Dunn Field Offsite Groundwater Investigation QAPP-SAP

Environmental Restoration Support at Former Defense Depot Memphis, Tennessee

Contract W91278-16-D-0061, Task Order W9127819F0090

Revision 1

May 2020

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Acronyms and Abbreviations

°C	degrees Celsius
ASTM	American Society for Testing and Materials
BEC	BRAC Environmental Coordinator
BFB	4-bromofluorobenzene
bgs	below ground surface
BRAC	Base Realignment and Closure
CA	corrective action
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF	chloroform
CFR	Code of Federal Regulations
CoC	chain-of-custody
COR	Contracting Officer’s Representative
CT	carbon tetrachloride
CT Labs	CT Laboratories
CVOC	chlorinated volatile organic compound
DCE	1,1-dichloroethene
DDMT	Defense Depot Memphis, Tennessee
DO	dissolved oxygen
DoD	Department of Defense
DQCR	daily quality control report
DQO	data quality objective
EICP	extracted ion current profile
ELAP	Environmental Laboratory Accreditation Program
ESI	Expanded Site Investigation
FDSV	Fluvial Deposit Specific Values.
FFA	Federal Facilities Agreement
ft	feet/foot
FTL	Field Team Leader
GC/MS	gas chromatography/mass spectrometry
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDR	HDR Environmental, Operations and Construction, Inc.
ICAL	initial calibration
ICV	initial calibration verification
I.D.	inside diameter
IDW	investigative derived waste
IRA	interim remedial action
IS	internal standard
ISTD	in situ thermal desorption
LCS	laboratory control sample

LCSD	laboratory control sample duplicate
LIMS	Laboratory Information Management System
LOD	limit of detection
LOQ	limit of quantitation
LSV	Loess-Specific Value
LTM	long-term monitoring
MCL	maximum contaminant level
mg/L	milligrams per liter
MI	Main Installation
Microbac	Microbac Laboratories, Inc.
MIP	membrane interface probe
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
ORP	oxygen reduction potential
OSHA	Occupational Safety and Health Administration
PA	preliminary assessment
PCE	tetrachloroethene
PDB	passive diffusion bag
PID	photoionization detector
PM	Project Manager
ppm	parts per million
PQO	Project Quality Objective
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RF	response factor
RG	remediation goal
RDI	remedial design investigation
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention time
RSD	relative standard deviation
RT	retention time
RW	recovery well
SB	soil boring

SCHD	Shelby County Health Department
SI	site investigation
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SPLP	Synthetic Precipitation Leaching Procedure
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environment & Conservation
TM	Technical Manager
TSA	technical systems audit
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
ZHE	volatile fraction
%R	percent recovery
µg/kg	micrograms per kilogram
µg/L	micrograms per liter

QAPP Worksheet #1 & 2: Title and Approval Page

Project Name	Environmental Restoration Support, Former Defense Depot Memphis, Tennessee (DDMT)
Site Location	Memphis, Shelby County, Tennessee
Contract Number	W91278-16-D-0061
Task Order	W9127819F0090

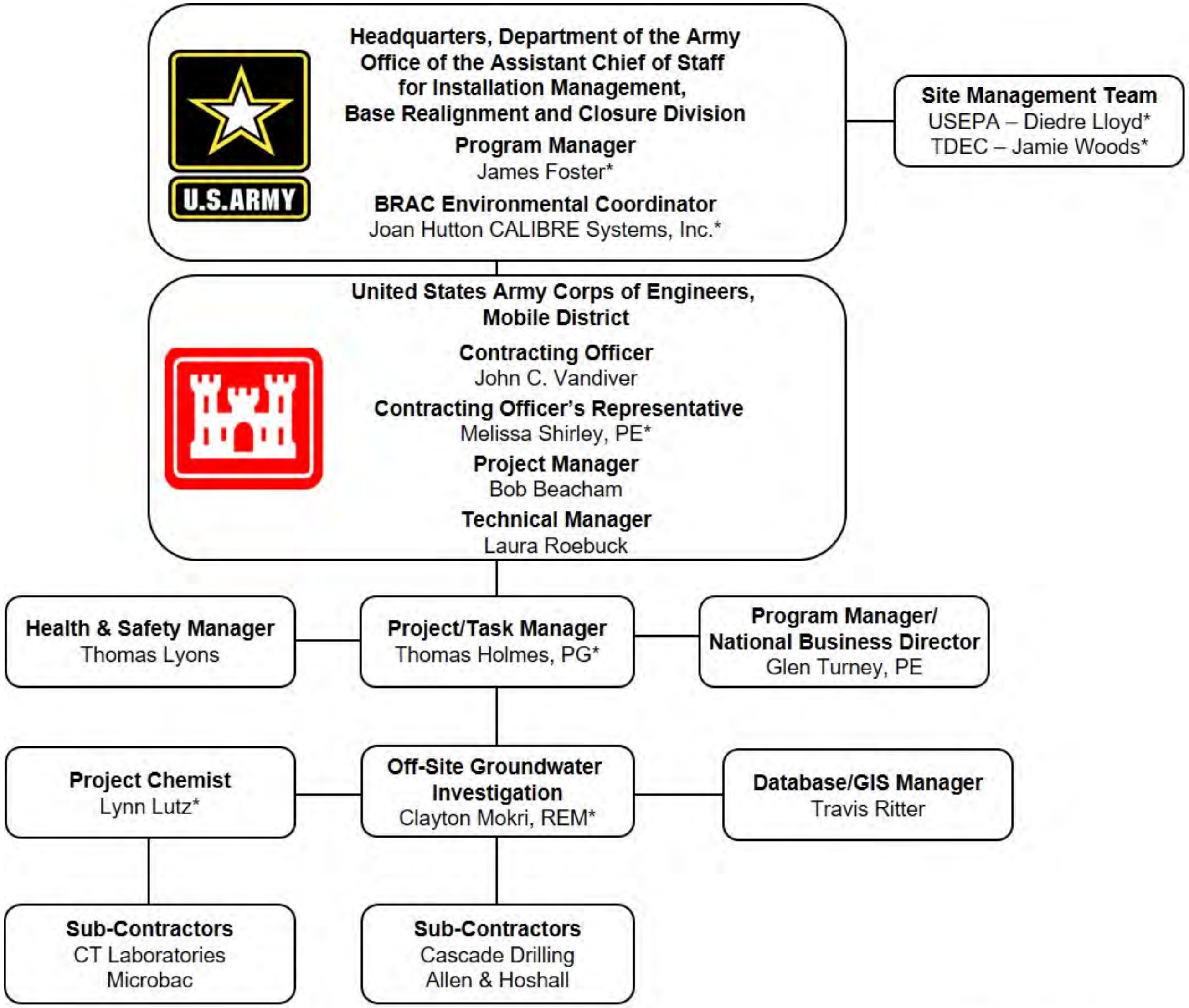
Approvals:

Role	Title	Organization	Name
Lead Organization	Program Manager	United States Army, Assistant Chief of Staff for Installation Management, Base Realignment and Closure (BRAC) Division	James Foster
Lead Organization	BRAC Environmental Coordinator (BEC)	CALIBRE Systems, Inc.	Joan Hutton
Stakeholder Agency	Contracting Officer’s Representative (COR)	United States Army Corps of Engineers (USACE), Mobile District	Melissa Shirley
Stakeholder Agency	Project Manager (PM)	USACE – Mobile District	Bob Beacham
Stakeholder Agency	Technical Manager (TM)	USACE – Mobile District	Laura Roebuck
Federal Regulatory Agency	Remedial Project Manager (RPM)	United States Environmental Protection Agency (USEPA), Region 4	Diedre Lloyd
State Regulatory Agency	RPM	Tennessee Department of Environment & Conservation (TDEC)	Jamie Woods
Plan Preparation and Implementation	PM	HDR Environmental, Operations and Construction, Inc. (HDR)	Tom Holmes
Plan Preparation and Implementation	Quality Assurance (QA) Officer / Project Chemist	HDR	Lynn Lutz
Plan Preparation and Implementation	Project Geologist	HDR	Clayton Mokri

Previous Plans and Reports Relevant to Project:

Title	Date	Author
Memphis Depot Dunn Field Remedial Investigation Report, Sections 1 through 18, Defense Distribution Center (Memphis), Revision 2	July 2002	CH2M HILL
Technical Memorandum, Installation of Upgradient Wells near Dunn Field.	August 2003	Jacobs Federal Programs
Membrane Interface Probe Survey Report. Dunn Field - Defense Depot Memphis, Tennessee, Department of the Army, Revision 0	July 2017	Trinity
Memorandum, Data Collection at TDEC Wells, Dunn Field, Defense Depot Memphis, Tennessee	November 2017	HDR
Project Management Plan	April 2019	HDR
Annual Long-Term Monitoring Report-2018, Defense Depot Memphis, Tennessee, TN42100220570, Revision 0	March 2019	HDR

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution



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Stephanie Mossburg	Microbac	Laboratory PM	stephanie.mossburg@microbac.com	800-373-4071	
Larry Yancey	Cascade	Drilling PM	lyancey@cascade-env.com	901-620-5949	425-219-3952
Jay Caughman	Allen & Hoshall	Surveying PM	jcaughman@allenhoshall.com	901-261-4710	

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

ORGANIZATION: HDR

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Tom Holmes	PM	MS Geophysics 40 years	Registered Professional Geologist, Georgia	
Lynn Lutz	QA Officer / Project Chemist	BA Chemistry 35 years	Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER), 40-hour; First Aid/CPR certification	
Clayton Mokri	Project Geologist / Field Team Leader (FTL)	BS Environmental Science 15 years	OSHA HAZWOPER, 40-hour , OSHA 30-hour construction safety, First Aid/CPR certification, Registered Environmental Manager	
Travis Ritter	Project DB/ GIS Manager	MS Environmental Science 15 years	OSHA HAZWOPER, 40-hour; OSHA 510 Construction Industry Health and Safety	

ORGANIZATION: CT Laboratories

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Eric Korthals	Laboratory PM	BS/MS Biology 36 years	--	

ORGANIZATION: Microbac

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Stephanie Mossburg	Laboratory PM	BS Biochemistry 28 years	--	

**Signatures indicate personnel have read and agree to implement this Quality Assurance Project Plan (QAPP) as written.*

QAPP Worksheet #6: Communication Pathways

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, etc.)
Contract Execution/ Document Review	USACE COR/TM	Melissa Shirley/Laura Roebuck	251-690-2616 251-690-3480	Email/verbal communication with HDR PM. QA supervision for contract activities. Participate in monthly Site Management Team calls to discuss recent project activities, document review and project schedule, upcoming documents and issue resolution.
Regulatory Interface	BEC	Joan Hutton	770-317-4323	Communicate with USEPA/TDEC as needed and submit project documents for regulatory review. Monitor compliance with the Federal Facilities Agreement (FFA) (USEPA, 1995) regarding submittals and timing.
Technical Direction	BEC	Joan Hutton	770-317-4323	Review project documents and represents the BRAC PM. Lead monthly Site Management Team calls to discuss recent project activities, document review and project schedule, upcoming documents and issue resolution.
USEPA Oversight	USEPA RPM	Diedre Lloyd	404-562-8855	Review and comment on project documents. Documents for initial review will be submitted electronically by email or on CD via overnight delivery; in either case a paper copy of the text, tables and figures will be submitted via overnight delivery. Final documents will be submitted electronically by email or on CD via overnight delivery; paper copies will not be provided, unless requested.
TDEC Oversight	TDEC RPM	Jamie Woods	901-371-3041	Review and comment on project documents. Documents for initial review will be submitted electronically by email or on CD via overnight delivery; in either case a paper copy of the text, tables and figures will be submitted via overnight delivery. Final documents will be submitted electronically by email or on CD via overnight delivery; paper copies will not be provided, unless requested.
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. Prepare draft agenda, participate and prepare draft summary for monthly Site Management Team calls.
Field Decisions	HDR PM	Tom Holmes	404-295-3279	Notify USACE TM and BEC of significant changes to field activities due to site conditions or other factors for discussion with USEPA and TDEC RPMs and regulatory buy-in. Communicate by phone or email within at least 4 hours of identifying the required change. The BEC will inform USEPA and TDEC RPMs of significant corrective actions (CAs) or when significant changes to procedures in the QAPP occur in the field. The RPMs will be informed of the actions by phone or email within two to six hours of the BEC being informed

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, etc.)
Manage Field Tasks	HDR Project Geologist	Clayton Mokri	530-902-7106	Supervise HDR field activities. Communicate with HDR PM and Project Chemist. Provide daily quality control reports (DQCRs) and notification of work problems.
QAPP changes in the field	HDR QA Officer	Lynn Lutz	303-754-4266	Manage and implement in-field QAPP changes. Notify HDR PM of QAPP changes.
Reporting Lab Data Quality Issues	CT Laboratories/ Microbac Laboratory PMs	Eric Korthals Stephanie Mossburg	608-356-2760 740-373-4071	Notify the HDR Project Chemist regarding laboratory data quality issues including CAs and data usability.
Field CAs	HDR Project Geologist/FTL	Clayton Mokri	530-902-7106	Issue CAs in writing to the HDR PM for review and submittal to USACE TM and BEC. The BEC will inform the USEPA and TDEC RPMs of significant field CAs by phone or email within two to six hours of the BEC being informed.
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 written CAs to PM for review and submittal to USACE TM and BEC. Provide the data validation report and releases data to the HDR PM. The BEC will inform the USEPA and TDEC RPMs of significant analytical CAs by phone or email within two to six hours of the BEC being informed.
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.
QAPP Changes	HDR QA Officer / HDR PM	Lynn Lutz/ Tom Holmes	303-754-4266 404-295-3279	Manage and implement QAPP changes. Provide revisions to all QAPP recipients via email or hard copy, as applicable.

QAPP Worksheet #9: Project Planning Session Summary

No planning sessions were held; however, offsite groundwater investigation was discussed during the 1 March 2019 project kick off teleconference and documented in the *Project Management Plan* (HDR, 2019b).

The Statement of Work (SOW) for Contract No. W91278-16-D-0061 Task Order W9127819F0090 (USACE, 2019) defined the work to be performed in Task 8, Offsite Groundwater Investigation. The SOW notes that the plume along the northern boundary of Dunn Field was considered to have both onsite and offsite sources, based on chlorinated volatile organic compounds (CVOCs) detected in offsite monitoring wells upgradient of Dunn Field. The SOW requires additional offsite investigation to evaluate potential offsite source areas to include installation of 10 monitoring wells, initial groundwater sampling from the 10 new wells and four subsequent quarterly groundwater monitoring events at the 10 new wells and 10 existing TDEC wells, with analysis for volatile organic compounds (VOCs). An aerial photograph showing the area of investigation is presented on Figure 1. The area includes the northern portion of Dunn Field and the offsite area to the north and northeast; existing and abandoned long-term monitoring (LTM) wells installed by DDMT and wells installed by TDEC are also shown.

Following well installation/initial sampling and the first three quarterly monitoring events, data reports will be prepared to document the field activities and sampling results. After completion of the fourth quarterly monitoring event, a comprehensive Offsite Groundwater Investigation Report will be prepared.

Army submitted *Dunn Field Offsite Groundwater Investigation QAPP, Revision 0* (HDR, 2019) on 16 July 2019. TDEC approved the QAPP on 20 September 2019. USEPA submitted comments for the QAPP on 12 November 2019 and Army provided responses on 18 March 2020. A conference call to discuss the USEPA comments and responses was held on 24 March 2020. Revised responses and additional information on well screen depths for existing wells were submitted to USEPA and TDEC on 7 April; USEPA approved the responses on 21 April. This QAPP-SAP has been revised in accordance with the approved responses. The approval letters, responses to comments and information on well screen depths are provided in Appendix D.

QAPP Worksheet #10: Conceptual Site Model

Site History

DDMT is located in southeastern Memphis, Tennessee and consists of approximately 634 acres at the Main Installation (MI) and Dunn Field. The MI contains approximately 567 acres with open storage areas, warehouses, former military family housing, and outdoor recreational areas. 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.

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.

During operations from 1942 to 1997, DDMT received, warehoused, and distributed supplies to U.S. military services and civilian agencies. The supplies included hazardous substances; textile products; food products; electronic equipment; construction materials; and industrial, medical, and general supplies.

Geology and Hydrogeology

The geologic units of interest on Dunn Field and to the northeast, are (from youngest to oldest): loess, including surface soil; fluvial deposits; and the Jackson Formation/Upper Claiborne Group (Jackson/Upper Claiborne). The Memphis Sand, is located beneath the Jackson/Upper Claiborne formation, but will not be reached in this investigation.

The loess consists of wind-blown and deposited brown to reddish-brown, low-plasticity clayey silt to silty clay. The loess deposits to the northeast of Dunn Field are approximately 15 to 30 feet (ft) thick.

The fluvial (terrace) deposits northeast of Dunn Field consist of two general layers. The upper layer is silty, sandy clay to clayey sand and ranges from about 2 to 20 ft thick. The lower layer is composed of interlayered sand, sandy gravel, and gravelly sand, and ranges from 20 to 40 ft thick. The uppermost aquifer is the unconfined Fluvial Aquifer, consisting of saturated sands and gravelly sands in the lower portion of the deposits.

The Upper Claiborne Group includes the Cockfield and Cook Formations, and the individual formations of the Jackson/Upper Claiborne consist of clays, silts, and sands deposited in lenses or individual beds that are not areally extensive. A clay layer at the top of the Jackson/Upper Claiborne forms the base of the Fluvial Aquifer throughout the area of this investigation.

The groundwater flow direction in the Fluvial Aquifer within the area of investigation is to the southwest; the gradient is 0.01 (CS-01 to MW-78 and CS-05 to MW-03). Groundwater elevations decrease from 259.01 ft NAVD at WB-03 to 231.50 at MW-03. The ground surface elevation in the area of investigation has a high point at CS-06 (301.6 ft NAVD) located northeast of Dunn Field and decreases toward WB-03 (265.6 ft NAVD) and MW-03 (290.4 ft NAVD). The depth to groundwater ranges from 6.3 ft at WB-03 to 60.9 ft at MW-03; the potentiometric surface is in the fine-grained loess or upper fluvial deposits in the northernmost wells (WB-01 to WB-03 and CS-01 to CS-04) and in the coarse-grained lower fluvial deposits in the remaining wells.

