples collected in 2020 and 2021. If no value listed, CVOC was not detected above commercial VISL

Units: micrograms per cubic meter
J: estimated value

TCA: 1,1,2-trichloroethane
CF: chloroform
PCE: tetrachloroethene
TCE: trichloroethene
VC: vinyl chloride
NS: not sampled

Legend

- FDAQ LTM Well
- DFW Shallow VMP
- DFW Deep VMP
- 2009 VI Investigation Shallow VMPs (Abandoned)
- SVE System VMP
- Original Dunn Field Boundary
- TA-3 Loess Excavation Area
- In Situ Thermal Desorption Treatment Area
- Fluvial SVE Well 60-foot radius of influence

N W E S

0 50 100

Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/23/2023
Edition: Rev 0

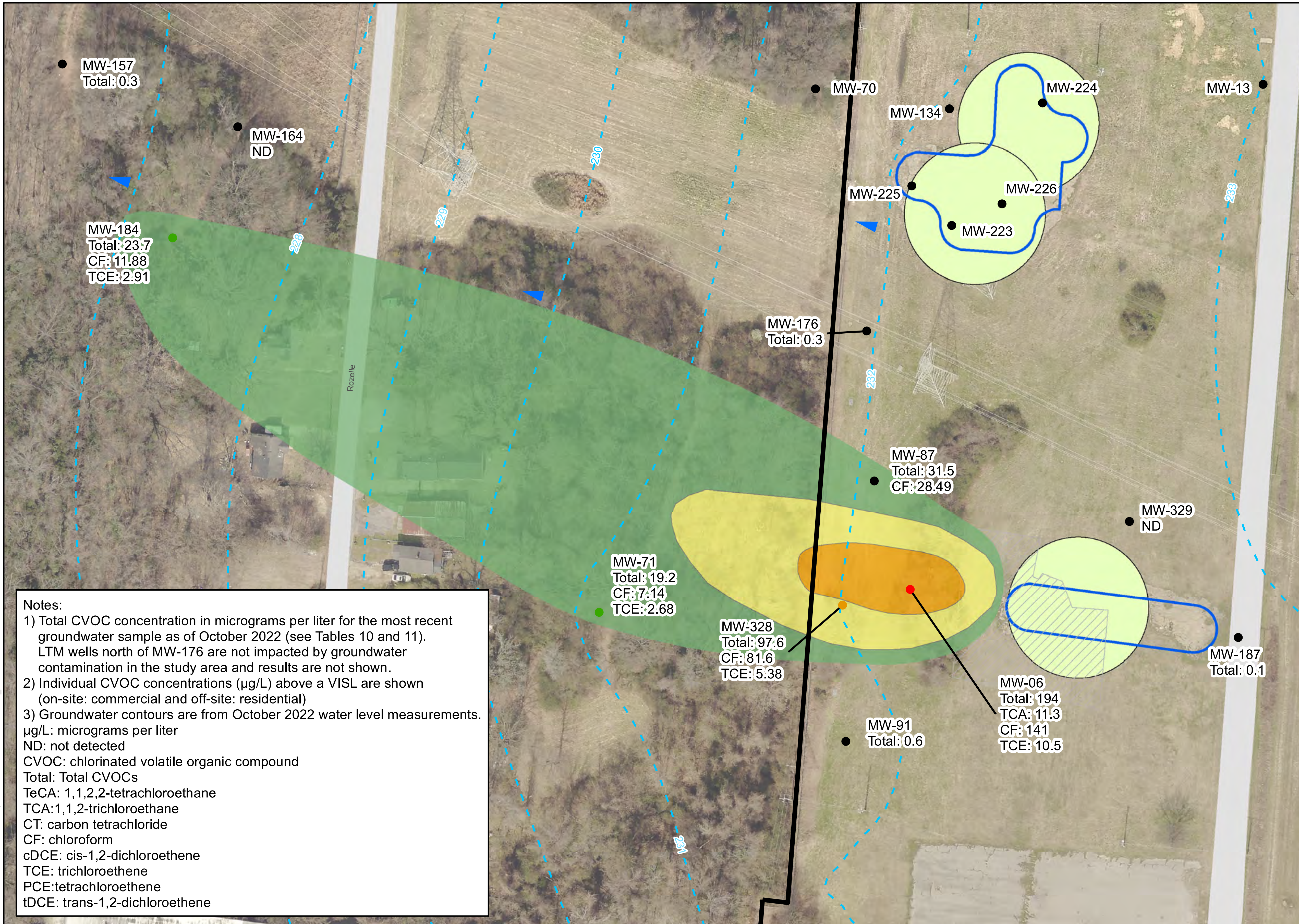
Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\05_CVOC_SoilVapor.mxd

Figure 6

CVOC Concentrations in Groundwater

DFW Vapor Intrusion Sampling and Analysis Plan

Defense Depot Memphis, Tennessee



Notes:

1) Total CVOC concentration in micrograms per liter for the most recent groundwater sample as of October 2022 (see Tables 10 and 11). LTM wells north of MW-176 are not impacted by groundwater contamination in the study area and results are not shown.

2) Individual CVOC concentrations (µg/L) above a VISL are shown (on-site: commercial and off-site: residential)

3) Groundwater contours are from October 2022 water level measurements.

µg/L: micrograms per liter
ND: not detected
CVOC: chlorinated volatile organic compound
Total: Total CVOCs
TeCA: 1,1,2,2-tetrachloroethane
TCA:1,1,2-trichloroethane
CT: carbon tetrachloride
CF: chloroform
cDCE: cis-1,2-dichloroethene
TCE: trichloroethene
PCE:tetrachloroethene
tDCE: trans-1,2-dichloroethene

Legend

Aquifer

- FDAQ LTM Well
- Groundwater Flow Direction
- Fluvial Aquifer 1-ft. contour
- Original Dunn Field Boundary
- Roads
- Loess Excavation Areas
- In Situ Thermal Desorption Treatment Areas
- Fluvial SVE Well - 60-foot radius of influence

Total CVOC Range (μg/L)

Well Symbol

- 0-10
- 10-50
- 50-100
- >100

Contour Shading

- 10-50
- 50-100
- >100

N W E S

0 75 150

Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 11/8/2023
Edition: Rev 0

HDR

Figure 7

Vapor Sample Locations

DFW Vapor Intrusion
Sampling and Analysis Plan

Defense Depot
Memphis, Tennessee

Legend

Aquifer

- FDAQ LTM Well
- Vapor Sample Location
- Groundwater Flow Direction
- Approximate Groundwater Flow, MW-06 to MW-184
- Fluvial Aquifer 1-ft.
- Original Dunn Field Boundary
- Roads
- Loess Excavation Areas
- In Situ Thermal Desorption Treatment Areas
- Fluvial SVE Well - 60-foot radius of influence

Total CVOC Range (μg/L)

Well Symbol

- 0-10
- 10-50
- 50-100
- >100

Contour Shading

- 10-50
- 50-100
- >100

N W E S

0 75 150
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 11/9/2023
Edition: Rev 0

Document Path: W:\MW87\DFW Vapor Intrusion SAP\June2023\07_Vapor Sample Locations.mxd

A

Appendix A. Responses to Agency Comments and Correspondence

Responses to:
U.S. Environmental Protection Agency (EPA) Region 4 Comments on:
Dunn Field West Vapor Intrusion Sampling and Analysis Plan, Revision 0
Defense Depot Memphis, Tennessee
Dated August 2023
Comments Received 28 September 2023

General Comments:

1. It is unclear if the conceptual site model (CSM) for Dunn Field sufficiently defines the extent of groundwater contamination off-site and west of the Dunn Field boundary. Currently, there are no monitoring wells installed to define the downgradient boundary of the plume shown on the figure. As such, the CSM appears to be insufficient, and the off-site extent of groundwater contamination needs to be further evaluated to support the vapor intrusion (VI) investigation.

   Moreover, the text in Section 2.3.3 (Groundwater Samples) indicates that based on groundwater elevation contours and analytical results, the core of the plume extends from MW-06 to MW-184; however, according to Figure 6 (CVOC Concentrations in Groundwater), well MW-184 is located over 450 feet downgradient of the chlorinated volatile organic compound (CVOC) plume boundary.

   Please revise the SAP to address this issue to ensure the off-site extent of groundwater contamination has been sufficiently evaluated and defined in the CSM in support of the VI investigation study boundaries.

   Response G1: The extent of groundwater contamination is sufficiently defined by the existing monitoring wells. Figure 6 only includes contour shading for total CVOC concentrations for 50-100 µg/L and >100 µg/L; shading for 10-50 µg/L will be added; that will show the plume extending to MW-184. Wells MW-06, MW-328, MW-71 and MW-184 all have reported CF and TCE concentrations listed on Figure 6; concentrations decrease from MW-06 to MW-328 to MW-184. CF and TCE concentrations at MW-71 are lower than at MW-184, indicating MW-71 is side-gradient to the plume; that is supported by the groundwater elevation contours. The focus of this SAP is the centerline of the groundwater plume in the Rozelle Street neighborhood; concentrations should be highest along the centerline, resulting in the highest potential for VI. Other than the revision to Figures 6 and 7, changes to the SAP are not considered necessary for this comment.

Specific Comments:

1. **Section 4.2, VMP Construction and Sampling, Page 11:** The second paragraph of the section states, *"Soil samples will be collected for laboratory analysis where PID [photoionization detector] readings exceed 25 parts per million (ppm);"* however, the rationale for the 25 ppm trigger level for submitting soil samples for laboratory analysis is not presented.

   As such, it is unclear if any soil samples will be collected if PID readings are less than 25 ppm. It appears if no results are greater than 25 ppm, then default soil samples should be collected from the same intervals that are screened for vapor sampling, shallow and deep.

   Please revise the SAP to include rationale for the 25 ppm trigger level for submitting soil samples for laboratory analysis.

   Response S1: The 25 ppm PID measurement for collection of soil samples was used in the Offsite Groundwater Investigation QAPP and the Main Installation VI SAP. EPA VI Guidance (Section 6.4) states soil (as opposed to soil gas) sampling is not recommended for estimating the potential for vapor intrusion to pose unacceptable human health risk in indoor air.

2. **Figure 4, CVOC and Other VOC Concentrations in Soil, PDF Page 77:** The figure shows the total concentrations of CVOCs and other volatile organic compounds (VOCs) in soil; however, dates for sample collection were not included in the figure legend. It is noted that the legend distinguishes the initial soil boring locations from the additional soil boring locations.

Please revise the figure to include dates of when the samples were collected.

Response S2: Samples were collected in May and June 2020 and in June and July 2021. Analytical results for soil samples with sample dates are listed on Table 5 of this SAP. The dates are available for EPA to consider in their review; inclusion of sample dates on Figure 4 is not considered necessary.

3. **Last 2 sentences of Section 3.1, Page 8:** Verbiage in the 2nd to last sentence *("…potential for current exposure on-site and for current offsite residents is considered to be incomplete…")* appears to be contradicted by verbiage in the last sentence *("…further investigation is required to determine whether current off-site residents will be potentially exposed to unacceptable VI risk and hazard using soil vapor data…")*.

   Per EPA guidance, for Vapor Intrusion (EPA 2015), the exposure pathway is considered to be ***"complete"*** when there are contaminants migrating from the subsurface to the indoor air. The concentrations of indoor air contaminants will also provide critical information as to whether there are unacceptable risks.

   Please revise/clarify the verbiage in one or both sentences.

   Response S3: The text will be revised to state "*Pathways for current exposure … are considered to be potentially complete … Further investigation is …".* The purpose of the planned sampling is to determine if soil vapor concentrations support potential for vapor intrusion, as indicated by groundwater concentrations above VISLs. Indoor air samples are not included in this SAP.

4. **Section 3.2 Page 8:** *"Vapor analytical results…and groundwater results from recent LTM sampling events, will be used to evaluate whether VOCs in subsurface vapor and groundwater present an unacceptable VI risk to current off-site residents."* Modeling from these media (soil vapor, groundwater) to indoor air is a critical component of the VI screening evaluation.

   Thus, the EPA recommends revising this verbiage to read: *"Vapor analytical results from the DFW investigation…and groundwater results from recent LTM sample events- together with modeling to predict indoor air concentrations- will be used to evaluate whether VOCs in subsurface vapor and groundwater potentially present an unacceptable VI risk to current off-site residents."*

   Response S4: Modeling to predict indoor air concentrations is not including in the data evaluation discussed in Section 5 of this SAP. Modeling will be considered if appropriate based on soil vapor concentrations. Does the comment refer to a specific model? The Johnson-Ettinger model was used for evaluation of the 2018 soil vapor sample results on the MI.

5. **Section 5.3, Page 15:** *"A VI risk assessment will be performed after the second round of soil vapor samples to determine whether current off-site residents will be potentially exposed to unacceptable VI risk and hazard using soil vapor data."* Indoor air is the critical exposure media for determination of unacceptable health risks from a VI exposure pathway.

   According to EPA Vapor Intrusion guidance, 1 of the 5 conditions that must be met to have a complete VI exposure pathway is "*One or more vapor-forming chemicals comprising the subsurface vapor source(s) is (or are) present in the indoor environment."* (EPA 2015).

   Therefore, for situations with existing building structures, EPA Region 4's approach has generally been to collect and analyze indoor air samples and to analyze for COPCs (determined from screening of soil vapor data), and then to calculate *"final"* risks from the indoor air data. Data from concurrent soil vapor samples should make it clear if any unacceptable risks from indoor air concentrations are due to a complete VI pathway. If there are currently no building structures in a given area then, of course, decisions will have to be made based on the soil vapor data alone

   Response S5: The condition cited is the first of the five conditions to be met. The second condition is "*Vapors form and have a route along which to migrate (be transported) toward the* *building*." The purpose of this SAP is to determine whether that condition is met. If the loess and upper fluvial deposits provide an effective barrier to VI, the condition will not be met and further action will not be necessary.

Editorial Comments

1. The title for **Figure 7** is **"Vapor Sample Locations**;" however, the table of contents (TOC) lists the title as "Planned VMP Locations." Please revise the SAP to resolve the discrepancy.

   Response E1: The TOC will be revised to match the title on Figure 7

2. The title for **Appendix A** is "**Responses to Agency Comments**" however, the TOC lists the title as "Responses to Agency Comments and Correspondence." Please revise the SAP to resolve the discrepancy.

   Response E2: The Appendix title will be revised to match the TOC.

REGION 4
ATLANTA, GA 30303

January 8, 2024

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The United States Environmental Protection Agency (USEPA) has completed its regulatory review of the Responses to USEPA Region 4 Comments on Dunn Field West Vapor Intrusion Sampling and Analysis Plan (SAP), Revision 0 of August 2023 for the Defense Depot Memphis, Tennessee (DDMT); submitted by the United States Army (USARMY) on 28 September 2023.

The USEPA notes that the responses to comments adequately addressed the Regulator's comments; however, the revised SAP will require review to ensure that the appropriate changes were made based on the responses.

The USEPA commends the USARMY for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

Fernando Martinez Torres
Remedial Project Manager
Department of Defense Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Remediation
Memphis Environmental Field Office
8383 Wolf Lake Drive
Bartlett, TN 38133-4119

October 26, 2023

James C. Foster
BRAC Program Manager
Headquarters Department of the Army,
Assistant Chief of Staff for
Installation Management (DAIM-ODB)
Army Pentagon,
2530 Crystal Drive,
Arlington, VA 22202-3934

Subject: **Dunn Field West Vapor Intrusion Sampling & Analysis Plan, Rev 0**
Defense Depot Memphis, Tennessee
TDoR ID # 79-736
TN4210020570

Mr. Foster,

TDEC-DoR has reviewed the **Dunn Field West Vapor Intrusion Sampling & Analysis Plan, Rev 0** and approves of the proposed sampling strategy. If there are questions regarding the approval, please contact me at (901) 371-3041 or at jamie.woods@tn.gov .

Regards,

Jamie A. Woods, P.G.
Project Manager
Division of Remediation
Memphis Environmental Field Office

cc: Bill Millar (CALIBRE)
T. Holmes (HDR Inc)
F. Martinez-Torres (EPA-PM)

TDEC DOR: file # 79-736

B

Appendix B.
Updated Work Sheets
from DDMT QAPP

QAPP Worksheet #6: Communication Pathways

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, etc.)
Contract Execution/ Document Review	USACE TM	Laura Roebuck	251-690-3480	Email/verbal communication with HDR PM. Quality assurance (QA) supervision for contract activities
Regulatory Interface	BEC	Bill Millar	703-819-0100	Communicate with USEPA/TDEC as needed and submit project documents for regulatory review.
Technical Direction	BEC	Bill Millar	703-819-0100	Review project documents and represent the BRAC PM.
Manage Task Order activities	HDR PM	Tom Holmes	404-295-3279	Submit task order deliverables; notify USACE TM and BEC of field-related problems by phone or email by close of business the day of the event if possible and no later than noon Central Time the following day.
Manage VI Assessment	VI Task Manager	Clayton Mokri	916-817-4762	Supervise VI related activities. Communicate with HDR PM and Project Chemist.
Field Team Leader (FTL)	HDR Environmental Scientist	Clayton Mokri	916-817-4762	Supervise HDR field activities. Communicate with HDR PM and Project Chemist. Provide daily quality control reports (DQCRs) and notification of any work problems.
WP changes in the field	HDR Project Chemist	Lynn Lutz	303-754-4266	Manage and implement in-field QAPP changes. Notify VI Task Manager and PM of QAPP changes.
Reporting Lab Data Quality Issues	ALS Global Laboratory PM	Sue Anderson	805-526-7181	Notify the HDR Project Chemist regarding laboratory data quality issues including corrective actions (CAs) and data usability.
Reporting Lab Data Quality Issues	CT Laboratories Laboratory PM	Eric Korthals	608-356-2760	Notify the HDR Project Chemist regarding laboratory data quality issues including corrective actions (CAs) and data usability.
Field CAs	HDR FTL	Clayton Mokri	916-817-4762	Issue CAs in writing to the HDR PM for review and submittal to USACE TM and BEC.
Analytical CAs	HDR Project Chemist	Lynn Lutz	303-754-4266	Coordinate laboratory analyses, review deliverables, determine the need for CA on analytical issues and notify the HDR PM. Provide the data validation report and release data to the HDR PM.
Stop Work Authority	All Site Workers	-	-	All site workers can issue a stop work order for issues that present immediate and imminent danger. The HDR PM and Health and Safety Officer will be consulted verbally after the Stop Work and then with a follow-up report per the Site Safety and Health Plan.
Work Plan Changes	HDR Project Chemist / HDR PM	Lynn Lutz/ Tom Holmes	303-754-4266 404-395-3279	Manage and implement QAPP changes. Provide revisions to all QAPP recipients via email and hard copy, as applicable.

QAPP Worksheet #23: Analytical SOPs

SOP #	Title, Revision Number and Date	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project Work? (Y/N)
ALS-6	VOCs in Air by GC/MS (VOA-TO15, Rev. 29, 8/5/2022)	Definitive	VOCs in Air	-Head Space autosampler -GC instrument -Mass spectrometer -Analytical column -Data system -Canister pressurization station -Dynamic dilution system	N
ALS-5	Flow Controllers and Critical Orifices (SMO-Flow_Cntrl, Rev. 15.0, 7/16/2021)	Prep	VOCs in Air	-Flow controllers -Nitrogen gas source -Electric ovens	N
ALS-4	Sample Receiving (SMO-SMPL_REC, Rev. 20.0, 6/14/2021)	NA	VOCs in Air	-Chain of Custody forms -Service Request form -Sample Acceptance check form	N
ALS-3	Canister Pressurization (SMO-CAN_PRESS, Rev. 13.0, 9/14/2019)	Prep	VOCs in Air	-Bubbler -Purifier -Vacuum pump	N
ALS-2	Canister Cleaning and Certification (SMO-Can_Cert, Rev. 20.0, 1/11/2021)	Prep	VOCs in Air	-Pre-purge system -Canister manifolds -Liquid nitrogen source -Vacuum pumps -Electric ovens -Controller unit -LIMS -Pressure/vacuum gauge	N
ALS-1	Data Review and Reporting (ADM-DATA_REV, Rev. 17.0, 5/30/2022)	Definitive	VOCs in Air	-LIMS	N
CTLabs-1	Analysis of VOCs by GC/MS (SOP VO004, Rev. 5.2, 10/20/2021)	Definitive	VOCs in Water and Soil	-Purge and trap concentrator -GC/MS -Data System	N

SOP #	Title, Revision Number and Date	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project Work? (Y/N)
CTLabs-2	Regulated Soil Sample Receiving and Processing (SOP PM005, Rev. 9.0, 3/7/2022)	prep	VOCs in Soil	-Chains of custody -Samples -Oven set between 110 and 232 deg C	N
CTLabs-3	Chemistry and Microbiology Sample Receiving and Processing (SOP PM003, Rev. 9.0, 7/27/2022)	Definitive	VOCs in Water and Soil	-Chains of custody -Samples -Data system	N
CTLabs-4	TCLP and SPLP Extraction, Volatile Fraction (ZHE) (SOP PR002, Rev. 4.3, 7/22/2022)	Prep	VOCs in Water and Soil	-Rotator apparatus, 30 rpm -ZHE extraction device -Pressure filtration apparatus -Glass fiber filters, 0.6-0.8 micron, 11 and 15 cm diameter -Fluid pump -Vacuum pump	N

QAPP Worksheet #24: Analytical Instrument Calibration

Instrument	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS for VOCs in Air and Water/Soil TO-15 and SW-8260	Prior to ICAL and prior to each 12-hour period of sample analysis.	Every 24 hours prior to initial calibration (ICAL), initial calibration verification (ICV) or continuing calibration verification (CCV)	Specific ion abundance criteria of BFB or DFTPP from method.	Retune instrument and repeat BFB check. Flagging criteria are not appropriate.	Analyst	ALS-6 and Beacon-4 and CTLabs-1
	At instrument set-up and after ICV or CCV failure, prior to sample analysis.	ICAL prior to sample analysis	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r2 ≥ 0.99; Option 3: non-linear least squares regression (quadratic) for each analyte: r2 ≥ 0.99.	Correct problem then repeat ICAL. Flagging criteria are not appropriate.	Analyst	

Instrument	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS for VOCs in Air and Water/Soil TO-15 and SW-8260 (contd.)	CCV	Daily before sample analysis; after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ± 20% of true value. All reported analytes and surrogates within ± 50% for end of analytical batch CCV.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable calibration verification. Results may not be reported without valid CCVs. Flagging is only appropriate in cases where the samples cannot be reanalyzed. If the specific version of a method requires additional evaluation (e.g., average RFs) these additional requirements must also be met.	Analyst	ALS-6 and Beacon-4 and CTLabs-1

Instrument	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS for VOCs in Air and Water/Soil TO-15 and SW-8260 (contd.)	Internal Standards (IS)	Every field sample, standard, and QC sample	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; EICP area within – 50% to +100% of ICAL midpoint standard. On days when ICAL is not performed, the daily initial CCV can be used.	Inspect mass spectrometer and GC for malfunctions and correct problem. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	If corrective action fails in field samples, data must be qualified and explained in the Case Narrative. Apply Q-flag to analytes associated with the non-compliant IS. Flagging is not appropriate for failed standards.	ALS-6 and Beacon-4 and CTLabs-1

Reference: Worksheet #23

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS for VOCs in Air, Water, Soil	Concentrating Trap	GC/MS	NA	Routine maintenance includes periodic solvent cleaning	Acceptable performance	Fix issues as necessary.	Analyst	ALS-6 and Beacon-4 and CTLabs-1
	Column Performance			Monitored by observing both peak shapes and column bleed.	Acceptable performance	Fix issues as necessary.	Analyst	
	Vacuum System			Every 6 months, including changing the pump oil and checking the molecular sieve in the back-streaming trap.	Acceptable performance	Fix issues as necessary.	Analyst	
TCLP/SPLP prep for VOCs in Soil, Water	O-rings (Viton)	TCLP/SPLP extraction	Leaks, cannot hold vacuum	As noticed	Acceptable performance	Fix issues as necessary.	Analyst	CTLabs-1

Reference: Worksheet #23

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
Off-Site Laboratory Technical Systems Audit (TSA)	DoD ELAP personnel or contractor	Annual	NA	ELAP annual certification audit report	NA
Laboratory Performance Audit	HDR Data reviewer/ validator, HDR Project Chemist	Ongoing with data package data validation	NA	Email from HDR Project Chemist to Laboratory PM	14 days after receipt of analytical data package

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Off-Site Laboratory TSA	Laboratory Representative	Per ELAP	Per ELAP	Laboratory PM, Analysts, Technicians	Laboratory PM and HDR Project Chemist
Laboratory Performance Audit	Laboratory PM, Analysts, Technicians	Documented in data package if edits to the data package required	Corrections are to be made before final data package is issued, and included in final data package	Laboratory PM, Analysts, Technicians	HDR Project Chemist

QAPP Worksheet #34: Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	X
2	Field SOPs	X	X
3	Laboratory SOPs	X	X
Field Records			
4	Field Logbooks	X	X
5	Equipment Calibration Records	X	X
6	CoC Forms	X	X
7	Sampling Forms	X	X
8	Drilling Logs	X	X
9	Relevant Correspondence	X	X
10	Field Audit Reports	X	X
11	Field CA Reports	X	X
Analytical Data Package			
12	Cover Sheet (laboratory identifying information)	X	X
13	Case Narrative	X	X
14	Internal Laboratory CoC	X	X
15	Sample Receipt Records	X	X
16	Sample Chronology (i.e. dates and times of receipt, preparation and analysis)	X	X
17	Communication Records	X	X
18	Standards Traceability	X	X
19	Instrument Calibration Records	X	X
20	Definition of Laboratory Qualifiers	X	X
21	Results of Reporting Forms	X	X
22	QC Sample Results	X	X
23	CA Reports	X	X
24	Raw Data	X	X
25	TIC searches for up to 20 unidentified peaks	X	X
26	Electronic Data Deliverable	X	X

QAPP Worksheet #35: Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
CoC Forms, Shipping Airbills	CoC Forms, Shipping Airbills	CoC Forms and shipping documents will be reviewed and verified for completeness and accuracy against the actual contents of the coolers represented in the shipment. Three sheet carbon CoC forms will be used with the original and second copy sent with the samples, and the third copy kept by the sampling team.	HDR FTL, Laboratory Sample Custodian
Field Notes	Field Logbook, Forms and Drilling Logs	Field notes and forms will be reviewed for completeness and accuracy prior to being placed in the site file and scanned into electronic files.	HDR FTL
Laboratory Data	Laboratory Data	All data packages will be verified internally by laboratory personnel for technical accuracy and completeness prior to delivery to HDR Upon receipt, the HDR Project Chemist will verify all data in accordance with standard data validation procedures.	Laboratory PM, HDR Project Chemist
SOPs	SOPs	Verify that all SOPs associated with field activities were met.	HDR PM, HDR FTL
Documentation of QC Sample Results	Documentation of QC Sample Results	Confirm that all method required QC samples were run and met required limits.	HDR Project Chemist
Offsite laboratory raw data	This QAPP; Environmental Quality Guidance for Evaluating Performance-Based Chemical Data (USACE, EM 200-1-10, June 30, 2005); General Data Validation Guidelines (DoD, Environmental Data Quality Workgroup, February 09, 2018)	Compare and evaluate all sampling procedures, sampling plans, duplicate criteria, project quantitation limits, method performance criteria, and data qualifiers as specified in the UFP-QAPP.	HDR Project Chemist

QAPP Worksheet #36: Data Validation Procedures

Data Validator: Project Chemist, HDR

Analytical Group/Method	Organics (VOCs in Soil and Water, Metals in Water) (HDR SOP 10)
Data Deliverable Requirements:	Stage 4 data package including all instrument raw data
Analytical Specifications:	Per method and this QAPP
Measurement of Performance Criteria:	DQOs in this QAPP
Percent of Data Packages to be Validated:	100%
Percent of Raw Data to be Reviewed:	10%
Percent of Results to be Recalculated:	One result per analytical method per matrix
Validation Procedure:	*General Data Validation Guidelines* (DoD, Environmental Data Quality Workgroup, February 09, 2018); *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (Intergovernmental Data Quality Task Force, 2005); *Environmental Quality Guidance for Evaluating Performance-Based Chemical Data, EM 200-1-10* (USACE, 2005).
Validation Code:	S2bVM (100%), S3VM (10%); Step I (verification) / Step IIa and Step IIb (validation) (100%)
Electronic Validation Program/Version:	NA

Validation Code and Label Identifier Table:

Validation Code*	Validation Label	Description/Reference
S2bVM	Stage 2b Validation, Manual	DoD *General Data Validation Guidelines*
S3VM	Stage 3 Validation, Manual	DoD *General Data Validation Guidelines*
Stage I	Verification	*UFP-QAPP Manual*
Stage IIa / Stage IIb	Validation	*UFP-QAPP Manual*

Qualifier	Explanation
The following data qualifiers will be applied during data validation. Potential impacts on project-specific DQOs will be discussed in the data validation report.	
U	Not detected above MDL
J	Detected, concentration is estimated
J+	Detected, concentration is estimated, possibly biased high
J-	Detected, concentration is estimated, possibly biased low
UJ	Not detected, MDL is estimated
R	Rejected, data not usable (Numerical values for rejected data will not be shown.)

QAPP Worksheet #37: Data Usability Assessment

Project Manager: Tom Holmes
VI Task Manager/ Field Team Leader: Clayton Mokri
Project Chemist: Lynn Lutz

Step 1	**Review the project's objectives and sampling design** Review the key outputs defined during systematic planning (i.e., Project Quality Objectives or DQOs and Measurement Performance Criteria) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.
Step 2	**Review the data verification and data validation outputs** Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.
Step 3	**Verify the assumptions of the selected statistical method** Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.
Step 4	**Implement the statistical method** Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in groundwater are below the action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.
Step 5	**Document data usability and draw conclusions:** Determine if the data can be used as intended, considering implications of deviations and CAs. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

A Data Validation Report will be included as an Appendix to the final report and will document the results of the data review, verification and validation. This report will describe the conclusions made during the data assessment regarding the data usability. Any limitations on the usability of the data will be explained, including the reasons for data qualifiers, the definitions of the qualifiers and a summary of the specific acceptance criteria that was assessed and found to be outside of control limits.

The following is a summary of the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:
For samples analyzed by off-site laboratories, results will be subjected to data review, verification and validation, in accordance with the USEPA's National Functional Guidelines for Organic Data Review (USEPA, 2017a).

Equations used to assess acceptance criteria include:

For Accuracy:

Percent Recovery for Matrix Spike (MS) $\%R = \left(\frac{Spike\ conc. - Sample\ conc.}{Amount\ of\ spike\ added}\right)\ x\ 100$

Percent Recovery for LCS $\%R = \left(\frac{Spike\ conc.}{Amount\ of\ spike\ added}\right)\ x\ 100$

For Precision:

Relative Percent Different for Matrix Spike Duplicate (MSD), and field duplicates $\%\ RPD = \left[\frac{|Amount\ in\ sample\ 1 - Amount\ in\ Sample\ 2|}{\frac{Amount\ in\ Sample\ 1 + Amount\ in\ sample\ 2}{2}}\right]\ x\ 100$

For Completeness:

$$\%Completeness = \left(\frac{Number\ of\ usable\ measurements}{Number\ of\ planned\ measurements}\right)\ x\ 100$$

All data collected from the SI field activities will be evaluated against the following data quality parameters:

Precision – Precision refers to the degree to which repeated measurements are similar to one another, when obtained under prescribed conditions. Laboratory precision will be assessed by evaluating results of field and laboratory duplicates to determine RPD, LCSs, and MS/MSDs. The requirements for RPD are shown in Table 14, Measurement and Performance Criteria.

Accuracy – Accuracy is defined as the measure of the closeness of an individual measurement or the average of a number of measurements to the actual or 'true' value. Laboratory accuracy will be assessed by evaluating LCSs and MSs and calculating the %R. The requirements for %R are shown in Table 14, Measurement and Performance Criteria.

Representativeness – Representativeness is defined as a measure of the degree to which data accurately and precisely represents the characteristics and conditions of the sample from where the measurement was taken. Laboratory representativeness is assessed by ensuring that all analytical methods and laboratory procedures were followed consistently. In addition, method and instrument blanks are evaluated against the sample data to determine if results could be due to an outside source, such as glassware cross-contamination or instrument carryover. Field representativeness is evaluated in the same manner, through equipment blanks and review of sampling/decontamination techniques. Target analytes should not be present in any blanks. Data may be qualified accordingly if any analytes are detected in blank samples.

Completeness – Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected or planned for. Qualified data will be considered unless it has been rejected (R), in which case it is unusable. The goal for completeness is 100%, however rejected (unusable) data will be evaluated to determine whether data gaps exist, or if the project objectives were met, without it.

Comparability – Comparability is a measure of the confidence with which data sets may be compared to each other. Comparability is evaluated by reviewing adherence to Work Plans, SOPs, method requirements, and consistency in task execution, both in the field, and at off-site laboratories.

Sensitivity – Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. In order to meet the project-specific DQOs, definitive data will be compared to the project's action limits or quantitation goals as listed in Table 14, Measurement and Performance Criteria.

Identify the personnel responsible for performing the usability assessment:
Lynn K. Lutz, Project Chemist, HDR

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:
A Data Validation Report will be included as an Appendix to the final report and will document the results of the data review, verification and validation. This report will describe the conclusions made during the data assessment regarding the data usability. Any limitations on the usability of the data will be explained, including the reasons for data qualifiers, the definitions of the qualifiers and a summary of the specific acceptance criteria that was assessed and found to be outside of control limits.

C

Appendix C.
HDR Standard Operating Procedures

STANDARD OPERATING PROCEDURE 1 - GENERAL PROCEDURES FOR FIELD PERSONNEL

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose

This Standard Operating Procedure (SOP) provides guidance for the general field practices to be followed during field activities at Defense Depot Memphis, Tennessee (DDMT); review is mandatory prior to the start of each field event. This SOP provides general guidance; the project-specific work plan must be reviewed for specific project requirements.

2 Health and Safety

Each individual assigned to field work must participate in the HDR Medical Monitoring Program, must have taken the Occupational Safety and Health Administration (OSHA) 40-Hour course (updated with the 8-Hour OSHA Refresher, when necessary), and must be certified as able to wear respiratory protection.