Land Use

Dunn Field 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 established for Dunn Field are to limit use of the Disposal Area to light industrial land uses, to prevent residential use of Dunn Field, and to prevent exposure to contaminated groundwater (CH2M HILL, 2008). The majority of the eastern section of Dunn Field was approved for unrestricted use in the *Memphis Depot Dunn Field Record of Decision* (ROD) (CH2M HILL, 2004).

Approximately 41 acres on the east side of Dunn Field have been transferred, 39 acres to Dunn Field Business Park LLC in 2007 through competitive public sale and 2 acres to City of Memphis in 2005 through a public benefit conveyance for realignment of Hayes Road. Approximately 26 acres along the western and northern side of Dunn Field are still held by the Army and are to be transferred through a competitive public sale when remedial activities are completed.

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 commercial and industrial uses including a construction materials recycling facility and on the west by an electrical substation and commercial warehouses with residential properties further west.

Previous Investigation and Remedial Action

Beginning with the initial investigation at Dunn Field in 1982, 153 monitoring wells have been installed at Dunn Field. LTM currently includes 85 wells; the remainder have been abandoned because of damage, or a determination that the well was no longer needed or required abandonment to allow remedial action (RA). The wells located within the area of this current investigation are listed on Table 1; there are 11 active LTM wells and 11 abandoned wells. Groundwater concentrations of CVOCs in all samples from these wells are listed in Appendix A-1, Tables A-1.1 and A-1.2.

Wells MW-51 and MW-128 were abandoned in March 2013 because continued sampling was not considered necessary at that time; the wells were located north of Dunn Field but not directly upgradient. The wells were recommended for abandonment in the 2011 Off Depot LTM Report. At the time, MW-51 and MW-128 were recommended for abandonment, neither EPA nor TDEC had requested Army provide additional lines of evidence for an off-site source of the groundwater contamination upgradient of Dunn Field. Elevated concentrations of PCE, TCE and/or 1,1-DCE had been observed at MW-51 and MW-128, and replacement wells are planned to provide current data at those locations in order to determine the current extent of contaminants in the upgradient portion of the plume.

The previous investigations and RAs that included the area of investigation are summarized in the following sub-sections.

Initial Investigations

The initial environmental investigation of groundwater on Dunn Field was *Geohydrologic Study No. 38-26-0195-83* (U.S. Army Environmental Hygiene Agency, 1983). Seven wells (MW-1 to MW-7) were installed on Dunn Field, although the well casing for MW-1 was damaged and that well was not completed.

A site-wide remedial investigation (RI) for DDMT was performed in 1989 (Law Environmental, 1990), which included installation of 32 monitoring wells (MW-8 to MW-39); 18 wells were installed on and adjacent to Dunn Field (MW-8 to MW-15 and MW-28 to MW-37). The site-wide RI report stated elevated concentrations of CVOCs and metals were present in the Fluvial Aquifer on Dunn Field and the plume had migrated offsite in a generally west-northwest direction. The report included the following recommendations for Dunn Field: locate waste burial sites through geophysical surveys; evaluate the western (offsite) extent of the Dunn Field plume through additional monitoring wells; evaluate contaminant source areas and site hydrogeology through additional soil borings and monitoring wells; and remediation of groundwater contamination through a conventional pump and treat system, a pumping system in conjunction with bioremediation, or some other system.

Interim Remedial Action

The *Record of Decision for Interim Remedial Action of the Groundwater at Dunn Field (OU-1)* (CH2M HILL, 1996) was signed in April 1996; the objective was hydraulic containment to prevent further contaminant plume migration and reduce contaminant mass in groundwater. The interim remedial action (IRA) groundwater recovery system included 11 recovery wells (RWs) screened in the Fluvial Aquifer along the western boundary of Dunn Field. Supplemental information from the *Annual Operations Report-2008, Dunn Field Groundwater Interim Remedial Action-Year Ten* (e2M, 2009) is provided in Appendix A-2. The well location map showing the RWs and LTM wells on Dunn Field is provided in Appendix A-2.1.

Based on reduction of CVOC concentrations in groundwater following implementation of the Dunn Field Source Areas RA, five RWs (RWs 5, 6, 7, 8 and 9) were shut down in June 2008 and the remaining RWs (RW-1, 1A, 1B, 2, 3 and 4) were shut down in January 2009. A chart of trichloroethene (TCE) and total VOC concentrations in the IRA discharge from 1998 through 2008 is shown in Appendix A-2.2. The volume of groundwater discharge and the estimated mass of VOCs removed were provided in monthly discharge reports included in the annual operations reports. During approximately 10 years of operation ending in December 2008, the IRA removed approximately 918 pounds of total VOCs, including 369 pounds of TCE (Appendix A-2.3). The IRA system was removed and the RWs abandoned in July 2010.

Dunn Field Remedial Investigation

The Dunn Field RI was performed to evaluate the nature and extent of contamination at Dunn Field and the associated risk to human health and the environment. Supplemental information from the *Final Memphis Depot Main Installation Remedial Investigation Report* (CH2MHILL, 2002) is provided in Appendix A-3.

The Dunn Field RI was organized by investigation of areas considered to have similar levels of contamination rather than individual sites. The three areas (Northeast Open Area, Disposal Area and Stockpile Area) are shown on Figure 2; the environmental sites within each area are also shown.

The groundwater flow direction is to the southwest at the northeast corner of Dunn Field; thus, the Northeast Open Area is the relevant section for evaluation of an onsite or offsite source of the plume along the northern boundary of Dunn Field.

The Northeast Open Area, covering approximately 20 acres, consists of a grassy area with interspersed mature trees in the northeast quadrant of Dunn Field. The environmental sites are listed below with the general RI sampling activities.

- Site 19 (Former Tear Gas Canister Burn Site) – soil borings drilled and sampled.
- Site 20 (Asphalt Burial Site) – soil boring drilled and sampled.
- Site 21 (XXCC-3 [stabilized impregnite] Burial Site) - soil borings drilled and sampled.
- Site 50 (Dunn Field Northeast Quadrant Drainage Ditch) – two sets of surface water and sediment samples collected.
- Site 60 (Pistol Range Impact Area and Bullet Stop) and Site 85 (Pistol Range Building and Temporary Pesticide Storage Building) – surface soil samples collected and a visual search made for spent bullets and casings.
- Site 62 (Bauxite Storage) – common investigation conducted for mineral storage sites (62, 63 and 64) with soil borings to assess potential for waste disposal prior to mineral storage; waste disposal was not observed.

The area of the current investigation (Figure 1) also includes the northern portion of the Disposal Area on the western side of Dunn Field, which has several environmental sites in the northwest corner of Dunn Field. Residual soil contamination and groundwater impacts from these sites were identified and addressed in the Source Areas RA discussed later in this section.

Initial studies, including a geophysical investigation and a soil gas survey, “indicated that soil contamination and disposed items did not, in all cases, correspond to boundaries of known or suspected burial sites” (CH2MHILL, 2002). Figures from the Dunn Field RI showing VOCs detected in the initial soil gas survey are provided in Appendix A-3.1. The highest CVOC concentrations in soil gas were observed in the Disposal Area.

Soil samples were collected from nine borings in the Northeast Open Area. VOC analyses were performed on eight surface soil samples (0 to 1 ft) and 18 subsurface soil samples (3 to 5 ft and 8 to 10 ft). The analytical results for CVOCs (including 1 surface soil duplicate and two subsurface soil duplicates) are summarized on Table 2. The nine surface soil samples contained only TCE and total 1,2-dichlorethene were reported above 0.01 mg/kg with maximum concentrations of 0.7 mg/kg and 0.2 mg/kg, respectively. The highest concentration reported in the 20 subsurface soil samples was TCE at 0.1 mg/kg. Figures from the Dunn Field RI showing VOCs detected in the Northeast Open Area soil samples are included Appendix A-3.2. The Dunn Field RI report (CH2MHILL, 2002) stated the VOC concentrations did not appear to be high enough to indicate a release from a definable source area.

The Dunn Field RI groundwater investigation included installation of 34 wells and sampling new and existing wells; three CVOC plumes were identified: the Southwest, Northwest and North plumes. Eleven wells were identified within the North plume (MW-02, MW-03, MW-07, MW-08, MW-10, MW-

29, MW-30, MW-31, MW-51, MW-68 and MW-78); the plume was considered to have both onsite and offsite sources.

Groundwater samples were collected from three wells (MW-07, MW-10 and MW-29) along the northern border of Dunn Field in two sample events during the RI, January-February 1996 and October 1998 (Tables A-1.1 and A-1.2). MW-10 and MW-29 were later abandoned. MW-10 was located at the western end of Dunn Field's northern border, MW-07 is near the middle and MW-29 was near the eastern end (Figure 1). The concentrations from 1996 and 1998 fluctuated at each location but tetrachloroethene (PCE) and TCE were higher at MW-10 than at MW-07 and MW-29. 1,1,2,2-Tetrachloroethane (TeCA) was detected at low concentration at MW-10 but was not detected at MW-07 and MW-29. Concentrations of 1,1-dichloroethene (DCE) were similar at the three wells. The higher concentrations of PCE and TCE and the presence of TeCA at MW-10 indicated an onsite source of contaminants in that area. The similar concentrations of DCE at all three wells and the decrease in groundwater elevation of approximately 10 ft from MW-29 to MW-10 indicated a contaminant source for PCE, TCE, and DCE northeast of MW-29.

Upgradient Wells

Three upgradient monitoring wells (MW-128, MW-129, and MW-130) were installed in June 2003 to evaluate the potential for offsite contamination migrating onto the northeast corner of Dunn Field. Well installation and results of groundwater analyses were described in a technical memorandum (Jacobs, 2003). MW-128 is located approximately 600 ft north of Dunn Field, MW-129 is across E. Person Avenue from Dunn Field, and MW-130 is across Hayes Road from Dunn Field (Figure 1). The initial groundwater samples were collected on 28 July 2003 (Tables A-1.1 and A-1.2). MW-128 had low concentrations of DCE and TCE that were below the USEPA maximum contaminant level (MCL); MW-129 and MW-130 had concentrations of DCE, PCE, and TCE that were above the MCL, with the highest concentrations at MW-130. The well locations and analytical results provided further evidence of a separate source for CVOCs located north or northeast of Dunn Field.

Dunn Field Remedial Design Investigation

A remedial design investigation (RDI) was conducted to refine the limits of soil contaminated with CVOCs in the four treatment areas along the west side of Dunn Field and to further delineate the groundwater plume and provide additional monitoring locations for the groundwater remedy. The field activities were performed in phases from October 2005 through August 2006. The investigation is documented in *Results of the Memphis Depot-Dunn Field Remedial Design Investigation* in Appendix A of the *Memphis Depot Dunn Field Source Areas Final Remedial Design* (CH2MHILL, 2007).

The RDI included a membrane interface probe (MIP) with confirmatory soil sampling and installation of twelve onsite and five offsite monitoring wells (MW-172 to MW-188). The RDI figure showing locations for MIP survey points and soil samples is provided in Appendix A-4.1. The figure showing results of the MIP investigation for Treatment Area 1 in the northwest corner of Dunn Field is provided in Appendix A-4.2. The MIP electron capture detector (ECD) response was used as a screening tool to assess the extent of CVOCs above the remediation goals (RGs) specified in the Dunn Field ROD. Appendix A-4.2 shows the maximum ECD response at each survey point, CVOC concentrations in soil samples above RGs and estimated extent of areas requiring remediation. Maximum concentrations of CVOC in soil samples reported in Treatment Area 1 included TeCA at

953,000 micrograms per kilogram (µg/kg) PCE at 20,800 µg/kg, TCE at 564,000 µg/kg and DCE at 2,340 µg/kg.

Locations of the two onsite wells installed in Treatment Area 1 during the RDI (MW-180 and MW-181) are also shown in Appendix A-4.2 and on Figure 1. The initial groundwater samples were collected in November 2005 (Tables A-1.1 and A-1.2). MW-181, which is located closer to Dunn Field's northern border had DCE at 11.5 micrograms per liter (µg/L), PCE at 13.7 µg/L and TCE at 9.88 µg/L; TeCA was not detected (< 1 µg/L), MW-180 had TeCA at 44.2 µg/L, PCE at 5.02 and PCE at 24.4 µg/L; DCE was not detected (< 1 µg/L).

Source Areas Remedial Action

Remedial activities on Dunn Field are documented in the *Source Areas Interim Remedial Action Completion Report* (IRACR) (HDR/e2M, 2009). The report describes the RAs conducted in the Disposal Area at Dunn Field (Figure 2). The actions, which consisted of excavation and offsite disposal of shallow soil and waste materials, soil vapor extraction (SVE) in the Fluvial sands, and in situ thermal desorption (ISTD) in the loess. The figure from the Source Areas IRACR showing locations of the different actions is included as Appendix A-5.1.

The Fluvial SVE system began operation in July 2007 and was shutdown in July 2012 based on confirmation soil sample results demonstrating that RGs had been met; approximately 4,000 pounds of VOCs were removed during system operations. Excavation in the two areas shown in Appendix A-5.1 was completed in two phases (October 2007 to January 2008 and February to June 2009); confirmation samples met the RGs. The ISTD system operated continuously from May to November 2008 when the heaters were shut down; approximately 12,500 pounds of VOCs were removed and confirmation soil samples met the RGs.

The decrease in CVOC concentrations in groundwater following implementation was demonstrated by the reduced concentrations in the IRA system effluent, as shown in Appendix A-2.2. The total CVOC concentrations in groundwater from April 2007, prior to startup of the Fluvial SVE system, are shown on Figure 3. As a comparison, the April 2007 and April 2016 total CVOC isopleths are shown side by side in a figure from the 2017 Site Management Plan (HDR, 2017) included as Appendix A-5.2. As shown by the 2016 plume map, CVOC concentrations in groundwater were reduced throughout Dunn Field, including near the northwest corner of Dunn Field, but not in the upgradient portion of the North plume.

TDEC Offsite Investigations

TDEC investigated three sites located upgradient of Dunn Field to identify a potential source(s) of CVOCs in the offsite monitoring wells installed in 2003 (MW-128, MW-129, and MW-130), A pre-screening investigation was initially performed at the Wabash Avenue Site/General Machinery Works located northeast of Dunn Field and then at the Cintas and Production Specialties sites located on South McLean Blvd north of Dunn Field; the three sites are shown on Figure 1. The prescreening investigations led to a preliminary assessment/site investigation (PA/SI) at Wabash Avenue and Cintas and then to an Expanded Site Investigation (ESI) at Cintas.

TDEC conducted a pre-CERCLIS screening assessment of the Wabash Avenue Site in 2004 because it was the closest commercial area, located approximately 0.3 mile upgradient of MW-130. General Machine Works at 2001 Wabash Avenue became the focus of TDEC's inquiry, and was subsequently recommended for CERCLIS listing because it was the type of facility that would use chlorinated solvents, had a 33-year operational history and had no record of previous environmental investigations. TDEC conducted an SI at the Wabash Avenue Site in December 2005, which included installation of four monitoring wells (WB-01 to WB-04 on Figure 1) and groundwater sampling from the new wells and DDMT LTM well MW-65 (TDEC, 2006a). Soil cuttings from the well borings were field-screened for VOCs by the Color-Tec method; the results were inconclusive due to low temperatures (28 to 45 degrees Fahrenheit) that may have suppressed volatilization of VOCs in the samples. VOCs were not detected in the groundwater samples. TDEC concluded that further investigation of the Wabash Avenue Site was not warranted.

TDEC conducted concurrent prescreening investigations at Production Specialties and Cintas in November 2006. Production Specialties was determined to have housed industrial operations since 1955. At the time of the site inspection, the majority of the building was used for manufacture of light fixtures for commercial and industrial uses. The southeast portion of the building was used for warehousing and distribution of paint products. Although the content of every drum was not verified, no solvents related to PCE and TCE were observed. Based on information gathered during the concurrent investigation of the adjacent Cintas site, TDEC recommended that a decision on further investigation of the Production Specialties site be delayed until the Cintas SI was completed (TDEC, 2006b).

The one building at the Cintas site was not occupied during the site visit for the prescreening investigation in November 2006. Seven drums and one caged polyethylene tank were observed outside the building: two drums were empty, one contained approximately 1 ft of sludge; one was three-quarters full, had a missing bung cap and a paint solvent odor; one was full, sealed and labeled “Combustible Liquid”; two drums and the tank appeared to contain used engine oil. Previous site owners were stated to include Uniform Manufacturing Companies and a Uniform Services Company; Sunshine Cleaners was reported to operate at the site before Cintas purchased the property in 1994. TDEC recommended further investigation in the form of PA/SI (TDEC, 2009).

The Cintas SI included installation of monitoring wells (CS-01 to CS-04 on Figure 1). Groundwater samples were collected in July 2007 from the four Cintas wells and from five DDMT LTM wells (MW-51, MW-65, MW-128, MW-129, and MW-130). CVOCs were reported in samples from several wells, and concentrations were above the MCL for DCE in CS-02 and MW-51, and for PCE, TCE, and DCE in MW-129 and MW-130. TDEC recommended the Cintas site be considered for inclusion on the National Priority List (NPL) (TDEC 2009).

An ESI at the Cintas site was conducted in 2008; the scope included a passive soil gas (PSG) survey, installation of three monitoring wells (CS-05 to CS-07 on Figure 1), and groundwater sampling from TDEC wells (CS-01 to CS-07, WB-01 and WB-04) and DDMT LTM wells (MW-65, MW-128, MW-129 and MW-130). A total of 59 PSG samplers were installed at depths of 3 to 5 ft below ground surface (bgs) around the building, on the surrounding Cintas properties, and offsite to the southeast. VOCs were detected at or slightly above the detection limit of 0.01 µg in several samples, but not at concentrations that indicated a chlorinated solvent source on the Cintas site or upgradient of DDMT wells MW-129 and MW-130. As in the initial SI groundwater samples, CVOCs were reported in ESI groundwater samples from several wells; concentrations were above the MCL for DCE in CS-02 and CS-03, for PCE in CS-05, and for PCE, TCE, and DCE in MW-129 and MW-130. The ESI report noted that DCE concentrations were above the MCL in CS-02 and CS-03, but that PCE and TCE concentrations detected in MW-129 and MW-130 were not observed in the Cintas site wells. The ESI report concluded the analytical results and groundwater elevations from 2007 and 2008 did not indicate a source responsible for CVOCs in MW-129 and MW-130 exists on the Cintas site. The report also stated that the low concentrations of CVOCs in CS-05, CS-06, and CS-07 did not indicate an upgradient source for the CVOCs in MW-129 and MW-130 (TDEC, 2009).