Each individual is required to have read and understood the project Site Safety and Health Plan (SSHP) for the specific project activity. Upon arrival at the site, each person shall sign the acknowledgement sheet confirming their review of the SSHP. Personal protective equipment (PPE) and other provisions for site safety requirements are discussed in the project specific Health and Safety plan.

All equipment will only be used by properly trained personnel. Only personnel that have received forklift operator safety training are permitted to use the forklift. Proper tools will be made available to each employee as necessary. Any questions should be addressed to the Field Team Leader (FTL).

3 Personnel Qualifications and Responsibilities

Field activities will be directed by the FTL, an environmental professional (engineer, geologist or scientist) with experience in performing and directing the planned activities. Field staff will be junior to mid-level environmental professionals or environmental technicians. Field work will be conducted by persons with experience in performing the planned activities. At least one person on each team will have a current certification in first aid and CPR.

The FTL will provide direction to field staff to ensure work is performed in accordance with the project documents (Quality Assurance Project Plan [QAPP], project work plan and SOPs). The field staff will carefully review the project documents, conduct the work as planned, seek direction from the FTL when questions or problems arise, and carefully complete field documentation.

4 Equipment and Supplies

The required equipment and supplies will be identified in the SOPs for the specific field activities to be performed and in the project work plan. Field activities should not proceed until the proper tools and equipment are available and in good working order.

Each team will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance. For each HDR owned vehicle, mileage will be recorded on the vehicle mileage log at the start and end of each field event.

5 Procedure

5.1 Start-Up Activities

5.1.1 Office

Prior to leaving the office for field work, personnel will perform the following actions:

1. The Project Manager (PM) will assign an FTL to direct field activities and coordinate with project personnel. Task specific responsibilities of the FTL will be addressed in the appropriate SOP; general responsibilities include:
   a. Review project work plan, SSHP, and QAPP.
   b. Work with PM to properly staff the field activity.
   c. Coordinate sampling activities with the project chemist and analytical laboratory.
   d. Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies for delivery prior to the start of each event.
   e. Prepare field forms and other documentation for the planned event.
   f. If work is to be subcontracted, review the subcontract agreement, work plan, and SSHP.
   g. Confirm that field staff have Driver's License (or other picture identification) and current OSHA Certification in their possession prior to leaving the office.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for field activities are on site.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies.

- Review locations for planned field activities for hazards, determine requirements for site preparation and clearance, and select location for the storage of purge and decontamination waters.
- Conduct team safety meetings as required by the SSHP.
- Conduct team review of the project documents including SOPs to be utilized.
- Complete the Field Event Startup Report and submit to PM (Attachment 1-1).

5.2 Field Operations

Field staff responsibilities are project-specific. At a minimum, field personnel will perform the following activities:

1. Document field activities in a log book for each team and/or field records as required by the work plan or SOPs.
2. Record the following additional information for field measurements:
    a. The identification number and calibration results for each field instrument
    b. The numerical value and units of each measurement
    c. A description of any unexpected delays or problems observed during purging or sampling activities
3. Complete required data collection/sample control forms (e.g., Chain-of-Custody, Field Sampling Report, etc.).
4. Communicate with the PM regarding site conditions and out of scope work to be performed.
5. Perform following activities daily before leaving the site:
    a. Decontaminate and check condition of field equipment.
    b. Provide log books and other field documentation to FTL for review and scanning.
    c. Properly dispose of trash, debris and used PPE.
    d. Safely store purge and decontamination water, or transfer to large storage tanks at Dunn Field.
    e. Make arrangements for shipment of samples (if applicable) and follow-up with the analytical laboratory to confirm samples arrived in good condition.
    f. Complete activity-specific field reports as required by applicable SOPs.
    g. Complete the Daily Field Report and submit to PM (Attachment 1-2).

5.3 Field Log Books and Documentation

Dedicated log books will be used by each field team in addition to documentation required by activity-specific SOPs.

- The first page of each log book will list the following information:
    - Site Name: Former Defense Depot Memphis Tennessee

  - EPA ID (TN4210020570)
  - Project Location: 2241 Truitt Street, Memphis, TN 38114
- The first entry for each field event will list the following information: log books:
  - Project Name and Number
  - FTL (full name) and initials
  - Sample team leader and members (full names) and initials
- At minimum, the log book will describe general activities performed, date and time, personnel and weather conditions. All field equipment calibration and maintenance records will be documented in the logbook. Communications with the FTL, PM or project chemist regarding field activities will be documented. Additional field data will be recorded in the log book if other field records are not used.
- Any deviations from the QAPP or work plan will be noted in the log books.
- Errors will be crossed out with a single line, the correction added and the entry initialed.
- Each page will be numbered and dated. A diagonal line will be drawn through any unused portion of a page containing an entry. To indicate the end of an entry, personnel are required to initial and date the page at the conclusion of each day.

5.4 Closeout

Upon the completion of field activities, the FTL will view each site to verify the area has been cleared and restored as closely as possible to its prior condition. Trash will be removed from the site, and surface damage, including ruts caused by vehicles, will be repaired.

Confirm all equipment is accounted for and properly decontaminated and in good working condition. Notify PM if repairs are needed. Properly package and ship all rental equipment to the vendor. When shipping equipment, use the proper HDR FedEx number and insure the package for the cost of the equipment. Follow manufacturer's instructions on long and short term storage when storing government and/or HDR equipment.

Rental trucks should be fueled and returned to the rental company as soon as possible. HDR leased trucks should also be fueled and cleaned prior to storing at the shop.

Work areas should be cleaned with tools and equipment properly stored.

The FTL will make a final check of all logbooks and other field records to ensure there are no blanks or missing data and the entries are legible. FTL will organize scanned forms in proper order and transmit to PM.

The FTL will complete Field Event Closeout Report and submit to PM (Attachment 1-3).

6 Data and Records Management

All field forms and log book entries will be scanned and copied to the project folder on the HDR network file share drive within one week of the field event completion. All photographs taken during the field event will be uploaded along with a typed photograph log (date, project and subject) to the HDR network file share drive. The photographs will then be erased from the camera. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM, project chemist and project administrator will be sent a link for the data.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the specific work plan, and applicable SOPs. All field activities will be recorded in the log books in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor.

8 References

HDR, 2018. *DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1*. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

USEPA Region 4 SESD Guidance, *Soil Sampling* (SESDPROC-010-4). October, 2010.

Field Event Startup Report

Prepared by: Date:

Event Name:

Project-Activity Number:

Summary of Planned Event:

Planned Performance Period: _______to___________

Project Documents - Title, Date

Work Plan:

Health and Safety Plan:

Other SOPs – List number/revision and title:

Field Event Staffing

Position	Name	OSHA Cert. (Y/N)	First Aid/ CPR (Y/N)	Driver's License (Y/N)	Proj. Plans reviewed (Y/N)	Experience (Hi-Med-Low-None)
Field Team Leader						

DDMT Field Equipment

Name/Use	Mfr./Model No.	Condition	Calibration Req'd.(Y/N)	Calibration supplies	Other supplies (batteries, etc.)

Rental Equipment

Name/Use	Mfr./Model No.	Condition	Calibration Req'd.(Y/N)	Calibration supplies	Other supplies (batteries, etc.)

Lab-provided Sampling Supplies

Sample Type	Number	Supplies

Additional Tools/Supplies

Camera
Field forms (list):
Sample supplies (list):
Water/Ice cooler
Sample cooler

Final Check

1. All required equipment/tools received and condition checked

Yes ___ No ___ Comment:

2. Initial equipment calibration completed

Yes ___ No ___ Comment:

3. Vehicles inspected

Yes ___ No ___ Comment:

4. Field locations reviewed

Yes ___ No ___ Comment:

5. Weather forecast checked

Yes ___ No ___ Comment:

6. Staff documents (OSHA, DL) checked

Yes ___ No ___ Comment:

7. Review of project plans confirmed and activities discussed

Yes ___ No ___ Comment:

8. Initial Safety Meeting held and SSHP signed

Yes ___ No ___ Comment:

Daily Field Report

Project Number/Activity:	**Date:**
Project Name:	**Field Team Leader:**
Brief Work Description:	

Weather:	**Temp:**

Previous Day's Samples received at laboratory – Y / N Comment:

Time	Description

Name/Organization of Field Staff, Subcontractors and Site Visitors	

Samples Collected

Problems or Deviations from Work Plan

Tasks to be completed next workday

____________________	______________________________	_____________
Name	**Signature**	**Date**

Field Event Close-Out Report

Prepared by: Date:

Event Name:

Project-Activity Number:

Performance Period: ________to__________

Field Team Leader:

Field Staff:

Summary of Completed Event:

Field problems and/or changes from planned activities:

Change in number/type of samples collected:

Health and Safety problems/Injuries:

Close-out Checklist

1. Log book and field forms scanned and originals placed in project file

Yes ___ No ___ Comment:

2. Equipment/tools decontaminated

Yes ___ No ___ Comment:

3. Rental equipment shipped to supplier

Yes ___ No ___ Comment:

4. Rental vehicles returned

Yes ___ No ___ Comment:

5. DDMT equipment and tools properly stored

Yes ___ No ___ Comment:

6. List damaged equipment

Yes ___ No ___ Comment:

7. Replacement supplies ordered

Yes ___ No ___ Comment:

8. Field locations inspected and trash/debris removed

Yes ___ No ___ Comment:

9. Field shop/office cleaned

Yes ___ No ___ Comment:

STANDARD OPERATING PROCEDURE 2 – DRILLING AND SAMPLING

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for drilling and soil sampling operations in support of investigative activities at Defense Depot Memphis, Tennessee (DDMT). Drilling activities will enable collection of subsurface samples and allow the installation of monitoring wells. This SOP provides general guidance; the project-specific work plan must be reviewed for specific project requirements.

2 Overview

There are several methods by which drilling operations may be conducted including manual (hand) augering, power augering with hollow-stem augers, direct push technology (DPT), sonic drilling, and cable tool or mud rotary drilling with installation of surface casing. Generally, hand augering is useful only for surficial soil sampling while the other methods are used for deeper, subsurface investigations, sampling and installation of monitoring wells. Sonic drilling is the recommended drilling method for well installation at DDMT; it has proven to be the most effective method for boring advancement and well installation based on the depth to water (i.e. 75-105 feet below ground surface [ft bgs]) and geologic characteristics of the fluvial aquifer (i.e. tight sands mixed with gravel up to cobble size).

Drilling activities that require the use of a truck-mounted drill rig will be conducted by a Tennessee-licensed subcontractor with experience on similar projects. The drilling subcontractor will advance boring to the target depth using the selected drilling technology and provide equipment sufficient to carry out the work as specified. Drilling and sampling will be overseen by the field team leader (FTL), an environmental professional (engineer, geologist or scientist), with support staff if required. HDR personnel will prepare soil boring logs with lithologic descriptions and observations relevant to investigative activities, collect samples for field, geotechnical or laboratory analysis and monitor compliance with the project Site Safety and Health Plan (SSHP).

3 Health and Safety

Proper safety precautions must be observed during drilling activities and when collecting samples in accordance with the SSHP. Each individual assigned to field work must: (1) participate in the HDR Medical Monitoring Program, or subcontractor medical surveillance program, as applicable, (2) must have taken the Occupational Safety and Health Administration (OSHA) 40-Hour course (updated with the 8-Hour OSHA Refresher, when necessary), and (3) must be certified as able to wear respiratory protection.

Each individual is required to have read and understood the SSHP for the specific project activity. Upon arrival at the site, each person shall sign the acknowledgement sheet confirming their review of the SSHP. Personal protective equipment (PPE) and other provisions for site safety requirements are discussed in the SSHP. At a minimum for drilling, personnel will wear a hard hat, steel toe shoes, safety glasses, hearing protection, and a high visibility outer garment.

Equipment will only be used by properly trained personnel. In particular, the use of a photoionization detector (PID) will only be performed by personnel familiar with the equipment. Proper tools will be made available to each employee as necessary. Questions should be addressed to the FTL.

Drilling locations will be cleared for underground and above ground utilities prior to beginning drilling activities. Prior to setting up on the drilling location, the FTL will confirm the location has been cleared with the appropriate utility companies and the property owner/tenant. Drilling will only proceed where no aboveground or subsurface obstructions exist. Locations will be offset if these obstructions are identified prior to drilling, or encountered after drilling has begun. The new locations will be as close as possible to the originally proposed locations; utility clearance will be performed again as necessary.

If drilling is to occur in the vicinity of overhead utilities, HDR personnel will measure utility line height from the ground surface using a clinometer (or similar device) to ensure a minimum safe clearance distance is maintained between on-site equipment and overhead utility lines. As needed, the appropriate utility company will be contacted in order to determine a recommended safe clearance distance from aboveground or underground on-site utilities.

Prior to the start of drilling activities, the drilling subcontractor will hand clear each drilling location to a depth of at least 4 ft bgs, in order to verify that underground utilities or other hazards are not present.

4 Personnel Qualifications and Responsibilities

Field activities will be directed by the FTL, an engineer/geologist with experience in the planned drilling activities; junior to mid-level geologists will assist, if necessary. Field activities will be overseen by a Tennessee-licensed geologist or engineer. Drilling will be conducted by a licensed driller and crew familiar with planned activities, the project-specific work plan and SSHP. At least one person on each team will have a current certification in first aid and CPR. Operation of fork lifts on site will be limited to personnel that have documentation for forklift operator safety training.

The FTL will provide direction to field staff to ensure work is performed in accordance with the project documents (Quality Assurance Project Plan [QAPP], project-specific work plan, SSHP, and SOPs). The field staff will carefully review the project documents, conduct the work as planned, seek direction from the FTL when questions or problems arise, and carefully complete field documentation.

5 Equipment and Supplies

The required equipment and supplies will be identified in the project-specific work plan. Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for a drilling project will include: a PID, tape measure, Munsell color chart, knife, PPE, field drill log forms, camera, sample containers and work table.

Each team will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance.

6 Procedures

6.1 Start-Up Activities

6.1.1 Office

Prior to leaving the office for field work, personnel will perform the following actions:

1. The Project Manager (PM) will assign a FTL to direct field activities and coordinate with project personnel. Task specific responsibilities of the FTL will be addressed in the appropriate SOP; general responsibilities include:
    a. Review project-specific work plan, SSHP, QAPP, and for subcontracted work, review of the subcontract agreement.
    b. Work with PM to properly staff the field activity.
    c. Arrange site access with the property manager (Colliers International-Memphis Depot Industrial Park), tenants and/or property owners.
    d. Locate the proposed drilling locations, and mark each location with a wooden stake and white flagging or white paint.
    e. Notify the Tennessee One Call underground utility location and, if necessary, a private utility location service.
    f. Provide drilling subcontractor with proposed boring location and depth for well permits from Shelby County Health Department (SCHD); confirm receipt of permits.
    g. Coordinate sampling activities and supplies with the project chemist and analytical laboratory.
    h. Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies for delivery prior to the start of each event.
    i. Prepare field forms and other documentation for the planned event.
    j. Provide all HDR and subcontracted field personnel with time and location for personnel to meet prior to beginning field activities.
    k. Confirm that field staff have a valid Driver's License (or other picture identification) in their possession prior to leaving the office and current OSHA Certification.

6.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for drilling and soil sampling activities are on site.
- Notify SCHD prior to start of drilling activities in accordance with permit requirements.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies.
- Confirm drilling and soil sampling locations are clearly marked and review locations for hazards; determine if the utility locators have adequately marked utilities on the site. Check for overhead dangers such as power lines, and make necessary height measurements to ensure safe clearance distances are maintained.
- Determine requirements for site preparation and clearance, and select location for the placement of the decontamination area, storage of decontamination waters, and soil cuttings.
- Confirm locations and requirements for each sample to be collected.
- Conduct site set up activities to include posting of signage (if applicable) and delineation of work zones as required in the SSHP.
- Calibrate field equipment.
- Conduct team safety meetings as required by the SSHP.
- Conduct team review of the project documents including SOPs to be utilized.
- Complete the Field Event Startup Report (SOP 1 *General Procedures for Field Personnel*) and submit to PM.

6.2 Field Operations

Field staff responsibilities are project-specific. At a minimum, field personnel are required to ensure the following items are completed as part of field operations during drilling and soil sampling activities.

6.2.1 Field Documentation

Field activities will be documented in a bound logbook for each team and in field records as required by the project-specific work plan or SOPs. At minimum, the logbook will describe general activities performed, date and time, personnel performing the activity, and weather conditions.

For field measurements, the following additional information will be required:

- The numerical value and units of each measurement
- The identity of and calibration results for each field instrument

For sampling activities, the following additional information will be required:

- Sampling type and method
- The identity of each sample and the depth(s) from which it was obtained
- The amount of each sample
- Sample description (e.g., color, odor, clarity)
- Identification of sampling devices
- Identification of conditions that might reflect representativeness of a sample (e.g., refueling operations, damaged well casings)

Field personnel will complete required data collection/sample control forms (e.g., Chain-of-Custody [COC], Drill logs, Field Sampling Report, etc.).

6.2.2 Drilling Logs

The geologist/engineer will log the subsurface conditions encountered in the boring, and record the information on the drilling log and/or the logbook. Additional pertinent information will be recorded on the drilling log, including, but not limited to, the following:

- Drilling date
- Drilling method
- Geologist name
- Location of boring/Boring identification
- Driller's name/Drilling subcontractor name/Type of drill rig
- Diameter of inner and outer drill casings
- Diameter of surface casing, casing type and method of installation
- Types of drilling fluids and depths at which they were used
- Weather conditions
- Start and completion time for each boring
- Standard Penetration Test blow counts per six inch advance, if applicable
- Recovery length of each sample
- Visual description of soil using the Unified Soil Classification System (USCS) (ASTM-D-2488-00)
- Depths at which each soil sample was collected for chemical or physical analysis
- Total number of samples taken
- Total depth of boring
- Boring refusal
- Water losses (if applicable)
- Water bearing strata (depth and thickness)

- Depth at which saturated conditions were first encountered
- Lithologic descriptions and depths of lithologic boundaries
- Zones of caving or heaving
- Depths at which drilling fluid was lost and amount lost
- Drilling rate
- Drill rig reactions such as chatter, rod drops, or bouncing
- Location of the boring relative to an easily identifiable landmark.

6.2.3 Drilling Procedures

Generally, drilling activities will be completed in accordance with the planned activities presented in project work plan. Additionally, the following requirements will apply to drilling activities at DDMT:

- Drilling will conform to Shelby County rules and regulations, and Rules of Tennessee Department of Environment and Conservation (TDEC), Division of Water Supply, Chapter 12-4-10.
- All necessary precautions will be taken to prevent leakage of hydraulic oil or other contaminants from the drilling rig into the borehole or onto equipment that is placed in the hole.
- The only acceptable drilling fluid to be used while advancing the borehole is water. However, water will be used only when necessary as approved by the FTL, and will be from an approved potable water source, if the onsite subcontractor and HDR personnel determine drilling fluid additives (e.g. sodium bentonite) are necessary for drilling operations. PM authorization must be obtained prior to their use.
- During drilling of boreholes with a sonic rig, soil will be collected continuously as 10-foot sections of soil core. These cores will be deposited from the drill casing into 10-foot polyethylene liners.
- During drilling of boreholes with DPT, soil core will be collected continuously in 4-foot sections in clear plastic liners.
- The HDR geologist/engineer will maintain visual and verbal communication with the onsite subcontracted driller in order to maintain awareness of any changes in subsurface conditions, amount of water used (if any) during drilling, quantities of materials used during drilling and well installation, or any mechanical problems with the drill rig or support equipment.
- The HDR geologist/engineer will carefully and thoroughly complete all required field documentation in order to provide a complete record of drilling activities, including drill rig maintenance and repairs, subcontractor down time, subsurface conditions and geologic materials encountered.
- The HDR geologist/engineer will determine and record the depth to groundwater observed during drilling.

- When the HDR geologist/engineer is finished with visual logging and sampling soil core, the drilling subcontractor will place the core in an approved container for disposal of soil cuttings.
- During drilling activities, the drilling subcontractor will notify the onsite HDR geologist/engineer of any significant changes in lithology encountered, significant changes in amount of water being used, and any mechanical problems with the drill rig.
- The HDR geologist/engineer will monitor the breathing zone for organic vapors in accordance with the procedures contained in the SSHP. The tops of the boreholes will be monitored for organic vapors using a PID.
- The HDR geologist/engineer collect soil samples at specified intervals in borings for soil classification and/or chemical analysis or field screening as specified in the project-specific work plan.
- Drilling equipment will be decontaminated prior to drilling activities in accordance with SOP 9 *Equipment Decontamination*.
- Investigative-derived waste (i.e., drill cuttings, drilling fluid) will be characterized and disposed as specified in the project work plan.
- Soil cuttings will be examined (e.g. olfactory, PID, and visual inspection) for contamination. If contamination is suspected, the finding will be noted on the boring log form and the contaminated soil cuttings will be segregated.
- The HDR geologist/engineer will communicate with the PM regarding site conditions and out of scope work to be performed.

6.2.4 Boring Diameter

Soil boring diameter and drilling method shall be established in a project specific work plan and selected based on the boring purpose. Shallow borings advanced for the purpose of soil or soil vapor sampling may only need to 1.25 inch in diameter while borings advanced to construct monitoring wells in conductor casings may be 12 inches in diameter. Some drilling methods and their respective boring diameter are listed below.

6.2.4.1 Sonic Drilling

The boring diameter is based on a minimum of 2 inches of annular space between the outside diameter of the well casing and the borehole wall. The majority of borings at DDMT are advanced via sonic drilling methods for monitoring well construction in the fluvial aquifer, which is underlain by the uppermost clay of the Jackson Formation/Upper Claiborne Group. For these borings, a 6-inch diameter borehole is advanced 5-10 feet into the clay; after the depth to the clay is confirmed, the boring is back-filled to just below the top of clay with bentonite chips. A borehole diameter of 6 inches allows proper installation of a nominal 2-inch outside diameter well casing.

For wells to be installed in the deeper intermediate or Memphis aquifer, a surface casing is typically installed into the uppermost clay of the Jackson Formation/Upper Claiborne Group in order to prevent cross contamination between formations. For the deeper borings, a 12-inch diameter borehole will be advanced 10 feet into the uppermost clay and an 8-inch diameter surface casing will be installed, either welded sections of carbon steel or threaded Schedule 80 polyvinyl chloride

(PVC). After placing the surface casing, the driller will lower a tremie pipe connected to a grout pumping unit through the outer annulus of the casing. The driller will pump grout through the tremie pipe until the grout returns to the ground surface. The grout will cure for 24 hours before continuing to advance the borehole. Water present in the inner annulus of the casing will be pumped to a holding tank before the borehole is advanced to the target depth. A 6-inch diameter borehole will then be advanced to the target depth for installation of a 2-inch diameter well.

6.2.4.2 DPT Drilling

DPT drilling at DDMT is performed for the purpose of soil, groundwater and soil vapor sampling using the Geoprobe dual tube system. The dual tube system uses a 2.25-inch outer diameter (OD) drive rod and cutting shoe attached to the leading edge of the rod string. As the drive rod is advanced into the subsurface, the cutting shoe shears a 1.125-inch OD soil core which is collected in a clear plastic liner inside the drive rod.

6.2.5 Soil Sampling Procedures

During drilling of boreholes with a sonic rig, soil samples will be collected continuously as 10-foot sections of soil cores. These cores are deposited from the drill casing into 10-foot polyethylene liners, and the liners laid out for visual logging, and to obtain samples for headspace readings and laboratory analysis, if required by the project work plan.

During drilling of boreholes with DPT, soil samples are collected continuously as 4-foot sections of soil cores. The cores are sheared by the soil cutting shoe and deposited into the clear plastic liner as the drive rod is advanced. The plastic liners are cut lengthwise and laid out for visual logging, and to obtain samples for headspace readings and laboratory analysis, if required by the project work plan.

During advancement of the soil borings, the following sampling devices with sand catchers to retain loose material may also be used:

- Chemical Sample Collection (undisturbed): 2 or 3-inch diameter carbon steel California modified split spoon sampler lined with brass rings or stainless steel liners.
- Geotechnical Sample (undisturbed) Collection: 2-inch diameter carbon steel split-barrel sampler with brass or stainless steel liners.
- Geotechnical Sample (undisturbed) Collection: 3-inch diameter “Shelby Tube” or thin-walled tube sampler

6.2.5.1 Soil Description

Soils will generally be described in accordance with the 1990 ASTM D-2488-90, *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure). Descriptive information to be recorded in the field will include:

- Identification of the predominant particle size and range of particle sizes
- Percent of gravel, sand, fines, or all three
- Description of grading and sorting of coarse particles

- Particle angularity and shape
- Maximum particle size or dimension

The plasticity of fines description will include:

- Color using Munsell Color System
- Moisture (dry, wet, or moist)
- Consistency of fine grained soils
- Structure of consolidated materials
- Cementation (weak, moderate, or strong)

The USCS group symbols will be used for identification. Additional information to be recorded includes: depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory sample collection, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

6.2.5.2 Headspace Sampling

At least five-foot intervals within the soil cores, the headspace will be screened with a PID. The headspace samples will be collected and analyzed using the following procedure:

- From the sampling location within the soil core, remove the top 1 to 2 inches of soil using a decontaminated stainless steel spoon or gloved hand.
- Partially fill one decontaminated 16-ounce container or zip top bag with soil using the stainless steel spoon or gloved hand.
- Cover the jar immediately with aluminum foil and fasten the jar lid or seal the zip top bag.
- Allow the sample vapors to equilibrate (approximately 5 minutes). If necessary, the headspace samples will be brought to a temperature of 20 degrees Celsius (°C) (68 degrees Fahrenheit [°F]) to 32°C (90°F) by placing in sunlight.
- Collect a reading from the first sample jar by puncturing the aluminum foil or inserting the tip of a calibrated PID into the bag and recording the highest reading.
- If the reading is > 10 parts per million, collect a second reading with the activated charcoal filter on the calibrated PID. Determine corrected hydrocarbon measurement of the sample by subtracting the filtered reading from the unfiltered reading.

6.2.5.3 Soil Sample Collection for Laboratory Analysis

Selected soil samples may be collected for laboratory analysis based upon the results of the headspace screening. At these selected locations, samples for volatile organic compound (VOC) analysis will be collected using an Encore or Terracore sampler, or acceptable equivalent. (Note: There is no difference in field criteria for the two samplers. Different laboratories supply different devices and there is a difference in cost). Samples collected for VOC analysis should be collected from the soil cores in a manner that minimizes disturbance of the sample.

The following items should be considered when collecting soil samples:

- A clean pair of new, non-powdered, disposable gloves will be worn each time a sample is collected.
- Samplers must use new, verified/certified-clean disposable or non-disposable equipment cleaned in accordance with SOP 9 *Equipment Decontamination*.
- Document field sampling, including field conditions, problems encountered during sampling and sample appearance, in the field logbook. Samples collected will also be noted on the drilling log sheet at the corresponding depth.
- Place unused sample material into the approved transport/disposal containers along with other drill cuttings generated during sonic drilling activities.
- When soil sampling is completed or when time permits, transfer samples to site office for final packaging. Complete COC documentation and shipping procedures in accordance with relevant SOPs. The completed COC will remain with the samples until custody is relinquished.
- Note problems encountered during sampling in the Field Sampling Report Form and Daily Quality Control Report Form.

6.2.5.3.1 Encore ™ Sampler Procedure

The procedure for collection of VOC samples using an Encore ™ Sampler are as follows:

- Remove sampler and cap from package and attach T-handle to the sampler body.
- Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.
- Carefully wipe the exterior of the sampler head with a clean disposable paper towel so that the cap can be tightly attached.
- Push cap on with a twisting motion to attach and seal the sampler.
- Attach the label onto the sampler body, place the sampler into a plastic Ziploc™ bag and place into a cooler with ice.
- Repeat steps through for the remaining sampler(s) as necessary.
- Collect a bulk soil sample for screening and moisture determination in a 2 or 4-ounce wide mouth glass or polyethylene jar. Fill the jar completely allowing no headspace. Place the sample in a cooler containing ice.
- Thoroughly mix remaining soil and place into specified labeled containers for remaining parameters.
- Place sample bottles into Ziploc™ or bubble bag and in an iced cooler.
- Complete COC documentation and shipping procedures in accordance with relevant SOPs.

6.2.5.3.2 Terracore Sampler Procedures

The procedure for collection of VOC samples using a Terracore Sampler are as follows:

- Label appropriate laboratory containers
- Quickly push the sampler (Terracore or equivalent) into a freshly exposed surface of soil to collect 5 grams (+ 0.5g) of sample. Also collect a bulk aliquot container for moisture content analysis in the laboratory supplied 4 ounce container.
- Carefully wipe the exterior of the sampler head with a clean disposable paper towel.
- Empty sampler into appropriate laboratory container. The cored samples must be extruded from the selected coring tool to a volatile organic analysis (VOA) vial in accordance with collection and preservation methods described in EPA method 5035A. The extruded core is transferred into a laboratory pre-weighed (tared) VOA vial. The VOA threads should be wiped with a new paper towel to remove soil and the VOA capped with septum cap. Unpreserved VOA vials must be analyzed within 48 hours of collection, VOA vials preserved with sodium bisulfate or methanol must be analyzed within 14 days of collection.
- Place the sample into a plastic Ziploc™ bag and place into a cooler with ice.
- Complete COC documentation and shipping procedures in accordance with relevant SOPs.

6.2.5.4 Grab Groundwater Sample Collection for Laboratory Analysis

The Geoprobe® Screen Point 15/16 Groundwater Sampler is a discrete interval ground water sampling device that can be pushed to pre-selected sampling depths in saturated, unconsolidated materials. Once the target depth has been reached, the screen is opened and groundwater can be sampled as a temporary monitoring well, which yields a representative, uncompromised sample from that depth. Methods to install and operate the SP 16 are listed below:

- Attach drive cap to top of sampler and slowly drive it into the ground. Raise the hammer assembly, remove the drive cap and place an O-ring* in the top groove of the drive head. Add a probe rod and continue to push the rod string.
- Continue to add probe rods until the desired sampling depth is reached.
- When the desired sampling depth is reached, re-position the probe derrick and position either the casing puller assembly or the rod grip puller over the top of the top probe rod.
- Thread a screen push adapter on an extension rod and attach sufficient additional extension rods to reach the top of the Screen Point® 15/16 sampler. Add an extension handle to the top of the string of extension rods and run this into the probe rod, resting the screen push adapter on top of the sampler.
- To expose the screened portion of the sampler, exert downward pressure on the sampler, using the extension rod and push adapter, while pulling the probe rod upward. To expose the entire open portion of the screen, pull the probe rod upward approximately 41 inches.
- At this point, the Screen Point® 15/16 Groundwater Sampler has been installed as a temporary well and may be sampled using appropriate ground water sampling methodology.

6.2.6 Post Run Tubing Boring Construction

Post run tubing (PRT) drill rod will be advanced into the subsurface to the target depth via DPT. After reaching the desired depth, the PRT rod will be retracted approximately 6 inches exposing the soil interval to be sampled. Teflon® tubing will be threaded into the PRT adaptor through the center of the PRT rod and capped to prevent soil gas venting. The annulus around the PRT rod where it penetrates ground surface will be packed with bentonite crumbles and hydrated. The boring will not be disturbed or sampled for a minimum of 2 hours to allow the bentonite crumbles to seal the annulus and allow soil gas to equilibrate. After the soil gas sample has been collected, the PRT drill rod and tubing will be removed from the boring and the boring will be filled to ground surface with neat cement.

6.3 Soil Boring Abandonment

Vadose zone soil borings advanced to 15-feet bgs or less can be abandoned by filling the boring with neat cement from the ground surface. Borings advanced greater than 15 ft bgs shall be grouted from the bottom up as the drill string is removed. When water is present, a tremi pipe will be lowered through the drill string to the base of the boring. Type II Portland cement with 3 to 5 percent bentonite powder will be mixed at a ratio of 7.2 to 8.5 gallons of potable water to one sack (94 pounds) of dry cement. The grout shall be thoroughly mixed to a smooth, uniform consistency, with no lumps or balls. The bentonite grout will be pumped through the tremi pipe to displace groundwater as the drill string is removed. The bentonite grout shall fill the boring to within 2 ft of ground surface and rechecked for settlement after at least 12 hours. If grout has settled, the boring shall be topped off and the ground surface restored to match adjacent conditions.

6.4 Closeout

6.4.1 Daily Closeout

Perform following activities daily before leaving the site:

- Decontaminate and check condition of field equipment.
- Provide logbooks and other field documentation to FTL for review.
- Properly dispose of trash, debris and used PPE.
- Make arrangements for shipment of samples (if applicable) and follow-up with the analytical laboratory to confirm samples arrived in good condition.
- Secure the site for the night and/or weekend.
- Prepare the daily field report as required by the project-specific work plan or SOPs and submit report to the PM. Note any problems or deficiencies in field activities.

6.4.2 Field Event Closeout

Upon completion of field activities, the FTL will view each site to verify the area has been cleared and restored as closely as possible to its prior condition. The following activities will be performed prior to the completion of each field event:

- All trash will be removed from site and disposed of appropriately
- Any damage to the ground surface, including ruts, will be repaired
- All equipment is accounted for, properly decontaminated, and in good working condition. The FTL will be notified if repairs are needed
- Rental equipment has been properly cleaned, packaged, and shipped to the appropriate vendor
- Shipments are made using the correct HDR FedEx number and packages insured for the cost of the rental item
- Manufacturer's instructions are followed regarding long and short term storage for all equipment
- Rental vehicles are refueled and returned to the rental company
- HDR leased vehicles are cleaned and refueled
- All work areas have been cleaned, and tools and equipment have been stored properly

The FTL will make a final check of all drilling logs, logbooks and other field records to ensure there are no blanks or missing data and the entries are legible. The FTL will complete Field Event Closeout Report and submit to PM.

7 Data and Records Management

All field forms and logbook entries will be scanned and copied to the project folder on the network file share drive within one week of the field event completion. All photographs taken during the field event will also be uploaded along with a typed photograph log (date, project and subject) to the network file share. All uploaded photographs will then be erased from the camera. All original forms will be stored on site at the field office in Memphis in the appropriate project-specific filing cabinet and task-specific labeled folder.

8 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the project-specific work plan, and applicable SOPs. All field activities will be recorded in the logbooks in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or logbooks. A single line will be used to strike out errors and will be annotated with the initials and date of the editor. Boring logs will be typed into a spreadsheet provided by the CAD operator for the inclusion into computerized drill logs.