Northeast Dunn Field MIP Survey

Following discussion with USEPA and TDEC, Army agreed to conduct additional investigation to provide additional lines of evidence for the presence of an offsite source(s). A MIP survey was conducted in March and April 2017, and groundwater samples from the TDEC wells installed for the Cintas and Wabash Avenue investigations were collected in October 2017.

Trinity Analysis and Development Corp. (Trinity) performed the MIP survey with soil confirmation sampling in the northeast corner of Dunn Field, based on the original property boundary. The survey included 49 MIP locations and 26 borings for confirmation soil sampling. The sample locations and results for the MIP survey are shown on report figures included in Appendix A-6. There were no MIP locations where the data indicated elevated levels of contaminants; CVOCs were not detected in soil samples except one soil sample with an estimated detection of PCE below the laboratory reporting limit (RL). There was no indication of source materials on current or former Army-owned property contributing to elevated CVOC concentrations in groundwater in the northeast portion or upgradient of Dunn Field (Trinity, 2017).

TDEC Well Assessment

In September 2017, HDR located and assessed the TDEC wells north and northeast of Dunn Field; performed well maintenance and conducted a well survey. Well WB-04 was found to be damaged and not suitable for water level measurements or groundwater sampling. In October 2017, the other 10 TDEC wells and six nearby long-term monitoring (LTM) wells were sampled. CVOCs detected above the laboratory RL in the TDEC wells include: DCE, carbon tetrachloride (CT), chloroform (CF), PCE, and TCE. The only CVOC reported above an MCL in the TDEC wells was DCE in CS-02 at 16.3 µg/L (HDR, 2017).

Analytical results for CVOCs in the active and abandoned LTM wells within the offsite investigation area and the TDEC wells are provided in Appendix A-1, Tables A-1.1, A-1.2, and A-1.3. The results for PCE, TCE and DCE, which are the most common contaminants, are summarized on Table 3.

Summary

As noted above, the North plume is considered to have both onsite and offsite sources. Onsite sources were located near the northwest corner of Dunn Field and were remediated during the Source Areas RA. Trend plots of CVOC concentrations in MW-07, MW-130, and MW-220 are provided in Appendix A-7. MW-220 (A-7.3) was installed in May 2007 near the northwest corner of Dunn Field to monitor performance of the Source Areas RA. The initial concentrations of the primary contaminants, TeCA and TCE, decreased from near 1,000 µg/L to about 10 µg/L for TCE and below 1 µg/L for TeCA after start-up of the Fluvial SVE system. PCE and DCE concentrations were near 10 µg/L initially. Since 2008, the concentrations of PCE, TCE, and DCE have had similar trends above and below 10 µg/L. Trend plots from MW-07 (A-7.1), located near the middle of Dunn Field border, and MW-130 (A-7.2), located offsite near the northeast corner of Dunn Field, do not show any impact from the Source Areas RA; the PCE, TCE, and DCE concentration trends are similar. Post-RA (2008) concentrations in these three wells at each sample event have generally been highest in MW-130 and lowest in MW-220, which is consistent with an offsite, upgradient source. Since 2015, concentrations of DCE and PCE have been highest in MW-07, while concentrations of TCE have been highest in MW-130; this may reflect plume migration from a decreasing source area.

While the TDEC ESI report concluded that a source for PCE and TCE in MW-129 and MW-130 was not identified on the Cintas site, analytical results and groundwater elevations indicate the source is upgradient of Dunn Field. Sampling at the TDEC wells has been limited to three sample events for six wells, two sample events for four wells, and one sample event for one well (Table 3). Occasional high concentrations of TCE have been detected in wells upgradient of MW-129 and MW-130. The April 2002 sample from PZ-02 contained TCE at 24.2 µg/L and three samples from MW-128 contained TCE at 16 to 38 µg/L in 2004 and 2005 (Figure 1); the 2005 sample at MW-128 also contained DCE at 153 µg/L. Source areas may also be present in other areas upgradient of Dunn Field. The only suspected, potential sources, other than the Cintas and Wabash Avenue sites, are potential for spills along the railroad lines that run SW to NE and NW to SE near Dunn Field (Figures 1, 4, 5 and 6). This suspicion is not based on reported spills.

The source of groundwater contamination present in wells upgradient of Dunn Field has not been identified. General data gaps are:

1. Limited distribution of existing monitoring wells upgradient of the Dunn Field North plume.
2. Limited sampling over time for wells upgradient of the Dunn Field North plume.

Army plans to install 10 new monitoring wells and collect water levels and samples from the new wells and the existing TDEC wells for one year to better delineate the plume and to provide a more comprehensive data set. The planned well locations were selected to augment previous wells installed by TDEC to provide more complete coverage of the area upgradient of the northeast section of Dunn Field. Army's goal is not necessarily to identify specific source(s) but to build sufficient evidence that upgradient sources exist based on the extent of upgradient groundwater contamination. Specific Data Gaps to be addressed by each well are listed on Table 4 of WS #17.

This investigation is evaluating additional lines of evidence for an upgradient off-site source of the Dunn Field North plume, which is in the surficial, Fluvial Aquifer. The Fluvial Aquifer on Dunn Field and in the upgradient area is underlain by clay of the upper Claiborne formation, which limits potential for contaminant migration into deeper aquifers. Downward migration through a window or sink would be indicated by a depressed area of Fluvial Aquifer groundwater elevations, which is not observed in the vicinity of the Dunn Field North plume.

As discussed in the conference call with USEPA, TDEC and Army on 24 March 2020, the lithology and screen position for LTM wells (existing and abandoned) and TDEC wells in the investigation area were reviewed, as shown on Appendix D, Addendum and Table 1. Most of the wells were drilled into the clay at the base of the Fluvial Aquifer. The clay was not reached in three wells (MW-07, MW-08 and MW-29); the depth to the base of the aquifer was estimated at 80 ft bgs based on nearby wells. The saturated thickness was determined based on depth to water level and the base of the clay; the water levels in several TDEC wells were above the fluvial sand and the entire thickness of the sand was taken as the saturated thickness. The saturated thickness (Table 1) ranged from 16 to 34 ft. Well screens were 10 to 20 ft in length and the screened percentage of the saturated thickness ranged from 30% to 100%, based on the saturated thickness and the length of screen within the saturated fluvial sand. (Note: TDEC well CS-07 is excluded. The well diagram for CS-07 showed the screen to be in the clay beneath the fluvial sand).

The majority of wells were screened at the base of the fluvial sand: all TDEC wells except CS-07; existing LTM wells MW-129, MW-130 and MW-230; and abandoned LTM wells MW-51 and MW-128. Existing LTM well MW-07 was screened in the middle of the saturated zone. Existing LTM well MW-08 and abandoned well MW-29 were screened at the water table.

Well screens in the new wells will be installed just above the clay in order to evaluate presence of denser solvent contamination and to be consistent with the existing wells.

QAPP Worksheet #11: Project Data Quality Objectives

Data Quality Objectives (DQOs) for the offsite groundwater investigation were established using the seven step process in *Guidance on Systematic Planning Using the Data Quality Objective Process* (USEPA, 2006). The purpose of these DQOs are to identify the project objective and establish performance and acceptance criteria, which serves as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study.

Problem Statement

A plume along the northern boundary of Dunn Field identified during the Dunn Field RI is considered to have both onsite and offsite sources. Potential sources for groundwater contamination were not identified in the northeast section of Dunn Field during the RI or by a MIP survey conducted in 2017. October 2017 groundwater samples from monitoring wells previously installed by TDEC northeast of Dunn Field contained CVOCs greater than laboratory RLs; the DCE concentration in one well was greater than the MCL. The presence of CVOCs in groundwater upgradient from Dunn Field indicates that an offsite source may be contributing to CVOC detected in groundwater along the northern boundary of Dunn Field.

Goal of the Study

The goal of this offsite investigation is to construct 10 monitoring wells, and collect hydrogeological and analytical data from the new wells and 10 existing TDEC monitoring wells in the Fluvial Aquifer northeast of Dunn Field. This information will be used to evaluate potential offsite sources of CVOCs.

Information Inputs

Additional investigation will provide soil lithology from boring logs, soil analytical data, groundwater elevations, and groundwater analytical data. Following installation of the 10 new wells, a water level sweep will be conducted at the new wells and the 10 existing TDEC wells, and initial ground water samples will be collected from the new wells. Water levels and groundwater samples will then be collected from the new wells and the TDEC wells in four quarterly events. The first quarterly event will be scheduled one to three months following well installation in order for two of the quarterly events to coincide with semiannual LTM events on Dunn Field. Groundwater elevations will be determined from water level measurements referenced to surveyed benchmarks.

Soil samples from the borings will be analyzed for VOCs by Method SW8260.

Study Boundaries

The study area includes the LTM wells in the North plume on Dunn Field and to the north, and the wells installed by TDEC at the Cintas and Wabash Avenue sites north and northeast of Dunn Field. The wells are shown on Figure 1.

The temporal boundaries are the 1982 initial investigation including the study area through completion of the four quarterly sample events in 2021.

Analytical Approach

Groundwater contaminants in the North plume are CVOCs, but sample analyses include a full list of VOCs to identify degradation products and to differentiate potential offsite sources. Groundwater samples will be analyzed for VOCs by Method SW8260B.

Lithology at each boring will be described using the Unified Soil Classification System (American Society for Testing and Materials [ASTM] D2487-83).

Five soil samples are planned; the locations will be selected by screening soil core with a photoionization detector (PID) during drilling for well installation. Samples will be collected if PID screening of the soil core exceeds 25 parts per million (ppm). If more than five locations have PID readings greater than 25 ppm, additional samples may be submitted to the laboratory but only the five samples with the highest PID readings will be analyzed.

Initial groundwater samples will be collected by low-flow sampling with measurement of water quality parameters. Passive diffusion bag (PDB) samplers will be installed, where saturated thickness is sufficient, for sampling during subsequent quarterly monitoring events.

The groundwater elevations and analytical results for the 10 new wells and the 10 existing TDEC wells will be used to document trends in CVOC concentrations, determine groundwater flow direction, and evaluate potential source areas.

If elevated concentrations of the target contaminants (PCE, TCE and 1,1-DCE) are present upgradient of Dunn Field based on flow paths determined from the measured groundwater elevations, then an offsite contaminant source will be confirmed.

Performance or Acceptance Criteria

Groundwater samples will be collected from monitoring wells and analyzed at a United States Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) laboratory for VOCs by Method SW8260B.

Although the soil analyses for VOCs by Method SW8260 will provide definitive results, the overall soil data will be screening level quality because the soil will be disturbed by heat during sonic drilling. If sample analyses detect elevated CVOC concentrations, then additional soil sampling will be considered, but is not included in the current statement of work.

Performance criteria for analytical data are presented in Worksheet #12. Acceptance criteria will be based on compliance with the task descriptions in Worksheet #14/16 and the applicable Standard Operating Procedures (SOPs).

A Tennessee-registered land surveyor will establish horizontal and vertical control for all new monitoring wells. 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.

Well installation and development, groundwater sampling, laboratory analysis, and data validation will be conducted in accordance with:

- this QAPP;
- DDMT Uniform Federal Policy – Quality Assurance Project Plan (DDMT UFP-QAPP) (HDR, 2018);
- DoD General Data Validation Guidelines (DoD, 2018); and
- Environmental Quality Guidance for Evaluating Performance-Based Chemical Data, EM 200-1-10 (USACE, 2005).

Plan for Obtaining Data

The project schedule and task summaries are provided on Worksheet #14/16, and sampling design and rationale are provided on Worksheet #17.

QAPP Worksheet #12: Measurement Performance Criteria

Matrix: Groundwater, Soil
Analytical Group: VOCs
Concentration Level: Low/Medium

Data Quality Indicators	Quality Control (QC) Sample and / or Activity Used to Assess Measurement Performance	Measurement Performance Criteria
Precision-overall	Field duplicate	≤ 20% Relative Percent Difference (RPD)
Precision-overall	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	≤ 20% RPD
Precision-lab	Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD)	± 20% RPD
Accuracy/bias	Surrogate spike recoveries	Quality Systems Manual (QSM) v.5.1 App. C Table 24 (or lab if not in QSM) control limits
Accuracy/bias	MS/MSD recoveries	QSM v.5.1 App. C Table 24 (or lab if not in QSM) control limits
Accuracy/bias	LCS/LCSD recoveries	QSM v.5.1 App. C Table 24 (or lab if not in QSM) control limits
Accuracy/bias-contamination	Method blanks	No analyte detected at ≥1/2 RL or > 10% sample concentration or regulatory limit
Accuracy/bias-contamination	Equipment blanks, ambient blanks, trip blanks	No analyte detected at ≥ RL

Matrix: Investigation Derived Waste (IDW) Water, IDW Soil (total), IDW Soil Toxicity Characteristic Leaching Procedure (TCLP)
Analytical Group: VOCs, metals
Concentration Level: Low/Medium

Data Quality Indicators	QC Sample and / or Activity Used to Assess Measurement Performance*	Measurement Performance Criteria
Precision-lab	LCS/LCSD	≤ 20% RPD
Accuracy/bias	Surrogate spike recoveries	QSM v.5.1 App. C Table 23 (or lab if not in QSM) control limits
Accuracy/bias	LCS/LCSD recoveries	QSM v.5.1 App. C Table 23 (or lab if not in QSM) control limits
Accuracy/bias-contamination	Method blanks	No analyte detected at ≥1/2 RL or > 10% sample concentration or regulatory limit

**Samples of water and soil IDW will be collected at the completion of field work or before if storage capacity is reached; field QC samples are not required by the disposal facility and will not be collected.*

QAPP Worksheet #13: Secondary Data Uses and Limitations

Source	Data Type	Data Uses for Current Project
HDR. *Annual Long-Term Monitoring Report-2018, Defense Depot Memphis Tennessee, TN4210020570, Revision 0*. March 2019	Recent groundwater elevation and analytical data	Background information and selection of well locations.
HDR. *Data Collection at TDEC Wells Memorandum*. November 2017	Recent groundwater elevation and analytical data	Background information and selection of well locations.

Note: The data sources listed are for recent groundwater sampling activities with no significant differences to the activities and analytical methods for the planned data collection. There are no limitations on the use of this data in evaluating site conditions.

QAPP Worksheet #14/16: Project Tasks & Schedule

The tasks and schedule for the offsite groundwater investigation and submittal of deliverables for regulatory agency review are shown below.

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Planned deliverable due date
Draft QAPP	HDR	3/11/19	6/28/19	Offsite Groundwater Investigation QAPP, Revision 0	6/28/19
Regulatory Review	TDEC & USEPA	6/28/19	4/21/20	Comments or Approval	4/21/20
Final QAPP	HDR	4/21/20	5/15/20	Offsite Groundwater Investigation QAPP, Revision 1	5/15/20
Well Installation and Sampling	HDR/ Cascade	6/1/20	6/26/20	Field reports	7/1/20
Well Installation Data Report	HDR	7/20/20	8/14/20	Field reports, boring logs, well diagrams, analytical summary tables	8/14/20
Q1 - Groundwater Sampling Event	HDR	10/7/20	10/17/20	None	None
Q2 - Groundwater Sampling Event	HDR	1/6/21	1/16/21	None	None
Q3 - Groundwater Sampling Event	HDR	4/7/21	4/17/21	None	None
Q4 - Groundwater Sampling Event	HDR	7/7/21	7/17/21	None	None
Offsite Groundwater Investigation Report	HDR	8/16/21	11/19/21	Offsite Groundwater Investigation Report, Revision 0	11/19/21
Regulatory Review	TDEC & USEPA	11/20/21	2/18/22	Comments or Approval	2/18/22
Offsite Groundwater Investigation Report	HDR	2/21/22	4/22/22	Offsite Groundwater Investigation Report, Revision 1	4/22/22

The offsite groundwater investigation, analytical and data review tasks are summarized below. Additional details are provided in the SOPs.

Well Access

Access for well locations will be obtained through access agreements with the property owners; HDR will contact property owners to facilitate completion of access agreements in support of USACE real estate staff with oversight by the Army BEC.

Well Installation

Permits for well installation from Shelby County Health Department (SCHD) and utility clearances will be obtained by the drilling contractor.

Borings will be advanced by rotasonic drilling at least 10 ft into the saturated zone of the Fluvial Aquifer and the wells installed using 2-inch inside diameter (I.D.) Schedule 40 polyvinyl chloride (PVC) casing and screen. If a competent clay layer is encountered, the boring will be backfilled with bentonite to the top of the clay and hydrated for at least one hour before well construction.

During well construction, the grout will be allowed to cure for at least 24 hours before the surface pad and manhole or protective casing are installed. Wells will be developed no sooner than 48 hours after grouting and 24 hours after installation of the well pad. Depending on the project schedule, wells may be developed prior to the well pad being installed.

Soil cuttings from well borings will be staged on Dunn Field for testing prior to disposal; the cuttings will be contained in a roll-off or on and covered by plastic sheeting. Cuttings with suspected contamination due to elevated photoionization detector (PID) readings or visible staining will be placed in a covered drum after logging and screening the soil core. Wastewater generated during drilling, well installation and development will be contained for sampling and analysis to determine disposal requirements.

Horizontal and vertical coordinates for each new well will be determined by Tennessee-registered land surveyor after installation.

Project-specific requirements for well installation are provided in the attachment at the end of this worksheet.

Sampling

Water levels will be measured at the new wells and TDEC wells during a one-day sweep. Measurements will be made at least 24 hours after well development or sampling.

Wells will be sampled no sooner than 24 hours after development. Initial groundwater samples will be collected using bladder pumps for low-flow sampling; if the saturated thickness or recharge is insufficient for a bladder pump, samples will be collected using disposable Teflon® bailers. Water quality parameters will be measured to confirm well stabilization prior to sampling. After the initial sampling, PDBs will be deployed in the newly constructed wells and the TDEC wells where saturated thickness is sufficient.

Samples will be collected from IDW (soil cuttings by HDR and wastewater by the drilling contractor) to determine disposal requirements. Soil cuttings with suspected contamination (e.g., stained soil or hydrocarbon or solvent odor) will be stored separately from other soil cuttings.

Analysis

Analyze groundwater samples for VOCs. Analyze soil samples for VOCs by standard analysis. Analyze soil IDW samples for VOCs by standard analysis and TCLP.

Analyze wastewater samples from soil boring, equipment decontamination, well installation and development per analytical requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-approved disposal facility; the number of samples will be specified by the disposal facility.

Analyze wastewater samples from purging prior to sampling for VOCs, total copper, and total zinc in accordance with the existing DDMT agreement with TDEC for discharge to stormwater.

Quality Control

Follow SOP 1-General Procedures for Field Personnel; SOP 2-Drilling and Soil Sampling; SOP 3-Well Installation, Development and Abandonment; SOP 4-Groundwater Sample Collection; SOP 7-Sample Control and Documentation; SOP 8-Sample Packing and Shipping; SOP 9-Equipment Decontamination. These SOPs are provided in Appendix B. Field QC samples are described on Worksheet #20-Field QC Summary and laboratory QC on Worksheet #28-Analytical Quality Control and Corrective Action.

Data Management

Laboratories will provide complete analytical data packages including raw data (Stage 4) for groundwater samples in accordance with Appendix E, SW-846 Reporting Requirements, of the *DoD Quality Systems Manual Version 5.1* (January 2017).

Analytical data will be added to the DDMT database after validation.

Documentation and Records

Each well location will have final coordinates documented with surveyor stamped plats. Field measurements and sample data will be noted in field records and maintained in project files.

Groundwater sample analytical results will be provided in summary tables for analytes detected and in tables showing complete analytical results in an appendix. The complete laboratory analytical reports and data validation will also be provided in appendices to the comprehensive Offsite Groundwater Investigation Report.

Assessment/Audit Tasks

Field sampling procedures are reviewed in biennial audits by QA officer.

Annual laboratory audits are performed through DoD ELAP.

Data Review Tasks

Laboratories will verify that data are complete for samples received and data package deliverables requirements met. Data will be reviewed by HDR at the Step I (Verification)/Steps IIa and IIb (Validation) levels as described in the *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (Intergovernmental Data Quality Task Force, 2005) and Stages 1VM, 2AVM and 2BVM on 100% of the data and Stage 3VM on 10% of the data as described in the *General Data Validation Guidelines* (DoD Environmental Data Quality Workgroup, February 09, 2018). Qualification recommendations from the DoD Guidelines will be followed. Achievement of project-specific measurement performance criteria specified in the QAPP and data validation criteria will be evaluated during the data verification and validation, and the analytical measurement error will be assessed. A Data Validation Report will be produced for each Sample Delivery Group.

Validated data and related field logs/notes/records will be reviewed to assess total measurement error and determine overall usability of the data for project purposes. Data limitations will be determined and data will be compared to Project Quality Objectives (PQOs) and required Action Limits. Corrective action will be initiated, as necessary. Final data are placed in a database, with any necessary qualifiers, and tables, charts, and graphs are generated.

Attachment - Well Installation Summary

Borings will be advanced using rotasonic drilling methods and continuous soil cores will be collected from ground surface to the termination depth of each boring. Drilling and well installation will be performed by Cascade Drilling, a licensed Tennessee well driller. An HDR field geologist will record field observations and log the soil core. Headspace analysis with a PID will be made on grab samples selected from each soil core; PID readings will be recorded on the boring log. A 6-inch borehole will be advanced to the target depth; borings terminated in a clay layer beneath the water table will be back-filled with bentonite pellets to just below the top of clay.

Well casings will be new, unused, 10-ft sections of 2-inch I.D. Schedule 40 PVC pipe with internal flush, threaded joints. Well screens will be one 10-ft section of Schedule 40 PVC continuous slotted 0.010-inch screen. A threaded PVC cap or point will be placed at the bottom of the screen. Centralizers will be used at the top of the screened section, and every 30 ft along the riser.

A filter pack of clean, inert, hard, well-rounded coarse sand will be installed from approximately 1 ft below to 5 ft above the well screen. A minimum 5-ft-thick bentonite seal will be placed above the filter pack and hydrated with potable water for at least one hour. Cement-bentonite grout will be placed in the annular space above the bentonite seal to approximately 6 inches bgs.

Wells will be set as flush-mounted completions. Each well pad will be 3 by 3 ft square and 4 inches thick constructed using Quikcrete® crack resistant (No. 1006) or equivalent concrete mix. The manhole will be a Morrison Bros. Co. 519 9-inch diameter powder-coated single-bolt water tight manhole (or equivalent) placed in the center of the pad and approximately 1-inch higher than the edge of the pad. The manhole will have an identification brass label stamped to clearly show the well identification. Wells will be secured as soon as possible after drilling with corrosion resistant locks.

The wells will be developed by surging and pumping. Well development will be initiated no sooner than 48 hours following grout installation. Development will continue until clear, sand-free formation water is produced from the well and water quality parameters have stabilized. Stabilization of water quality parameters is achieved after three successive readings are within ± 0.1 for pH, ± 3% for specific conductance, ± 10% for 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 stabilization parameters are not met after four hours of development the PM will be contacted and a determination will be made whether or not to continue development.

Investigation Derived Waste

IDW consisting of soil cuttings from the borings, wastewater from equipment decontamination and groundwater from well development will be stored and analyzed prior to disposal.

Soil cuttings from the well borings will be transported to Dunn Field and placed on plastic sheeting; the cuttings will be covered by plastic sheeting held in place by perimeter weights. Upon drilling completion, one soil sample will be collected from approximately each 5 cubic yards of soil cuttings. 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 TCLP extraction. 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 CERCLA-approved facility.

Water IDW from soil borings, well installation and development will be stored in an aboveground storage tank placed on the MI or Dunn Field by the driller; the location will be determined during mobilization. The tank will be properly labeled with the water source (equipment decontamination and well development) and the start/end dates. After well installation, development and sampling are completed, grab samples of wastewater will be collected by the drilling contractor for complete TCLP analysis and disposal as non-hazardous waste at a CERCLA-approved facility.

Water IDW from purging wells prior to sampling will be stored in the existing AS/SVE condensate tank on Dunn Field. Water will be sampled by HDR and submitted for analysis of VOCs and metals (copper and zinc) in accordance with TDEC requirements.

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

Matrix: Groundwater, IDW Water
Analytical Method: VOCs – Microbac
Concentration Level: Low/Medium

Analyte	Project Action Limit (MCL)	Project Quantitation Limit Goal	Achievable Laboratory Limits[1]		
			DLs	LODs	LOQs
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
1,1,2,2-Tetrachloroethane	2.2	0.8	0.2	0.4	0.8
1,1,2-Trichloroethane	5	1	0.25	0.5	1
1,1-Dichloroethene	7	2	0.5	1	2
1,2-Dichloroethane	5	1	0.125	0.25	1
Carbon tetrachloride	5	1	0.25	0.5	1
Chloroform	80	1	0.125	0.25	1
Tetrachloroethene	5	1	0.25	0.5	1
Trichloroethene	5	1	0.25	0.5	1
Vinyl chloride	2	1	0.25	0.5	1
cis-1,2-Dichloroethene	70	1	0.25	0.5	1
trans-1,2-Dichloroethene	100	1	0.25	0.5	1

[1] *Achievable Detection Limits (DLs), Limits of Detection (LODs) and Limits of Quantitation (LOQs) are limits that an individual laboratory can achieve when performing a specific analytical method.*

Project Action Limits (PALs) for groundwater are the current (November 2018) USEPA MCLs. 1,1,2,2-Tetrachloroethane does not have an MCL; the Target Concentration from the Dunn Field Record of Decision (2.2 µg/L) will be used as the Project Action Limit. All LOQs are below the PALs.

Groundwater analysis for VOCs is the major focus of this project, and all LOQs for VOCs in groundwater are below the PALs. For VOCs in soil, several LOQs are above the PALs but all DLs are below the PALs.

Option 3 listed in the UFP-QAPP manual ("Accept a higher level of uncertainty for data falling between the MDL and QL") is appropriate for this project, as soil contamination is not the primary focus.

Matrix: Soil, Soil IDW
Analytical Method: VOCs – CT Labs
Concentration Level: Low/Medium

Analyte	Project Action Limit[2] LSV	Project Action Limit[2] FDSV	Project Quantitation Limit Goal	Achievable Laboratory Limits[1]		
				DLs	LODs	LOQs
	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
1,1,2,2-Tetrachloroethane	11.2	6.6	50	6	20	50
1,1,2-Trichloroethane	62.7	35.5	50	8	20	50
1,1-Dichloroethene	150	76.4	50	16	20	50
1,2-Dichloroethane	32.9	18.9	50	12	20	50
Carbon tetrachloride	215	108.6	50	11	20	50
Chloroform	917	486	50	9	20	50
Tetrachloroethene	180.6	92.0	50	8	20	50
Trichloroethene	182	93.2	50	10	20	50
Vinyl chloride	29.4	15.0	50	14	20	50
cis-1,2-Dichloroethene	755	404	50	10	20	50
trans-1,2-Dichloroethene	1,520	719	50	11	20	50

[1] *Achievable DLs, LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.*

[2] *Project Action Limits (PALs) for soil are the Dunn Field remedial goals – LSV = Loess-Specific Values and FDSV = Fluvial Deposit Specific Values from the Dunn Field Record of Decision Table 2-21G. Several LOQs are above the PALs but all DLs are below the PALs. Option 3 listed in the UFP-QAPP manual (“Accept a higher level of uncertainty for data falling between the MDL and QL”) is appropriate for this project, as soil contamination is not the primary focus.*

Matrix: Soil IDW
Analytical Method: VOCs, TCLP – CT Labs
Concentration Level: Low

Analyte	Project Action Limit	Project Quantitation Limit Goal	Achievable Laboratory Limits[1]		
			DLs	LODs	LOQs
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Benzene	0.5	0.001	0.00019	0.0005	0.001
Carbon tetrachloride	0.5	0.001	0.00023	0.0005	0.001
Chlorobenzene	100.0	0.001	0.00024	0.0005	0.001
Chloroform	6.0	0.0005	0.00015	0.00025	0.0005
1,4-Dichlorobenzene	7.5	0.001	0.00023	0.0005	0.001
1,2-Dichloroethane	0.3	0.001	0.0003	0.0005	0.001
1,1-Dichloroethene	0.7	0.001	0.00024	0.0005	0.001
Methyl ethyl ketone (MEK) (2-Butanone)	200.0	0.01	0.0024	0.005	0.01
Tetrachloroethene	0.7	0.001	0.0003	0.0005	0.001
Trichloroethene	0.5	0.001	0.00021	0.0005	0.001
Vinyl chloride	0.2	0.001	0.00018	0.0005	0.001

Project Action Limits (PALs) for TCLP VOCs – Resource Conservation and Recovery Act TCLP regulatory limits (hazard characteristic)

[1] Achievable DLs, LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. All LOQs are below the PALs.

Matrix: Water IDW
Analytical Method: Metals – Microbac Laboratories
Concentration Level: Low

Analyte	Project Action Limit	Project Quantitation Limit Goal	Achievable Laboratory Limits[1]		
			DLs	LODs	LOQs
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Total Copper	0.032	0.02	0.005	0.01	0.02
Total Zinc	0.521	0.04	0.01	0.02	0.04

Project Action Limits (PALs) for metals – criteria provided by Tennessee Department of Environment and Conservation (TDEC). All LOQs are below the PALs.

[1] Achievable DLs, LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

QAPP Worksheet #17: Sampling Design and Rationale

The sampling activities will be conducted in accordance with the field SOPs listed on Worksheet #21 and provided in Appendix B. The number of samples and the analytical parameters are summarized on Worksheet #18. Samples to be collected consist of groundwater samples and soil samples from well borings. Soil and/or water samples will be collected from IDW as appropriate to profile waste for disposal.

Physical Boundaries for the Area

The areas considered for sample locations are the northern portion of Dunn Field and the offsite area to the north and east; the extent is approximated by the existing and abandoned LTM wells and the TDEC wells shown on Figure 1.

Basis for the Placement and Number of Sample Locations

Well locations were selected in accordance with the data quality objectives listed in Worksheet #11 based on review of analytical results and groundwater elevation contours from October 2017. Isopleths for primary contaminants (PCE, TCE and DCE), groundwater elevation contours and proposed well locations are shown on Figure 4, 5 and 6.

The extent of contamination north of MW-08 and south of MW-230 has not been fully delineated. However, results from other wells provide data on the extent of the plume in this area: existing wells MW-28, MW-68 and MW-78; and abandoned wells MW-09, MW-51 and MW-61. Additional wells to the north/northeast of CS-03 are not proposed because the purpose of this investigation does not require complete delineation of the plume. Army's goal is to provide sufficient evidence of an off-site source for the Dunn Field North plume.

The rationale and general location for each well is listed in Table 4 below. The location coordinates and estimated depths to groundwater and top of screen for the proposed wells are shown on Table 5. Construction data for existing and abandoned wells in the North plume are shown on Table 1.

Table 4. Offsite Investigation Well Locations

Rationale	Boring ID and Location
Lateral delineation of PCE, TCE and DCE detected above the MCL in MW-130.	F-1: South of MW-130.
Evaluate CVOC concentrations in upgradient area of Dunn Field.	F-2: Northern edge of Dunn Field. Downgradient from MW-129 and upgradient from abandoned well MW-29.
Evaluate CVOC concentrations downgradient from the Cintas site.	F-3: Downgradient from the Cintas Site and CS-02 and adjacent to abandoned well MW-51.
Evaluate Cintas Site as source of CVOCs.	F-4: Adjacent to southwest side of Cintas Site building, area of drum storage noted in TDEC PA/SI. F-5: Upgradient (northeast) of CS-02 and adjacent to southeast corner of Cintas Site building.
Evaluate upgradient extent of DCE	F-6: Between CS-01 and CS-02, and adjacent to abandoned wells MW-128 and PZ-02.
Evaluate upgradient extent of PCE and TCE	F-7: Upgradient (northeast) of MW-129 and MW-130.

Rationale	Boring ID and Location
Evaluate upgradient extent of CVOCs	F-8: Upgradient (northeast) of CS-05.
Extent of plume and groundwater flow direction downgradient from Wabash Avenue Site	F-9: Upgradient (northeast) of F-8 and west of Wabash Avenue Site
Determine whether Wabash Avenue Site may be a source of CVOCs	F-10: Downgradient (southeast) side of Wabash Avenue Site.

A PID will be used to screen soil cores for the presence of VOCs as the borings are advanced. Soil samples will be collected where elevated PID readings and/or field observations indicate potential contamination. Up to 5 soil samples from the borings will be submitted to the laboratory for analysis by Method SW8260B.

Soil IDW samples will be collected upon completion of drilling. One soil sample will be collected for approximately each 5 cubic yards of soil cuttings. At each sample location, approximately 6 inches of surface soil will be removed prior to sampling.

Purge water IDW samples will be collected after well installation, development, and sampling are completed. Grab samples of wastewater IDW will be collected and analyzed by the drilling contractor per requirements of the disposal facility.

Sample Identification

Individual samples will be identified by a unique alphanumeric code (also referred to as a sample ID number) which will be written on the sample label and recorded on the chain-of-custody (CoC) form. The sample ID will include the type [DDMT well (MW), soil boring (SB) or TDEC well (CS or WB)], location (xxx) and sampling event; the event designation will be OSI for samples collected during well installation and initial groundwater sampling, and OSIQx for the four quarterly sample events. Soil samples collected at different depths include the depth.

IDW samples will include the medium (S for soil and W for water), the sample sequence and sample event (IDW-Sxx-OSI).

Prefixes will replace the location for trip blanks (TB-xx-OSI) and rinse blanks (RB-xx-OSI-Q1) and suffixes will identify the locations of MSs or duplicates (MW-xxx-OSIQ1-MS). Additional information is provided in SOP-7, *Sample Control and Documentation*.