9 References

HDR, 2018. DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

Shelby County Health Department, Pollution Control Section, Water Quality Branch, <http://www.shelbycountytn.gov/DocumentCenter/Home/View/767>.

USEPA Region 4 SESD Guidance, *Design and Installation of Monitoring Wells* (SESDGUID-101-R1), January, 2013.

USEPA Region 4 SESD Guidance, *Field Equipment Cleaning and Decontamination* (SESDPROC-205-R2), December, 2011.

USEPA Region 4 SESD Guidance, *Soil Sampling* (SESDPROC-300-R3), August, 2014.

STANDARD OPERATING PROCEDURE 3 – WELL INSTALLATION, DEVELOPMENT AND ABANDONMENT

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for installation, development and abandonment of monitoring wells at Defense Depot Memphis, Tennessee (DDMT). This SOP provides general guidance; the project-specific work plan must be reviewed for specific project requirements.

2 Overview

Monitoring wells will be installed, developed and abandoned by a Tennessee-licensed subcontractor and supervised by an HDR geologist/engineer. Well installation and development will occur immediately after drilling and preparations should be made prior to beginning drilling operations, which are described in SOP 2 *Drilling and Soil Sampling*. This SOP incorporates past practice at DDMT as described in work and test procedures (WTPs) from the DDMT QAPP (HDR, 2018) and SOPs prepared by United States Environmental Protection Agency (USEPA) Region 4.

3 Health and Safety

Proper safety precautions must be observed during drilling activities and when collecting soil samples in accordance with the site-specific Health and Safety Plans (HASPs). Each individual assigned to field work must: (1) participate in the HDR Medical Monitoring Program, or subcontractor medical surveillance program, as applicable, (2) must have taken the OSHA 40-Hour course (updated with the 8-Hour OSHA Refresher, when necessary), and (3) must be certified as able to wear respiratory protection.

Each individual is required to have read and understood the HASP for the specific project activity. Upon arrival at the site, each person shall sign the acknowledgement sheet confirming their review of the HASP. Personal protective equipment (PPE) and other provisions for site safety requirements are discussed in the HASP. At a minimum for drilling all personnel will wear a hard hat, steel toe shoes, safety glasses, hearing protection, and a high visibility outer garment.

All equipment will only be used by properly trained personnel. In particular, the use of a photoionization detector (PID) will only be performed by personnel familiar with the equipment. Proper tools will be made available to each employee as necessary. Any questions should be addressed to the Field Team Leader (FTL).

4 Personnel Qualifications and Responsibilities

Field activities will be directed by the FTL, a mid- or senior level engineer/geologist with experience in monitoring well installation, development and abandonment; junior to mid-level geologists will assist, if necessary. The well installation, development and/or abandonment will be conducted by a TN-licensed driller and crew familiar with planned activities, the project-specific work plan and HASP. At least one person on each team will have a current certification in first aid and CPR. If a fork lift is used on site the person driving the fork lift will have the proper Occupational Safety and Health Administration (OSHA) training.

The FTL will provide direction to field staff to ensure work is performed in accordance with the project documents (Quality Assurance Project Plan [QAPP], project-specific work plan HASP, and SOPs). The field staff will carefully review the project documents, conduct the work as planned, seek direction from the FTL when questions or problems arise, and carefully complete field documentation.

5 Equipment and Supplies

The required equipment and supplies will be identified in the project-specific work plan or quality assurance project plan (QAPP). Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for a monitoring well installation, well development, and well abandonment will include: a PID, tape measure, knife, nitrile gloves, well pump, compressor, grout mixer, grout pump, bleach, sand, bentonite, Portland cement, well construction forms, well abandonment forms, camera, and development water containers.

Each team will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance.

6 Procedures

6.1 Start-Up Activities

6.1.1 Office

Prior to leaving the office for field work, personnel will perform the following actions:

1. The Project Manager (PM) will assign a FTL to direct field activities and coordinate with project personnel. Task specific responsibilities of the FTL will be addressed in the appropriate SOP; general responsibilities include;
    a. Review project project-specific work plan, HASP, and QAPP and for subcontracted work, review of the subcontract agreement.
    b. Work with PM to properly staff the field activity.

c. Arrange site access with the Memphis Depot Associates, tenants and/or property owners.

d. Confirm availability and condition of on-site equipment and order additional equipment/supplies for delivery prior to the start of each event.

e. Prepare field forms and other documentation for the planned event.

f. Prepare the required Shelby County Health Department (SCHD) well installation and abandonment forms.

g. Provide all HDR and subcontracted field personnel with time and location for personnel to meet prior to beginning field activities.

h. Confirm that field staff have a valid Driver's License (or other picture identification) and current OSHA Certification in their possession prior to leaving the office.

6.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for field activities are on site.
- Review condition of DDMT-owned and rental equipment, and inventory field supplies.
- Review locations for planned field activities for hazards, including overhead dangers such as power lines, and select location for the placement of the decontamination area, storage of decontamination and development waters.
- Confirm the exact locations of the wells to be abandoned and that the correct well is being abandoned.
- Confirm the location and length of the screened interval and the total depth of the well to be installed and developed.
- Conduct site set up activities to include posting of signage (if applicable) and delineation of work zones as required in the HASP.
- Calibrate field equipment.
- Conduct team safety meetings as required by the HASP.
- Conduct team review of the project documents including SOPs to be utilized.
- Complete the Field Event Startup Report and submit to PM.

6.2 Field Operations

Field activities will be documented in a logbook for each team and in field records as required by the project-specific work plan or SOPs. At minimum, the logbook will describe general activities performed, date and time, personnel and weather conditions. Additional information will be recorded in the log book if other field records are not used.

The following information will be required as part of the field documentation.

- The length of risers, screens, and end caps for each monitoring well including adjustments to riser sections during installation.
- The type, manufacturer, and gradation of the filter sand, and the volume used for each well.
- The type and manufacturer of the Portland cement and bentonite and the volume used for the bentonite seal and grout at each well.
- Surface completion details including: completion type, number of bollards installed, and a description of surface completion materials.

6.2.1 Monitoring Well Installation and Materials

Monitoring well installation will be completed in a manner consistent with relevant sections of USEPA Region 4 SESD Guidance, *Design and Installation of Monitoring Wells* (SESDGUID-101-R1), and applicable state/local requirements. Monitoring well installation will be conducted by a licensed driller and well installation subcontractor. A qualified geologist/engineer will oversee well installation activities.

Borings for monitoring wells will be advanced using sonic drilling. The following procedure will be used to install the well casing and screen:

- If the boring is drilled deeper than the total depth of the well, backfill the boring to approximately 1 foot below the planned well depth in accordance with the work plan, either with bentonite or by allowing the formation material to collapse as the casing is raised.
- Remove the new polyvinyl chloride (PVC) or stainless steel screen and riser from manufacturer packaging.
- Install a section of minimum 2-inch (I.D.), threaded, flush jointed, pre-manufactured PVC or stainless steel screen inside the steel drill casing; screen length will be 10 feet unless a different length is specified in the work plan..
- Install solid riser to ground surface, plus stick-up (if required).
- Install the filter pack using the gravity method through the annular opening between drill casing and well screen as the drill casing is removed. Continue removing drill casing and installing filter pack until at least 5 feet above the top of the well screen. Use the sonic drilling head to vibrate the steel casing as it is slowly withdrawn to distribute and compact the filter pack around the screen and to prevent bridging. Measure the thickness of the filter pack as it is placed.
- Install a minimum 5-foot bentonite seal. If bentonite is gravity fed in dry form, the seal will be hydrated with potable water. Allow the bentonite seal a minimum of 1 hour of hydration time before grouting the annulus. If the seal is in the saturated section of if potential for bridging is an issue, a bentonite slurry can be installed using a side-discharge tremie pipe.
- The remaining annulus will be filled with bentonite grout via tremie pipe to within 6-inches of the ground surface. Once the boring has been filled, the casing is removed and additional grout added as necessary.

- Wait at least 24 hours after grout installation to develop the well.

Well Construction Materials

Well risers will consist of material durable enough to retain their long-term stability and structural integrity and be relatively inert to minimize alteration of groundwater samples. Selection of PVC or stainless steel for the monitoring wells is based on the primary purpose of the well, which is the detection of potential contaminants, and site-specific conditions, such as planned remedial actions.

Well materials will consist of new, threaded, flush joint PVC or stainless steel pipe, with a minimum inside diameter of 2 inches. If PVC is used, the riser pipe will conform to ASTM D 1785, Standards for Schedule 40 Pipe; deeper wells installed in the intermediate or Memphis aquifers require Schedule 80 Pipe. Materials will be new, unused and joined with compatible welds or couplings that do not interfere with the primary purpose of the well. Use of solvent or glue will not be permitted.

Monitoring well screens will consist of new, commercially fabricated, threaded, flush joint, minimum 2-inch inside diameter (ID), factory slotted or continuous wrap PVC or stainless steel screen. Screen slot size will be based on previously available soil information, but will be generally sized to prevent 90 percent of the filter pack from entering the well. The screen slot size will be adjusted if site geologic conditions significantly differ from the expected conditions. Previous well installation at DDMT have generally used factory-slotted or wire-wrapped screens with 0.010-inch openings,

Silt traps will not be used in monitoring wells. A notch will be cut in the top of the casing to be used as a measuring point for water levels.

6.2.1.1 Well Design

Monitoring wells will be designed and installed in a manner to accomplish the following objectives: to collect representative water levels and groundwater samples; to prevent contamination of the aquifer by the drilling equipment; to prevent vertical seepage of surface water or inter-aquifer contamination.

Well design includes placement of the screen and the type and amount of filter pack, bentonite seal, and grout seal. The FTL and PM will collectively make decisions on well depths, locations, screened intervals, etc. If the borings are advanced into the clay unit at the base of the aquifer, bentonite chips will be used to backfill the boring to the top of the clay and allowed to hydrate for one hour prior to placing the filter pack or screen.

The well pipe assembly will be hung in the borehole, prior to placement of the filter pack, and will not be allowed to rest on the bottom of the hole in order to keep the well assembly straight and plumb. Centralizers will be installed at the top of the screened section and at 30-foot intervals.

6.2.1.1.1 Screen Location

The screened intervals will be selected for each proposed well, based on visual observations of aquifer materials encountered and objectives in the project work plan.

6.2.1.1.2 Filter Pack

A filter pack will be installed in the annular space between the boring and the well screen. The filter pack will consist of clean, inert, well rounded silica sand and contain less than 2 percent flat particles. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen.

A filter pack size of 8-16 or 10-20 grade is typically used for monitoring wells at DDMT. If the site conditions show significant change (i.e. more gravelly, or more fine-grained soil) from those previously encountered, a grain-size analysis will be completed and the filter pack selected based on those results.

The filter pack will be placed from the bottom of the hole to a minimum of 5 feet above the top of the well screen. The filter pack will not extend across more than one water-bearing unit.

Prior to installation of the well screen and casing, the total depth of the borehole depth will be measured from the top of the 6-inch steel drill casing by the drilling contractor to verify that the target depth has been reached. The sand filter pack will be gravity-placed through the 6-inch steel casing in lifts of approximately 1 foot. Care will be taken to prevent bridging by frequently measuring the thickness of the filter pack as it is placed. As the steel casing is slowly withdrawn between lifts, it will be vibrated with the sonic drilling head to compact the sand filter pack.

6.2.1.1.3 Bentonite Seal

A minimum 5-foot thick bentonite seal will be installed above the filter pack in the annular space of the well. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. When the seal is installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of one hour prior to placement of the grout collar around the wells. When the seal is placed below the water table, a bentonite slurry may be installed using a side-discharge tremie pipe.

6.2.1.1.4 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the bentonite seal to approximately 6-inches below the ground surface. Concrete will be added in the remaining annular space during installation of the protective casing and concrete pad.

The cement-bentonite mixture will consist of 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water. The cement-bentonite mixture may be modified to reduce the heat generated during curing. A side discharge tremie pipe will be used to place the grout mixture into the annular space. The tremie pipe will be located a maximum of 10 feet from the top of the bentonite seal in deep wells to ensure even placement of grout in the annular space. Pumping will continue until undiluted grout is visible at the surface.

6.2.2 Nested Monitoring Well Construction and Materials

Nested monitoring well installation will be conducted by a TN-licensed driller overseen by a qualified geologist/engineer. Borings will be advanced via sonic drilling utilizing a 6-inch inner casing and an 8-inch diameter outer casing. After reaching the desired depth, the 6-inch casing will be removed and the nested well will be constructed.

Each nested well will consist of up to four 1-inch inside diameter wells constructed within a single boring. The 1-inch wells will be constructed with Schedule 80 PVC well casing and screen for increased rigidity and strength, and will have one 2.5-feet long, pre-packed screen with a 2-inch diameter centralizer placed approximately one foot above the screen. The 8-inch boring will be filled with filter sand around the pre-packed screen; the screened intervals will be separated by a minimum 5-foot thick bentonite seal. Schedule 80 PVC well casing will extend from each screen interval to the ground surface. The annulus will be filled with a neat cement grout mixture from the uppermost bentonite seal to the surface. A diagram of a nested well is included as Attachment 1. The well construction steps are listed below:

- After reaching the desired depth with the 8-inch diameter casing, place one foot of filter sand in the base of the boring; confirm the depth to the top of the sand by tape measure.
- Insert a PVC plug in the bottom of the prepacked well screen, connect Schedule 80 PVC casing to the top of the screen and attach a 2-inch centralizer approximately one foot above the well screen.
- Lower the screen and casing to the sand at the bottom of the boring; suspend the well casing and maintain tension on the casing throughout construction in order to minimize bowing.
- Place filter sand through the 8-inch casing in lifts while measuring the depth to the top of the sand. Sand should extend two feet above the top of the screen interval.
- Raise the 8-inch sonic casing to the top of the filter pack while vibrating. Measure the depth to the top of the filter pack and add additional sand as necessary.
- Slowly pour bentonite chips and raise the 8-inch diameter casing while vibrating until bentonite is at least 5-feet thick and two feet below the next screen interval. Allow the bentonite to hydrate for at least one hour.
- Place two feet of sand on top of the bentonite seal. Confirm the thickness of the sand and install the next 1-inch well following the steps listed above.
- Continue this process until each of the nested wells has been constructed.
- After a 5-foot thick bentonite seal has been placed and hydrated above the shallowest screened interval, place a neat cement/bentonite grout mixture in the annulus via tremie pipe to within 6-inches of the ground surface.
- Develop the well at least 24 hours after grout installation.

6.2.2.1 Well Construction Materials

Well materials will consist of new, threaded, flush joint schedule 80 PVC, with an inside diameter of approximately 1-inch and conform to ASTM D 1785, where applicable. Casing will only be joined with compatible welds or couplings that do not interfere with the primary purpose of the well. Use of solvent or glue will not be permitted.

To ensure well screen separation from the borehole wall and adjacent well casings, Geoprobe pre-packed well screens will be utilized. The Geoprobe screens are constructed from PVC, slotted to 0.010 inch, measure 2.5-feet in length and include 20/40 mesh sand enclosed within a stainless steel screen.

A notch will be cut in the top of the casing to be used as a measuring point for water levels.

6.2.2.1.1 Screen Location

The screened intervals will be selected for each proposed well, based on visual observations of aquifer materials encountered and objectives in the project work plan.

6.2.2.1.2 Filter Pack

A filter pack will be installed in the annular space between the borehole wall and the Geoprobe pre-packed well screen. The filter pack will consist of clean, inert, well rounded silica sand and contain less than 2 percent flat particles. The filter pack will be certified as free of contaminants by the supplier and have a grain size distribution compatible with the formation materials and the screen.

A filter pack size of 8-16 or 10-20 grade sand will be used based on past practice at DDMT. If the site conditions show significant change (i.e. more gravelly, or more fine-grained soil) from those previously encountered a grain-size analysis will be completed and the filter pack selected based on those results. The filter pack will be placed from two feet below to two feet above the well screen, except at the deepest well screen where the filter pack will extend 1 foot below the well screen.

Prior to installation of the well casing, the total depth of the borehole depth will be measured from the top of the 8-inch steel drill casing by the drilling contractor to verify that the target depth has been reached. Care will be taken to prevent bridging by frequently measuring the thickness of the filter pack as it is placed. As the steel casing is slowly withdrawn between lifts, it will be vibrated with the sonic drilling head to compact the sand filter pack.

6.2.2.1.3 Bentonite Seal

A minimum 5-foot thick bentonite seal will be installed in the annular space of the well above each filter pack to separate the nested well screens. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. When the seal is installed above the water table, the bentonite will be hydrated with water from an approved water source. At least 5 gallons of water will be added after each 24 to 30 inches of bentonite is placed. The bentonite seal will be allowed to hydrate for a minimum of one hour prior to construction of overlying filter pack or placement of the grout collar around the wells.

6.2.2.1.4 Grout Seal

A non-shrinking cement-bentonite grout mixture will be placed in the annular space from the top of the uppermost bentonite seal to approximately 6-inches below the ground surface. Concrete will be added in the remaining annular space during installation of the protective casing and concrete pad.

The cement-bentonite mixture will consist of 94 pounds of neat Type I Portland or American Petroleum Institute (API) Class A Cement, not more than four pounds of 100 percent sodium bentonite powder, and not more than 8 gallons potable water. A side discharge tremie pipe will be used to place the grout mixture into the annular space. The tremie pipe will be located a maximum of 10 feet from the top of the bentonite seal in deep wells to ensure even placement of grout in the annular space. Pumping will continue until undiluted grout is visible at the surface.

6.2.3 Discreet Vapor Monitoring Point

VMPs will be constructed in soil borings advanced using direct push technology or sonic drilling methods. Each VMP borehole will be drilled approximately 0.5 feet below the target depth and backfilled with filter sand before installing the VMP. A 12-inch section of #100 mesh stainless steel screen implant will be installed to the surface with ¼-inch ID Teflon tubing. VMP screen and tubing will be new and unused material.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged #2 sand with a grain size distribution curve that meets the gradation specification. The filter pack will be gravity-placed through the drill casings in lifts of one to two feet. Care will be taken to prevent bridging by slowly pouring filter pack and frequently measuring the thickness as it is placed. The drill casing will be withdrawn between lifts to place the sand filter pack against the native soil. The filter pack will extend from the bottom of the borehole to approximately one foot above the top of the VMP screen.

A seal of dry bentonite with a thickness of approximately one foot will be placed above the filter pack. The 100 percent sodium bentonite seal will consist of ¼-inch chips or crumbles. Bentonite will continue to be placed into the borehole until approximately 3 feet bgs and hydrated in 5-foot lifts. The bentonite seal will be placed using gravity methods, or by the tremie method if bridging is encountered. Because the bentonite seal will be placed above the water table, sufficient water will be added to allow complete hydration of the bentonite.

6.2.4 Nested Vapor Monitoring Point

Borings will be advanced via sonic drilling utilizing a 6-inch inner casing and an 8-inch diameter outer casing. After reaching the desired depth, the 6-inch casing will be removed and the nested VMP will be constructed.

Each nested VMP will consist of up to four VMPs constructed within a single boring. The VMPs will be constructed with 1/4-inch inside diameter Teflon tubing and 12-inch section of #100 mesh stainless steel screen implant. Each VMP will be secured to ¼-inch dimeter threaded rod, stainless steel where adjacent to implant, with new stainless steel hose clamps to prevent coiling of the flexible tubing in the boring. VMP screen and tubing will be new and unused material.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged #2 sand with a grain size distribution curve that meets the gradation specification. The filter pack will be gravity-placed through the drill casings in lifts of one to two feet. Care will be taken to prevent bridging by slowly pouring filter pack and frequently measuring the thickness as it is placed. The drill casing will be withdrawn between lifts to place the sand filter pack against the native soil. The filter pack will extend from the bottom of the borehole to approximately one foot above the top of the VMP screen.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged sand with a grain size distribution curve that meets the gradation specification. The filter pack will be gravity-placed through the hollow stem auger drill casings in lifts of one to two feet. Care will be taken to prevent bridging by measuring the thickness of the filter pack as it is placed. The drill casing will be withdrawn between lifts to place the sand filter pack against the native soil. The filter pack will extend from the bottom of the borehole below the screen interval to approximately one foot above the top of the well screen.

A seal of dry bentonite with a thickness of approximately one foot will be placed above the filter pack. The 100 percent sodium bentonite seal will consist of ¼-inch or ⅜-inch diameter dry bentonite pellets or chips. Bentonite pellets or chips will continue to be placed into the borehole until approximately 3 feet below the shallower screen interval and hydrated in 5-foot lifts. Approximately 2.5 feet of dry bentonite chips or pellets will be placed below the shallower filter pack and not hydrated to prevent swelling. The shallower VMP(s) will be constructed in the same method as above.

6.2.5 Soil Vapor Extraction Well

The SVE wells are to be constructed in 6-inch diameter soil borings advanced using sonic drilling methods. SVE soil borings will be advanced to first encountered groundwater. The borehole will be backfilled with filter sand at least five feet above the first encountered groundwater. 10-foot sections of 0.010-inch slot size 2-inch diameter Schedule 40 polyvinyl chloride (PVC) screen will be installed from 5 feet bgs above groundwater to the top of the fluvial sands. Schedule 40 PVC riser will extend to approximately 6 inches bgs. Centralizers will be used at the top of the screened section, and every 30 feet along the riser. Well screen and riser will be new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged sand with a 15/18 or 10/20 grain size distribution. The filter pack will be gravity-placed through the center of the sonic drill casings in lifts of one to two feet. Care will be taken to prevent bridging by measuring the thickness of the filter sand as it is placed. The drill casing will be withdrawn between lifts to place the sand filter pack against the native soil. The filter pack will extend from the bottom of the borehole below the screen interval to approximately three feet above the top of the well screen.

A seal of hydrated bentonite with a thickness of approximately five foot will be placed above the filter pack. The 100 percent sodium bentonite seal will consist of ¼-inch or ⅜-inch diameter dry bentonite pellets or chips. The bentonite seal will be placed using gravity methods, or by the tremie method if the pellets or chips bridge in the borehole annulus. Because the bentonite seal will be placed above the water table, sufficient water will be added to allow complete hydration of the bentonite.

A bentonite-cement grout seal will be placed in the annular space above the bentonite seal. The grout will be placed using a side discharge tremie pipe and will be continuously pumped until grout returns to within 6-inches of the ground surface. The grout will be allowed to cure for a minimum of 24-hours before further grouting or well construction.

6.2.6 Surface Completion

Surface completion (flush-mount or stick-up) will be selected by the PM based on location and planned land use. For flush-mount completions, the well casing(s) will be cut approximately 3 inches below ground surface and secured with a water-tight locking cap to prevent surface water from entering the well. VMP tubing will be cut and capped with a valve. The VMP tubing or well casing will be covered by a bolted manhole cover set in a 3-foot by 3-foot by 4-inch thick concrete pad that slopes away from the manhole.

If an aboveground surface completion is used, the VMP tubing or well casing will be extended 2 or 3 feet above ground surface and secured with a valve or water-tight cap. The protective casing will be a steel sleeve placed over the VMP tubing or well casing; the steel sleeve diameter will be at least 4 inches greater than the well casing diameter or at least 8-inches diameter for nested wells and 4-inches in diameter for VMPs. The protective casing will be set in a 3-foot by 3-foot by 4-inch concrete surface pad. A vent hole will be drilled in the steel sleeve about 1 inch above the top of the well pad. The pad will be sloped away from the well sleeve and a lockable cap or lid will also be installed. Three 3-inch diameter concrete-filled steel guard posts will be installed around each well unless the well is located in an area receiving vehicular traffic. These guard posts will be 5 feet in total length and installed radially from the well head. The guard posts will be installed approximately 2 feet into the ground and set in concrete just outside the concrete pad. The protective sleeve and guard posts will be brush-painted yellow or orange.

Wells and VMPs will be secured immediately after well completion. Corrosion-resistant locks will be provided for both flush and aboveground surface completions. A brass survey marker will be installed in each concrete pad and the well ID will be stamped in the marker. A reference point will be marked on the well casing for use in groundwater level and well depth measurements. This reference point will marked by the HDR geologist/engineer with permanent marker for PVC wells, or by notching the top of casing for stainless steel wells. By convention, this marking is usually placed on the north side of the top of casing.

6.2.7 Location Survey

Following installation of the surface completion for each well and VMP, the locations will be surveyed for horizontal control and elevations at top of casing (wells only), ground surface and well pad by a Tennessee-licensed surveyor. The top of casing elevation will be made at the reference point on the north side of the top of casing; the surveyor will not mark the wells in any way. Vertical coordinates will be based on the North American Datum, 1927 used for all survey data at DDMT. Horizontal coordinates will be provided in the Tennessee State Plane coordinate system. Accuracy for well locations will be within 0.01 foot for elevations and within 0.1 feet for horizontal coordinates.

6.2.8 Installation Diagrams

The HDR geologist/engineer will maintain suitable logs detailing drilling and construction practices. Well dimensions, amount, type and manufacture of materials used to construct each well will be recorded in the logbook. Additional information to be recorded in the field for the well installation diagram will include:

- Well or VMP identification.

- Drilling method.
- Installation date(s).
- Total boring depth.
- Lengths and descriptions of the screen(s) and riser(s).
- Thickness and descriptions of filter pack, bentonite seal, annular grout, and any backfilled material.
- Quantities of all construction materials used.

6.2.9 Well Development

The purpose of well development is to create good hydraulic contact between the well and the aquifer and to remove accumulated sediments from the well. Each newly installed monitoring well will be developed no sooner than 24 hours after installation to allow for adequate grout curing time. The water volume purged during development will exceed the volume of potable water or other drilling fluids used during drilling and well installation.

The wells will be developed with a surge block in conjunction with a pump sized to effectively develop the well. No detergents, soaps, acids, bleaches, or additives will be used during well development. Development will continue until clear, sand-free formation water is produced from the well and until pH, conductivity, turbidity, and temperature measurements have stabilized.

The monitoring well development protocol is as follows:

- Measure the static water level (SWL) and the depth to the top of sediment in the well.
- Record the total depth of the well (from the Well Installation Diagram).
- Calculate the volume of water in the well and saturated annulus.
- Begin developing the well using a combination of surging and pumping. Continue pumping and periodically surging until each the following criteria have been met:
    - Fluids lost to the formation during drilling and well installation have been removed (this is a minimum requirement where conditions permit).
    - Stabilization of water quality parameters is achieved after three successive readings are within ± 0.1 for pH, ± 3% for specific conductance, ± 10% for dissolved oxygen (DO) values greater than 0.5 milligrams per liter (mg/L) or three successive DO values less than 0.5 mg/L, ± 10 millivolts for oxidation reduction potential (ORP), 3% for temperature, and 10% for turbidity values greater than 5 nephelometric turbidity units (NTU) or three successive values less than 5 NTU (USEPA, 2017).
    - If feasible, monitor the SWL during purging. Adjust the purge rate to keep the SWL from dropping more than 0.3 meter from the initial SWL.
    - No sediment remains in the bottom of the well. However, it can be accepted if the sediment thickness remaining within the well is less than 1 percent of the screen length.

- In the event that the above criteria have not been met after six hours of pumping, surging, and bailing (including recharge time for poorly recharging wells), development activities will be temporarily discontinued at that well. The FTL and PM will decide whether or not to continue development.
- In the event of slowly recharging wells that will not sustain pumping or bailing, the field staff will advise the FTL as soon as a determination of estimated recharge time has been made.
- Physical characteristics of the water (suspended sediment, turbidity, temperature, pH, EC, purge rate, odor, etc.) will be recorded throughout the development operation. At a minimum, they will be recorded initially and after each well volume has been removed, or every 30 minutes, whichever comes first.
- The total quantity of water removed and final depth to the top of sediment (total depth of well) will be recorded.
- Well development equipment will be decontaminated prior to use in each newly-installed monitoring well.

6.2.9.1 Well Development Records

Well development data will be recorded on Well Development Data Sheets, which should include the following information:

- Method of development.
- The model number and type of water quality instruments.
- The model and type of water pump used for development.
- The flow rate of the pump.
- The type and technique used for surging of the well.
- Final water quality description (e.g., color, odor, clarity).
- Identification of conditions that might reflect the results of the development if it was successful or why it was not.
- Volume of water removed from the well.

6.2.9.2 Well Development Water

Development water will be drummed or stored in bulk containers. The containers will be clearly labeled with site name, well name, date, and contents. The development water will be properly disposed in accordance with investigation derived waste (IDW) procedures set forth in the project work plan.

6.2.10 Well Abandonment

Monitoring wells at DDMT are reviewed annually with regard to classification, sample frequency and utility. Wells are recommended for abandonment based on the following criteria:

1. The well is redundant: duplicates information; not in the flow pathway of on-coming plumes and not required to establish background; or analytical data will have no clear, reasonable use in future decision making.
2. The monitoring well (MW) has sustained damage and cannot be repaired, or an object that cannot be removed has become lodged in the MW.
3. The MW was installed for a specific reason that no longer applies.

Wells are scheduled for abandonment after recommendations are approved by USEPA and Tennessee Department of Environment and Conservation (TDEC).

Well abandonment will be completed in accordance with SCHD requirements following issuance of a fill and abandonment construction permit from SCHD. Well abandonment will be conducted by a TN-licensed well contractor. An HDR geologist/engineer will oversee well abandonment activities. The following procedure will be used for well abandonment:

- Total well depths will be measured and compared to depths recorded during well installation to determine if obstructions are present in the well.
- One-half gallon of bleach will be poured into the well as a disinfectant.
- The well screen and casing will be filled with grout (Portland type II cement with 5 percent bentonite) from the bottom up using a tremie pipe. After allowing the grout time to settle, additional grout will be added to fill the well casing to approximately 6 inches below ground surface (bgs).
- Surface completions including well pads and manholes will be removed at wells located in grassed or graveled areas. If necessary, the well casing will be cut off a few inches below the ground surface. The pad areas will be recovered with either topsoil/grass seed or gravel. At wells located in concrete or asphalt-paved areas, the manhole covers will be removed and the manholes filled with concrete. Bollards will be removed at all abandoned wells.
- Surface completion materials including manholes, bollards, well lids and wells casings will be placed in a roll-off and properly disposed.

The following information will be recorded to document the well abandonment:

- The total depth of the abandoned wells and whether obstructions had to be removed.
- The amount and type of Portland and bentonite used for grouting.
- The volume of grout used to fill the well casing and the volume of water recovered during grouting.
- Disposal of surface completion materials removed during well abandonment.

6.3 Closeout

6.3.1 Daily Closeout

Perform following activities daily before leaving the site:

- Decontaminate and check condition of field equipment.

- Provide log books and other field documentation to FTL for review.
- Properly dispose of trash, debris and used PPE.
- Secure the site for the night and/or weekend.
- Prepare daily report as required by the project-specific work plan or SOPs and submit report to the PM. Note any problems or deficiencies in field activities.

6.3.2 Field Event Closeout

Upon completion of field activities, the FTL will view each site to verify the area has been cleared and restored as closely as possible to its prior condition. Trash will be removed from the site, and surface damage including ruts caused by vehicles, will be repaired.

Confirm all equipment is accounted for and properly decontaminated and in good working condition. Notify FTL if repairs are needed. Properly package and ship all rental equipment to the vendor. When shipping equipment, use the proper HDR FedEx number and insure the package for the cost of the equipment. Follow manufacturer’s instructions on long and short term storage when storing government and/or HDR equipment.

Rental trucks should be fueled and returned to the rental company as soon as possible. HDR leased trucks should also be fueled and cleaned prior to storing at the shop.

Work areas should be cleaned with tools and equipment properly stored.

The FTL will make a final check of all logbooks and other field records to ensure there are no blanks or missing data and the entries are legible.

The FTL will complete Field Event Closeout Report and submit to PM.

7 Data and Records Management

All field forms and logbook entries will be scanned and copied to the project folder on the network file share drive within one week of the field event completion. All photographs taken during the field event will also be uploaded along with a typed photograph log (date, project and subject) to the network file share. All uploaded photographs will then be erased from the camera. All original forms will be stored on site at the field office in Memphis in the appropriate project-specific filing cabinet and task-specific labeled folder.

Well logs and sample results for new wells will be submitted to the SCHD in accordance with permit requirements.

8 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the project-specific work plan, and applicable SOPs. All field activities will be recorded in the logbooks in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or logbooks. A single line will be used to strike out errors and will be annotated with the initials and date of the editor. Well completion diagrams will be typed into a spreadsheet provided by the CAD operator for the inclusion into computerized well diagrams.

9 References

HDR, 2018. *DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1*. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

Shelby County Health Department, Pollution Control Section, Water Quality Branch, <http://www.shelbycountytn.gov/DocumentCenter/Home/View/767>.

United States Environmental Protection Agency (USEPA) Region 4 SESD Guidance, *Design and Installation of Monitoring Wells* (SESDGUID-101-R1), January, 2013.

USEPA 2017. *Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. September 2017.

STANDARD OPERATING PROCEDURE 5 – VAPOR SAMPLE COLLECTION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for vapor sampling at Defense Depot Memphis, Tennessee (DDMT). Vapor samples can be collected using active methods (e.g. vacuum to extract the vapor) for field screening with photoionization detector (PID) and in Summa cannisters for laboratory analysis or via passive methods using sorbent media. The project work plan must be reviewed for specific requirements.

2 Health and Safety

General Information on health and safety requirements are provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for vapor sampling include the use of lead-acid batteries, pressurized tubing, hot surfaces, and biological hazards. Batteries should be handled and transported properly to avoid acid spills. Some vapor samples locations are under positive pressure, and safety glasses should be worn at all times. Equipment in the machine rooms, including metal piping, can be very hot and care should be taken to not come in contact with the hot surfaces. Biological hazards include spiders, wasps, bees, and possibly snakes; care should be taken when reaching into areas that cannot be visually inspected.

3 Personnel Qualifications and Responsibilities

Vapor sampling will be directed by a Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with appropriate experience. Field staff will be junior to mid-level environmental professionals or environmental technicians.

4 Equipment and Supplies

Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for a vapor sampling will include a combination of the following based on project requirements: a photoionization detector (PID), a vacuum pump, Tedlar bags, flow controller(s), Summa canisters, passive samplers, hand tools, hammer drill and bits, 5-gallon buckets, concrete, water, and cones.

Each sampler will have use of a truck/van during field activities. An initial safety check should be performed at the start of each shift to confirm the vehicle is in good working condition. The vehicle should then be checked daily for damage or required maintenance.

5 Procedure

5.1 Start-Up Activities

5.1.1 Office

The Project Manager (PM) will assign a FTL to direct field activities and coordinate with project personnel. General responsibilities are described in SOP 1. Task specific responsibilities include:

- Coordinate sampling activities with the project chemist (PC) and analytical laboratory; prepare a sampling plan detail listing the sample locations and schedule shipment of laboratory-supplied Summa canisters and equipment for arrival prior to the start of sampling.
- Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies (tubing and Tedlar bags) for delivery prior to the start of sampling event.
- Prepare field forms and other documentation for the planned event.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the following activities will be performed:

- Complete equipment and supply checklists and verify that required documentation and equipment for field activities are on site.
- Review condition of DDMT-owned and rental equipment; inventory field supplies and laboratory-provided sampling supplies. Sample tubing and Tedlar bags should be replaced every three months.
- Confirm the exact locations of the samples to be collected.
- Check that monitoring equipment is functioning properly and calibrated as needed.
- Due to the limited field activities for vapor sampling, completion of the Field Event Startup Report (SOP 1, Attachment 1-1) is not required.

5.2 Field Operations

Vapor samples at DDMT can be collected using active methods (e.g. vacuum to extract the vapor) for field screening with PID and in Summa cannisters for laboratory analysis or via passive methods using sorbent media. Methods to conduct vapor sampling at DDMT using active or passive sampling methods is described below.

Prior to sampling, a field station will be established. The station will contain equipment, supplies, safety gear, and instrumentation necessary for the collection of samples. Environmental conditions will also be noted. Each sampling site will be characterized by the following factors:

- Location of work
- Weather conditions including precipitation, temperature and wind direction
- Ongoing activities that may influence or disrupt sampling efforts
- Accessibility to the sampling locations

All laboratory sampling will be documented in the field logbook. The logbook will summarize sampling events include sampling locations and times, field conditions and other significant information.

5.2.1 Active Sampling

Active sampling utilizes a vacuum to extract soil vapor from the subsurface for field measurements in a Tedlar bag and/or analysis at a laboratory. Field screening and laboratory vapor samples are collected from individual soil vapor extraction (SVE) wells, the SVE system effluent (vapor stream from all SVE wells), vapor monitoring points (VMPs), sub-slab vapor ports, and soil borings using the post run tubing (PRT) method. Samples for field measurements will be collected using an oil-less vacuum pump and captured in Tedlar bags for photoionization detector (PID) readings. Laboratory vapor samples will be collected via Summa canisters; flow controllers may be used depending on project requirements.

5.2.1.1 Sample Containers for Laboratory Analysis

Laboratory samples will be collected by field personnel in accordance with the project work plan and at the direction of the PM. Sample collection will follow United States Environmental Protection Agency (USEPA) TO-15 volatile organic compounds (VOCs) procedures. Laboratory samples from the SVE system effluent will be collected in unrestricted 6-liter Summa canisters; a 200-milliliter/minute (mL/min) regulator for laboratory analysis will be used when collecting samples from VMPs, sub-slab sample ports and PRT soil borings. Laboratory samples from sub-slab sample ports and soil borings will be collected in 1-liter Summa canisters restricted with a 200 mL/min regulator. Standard turnaround time (TAT) for laboratory results is 15 workdays.

Summa canisters should be delivered from the analytical laboratory with a pressure gauge and a flow regulator (if needed) for each canister. Arrangements for delivery will be coordinated by the PC.

5.2.1.2 Sample Containers for Field Measurements

Samples for field measurements will be collected using an oil-less vacuum pump or syringe and contained in a 1-liter Tedlar bag. A 200 mL/min flow regulator may be necessary when utilizing the vacuum pump or flow rate manually controlled with a syringe, depending on project specific data quality objectives.

5.2.2 SVE Wells and System Effluent

Field measurements and samples for laboratory analysis will be collected to monitor system performance and VOC concentrations in emissions.

5.2.2.1 Field Measurements

Field measurements will be collected from individual SVE wells and system effluent. While online, the SVE system is continuously pulling vapor from the subsurface; thus, no purging of wells or the system is required prior to PID measurements. Ensure all wells to be sampled are online for a minimum of two hours prior to sample collection. Field measurement procedures are as follows:

- Connect sampling pump inlet hose to SVE well sample port located on SVE manifold.
- Open appropriate well sample port ball valve.
- Turn on sampling pump and allow it to run for five seconds to purge the pump and tubing.
- Connect Tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow Tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect Tedlar bag from sampling pump.
- Close SVE well sample port ball valve.
- Connect calibrated PID to Tedlar bag.
- Allow PID to measure VOC concentration. Ensure reading on PID stabilizes before recording VOC concentration (usually 10 to 15 seconds).
- Record peak VOC concentration and time.

5.2.2.2 Laboratory Samples

Procedures for sample collection from the SVE wells and system effluent are as follows:

- Fill out Summa canister tag with sampling information using a pen with blue or black waterproof ink.
- Remove the Summa canister valve cap.
- Use vacuum gauge to measure Summa cannister pressure and record the pressure on the chain-of-custody (COC). The starting Summa canister pressure should be at least -25 inches of mercury (in. Hg) or greater. If not, the canister has leaked and should not be used.
- Run dedicated tubing from SVE manifold to canister by connecting Swagelok.
- Open appropriate SVE well/effluent sample port ball valve.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow Summa canister to fill until pressure gauge reads -5 in. Hg. (approximately 15-seconds with a 6-liter canister).
- Close Summa canister valve.
- Close sampling port ball valve at SVE well or effluent port.
- Disconnect Summa canister from regulator, if used.

- Record time of sample collection, date, and Summa canister serial and regulator (if used) numbers on COC form.

5.2.3 Vapor Monitoring Points

PID measurements and samples for laboratory analysis will be collected from VMPs to measure VOC concentrations in soil vapor; the results can be used to evaluate potential for vapor intrusion or SVE system performance. PID measurements will usually be made prior to collecting samples for laboratory analysis. Pressure measurements at VMPs are used to estimate SVE system vacuum influence. It is necessary to conduct a shut-in test and purge VMPs prior to collecting samples for laboratory analysis; the procedure will be repeated for each VMP screen at nested VMPs. Methods for field measurement and laboratory analysis are listed below.

<u>Shut-in Test</u>

A shut-in test of the aboveground sampling train will be performed to locate leaks prior to purging and sampling for laboratory analysis. This test is performed by assembling the sample train, as if a sample was being collected, using a vacuum of at least 100 inches of water (7.4 in. Hg) is applied. At this point, the sample train should be isolated from the sample port either by a valve or disconnected and plugged so that the vacuum can be applied without evacuating soil vapor. After the vacuum is applied, the field technician will observe the vacuum gauge on the sample train for any change in vacuum. If the vacuum in the sample train dissipates then the leak will be located, corrected, and the test will be repeated until the sample train can hold a vacuum for at least thirty seconds.

<u>Pressure Measurement:</u>

- Unlock VMP well casing (secured by padlock).
- Select a digital manometer or magnehelic gauge based on project requirements.
- Zero the pressure gauge at the point of use and connect to the sample port.
- Open the valve on the sample port and allow the reading to stabilize.
- Record the stabilized reading on the sample form.

<u>Purging:</u>

- Prepare sample train, which includes flow regulator, summa cannister, pressure gauge, flow gauge, three-way valve and syringe or oil-less vacuum pump.
- Perform shut in test and correct leaks if any.
- Use the syringe, or vacuum pump, and allow lines to purge for approximately five minutes, or as necessary to remove three casing volumes based on VMP depth. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.
- Measure the pressure and flow rate during purging. If pressure exceeds 100 inches of water and/or flow rate is less than 100 ml/min the sample should be collected with qualification that high vacuum and low flow condition was measured.

<u>Field (PID) Measurements:</u>

- After purging, attach Tedlar bag to discharge of sampling pump or syringe by inserting nipple of bag into discharge tube.
- Allow Tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect Tedlar bag from sampling pump.
- Connect calibrated PID to Tedlar bag.
- Allow PID to measure VOC concentration. Ensure reading on PID stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds.
- Record peak VOC concentration and time.
- Open valve on Tedlar bag to completely deflate bag.
- Collect additional PID readings following the previous steps until three consecutive readings are within 10% of each other.

5.2.3.1 Laboratory Samples

Procedures for sample collection are as follows:

- Purge vapor from the VMP, if not already performed for PID measurement.
- Record starting Summa canister pressure on COC. The starting Summa canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow Summa canister to fill until pressure gauge on regulator reads -5 in. Hg.
- Close sampling port ball valve at VMP cap.
- Disconnect Summa canister from regulator.
- Record time of sample collection, date, and Summa canister serial and regulator numbers on COC form.

5.2.4 Sub-Slab and Soil Boring Vapor Sampling

Sub-slab sample ports will be installed to evaluate VOC concentrations beneath or adjacent to impervious surfaces. Vapor Pin, or equivalent device, will be constructed in accordance with manufacture specifications to allow for collection of sub-slab samples for field measurements or laboratory analysis. Active shallow soil vapor samples will be collected from soil borings via the post run tubing (PRT) method. Procedures for these sampling methods are presented below.

5.2.4.1 Water Dam Procedure

Leak testing of the Vapor Pin annular seal will be performed with a water dam in accordance with the method prescribed in the Vapor Intrusion Technical Guidance (NJDEP, 2016). The water dam will be constructed from PVC and surround the sub-slab sample port. The water dam will be sealed to the concrete floor with modeling clay or other VOC free inert material. The water dam will be filled with distilled/deionized water so that it is covering the sub-slab sample port annular seal. The water level will be briefly observed to verify that the water level is not receding. If the water level remains stable the sample train will be purged and a sample will be collected while continuing to observe the water level. Should the water level decrease, the sampling will be stopped, a new sub-slab sample port will be installed and the process repeated.

5.2.4.2 Sampling

After the field technician has completed the shut-in test and purged three casing volumes, the soil vapor sample will be collected, in accordance with methods listed in Section 5.2.3. This will be performed by opening the valve on the top of the 1-liter Summa canister and allowing the canister vacuum to remove one liter of soil vapor at a 200 ml/min flow rate. The Summa canister will be labeled with the sample identification (ID), starting vacuum, ending vacuum, sampler's initials, sample date, and sample time.

Field records will be maintained that detail site activities and observations so that an accurate, factual account of field procedures may be reconstructed. At a minimum, the field records will contain sample ID, collection time, location description, methods used, daily weather conditions, field measurements, name of sampler(s), names of contractor/subcontractor personnel, and other site-specific observations including any deviations from the project work plan. HDR will periodically record the precipitation, temperature, and barometric pressure from a nearby weather station during and 72 hours prior to sample collection.

5.3 Passive Vapor Sampling

Passive soil vapor sampling utilizes sorbent material that are placed into the subsurface to adsorb volatile and semi-volatile organic compounds (VOCs and SVOCs) in vapor without forcing the flow rate of vapor. Passive samplers for soil vapor sampling are typically placed in a grid pattern to simultaneously sample trace levels of compounds that originate from contaminants in soil or groundwater. Passive samplers may also be placed in crawlspaces or in sewer lines to measure VOC concentrations prior to vapor intrusion. Passive samplers may be provided by Beacon-Environmental (Beacon) or other manufacture utilizing similar equipment.

5.3.1 Soil Vapor Sampling

A one-inch diameter hole is advanced to the appropriate depth to meet the objectives of the survey (e.g., one to three feet). The passive sampler (which contains two sets of hydrophobic sorbent cartridges) is installed in the hole and covered with an aluminum foil plug and soil or a thin layer of concrete to seal the sampler in the ground and allowed to remain undisturbed for up to two weeks, or less, based on reporting limits and data quality objectives. Methods to install and collect the passive sampler is listed below.

5.3.1.1 Sampler Deployment

After the passive sample locations have been cleared for underground utilities by Tennessee 811, the following procedures will be completed to deploy passive samplers.

- For locations covered by asphalt or concrete, an approximately 1 ½-inch diameter hole is drilled through the pavement to the underlying soil. A 1-inch diameter drill bit is then used to advance the hole to three feet below ground surface (bgs).
- The drill bit is removed from the hole, and the ground surface is cleaned of soil cuttings and other debris.
- The upper 12 inches of the boring will be sleeved with a 12-inch-long sanitized metal pipe provided by Beacon.
- The passive sampler is installed inside the metal pipe and the boring is patched with aluminum foil.
- A thin patch of concrete, if deployed in paved area, or soil, if deployed in an unpaved area, is placed on top of the aluminum foil to protect the sampler.
- The samplers remain in place for approximately 14 days, with duration dependent on data quality objectives and laboratory reporting limits.
- The sampler location is recorded with submeter global positioning system (GPS) receiver and marked with spray paint or other method to ensure that the sampler can be located.

5.3.1.2 Sampler Retrieval

- The following procedures will be completed to retrieve passive samplers. The recorded GPS coordinates will be used to locate the sampler. A metal detector may be used to further pinpoint the aluminum foil and metal pipe as locating the sampler may be difficult if properly covered.
- The thin concrete patch covering the sampler is removed with hammer and chisel, or equivalent. A garden trowel or other hand tool can be used to remove soil covering the sampler.
- The passive sampler is removed from the steel tube and wiped clean with a paper towel.
- A label is added to the sample which indicates sample ID, time, and date at a minimum.
- Clear tape is placed over the label, the sample is placed into bubble wrap and stored per manufacture specification. Sample preservation or storage on ice is not necessary.

5.3.1.3 Boring Abandonment

After sample collection the 12-inch long steel tube will be removed from the boring. The boring will be filled to the ground surface with cement grout and the surface restored to match adjacent conditions.

5.3.2 Sewer Line Vapor Sampling

5.3.2.1 Initial Assessment

Prior to Beacon sampler deployment, each manhole will be evaluated without entering the confined space. HDR will attempt to measure the depth and diameter of the sewer line, manhole diameter, and depth of fluid, if any. The sewer line condition will be noted, to extent it can be assessed from the ground surface.

5.3.2.2 Sampler Deployment

Sewer line vapor samples will be collected from approximately one foot above the liquid level or one foot above the base of the sewer line if liquid is not present. Beacon samplers will be suspended from the manhole lid so that they can easily be deployed and collected without confined space entry. Due to variability of manholes at DDMT, the following general procedures are listed below:

- Deploy traffic control, and cones as necessary around the manhole and work area.
- Use proper tool to remove the manhole cover.
- Use tape measure to measure manhole diameter, sewer line depth and depth to liquid surface, if any.
- Document manhole condition, cracking, soil accumulation or other condition that would indicate that the sewer line has been damaged. Note whether liquid is present.
- Measure and cut tether (e.g. nylon string) so that the Beacon sampler will be suspended approximately one foot above the base of the sewer line or liquid level, if present. Attach one end of tether to Beacon sampler and other end to Neodymium magnet with eye bolt.
- Attach Neodymium magnet to the center of the bottom of the manhole cover and slide the manhole cover back into place.
- Record sample latitude and longitude with GPS receiver.

5.3.2.3 Sampler Retrieval

The following procedures will be completed to retrieve passive samplers.

- The recorded GPS coordinates will be used to locate the manhole.
- The manhole cover will be opened, and the magnet and passive sampler will be removed and wiped clean with a paper towel. Evidence of the sampler being inundated by flow through the sewer line will be noted.
- A label will be added to the sampler indicating sample ID, time, and date at a minimum.
- Clear tape is placed over the label, the sample is placed into bubble wrap and stored per manufacture specification. Sample preservation or storage on ice is not necessary.

5.4 Closeout

5.4.1 Field

Following sample collection, the following procedures will be performed by on-site personnel:

- Decontaminate all field equipment.
- Ensure all field documentation is completely filled out; this includes the COC, passive sampler or Summa sampling tags/labels. Unless revised by the PM, standard turn-around time (15 days) will be used. Retain copy of COC for the project file.

- Package Summa canisters and/or passive samplers in sturdy cardboard boxes with packing material to prevent any damage. In most cases, the boxes and packing material used by the laboratory to ship the sample containers to the site can be reused.
- Affix a custody seal across the top taped seam of the shipping carton and elsewhere as necessary to ensure security.
- Ship samples to laboratory for analysis. Ensure copy of COC is included in shipment. Send email to inform the laboratory of the shipment and expected delivery date.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Ensure that equipment and associated supplies have been properly stored or shipped to the supplier.
- Ensure that all IDW/trash has been disposed in accordance with the project work plan and QAPP.

5.4.2 Office

Upon return to the office, field personnel will perform the following:

- Submit logbook and any original forms to Project/Task Manager for review
- Completion of the Field Event Closeout Report (Attachment 1-3) is not required.

6 Data and Records Management

All field forms and log book entries will be scanned and copied to the project folder on the “Z” drive within one week of the field event completion. All photographs taken during the field event will be uploaded along with a typed photograph log (date, project and subject) to the “Z” drive. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM and PC will be sent a link for the data.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the Quality Assurance Project Plan (HDR, 2018), the project work plan, and applicable SOPs. All field activities will be recorded in the log books in sufficient detail to reconstruct the events. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor.

8 References

HDR, 2018. *DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1*. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

New Jersey Department of Environmental Protection (NJDEP), 2016. *Vapor Intrusion Technical Guidance,* August 2016.

STANDARD OPERATING PROCEDURE 7 – SAMPLE CONTROL AND DOCUMENTATION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for sample control and identification, data recording, and proper completion of Chain-of-Custody (COC) forms.

2 Health and Safety

General Information on health and safety requirements are provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for sample handling include potential for exposure to contaminants, sample container preservatives, and injury from breakage of sample containers. Contamination levels at Defense Depot Memphis, Tennessee (DDMT) are relatively low but care should be taken to avoid exposure. Sample containers should be handled carefully; nitrile gloves and safety glasses should be used.

3 Personnel Qualifications and Responsibilities

Sample control activities will be directed by the Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with experience in sampling activities. The field staff, environmental professionals or technicians, are responsible for proper sample handling and documentation of the sample collection.

4 Equipment and Supplies

The field staff will use a pen with blue or black waterproof ink to record field activities and document sample handling in a field logbook and on field data sheets. A laptop computer with laboratory-provided software may also be used for sample documentation.

5 Procedure

Proper field sampling and documentation help ensure sample authenticity and data integrity. These procedures describe sample collection documentation and sample handling, tracking, and custody procedures to ensure that sample integrity and custody are maintained.

If the computer is being used to scan the samples as they are collected the data recorded by the computer should be checked for correctness. The date and time on the computer should be checked prior to scanning of any samples. The sample label should be completed when the sample is collected. If a hand written COC will be used, all information should be recorded in a log book as to the type of sample, date and time collected and number of sample containers. The COC can then be filled out back at the field office in a quiet environment without disturbances to avoid errors.

Corrections to the COC, field logbook or field data forms will be made by a single line to strike out errors annotated with the initials and date of the editor; the correct information will be inserted as appropriate.

The number of sample containers on the COC should be physically checked against the number of containers collected. Once this is confirmed the sample crew can properly store the samples for shipment.

5.1 Start-Up Activities

5.1.1 Office

The FTL will work with the project chemist (PC) to:

- Prepare the sampling plan detail (Attachment 7-1).
- Coordinate with the analytical laboratory and ensure that sample forms including chain of custody forms and custody seals are shipped to the site.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the FTL will confirm that required documentation and equipment for field activities are on site.

5.2 Field Operations

5.2.1 Sample Identification

Individual samples will be identified by a unique alphanumeric code (also referred to as a sample ID number or field number) which will be written on the sample label and recorded on the COC form. The sample ID will include the location and sampling event as described in Worksheet #17 of the Quality Assurance Project Plan (QAPP). Additional information to be written on the label includes sample ID, time and date of sample, sampler's initials, and the analytical methods to be performed, as described in Section 5.2.3 of this SOP.

Field Quality Control (QC) samples to be collected at DDMT include trip blanks, rinsate blanks, field (ambient) blanks, and field duplicates. The ID for trip blanks, rinsate blanks and field blanks will consist of the prefix TB, RB or FB, respectively, followed by a number, followed by the sampling event, as shown below:

TB-1-ODPM-9	first Trip Blank for event ODPM-9
TB-2-ODPM-9	second Trip Blank for event ODPM-9
RB-1-ODPM-9	Rinsate Blank for event ODPM-9
FB-1-ODPM-9	Field Blank for event ODPM-9

Matrix spike and matrix spike duplicate samples will also be collected. The ID for these samples will consist of the location ID, followed by the sampling event, followed by the suffix matrix spike (MS) or matrix spike duplicate (MSD), as shown below:

MW-315-ODPM-9-MS	Matrix Spike sample for well MW-315
MW-315-ODPM-9-MSD	Matrix Spike Duplicate sample for well MW-315

The identity of field duplicate samples will be concealed from the laboratory by using a consecutively numbered duplicate identifier, followed by the sampling event, as shown below:

DUP-1-ODPM-9	first field duplicate for event ODPM-9
DUP-2-ODPM-9	second field duplicate for event ODPM-9

The location of field duplicates will be recorded on the sampling plan detail (SPD) and field notebook. The final SPDs will be maintained in the project file and copies will be kept at the on-site field office. At the end of the sampling event, the FTL will send the PM and PC the final SPD with changes to field duplicate or MS/MSD sample IDs, additional blanks collected, and any other changes.

5.2.2 Field Documentation

5.2.2.1 Logbook

The logbook is a written record of sampling activities to be completed in the field during sampling. The purpose is to document field conditions or procedural exceptions that may aid in the analysis of data generated from sampling activities. The log book will have with sequentially numbered pages and information will be recorded in blue or black waterproof ink. The recorder will sign and date each entry.

Information pertaining to environmental conditions at the site during the field investigation will be noted in the field log book for each day. The following information will be recorded for each activity:

1. Activity
2. Location
3. Date and time
4. Weather conditions

For field sampling activities, the following information will be recorded, if a sampling form is not used:

1. Sample type and sampling method

2. The identity of each sample and the depth(s) from which it was collected
3. Sample description (e.g., color, odor, clarity)
4. Identification of sampling devices used
5. Identification of sampling conditions that might affect the representativeness of a sample (i.e., refueling operations, damaged casings)

5.2.2.2 Daily Field Reports

Each day the FTL will prepare a Daily Field Report (SOP 1, Attachment 1-2). The report will include daily weather, time and description of field activities, samples collected, and any problems or changes in scope that occurred that day. The report also lists field staff, subcontractors and site visitors.

5.2.2.3 Photographs

Photographs taken for the purpose of project documentation will be noted in the field logbook. The sequential number of the photograph, photographer, date, time, location, description, and orientation of the photograph will be recorded in the logbook as the photographs are taken. The photographs and documentation will be loaded on the HDR network project file.

5.2.3 Sample Labels/Tags

Sample labels will be filled out for each sample with an indelible pen. The label will be protected from water and solvents with clear label protection tape. Any change in the pre-prepared label information will be initialed by the sampler.

5.2.3.1 Labels for Groundwater Samples

Pre-printed labels from the laboratory for groundwater sampling events contain the following information:

- Sample ID
- Preservative
- Date the bottle was prepared
- Matrix
- Tests
- Laboratory name
- Bar code

The sample collector will write in the following information:

- Date of collection
- Time of collection
- Name or initials of collector

5.2.3.2 Sample Tags for Air Samples

Sample tags from the laboratory for air sampling events contain the following information:

- Laboratory name, address, phone number and fax number

The sample collector will write in the following information:

- Client name (HDR)
- Sample ID
- Analysis (TO-15)
- Date and time of sample collection
- Sampler's initials
- Comments

5.2.4 Sample Custody

Sample custody is a part of a quality field or laboratory operation. Custody of a sample is defined as:

1. Having physical possession
2. Being in view, after being in possession
3. Having possession, then being placed in a secure area
4. Being maintained in a secure area by the person who had possession last

These custody practices will be observed in the field. They will be performed according to the procedures described in the following subsections.

5.2.4.1 COC Records

A hand-written three-part COC will be fully completed, in triplicate. The first two pages will accompany the cooler to the laboratory, and the bottom copy will be retained in the files at the field office after it is scanned into the computer file.

A computer-generated COC will have one copy printed that will accompany the cooler to the laboratory. The data used to generate the COC will be transmitted via E-mail to the laboratory and a PDF copy of the COC will be saved on the computer in the sampling file.

The information specified on the COC record will contain the same level of detail found in the site log book, with the exception that on-site measurement data will not be recorded. The custody record will include at least the following information:

- Name of person collecting the samples
- Date samples were collected
- Type of sampling conducted (composite/grab)
- Location of sampling station (including the site location)
- Number and type of containers used

- Signature of the HDR person relinquishing samples to a non-HDR person (such as a FedEx agent), with the date and time of transfer noted, and the cooler designation
- Airbill Number

If samples will require rapid turnaround in the laboratory because of project time constraints or analytical concerns such as extraction time or sample retention period limitations, these constraints will be noted in the remarks section of the custody record. The FTL or designee will contact the laboratory to confirm the turnaround time can be achieved. The computer generated COC is for use with Microbac Laboratories only. Other laboratories will provide COCs for use.

It is not practicable to seal the sample coolers or cartons at a FedEx office; they will be sealed beforehand. The custody record will, therefore, have the signature of the relinquishing field technician with the date and time, but the "relinquished to" box will not be completed.

The duplicate custody record will then be placed in a plastic bag, taped to the underside of the cooler lid, and the cooler closed. COCs for air samples will be included in the carton. The container will be tightly bound with filament tape. Finally, custody seals will be signed by the individual relinquishing custody and affixed in such a way that the cooler or carton cannot be opened without breaking the seals.

The original and duplicate custody records and the airway bill or delivery note together constitute a complete record. The FTL will email a copy of the airbill and the COC to the PC, who will maintain the custody records as part of the analytical data file.

<u>Custody Seals</u>: Custody seals will be preprinted, adhesive-backed seals designed to break if disturbed. For groundwater samples, affix custody seals on the sample shipping containers (coolers) in as many places as necessary to ensure security. For vapor samples affix a custody seal across the top, taped seam of the canister shipping carton and additional locations as necessary. Seals will be signed and dated before application.

Laboratory custody procedures are described in the laboratory sample handling and storage SOPs, included in Appendix C of this QAPP.

5.3 Closeout

Before leaving the site daily, the following procedures will be performed by on-site personnel:

- Maintain custody of samples, maintaining them as specified for the analyses to be performed.
- Prepare samples for shipment to the laboratory.
- Complete the COC forms.
- Contact the laboratory to inform them that samples will be shipped and also remind them of any special requirements for the sample analyses.
- Verify completion of logbook, ensuring that required information has been recorded.

Upon the completion of sample collection and shipment, copies of the COCs will be scanned and sent to interested parties to include the PM and PC. The FedEx tracking numbers will be checked each day to confirm the samples were delivered and the laboratory will be contacted to check on problems with the samples or COCs.

6 Data and Records Management

All field forms, COCs, and log book entries will be scanned and copied project folder on the HDR network project file within one week of the field event completion. All original forms will be stored on site in Memphis in the filing cabinet in the proper folder labeled for the project. The PM and PC will be sent a link for the data.

7 Quality Control and Quality Assurance

Work will be performed in accordance with the QAPP, the specific work plan, and applicable SOPs. Field activities will be recorded in the log books in sufficient detail to reconstruct the events and forms provided with the SOP will be completed. No erasures or mark outs will be made on field forms or log books. A single line will be used to strike out errors and will be annotated with the initials and date of the editor; the correct information will be inserted as appropriate.

8 References

HDR, 2018. DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

USEPA Region 4 Science and Ecosystem Support Division (SESD) 2011. SESDPROC-209-R2, *Operating Procedure: Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*. April 2011.

Attachment 7-1

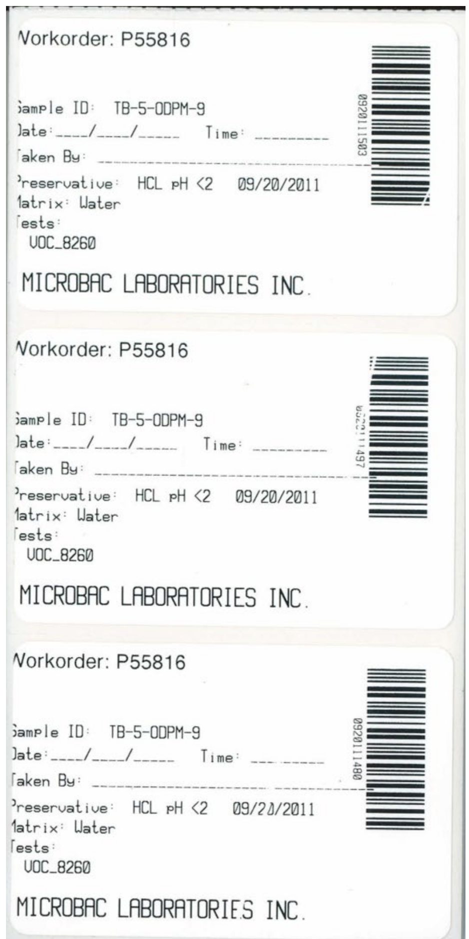
EXAMPLE: Sample Plan Detail

SAMPLING PLAN DETAIL (OFF DEPOT PM WELLS September 2011) - ODPM-9

			Parameter	**VOCs**
			Method	**8260B**
			Container	**40 mL VOA**
			Preservative	**HCl to pH<2**
				Cool to 4°C
#	**Well ID**	**Sample ID**	**Additional**	**No. of Containers**
1	MW-54	MW-54-ODPM-9		3
2	MW-70	MW-70-ODPM-9		3
3	MW-76	MW-76-ODPM-9		3
4	MW-77	MW-77-ODPM-9		3
5	MW-79	MW-79-ODPM-9	DUP-1	3
6	MW-148	MW-148-ODPM-9		3
7	MW-149	MW-149-ODPM-9		3
8	MW-150	MW-150-ODPM-9		3
9	MW-151	MW-151-ODPM-9		3
10	MW-152	MW-152-ODPM-9		3
11	MW-155	MW-155-ODPM-9		3
12	MW-157	MW-157-ODPM-9		3
13	MW-158	MW-158-ODPM-9		3
14	MW-158A	MW-158A-ODPM-9		3
15	MW-159	MW-159-ODPM-9	DUP-2	3
16	MW-160	MW-160-ODPM-9		3
17	MW-161	MW-161-ODPM-9		3
18	MW-162	MW-162-ODPM-9		3
19	MW-163	MW-163-ODPM-9		3
20	MW-164	MW-164-ODPM-9		3
20	MW-164	MW-164-ODPM-9-MS	MS	3
20	MW-164	MW-164-ODPM-9-MSD	MSD	3
21	MW-165	MW-165-ODPM-9		3
22	MW-165A	MW-165A-ODPM-9		3
23	MW-166	MW-166-ODPM-9		3
24	MW-166A	MW-166A-ODPM-9		3
25	MW-241	MW-241-ODPM-9		3
26	MW-242	MW-242-ODPM-9		3
27	MW-243	MW-243-ODPM-9		3
28	MW-244	MW-244-ODPM-9		3
29	MW-245	MW-245-ODPM-9		3
30	MW-246	MW-246-ODPM-9		3
31	RB	RB-ODPM-9		3
32	DUP-1	DUP-1-ODPM-9		3
33	DUP-2	DUP-2-ODPM-9		3
34	TB-1	TB-1-ODPM-9		3
35	TB-2	TB-2-ODPM-9		3

Attachment 7-2

<u>EXAMPLE:</u> Sample Labels for Groundwater Samples

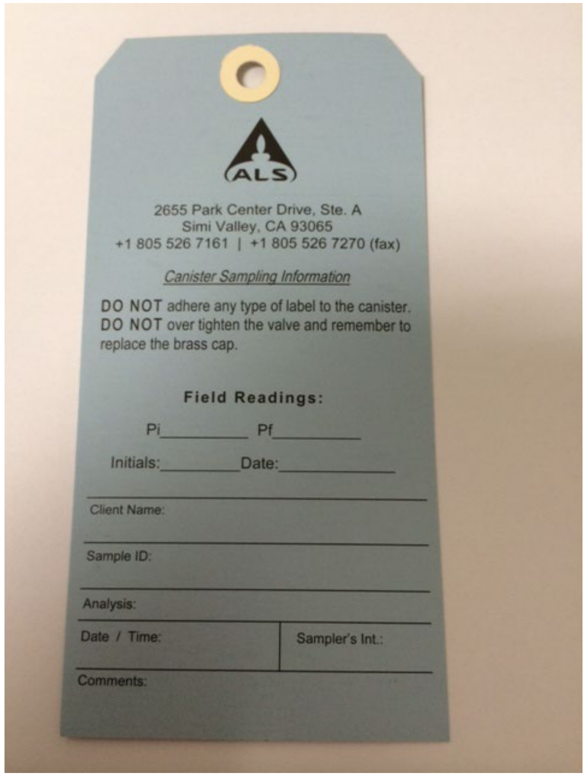

Workorder: P55816
Sample ID: TB-5-ODPM-9
Date: ____/____/_____ Time: _________
Taken By: ______________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260
MICROBAC LABORATORIES INC.
0920111503

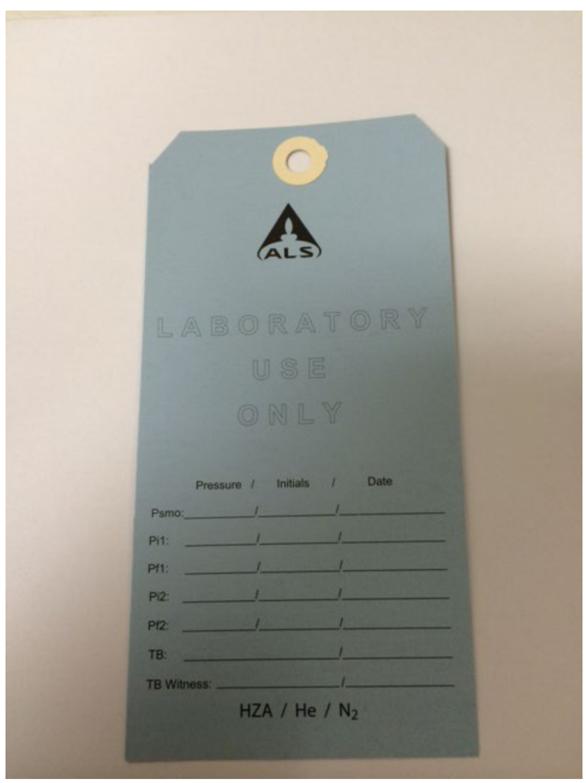
Workorder: P55816
Sample ID: TB-5-ODPM-9
Date: ____/____/_____ Time: _________
Taken By: ______________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260
MICROBAC LABORATORIES INC.
0920111497

Workorder: P55816
Sample ID: TB-5-ODPM-9
Date: ____/____/_____ Time: _________
Taken By: ______________________________
Preservative: HCL pH <2 09/20/2011
Matrix: Water
Tests:
VOC_8260
MICROBAC LABORATORIES INC.
0920111480

Attachment 7-3

EXAMPLE: Sample Labels for Air Samples





Attachment 7-4

EXAMPLE: Microbac Chain-of-Custody Form (Computer)

Microbac

Chain of Custody
Chain #: 1001
Printed at : 04/26/2011 08:46

Barcode	Client ID	Tests	Collect Date	Beg. Depth	End. Depth	Notes
~~0420111~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	ks 4/26		
~~0420112~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	ks 4/26		
~~0420113~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	ks 4/26		
0420111	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420112	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420113	04/25/11-TB-1-ODPM-8	VOC_8260	04/25/2011 10:09			
0420114	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420115	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420116	DUP-1-ODPM-8	VOC_8260	04/25/2011 11:32			
0420117	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
0420118	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
0420119	MW-250-ODPM-8	VOC_8260	04/25/2011 10:30			
04201110	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201111	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201112	MW-251-ODPM-8	VOC_8260	04/25/2011 10:42			
04201113	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201114	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201115	MW-54-ODPM-8	VOC_8260	04/25/2011 11:32			
04201116	MW-70-ODPM-8	VOC_8260	04/25/2011 13:23			
04201117	MW-70-ODPM-8	VOC_8260	04/25/2011 13:23			
04201119	MW-70-ODPM-8-MS	VOC_8260	04/25/2011 13:23			
04201120	MW-70-ODPM-8-MS	VOC_8260	04/25/2011 13:23			
04201122	MW-70-ODPM-8-MSD	VOC_8260	04/25/2011 13:23			
~~04201123~~	~~MW-70-ODPM-8-MSD~~	~~VOC_8260~~	~~04/25/2011 13:23~~	ks 4/26		
04201125	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201126	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201127	MW-76-ODPM-8	VOC_8260	04/25/2011 13:07			
04201128	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201129	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201130	MW-77-ODPM-8	VOC_8260	04/25/2011 13:14			
04201131	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			
04201132	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			

Microbac OVD 221000014398
Received: 04/27/2011 12:56
By: BRENDA GREENWALT
(signed)

Barcode	Client ID	Tests	Collect Date	Beg. Depth	End. Depth	Notes
04201133	MW-79-ODPM-8	VOC_8260	04/25/2011 11:17			

Samples Collected on: 04/25/2011 by jbsperry
(signed)

Attachment 7-4

EXAMPLE: Microbac Chain-of-Custody Form (Hand)

COC No. A 23953

158 Starlite Drive
Marietta, OH 45750

Microbac

CHAIN-OF-CUSTODY RECORD

Phone: 740-373-4071
Fax: 740-373-4835

Company Name:	
Project Contact:	Contact Phone #:
Turn Around Requirements:	Location:
Project ID:	
Sampler (print):	Signature:

Program
- ☐ CWA
- ☐ RCRA
- ☐ DOD
- ☐ AFCEE
- ☐ Other ____________

ADDITIONAL REQUIREMENTS

Sample I.D. No.	Comp	Grab	Date	Time	Matrix*	NUMBER OF CONTAINERS	Hold															TOTAL # (LAB USE)	ADDITIONAL REQUIREMENTS

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:	

*Water (W), Soil (S), Solid Waste (SD), Unknown (X)

Page ________ of ________

Attachment 7-5

EXAMPLE: ALS Chain-of-Custody Form

Air - Chain of Custody Record & Analytical Service Request

Page _______ of _______

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No.