QAPP Worksheet #18: Sampling Locations and Methods/SOP Requirements

Sampling Location	Number of Locations	Matrix	Depth (ft)	Analytical Group	Concentration Level	Number of Samples (identify field duplicates)	Sampling SOP Reference[1]	Rationale for Sampling Location
Off Site Wells	5	SO	0-65	VOCs	Low	5 field, 1 duplicate	SOP 2	Evaluate potential contaminant source areas
Off Site Wells	10	GW	20-65	VOCs	Low	50 field, 5 duplicate	SOP 4	Determination of hydraulic gradient and contaminant extent
TDEC Wells	10	GW	20-85	VOCs	Low	40 field, 4 duplicate	SOP 4	Determination of hydraulic gradient and contaminant extent
Soil cuttings IDW	1 per 5 cubic yard soil cuttings	SO	NA	VOCs, TCLP VOCs	Low	1 per 5 cubic yard soil cuttings	SOP 2	Determination of waste classification for disposal
Water IDW	1 per full storage tank	Water	NA	Per disposal facility requirements	Low	1 per full storage tank	SOP 4	Determination of waste classification for disposal

[1] *Specify the appropriate letter or number from the Project Sampling SOP References (Worksheet #21).*

GW: Groundwater

SO: Soil

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times

Analytical Laboratory (Name, sample receipt address, point of contact, e-mail, and phone numbers)
Required Accreditations/Certifications: DoD ELAP
Groundwater: Microbac Laboratories, Inc., 158 Starlite Drive, Marietta, Ohio 45750, Stephanie Mossburg, 800-373-4071, stephanie.mossburg@microbac.com
Soil/Soil IDW: CT Laboratories, 1230 Lange Court, Baraboo, Wisconsin 53913, Eric Korthals, ekorthals@ctlaboratories.com
Sample Delivery Method: FedEx next day air

Analyte Group	Matrix	Method/ SOP Reference	Accreditation Expiration Date	Containers (number, size & type per sample)	Preservation Requirements	Maximum Holding Time (preparation/ analysis)	Data Package Turnaround
VOCs	Groundwater, IDW Water	USEPA SW846 5030B/8260 (Microbac MSV01)	Microbac: 12/31/2020	3 40-milliliter (mL) VOC vials w/ Teflon®-lined septa; no headspace	Chill ≤ 6 degrees Celsius (°C), hydrochloric acid (HCl) to pH<2	14 Days (preserved) 7days (unpreserved)	3 weeks for Stage 3 (1 week for IDW); 4 weeks for Stage 4 (3 weeks for IDW)
VOCs	Soil, IDW Soil (total)	USEPA SW846 5030B/8260 (CT Labs VO004)	CT Labs: 04/30/2020	Terracore kit (2 vials with water/sodium bisulfite, one vial with methanol)	Chill ≤ 6°C	14 Days	1 week for Stage 3; 3 weeks for Stage 4
VOCs	IDW Soil (TCLP)	USEPA SW846 1311/8260 (CT Labs PR002 [prep]/VO004 [analysis])	CT Labs: 04/30/2020	8 ounce glass jar Teflon®-lined septum	Chill ≤ 6°C	14 Days	1 week for Stage 3; 3 weeks for Stage 4
Metals	IDW Water	USEPA SW846 6010C (Microbac ME600G)	Microbac: 12/31/2020	500 mL plastic	Chill ≤ 6°C, nitric acid (HNO_3) to pH<2	180 Days	1 week for Stage 3; 3 weeks for Stage 4

QAPP Worksheet #20: Field QC Summary

Matrix[1]	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks[1]	Trip Blanks	Other	Total # analyses
Groundwater - Initial	VOCs	10	1	1	1	0	3	2	0	18
Groundwater - Quarterly	VOCs	80	8	4	4	0	0	12	0	108
Soil	VOCs	5	1	1	1	0	5	5	0	18
Soil IDW[2]	VOCs. TCLP VOCs	2	0	0	0	0	0	0	0	2
Water IDW[2,3]	VOCs, Metals (Cu, Zn), TBD	6	0	0	0	0	0	0	0	6

Note:

1) *Initial samples will be collected using low-flow method over 5 to 6 days. Following the initial samples, passive diffusion bags will be installed, where appropriate, for sampling during quarterly events; therefore, equipment blanks are not necessary for quarterly events.*

2) *Samples of IDW soil and water will be collected at completion of field work or before if storage capacity is reached; field QC samples are not required by the disposal facility and will not be collected.*

3) *Water IDW generated during drilling and well development will be stored in a tank provided by the drilling contractor and samples will be collected by the contractor for analyses to be determined (TBD) by the CERCLA-approved disposal facility. Water IDW generated during sampling will be stored in the condensate tank on Dunn Field and samples will be collected by HDR for analysis of VOCs, copper (Cu) and zinc (Zn) per discharge requirements established by TDEC.*

QAPP Worksheet #21: Field SOPs

Method/ SOP Reference	Title, Revision Number and Date	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)
SOP 1	General Procedures for Field Personnel, Rev. 2, August 2017	HDR	Log books, first aid kit, personal protective equipment	N
SOP 2	Drilling and Soil Sampling, Rev. 4, March 2019	HDR	Drilling equipment, sample jars, disposable scoops	N
SOP 3	Well Installation, Development and Abandonment, Rev. 3, February 2019	HDR	Well construction materials, cement/bentonite grout, concrete	N
SOP 4	Groundwater Sample Collection, Rev. 3, March 2019	HDR	YSI6920 or similar multi-probe device with flow-through cell, non-dedicated bladder pumps, disposable Teflon bailers, passive diffusion bags	Y
SOP 7	Sample Control and Documentation, Rev. 4, March 2019	HDR	Sampling log book, DQCR forms, digital camera, CoC forms	N
SOP 8	Sample Packing and Shipping, Rev. 3, March 2019	HDR	Sample bottles, bubble wrap, ice, zip lock bags, coolers, tape, custody seals	N
SOP 9	Sampling Equipment Decontamination, Rev. 3, March 2019	HDR	ASTM Type II water (supplied by lab) or distilled water, pesticide-grade methanol, Alconox detergent, brushes	N
LOGIN01	Standard Operating Procedure Sample Receiving and Login, Revision 20, November 2018	Microbac	Thermometers, hood, pH strips, IR temperature guns, Geiger counter, disposable gloves	N
PM003	Chemistry & Microbiology Sample Receiving and Processing, Revision 5.1, 05/22/2018	CT Labs	Thermometers, hood, pH strips, IR temperature guns, Geiger counter, disposable gloves	N

Note: The drilling subcontractor, Cascade Drilling, will collect and submit the IDW water samples per their SOP and the disposal facility requirements.

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
YSI 650MDS	Water quality measurement (pH, ORP, dissolved oxygen [DO], conductivity, temperature)	HDR SOP 4	FTL	Daily during use and when readings are inconsistent	Meet manufacturer's specifications	Replace components and re-try. Send to manufacturer for repair
GeoTech turbidity meter	Water quality measurement (turbidity)	HDR SOP 4	FTL	Daily during use and when readings are inconsistent	Meet manufacturer's specifications	Replace components and re-try. Send to manufacturer for repair
RAE PGM-7600 PID	VOC screening	HDR SOP 3	FTL	Daily during use and when readings are inconsistent	Meet manufacturer's specifications	Re-try. Send to manufacturer for repair
Heron Dipper-T	Water level measurement	HDR SOP 4	FTL	Daily during use	Meet manufacturer's specifications	Re-try. Send to manufacturer for repair
Solinst 101	Water level measurement	HDR SOP 4	FTL	Daily during use	Meet manufacturer's specifications	Re-try. Send to manufacturer for repair
Geotech PRO Pump box and Geocontrol 2	Groundwater purge and sample	HDR SOP 4	FTL	Daily during use	Meet manufacturer's specifications and project requirements	Send to manufacturer for repair

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)
HDR SOP 4	Groundwater Sample Collection, Revision 3, March 2019	Screening	Field water quality (pH, conductivity, DO, ORP, temperature, turbidity)	Field multimeter (YSI, Horiba, Lamotte)	Y
Microbac MSV01	Analysis of Volatile Organic Analytes by Method 8260, Revision 26, January 2019	Definitive	VOCs in Water	- Gas chromatography/mass spectrometry (GC/MS): Hewlett-Packard (HP), Agilent 6890 Gas Chromatograph equipped with HP, Agilent 5973 Mass Spectrometer, Agilent 7890 GC equipped with Agilent 5977 MSD -Chemstation: HP, Agilent Eviroquant; Agilent Mass Hunter -Purge-and-trap: Tekmar liquid sample concentrator (LSC), 3000, Stratum; Varian, Archon auto-sampler; Tekmar Atomx liquid sample concentrator/ autosampler	N
Microbac MISDATA01	Data Entry, Data Review, and Reporting, Revision 12, July 2018	Reporting	All	Data system	N
CT Labs VO004	Analysis of Volatile Organic Compounds by GC/MS (8260C), Revision 03, January 2019	Definitive	VOCs in Water and Soil	-Hewlett Packard 5890 and 6890 gas chromatographs -Hewlett Packard 5972 and 5973 mass spectrometers -Hewlett Packard Chemstation data management system	N
CT Labs PR002	TCLP and Synthetic Precipitation Leaching Procedure (SPLP) Extraction, Volatile Fraction (ZHE), Revision 3.1, March 2018	Sample Prep	VOCs in Soil TCLP extraction	-Rotator apparatus capable of turning at 30 +/- 2 rpm (Lars Land or equivalent) -ZHE extraction devices (Lars Land or equivalent) -Pressure filtration apparatus (Millipore or equivalent)	N
CT Labs QA020	Data Reporting, Revision 2.1, August 2017	Reporting	All	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)
Microbac ME600G	Thermo ICAP6000/7000 Series Inductively Coupled Plasma Atomic Emission Spectroscopy, SW-846 Method 6010/EPA 200.7 Revision 9, September 2017	Definitive	Metals in Water	-Thermo ICAP 6000 or 7000 with ESI SC-8 DXFAST Autosampler -Dell intel Core 2 VPRO or DUO computer with Thermo Fisher Scientific iTEVA Analyst software	N
HDR SOP 10	Data Verification, Validation, Qualification, and Usability Assessment Revision 4, January 2020	Reporting	All	--	N

QAPP Worksheet #24: Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
GC/MS for VOCs in Water, Soil SW-846 8260	Mass spectral ion intensities with 4-bromofluorobenzene (BFB)	Every 12 hours prior to initial calibration (ICAL), initial calibration verification (ICV) or continuing calibration verification (CCV)	Mass – Ion Abundance Criteria 50 – 15-40% of mass 95 75 – 30-60% of mass 95 95 – base peak, 100% relative abundance 96 – 5-9% of mass 95 173 – <2% of mass 174 174 – >50% of mass 95 175 – 5-9% of mass 174 176 - >95% and <101% of mass 174 177 - 5-9% of mass 176 (Established criteria in Table 4 of SW-846 8260B)	Retune instrument and repeat BFB check. Flagging criteria are not appropriate.	Analyst	VO004 MSV01
	Initial multipoint calibration for all analytes (ICAL) (minimum five standards)	When second source calibration or continuing calibration is out of control or when system conditions have been altered.	1. Average response factor (RF) for System Performance Check Compounds (SPCCs): ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. Relative Standard Deviation (RSD) for RFs for Calibration Check Compounds: ≤ 30% and one option below: Option 1: RSD for each analyte ≤ 15%; Option 2: linear least squares regression r ≥ 0.995; Option 3: non-linear regression–coefficient of determination r2 ≥ 0.99 (6 points shall be used for second order, 7 points shall be used for third order).	Evaluate cause; repeat calibration; or qualify data and discuss in narrative. Flagging criteria are not appropriate.	Analyst	VO004 MSV01

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
GC/MS for VOCs in Water, Soil SW-846 8260 (continued)	CCV	Once per each 12 hours, prior to sample analysis (criteria for these checks must be met prior to sample analysis)	1. Average Relative RF for SPCCs : ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. %Difference/Drift for all target compounds and surrogates: VOCs and semi-volatile organic compounds (SVOCs) ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	1) Evaluate system and take CA. 2) Rerun calibration check. 3) If still out, prepare new calibration curve for any analyte not meeting criteria. 4) Reinject any samples analyzed after criteria were exceeded. 5) Qualify the data. Criteria for these checks must be met prior to sample analysis. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.	Analyst	VO004 MSV01
	Retention time (RT) window position establishment for each analyte and surrogate	Once per ICAL	Position shall be set using the midpoint standard of the ICAL curve.	NA	Analyst	VO004 MSV01
ICP for Metals in Water SW-846 6010	ICAL for all analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r2 ≥ 0.99. Minimum one high standard and a calibration blank.	Correct problem, then repeat ICAL. No samples shall be analyzed until ICAL has passed.	Analyst	ME600G

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
ICP for Metals in Water SW-846 6010 (continued)	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL. No samples shall be analyzed until calibration has been verified with a second source.	Analyst	ME600G
	Low-level Calibration Check Standard (LLICV)	Daily.	All reported analytes within ± 20% of true value. Low level calibration check standard should be less than or equal to the LOQ.	Correct problem and repeat ICAL. No samples shall be analyzed without a valid LLICV.	Analyst	ME600G
	CCV	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; -or- Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take CA(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV. Results may not be reported without a valid CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst	ME600G

[1] Specify the appropriate reference letter or number from the Analytical SOP References (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[1]
GC/MS for VOCs in Water, Soil	Clean mass spectrometer, change/check helium, change trap, clip column, change purge and trap ferrules, bake out column	GC/MS	Purge lines, purge flow, trap, ion source, column	Prior to calibration check and/or as necessary	Acceptable ICAL or CCV	Correct problem and repeat ICAL or CCV	Analyst / Supervisor	MSV01 VO004
ICP for metals in water	Clean torch and nebulizer when needed.	ICP	Check torch and nebulizer every day.	Daily	Acceptable instrument performance	Fix issues as necessary.	Analyst	ME600G
	Change tubing.		Inspect tubing	When it loses pliability and is worn.	Acceptable performance	Fix issues as necessary.	Analyst	
	Drain compressor daily.		Drain compressor daily.	Daily	Acceptable performance	Fix issues as necessary.	Analyst	
	The instruments are under service contracts so that every year a service representative will perform a systems check.		The instruments are under service contracts so that every year a service representative will perform a systems check.	Yearly	Acceptable performance	Fix issues as necessary.	Service representative	
	The water in the recirculator/cooler must be changed yearly.		The water in the recirculator/cooler must be changed yearly.	Yearly	Acceptable performance	Fix issues as necessary.	Analyst	

[1] *Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).*

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal

Sampling Organization: HDR
Laboratory: CT Labs / Microbac
Method of sample delivery (shipper/carrier): FedEx
Number of days from reporting until sample disposal: 60

Activity	Organization and title or position of person responsible for the activity	SOP Reference
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT		
Sample Collection	HDR Field Team	HDR SOP 2, HDR SOP 4
Sample Packaging	HDR Field Team	HDR SOP 8
Coordination of Shipment	HDR Field Team and Project Chemist, Laboratory (CT Labs, Microbac) PM	HDR SOP 8
Type of Shipment/Carrier: Cardboard carton (air sample in Summa^{TM} canister), shipped via FedEx Ground.	HDR Field Team	HDR SOP 8
Type of Shipment/Carrier: Cooler with ice (soil samples in Terracore kit of three 40-mL vials), shipped via FedEx next morning delivery.	HDR Field Team	HDR SOP 8
SAMPLE RECEIPT AND ANALYSIS		
Sample Receipt	Laboratory (CT Labs, Microbac) sample custodian	CT Labs SOP PM003 Microbac SOP LOGIN01
Sample Custody and Storage	Laboratory (CT Labs, Microbac) sample custodian	CT Labs SOP PM003 Microbac SOP LOGIN01
Sample Preparation	Laboratory (CT Labs, Microbac) sample preparation chemist or analyst	CT Labs SOP PR002, VO004 Microbac SOPs MSV01
Sample Determinative Analysis	Laboratory (CT Labs, Microbac) sample analyst	CT Labs SOP VO004 Microbac SOPs MSV01

Activity	Organization and title or position of person responsible for the activity	SOP Reference
Sample Reporting	Laboratory (CT Labs, Microbac) sample analyst	CT Labs SOP PM003 Microbac SOP MISDATA1
SAMPLE ARCHIVING		
Field Sample Storage (No. of days from sample collection): 60 days from data package report	Laboratory (CT Labs, Microbac) sample custodian.	CT Labs SOP PM003 Microbac SOP LOGIN01
Sample Extract/ Digestate Storage (No. of days from extraction/digestion): 60 days from data package report	Laboratory (CT Labs, Microbac) sample custodian	CT Labs SOP PM003 Microbac SOP LOGIN01
SAMPLE DISPOSAL		
Number of Days from Analysis: 60 days from data package report	Laboratory (CT Labs, Microbac) sample custodian	CT Labs SOP PM003 Microbac SOP LOGIN01

QAPP Worksheet #28: Analytical Quality Control and Corrective Action

Matrix: Groundwater, Soil, TCLP
Analytical Group: VOCs by GC/MS
Analytical Method/SOP: SW-846 8260 / Microbac MSV01 & CT Labs VO004

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Second-source calibration verification	One each time a five-point calibration is performed	Compounds within ± 20% expected value	Reanalyze ICV. Upon second failure, repeat ICAL.	Analyst	Accuracy/ Bias	Compounds within ± 20% expected value. Flagging criteria are not appropriate.
Evaluation of relative retention time (RRT)	Each sample.	RRT of the analyte within ± 0.06 RRT units of ICAL	Correct problem then reanalyze all samples analyzed since the last RT check. Lab may update RTs based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping). With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ±0.06 RRT units since the last update, this indicates a significant change in system performance and the lab must take appropriate CAs as required by the method and rerun the ICAL to reestablish the RTs.	Analyst	--	RRT of the analyte within ± 0.06 RRT units of ICAL. Flagging criteria are not appropriate.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Internal standard (IS) –RT and area response checked from daily calibration check	Every field sample, standard, and QC sample.	RT ± 30 seconds and extracted ion current profile (EICP) area within -50% to +100% of *the mid-point standard in the ICAL* for each IS compound.	1) Inspect MS and GC for malfunctions. 2) Take appropriate CAs. 3) Reanalyze samples analyzed while system was malfunctioning. 4) If sample exceeds criteria, reanalyze sample. If still out, report both analyses and document CA.	Analyst	Accuracy	RT ± 30 seconds and EICP area within -50% to +100% of the mid-point standard in the ICAL for each IS compound. Apply Q-flag to analytes associated with the non-compliant IS.
Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a second source QC check sample	Once per analyst	Analyte-specific limits as per laboratory historical limits.	1) Recalculate results. 2) Locate and fix the source of the problem. 3) Rerun demonstration for those analytes that did not meet criteria.	Analyst	Precision, Accuracy	Analyte-specific limits as per laboratory historical limits.
Method Detection Limit (MDL) Study	Once per year, upon any major system change, or quarterly MDL check.	MDLs established as described in 40 Code of Federal Regulations (CFR) Part 136, App. B shall not exceed one-half the RL.	MDLs that exceed established criteria shall be submitted to the USACE for approval prior to the analysis of any project samples.	Analyst	Sensitivity	MDLs established as described in 40 CFR Part 136, App. B shall not exceed one-half the RL.
Field duplicate	Sampling: 1 for every 10 field samples Lab: NA	RPD ≤ 20%	1) Review lab QC data to determine if they are in control. 2) Qualify data. Use data to evaluate whether proper collection procedures were followed. 3) Determine further CA.	Analyst	Precision-overall	RPD ≤ 20%

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
MS/MSD	Sampling: 1 pair per every 20 samples Lab: same	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-4. RPD ≤ 20 %	Qualify data.	Analyst	Precision-overall and accuracy/ bias	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-4. RPD ≤ 20 % For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.
LCS	One per preparatory batch	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-4. Up to 3 marginal exceedances if full list of 66 analytes is run.	1) The analytical batch must be reprocessed. 2) Reprep and analyze LCS and affected samples. 3) Qualify the data if CA was unsuccessful or was not performed	Analyst	Precision-lab	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-4. Up to 3 marginal exceedances if full list of 66 analytes is run. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.
Surrogate spike recoveries	Every sample, spike, standard, and reagent blank	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-3.	1) Recalculate result, and reanalyze sample if still out. 2) Re-extract and reanalyze sample, if still out. 3) Report both analyses and document in report that steps 1 and 2 were performed. 4) Qualify the data.	Analyst	Accuracy/ bias	In-house control limits (or, if not established, control limits in DoD QSM 5.1 Table G-3. Apply Q-flag to all associated analytes if acceptance criteria are not met.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method blanks	One per preparatory batch	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	1) Take and document appropriate CA 2) Reanalyze all samples processed with a contaminated blank. 3) Qualify the data if the CA was not successful or was not performed.	Analyst	Accuracy/ bias-contamination	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.
Trip blank	Sampling: 1 for each batch of samples shipped to laboratory Lab: NA	No analytes detected at > RL	1) Review lab QC data to determine if there is a laboratory problem. 2) If same compounds are found in field samples at similar concentrations, qualify the data. OR 3) Resample the batch	Analyst	Accuracy/ bias-contamination	No analytes detected at > RL Apply B-flag to all results for the specific analyte(s) in all samples associated with the trip blank.
Ambient blank	Sampling: Collected when samples are collected downwind of possible volatile sources. Lab: NA	No analytes detected at > RL	1) Review lab QC data to determine if there is a laboratory problem. 2) If same compounds are found in field samples at similar concentrations, qualify the data. OR 3) Resample the batch.	Analyst	Accuracy/ bias-contamination	No analytes detected at > RL Apply B-flag to all results for the specific analyte(s) in all samples associated with the ambient blank.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Rinsate blank	Sampling: 1 per day per sampling team per matrix if using non-dedicated equipment Lab: NA	No analytes detected at > RL	Qualify data.	Analyst	Accuracy/ bias-contamination	No analytes detected at > RL Apply B-flag to all results for the specific analyte(s) in all samples associated with the rinsate blank.
Results reported between MDL and RL.	--	--	--	--	--	Apply J-flag to all results between MDL and RL.