ALS Contact:

Company Name & Address (Reporting Information)				Project Name					**Analysis Method**		**Comments** e.g. Actual Preservative or specific instructions
				Project Number							
Project Manager				P.O. # / Billing Information							
Phone	Fax										
Email Address for Result Reporting				Sampler (Print & Sign)							
Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume			

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____ Tier III (Results + QC & Calibration Summaries) ____
Tier II (Results + QC Summaries) ____ Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ______________ Units:__________

Chain of Custody Seal: (Circle)
INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:		
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:	Cooler / Blank Temperature ____°C	

STANDARD OPERATING PROCEDURE 9 – EQUIPMENT DECONTAMINATION

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Field Team Leader: Clayton Mokri
Project QA Officer: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operation Procedure (SOP) provides guidance for proper decontamination of equipment used in sampling and collection of equipment rinsates to evaluate effectiveness of decontamination procedures.

2 Health and Safety

General Information on Health and Safety requirements is provided in SOP 1. Each individual is required to have read and understood the Site Safety and Health Plan for the project and signed the acknowledgement sheet confirming their review.

Health and safety concerns for equipment decontamination include exposure to contaminants from sampling equipment. Nitrile gloves and safety glasses should be used during decontamination.

3 Personnel Qualifications and Responsibilities

Sampling equipment decontamination and rinsate sample collection will be directed by the Field Team Leader (FTL), an environmental professional (engineer, geologist or scientist) with experience in equipment decontamination and sampling activities. The field staff, environmental professionals or technicians, are responsible for following these procedures and seeking direction from the FTL when questions or problems arise.

4 Equipment and Supplies

The required equipment and supplies will consist of Alconox soap, deionized water (DI), tap water, paper towels, foil, and sample containers.

5 Procedure

Proper equipment decontamination will prevent cross-contamination of samples due to residual contamination from previous sample locations and spread of contamination via sampling equipment. Proper decontamination also supports the legal defensibility of data generated during site activities.

Decontamination procedures will be evaluated by the collection of equipment rinsate samples. These samples consist of reagent water collected from final rinse of sampling equipment after the decontamination procedure has been performed. The samples are analyzed with the environmental sample to assess the adequacy of the decontamination performed.

5.1 Start-Up Activities

5.1.1 Office

The FTL will confirm that sufficient equipment and supplies are available at the site based on the number of samples and estimated field days.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the FTL will confirm that decontamination supplies and equipment are available on site and review procedures with field staff.

5.2 Field Operations

5.2.1 Decontamination Area

The location of the decontamination area, used primarily for larger pieces of equipment, will be determined in consultation with subcontractor personnel. The decontamination pad will include a sump lined with 6-mil polyethylene sheeting to collect the decontamination water. The sump will be constructed by either excavating a small area to create a depression or by elevating the edges of the sheeting. Existing concrete pads with containment areas can be used for large equipment like drill rigs. Small handheld equipment will be decontaminated in 5-gallon buckets in order to contain the water.

5.2.2 Decontamination Water Source

Potable water from the municipal water system will be used as a rinse in the decontamination procedure. The FTL will be responsible for coordinating with the subcontractor personnel to secure an adequate supply of potable water for decontamination procedures. If large quantities of water are to be used, the subcontractor will rent a water meter from Memphis Light Gas and Water (MLGW). For smaller amounts, the field office water supply can be used.

5.2.3 Decontamination Procedures

The required decontamination procedure for large pieces of equipment such as drill rigs, auger flights, and drilling and well casing is:

1. Wash the external surface of equipment or materials with high pressure hot water and Alconox or equivalent, and scrub with brushes if necessary until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed from the equipment.
2. Air dry.
3. Decontamination waste water will be stored at the site and analyzed prior to disposal.

The required decontamination procedure for sampling equipment except the water level indicator probe is:

1. Wash and scrub with Alconox solution (or equivalent) and nylon brushes.
2. Double tap water rinse.
3. Rinse with American Society for Testing and Materials (ASTM) Type II Reagent - Grade Water
4. Wrap in oil free aluminum foil for transport.
5. Collect all decontamination rinse water in 5 gallon buckets. Rinse water will be combined with other wastewater generated during sampling activities and disposed of according to the work plan.

During water level sweeps and measurements in low-flow sampling, the water level tape and indicator in contact with groundwater will be decontaminated before initial use and before moving to a new location. The decontamination procedure for the water level indicator is:

1. Hand wash the calibrated tape and probe with Alconox solution (or equivalent).
2. Rinse with deionized (Reagent Grade II) water.

5.2.4 Equipment Rinsate Collection

When non-dedicated sampling equipment is used, the equipment will be decontaminated before initial use and after each sample is collected. An equipment rinsate sample will be collected for equipment type (bladder pump or bailer). At least one equipment rinsate will be collected for each sampling protocol (i.e. soil sampling, bladder pumps used for groundwater sampling) during each week of sampling. Equipment rinsate samples will be collected to be representative of field decontamination procedures.

<u>Sampling Equipment</u>: Equipment rinsate samples will be obtained from decontaminated bladder pumps, bailers, stainless steel split-spoons, hand augers, and stainless steel bowls with ASTM Type II water or better.

The equipment rinsate protocol will be as follows:

a. <u>Label Sample Container</u> - Label the sample container as outlined in SOP 7 – Sample Control and Documentation.
b. <u>Collect Sample</u> - After sample collection and equipment has been decontaminated as described above, an equipment rinsate will be collected. ASTM Type II water (or better) will be poured over and through the sampling equipment into a cleaned stainless steel bowl (preferably the equipment and bowl to be used on a specifically identifiable sample location). The collected water will be poured into the appropriate sample container. Repeat the process as necessary to fill each container to the required volume. Vials for volatile analysis and bottles for total organic carbon (TOC) analysis will be completely filled, leaving no air space above the liquid portion (to minimize volatilization). Check that the Teflon on the Teflon- lined silicone septum is toward the sample in the caps and secure the cap tightly. If semi-volatile compounds are to be sampled for, collect these samples next. Proceed to the collection of

samples for the remaining analyses. Be careful of all pre-preserved bottles. If acids are present, open the bottle downwind and away from the body.

c. Custody, Handling and Shipping - Complete the procedures as outlined in SOP 7 – Sample Control and Documentation and SOP 8 - Sample Packing and Shipping.

5.3 Closeout

Before leaving the site daily, the following procedures will be performed by the FTL or designated field staff:

- Confirm all equipment is decontaminated and properly stored all equipment.
- Add decontamination rinse water to the wastewater storage tank
- Note equipment decontamination activities and rinsate sample collection on the Daily Field Report (SOP 1, Attachment 1-2).

6 Data and Records Management

All field forms and log book entries will be scanned and copied project folder on the “Z” drive within one week of the field event completion.

7 Quality Control and Quality Assurance

Work will be performed in accordance with the Quality Assurance Project Plan (QAPP), the specific work plan, and applicable SOPs.

8 References

HDR, 2018. DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

SESDPROC-205-R2, *Operating Procedure Field Equipment Cleaning and Decontamination,* 2011.

STANDARD OPERATING PROCEDURE 10 – DATA VERIFICATION, VALIDATION, QUALIFICATION AND USABILITY ASSESSMENT

Lead Organization: Department of the Army (DA)
Preparing Organization: HDR
SOP Approved by: Project Chemist: Lynn Lutz
Project Manager: Tom Holmes

1 Purpose and Summary

This Standard Operating Procedure (SOP) provides guidance for the data verification, validation, qualification and usability assessment (hereafter called "data review" to denote all four stages) performed for analytical data generated for groundwater and vapor samples collected at Defense Depot Memphis, Tennessee (DDMT).

2 Health and Safety

There are no health and safety issues associated with the activities described in this SOP.

3 Personnel Qualifications and Responsibilities

Data review will be performed by the DDMT Project Chemist (PC), who will be familiar with the sampling areas and data requirements at DDMT and experienced in data review.

4 Equipment and Supplies

A computer loaded with Microsoft Excel, Microsoft Word and Adobe Acrobat (reader level or higher) is required.

5 Procedure

This section describes the data qualifiers that will be applied to the data during the verification and validation steps of the data review, and how the determination of usability will be performed. General guidelines for final qualification are provided; individual circumstances for data packages or specific samples may result in different qualification.

To maintain comparability among data sets for the entire DDMT project, the data validation guidelines in the DDMT Quality Assurance Project Plan (QAPP) (HDR, 2018), the United States Environmental Protection Agency (USEPA) National Functional Guidelines (USEPA, November 2020), the U.S. Department of Defense *General Data Validation Guidelines* (Environmental Data Quality Workgroup, 04 November 2019), and the Quality Systems Manual (QSM) most recent version have been incorporated herein.

Refer to Sections 1 and 2 and Worksheets #12, #19, #24 and #28 of the QAPP for the quality control limits to be used for data validation.

Final qualifiers will be:

- No qualification
- Non-detect (U)
- Detected and estimated (J)
- Detected and estimated with possible low bias (J-)
- Detected and estimated with possible high bias (J+)
- Non-detect and estimated (UJ)
- Rejected (R)

An example data validation report for volatiles in air samples by USEPA Method TO-15 is included as Attachment 10-2.

5.1 Chain-of-Custody

If the chain-of-custody (COC) form was not received by the laboratory with the sample, was not signed with date and time by the sampler in the “relinquished by” box, and/or was not signed with date and time by the lab’s sample receipt personnel in the “received by” box, the legal trail of custody may be compromised. The original COC will accompany the samples to the lab. A copy of the COC will be sent to the lab and the PC by the Field Team Leader (FTL) following sample shipment. The PC will examine sample receipt documentation and call or email the lab when discrepancies are identified. Custody seals should be noted as unbroken.

5.2 Sample Receipt

5.2.1 Water Samples

Water samples should arrive at the lab between 0 degrees Celsius (ºC) and 6ºC. If water samples were received warm, the lab will contact the PC immediately. The PC and Project Manager (PM) will determine whether samples should be analyzed or re-collected. If samples are analyzed and reported, generally all results will be qualified as estimated (J), estimated with possible low bias (J-), or non-detect estimated (UJ).

5.2.2 Air Samples

Air samples have no temperature requirements.

5.3 Holding Times and Preservation

For samples analyzed past their holding time, generally all results will be qualified as estimated with possible low bias (J-) or non-detect estimated (UJ) unless holding times are grossly exceeded.

5.4 Method Identification, Analyte List, and LOQs/LODs/DLs

The correct methods (e.g., SW-846 8260B, SW-846 9060 modified, SW-846 6010, RSK-175 and 830-MBA for waters, TO-15 for air samples) used for analysis must be identified on the sample result pages. If an incorrect method was used, the lab may be instructed to reanalyze samples using the correct method.

If the list of reported analytes is incorrect, or incorrect limits of quantitation (LOQ), limits of detection (LOD), and detection limits (DL) are reported, the lab will be requested to report the correct analyte list or the correct LOQs, LODs, and DLs.

5.5 Gas Chromatography/Mass Spectrometry Tuning and Analytical Sequence

If tuning requirements were not met, the lab should not have proceeded with sample analysis. If samples were analyzed and reported after an unacceptable tune with 4-bromofluorobenzene (BFB), this will be brought to the attention of the lab PM, and it should have been mentioned in the Case Narrative.

For volatile organic compounds (VOCs) in water and air the critical ion abundance criteria for BFB are the m/z 95/96, 174/175, 174/176, and 176/177 ratios. The relative abundances of m/z 50 and 75 are of lower importance. Samples reported after an unacceptable tune may be rejected (R), or qualified as estimated (J) and non-detect estimated (UJ), according to the reviewer’s judgment.

Analysis of all field and QC samples must begin within 12 hours (for waters) or within 24 hours (for air samples) of a valid BFB tune. If sample analysis began later than required, sample results will be qualified as estimated (J) or non-detect estimated (UJ). If analysis began only a short time (within 15 minutes) after the required interval, the results need not be qualified.

5.6 Initial Calibration

Initial calibration Relative Response Factors (RRFs) and % Relative Standard Deviations (RSDs) will be examined to determine whether they met required control limits.

5.6.1 Water Samples

VOC analytes with a %RSD greater than 15% should have had a linear curve fit with an r value of at least 0.995 or a quadratic curve fit with an r^2 value of at least 0.990, or the average %RSD of all analytes in the calibration curve must be 15% or less. Calibration check compounds (CCCs) must have %RSDs less than or equal to 30%. Analytes outside these limits will be qualified as estimated (J) or non-detect estimated (UJ).

A number of VOC analytes (shown below) are considered poor responders and have less stringent requirements for minimum RRF.

Poor Responders		
Acetone	Chloroethane	1,2-Dibromoethane (EDB)
2-Butanone	Chloromethane	1,2-Dibromo-3-chloropropane
2-Hexanone	Dichlorodifluoromethane	cis-1,2-Dichloroethene
4-Methyl-2-pentanone	Trichlorofluoromethane	trans-1,2-Dichloroethene
Carbon disulfide	Methyl tert-butyl ether (MTBE)	1,2-Dichloropropane
	Isopropylbenzene	Methylene chloride

All VOC analytes except the poor responders should have an RRF of at least 0.05. The poor responders should have an RRF of at least 0.01. System performance check compounds (SPCCs) must have RRFs of at least 0.1 or 0.3 as required by the method. Analytes outside these limits will be qualified as estimated (J) or non-detect estimated (UJ).

Initial calibrations for other analytes that do not meet requirements will be qualified in a similar manner as VOCs.

5.6.2 Air Samples

Analytes with a %RSD greater than 30% will be qualified as estimated (J) or non-detect estimated (UJ).

5.7 Initial Calibration Verification (Second Source Standard)

A second source standard must be analyzed after every initial calibration. An LCS can serve as a second source standard for VOCs or dissolved gases as long as it can be determined from the standard prep sheets or instrument run logs that a different standard than those used for the calibration curve was used.

5.7.1 Water Samples

Any analyte with a %D (difference or drift) greater than the control limit compared to the initial calibration will be qualified as estimated (J), estimated with a possible high bias (J+), estimated with a possible low bias (J-), or non-detect estimated (UJ).

5.7.2 Air Samples

Any analyte with a %D (difference or drift) greater than 30% compared to the initial calibration will be qualified as estimated (J), estimated with a possible high bias (J+), estimated with a possible low bias (J-), or non-detect estimated (UJ).

5.8 Continuing Calibrations

5.8.1 Water Samples

VOC CCCs must have %D values less than or equal to 20%. Other analytes should have %D values less than or equal to 20%. Analytes outside these limits with lower responses than the initial calibration will be qualified as estimated with possible low bias (J-) or non-detect estimated (UJ).

Detected analytes outside these limits with higher responses than the initial calibration will be qualified as estimated with possible high bias (J+).

All VOC analytes except the poor responders should have an RRF of at least 0.05. The poor responders should have an RRF of at least 0.01. SPCCs must have RRFs of at least 0.1 or 0.3 as required by the method. Analytes outside these limits will be qualified as estimated (J) or non-detect estimated (UJ).

Any other analyte with a %D (difference or drift) greater than the control limit compared to the initial calibration will be qualified as estimated with possible low bias (J-) , estimated with possible high bias (J+), or non-detect estimated (UJ), as in Section 5.8.1 above.

5.8.2 Air Samples

All analytes must have %D values less than or equal to 30%. Analytes outside these limits with lower responses than the initial calibration will be qualified as estimated with possible low bias (J-) or non-detect estimated (UJ). Detected analytes outside these limits with higher responses than the initial calibration will be qualified as estimated with possible high bias (J+).

5.9 Blanks

5.9.1 Method Blank

There must be a method blank associated with each sample. Method blanks should contain no COCs above one-half the RL. Analytes detected above the RL should be discussed in the Case Narrative.

Analytes detected in the samples as well as the method blank will be qualified as non-detect (U), estimated with possible high bias (J+), or not qualified, in accordance with the qualification as discussed in the applicable National Functional Guidelines (USEPA, 2020).

5.9.2 Trip Blank

A trip blank must accompany all VOC water samples during sampling and shipment, in the same cooler. Trip blanks are not required for air samples.

Analytes detected in the samples as well as the trip blank will be qualified as for a method blank.

5.9.3 Rinsate Blank

A rinsate blank must be collected periodically when non-dedicated sampling equipment is used to collect water samples. Rinsate blanks are not required for air samples.

Analytes detected in the associated samples as well as the rinsate blank will be qualified as for a method blank.

5.10 Laboratory Control Sample and Duplicate

There must be a laboratory control sample (LCS) associated with each sample. There may also be a laboratory control sample duplicate (LCSD), although this is not required. LCSs must be spiked with all COCs.

Analytes with recoveries above the control limits may be biased high and will be qualified as estimated with possible high bias (J+) when detected; non-detect results will not be qualified. Analytes with recoveries below the control limits may be biased low and will be qualified as estimated with possible low bias (J-) or non-detect estimated (UJ). If an LCSD is also analyzed, analytes with relative percent difference (RPD) values greater than 20% (30% for VOCs in air) will be qualified as estimated (J) when detected; non-detect results will not be qualified. All samples associated with the LCS will be qualified.

5.11 Matrix Spike and Matrix Spike Duplicate

MS/MSD samples will be indicated on the COC. Matrix spike/matrix spike duplicate (MS/MSD) samples must be spiked with all COCs.

5.11.1 Water Samples

One set of MS/MSD samples will be collected for every 20 field samples. Recovery limits are the lab’s in-house control limits. Analytes with higher recoveries will be qualified as estimated (J) when detected; non-detect results will not be qualified. Analytes with lower recoveries will be qualified as estimated (J) or non-detect estimated (UJ). Analytes with RPD values greater than 20% will be qualified as estimated (J) when detected; non-detect results will not be qualified. Only the parent sample will be qualified.

5.11.2 Air Samples

MS/MSD samples are not collected for air samples.

5.12 Field Duplicates

Field duplicate samples will be sent blind to the laboratory. They will be designated on the COC but not identified with a specific sample location. One field duplicate sample will be collected for every 10 field samples.

Analytes detected above the LOQ should agree within the RPD control limit. Sample results outside this control limit will be qualified as estimated (J). Results detected below the LOQ will not be assessed. If one result is above the LOQ and the other result is below the LOQ, both results will be qualified as estimated (J). If one result is above the LOQ and the other result is non-detect, the detected result will be qualified as estimated (J) and the non-detect result will be qualified as non-detect estimated (UJ).

5.13 Laboratory Duplicates

5.13.1 Water Samples

Laboratory duplicates may be analyzed for metals in water samples. Control limits and qualification are the same as for a field duplicate.

5.13.2 Air Samples

A laboratory duplicate of an air sample must be analyzed daily. Laboratory duplicate results are assessed only if the duplicate was on a DDMT sample. Control limits and qualification are the same as for a field duplicate.

5.14 Surrogates

Surrogates are spiked into every field sample, quality control (QC) sample, and standard for VOCs in water and air.

Surrogates with recoveries above the control limits may indicate a high bias in detected sample results; all detected analytes in the sample will be qualified as estimated with possible high bias (J+). Surrogates with recoveries below control limits may indicate a low bias in sample results; all analytes in the sample will be qualified as estimated with possible low bias (J-) or non-detect estimated (UJ). Samples will not be qualified if only one surrogate out of three or four has a high or low recovery.

5.15 Internal Standards

Internal Standards are spiked into every field sample, QC sample, and standard for VOCs in water and air.

Internal standards with recoveries or retention times outside control limits may indicate interferences in the sample matrix or poor purging.

All analytes associated with an internal standard that has an area outside control limits will be qualified as estimated (J) or non-detect estimated (UJ).

If an internal standard has a retention time outside control limits, the chromatogram and quantitation report will be examined to determine possible impact on the detected or non-detected sample results. Retention times outside control limits may lead to false positive or false negative results for other analytes.

5.16 Usability Assessment

The HDR PC will assess the Precision, Accuracy/bias, Representativeness, Comparability, Completeness, and Sensitivity (PARCCS) parameters and determine overall usability of the data. In general, non-rejected data will be considered usable. Measurement error will be deemed within acceptable limits when project data quality objectives (DQOs) as assessed by PARCCS parameters are met. The PC will write a brief assessment of data usability for each data package.

6 Data and Records Management

This section details the distribution of data files from the laboratories to HDR and the project files.

6.1 Data Files from Laboratories

The laboratories will email to the HDR PC the Level IV data package in PDF format, and an electronic data deliverable (EDD) file in Excel to the PC. The PC will save these files to the appropriate folders on the HDR network drive, to be retained in perpetuity

Hardcopy (paper) data files are not required for this project.

6.2 Data Files from HDR

The HDR PC will email the PDF Level IV data package and the Excel EDD to the HDR Project Manager (PM).

6.3 Data Files at HDR

The PC will save the report and EDD file to the appropriate folders on the HDR network drive. The PC will make a copy of the EDD file, with the same name plus "-final".

The PC will open the "final" file and add a column before the analytes column, called "Report?"; all entries will default to "Y(es)", and will be changed to "N(o)" in the event of multiple runs and/or dilution runs of a sample, so that there is only one reportable result per analyte in all samples. The PC will also add a field named "Final Qualifier" after the field for lab flags and record final qualifiers as described in Section 5.6.1 of this SOP. Qualifiers for undetected results (U) will be copied to this field, unless the final qualifier is UJ or R, which will be entered into this field.

When all the EDDs have been completed for a sampling event, the PC will email the database manager the location of the files, or the files themselves, to create result tables to be used in reports.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the QAPP, the specific work plan, the specific sampling plan details (SPD), and applicable SOPs.

8 References

HDR, 2018. *DDMT Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1*. Prepared for the U.S. Army Corps of Engineers, Mobile District. March 2018.

US DoD, 2018. *General Data Validation Guidelines, Environmental Data Quality Workgroup*. February 09, 2018

United States Environmental Protection Agency (USEPA), 2020. *National Functional Guidelines for Superfund Organic Methods Data Review (SFAM01.10)* (USEPA, EPA-540-R-20-005), November 2020.

USEPA, 2016. *National Functional Guidelines for Inorganic Superfund Methods Data Review (SFAM01.1)* (USEPA, EPA-542-R-20-006), November 2020.

DATA VALIDATION REPORT

VOLATILES IN AIR by USEPA Method TO-15

Project: DDMT Memphis REAT-2 SVE
Project/Task Number: 10101451 - 001
Sample Data Package: P2105435
Laboratory: ALS Environmental, Simi Valley, California
Sample Matrix: Soil Gas
Sampling Dates: 13 October 2021
Validation Guidelines: Project Quality Assurance Project Plan (QAPP) (Final Soil Vapor Extraction Pilot Test Work Plan, Defense Depot Memphis, Tennessee, TN4210020570 [HDR, May 2019]); United States Environmental Protection Agency (USEPA) *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air,* 2nd edition (1999) Method TO-15; and professional judgment
Validation Level: Stage 2bVM
Data Reviewer: Lynn K. Lutz, HDR

Sample ID	Collection Date	ALS ID	TO-15 VOCs	Canister Volume
PT-V-SVE1-EFF2-6	13 October 2021	P2105435-009	X	6 L
DUP-1	13 October 2021	P2105435-008	X	1 L
PT-V-2.1-6	13 October 2021	P2105435-001	X	1 L
PT-V-2.2-6	13 October 2021	P2105435-002	X	1 L
PT-V-2.3-6	13 October 2021	P2105435-003	X	1 L
PT-V-2.4-6	13 October 2021	P2105435-004	X	1 L
PT-V-2.5-6	13 October 2021	P2105435-005	X	1 L
PT-V-2.5D-6	13 October 2021	P2105435-006	X	1 L
PT-V-2.6-6	13 October 2021	P2105435-007	X	1 L

SUMMARY

All laboratory data were acceptable with qualification.

I. SAMPLE RECEIPT / CHAIN OF CUSTODY

The samples were collected in 1-liter or 6-liter Summa canisters. The samples were received in good condition. The canisters' initial field pressures (vacuums) of -27.3 inches mercury to -30 inches mercury were within the acceptable range of -25 to -30 inches mercury. The chains of custody (COCs) were filled out and signed. No qualification was required.

II. SAMPLES ANALYZED

All planned samples were collected and analyzed. No qualification was required.

III. HOLDING TIMES

The holding time criterion of 30 days was met. No qualification was required.

IV. GC/MS TUNING

GC/MS BFB tuning criteria were met. Sample analyses were begun within 24 hours of the BFB analysis. No qualification was required.

V. INSTRUMENT CALIBRATION

INITIAL CALIBRATIONS

Initial calibration criteria of relative standard deviation (RSD) less than 30% were met. No qualification was required.

SECOND SOURCE STANDARDS

All results were within the required criterion of %D less than 30%. No qualification was required.

CONTINUING CALIBRATIONS

Several analytes had results outside the criterion of %D less than 30% and required qualification as shown below.

CCV	Analyte	%D	Associated Samples	Qualifier
10/26/21 02:45	Propene	+35.8%	DUP-1	J+
	Chloromethane	+35.6%	PT-V-2.5D-6 DUP-1	J+ J+
10/26/21 14:21	Chloromethane	+32.9%	PT-V-2.5D-6 DUP-1	J+ J+
	Hexachlorobutadiene	-33.6%	PT-V-2.1-6 PT-V-2.2-6 PT-V-2.6-6 DUP-1 PT-V-SVE1-EFF2-6	UJ UJ UJ UJ UJ

VI. BLANKS

METHOD BLANKS

Analytes were not detected in the method blank. No qualification was required.

CANISTER BATCH CERTIFICATION BLANKS

Several analytes were detected in one canister batch blank. Associated sample results were qualified as shown in the table below. Most analytes did not require qualification, as the sample result was either well above the blank results or was non-detect.

Canister blank	Analyte	Blank result	Associated sample	Sample result	Qualifier
Batch 28377 (6-L can)	Ethanol	1194 pg	PT-V-SVE1-EFF2-6	2109 pg	U
Batch 28381 (1-L can)	Ethanol	181 pg	PT-V-2.6-6	371 pg	U

VII. LABORATORY CONTROL SAMPLES (LCS) and LABORATORY CONTROL SAMPLE DUPLICATE (LCSD)

Some recoveries were outside control limits, and associated sample results required qualification as shown below.

LCS	Analyte	Recovery	Control Limits	Associated Samples	Qualifier
10/25/21	Chloromethane	134%, OK	59-132%	PT-V-2.5D-6	J+
	1,2-Dichloro-1,1,2,2-tetrafluoroethane	OK, 122%	63-121%	--	None – ND
10/26/21	Propene	139%, OK	57-136%	DUP-1	J+
	Chloromethane	142%, 137%	59-132%	DUP-1	J+
	1,2-Dichloro-1,1,2,2-tetrafluoroethane	122%, 123%	63-121%	--	None – ND
	Vinyl chloride	131%, 128%	64-127%	DUP-1	J+

VIII. SURROGATES
Surrogate recoveries were within control limits. No qualification was required.

IX. LABORATORY DUPLICATES
Lab duplicate analysis was not performed on any samples from this project. No qualification was required.

X. FIELD DUPLICATES
DUP-1 was collected as a field duplicate of PT-V-2.5D-6. All analytes detected above the limit of quantitation (LOQ) had relative percent difference (RPD) values below the control limit of 30%, and sample results did not require qualification, except as shown below.

Parent / FD sample	Analyte	Concentrations	RPD	Qualifier
PT-V-2.5D-6 DUP-1	2-Butanone (MEK)	2.1 / 15 ppbv	151%	J / J
	Acetone	22 / 120 ppbv	136%	J / J
	Bromomethane	ND / >RL	--	UJ / J
	Propene	1.2J /6.7 ppbv	139%	J / J
	Vinyl acetate	3.5J / 44 ppbv	171%	J / J

XI. INTERNAL STANDARDS (ISTD)
The ISTD criterion of area responses within 40% of the CCV was met for all samples. No qualification was required.

XII. LIMITS OF QUANTITATION (LOQs), LIMITS OF DETECTION (LODs) AND DETECTION LIMITS (DLs)
Some samples were analyzed only at dilution due to high concentrations indicated in the screening analysis. The dilutions resulted in elevated LOQs, greater than the PAL for some analytes.

XIII. SAMPLE RESULTS / TRANSCRIPTION VERIFICATION
Transcription between the data packages and the EDDs was verified. Results between the DL and LOQ have been qualified as estimated (J).

D

Appendix D.
Laboratory Standard Operating Procedures

E

Appendix E. Supporting Documentation for Screening Levels

APPENDIX E TABLE OF CONTENTS:

<u>Documentation for Groundwater and Soil Vapor Screening Levels</u>

Table E.1A

VISL Commercial - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m^3)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m^3)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (20.3 °C) (µg/m^3)	Maximum Groundwater Vapor Concentration C_{hc} (µg/m^3)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$(µg/m^3)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$(µg/m^3)
Acetone	67-64-1	Yes	Yes	Yes	Yes	1.36E+04	NC	4.53E+05	2.28E+07	--	7.25E+08	1.19E+09	2.03E+01	2.50E+00	U	-		3.10E+01	**2021 ATSDR**	No	-	1.36E+04
Acetonitrile	75-05-8	Yes	Yes	Yes	Yes	2.63E+01	NC	8.76E+02	4.54E+04	--	1.96E+08	1.16E+09	2.03E+01	3.00E+00	CRC	-		6.00E-02	I	No	-	2.63E+01
Acrolein	107-02-8	Yes	Yes	Yes	Yes	8.76E-03	NC	2.92E-01	4.20E+00	--	8.26E+08	8.85E+08	2.03E+01	2.80E+00	CRC	-		2.00E-05	I	No	-	8.76E-03
Acrylonitrile	107-13-1	Yes	Yes	Yes	Yes	1.80E-01	CA	6.01E+00	7.94E+01	--	3.10E+08	3.39E+08	2.03E+01	3.00E+00	CRC	6.80E-05	I	2.00E-03	I	No	1.80E-01	8.76E-01
Allyl Chloride	107-05-1	Yes	Yes	Yes	Yes	4.38E-01	NC	1.46E+01	2.33E+00	--	1.51E+09	1.27E+09	2.03E+01	2.90E+00	CRC	6.00E-06	C	1.00E-03	I	No	2.04E+00	4.38E-01
Benzene	71-43-2	Yes	Yes	Yes	Yes	1.57E+00	CA	5.24E+01	1.69E+01	No (5)	3.98E+08	3.32E+08	2.03E+01	1.20E+00	CRC	7.80E-06	I	3.00E-02	I	No	1.57E+00	1.31E+01
Benzyl Chloride	100-44-7	Yes	Yes	Yes	Yes	2.50E-01	CA	8.34E+00	3.90E+01	--	8.37E+06	6.74E+06	2.03E+01	1.10E+00	CRC	4.90E-05	C	1.00E-03	P	No	2.50E-01	4.38E-01
Bromodichloromethane	75-27-4	Yes	Yes	Yes	Yes	3.31E-01	CA	1.10E+01	9.49E+00	Yes (80)	4.41E+08	2.12E+08	2.03E+01	-		3.70E-05	C	-		No	3.31E-01	-
Bromoform	75-25-2	Yes	Yes	Yes	Yes	1.11E+01	CA	3.72E+02	1.35E+03	No (80)	7.34E+07	5.13E+07	2.03E+01	-		1.10E-06	I	-		No	1.11E+01	-
Bromomethane	74-83-9	Yes	Yes	Yes	Yes	2.19E+00	NC	7.30E+01	1.67E+01	--	8.25E+09	3.99E+09	2.03E+01	1.00E+01	CRC	-		5.00E-03	I	No	-	2.19E+00
Butadiene, 1,3-	106-99-0	Yes	Yes	Yes	Yes	4.09E-01	CA	1.36E+01	3.07E-01	--	6.13E+09	1.96E+09	2.03E+01	2.00E+00	CRC	3.00E-05	I	2.00E-03	I	No	4.09E-01	8.76E-01
Butyl Alcohol, t-	75-65-0	Yes	Yes	Yes	Yes	2.19E+03	NC	7.30E+04	1.56E+07	--	1.62E+08	2.81E+08	2.03E+01	2.40E+00	CRC	-		5.00E+00	I	No	-	2.19E+03
Butylbenzene, n-	104-51-8	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		7.68E+06	5.68E+06	2.03E+01	8.00E-01	CRC	-		-		No	-	-
Butylbenzene, sec-	135-98-8	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1.26E+07	8.80E+06	2.03E+01	8.00E-01	YAWS	-		-		No	-	-
Carbon Disulfide	75-15-0	Yes	Yes	Yes	Yes	3.07E+02	NC	1.02E+04	1.23E+03	--	1.47E+09	1.08E+09	2.03E+01	1.30E+00	CRC	-		7.00E-01	I	No	-	3.07E+02
Carbon Tetrachloride	56-23-5	Yes	Yes	Yes	Yes	2.04E+00	CA	6.81E+01	4.40E+00	Yes (5)	9.51E+08	7.37E+08	2.03E+01	-		6.00E-06	I	1.00E-01	I	No	2.04E+00	4.38E+01
Chlorobenzene	108-90-7	Yes	Yes	Yes	Yes	2.19E+01	NC	7.30E+02	4.41E+02	No (100)	7.25E+07	4.95E+07	2.03E+01	1.30E+00	CRC	-		5.00E-02	P	No	-	2.19E+01
Chloroform	67-66-3	Yes	Yes	Yes	Yes	5.33E-01	CA	1.78E+01	8.56E+00	Yes (80)	1.26E+09	9.91E+08	2.03E+01	-		2.30E-05	I	9.77E-02	A	No	5.33E-01	4.28E+01
Chloromethane	74-87-3	Yes	Yes	Yes	Yes	3.94E+01	NC	1.31E+03	2.44E+02	--	1.17E+10	1.72E+09	2.03E+01	8.10E+00	CRC	-		9.00E-02	I	No	-	3.94E+01
Cumene	98-82-8	Yes	Yes	Yes	Yes	1.75E+02	NC	5.84E+03	1.03E+03	--	2.91E+07	2.09E+07	2.03E+01	9.00E-01	CRC	-		4.00E-01	I	No	-	1.75E+02
Cyclohexane	110-82-7	Yes	Yes	Yes	Yes	2.63E+03	NC	8.76E+04	1.04E+03	--	4.38E+08	2.77E+08	2.03E+01	1.30E+00	CRC	-		6.00E+00	I	No	-	2.63E+03
1,2-	96-12-8	Yes	Yes	Yes	Yes	2.04E-03	CA	6.81E-02	9.34E-01	No (0)	7.37E+06	5.38E+06	2.03E+01	-		6.00E-03	P	2.00E-04	I	Mut	2.04E-03	8.76E-02
Dibromochloromethane	124-48-1	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		6.21E+07	7.37E+07	2.03E+01	-		-		-		No	-	-
Dibromoethane, 1,2-	106-93-4	Yes	Yes	Yes	Yes	2.04E-02	CA	6.81E-01	1.96E+00	No (0)	1.13E+08	8.18E+07	2.03E+01	-		6.00E-04	I	9.00E-03	I	No	2.04E-02	3.94E+00
Dichlorobenzene, 1,2-	95-50-1	Yes	Yes	Yes	Yes	8.76E+01	NC	2.92E+03	2.98E+03	No (600)	1.08E+07	9.16E+06	2.03E+01	2.20E+00	CRC	-		2.00E-01	H	No	-	8.76E+01
Dichlorobenzene, 1,3-	541-73-1	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1.70E+07	1.01E+07	2.03E+01	1.80E+00	YAWS	-		-		No	-	-
Dichlorobenzene, 1,4-	106-46-7	Yes	Yes	Yes	Yes	1.11E+00	CA	3.72E+01	3.02E+01	Yes (75)	1.38E+07	5.99E+06	2.03E+01	1.80E+00	YAWS	1.10E-05	C	8.00E-01	I	No	1.11E+00	3.50E+02
Dichlorodifluoromethane	75-71-8	Yes	Yes	Yes	Yes	4.38E+01	NC	1.46E+03	6.87E+00	--	3.15E+10	3.57E+09	2.03E+01	-		-		1.00E-01	X	No	-	4.38E+01
Dichloroethane, 1,1-	75-34-3	Yes	Yes	Yes	Yes	7.67E+00	CA	2.56E+02	8.01E+01	--	1.21E+09	9.65E+08	2.03E+01	5.40E+00	CRC	1.60E-06	C	-		No	7.67E+00	-
Dichloroethane, 1,2-	107-06-2	Yes	Yes	Yes	Yes	4.72E-01	CA	1.57E+01	2.42E+01	No (5)	4.20E+08	3.36E+08	2.03E+01	6.20E+00	CRC	2.60E-05	I	7.00E-03	P	No	4.72E-01	3.07E+00
Dichloroethylene, 1,1-	75-35-4	Yes	Yes	Yes	Yes	8.76E+01	NC	2.92E+03	1.92E+02	No (7)	3.13E+09	2.21E+09	2.03E+01	6.50E+00	CRC	-		2.00E-01	I	No	-	8.76E+01
Dichloroethylene, cis-1,2-	156-59-2	Yes	No	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	3.50E+02	NC	1.17E+04	5.09E+03	No (70)	1.04E+09	8.83E+08	2.03E+01	3.00E+00	U	-		**8.00E-01**	**trans-1,2-DCE ATSDR surrogate**	No	-	3.50E+02
Dichloroethylene, trans-1,2-	156-60-5	Yes	Yes	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	3.50E+02	NC	1.17E+04	2.19E+03	No (100)	1.73E+09	1.45E+09	2.03E+01	6.00E+00	U	-		**8.00E-01**	**trans-1,2-DCE ATSDR surrogate**	No	-	3.50E+02
Dichloropropane, 1,2-	78-87-5	Yes	Yes	Yes	Yes	1.75E+00	NC	5.84E+01	3.76E+01	No (5)	3.24E+08	2.61E+08	2.03E+01	3.40E+00	YAWS	3.70E-06	P	4.00E-03	I	No	3.31E+00	1.75E+00
Dichloropropene, 1,3-	542-75-6	Yes	Yes	Yes	Yes	3.07E+00	CA	1.02E+02	5.33E+01	--	2.03E+08	3.22E+08	2.03E+01	5.30E+00	N	4.00E-06	I	2.00E-02	I	No	3.07E+00	8.76E+00
Dioxane, 1,4-	123-91-1	Yes	Yes	Yes	Yes	2.45E+00	CA	8.18E+01	3.15E+04	--	1.80E+08	1.56E+08	2.03E+01	2.00E+00	CRC	5.00E-06	I	3.00E-02	I	No	2.45E+00	1.31E+01
Ethyl Acetate	141-78-6	Yes	Yes	Yes	Yes	3.07E+01	NC	1.02E+03	1.39E+04	--	4.42E+08	3.54E+08	2.03E+01	2.00E+00	CRC	-		7.00E-02	P	No	-	3.07E+01
Ethyl Chloride	75-00-3	Yes	Yes	Yes	Yes	1.75E+03	NC	5.84E+04	8.89E+03	--	3.50E+09	2.64E+09	2.03E+01	3.80E+00	CRC	-		4.00E+00	P	No	-	1.75E+03
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	4.91E+00	CA	1.64E+02	3.93E+01	Yes (700)	5.48E+07	4.22E+07	2.03E+01	8.00E-01	CRC	2.50E-06	C	1.00E+00	I	No	4.91E+00	4.38E+02
Heptane, N-	142-82-5	Yes	Yes	Yes	Yes	1.75E+02	NC	5.84E+03	5.35E+00	--	2.48E+08	2.23E+08	2.03E+01	1.05E+00	CRC	-		4.00E-01	P	No	-	1.75E+02
Hexachlorobutadiene	87-68-3	Yes	Yes	Yes	Yes	5.57E-01	CA	1.86E+01	3.67E+00	--	3.09E+06	9.72E+05	2.03E+01	2.90E+00	YAWS	2.20E-05	I	-		No	5.57E-01	-
Hexane, N-	110-54-3	Yes	Yes	Yes	Yes	3.07E+02	NC	1.02E+04	1.01E+01	--	7.01E+08	5.78E+08	2.03E+01	1.10E+00	CRC	-		7.00E-01	I	No	-	3.07E+02
Hexanone, 2-	591-78-6	Yes	Yes	Yes	Yes	1.31E+01	NC	4.38E+02	8.99E+03	--	6.25E+07	5.03E+07	2.03E+01	1.00E+00	CRC	-		3.00E-02	I	No	-	1.31E+01
Isopropanol	67-63-0	Yes	Yes	Yes	Yes	8.76E+01	NC	2.92E+03	7.00E+05	--	1.47E+08	2.50E+08	2.03E+01	2.00E+00	CRC	-		2.00E-01	P	No	-	8.76E+01
Butanone)	78-93-3	Yes	Yes	Yes	Yes	2.19E+03	NC	7.30E+04	2.32E+06	--	3.51E+08	4.21E+08	2.03E+01	1.40E+00	CRC	-		5.00E+00	I	No	-	2.19E+03
methyl-2-pentanone)	108-10-1	Yes	Yes	Yes	Yes	1.31E+03	NC	4.38E+04	5.96E+05	--	1.07E+08	8.38E+07	2.03E+01	1.20E+00	CRC	-		3.00E+00	I	No	-	1.31E+03
Methyl Methacrylate	80-62-6	Yes	Yes	Yes	Yes	3.07E+02	NC	1.02E+04	6.07E+04	--	2.07E+08	1.51E+08	2.03E+01	1.70E+00	CRC	-		7.00E-01	I	No	-	3.07E+02
(MTBE)	1634-04-4	Yes	Yes	Yes	Yes	4.72E+01	CA	1.57E+03	4.70E+03	--	1.19E+09	1.02E+09	2.03E+01	2.00E+00	YAWS	2.60E-07	C	3.00E+00	I	No	4.72E+01	1.31E+03
Methylene Chloride	75-09-2	Yes	Yes	Yes	Yes	2.63E+02	NC	8.76E+03	4.70E+03	No (5)	1.99E+09	1.45E+09	2.03E+01	1.30E+01	CRC	1.00E-08	I	6.00E-01	I	Mut	1.23E+03	2.63E+02
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	3.61E-01	CA	1.20E+01	5.57E+01	--	5.86E+05	4.01E+05	2.03E+01	9.00E-01	CRC	3.40E-05	C	3.00E-03	I	No	3.61E-01	1.31E+00
Nonane, n-	111-84-2	Yes	Yes	Yes	Yes	8.76E+00	NC	2.92E+02	1.68E-01	--	3.07E+07	2.29E+07	2.03E+01	8.00E-01	CRC	-		2.00E-02	P	No	-	8.76E+00
Propyl benzene	103-65-1	Yes	Yes	Yes	Yes	4.38E+02	NC	1.46E+04	2.71E+03	--	2.21E+07	1.69E+07	2.03E+01	8.00E-01	CRC	-		1.00E+00	X	No	-	4.38E+02
Propylene	115-07-1	Yes	Yes	Yes	Yes	1.31E+03	NC	4.38E+04	3.55E+02	--	1.97E+10	1.48E+09	2.03E+01	2.00E+00	CRC	-		3.00E+00	C	No	-	1.31E+03
Styrene	100-42-5	Yes	Yes	Yes	Yes	4.38E+02	NC	1.46E+04	1.03E+04	No (100)	3.58E+07	2.63E+07	2.03E+01	9.00E-01	CRC	-		1.00E+00	I	No	-	4.38E+02

Table E.1A

VISL Commercial - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (μg/m^3)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (μg/m^3)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (μg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (20.3 °C) (μg/m^3)	Maximum Groundwater Vapor Concentration C_{hc} (μg/m^3)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$(μg/m^3)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$(μg/m^3)
Tetrachloroethane, 1,1,2,2-	79-34-5	Yes	Yes	Yes	Yes	2.11E-01	CA	7.05E+00	3.69E+01	--	4.17E+07	3.24E+07	2.03E+01	-		5.80E-05	C	-		No	2.11E-01	-
Tetrachloroethylene	127-18-4	Yes	Yes	Yes	Yes	1.75E+01	NC	5.84E+02	6.15E+01	No (5)	1.65E+08	1.17E+08	2.03E+01	-		2.60E-07	I	4.00E-02	I	No	4.72E+01	1.75E+01
Tetrahydrofuran	109-99-9	Yes	Yes	Yes	Yes	8.76E+02	NC	2.92E+04	7.36E+05	--	6.29E+08	2.38E+09	2.03E+01	2.00E+00	CRC	-		2.00E+00	I	No	-	8.76E+02
Toluene	108-88-3	Yes	Yes	Yes	Yes	2.19E+03	NC	7.30E+04	2.03E+04	No (1000)	1.41E+08	1.14E+08	2.03E+01	1.10E+00	CRC	-		5.00E+00	I	No	-	2.19E+03
trifluoroethane, 1,1,2-	76-13-1	Yes	Yes	Yes	Yes	2.19E+03	NC	7.30E+04	2.41E+02	--	3.65E+09	3.09E+09	2.03E+01	-		-		5.00E+00	P	No	-	2.19E+03
Trichlorobenzene, 1,2,4-	120-82-1	Yes	Yes	Yes	Yes	8.76E-01	NC	2.92E+01	4.24E+01	Yes (70)	4.49E+06	2.03E+06	2.03E+01	2.50E+00	CRC	-		2.00E-03	P	No	-	8.76E-01
Trichloroethane, 1,1,1-	71-55-6	Yes	Yes	Yes	Yes	2.19E+03	NC	7.30E+04	7.56E+03	No (200)	8.90E+08	7.47E+08	2.03E+01	8.00E+00	CRC	-		5.00E+00	I	No	-	2.19E+03
Trichloroethane, 1,1,2-	79-00-5	Yes	Yes	Yes	Yes	8.76E-02	NC	2.92E+00	6.61E+00	No (5)	1.65E+08	1.22E+08	2.03E+01	6.00E+00	CRC	1.60E-05	I	2.00E-04	X	No	7.67E-01	8.76E-02
Trichloroethylene	79-01-6	Yes	Yes	Yes	Yes	8.76E-01	NC	2.92E+01	5.36E+00	No (5)	4.88E+08	4.19E+08	2.03E+01	8.00E+00	CRC	4.10E-06	I	2.00E-03	I	Mut	2.99E+00	8.76E-01
Trichlorofluoromethane	75-69-4	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		5.93E+09	3.76E+09	2.03E+01	-		-		-		No	-	-
Trichloropropane, 1,2,3-	96-18-4	Yes	Yes	Yes	Yes	1.31E-01	NC	4.38E+00	2.46E+01	--	2.93E+07	1.87E+07	2.03E+01	3.20E+00	CRC	-		3.00E-04	I	Mut	-	1.31E-01
Trimethylbenzene, 1,2,4-	95-63-6	Yes	Yes	Yes	Yes	2.63E+01	NC	8.76E+02	2.81E+02	--	1.36E+07	1.07E+07	2.03E+01	9.00E-01	CRC	-		6.00E-02	I	No	-	2.63E+01
Trimethylbenzene, 1,3,5-	108-67-8	Yes	Yes	Yes	Yes	2.63E+01	NC	8.76E+02	1.97E+02	--	1.60E+07	1.29E+07	2.03E+01	1.00E+00	CRC	-		6.00E-02	I	No	-	2.63E+01
Vinyl Acetate	108-05-4	Yes	Yes	Yes	Yes	8.76E+01	NC	2.92E+03	1.06E+04	--	4.17E+08	3.32E+08	2.03E+01	2.60E+00	CRC	-		2.00E-01	I	No	-	8.76E+01
Vinyl Chloride	75-01-4	Yes	Yes	Yes	Yes	2.79E+00	CA	9.29E+01	5.47E+00	No (2)	1.00E+10	8.97E+09	2.03E+01	3.60E+00	CRC	4.40E-06	I	8.00E-02	A	Mut	2.79E+00	3.50E+01
Xylene, m-	108-38-3	Yes	Yes	Yes	Yes	4.38E+01	NC	1.46E+03	3.86E+02	--	4.73E+07	3.65E+07	2.03E+01	1.10E+00	CRC	-		1.00E-01	G	No	-	4.38E+01
Xylene, o-	95-47-6	Yes	Yes	Yes	Yes	4.38E+01	NC	1.46E+03	5.38E+02	--	3.77E+07	2.90E+07	2.03E+01	9.00E-01	CRC	-		1.00E-01	G	No	-	4.38E+01
Xylene, p-	106-42-3	Yes	Yes	Yes	Yes	4.38E+01	NC	1.46E+03	4.02E+02	--	5.05E+07	3.53E+07	2.03E+01	1.10E+00	CRC	-		1.00E-01	G	No	-	4.38E+01
Xylenes	1330-20-7	Yes	Yes	Yes	Yes	4.38E+01	NC	1.46E+03	4.18E+02	Yes (10000)	4.56E+07	2.22E+07	2.03E+01	-		-		1.00E-01	I	No	-	4.38E+01

Table E.1B
VISL Commercial - Chemical Properties - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m^3/mole)	Henry's Law Constant (unitless)	Henry's Law Constant (20.3 ℃) (unitless)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Enthalpy of vaporization @ groundwater temperature $\Delta H_{v,gw}$ (cal/mol)	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$ (cal/mol)	$\Delta H_{v,b}$ Ref	Normal Boiling Point BP (K)	BP Ref	Exponent for $\Delta H_{v,gw}$	Vapor Pressure VP (mm Hg)	VP Ref	Vapor Pressure VP (20.3 ℃) (mm Hg)	Critical Temperature T_C (K)	T_C Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Acetone	67-64-1	Yes	Yes	5.81E+01	U	1.00E+06	U	-	3.50E-05	1.43E-03	1.19E-03	1.19E-03	U	7.44E+03	6.96E+03	U	3.29E+02	U	3.63E-01	2.32E+02	U	1.90E+02	5.08E+02	U	2.50E+00	U
Acetonitrile	75-05-8	Yes	Yes	4.11E+01	ROP	1.00E+06	OP	-	3.45E-05	1.41E-03	1.16E-03	1.16E-03	PHYSPROP	7.87E+03	7.11E+03	CRC	3.55E+02	PHYSPROP	3.65E-01	8.88E+01	PHYSPROP	7.18E+01	5.45E+02	CRC	3.00E+00	CRC
Acrolein	107-02-8	Yes	Yes	5.61E+01	ROP	2.12E+05	OP	-	1.22E-04	4.99E-03	4.17E-03	4.17E-03	PHYSPROP	7.18E+03	6.76E+03	CRC	3.26E+02	PHYSPROP	3.60E-01	2.74E+02	PHYSPROP	2.26E+02	5.06E+02	YAWS	2.80E+00	CRC
Acrylonitrile	107-13-1	Yes	Yes	5.31E+01	ROP	7.45E+04	OP	-	1.38E-04	5.64E-03	4.55E-03	4.55E-03	PHYSPROP	8.57E+03	7.79E+03	CRC	3.50E+02	PHYSPROP	3.64E-01	1.09E+02	PHYSPROP	8.61E+01	5.40E+02	CRC	3.00E+00	CRC
Allyl Chloride	107-05-1	Yes	Yes	7.65E+01	ROP	3.37E+03	OP	-	1.10E-02	4.50E-01	3.76E-01	3.76E-01	EPI	7.22E+03	6.93E+03	CRC	3.18E+02	PHYSPROP	3.42E-01	3.68E+02	PHYSPROP	3.03E+02	5.14E+02	YAWS	2.90E+00	CRC
Benzene	71-43-2	Yes	Yes	7.81E+01	ROP	1.79E+03	OP	5.00E+00	5.55E-03	2.27E-01	1.86E-01	1.86E-01	PHYSPROP	8.02E+03	7.34E+03	CRC	3.53E+02	PHYSPROP	3.49E-01	9.48E+01	PHYSPROP	7.63E+01	5.62E+02	CRC	1.20E+00	CRC
Benzyl Chloride	100-44-7	Yes	Yes	1.27E+02	ROP	5.25E+02	OP	-	4.12E-04	1.68E-02	1.28E-02	1.28E-02	EPI	1.06E+04	8.77E+03	TOXNET	4.52E+02	PHYSPROP	3.72E-01	1.23E+00	PHYSPROP	9.23E-01	6.86E+02	YAWS	1.10E+00	CRC
Bromodichloromethane	75-27-4	Yes	Yes	1.64E+02	ROP	3.03E+03	OP	8.00E+01	2.12E-03	8.67E-02	6.99E-02	6.99E-02	PHYSPROP	8.56E+03	7.80E+03	Weast	3.63E+02	PHYSPROP	3.43E-01	5.00E+01	PHYSPROP	3.97E+01	5.86E+02	Weast	-	
Bromoform	75-25-2	Yes	Yes	2.53E+02	ROP	3.10E+03	OP	8.00E+01	5.35E-04	2.19E-02	1.66E-02	1.66E-02	PHYSPROP	1.09E+04	9.48E+03	CRC	4.22E+02	PHYSPROP	3.42E-01	5.40E+00	EPI	4.02E+00	6.82E+02	CRC	-	
Bromomethane	74-83-9	Yes	Yes	9.49E+01	ROP	1.52E+04	OP	-	7.34E-03	3.00E-01	2.62E-01	2.62E-01	PHYSPROP	5.55E+03	5.71E+03	CRC	2.77E+02	PHYSPROP	3.22E-01	1.62E+03	PHYSPROP	1.39E+03	4.67E+02	YAWS	1.00E+01	CRC
Butadiene, 1,3-	106-99-0	Yes	Yes	5.41E+01	ROP	7.35E+02	OP	-	7.36E-02	3.01E+00	2.67E+00	2.67E+00	EPI	5.05E+03	5.37E+03	CRC	2.69E+02	PHYSPROP	3.52E-01	2.11E+03	PHYSPROP	1.84E+03	4.25E+02	CRC	2.00E+00	CRC
Butyl Alcohol, t-	75-65-0	Yes	Yes	7.41E+01	ROP	1.00E+06	OP	-	9.05E-06	3.70E-04	2.81E-04	2.81E-04	PHYSPROP	1.07E+04	9.34E+03	CRC	3.56E+02	PHYSPROP	4.04E-01	4.07E+01	PHYSPROP	3.04E+01	5.06E+02	CRC	2.40E+00	CRC
Butylbenzene, n-	104-51-8	Yes	No	1.34E+02	ROP	1.18E+01	OP	-	1.59E-02	6.50E-01	4.81E-01	4.81E-01	EPI	1.17E+04	9.29E+03	CRC	4.56E+02	PHYSPROP	3.95E-01	1.06E+00	PHYSPROP	7.75E-01	6.61E+02	CRC	8.00E-01	CRC
Butylbenzene, sec-	135-98-8	Yes	No	1.34E+02	PHYSPROP	1.76E+01	PHYSPROP	-	1.76E-02	7.20E-01	5.00E-01	5.00E-01	EPI	1.40E+04	1.15E+04	TOXNET (converted)	4.47E+02	PHYSPROP	3.81E-01	1.75E+00	PHYSPROP	1.20E+00	6.65E+02	YAWS	8.00E-01	YAWS
Carbon Disulfide	75-15-0	Yes	Yes	7.61E+01	ROP	2.16E+03	OP	-	1.44E-02	5.89E-01	5.00E-01	5.00E-01	PHYSPROP	6.60E+03	6.39E+03	CRC	3.19E+02	PHYSPROP	3.12E-01	3.59E+02	PHYSPROP	3.00E+02	5.52E+02	CRC	1.30E+00	CRC
Carbon Tetrachloride	56-23-5	Yes	Yes	1.54E+02	ROP	7.93E+02	OP	5.00E+00	2.76E-02	1.13E+00	9.29E-01	9.29E-01	PHYSPROP	7.76E+03	7.13E+03	CRC	3.50E+02	PHYSPROP	3.49E-01	1.15E+02	PHYSPROP	9.33E+01	5.57E+02	CRC	-	
Chlorobenzene	108-90-7	Yes	Yes	1.13E+02	ROP	4.98E+02	OP	1.00E+02	3.11E-03	1.27E-01	9.94E-02	9.94E-02	PHYSPROP	9.70E+03	8.41E+03	CRC	4.05E+02	PHYSPROP	3.58E-01	1.20E+01	PHYSPROP	9.21E+00	6.32E+02	CRC	1.30E+00	CRC
Chloroform	67-66-3	Yes	Yes	1.19E+02	ROP	7.95E+03	OP	8.00E+01	3.67E-03	1.50E-01	1.25E-01	1.25E-01	PHYSPROP	7.45E+03	6.99E+03	CRC	3.34E+02	PHYSPROP	3.45E-01	1.97E+02	PHYSPROP	1.61E+02	5.36E+02	CRC	-	
Chloromethane	74-87-3	Yes	Yes	5.05E+01	ROP	5.32E+03	OP	-	8.82E-03	3.61E-01	3.23E-01	3.23E-01	PHYSPROP	4.62E+03	5.11E+03	CRC	2.49E+02	PHYSPROP	3.27E-01	4.30E+03	PHYSPROP	3.79E+03	4.16E+02	CRC	8.10E+00	CRC
Cumene	98-82-8	Yes	Yes	1.20E+02	ROP	6.13E+01	OP	-	1.15E-02	4.70E-01	3.41E-01	3.41E-01	PHYSPROP	1.25E+04	1.03E+04	TOXNET	4.26E+02	PHYSPROP	3.83E-01	4.50E+00	PHYSPROP	3.21E+00	6.31E+02	CRC	9.00E-01	CRC
Cyclohexane	110-82-7	Yes	Yes	8.42E+01	ROP	5.50E+01	OP	-	1.50E-01	6.13E+00	5.04E+00	5.04E+00	PHYSPROP	7.87E+03	7.16E+03	CRC	3.54E+02	PHYSPROP	3.57E-01	9.69E+01	PHYSPROP	7.83E+01	5.53E+02	CRC	1.30E+00	CRC
Dibromo-3-chloropropane, 1,2-	96-12-8	Yes	Yes	2.36E+02	PHYSPROP	1.23E+03	PHYSPROP	2.00E-01	1.47E-04	6.01E-03	4.38E-03	4.38E-03	EPI	1.23E+04	9.96E+03	MSDS (converted)	4.69E+02	PHYSPROP	3.77E-01	5.80E-01	PHYSPROP	4.16E-01	7.04E+02	from Tcrit=1.5xT	-	
Dibromochloromethane	124-48-1	Yes	No	2.08E+02	ROP	2.70E+03	OP	8.00E+01	7.83E-04	3.20E-02	2.73E-02	2.73E-02	PHYSPROP	6.48E+03	5.90E+03	Weast	3.93E+02	PHYSPROP	3.13E-01	5.54E+00	PHYSPROP	4.65E+00	6.78E+02	Weast	-	
Dibromoethane, 1,2-	106-93-4	Yes	Yes	1.88E+02	ROP	3.91E+03	OP	5.00E-02	6.50E-04	2.66E-02	2.09E-02	2.09E-02	PHYSPROP	9.45E+03	8.31E+03	CRC	4.05E+02	PHYSPROP	3.45E-01	1.12E+01	PHYSPROP	8.67E+00	6.50E+02	YAWS	-	
Dichlorobenzene, 1,2-	95-50-1	Yes	Yes	1.47E+02	ROP	1.56E+02	OP	6.00E+02	1.92E-03	7.85E-02	5.87E-02	5.87E-02	PHYSPROP	1.13E+04	9.48E+03	CRC	4.53E+02	PHYSPROP	3.60E-01	1.36E+00	PHYSPROP	1.00E+00	7.05E+02	YAWS	2.20E+00	CRC
Dichlorobenzene, 1,3-	541-73-1	Yes	No	1.47E+02	ROP	1.25E+02	OP	-	2.63E-03	1.08E-01	8.10E-02	8.10E-02	PHYSPROP	1.11E+04	9.23E+03	CRC	4.46E+02	PHYSPROP	3.65E-01	2.15E+00	PHYSPROP	1.59E+00	6.86E+02	CRC	1.80E+00	YAWS
Dichlorobenzene, 1,4-	106-46-7	Yes	Yes	1.47E+02	ROP	8.13E+01	OP	7.50E+01	2.41E-03	9.85E-02	7.37E-02	7.37E-02	PHYSPROP	1.13E+04	9.27E+03	CRC	4.47E+02	PHYSPROP	3.79E-01	1.74E+00	PHYSPROP	1.28E+00	6.69E+02	CRC	1.80E+00	YAWS
Dichlorodifluoromethane	75-71-8	Yes	Yes	1.21E+02	ROP	2.80E+02	OP	-	3.43E-01	1.40E+01	1.27E+01	1.27E+01	PHYSPROP	4.12E+03	4.80E+03	CRC	2.43E+02	PHYSPROP	3.52E-01	4.85E+03	PHYSPROP	4.34E+03	3.85E+02	CRC	-	
Dichloroethane, 1,1-	75-34-3	Yes	Yes	9.90E+01	ROP	5.04E+03	OP	-	5.62E-03	2.30E-01	1.91E-01	1.91E-01	PHYSPROP	7.34E+03	6.90E+03	CRC	3.31E+02	PHYSPROP	3.51E-01	2.27E+02	PHYSPROP	1.86E+02	5.23E+02	CRC	5.40E+00	CRC
Dichloroethane, 1,2-	107-06-2	Yes	Yes	9.90E+01	ROP	8.60E+03	OP	5.00E+00	1.18E-03	4.82E-02	3.90E-02	3.90E-02	PHYSPROP	8.41E+03	7.64E+03	CRC	3.57E+02	PHYSPROP	3.54E-01	7.89E+01	PHYSPROP	6.29E+01	5.62E+02	CRC	6.20E+00	CRC
Dichloroethylene, 1,1-	75-35-4	Yes	Yes	9.69E+01	ROP	2.42E+03	OP	7.00E+00	2.61E-02	1.07E+00	9.12E-01	9.12E-01	PHYSPROP	6.39E+03	6.25E+03	CRC	3.05E+02	PHYSPROP	3.52E-01	6.00E+02	PHYSPROP	5.05E+02	4.82E+02	YAWS	6.50E+00	CRC
Dichloroethylene, cis-1,2-	156-59-2	Yes	Yes	9.69E+01	U	6.41E+03	U	7.00E+01	4.08E-03	1.67E-01	1.38E-01	1.38E-01	U	7.68E+03	7.22E+03	U	3.33E+02	U	3.44E-01	2.00E+02	U	1.63E+02	5.36E+02	U	3.00E+00	U
Dichloroethylene, trans-1,2-	156-60-5	Yes	Yes	9.69E+01	U	4.52E+03	U	1.00E+02	9.38E-03	3.83E-01	3.20E-01	3.20E-01	U	7.24E+03	6.91E+03	U	3.22E+02	U	3.46E-01	3.31E+02	U	2.72E+02	5.16E+02	U	6.00E+00	U
Dichloropropane, 1,2-	78-87-5	Yes	Yes	1.13E+02	ROP	2.80E+03	OP	5.00E+00	2.82E-03	1.15E-01	9.31E-02	9.31E-02	PHYSPROP	8.50E+03	7.59E+03	Weast	3.69E+02	PHYSPROP	3.61E-01	5.33E+01	PHYSPROP	4.24E+01	5.72E+02	YAWS	3.40E+00	YAWS
Dichloropropene, 1,3-	542-75-6	Yes	Yes	1.11E+02	ROP	2.80E+03	OP	-	3.55E-03	1.45E-01	1.15E-01	1.15E-01	PHYSPROP	9.16E+03	7.90E+03	Weast	3.85E+02	PHYSPROP	3.78E-01	3.40E+01	PHYSPROP	2.65E+01	5.77E+02	YAWS	5.30E+00	N
Dioxane, 1,4-	123-91-1	Yes	Yes	8.81E+01	ROP	1.00E+06	OP	-	4.80E-06	1.96E-04	1.56E-04	1.56E-04	PHYSPROP	9.16E+03	8.16E+03	CRC	3.75E+02	PHYSPROP	3.56E-01	3.81E+01	PHYSPROP	2.97E+01	5.87E+02	CRC	2.00E+00	CRC
Ethyl Acetate	141-78-6	Yes	Yes	8.81E+01	ROP	8.00E+04	OP	-	1.34E-04	5.48E-03	4.42E-03	4.42E-03	PHYSPROP	8.50E+03	7.63E+03	CRC	3.50E+02	PHYSPROP	3.79E-01	9.32E+01	PHYSPROP	7.41E+01	5.23E+02	CRC	2.00E+00	CRC
Ethyl Chloride	75-00-3	Yes	Yes	6.45E+01	ROP	6.71E+03	OP	-	1.11E-02	4.54E-01	3.94E-01	3.94E-01	PHYSPROP	5.80E+03	5.89E+03	CRC	2.85E+02	PHYSPROP	3.43E-01	1.01E+03	PHYSPROP	8.62E+02	4.60E+02	CRC	3.80E+00	CRC
Ethylbenzene	100-41-4	Yes	Yes	1.06E+02	ROP	1.69E+02	OP	7.00E+02	7.88E-03	3.22E-01	2.50E-01	2.50E-01	PHYSPROP	1.00E+04	8.50E+03	CRC	4.09E+02	PHYSPROP	3.75E-01	9.60E+00	PHYSPROP	7.32E+00	6.17E+02	CRC	8.00E-01	CRC
Heptane, N-	142-82-5	Yes	Yes	1.00E+02	ROP	3.40E+00	OP	-	2.00E+00	8.18E+01	6.54E+01	6.54E+01	EPI	8.82E+03	7.59E+03	CRC	3.72E+02	PHYSPROP	3.93E-01	4.60E+01	PHYSPROP	3.62E+01	5.40E+02	CRC	1.05E+00	CRC
Hexachlorobutadiene	87-68-3	Yes	Yes	2.61E+02	ROP	3.20E+00	OP	-	1.03E-02	4.21E-01	3.04E-01	3.04E-01	PHYSPROP	1.27E+04	1.02E+04	Weast	4.88E+02	PHYSPROP	3.73E-01	2.20E-01	PHYSPROP	1.56E-01	7.38E+02	YAWS	2.90E+00	YAWS
Hexane, N-	110-54-3	Yes	Yes	8.62E+01	ROP	9.50E+00	OP	-	1.80E+00	7.36E+01	6.09E+01	6.09E+01	EPI	7.61E+03	6.90E+03	CRC	3.42E+02	PHYSPROP	3.82E-01	1.51E+02	PHYSPROP	1.23E+02	5.08E+02	CRC	1.10E+00	CRC
Hexanone, 2-	591-78-6	Yes	Yes	1.00E+02	ROP	1.72E+04	OP	-	9.32E-05	3.81E-03	2.92E-03	2.92E-03	EPI	1.04E+04	8.69E+03	CRC	4.01E+02	PHYSPROP	3.89E-01	1.16E+01	PHYSPROP	8.76E+00	5.87E+02	CRC	1.00E+00	CRC
Isopropanol	67-63-0	Yes	Yes	6.01E+01	ROP	1.00E+06	OP	-	8.10E-06	3.31E-04	2.50E-04	2.50E-04	PHYSPROP	1.09E+04	9.52E+03	CRC	3.55E+02	PHYSPROP	4.01E-01	4.54E+01	PHYSPROP	3.38E+01	5.08E+02	CRC	2.00E+00	CRC
Butanone)	78-93-3	Yes	Yes	7.21E+01	ROP	2.23E+05	OP	-	5.69E-05	2.33E-03	1.89E-03	1.89E-03	PHYSPROP	8.29E+03	7.48E+03	CRC	3.53E+02	PHYSPROP	3.70E-01	9.06E+01	PHYSPROP	7.24E+01	5.37E+02	CRC	1.40E+00	CRC
methyl-2-pentanone)	108-10-1	Yes	Yes	1.00E+02	ROP	1.90E+04	OP	-	1.38E-04	5.64E-03	4.41E-03	4.41E-03	EPI	9.68E+03	8.24E+03	CRC	3.90E+02	PHYSPROP	3.85E-01	1.99E+01	PHYSPROP	1.53E+01	5.75E+02	CRC	1.20E+00	CRC
Methyl Methacrylate	80-62-6	Yes	Yes	1.00E+02	ROP	1.50E+04	OP	-	3.19E-04	1.30E-02	1.01E-02	1.01E-02	EPI	1.01E+04	8.60E+03	CRC	3.74E+02	PHYSPROP	3.96E-01	3.85E+01	PHYSPROP	2.93E+01	5.40E+02	CRC	1.70E+00	CRC
(MTBE)	1634-04-4	Yes	Yes	8.82E+01	ROP	5.10E+04	OP	-	5.87E-04	2.40E-02	2.01E-02	2.01E-02	PHYSPROP	7.16E+03	6.68E+03	CRC	3.28E+02	PHYSPROP	3.73E-01	2.50E+02	PHYSPROP	2.06E+02	4.97E+02	CRC	2.00E+00	YAWS
Methylene Chloride	75-09-2	Yes	Yes	8.49E+01	ROP	1.30E+04	OP	5.00E+00	3.25E-03	1.33E-01	1.12E-01	1.12E-01	PHYSPROP	6.93E+03	6.71E+03	CRC	3.13E+02	PHYSPROP	3.40E-01	4.35E+02	PHYSPROP	3.61E+02	5.08E+02	CRC	1.30E+01	CRC
Naphthalene	91-20-3	Yes	Yes	1.28E+02	ROP	3.10E+01	OP	-	4.40E-04	1.80E-02	1.29E-02	1.29E-02	PHYSPROP	1.27E+04	1.03E+04	CRC	4.91E+02	PHYSPROP	3.70E-01	8.50E-02	PHYSPROP	6.02E-02	7.48E+02	CRC	9.00E-01	CRC
Nonane, n-	111-84-2	Yes	Yes	1.28E+02	ROP	2.20E-01	OP	-	3.40E+00	1.39E+02	1.04E+02	1.04E+02	EPI	1.12E+04	8.89E+03	CRC	4.24E+02	PHYSPROP	4.10E-01	4.45E+00	PHYSPROP	3.29E+00	5.94E+02	CRC	8.00E-01	CRC
Propyl benzene	103-65-1	Yes	Yes	1.20E+02	ROP	5.22E+01	OP	-	1.05E-02	4.29E-01	3.23E-01	3.23E-01	PHYSPROP	1.11E+04	9.12E+03	DECHEMA	4.32E+02	PHYSPROP	3.85E-01	3.42E+00	PHYSPROP	2.53E+00	6.38E+02	CRC	8.00E-01	CRC
Propylene	115-07-1	Yes	Yes	4.21E+01	ROP	2.00E+02	OP	-	1.96E-01	8.01E+00	7.40E+00	7.40E+00	PHYSPROP	3.50E+03	4.40E+03	CRC	2.25E+02	PHYSPROP	3.41E-01	8.69E+03	PHYSPROP	7.90E+03	3.65E+02	CRC	2.00E+00	CRC
Styrene	100-42-5	Yes	Yes	1.04E+02	ROP	3.10E+02	OP	1.00E+02	2.75E-03	1.12E-01	8.50E-02	8.50E-02	PHYSPROP	1.09E+04	9.25E+03	CRC	4.18E+02	PHYSPROP	3.71E-01	6.40E+00	PHYSPROP	4.76E+00	6.35E+02	CRC	9.00E-01	CRC
Tetrachloroethane, 1,1,2,2-	79-34-5	Yes	Yes	1.68E+02	ROP	2.83E+03	OP	-	3.67E-04	1.50E-02	1.14E-02	1.14E-02	PHYSPROP	1.06E+04	9.00E+03	CRC	4.20E+02	PHYSPROP	3.65E-01	4.62E+00	PHYSPROP	3.47E+00	6.45E+02	YAWS	-	
Tetrachloroethylene	127-18-4	Yes	Yes	1.66E+02	ROP	2.06E+02	OP	5.00E+00	1.77E-02	7.24E-01	5.69E-01	5.69E-01	PHYSPROP	9.45E+03	8.29E+03	CRC	3.94E+02	PHYSPROP	3.55E-01	1.85E+01	PHYSPROP	1.43E+01	6.20E+02	YAWS	-	
Tetrahydrofuran	109-99-9	Yes	Yes	7.21E+01	ROP	1.00E+06	OP	-	7.05E-05	2.88E-03	2.38E-03	2.38E-03	PHYSPROP	7.64E+03	7.12E+03	CRC	3.38E+02	PHYSPROP	3.47E-01	1.62E+02	PHYSPROP	1.32E+02	5.40E+02	CRC	2.00E+00	CRC
Toluene	108-88-3	Yes	Yes	9.21E+01	ROP	5.26E+02	OP	1.00E+03	6.64E-03	2.71E-01	2.16E-01	2.16E-01	PHYSPROP	9.04E+03	7.93E+03	CRC	3.84E+02	PHYSPROP	3.64E-01	2.84E+01	PHYSPROP	2.22E+01	5.92E+02	CRC	1.10E+00	CRC
trifluoroethane, 1,1,2-	76-13-1	Yes	Yes	1.87E+02	ROP	1.70E+02	OP	-	5.26E-01	2.15E+01	1.82E+01	1.82E+01	EPI	6.84E+03	6.46E+03	CRC	3.21E+02	PHYSPROP	3.71E-01	3.63E+02	PHYSPROP	3.01E+02	4.87E+02	CRC	-	
Trichlorobenzene, 1,2,4-	120-82-1	Yes	Yes	1.81E+02	ROP	4.90E+01	OP	7.00E+01	1.42E-03	5.81E-02	4.14E-02	4.14E-02	PHYSPROP	1.31E+04	1.05E+04	Weast	4.87E+02	PHYSPROP	3.81E-01	4.60E-01	PHYSPROP	3.23E-01	7.25E+02	YAWS	2.50E+00	CRC
Trichloroethane, 1,1,1-	71-55-6	Yes	Yes	1.33E+02	ROP	1.29E+03	OP	2.00E+02	1.72E-02	7.03E-01	5.79E-01	5.79E-01	PHYSPROP	7.77E+03	7.14E+03	CRC	3.47E+02	PHYSPROP	3.55E-01	1.24E+02	PHYSPROP	1.01E+02	5.45E+02	YAWS	8.00E+00	CRC
Trichloroethane, 1,1,2-	79-00-5	Yes	Yes	1.33E+02	ROP	4.59E+03	OP	5.00E+00	8.24E-04	3.37E-02	2.65E-02	2.65E-02	PHYSPROP	9.48E+03	8.32E+03	CRC	3.87E+02	PHYSPROP	3.60E-01	2.30E+01	PHYSPROP	1.78E+01	6.02E+02	YAWS	6.00E+00	CRC
Trichloroethylene	79-01-6	Yes	Yes	1.31E+02	ROP	1.28E+03	OP	5.00E+00	9.85E-03	4.03E-01	3.27E-01	3.27E-01	PHYSPROP	8.27E+03	7.50E+03	CRC	3.60E+02	PHYSPROP	3.51E-01	6.90E+01	PHYSPROP	5.52E+01	5.71E+02	YAWS	8.00E+00	CRC
Trichlorofluoromethane	75-69-4	Yes	No	1.37E+02	ROP	1.10E+03	OP	-	9.70E-02	3.97E+00	3.42E+00	3.42E+00	PHYSPROP	6.04E+03	6.00E+03	CRC	2.97E+02	PHYSPROP	3.50E-01	8.03E+02	PHYSPROP	6.82E+02	4.71E+02	CRC	-	
Trichloropropane, 1,2,3-	96-18-4	Yes	Yes	1.47E+02	ROP	1.75E+03	OP	-	3.43E-04	1.40E-02	1.07E-02	1.07E-02	PHYSPROP	1.06E+04	8.87E+03	CRC	4.30E+02	PHYSPROP	3.72E-01	3.69E+00	PHYSPROP	2.77E+00	6.52E+02	YAWS	3.20E+00	CRC
Trimethylbenzene, 1,2,4-	95-63-6	Yes	Yes	1.20E+02	ROP	5.70E+01	OP	-	6.16E-03	2.52E-01	1.87E-01	1.87E-01	PHYSPROP	1.16E+04	9.37E+03	TOXNET	4.42E+02	PHYSPROP	3.88E-01	2.10E+00	PHYSPROP	1.54E+00	6.49E+02	CRC	9.00E-01	CRC
Trimethylbenzene, 1,3,5-	108-67-8	Yes	Yes	1.20E+02	ROP	4.82E+01	OP	-	8.77E-03	3.59E-01	2.67E-01	2.67E-01	PHYSPROP	1.15E+04	9.32E+03	TOXNET	4.38E+02	PHYSPROP	3.92E-01	2.48E+00	PHYSPROP	1.82E+00	6.37E+02	CRC	1.00E+00	CRC
Vinyl Acetate	108-05-4	Yes	Yes	8.61E+01	ROP	2.00E+04	OP	-	5.11E-04	2.09E-02	1.66E-02	1.66E-02	EPI	9.14E+03	8.27E+03	CRC	3.46E+02	PHYSPROP	3.77E-01	9.02E+01	PHYSPROP	7.04E+01	5.19E+02	CRC	2.60E+00	CRC