Matrix: IDW Water
Analytical Group: Metals by ICP
Analytical Method/SOP: SW-846 6010 / Microbac ME600G

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Second-source calibration verification	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Analyst	Accuracy/ Bias	No samples shall be analyzed until calibration has been verified with a second source. Flagging is not appropriate.
LLICV	Daily	All reported analytes within ± 20% of true value.	Correct problem and repeat ICAL.	Analyst	Accuracy/ Bias/ Sensitivity	No samples shall be analyzed without a valid LLICV. Low level calibration check standard should be less than or equal to the LOQ. Flagging is not appropriate.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Linear Dynamic Range (LDR) or high-level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range.	Within ± 10% of true value.	Dilute samples to within the calibration range, or re-establish/ verify the LDR.	Analyst	Accuracy/ Bias/ Sensitivity	Data cannot be reported above the high calibration range without an established/passing high level check standard. Flagging is not appropriate.
Field duplicate	Sampling: 1 for every 10 field samples Lab: NA	RPD ≤ 20%	1) Review lab QC data to determine if they are in control. 2) Qualify data. Use data to evaluate whether proper collection procedures were followed. 3) Determine further CA.	Analyst	Precision-overall	RPD ≤ 20%
MS	Sampling: One per 20 samples. Lab: One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst	Precision-overall and accuracy/ bias	For the specific analyte(s) in the parent sample, apply J flag if acceptance criteria are not met and explain in the case narrative. If MS results are outside the limits, the data shall be evaluated to the source(s) of difference, i.e., matrix effect or analytical error.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
MSD or Matrix Duplicate (MD)	Sampling: One per 20 samples (if MSD). Lab: One per preparatory batch (MD).	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	Analyst	Precision-overall and accuracy/ bias	For the specific analyte(s) in the parent sample, apply J flag if acceptance criteria are not met and explain in the case narrative. The data shall be evaluated to determine the source of difference.
Dilution Test	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	Analyst	Precision-overall and accuracy/ bias	For the specific analyte(s) in the parent sample, apply J flag if acceptance criteria are not met and explain in the case narrative. Only applicable for samples with concentrations > 50 x LOQ (prior to dilution). Use along with MS/MSD and PDS data to confirm matrix effects.
PDS Addition	Perform if MS/MSD fails. One per preparatory batch (using the same sample as used for the MS/MSD if possible).	Recovery within 80-120%.	No specific CA, unless required by the project.	Analyst	Precision-overall and accuracy/ bias	For the specific analyte(s) in the parent sample, apply J flag if acceptance criteria are not met and explain in the case narrative. Criteria applies for samples with concentrations <50 X LOQ prior to dilution.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
LCS	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst	Precision-lab	Must contain all reported analytes. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.
Method blanks	One per preparatory batch	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	Analyst	Accuracy/ bias-contamination	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

QC SAMPLE	Number/ Frequency	Method / SOP Acceptance Limits	Corrective Action	Title/ Position Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
ICB/CCB	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Analyst	Accuracy/ bias-contamin-ation	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL. Flagging is not appropriate.
Interference Check Solutions (ICS) (also called Spectral Interference Checks)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes <LOD (unless they are a verified trace impurity from one of the spiked analytes) ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	Analyst	Accuracy/ bias-contamin-ation	If CA fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the failed ICS. All analytes must be within the LDR. ICS-AB is not needed if instrument can read negative responses.
Rinsate blank	Sampling: 1 per day per sampling team per matrix if using non-dedicated equipment Lab: NA	No analytes detected at > RL	Qualify data.	Analyst	Accuracy/ bias-contamin-ation	No analytes detected at > RL Apply B-flag to all results for the specific analyte(s) in all samples associated with the rinsate blank.
Results reported between MDL and RL.	--	--	--	--	--	Apply J-flag to all results between MDL and RL.

QAPP Worksheet #29: Project Documents and Records

Sample Collection and Field Records (HDR SOP 4)			
Record	***Generation***	***Verification***	***Storage location/archival***
Field Notes, and Logbooks	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
GIS files	HDR FTL	HDR PM	HDR Network Drive Project Folder
CoC Forms	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
Airbills	HDR FTL	HDR PM, Chemist	HDR Network Drive Project Folder
DQCRs	HDR FTL	HDR PM	HDR Network Drive Project Folder
Equipment Calibration Forms	HDR FTL	HDR PM	HDR Network Drive Project Folder
Logbooks	HDR FTL	HDR PM	HDR Network Drive Project Folder
Instrument data files	HDR FTL	HDR PM	HDR Network Drive Project Folder
Photo-documentation	HDR FTL	HDR PM	HDR Network Drive Project Folder

Project Assessments (HDR SOP 10)			
Record	***Generation***	***Verification***	***Storage location/archival***
Analytical Data Packages	Lab	HDR Project Chemist	HDR Network Drive Project Folder
Validation Checklists	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder
Data Validation Reports	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder
CA Reports	HDR Project Chemist	HDR Project Chemist/ HDR PM	HDR Network Drive Project Folder

Laboratory Records			
Record	***Generation***	***Verification***	***Storage location/archival***
CoC Forms	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Equipment Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Sample Prep Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Analytical Run Logs	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
CA Forms	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Extraction Records	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Reported Sample Results	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Raw Data Printouts	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Laboratory Information Management System (LIMS) Reports	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)
Data Packages and Checklists	Lab	Lab PM, HDR Project Chemist	Lab archives, HDR Network Drive Project Folder (data package)

Laboratory Data Deliverables		
Record	***VOCs (Groundwater)***	***VOCs and Metals (IDW Water and IDW Soil)***
CoC Forms	X	X
Equipment Logs	X	X
Sample Prep Logs	X	X
Analytical Run Logs	X	X
CA Forms	X	X
Extraction Records	X	X
Reported Sample Results	X	X
Raw Data Printouts	X	
LIMS Reports	X	X
Data Packages and Checklists	X	X

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

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
Offsite 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
Data Review TSA	HDR Project Chemist	Ongoing with review of data validation reports and data qualifications	NA	Email from HDR Project Chemist to Laboratory PM; Data Review Summary Report	14 days after receipt of data validation reports

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
Offsite 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
Data Review TSA	HDR Data reviewer/ validator	Summary Report prepared for each sampling event to summarize major issues with the data	Within one week from receipt of final Data Review Report for a sampling event	HDR Data reviewer/ validator	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	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
Project Chemist: Lynn Lutz
Field Team Leader: Clayton Mokri

Step 1	**Review the project's objectives and sampling design** Review the key outputs defined during systematic planning (i.e., PQOs 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 performance testing 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.

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 offsite laboratories, results will be subjected to data review, verification and validation, in accordance with:

- *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); and
- Environmental Quality Guidance for Evaluating Performance-Based Chemical Data, EM 200-1-10 (USACE, 2005).

Equations used to assess acceptance criteria include:

For Accuracy:

Percent Recovery (%R) for MS

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

%R for LCS

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

For Precision:

RPD for 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 the Worksheets above.

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 the Worksheets above.

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 offsite 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 Worksheet #15.

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.

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Tables

TABLE 1
WELL CONSTRUCTION SUMMARY, EXISTING AND ABANDONED WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

Well	Aquifer	Date Installed	Date Abandoned	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Riser Length (ft)	Screen Length (ft)	Total Well Depth (ft, btoc)	Depth to Water[2] (ft, btoc)
Abandoned LTM Wells											
MW-02	Fluvial	Jun-82	Jul-09	281693.8	802244.8	292.04	289.70	20.0	10	30.0	-
MW-09	Fluvial	Feb-89	Aug-07	281641.2	802516.4	304.32	304.66	70.1	10	80.1	-
MW-10	Fluvial	Mar-89	Mar-13	281662.6	802201.3	288.79	289.20	58.6	10	68.6	-
MW-29	Fluvial	Nov-89	Jul-09	282104.9	802864.0	273.22	273.35	34.2	20	54.2	-
MW-30	Fluvial	Nov-89	Jul-09	282229.2	802014.0	275.14	274.10	39.0	20	59.0	-
MW-51	Fluvial	Jan-96	Mar-13	282345.9	802828.6	275.23	275.50	55.0	10	65.0	-
MW-61	Fluvial	Aug-98	Jul-09	281585.7	802347.4	294.04	294.20	68.5	10	78.5	-
MW-65	Fluvial	Nov-98	Mar-13	283529.7	803887.7	263.22	264.00	40.8	10	50.8	-
MW-128	Fluvial	Jun-03	Mar-13	282712.2	803376.4	284.14	284.77	54.8	20	74.8	-
MW-181	Fluvial	Oct-05	Jun-07	282271.1	803128.5	291.14	291.51	67.0	10	77.0	-
PZ-02	Fluvial	Oct-98	Jul-09	282116.2	803242.0	284.39	285.00	44.0	10	54.0	-
Active LTM Wells											
MW-03	Fluvial	Jun-82	-	281596.3	802100.7	292.35	290.40	65.5	10	75.5	60.85
MW-07	Fluvial	Jun-82	-	281839.9	802481.7	295.10	293.10	67.0	10	77.0	60.89
MW-08	Fluvial	Feb-89	-	282001.0	802727.9	292.59	292.74	56.5	10	66.5	56.79
MW-28	Fluvial	Nov-89	-	281568.6	803154.5	294.79	294.89	54.3	15	69.3	52.04
MW-68	Fluvial	Feb-00	-	281500.8	802040.0	291.69	291.60	72.5	10	82.5	60.63
MW-78	Fluvial	Dec-00	-	282051.7	802065.3	275.00	275.40	44.5	20	64.5	42.76
MW-129	Fluvial	Jun-03	-	282271.1	803128.5	293.01	293.33	65.0	15	80.0	50.70
MW-130	Fluvial	Jun-03	-	282116.8	803241.5	293.17	293.77	59.5	20	79.5	50.64
MW-180	Fluvial	Oct-05	-	281476.4	802131.9	296.14	296.39	72.0	10	82.0	64.43
MW-220	Fluvial	May-07	-	281617.5	802166.9	293.29	290.31	64.9	15	79.9	60.94
MW-230	Fluvial	Jul-07	-	281842.8	802800.1	286.57	286.66	59.2	15	74.2	50.15

TABLE 1
WELL CONSTRUCTION SUMMARY, EXISTING AND ABANDONED WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

Well	Aquifer	Date Installed	Date Abandoned	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Riser Length (ft)	Screen Length (ft)	Total Well Depth (ft, btoc)	Depth to Water[2] (ft, btoc)
TDEC Wells											
CS-01	Fluvial	Jul-07	-	282850.4	803576.9	279.76	280.16	57.8	10	67.8	29.31
CS-02	Fluvial	Jul-07	-	282610.2	803152.0	280.18	280.37	60.0	10	70.0	34.45
CS-03	Fluvial	Jul-07	-	282927.4	803403.4	275.93	276.23	57.0	10	67.0	25.28
CS-04	Fluvial	Jul-07	-	283007.1	803119.1	271.30	271.68	52.0	10	62.0	22.10
CS-05	Fluvial	Dec-08	-	282417.6	803551.2	296.27	296.43	71.0	10	81.0	48.80
CS-06	Fluvial	Dec-08	-	282248.9	803501.6	301.25	301.59	75.3	10	85.3	56.40
CS-07	Fluvial	Dec-08	-	281869.7	803590.4	297.51	297.69	74.0	10	84.0	54.26
WB-01	Fluvial	Dec-05	-	282299.8	804620.1	275.97	276.18	35.0	20	55.0	23.81
WB-02	Fluvial	Dec-05	-	282427.5	804321.9	272.21	272.34	35.0	20	55.0	21.18
WB-03	Fluvial	Dec-05	-	282707.2	804642.3	265.33	265.64	20.0	20	40.0	6.32
WB-04[1]	Fluvial	Dec-05	-	282920.6	804373.1	263.76	264.00	25.0	20	45.0	-

Notes:

1) WB-04 is not usable for water levels or sampling
2) Depth to water measured April 5-6, 2019

ft: feet
btoc: below top of casing
NAVD: North American Vertical Datum of 1988

TABLE 2
CVOC SUMMARY, NORTHEAST OPEN AREA SOILS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

Analyte	Number Analyzed	Number Detected	Minimum Detected Concentration	Maximum Detected Concentration
Subsurface Soils				
1,1,2,2-Tetrachloroethane	20	1	0.01	0.01
Methylene Chloride	20	1	0.07	0.07
Tetrachloroethylene	20	7	0.0008	0.01
Total 1,2-Dichloroethylene	20	1	0.02	0.02
Trichloroethylene	20	5	0.0004	0.1
Surface Soils				
1,1,2,2-Tetrachloroethane	9	2	0.001	0.005
Tetrachloroethylene	9	3	0.002	0.006
Total 1,2-Dichloroethylene	9	1	0.2	0.2
Trichloroethylene	9	2	0.004	0.7
Vinyl Chloride	9	1	0.008	0.008

Notes:
1) All results in milligrams per kilograms
2) Data taken from Table 8-5, Dunn Field RI (CH2MHILL, 2002)

TABLE 3
CVOC SUMMARY, EXISTING AND ABANDONED WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

			Samples			PCE		TCE		DCE		MCL		
Well ID	Date Installed	Date Abandoned	Number	Start	End	Detections	Max (µg/L)	Detections	Max (µg/L)	Detections	Max (µg/L)	Samples w/ Exceedances	CVOCs> MCL	Last Exceedance
Abandoned LTM Wells														
MW-02	Jun-82	Jul-09	5	2/12/1996	10/15/1998	1	22	1	26	1	7	1	DCE, PCE, TCE	2/12/1996
MW-09	Feb-89	Aug-07	11	11/15/1993	11/22/2005	7	22.1	11	9.7	5	7.5	4	DCE, PCE, TCE, CT	10/28/2003
MW-10	Mar-89	Mar-13	12	11/11/1993	10/15/2009	11	180	12	1760	10	88.6	10	DCE, PCE, TCE, CT, cDCE, VC, TeCA	10/15/2009
MW-29	Nov-89	Jul-09	12	11/17/1993	11/7/2007	12	43.1	12	31	11	34.8	12	DCE, PCE, TCE	11/7/2007
MW-30	Nov-89	Jul-09	24	11/19/1993	11/7/2007	0	-	0	-	0	-	0		-
MW-51	Jan-96	Mar-13	26	2/8/1996	4/28/2011	23	4	26	15	26	57.9	25	DCE, TCE	4/28/2011
MW-61	Aug-98	Jul-09	3	3/15/1999	11/9/2007	1	0.44	2	0.96	0	-	0		-
MW-65	Nov-98	Mar-13	8	11/11/1998	4/28/2011	0	-	0	-	0	-	0		-
MW-128	Jun-03	Mar-13	11	7/28/2003	4/28/2011	2	0.35	8	38	8	153	4	DCE, TCE	4/20/2009
MW-181	Oct-05	Jun-07	2	11/20/2005	5/18/2007	2	13.7	2	110	2	11.5	2	DCE, PCE, TCE	5/18/2007
PZ-02	Oct-98	Jul-09	4	4/10/2002	4/8/2003	3	3.1	2	24.4	3	112	1	DCE, TCE	4/10/2002
Active LTM Wells														
MW-03	Jun-82	-	27	11/12/1993	4/7/2018	27	192	27	138	24	38.5	14	DCE, PCE, TCE	4/7/2018
MW-07	Jun-82	-	29	11/15/1993	4/7/2018	29	82	29	52.3	29	54	29	DCE, PCE, TCE, CF	4/7/2018
MW-08	Feb-89	-	19	11/17/1993	4/8/2018	17	35.2	17	16	18	34.4	14	DCE, PCE, TCE	4/8/2018
MW-28	Nov-89	-	8	11/19/1993	4/23/2017	0	-	0	-	0	-	0		-
MW-68	Feb-00		29	5/18/2000	4/23/2017	17	8.35	18	48.9	6	9.01	8	DCE, PCE, TCE	5/17/2007
MW-78	Dec-00	-	16	2/14/2001	4/23/2017	0	-	3	0.59	0	-	0		-
MW-129	Jun-03	-	15	7/28/2003	4/8/2018	15	30.2	15	21	15	42	15	DCE, PCE, TCE	4/8/2018
MW-130	Jun-03	-	23	7/28/2003	4/8/2018	23	196	23	79.5	23	80.2	23	DCE, PCE, TCE	4/8/2018
MW-180	Oct-05		16	11/20/2005	4/22/2017	5	5.02	5	78	3	2.04	2	PCE, TCE	5/21/2007
MW-220	May-07	-	20	5/18/2007	4/7/2018	20	19.8	20	530	20	45.9	16	DCE, PCE, TCE,TCA	4/7/2018
MW-230	Jul-07	-	12	10/18/2007	4/7/2018	12	100	12	98.4	12	32.7	12	DCE, PCE, TCE	4/7/2018
TDEC Wells														
CS-01	Jul-07	-	3	7/16/2007	10/9/2017	1	0.26	1	1.9	0	-	0		-
CS-02	Jul-07	-	3	7/15/2007	10/8/2017	1	0.439	3	4.4	3	48	3	DCE	10/8/2017
CS-03	Jul-07	-	3	7/16/2007	10/7/2017	0	-	0	-	2	23	1	DCE	11/10/2008
CS-04	Jul-07	-	3	7/15/2007	10/7/2017	0	-	0	-	0	-	0		-
CS-05	Dec-08	-	2	12/29/2008	10/8/2017	2	9.2	2	1.68	2	5.2	1	PCE	12/29/2008
CS-06	Dec-08	-	2	12/30/2008	10/8/2017	2	2.5	2	0.405	1	0.72	0		-
CS-07	Dec-08	-	2	12/30/2008	10/9/2017	0	-	0	-	0	-	0		-
WB-01	Dec-05	-	3	12/8/2005	11/12/2008	0	-	0	-	0	-	0		-
WB-02	Dec-05	-	3	12/8/2005	11/12/2008	0	-	0	-	0	-	0		-
WB-03	Dec-05	-	2	12/9/2005	10/10/2017	0	-	0	-	0	-	0		-
WB-04	Dec-05	-[1]	1	12/8/2005	-	0	-	0	-	0	-	0		-

Notes:

1) Well WB-04 is damaged and not usable.