Table E.1B
VISL Commercial - Chemical Properties - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m^3/mole)	Henry's Law Constant (unitless)	Henry's Law Constant (20.3 ℃) (unitless)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Enthalpy of vaporization @ groundwater temperature $\Delta H_{v,gw}$ (cal/mol)	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$ (cal/mol)	$\Delta H_{v,b}$ Ref	Normal Boiling Point BP (K)	BP Ref	Exponent for $\Delta H_{v,gw}$	Vapor Pressure VP (mm Hg)	VP Ref	Vapor Pressure VP (20.3 ℃) (mm Hg)	Critical Temperature T_C (K)	T_C Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Vinyl Chloride	75-01-4	Yes	Yes	6.25E+01	ROP	8.80E+03	OP	2.00E+00	2.78E-02	1.14E+00	1.02E+00	1.02E+00	PHYSPROP	4.61E+03	4.97E+03	CRC	2.60E+02	PHYSPROP	3.36E-01	2.98E+03	EPI	2.63E+03	4.25E+02	CRC	3.60E+00	CRC
Xylene, m-	108-38-3	Yes	Yes	1.06E+02	ROP	1.61E+02	OP	-	7.18E-03	2.94E-01	2.27E-01	2.27E-01	PHYSPROP	1.01E+04	8.52E+03	CRC	4.12E+02	PHYSPROP	3.79E-01	8.29E+00	PHYSPROP	6.30E+00	6.17E+02	CRC	1.10E+00	CRC
Xylene, o-	95-47-6	Yes	Yes	1.06E+02	ROP	1.78E+02	OP	-	5.18E-03	2.12E-01	1.63E-01	1.63E-01	PHYSPROP	1.03E+04	8.66E+03	CRC	4.18E+02	PHYSPROP	3.74E-01	6.61E+00	PHYSPROP	5.00E+00	6.30E+02	CRC	9.00E-01	CRC
Xylene, p-	106-42-3	Yes	Yes	1.06E+02	ROP	1.62E+02	OP	-	6.90E-03	2.82E-01	2.18E-01	2.18E-01	PHYSPROP	1.01E+04	8.53E+03	CRC	4.11E+02	PHYSPROP	3.78E-01	8.84E+00	PHYSPROP	6.72E+00	6.16E+02	CRC	1.10E+00	CRC
Xylenes	1330-20-7	Yes	Yes	1.06E+02	ROP	1.06E+02	OP	1.00E+04	6.63E-03	2.71E-01	2.10E-01	2.10E-01	PHYSPROP	1.01E+04	8.52E+03	Weast	4.12E+02	PHYSPROP	3.75E-01	7.99E+00	PHYSPROP	6.08E+00	6.20E+02	YAWS	-	

Table E.1C

VISL Commercial - Equation Inputs - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Variable	Commercial Air Default Value	Site-Specific Value
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001	0.0005
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03	0.03
AT_w (averaging time - composite worker)	365	365
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr	8	8
THQ (target hazard quotient) unitless	0.1	0.1
LT (lifetime) yr	70	70
TR (target risk) unitless	0.000001	0.000001

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Table E.2A

VISL Resident - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Sec

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m^3)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m^3)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (20.3 ℃) (µg/m^3)	Maximum Groundwater Vapor Concentration C_{hc} (µg/m^3)	Temperature for Maximum Groundwater Vapor Concentration (℃)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$(µg/m^3)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$(µg/m^3)
Acetone	67-64-1	Yes	Yes	Yes	Yes	3.23E+03	NC	1.08E+05	5.44E+06	--	7.25E+08	1.19E+09	2.03E+01	2.50E+00	U	-		3.10E+01	**2021 ATSDR**	No	-	3.23E+03
Acetonitrile	75-05-8	Yes	Yes	Yes	Yes	6.26E+00	NC	2.09E+02	1.08E+04	--	1.96E+08	1.16E+09	2.03E+01	3.00E+00	CRC	-		6.00E-02	I	No	-	6.26E+00
Acrolein	107-02-8	Yes	Yes	Yes	Yes	2.09E-03	NC	6.95E-02	1.00E+00	--	8.26E+08	8.85E+08	2.03E+01	2.80E+00	CRC	-		2.00E-05	I	No	-	2.09E-03
Acrylonitrile	107-13-1	Yes	Yes	Yes	Yes	4.13E-02	CA	1.38E+00	1.82E+01	--	3.10E+08	3.39E+08	2.03E+01	3.00E+00	CRC	6.80E-05	I	2.00E-03	I	No	4.13E-02	2.09E-01
Allyl Chloride	107-05-1	Yes	Yes	Yes	Yes	1.04E-01	NC	3.48E+00	5.55E-01	--	1.51E+09	1.27E+09	2.03E+01	2.90E+00	CRC	6.00E-06	C	1.00E-03	I	No	4.68E-01	1.04E-01
Benzene	71-43-2	Yes	Yes	Yes	Yes	3.60E-01	CA	1.20E+01	3.88E+00	Yes (5)	3.98E+08	3.32E+08	2.03E+01	1.20E+00	CRC	7.80E-06	I	3.00E-02	I	No	3.60E-01	3.13E+00
Benzyl Chloride	100-44-7	Yes	Yes	Yes	Yes	5.73E-02	CA	1.91E+00	8.93E+00	--	8.37E+06	6.74E+06	2.03E+01	1.10E+00	CRC	4.90E-05	C	1.00E-03	P	No	5.73E-02	1.04E-01
Bromodichloromethane	75-27-4	Yes	Yes	Yes	Yes	7.59E-02	CA	2.53E+00	2.17E+00	Yes (80)	4.41E+08	2.12E+08	2.03E+01	-		3.70E-05	C	-		No	7.59E-02	-
Bromoform	75-25-2	Yes	Yes	Yes	Yes	2.55E+00	CA	8.51E+01	3.08E+02	No (80)	7.34E+07	5.13E+07	2.03E+01	-		1.10E-06	I	-		No	2.55E+00	-
Bromomethane	74-83-9	Yes	Yes	Yes	Yes	5.21E-01	NC	1.74E+01	3.97E+00	--	8.25E+09	3.99E+09	2.03E+01	1.00E+01	CRC	-		5.00E-03	I	No	-	5.21E-01
Butadiene, 1,3-	106-99-0	Yes	Yes	Yes	Yes	9.36E-02	CA	3.12E+00	7.02E-02	--	6.13E+09	1.96E+09	2.03E+01	2.00E+00	CRC	3.00E-05	I	2.00E-03	I	No	9.36E-02	2.09E-01
Butyl Alcohol, t-	75-65-0	Yes	Yes	Yes	Yes	5.21E+02	NC	1.74E+04	3.71E+06	--	1.62E+08	2.81E+08	2.03E+01	2.40E+00	CRC	-		5.00E+00	I	No	-	5.21E+02
Butylbenzene, n-	104-51-8	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		7.68E+06	5.68E+06	2.03E+01	8.00E-01	CRC	-		-		No	-	-
Butylbenzene, sec-	135-98-8	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1.26E+07	8.80E+06	2.03E+01	8.00E-01	YAWS	-		-		No	-	-
Carbon Disulfide	75-15-0	Yes	Yes	Yes	Yes	7.30E+01	NC	2.43E+03	2.92E+02	--	1.47E+09	1.08E+09	2.03E+01	1.30E+00	CRC	-		7.00E-01	I	No	-	7.30E+01
Carbon Tetrachloride	56-23-5	Yes	Yes	Yes	Yes	4.68E-01	CA	1.56E+01	1.01E+00	Yes (5)	9.51E+08	7.37E+08	2.03E+01	-		6.00E-06	I	1.00E-01	I	No	4.68E-01	1.04E+01
Chlorobenzene	108-90-7	Yes	Yes	Yes	Yes	5.21E+00	NC	1.74E+02	1.05E+02	No (100)	7.25E+07	4.95E+07	2.03E+01	1.30E+00	CRC	-		5.00E-02	P	No	-	5.21E+00
Chloroform	67-66-3	Yes	Yes	Yes	Yes	1.22E-01	CA	4.07E+00	1.96E+00	Yes (80)	1.26E+09	9.91E+08	2.03E+01	-		2.30E-05	I	9.77E-02	A	No	1.22E-01	1.02E+01
Chloromethane	74-87-3	Yes	Yes	Yes	Yes	9.39E+00	NC	3.13E+02	5.81E+01	--	1.17E+10	1.72E+09	2.03E+01	8.10E+00	CRC	-		9.00E-02	I	No	-	9.39E+00
Cumene	98-82-8	Yes	Yes	Yes	Yes	4.17E+01	NC	1.39E+03	2.45E+02	--	2.91E+07	2.09E+07	2.03E+01	9.00E-01	CRC	-		4.00E-01	I	No	-	4.17E+01
Cyclohexane	110-82-7	Yes	Yes	Yes	Yes	6.26E+02	NC	2.09E+04	2.49E+02	--	4.38E+08	2.77E+08	2.03E+01	1.30E+00	CRC	-		6.00E+00	I	No	-	6.26E+02
1,2-	96-12-8	Yes	Yes	Yes	Yes	1.69E-04	CA	5.63E-03	7.72E-02	Yes (0)	7.37E+06	5.38E+06	2.03E+01	-		6.00E-03	P	2.00E-04	I	Mut	1.69E-04	2.09E-02
Dibromochloromethane	124-48-1	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		6.21E+07	7.37E+07	2.03E+01	-				-		No	-	-
Dibromoethane, 1,2-	106-93-4	Yes	Yes	Yes	Yes	4.68E-03	CA	1.56E-01	4.48E-01	No (0)	1.13E+08	8.18E+07	2.03E+01	-		6.00E-04	I	9.00E-03	I	No	4.68E-03	9.39E-01
Dichlorobenzene, 1,2-	95-50-1	Yes	Yes	Yes	Yes	2.09E+01	NC	6.95E+02	7.10E+02	No (600)	1.08E+07	9.16E+06	2.03E+01	2.20E+00	CRC	-		2.00E-01	H	No	-	2.09E+01
Dichlorobenzene, 1,3-	541-73-1	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1.70E+07	1.01E+07	2.03E+01	1.80E+00	YAWS	-		-		No	-	-
Dichlorobenzene, 1,4-	106-46-7	Yes	Yes	Yes	Yes	2.55E-01	CA	8.51E+00	6.93E+00	Yes (75)	1.38E+07	5.99E+06	2.03E+01	1.80E+00	YAWS	1.10E-05	C	8.00E-01	I	No	2.55E-01	8.34E+01
Dichlorodifluoromethane	75-71-8	Yes	Yes	Yes	Yes	1.04E+01	NC	3.48E+02	1.64E+00	--	3.15E+10	3.57E+09	2.03E+01	-		-		1.00E-01	X	No	-	1.04E+01
Dichloroethane, 1,1-	75-34-3	Yes	Yes	Yes	Yes	1.75E+00	CA	5.85E+01	1.83E+01	--	1.21E+09	9.65E+08	2.03E+01	5.40E+00	CRC	1.60E-06	C	-		No	1.75E+00	-
Dichloroethane, 1,2-	107-06-2	Yes	Yes	Yes	Yes	1.08E-01	CA	3.60E+00	5.53E+00	No (5)	4.20E+08	3.36E+08	2.03E+01	6.20E+00	CRC	2.60E-05	I	7.00E-03	P	No	1.08E-01	7.30E-01
Dichloroethylene, 1,1-	75-35-4	Yes	Yes	Yes	Yes	2.09E+01	NC	6.95E+02	4.57E+01	No (7)	3.13E+09	2.21E+09	2.03E+01	6.50E+00	CRC	-		2.00E-01	I	No	-	2.09E+01
Dichloroethylene, cis-1,2-	156-59-2	Yes	Yes	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	8.34E+01	NC	2.78E+03	1.21E+03	No (70)	1.04E+09	8.83E+08	2.03E+01	3.00E+00	U	-		**8.00E-01**	**trans-1,2-DCE ATSDR surrogate**	No	-	8.34E+01
Dichloroethylene, trans-1,2-	156-60-5	Yes	Yes	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	**Yes - Applied trans-1,2-DCE ATSDR surrogate**	8.34E+01	NC	2.78E+03	5.21E+02	No (100)	1.73E+09	1.45E+09	2.03E+01	6.00E+00	U	-		**8.00E-01**	**trans-1,2-DCE ATSDR surrogate**	No	-	8.34E+01
Dichloropropane, 1,2-	78-87-5	Yes	Yes	Yes	Yes	4.17E-01	NC	1.39E+01	8.96E+00	No (5)	3.24E+08	2.61E+08	2.03E+01	3.40E+00	YAWS	3.70E-06	P	4.00E-03	I	No	7.59E-01	4.17E-01
Dichloropropene, 1,3-	542-75-6	Yes	Yes	Yes	Yes	7.02E-01	CA	2.34E+01	1.22E+01	--	2.03E+08	3.22E+08	2.03E+01	5.30E+00	N	4.00E-06	I	2.00E-02	I	No	7.02E-01	2.09E+00
Dioxane, 1,4-	123-91-1	Yes	Yes	Yes	Yes	5.62E-01	CA	1.87E+01	7.22E+03	--	1.80E+08	1.56E+08	2.03E+01	2.00E+00	CRC	5.00E-06	I	3.00E-02	I	No	5.62E-01	3.13E+00
Ethyl Acetate	141-78-6	Yes	Yes	Yes	Yes	7.30E+00	NC	2.43E+02	3.30E+03	--	4.42E+08	3.54E+08	2.03E+01	2.00E+00	CRC	-		7.00E-02	P	No	-	7.30E+00
Ethyl Chloride	75-00-3	Yes	Yes	Yes	Yes	4.17E+02	NC	1.39E+04	2.12E+03	--	3.50E+09	2.64E+09	2.03E+01	3.80E+00	CRC	-		4.00E+00	P	No	-	4.17E+02
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	1.12E+00	CA	3.74E+01	9.00E+00	Yes (700)	5.48E+07	4.22E+07	2.03E+01	8.00E-01	CRC	2.50E-06	C	1.00E+00	I	No	1.12E+00	1.04E+02
Heptane, N-	142-82-5	Yes	Yes	Yes	Yes	4.17E+01	NC	1.39E+03	1.27E+00	--	2.48E+08	2.23E+08	2.03E+01	1.05E+00	CRC	-		4.00E-01	P	No	-	4.17E+01
Hexachlorobutadiene	87-68-3	Yes	Yes	Yes	Yes	1.28E-01	CA	4.25E+00	8.40E-01	--	3.09E+06	9.72E+05	2.03E+01	2.90E+00	YAWS	2.20E-05	I	-		No	1.28E-01	-
Hexane, N-	110-54-3	Yes	Yes	Yes	Yes	7.30E+01	NC	2.43E+03	2.40E+00	--	7.01E+08	5.78E+08	2.03E+01	1.10E+00	CRC	-		7.00E-01	I	No	-	7.30E+01
Hexanone, 2-	591-78-6	Yes	Yes	Yes	Yes	3.13E+00	NC	1.04E+02	2.14E+03	--	6.25E+07	5.03E+07	2.03E+01	1.00E+00	CRC	-		3.00E-02	I	No	-	3.13E+00
Isopropanol	67-63-0	Yes	Yes	Yes	Yes	2.09E+01	NC	6.95E+02	1.67E+05	--	1.47E+08	2.50E+08	2.03E+01	2.00E+00	CRC	-		2.00E-01	P	No	-	2.09E+01
Butanone)	78-93-3	Yes	Yes	Yes	Yes	5.21E+02	NC	1.74E+04	5.52E+05	--	3.51E+08	4.21E+08	2.03E+01	1.40E+00	CRC	-		5.00E+00	I	No	-	5.21E+02
methyl-2-pentanone)	108-10-1	Yes	Yes	Yes	Yes	3.13E+02	NC	1.04E+04	1.42E+05	--	1.07E+08	8.38E+07	2.03E+01	1.20E+00	CRC	-		3.00E+00	I	No	-	3.13E+02
Methyl Methacrylate	80-62-6	Yes	Yes	Yes	Yes	7.30E+01	NC	2.43E+03	1.45E+04	--	2.07E+08	1.51E+08	2.03E+01	1.70E+00	CRC	-		7.00E-01	I	No	-	7.30E+01
(MTBE)	1634-04-4	Yes	Yes	Yes	Yes	1.08E+01	CA	3.60E+02	1.08E+03	--	1.19E+09	1.02E+09	2.03E+01	2.00E+00	YAWS	2.60E-07	C	3.00E+00	I	No	1.08E+01	3.13E+02
Methylene Chloride	75-09-2	Yes	Yes	Yes	Yes	6.26E+01	NC	2.09E+03	1.12E+03	No (5)	1.99E+09	1.45E+09	2.03E+01	1.30E+01	CRC	1.00E-08	I	6.00E-01	I	Mut	1.01E+02	6.26E+01
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	8.26E-02	CA	2.75E+00	1.28E+01	--	5.86E+05	4.01E+05	2.03E+01	9.00E-01	CRC	3.40E-05	C	3.00E-03	I	No	8.26E-02	3.13E-01
Nonane, n-	111-84-2	Yes	Yes	Yes	Yes	2.09E+00	NC	6.95E+01	4.00E-02	--	3.07E+07	2.29E+07	2.03E+01	8.00E-01	CRC	-		2.00E-02	P	No	-	2.09E+00
Propyl benzene	103-65-1	Yes	Yes	Yes	Yes	1.04E+02	NC	3.48E+03	6.46E+02	--	2.21E+07	1.69E+07	2.03E+01	8.00E-01	CRC	-		1.00E+00	X	No	-	1.04E+02
Propylene	115-07-1	Yes	Yes	Yes	Yes	3.13E+02	NC	1.04E+04	8.45E+01	--	1.97E+10	1.48E+09	2.03E+01	2.00E+00	CRC	-		3.00E+00	C	No	-	3.13E+02
Styrene	100-42-5	Yes	Yes	Yes	Yes	1.04E+02	NC	3.48E+03	2.46E+03	No (100)	3.58E+07	2.63E+07	2.03E+01	9.00E-01	CRC	-		1.00E+00	I	No	-	1.04E+02

Table E.2A

VISL Resident - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Sec

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m^3)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m^3)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (20.3 °C) (µg/m^3)	Maximum Groundwater Vapor Concentration C_{hc} (µg/m^3)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$(µg/m^3)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$(µg/m^3)
Tetrachloroethane, 1,1,2,2-	79-34-5	Yes	Yes	Yes	Yes	4.84E-02	CA	1.61E+00	8.46E+00	--	4.17E+07	3.24E+07	2.03E+01	-		5.80E-05	C	-		No	4.84E-02	-
Tetrachloroethylene	127-18-4	Yes	Yes	Yes	Yes	4.17E+00	NC	1.39E+02	1.47E+01	No (5)	1.65E+08	1.17E+08	2.03E+01	-		2.60E-07	I	4.00E-02	I	No	1.08E+01	4.17E+00
Tetrahydrofuran	109-99-9	Yes	Yes	Yes	Yes	2.09E+02	NC	6.95E+03	1.75E+05	--	6.29E+08	2.38E+09	2.03E+01	2.00E+00	CRC	-		2.00E+00	I	No	-	2.09E+02
Toluene	108-88-3	Yes	Yes	Yes	Yes	5.21E+02	NC	1.74E+04	4.83E+03	No (1000)	1.41E+08	1.14E+08	2.03E+01	1.10E+00	CRC	-		5.00E+00	I	No	-	5.21E+02
trifluoroethane, 1,1,2-	76-13-1	Yes	Yes	Yes	Yes	5.21E+02	NC	1.74E+04	5.74E+01	--	3.65E+09	3.09E+09	2.03E+01	-		-		5.00E+00	P	No	-	5.21E+02
Trichlorobenzene, 1,2,4-	120-82-1	Yes	Yes	Yes	Yes	2.09E-01	NC	6.95E+00	1.01E+01	Yes (70)	4.49E+06	2.03E+06	2.03E+01	2.50E+00	CRC	-		2.00E-03	P	No	-	2.09E-01
Trichloroethane, 1,1,1-	71-55-6	Yes	Yes	Yes	Yes	5.21E+02	NC	1.74E+04	1.80E+03	No (200)	8.90E+08	7.47E+08	2.03E+01	8.00E+00	CRC	-		5.00E+00	I	No	-	5.21E+02
Trichloroethane, 1,1,2-	79-00-5	Yes	Yes	Yes	Yes	2.09E-02	NC	6.95E-01	1.57E+00	Yes (5)	1.65E+08	1.22E+08	2.03E+01	6.00E+00	CRC	1.60E-05	I	2.00E-04	X	No	1.75E-01	2.09E-02
Trichloroethylene	79-01-6	Yes	Yes	Yes	Yes	2.09E-01	NC	6.95E+00	1.28E+00	Yes (5)	4.88E+08	4.19E+08	2.03E+01	8.00E+00	CRC	4.10E-06	I	2.00E-03	I	Mut	4.78E-01	2.09E-01
Trichlorofluoromethane	75-69-4	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		5.93E+09	3.76E+09	2.03E+01	-		-		-		No	-	-
Trichloropropane, 1,2,3-	96-18-4	Yes	Yes	Yes	Yes	3.13E-02	NC	1.04E+00	5.85E+00	--	2.93E+07	1.87E+07	2.03E+01	3.20E+00	CRC	-		3.00E-04	I	Mut	-	3.13E-02
Trimethylbenzene, 1,2,4-	95-63-6	Yes	Yes	Yes	Yes	6.26E+00	NC	2.09E+02	6.69E+01	--	1.36E+07	1.07E+07	2.03E+01	9.00E-01	CRC	-		6.00E-02	I	No	-	6.26E+00
Trimethylbenzene, 1,3,5-	108-67-8	Yes	Yes	Yes	Yes	6.26E+00	NC	2.09E+02	4.69E+01	--	1.60E+07	1.29E+07	2.03E+01	1.00E+00	CRC	-		6.00E-02	I	No	-	6.26E+00
Vinyl Acetate	108-05-4	Yes	Yes	Yes	Yes	2.09E+01	NC	6.95E+02	2.52E+03	--	4.17E+08	3.32E+08	2.03E+01	2.60E+00	CRC	-		2.00E-01	I	No	-	2.09E+01
Vinyl Chloride	75-01-4	Yes	Yes	Yes	Yes	1.68E-01	CA	5.59E+00	3.29E-01	Yes (2)	1.00E+10	8.97E+09	2.03E+01	3.60E+00	CRC	4.40E-06	I	8.00E-02	A	Mut	1.68E-01	8.34E+00
Xylene, m-	108-38-3	Yes	Yes	Yes	Yes	1.04E+01	NC	3.48E+02	9.20E+01	--	4.73E+07	3.65E+07	2.03E+01	1.10E+00	CRC	-		1.00E-01	G	No	-	1.04E+01
Xylene, o-	95-47-6	Yes	Yes	Yes	Yes	1.04E+01	NC	3.48E+02	1.28E+02	--	3.77E+07	2.90E+07	2.03E+01	9.00E-01	CRC	-		1.00E-01	G	No	-	1.04E+01
Xylene, p-	106-42-3	Yes	Yes	Yes	Yes	1.04E+01	NC	3.48E+02	9.57E+01	--	5.05E+07	3.53E+07	2.03E+01	1.10E+00	CRC	-		1.00E-01	G	No	-	1.04E+01
Xylenes	1330-20-7	Yes	Yes	Yes	Yes	1.04E+01	NC	3.48E+02	9.95E+01	Yes (10000)	4.56E+07	2.22E+07	2.03E+01	-		-		1.00E-01	I	No	-	1.04E+01

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Table E.2B

VISL Resident - Chemical Properties - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m^3/mole)	Henry's Law Constant (unitless)	Henry's Law Constant (20.3 ℃) (unitless)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Enthalpy of vaporization @ groundwater temperature $\Delta H_{v,gw}$ (cal/mol)	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$ (cal/mol)	$\Delta H_{v,b}$ Ref	Normal Boiling Point BP (K)	BP Ref	Exponent for $\Delta H_{v,gw}$	Vapor Pressure VP (mm Hg)	VP Ref	Vapor Pressure VP (20.3 ℃) (mm Hg)	Critical Temperature T_C (K)	T_C Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Acetone	67-64-1	Yes	No	5.81E+01	PHYSPROP	1.00E+06	PHYSPROP	-	3.50E-05	1.43E-03	1.19E-03	1.19E-03	PHYSPROP	7.43E+03	6.96E+03	CRC	3.29E+02	PHYSPROP	3.63E-01	2.32E+02	PHYSPROP	1.89E+02	5.08E+02	CRC	2.50E+00	CRC
Acetonitrile	75-05-8	Yes	Yes	4.11E+01	PHYSPROP	1.00E+06	PHYSPROP	-	3.45E-05	1.41E-03	1.16E-03	1.16E-03	PHYSPROP	7.87E+03	7.11E+03	CRC	3.55E+02	PHYSPROP	3.65E-01	8.88E+01	PHYSPROP	7.18E+01	5.45E+02	CRC	3.00E+00	CRC
Acrolein	107-02-8	Yes	Yes	5.61E+01	PHYSPROP	2.12E+05	PHYSPROP	-	1.22E-04	4.99E-03	4.17E-03	4.17E-03	PHYSPROP	7.18E+03	6.76E+03	CRC	3.26E+02	PHYSPROP	3.60E-01	2.74E+02	PHYSPROP	2.26E+02	5.06E+02	YAWS	2.80E+00	CRC
Acrylonitrile	107-13-1	Yes	Yes	5.31E+01	PHYSPROP	7.45E+04	PHYSPROP	-	1.38E-04	5.64E-03	4.55E-03	4.55E-03	PHYSPROP	8.57E+03	7.79E+03	CRC	3.50E+02	PHYSPROP	3.64E-01	1.09E+02	PHYSPROP	8.61E+01	5.40E+02	CRC	3.00E+00	CRC
Allyl Chloride	107-05-1	Yes	Yes	7.65E+01	PHYSPROP	3.37E+03	PHYSPROP	-	1.10E-02	4.50E-01	3.76E-01	3.76E-01	EPI	7.22E+03	6.93E+03	CRC	3.18E+02	PHYSPROP	3.42E-01	3.68E+02	PHYSPROP	3.03E+02	5.14E+02	YAWS	2.90E+00	CRC
Benzene	71-43-2	Yes	Yes	7.81E+01	PHYSPROP	1.79E+03	PHYSPROP	5.00E+00	5.55E-03	2.27E-01	1.86E-01	1.86E-01	PHYSPROP	8.02E+03	7.34E+03	CRC	3.53E+02	PHYSPROP	3.49E-01	9.48E+01	PHYSPROP	7.63E+01	5.62E+02	CRC	1.20E+00	CRC
Benzyl Chloride	100-44-7	Yes	Yes	1.27E+02	PHYSPROP	5.25E+02	PHYSPROP	-	4.12E-04	1.68E-02	1.28E-02	1.28E-02	EPI	1.06E+04	8.77E+03	TOXNET	4.52E+02	PHYSPROP	3.72E-01	1.23E+00	PHYSPROP	9.23E-01	6.86E+02	YAWS	1.10E+00	CRC
Bromodichloromethane	75-27-4	Yes	Yes	1.64E+02	PHYSPROP	3.03E+03	PHYSPROP	8.00E+01	2.12E-03	8.67E-02	6.99E-02	6.99E-02	PHYSPROP	8.56E+03	7.80E+03	Weast	3.63E+02	PHYSPROP	3.43E-01	5.00E+01	PHYSPROP	3.97E+01	5.86E+02	Weast	-	
Bromoform	75-25-2	Yes	Yes	2.53E+02	PHYSPROP	3.10E+03	PHYSPROP	8.00E+01	5.35E-04	2.19E-02	1.66E-02	1.66E-02	PHYSPROP	1.09E+04	9.48E+03	CRC	4.22E+02	PHYSPROP	3.42E-01	5.40E+00	EPI	4.02E+00	6.82E+02	CRC	-	
Bromomethane	74-83-9	Yes	Yes	9.49E+01	PHYSPROP	1.52E+04	PHYSPROP	-	7.34E-03	3.00E-01	2.62E-01	2.62E-01	PHYSPROP	5.55E+03	5.71E+03	CRC	2.77E+02	PHYSPROP	3.22E-01	1.62E+03	PHYSPROP	1.39E+03	4.67E+02	YAWS	1.00E+01	CRC
Butadiene, 1,3-	106-99-0	Yes	Yes	5.41E+01	PHYSPROP	7.35E+02	PHYSPROP	-	7.36E-02	3.01E+00	2.67E+00	2.67E+00	EPI	5.05E+03	5.37E+03	CRC	2.69E+02	PHYSPROP	3.52E-01	2.11E+03	PHYSPROP	1.84E+03	4.25E+02	CRC	2.00E+00	CRC
Butyl Alcohol, t-	75-65-0	Yes	Yes	7.41E+01	PHYSPROP	1.00E+06	PHYSPROP	-	9.05E-06	3.70E-04	2.81E-04	2.81E-04	PHYSPROP	1.07E+04	9.34E+03	CRC	3.56E+02	PHYSPROP	4.04E-01	4.07E+01	PHYSPROP	3.04E+01	5.06E+02	CRC	2.40E+00	CRC
Butylbenzene, n-	104-51-8	Yes	No	1.34E+02	PHYSPROP	1.18E+01	PHYSPROP	-	1.59E-02	6.50E-01	4.81E-01	4.81E-01	EPI	1.17E+04	9.29E+03	CRC	4.56E+02	PHYSPROP	3.95E-01	1.06E+00	PHYSPROP	7.75E-01	6.61E+02	CRC	8.00E-01	CRC
Butylbenzene, sec-	135-98-8	Yes	No	1.34E+02	PHYSPROP	1.76E+01	PHYSPROP	-	1.76E-02	7.20E-01	5.00E-01	5.00E-01	EPI	1.40E+04	1.15E+04	TOXNET (converted)	4.47E+02	PHYSPROP	3.81E-01	1.75E+00	PHYSPROP	1.20E+00	6.65E+02	YAWS	8.00E-01	YAWS
Carbon Disulfide	75-15-0	Yes	Yes	7.61E+01	PHYSPROP	2.16E+03	PHYSPROP	-	1.44E-02	5.89E-01	5.00E-01	5.00E-01	PHYSPROP	6.60E+03	6.39E+03	CRC	3.19E+02	PHYSPROP	3.12E-01	3.59E+02	PHYSPROP	3.00E+02	5.52E+02	CRC	1.30E+00	CRC
Carbon Tetrachloride	56-23-5	Yes	Yes	1.54E+02	PHYSPROP	7.93E+02	PHYSPROP	5.00E+00	2.76E-02	1.13E+00	9.29E-01	9.29E-01	PHYSPROP	7.76E+03	7.13E+03	CRC	3.50E+02	PHYSPROP	3.49E-01	1.15E+02	PHYSPROP	9.33E+01	5.57E+02	CRC	-	
Chlorobenzene	108-90-7	Yes	Yes	1.13E+02	PHYSPROP	4.98E+02	PHYSPROP	1.00E+02	3.11E-03	1.27E-01	9.94E-02	9.94E-02	PHYSPROP	9.70E+03	8.41E+03	CRC	4.05E+02	PHYSPROP	3.58E-01	1.20E+01	PHYSPROP	9.21E+00	6.32E+02	CRC	1.30E+00	CRC
Chloroform	67-66-3	Yes	Yes	1.19E+02	PHYSPROP	7.95E+03	PHYSPROP	8.00E+01	3.67E-03	1.50E-01	1.25E-01	1.25E-01	PHYSPROP	7.45E+03	6.99E+03	CRC	3.34E+02	PHYSPROP	3.45E-01	1.97E+02	PHYSPROP	1.61E+02	5.36E+02	CRC	-	
Chloromethane	74-87-3	Yes	Yes	5.05E+01	PHYSPROP	5.32E+03	PHYSPROP	-	8.82E-03	3.61E-01	3.23E-01	3.23E-01	PHYSPROP	4.62E+03	5.11E+03	CRC	2.49E+02	PHYSPROP	3.27E-01	4.30E+03	PHYSPROP	3.79E+03	4.16E+02	CRC	8.10E+00	CRC
Cumene	98-82-8	Yes	Yes	1.20E+02	PHYSPROP	6.13E+01	PHYSPROP	-	1.15E-02	4.70E-01	3.41E-01	3.41E-01	PHYSPROP	1.25E+04	1.03E+04	TOXNET	4.26E+02	PHYSPROP	3.83E-01	4.50E+00	PHYSPROP	3.21E+00	6.31E+02	CRC	9.00E-01	CRC
Cyclohexane	110-82-7	Yes	Yes	8.42E+01	PHYSPROP	5.50E+01	PHYSPROP	-	1.50E-01	6.13E+00	5.04E+00	5.04E+00	PHYSPROP	7.87E+03	7.16E+03	CRC	3.54E+02	PHYSPROP	3.57E-01	9.69E+01	PHYSPROP	7.83E+01	5.53E+02	CRC	1.30E+00	CRC
Dibromo-3-chloropropane, 1,2-	96-12-8	Yes	Yes	2.36E+02	PHYSPROP	1.23E+03	PHYSPROP	2.00E-01	1.47E-04	6.01E-03	4.38E-03	4.38E-03	EPI	1.23E+04	9.96E+03	MSDS (converted)	4.69E+02	PHYSPROP	3.77E-01	5.80E-01	PHYSPROP	4.16E-01	7.04E+02	from Tcrit=1.5xT	-	
Dibromochloromethane	124-48-1	Yes	No	2.08E+02	PHYSPROP	2.70E+03	PHYSPROP	8.00E+01	7.83E-04	3.20E-02	2.73E-02	2.73E-02	PHYSPROP	6.48E+03	5.90E+03	Weast	3.93E+02	PHYSPROP	3.13E-01	5.54E+00	PHYSPROP	4.65E+00	6.78E+02	Weast	-	
Dibromoethane, 1,2-	106-93-4	Yes	Yes	1.88E+02	PHYSPROP	3.91E+03	PHYSPROP	5.00E-02	6.50E-04	2.66E-02	2.09E-02	2.09E-02	PHYSPROP	9.45E+03	8.31E+03	CRC	4.05E+02	PHYSPROP	3.45E-01	1.12E+01	PHYSPROP	8.67E+00	6.50E+02	YAWS	-	
Dichlorobenzene, 1,2-	95-50-1	Yes	Yes	1.47E+02	PHYSPROP	1.56E+02	PHYSPROP	6.00E+02	1.92E-03	7.85E-02	5.87E-02	5.87E-02	PHYSPROP	1.13E+04	9.48E+03	CRC	4.53E+02	PHYSPROP	3.60E-01	1.36E+00	PHYSPROP	1.00E+00	7.05E+02	YAWS	2.20E+00	CRC
Dichlorobenzene, 1,3-	541-73-1	Yes	No	1.47E+02	PHYSPROP	1.25E+02	PHYSPROP	-	2.63E-03	1.08E-01	8.10E-02	8.10E-02	PHYSPROP	1.11E+04	9.23E+03	CRC	4.46E+02	PHYSPROP	3.65E-01	2.15E+00	PHYSPROP	1.59E+00	6.86E+02	CRC	1.80E+00	YAWS
Dichlorobenzene, 1,4-	106-46-7	Yes	Yes	1.47E+02	PHYSPROP	8.13E+01	PHYSPROP	7.50E+01	2.41E-03	9.85E-02	7.37E-02	7.37E-02	PHYSPROP	1.13E+04	9.27E+03	CRC	4.47E+02	PHYSPROP	3.79E-01	1.74E+00	PHYSPROP	1.28E+00	6.69E+02	CRC	1.80E+00	YAWS
Dichlorodifluoromethane	75-71-8	Yes	Yes	1.21E+02	PHYSPROP	2.80E+02	PHYSPROP	-	3.43E-01	1.40E+01	1.27E+01	1.27E+01	PHYSPROP	4.12E+03	4.80E+03	CRC	2.43E+02	PHYSPROP	3.52E-01	4.85E+03	PHYSPROP	4.34E+03	3.85E+02	CRC	-	
Dichloroethane, 1,1-	75-34-3	Yes	Yes	9.90E+01	PHYSPROP	5.04E+03	PHYSPROP	-	5.62E-03	2.30E-01	1.91E-01	1.91E-01	PHYSPROP	7.34E+03	6.90E+03	CRC	3.31E+02	PHYSPROP	3.51E-01	2.27E+02	PHYSPROP	1.86E+02	5.23E+02	CRC	5.40E+00	CRC
Dichloroethane, 1,2-	107-06-2	Yes	Yes	9.90E+01	PHYSPROP	8.60E+03	PHYSPROP	5.00E+00	1.18E-03	4.82E-02	3.90E-02	3.90E-02	PHYSPROP	8.41E+03	7.64E+03	CRC	3.57E+02	PHYSPROP	3.54E-01	7.89E+01	PHYSPROP	6.29E+01	5.62E+02	CRC	6.20E+00	CRC
Dichloroethylene, 1,1-	75-35-4	Yes	Yes	9.69E+01	PHYSPROP	2.42E+03	PHYSPROP	7.00E+00	2.61E-02	1.07E+00	9.12E-01	9.12E-01	PHYSPROP	6.39E+03	6.25E+03	CRC	3.05E+02	PHYSPROP	3.52E-01	6.00E+02	PHYSPROP	5.05E+02	4.82E+02	YAWS	6.50E+00	CRC
Dichloroethylene, cis-1,2-	156-59-2	Yes	Yes	9.69E+01	U	6.41E+03	U	7.00E+01	4.08E-03	1.67E-01	1.38E-01	1.38E-01	U	7.68E+03	7.22E+03	U	3.33E+02	U	3.44E-01	2.00E+02	U	1.63E+02	5.36E+02	U	3.00E+00	U
Dichloroethylene, trans-1,2-	156-60-5	Yes	Yes	9.69E+01	U	4.52E+03	U	1.00E+02	9.38E-03	3.83E-01	3.20E-01	3.20E-01	U	7.24E+03	6.91E+03	U	3.22E+02	U	3.46E-01	3.31E+02	U	2.72E+02	5.16E+02	U	6.00E+00	U
Dichloropropane, 1,2-	78-87-5	Yes	Yes	1.13E+02	PHYSPROP	2.80E+03	PHYSPROP	5.00E+00	2.82E-03	1.15E-01	9.31E-02	9.31E-02	PHYSPROP	8.50E+03	7.59E+03	Weast	3.69E+02	PHYSPROP	3.61E-01	5.33E+01	PHYSPROP	4.24E+01	5.72E+02	YAWS	3.40E+00	YAWS
Dichloropropene, 1,3-	542-75-6	Yes	Yes	1.11E+02	PHYSPROP	2.80E+03	PHYSPROP	-	3.55E-03	1.45E-01	1.15E-01	1.15E-01	PHYSPROP	9.16E+03	7.90E+03	Weast	3.85E+02	PHYSPROP	3.78E-01	3.40E+01	PHYSPROP	2.65E+01	5.77E+02	YAWS	5.30E+00	N
Dioxane, 1,4-	123-91-1	Yes	Yes	8.81E+01	PHYSPROP	1.00E+06	PHYSPROP	-	4.80E-06	1.96E-04	1.56E-04	1.56E-04	PHYSPROP	9.16E+03	8.16E+03	CRC	3.75E+02	PHYSPROP	3.56E-01	3.81E+01	PHYSPROP	2.97E+01	5.87E+02	CRC	2.00E+00	CRC
Ethyl Acetate	141-78-6	Yes	Yes	8.81E+01	PHYSPROP	8.00E+04	PHYSPROP	-	1.34E-04	5.48E-03	4.42E-03	4.42E-03	PHYSPROP	8.50E+03	7.63E+03	CRC	3.50E+02	PHYSPROP	3.79E-01	9.32E+01	PHYSPROP	7.41E+01	5.23E+02	CRC	2.00E+00	CRC
Ethyl Chloride	75-00-3	Yes	Yes	6.45E+01	PHYSPROP	6.71E+03	PHYSPROP	-	1.11E-02	4.54E-01	3.94E-01	3.94E-01	PHYSPROP	5.80E+03	5.89E+03	CRC	2.85E+02	PHYSPROP	3.43E-01	1.01E+03	PHYSPROP	8.62E+02	4.60E+02	CRC	3.80E+00	CRC
Ethylbenzene	100-41-4	Yes	Yes	1.06E+02	PHYSPROP	1.69E+02	PHYSPROP	7.00E+02	7.88E-03	3.22E-01	2.50E-01	2.50E-01	PHYSPROP	1.00E+04	8.50E+03	CRC	4.09E+02	PHYSPROP	3.75E-01	9.60E+00	PHYSPROP	7.32E+00	6.17E+02	CRC	8.00E-01	CRC
Heptane, N-	142-82-5	Yes	Yes	1.00E+02	PHYSPROP	3.40E+00	PHYSPROP	-	2.00E+00	8.18E+01	6.54E+01	6.54E+01	EPI	8.82E+03	7.59E+03	CRC	3.72E+02	PHYSPROP	3.93E-01	4.60E+01	PHYSPROP	3.62E+01	5.40E+02	CRC	1.05E+00	CRC
Hexachlorobutadiene	87-68-3	Yes	Yes	2.61E+02	PHYSPROP	3.20E+00	PHYSPROP	-	1.03E-02	4.21E-01	3.04E-01	3.04E-01	PHYSPROP	1.27E+04	1.02E+04	Weast	4.88E+02	PHYSPROP	3.73E-01	2.20E-01	PHYSPROP	1.56E-01	7.38E+02	YAWS	2.90E+00	YAWS
Hexane, N-	110-54-3	Yes	Yes	8.62E+01	PHYSPROP	9.50E+00	PHYSPROP	-	1.80E+00	7.36E+01	6.09E+01	6.09E+01	EPI	7.61E+03	6.90E+03	CRC	3.42E+02	PHYSPROP	3.82E-01	1.51E+02	PHYSPROP	1.23E+02	5.08E+02	CRC	1.10E+00	CRC
Hexanone, 2-	591-78-6	Yes	Yes	1.00E+02	PHYSPROP	1.72E+04	PHYSPROP	-	9.32E-05	3.81E-03	2.92E-03	2.92E-03	EPI	1.04E+04	8.69E+03	CRC	4.01E+02	PHYSPROP	3.89E-01	1.16E+01	PHYSPROP	8.76E+00	5.87E+02	CRC	1.00E+00	CRC
Isopropanol	67-63-0	Yes	Yes	6.01E+01	PHYSPROP	1.00E+06	PHYSPROP	-	8.10E-06	3.31E-04	2.50E-04	2.50E-04	PHYSPROP	1.09E+04	9.52E+03	CRC	3.55E+02	PHYSPROP	4.01E-01	4.54E+01	PHYSPROP	3.38E+01	5.08E+02	CRC	2.00E+00	CRC
Butanone)	78-93-3	Yes	Yes	7.21E+01	PHYSPROP	2.23E+05	PHYSPROP	-	5.69E-05	2.33E-03	1.89E-03	1.89E-03	PHYSPROP	8.29E+03	7.48E+03	CRC	3.53E+02	PHYSPROP	3.70E-01	9.06E+01	PHYSPROP	7.24E+01	5.37E+02	CRC	1.40E+00	CRC
methyl-2-pentanone)	108-10-1	Yes	Yes	1.00E+02	PHYSPROP	1.90E+04	PHYSPROP	-	1.38E-04	5.64E-03	4.41E-03	4.41E-03	EPI	9.68E+03	8.24E+03	CRC	3.90E+02	PHYSPROP	3.85E-01	1.99E+01	PHYSPROP	1.53E+01	5.75E+02	CRC	1.20E+00	CRC
Methyl Methacrylate	80-62-6	Yes	Yes	1.00E+02	PHYSPROP	1.50E+04	PHYSPROP	-	3.19E-04	1.30E-02	1.01E-02	1.01E-02	EPI	1.01E+04	8.60E+03	CRC	3.74E+02	PHYSPROP	3.96E-01	3.85E+01	PHYSPROP	2.93E+01	5.40E+02	CRC	1.70E+00	CRC
(MTBE)	1634-04-4	Yes	Yes	8.82E+01	PHYSPROP	5.10E+04	PHYSPROP	-	5.87E-04	2.40E-02	2.01E-02	2.01E-02	PHYSPROP	7.16E+03	6.68E+03	CRC	3.28E+02	PHYSPROP	3.73E-01	2.50E+02	PHYSPROP	2.06E+02	4.97E+02	CRC	2.00E+00	YAWS
Methylene Chloride	75-09-2	Yes	Yes	8.49E+01	PHYSPROP	1.30E+04	PHYSPROP	5.00E+00	3.25E-03	1.33E-01	1.12E-01	1.12E-01	PHYSPROP	6.93E+03	6.71E+03	CRC	3.13E+02	PHYSPROP	3.40E-01	4.35E+02	PHYSPROP	3.61E+02	5.08E+02	CRC	1.30E+01	CRC
Naphthalene	91-20-3	Yes	Yes	1.28E+02	PHYSPROP	3.10E+01	PHYSPROP	-	4.40E-04	1.80E-02	1.29E-02	1.29E-02	PHYSPROP	1.27E+04	1.03E+04	CRC	4.91E+02	PHYSPROP	3.70E-01	8.50E-02	PHYSPROP	6.02E-02	7.48E+02	CRC	9.00E-01	CRC
Nonane, n-	111-84-2	Yes	Yes	1.28E+02	PHYSPROP	2.20E-01	PHYSPROP	-	3.40E+00	1.39E+02	1.04E+02	1.04E+02	EPI	1.12E+04	8.89E+03	CRC	4.24E+02	PHYSPROP	4.10E-01	4.45E+00	PHYSPROP	3.29E+00	5.94E+02	CRC	8.00E-01	CRC
Propyl benzene	103-65-1	Yes	Yes	1.20E+02	PHYSPROP	5.22E+01	PHYSPROP	-	1.05E-02	4.29E-01	3.23E-01	3.23E-01	PHYSPROP	1.11E+04	9.12E+03	DECHEMA	4.32E+02	PHYSPROP	3.85E-01	3.42E+00	PHYSPROP	2.53E+00	6.38E+02	CRC	8.00E-01	CRC
Propylene	115-07-1	Yes	Yes	4.21E+01	PHYSPROP	2.00E+02	PHYSPROP	-	1.96E-01	8.01E+00	7.40E+00	7.40E+00	PHYSPROP	3.50E+03	4.40E+03	CRC	2.25E+02	PHYSPROP	3.41E-01	8.69E+03	PHYSPROP	7.90E+03	3.65E+02	CRC	2.00E+00	CRC
Styrene	100-42-5	Yes	Yes	1.04E+02	PHYSPROP	3.10E+02	PHYSPROP	1.00E+02	2.75E-03	1.12E-01	8.50E-02	8.50E-02	PHYSPROP	1.09E+04	9.25E+03	CRC	4.18E+02	PHYSPROP	3.71E-01	6.40E+00	PHYSPROP	4.76E+00	6.35E+02	CRC	9.00E-01	CRC
Tetrachloroethane, 1,1,2,2-	79-34-5	Yes	Yes	1.68E+02	PHYSPROP	2.83E+03	PHYSPROP	-	3.67E-04	1.50E-02	1.14E-02	1.14E-02	PHYSPROP	1.06E+04	9.00E+03	CRC	4.20E+02	PHYSPROP	3.65E-01	4.62E+00	PHYSPROP	3.47E+00	6.45E+02	YAWS	-	
Tetrachloroethylene	127-18-4	Yes	Yes	1.66E+02	PHYSPROP	2.06E+02	PHYSPROP	5.00E+00	1.77E-02	7.24E-01	5.69E-01	5.69E-01	PHYSPROP	9.45E+03	8.29E+03	CRC	3.94E+02	PHYSPROP	3.55E-01	1.85E+01	PHYSPROP	1.43E+01	6.20E+02	YAWS	-	
Tetrahydrofuran	109-99-9	Yes	Yes	7.21E+01	PHYSPROP	1.00E+06	PHYSPROP	-	7.05E-05	2.88E-03	2.38E-03	2.38E-03	PHYSPROP	7.64E+03	7.12E+03	CRC	3.38E+02	PHYSPROP	3.47E-01	1.62E+02	PHYSPROP	1.32E+02	5.40E+02	CRC	2.00E+00	CRC
Toluene	108-88-3	Yes	Yes	9.21E+01	PHYSPROP	5.26E+02	PHYSPROP	1.00E+03	6.64E-03	2.71E-01	2.16E-01	2.16E-01	PHYSPROP	9.04E+03	7.93E+03	CRC	3.84E+02	PHYSPROP	3.64E-01	2.84E+01	PHYSPROP	2.22E+01	5.92E+02	CRC	1.10E+00	CRC
trifluoroethane, 1,1,2-	76-13-1	Yes	Yes	1.87E+02	PHYSPROP	1.70E+02	PHYSPROP	-	5.26E-01	2.15E+01	1.82E+01	1.82E+01	EPI	6.84E+03	6.46E+03	CRC	3.21E+02	PHYSPROP	3.71E-01	3.63E+02	PHYSPROP	3.01E+02	4.87E+02	CRC	-	
Trichlorobenzene, 1,2,4-	120-82-1	Yes	Yes	1.81E+02	PHYSPROP	4.90E+01	PHYSPROP	7.00E+01	1.42E-03	5.81E-02	4.14E-02	4.14E-02	PHYSPROP	1.31E+04	1.05E+04	Weast	4.87E+02	PHYSPROP	3.81E-01	4.60E-01	PHYSPROP	3.23E-01	7.25E+02	YAWS	2.50E+00	CRC
Trichloroethane, 1,1,1-	71-55-6	Yes	Yes	1.33E+02	PHYSPROP	1.29E+03	PHYSPROP	2.00E+02	1.72E-02	7.03E-01	5.79E-01	5.79E-01	PHYSPROP	7.77E+03	7.14E+03	CRC	3.47E+02	PHYSPROP	3.55E-01	1.24E+02	PHYSPROP	1.01E+02	5.45E+02	YAWS	8.00E+00	CRC
Trichloroethane, 1,1,2-	79-00-5	Yes	Yes	1.33E+02	PHYSPROP	4.59E+03	PHYSPROP	5.00E+00	8.24E-04	3.37E-02	2.65E-02	2.65E-02	PHYSPROP	9.48E+03	8.32E+03	CRC	3.87E+02	PHYSPROP	3.60E-01	2.30E+01	PHYSPROP	1.78E+01	6.02E+02	YAWS	6.00E+00	CRC
Trichloroethylene	79-01-6	Yes	Yes	1.31E+02	PHYSPROP	1.28E+03	PHYSPROP	5.00E+00	9.85E-03	4.03E-01	3.27E-01	3.27E-01	PHYSPROP	8.27E+03	7.50E+03	CRC	3.60E+02	PHYSPROP	3.51E-01	6.90E+01	PHYSPROP	5.52E+01	5.71E+02	YAWS	8.00E+00	CRC
Trichlorofluoromethane	75-69-4	Yes	No	1.37E+02	PHYSPROP	1.10E+03	PHYSPROP	-	9.70E-02	3.97E+00	3.42E+00	3.42E+00	PHYSPROP	6.04E+03	6.00E+03	CRC	2.97E+02	PHYSPROP	3.50E-01	8.03E+02	PHYSPROP	6.82E+02	4.71E+02	CRC	-	
Trichloropropane, 1,2,3-	96-18-4	Yes	Yes	1.47E+02	PHYSPROP	1.75E+03	PHYSPROP	-	3.43E-04	1.40E-02	1.07E-02	1.07E-02	PHYSPROP	1.06E+04	8.87E+03	CRC	4.30E+02	PHYSPROP	3.72E-01	3.69E+00	PHYSPROP	2.77E+00	6.52E+02	YAWS	3.20E+00	CRC
Trimethylbenzene, 1,2,4-	95-63-6	Yes	Yes	1.20E+02	PHYSPROP	5.70E+01	PHYSPROP	-	6.16E-03	2.52E-01	1.87E-01	1.87E-01	PHYSPROP	1.16E+04	9.37E+03	TOXNET	4.42E+02	PHYSPROP	3.88E-01	2.10E+00	PHYSPROP	1.54E+00	6.49E+02	CRC	9.00E-01	CRC
Trimethylbenzene, 1,3,5-	108-67-8	Yes	Yes	1.20E+02	PHYSPROP	4.82E+01	PHYSPROP	-	8.77E-03	3.59E-01	2.67E-01	2.67E-01	PHYSPROP	1.15E+04	9.32E+03	TOXNET	4.38E+02	PHYSPROP	3.92E-01	2.48E+00	PHYSPROP	1.82E+00	6.37E+02	CRC	1.00E+00	CRC
Vinyl Acetate	108-05-4	Yes	Yes	8.61E+01	PHYSPROP	2.00E+04	PHYSPROP	-	5.11E-04	2.09E-02	1.66E-02	1.66E-02	EPI	9.14E+03	8.27E+03	CRC	3.46E+02	PHYSPROP	3.77E-01	9.02E+01	PHYSPROP	7.04E+01	5.19E+02	CRC	2.60E+00	CRC

Table E.2B

VISL Resident - Chemical Properties - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m^3/mole)	Henry's Law Constant (unitless)	Henry's Law Constant (20.3 ℃) (unitless)	Henry's Law Constant Used in Calcs (unitless)	H\` and HLC Ref	Enthalpy of vaporization @ groundwater temperature $\Delta H_{v,gw}$ (cal/mol)	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$ (cal/mol)	$\Delta H_{v,b}$ Ref	Normal Boiling Point BP (K)	BP Ref	Exponent for $\Delta H_{v,gw}$	Vapor Pressure VP (mm Hg)	VP Ref	Vapor Pressure VP (20.3 ℃) (mm Hg)	Critical Temperature T_C (K)	T_C Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
Vinyl Chloride	75-01-4	Yes	Yes	6.25E+01	PHYSPROP	8.80E+03	PHYSPROP	2.00E+00	2.78E-02	1.14E+00	1.02E+00	1.02E+00	PHYSPROP	4.61E+03	4.97E+03	CRC	2.60E+02	PHYSPROP	3.36E-01	2.98E+03	EPI	2.63E+03	4.25E+02	CRC	3.60E+00	CRC
Xylene, m-	108-38-3	Yes	Yes	1.06E+02	PHYSPROP	1.61E+02	PHYSPROP	-	7.18E-03	2.94E-01	2.27E-01	2.27E-01	PHYSPROP	1.01E+04	8.52E+03	CRC	4.12E+02	PHYSPROP	3.79E-01	8.29E+00	PHYSPROP	6.30E+00	6.17E+02	CRC	1.10E+00	CRC
Xylene, o-	95-47-6	Yes	Yes	1.06E+02	PHYSPROP	1.78E+02	PHYSPROP	-	5.18E-03	2.12E-01	1.63E-01	1.63E-01	PHYSPROP	1.03E+04	8.66E+03	CRC	4.18E+02	PHYSPROP	3.74E-01	6.61E+00	PHYSPROP	5.00E+00	6.30E+02	CRC	9.00E-01	CRC
Xylene, p-	106-42-3	Yes	Yes	1.06E+02	PHYSPROP	1.62E+02	PHYSPROP	-	6.90E-03	2.82E-01	2.18E-01	2.18E-01	PHYSPROP	1.01E+04	8.53E+03	CRC	4.11E+02	PHYSPROP	3.78E-01	8.84E+00	PHYSPROP	6.72E+00	6.16E+02	CRC	1.10E+00	CRC
Xylenes	1330-20-7	Yes	Yes	1.06E+02	PHYSPROP	1.06E+02	PHYSPROP	1.00E+04	6.63E-03	2.71E-01	2.10E-01	2.10E-01	PHYSPROP	1.01E+04	8.52E+03	Weast	4.12E+02	PHYSPROP	3.75E-01	7.99E+00	PHYSPROP	6.08E+00	6.20E+02	YAWS	-	

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Table E.2C
VISL Resident - Equation Inputs - Applied Target Risk of 1E-06, Target Hazard Quotient of 0.1, Groundwater Attenuation Factor of 0.0005, and Temperature of 20.3 degrees Celsius

Variable	Resident Air Default Value	Site-Specific Value
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001	0.0005
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03	0.03
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration first phase) years	2	2
ED_{2-6} (mutagenic exposure duration second phase) years	4	4
ED_{6-16} (mutagenic exposure duration third phase) years	10	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10	10
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time first phase) hours/day	24	24
ET_{2-6} (mutagenic exposure time second phase) hours/day	24	24
ET_{6-16} (mutagenic exposure time third phase) hours/day	24	24
ET_{16-26} (mutagenic exposure time fourth phase) hours/day	24	24
THQ (target hazard quotient) unitless	0.1	0.1
LT (lifetime) years	70	70
TR (target risk) unitless	0.000001	0.000001

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