TABLE 5
PROPOSED WELL LOCATIONS AND ESTIMATED DEPTHS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

Well	Northing (ft)	Easting (ft)	Ground Elevation (ft, NAVD)	Groundwater Elevation (ft, NAVD)	Groundwater Depth (ft, bgs)	Top of Screen Depth (ft, bgs)	Total Well Depth (ft, btoc)	Total Boring Depth (ft, btoc)
F-1	803178.7	281927.4	285.2	241.2	43.95	45	55	57
F-2	802963.1	282148.8	273.2	239.8	33.36	35	45	47
F-3	802866.0	282357.9	273.0	240.2	32.78	34	44	46
F-4	803123.7	282795.8	276.9	246.9	30.04	31	41	43
F-5	803265.1	282740.3	282.4	248.1	34.33	36	46	48
F-6	803370.3	282705.8	287.6	248.5	39.10	41	51	53
F-7	803344.0	282409.4	294.1	245.7	48.42	50	60	62
F-8	803713.2	282675.1	284.2	250.0	34.24	36	46	48
F-9	803964.1	282829.9	276.2	252.4	23.79	24	34	36
F-10	804430.8	282754.6	269.0	252.4	16.57	18	28	30

Notes:

ft: feet
btoc: below top of casing
NAVD: North American Vertical Datum of 1988

Figures

Legend

●	LTM Well
⊕	TDEC Well
●	Abandoned Wells
☐	Area of Investigation
⊗	Unusable Well
◄	Groundwater Flow Direction
- - -	Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- - -	Potentiometric surface of the Fluvial Aquifer 1-ft. contour
—	Original Dunn Field Boundary

Note:
Groundwater contours are from October 2017

Figure 1

Area of Investigation, Existing and Abandoned Monitoring Wells

Offsite Groundwater Investigation QAPP-SAP

0 50 100
Feet

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

Dunn Field
Defense Depot
Memphis, Tennessee

Date: 7/11/2019
Edition: Rev 0

FDR

Path: W:\QAPP\OSI_OffDepot2019\01rev1.mxd

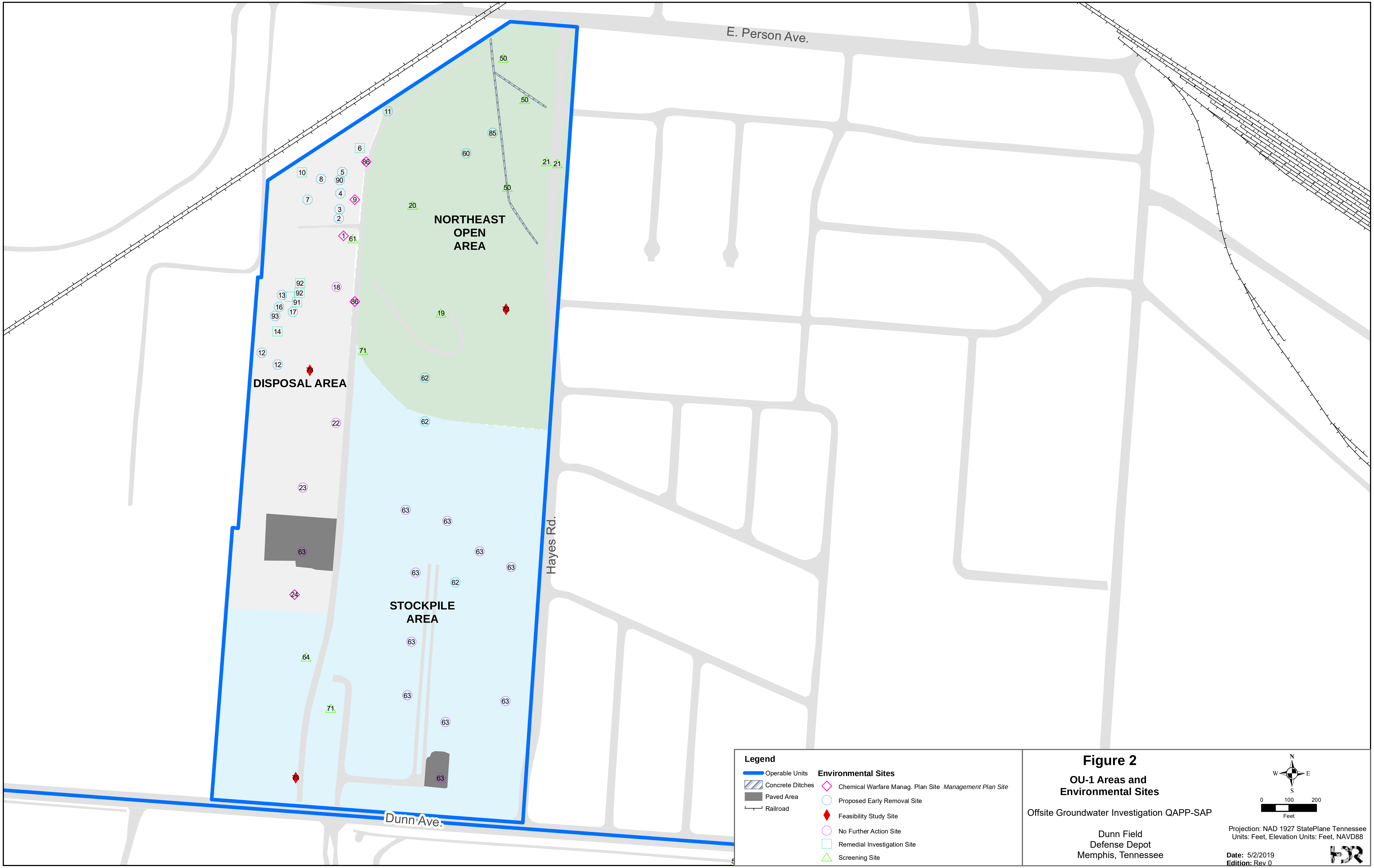


Figure 2

OU-1 Areas and Environmental Sites

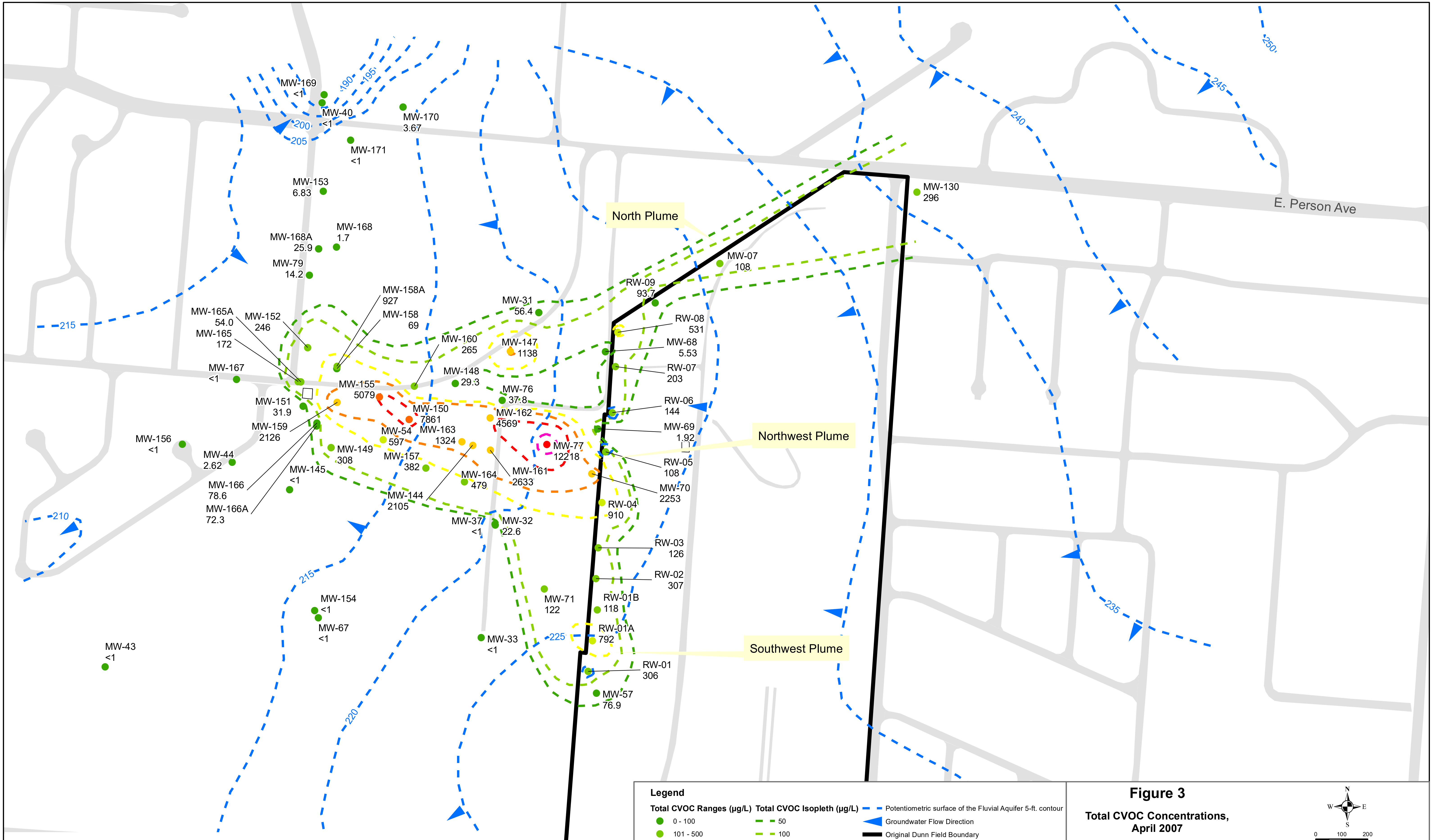
Offsite Groundwater Investigation QAPP-SAP

Dunn Field
Defense Depot
Memphis, Tennessee

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

Date: 5/2/2019
Edition: Rev 0

Document Path: W:\QAPP\OSI_OffDepot2019\01.mxd



Notes:
1. Highest concentration at well pairs used for contour.
2. Total CVOCs include: CT, CF, DCE, cDCE, tDCE, TCA, TCE, PCE, PCA and VC.
3. Analytical results for groundwater samples collected by e2M from 4/9/2007 to 4/11/2007.

Figure 3

Total CVOC Concentrations,
April 2007

Offsite Groundwater Investigation QAPP-SAP

Dunn Field
Defense Depot
Memphis, Tennessee

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

Date: 7/1/2019
Edition: Rev 0

Legend

- ● LTM Well
- ⊕ TDEC Well
- ● Proposed Well Location
- ● Abandoned Well
- ⊗ Unusable Well

PCE Ranges
Contour Shading (µg/L)

☐	1-5
🟩	5-10
🟨	10-50
🟧	50-100

- ◀ Groundwater Flow Direction
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Original Dunn Field Boundary

Figure 4

Proposed Offsite
Investigation Well Locations
PCE Concentrations

Offsite Groundwater Investigation QAPP-SAP

Dunn Field
Defense Depot
Memphis, Tennessee

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

Date: 4/27/2020
Edition: Rev 0

HDR

Notes:
1. Groundwater contours are from April 2019.
2. PCE concentrations are from October 2017.

Path: W:\QAPP\OSI_OffDepot2019\QAPP-SAP\04PCE.mxd

Notes:
1. Groundwater contours are from April 2019.
2. TCE and 1-1DCE contours are from October 2017.

Figure 5

Proposed Offsite
Investigation Well Locations
TCE Concentrations

Offsite Groundwater Investigation QAPP-SAP

Dunn Field
Defense Depot
Memphis, Tennessee

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

Date: 4/23/2020
Edition: Rev 0

Legend

● LTM Well

⊕ TDEC Well

● Proposed Well Location

● Abandoned Well

⊗ Unusable Well

DCE Ranges

Contour Shading (µg/L)

☐ 1-7

🟩 7-10

🟨 >10

◀ Groundwater Flow Direction

- - Potentiometric surface of the Fluvial Aquifer 5-ft. contour

- - Potentiometric surface of the Fluvial Aquifer 1-ft. contour

— Original Dunn Field Boundary

Notes:
1. Groundwater contours are from April 2019.
2. DCE concentrations are from October 2017.

Figure 6

Proposed Offsite Investigation Well Locations DCE Concentrations

Offsite Groundwater Investigation QAPP-SAP

Dunn Field
Defense Depot
Memphis, Tennessee

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

Date: 4/27/2020
Edition: Rev 0

Path: W:\QAPP\OSI_OffDepot2019\QAPP-SAP\06DCE.mxd

Appendix A Supplemental Information

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-02

Analyte	**Well** **Date** **Unit**	MCL	MW-02 2/12/1996	MW-02 6/21/1997	MW-02 9/26/1997	MW-02 3/27/1998	MW-02 10/15/1998
1,1,2,2-Tetrachloroethane	µg/L	-	ND	2 J	<10	<10	<10
1,1,2-Trichloroethane	µg/L	5	ND	<10	<10	<10	<10
1,1-Dichloroethene	µg/L	7	**7 J**	<10	<10	<10	<10
Carbon tetrachloride	µg/L	5	ND	<10	<10	<10	<10
Chloroform	µg/L	80	8 J	<10	<10	<10	<10
Tetrachloroethene	µg/L	5	**22**	<10	<10	<10	<10
Trichloroethene	µg/L	5	**26**	<10	<10	<10	<10
Vinyl chloride	µg/L	2	ND	<10	<10	<10	<10

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-09

	Well	MCL	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09	MW-09
	Date		11/15/1993	2/11/1996	6/20/1997	9/26/1997	3/26/1998	10/14/1998	7/28/2003	10/28/2003	4/28/2004	10/20/2004	11/22/2005
Analyte	**Unit**												
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1	1.76
1,1,2-Trichloroethane	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**7.5**	1 J	2 J	1 J	1 J	<10	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	3.07	2 J	**8 J**	1 J	3 J	**5 J**	<1	**8.34**	0.28 J	<1	0.69 J
Chloroform	µg/L	80	1.78	2 J	5 J	<10	2 J	4 J	1.15	27.2	2.2	<1	1.11
Tetrachloroethene	µg/L	5	**22.1**	ND	**7 J**	4 J	3 J	**6 J**	<1	1.89	<1	<1	1.55
Trichloroethene	µg/L	5	**9.7**	2 J	**6 J**	2 J	2 J	4 J	1.54	3.32	0.25 J	0.59 J	2.3
Vinyl chloride	µg/L	2	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-10

Analyte	Well Date Unit	MCL	MW-10 11/11/1993	MW-10 2/13/1996	MW-10 6/21/1997	MW-10 9/26/1997	MW-10 3/28/1998	MW-10 10/14/1998	MW-10 10/28/2004	MW-10 11/21/2005	MW-10 8/19/2008	MW-10 10/21/2008
1,1,2,2-Tetrachloroethane	µg/L	-	32.1	12	24 J	2 J	<10	2 J	3.43 J	3.41	1.39	1.01
1,1,2-Trichloroethane	µg/L	5	4.14	ND	<40	<10	<10	<10	0.610 J	0.89 J	<1	<1
1,1-Dichloroethene	µg/L	7	**88.6**	**48**	**48**	**72**	**41**	**19**	6.84	5.96	<1	<1
Carbon tetrachloride	µg/L	5	1.32	3 J	**8 J**	<10	<10	3 J	2.73	2.35 J	<1	<1
Chloroform	µg/L	80	4.22	14	60	<10	1 J	17	21.3	15.2	0.373	0.288 J
Tetrachloroethene	µg/L	5	**143**	**100**	**110**	**180**	**100**	**64**	**13.9**	**10.6**	0.343	<1
Trichloroethene	µg/L	5	**1020**	**250**	**450**	**100**	**63**	**190**	**415**	**1760**	2.22	3.23
Vinyl chloride	µg/L	2	ND	ND	<40	<10	<10	<10	**7.08**	**30.9 J**	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-10

Analyte	**Well** **Date** **Unit**	MCL	MW-10 4/15/2009	MW-10 10/15/2009
1,1,2,2-Tetrachloroethane	µg/L	-	29	14.6
1,1,2-Trichloroethane	µg/L	5	<1	<1
1,1-Dichloroethene	µg/L	7	0.769 J	1.07
Carbon tetrachloride	µg/L	5	<1	<1
Chloroform	µg/L	80	0.72	1.15
Tetrachloroethene	µg/L	5	1.41	3.19
Trichloroethene	µg/L	5	**7.11**	**6.79**
Vinyl chloride	µg/L	2	<1	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:

J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-29

Analyte	**Well** **Date** **Unit**	MCL	MW-29 11/17/1993	MW-29 2/11/1996	MW-29 6/20/1997	MW-29 9/26/1997	MW-29 3/28/1998	MW-29 10/14/1998	MW-29 7/28/2003	MW-29 10/28/2003	MW-29 4/28/2004	MW-29 10/20/2004
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1.7
1,1,2-Trichloroethane	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1.7
1,1-Dichloroethene	µg/L	7	**32.1**	ND	**32**	**29**	**28**	**21**	**20.7**	**34.8**	**24**	**22**
Carbon tetrachloride	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1.7
Chloroform	µg/L	80	4.26	ND	<10	<10	<10	<10	<1	<1	<1	<1.7
Tetrachloroethene	µg/L	5	**43.1**	**32**	**38**	**29**	**37**	**29**	**21.7**	**27.1**	**29**	**23**
Trichloroethene	µg/L	5	**14.9**	**13**	**18**	**18**	**17**	**17**	**23.8**	**29.6**	**31**	**30**
Vinyl chloride	µg/L	2	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1.7

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-29

Analyte	**Well** **Date** **Unit**	MCL	MW-29 11/21/2005	MW-29 11/7/2007
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1
1,1,2-Trichloroethane	µg/L	5	<1	<1
1,1-Dichloroethene	µg/L	7	**19.5**	**16**
Carbon tetrachloride	µg/L	5	<1	<1
Chloroform	µg/L	80	0.14 J	0.229
Tetrachloroethene	µg/L	5	**20.5**	**13.6**
Trichloroethene	µg/L	5	**26**	**22.3**
Vinyl chloride	µg/L	2	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-30

Analyte	**Well** **Date** **Unit**	MCL	MW-30 11/19/1993	MW-30 2/7/1996	MW-30 6/17/1997	MW-30 9/24/1997	MW-30 3/24/1998	MW-30 10/16/1998	MW-30 2/2/1999	MW-30 5/24/1999	MW-30 8/26/1999	MW-30 11/2/1999	MW-30 2/15/2000
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	µg/L	5	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
1,1-Dichloroethene	µg/L	7	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
Carbon tetrachloride	µg/L	5	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
Chloroform	µg/L	80	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	5	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
Trichloroethene	µg/L	5	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	2	ND	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-30

	Well	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30	MW-30
	Date	5/16/2000	8/22/2000	11/7/2000	2/13/2001	10/3/2001	4/10/2002	10/2/2002	4/8/2003	10/28/2003	4/29/2004	10/20/2004	11/18/2005
Analyte	**Unit**												
1,1,2,2-Tetrachloroethane	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vinyl chloride	µg/L	ND	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-30

	Well	MW-30
	Date	11/7/2007
Analyte	**Unit**	
1,1,2,2-Tetrachloroethane	µg/L	<1
1,1,2-Trichloroethane	µg/L	<1
1,1-Dichloroethene	µg/L	<1
Carbon tetrachloride	µg/L	<1
Chloroform	µg/L	<1
Tetrachloroethene	µg/L	<1
Trichloroethene	µg/L	<1
Vinyl chloride	µg/L	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-51

	Well	MCL	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51
	Date		2/8/1996	6/20/1997	9/27/1997	3/28/1998	10/19/1998	2/2/1999	5/24/1999	8/26/1999	11/3/1999	2/15/2000	5/16/2000
Analyte	**Unit**												
1,1,2,2-Tetrachloroethane	µg/L	-	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	µg/L	5	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	µg/L	7	4 J	6 J	**23**	**30**	**10**	**23.4**	**16.9**	**15.2**	**8.19**	1.08	**8.23**
Carbon tetrachloride	µg/L	5	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	80	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	5	2 J	1 J	4 J	4 J	2 J	1.5	ND	0.54 J	0.83 J	ND	ND
Trichloroethene	µg/L	5	**5 J**	**5 J**	**13**	**15**	**7 J**	**8.44**	4.64	3.71	2.93	0.7 J	4.63
Vinyl chloride	µg/L	2	ND	<10	<10	<10	<10	ND	ND	ND	ND	ND	ND

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 sample collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-51

	Well	MCL	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51	MW-51
	Date		8/24/2000	11/8/2000	2/19/2001	10/3/2001	4/10/2002	10/1/2002	4/8/2003	10/28/2003	4/29/2004	10/21/2004
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**12.9**	**57.9**	**15.8**	**31.4**	**26.4**	**57**	**33.3**	**17.6**	**21**	**16**
Carbon tetrachloride	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	5	1.49	3.51	1.86	2.13	<1	0.74 J	0.76	0.92 J	1.3	1.2
Trichloroethene	µg/L	5	**6.33**	**13.2**	**6.09**	**9.88**	1.9	**7.11**	**9.83**	**5.54**	**5.5**	**5.1**
Vinyl chloride	µg/L	2	ND	ND	<1	<1	<1	<1	<1	<1	<1	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 sample collected by TDEC.

DQE Flags:

J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-51

	Well	MCL	MW-51	MW-51	MW-51	MW-51	MW-51
	Date		7/15/2007	11/8/2007	4/20/2009	10/15/2009	4/28/2011
Analyte	**Unit**						
1,1,2,2-Tetrachloroethane	µg/L	-	<5.0	<1	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<5.0	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**15**	**17.6**	**20.3**	**15**	**13.9**
Carbon tetrachloride	µg/L	5	<5.0	<1	<1	<1	<1
Chloroform	µg/L	80	<5.0	0.186	0.449	0.231 J	<0.3
Tetrachloroethene	µg/L	5	1.2 J	1.65	1.01	2.3	2.27
Trichloroethene	µg/L	5	4.8 J	**7.71**	**6.32**	**10.4**	**8.84**
Vinyl chloride	µg/L	2	<5.0	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 sample collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-61

	Well	MCL	MW-61	MW-61	MW-61
	Date		3/15/1999	11/21/2005	11/9/2007
Analyte	**Unit**				
1,1,2,2-Tetrachloroethane	µg/L	-	<10	0.76 J	<1
1,1,2-Trichloroethane	µg/L	5	<10	<1	<1
1,1-Dichloroethene	µg/L	7	<10	<1	<1
Carbon tetrachloride	µg/L	5	<10	<1	<1
Chloroform	µg/L	80	<10	0.77 J	0.547
Tetrachloroethene	µg/L	5	<10	0.44 J	<1
Trichloroethene	µg/L	5	<10	0.96 J	0.895
Vinyl chloride	µg/L	2	<10	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-65

Analyte	**Well** **Date** **Unit**	MCL	MW-65 11/11/1998	MW-65 4/10/2002	MW-65 10/1/2002	MW-65 7/13/2007	MW-65 11/11/2008	MW-65 4/20/2009	MW-65 10/15/2009	MW-65 4/28/2011
1,1,2,2-Tetrachloroethane	µg/L	-	<10	<1	<1	<5.0	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<10	<1	<1	<5.0	<0.5	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<10	<1	<1	<5.0	<0.5	<1	<1	<1
Carbon tetrachloride	µg/L	5	<10	<1	<1	<5.0	<0.5	<1	<1	<1
Chloroform	µg/L	80	<10	<1	<1	<5.0	<0.5	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	<10	<1	<1	<5.0	<0.5	<1	<1	<1
Trichloroethene	µg/L	5	<10	<1	<1	<5.0	<0.5	<1	<1	<1
Vinyl chloride	µg/L	2	<10	<1	<1	<5.0	<0.5	<1	<1	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL

1) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-128

Analyte	**Well** **Date** **Unit**	MCL	MW-128 7/28/2003	MW-128 10/28/2003	MW-128 4/29/2004	MW-128 10/22/2004	MW-128 6/15/2005	MW-128 7/14/2007	MW-128 11/8/2007	MW-128 11/11/2008	MW-128 4/20/2009	MW-128 10/15/2009
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<11	<5	<1	<5.0	<1	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<11	<5	<1	<5.0	<1	<0.5	<1	<1
1,1-Dichloroethene	µg/L	7	5.32	3.41	5.1	**54**	**153**	<5.0	0.795	2.1	**24.9**	<1
Carbon tetrachloride	µg/L	5	<1	<1	<11	<5	<1	<5.0	<1	<0.5	<1	<1
Chloroform	µg/L	80	<1	<1	<11	<5	<1	<5.0	<1	<0.5	<0.3	<0.3
Tetrachloroethene	µg/L	5	<1	<1	0.18 J	<5	<1	<5.0	<1	0.35 J	<1	<1
Trichloroethene	µg/L	5	2.17	1.14	**38**	**16**	**24.2**	<5.0	0.883	0.65	4.12	<1
Vinyl chloride	µg/L	2	<1	<1	<11	<5	<1	<5.0	<1	<0.5	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-128

Analyte	Well Date Unit	MCL	MW-128 4/28/2011
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5
1,1,2-Trichloroethane	µg/L	5	<1
1,1-Dichloroethene	µg/L	7	<1
Carbon tetrachloride	µg/L	5	<1
Chloroform	µg/L	80	<0.3
Tetrachloroethene	µg/L	5	<1
Trichloroethene	µg/L	5	<1
Vinyl chloride	µg/L	2	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

MW-181

	Well	MCL	MW-181	MW-181
	Date		11/20/2005	5/18/2007
Analyte	**Unit**			
1,1,2,2-Tetrachloroethane	µg/L	-	<1	0.67
1,1,2-Trichloroethane	µg/L	5	<1	<
1,1-Dichloroethene	µg/L	7	**11.5**	3.8
Carbon tetrachloride	µg/L	5	<1	1.2
Chloroform	µg/L	80	2.86	22
Tetrachloroethene	µg/L	5	**13.7**	**5.6**
Trichloroethene	µg/L	5	**9.88**	**110**
Vinyl chloride	µg/L	2	<1	<

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

TABLE A-1.1
HISTORICAL CVOC RESULTS - ABANDONED LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Dunn Field - Defense Depot Memphis, Tennessee

PZ-02

Analyte	**Well** **Date** **Unit**	MCL	PZ-02 4/10/2002	PZ-02 10/2/2002	PZ-02 1/20/2003	PZ-02 4/8/2003
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<0.5	<1
1,1,2-Trichloroethane	µg/L	5	<1	<1	<0.5	<1
1,1-Dichloroethene	µg/L	7	**112**	1.71	<1	2.39
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1
Chloroform	µg/L	80	<1	1.13	0.162 J	<1
Tetrachloroethene	µg/L	5	<1	3.1	1.15	2.37
Trichloroethene	µg/L		**24.4**	<1	<1	1.34
Vinyl chloride	µg/L		<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-03

	Well	MCL	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03
	Date		11/12/1993	6/21/1997	9/27/1997	3/27/1998	10/15/1998	10/28/2004	11/21/2005	5/14/2007	11/7/2007	4/16/2008
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	ND	33	<10	<10	1 J	78.4 J	96.2	67	<1	<0.5
1,1,2-Trichloroethane	µg/L	5	ND	<10	<10	<10	<10	1.3 J	1.66	1.5	<1	<1
1,1-Dichloroethene	µg/L	7	**38.5**	**15**	**17**	**25**	**10**	**34.5 J**	**9.47**	1.3	2.89	1.54
Carbon tetrachloride	µg/L	5	ND	2 J	<10	<10	<10	0.53 J	1.56 J	0.82	<1	<1
Chloroform	µg/L	80	3.25	17	2 J	9 J	2 J	3.53 J	12.4	12	3.07	0.147 J
Tetrachloroethene	µg/L	5	**192**	**33**	**40**	**38**	**29**	**12.3 J**	**8.19**	1.8	2.63	2.71
Trichloroethene	µg/L	5	**55.5**	**33**	**17**	**18**	**16**	**83.4 J**	**138**	87	2.18	2.04
Vinyl chloride	µg/L	2	ND	<10	<10	<10	<10	<1	<1	ND	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or
reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-03

	Well	MCL	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03	MW-03
	Date		8/19/2008	10/21/2008	4/17/2009	10/13/2009	7/19/2011	4/19/2012	10/17/2012	4/13/2013	10/10/2013	4/25/2014
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	0.425	2.46	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**10.4**	**17.3**	**10.7**	**13.4**	<1	<1	0.524 J	<1	2.52	1.72
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	0.229	0.212 J	0.14 J	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	**5.71**	**9.5**	**9.13**	**10.1**	1.2	0.871 J	1.06	0.311 J	**5.32**	4.37
Trichloroethene	µg/L	5	**5.8**	**10.1**	**9.26**	**10.4**	1.44	1	1.28	0.364 J	3.95	2.97
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-03

Analyte	**Well** **Date** **Unit**	MCL	MW-03 10/18/2014	MW-03 4/11/2015	MW-03 10/5/2015	MW-03 4/24/2016	MW-03 10/16/2016	MW-03 4/22/2017	MW-03 4/7/2018
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	2.63	1.04	2.19	0.587 J	1.14	1.05	0.965 J
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<0.3	<0.3	0.135 J	0.166 J	0.16 J	<0.3	0.204 J
Tetrachloroethene	µg/L	5	3.65	2.35	3.45	2.18	2.36	2.38	2.37
Trichloroethene	µg/L	5	4.33	1.92	3.43	1.64	3.13	2.66	**5.81**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-07

	Well	MCL	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07
	Date		11/15/1993	2/12/1996	6/21/1997	9/27/1997	4/2/1998	10/14/1998	7/28/2003	10/28/2003	4/28/2004	10/20/2004
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<10	<10	<10	<10	<1	<1	<1.2	<1.4
1,1,2-Trichloroethane	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1.2	<1.4
1,1-Dichloroethene	µg/L	7	**36.5**	**54**	**26**	**50**	**47**	**25**	4.06	**40.9**	**32**	**17**
Carbon tetrachloride	µg/L	5	ND	ND	<10	<10	<10	<10	2.99	1.23	0.29 J	<1.4
Chloroform	µg/L	80	12.8	8 J	8 J	9 J	2 J	7 J	**911**	**139**	8	0.44 J
Tetrachloroethene	µg/L	5	**35**	**51**	**32**	**82**	**78**	**47**	**32.3**	**42.6**	**50**	**18**
Trichloroethene	µg/L	5	**13.7**	**26**	**16**	**32**	**31**	**21**	**46.3**	**27.6**	**32**	**14**
Vinyl chloride	µg/L	2	ND	ND	<10	<10	<10	<10	<1	<1	<1.2	<1.4

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-07

	Well	MCL	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07
	Date		6/14/2005	11/18/2005	4/12/2006	10/18/2006	4/9/2007	5/14/2007	10/8/2007	4/14/2008	8/19/2008	10/17/2008
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<1	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	ND	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**15.3**	**18.1**	**27.4**	**18.5**	**22.8**	**20**	**12.8**	**24.8**	**26.8**	**32.7**
Carbon tetrachloride	µg/L	5	<1	<1	<1	0.273 J	0.641 J	ND	0.48 J	<1	<1	<1
Chloroform	µg/L	80	<1	1.07 B	0.501 B	4.49	20	0.55	13.8	0.273 J	0.288	0.299 J
Tetrachloroethene	µg/L	5	**20.6**	**26.3**	**50.7**	**34.5**	**39.4**	**47**	**24.3**	**56.2**	**61.2**	**63.9**
Trichloroethene	µg/L	5	**14.9**	**15.4**	**26.5**	**19.6**	**24.7**	**25**	**16**	**29.4**	**30.9**	**38.9**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	ND	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-07

	Well	MCL	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07	MW-07
	Date		4/15/2009	10/13/2009	4/19/2012	4/13/2013	4/25/2014	4/10/2015	4/24/2016	4/22/2017	4/7/2018
Analyte	**Unit**										
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**35.6**	**24**	**16.2**	**20**	**14.6**	**17.2**	**15**	**12.9**	**10.5**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	0.357	0.263 J	0.192 J	0.276 J	0.22 J	0.285 J	0.306	0.252 J	0.304
Tetrachloroethene	µg/L	5	**70.6**	**62.8**	**35.1**	**55.9**	**35.6**	**43.8**	**39.2**	**32.2**	**24**
Trichloroethene	µg/L	5	**40.9**	**40.4**	**30.3**	**52.3**	**28.8**	**42.2**	**39.8**	**32.9**	**22.2**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-08

	Well	MCL	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08
	Date		11/17/1993	2/13/1996	6/21/1997	9/26/1997	3/30/1998	10/13/1998	7/28/2003	10/28/2003	4/28/2004	10/20/2004
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<10	<10	2 J	<10	<1	<1	<1	<1
1,1,2-Trichloroethane	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**34.4**	**26**	**12**	**20**	**19**	**22**	1.58	1.43	1.3	1.1
Carbon tetrachloride	µg/L	5	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1
Chloroform	µg/L	80	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1
Tetrachloroethene	µg/L	5	**35.2**	**26**	**16**	**27**	**24**	**33**	1.6	<1	0.37 J	1.4
Trichloroethene	µg/L	5	**15.3**	**14**	**9 J**	**13**	**12**	**16**	1.51	<1	0.85 J	1.3
Vinyl chloride	µg/L	2	ND	ND	<10	<10	<10	<10	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-08

	Well	MCL	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08	MW-08
	Date		11/21/2005	11/7/2007	4/18/2012	4/12/2013	4/28/2014	4/11/2015	5/24/2016	4/22/2017	4/8/2018
Analyte	**Unit**										
1,1,2,2-Tetrachloroethane	µg/L	-	0.26 J	<1	<0.5	<0.5	<0.5	<0.5	<0.5	0.205 J	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	3.85	<1	2.99	5.64	1.48	3.24	2.59	2.11	2.08
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<1	0.158	<0.3	0.197 J	<0.3	0.181 J	0.225 J	0.3	0.281 J
Tetrachloroethene	µg/L	5	**5.28**	<1	**5.25**	**9.91**	**3.65**	**5.09**	**5.99**	4.29	4.56
Trichloroethene	µg/L	5	**5.68**	<1	**7**	**14.5**	**6.09**	**9.73**	**9.55**	**7.49**	**9.4**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-28

Analyte	**Well** **Date** **Unit**	MCL	MW-28 11/19/1993	MW-28 2/7/1996	MW-28 4/19/2012	MW-28 10/16/2012	MW-28 4/13/2013	MW-28 10/10/2013	MW-28 4/11/2015	MW-28 4/23/2017
1,1,2,2-Tetrachloroethane	µg/L	-	ND	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	ND	ND	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	ND	ND	<0.3	0.154 J	0.332	0.476	0.251 J	0.149 J
Tetrachloroethene	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	5	ND	ND	<1	<1	<1	<1	<1	<1
Vinyl chloride	µg/L	2	ND	ND	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
ND: Not Detected, RL unavailable
<: Not detected at sample RL

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-68

Analyte	**Well** **Date** **Unit**	MCL	MW-68 5/18/2000	MW-68 8/23/2000	MW-68 11/8/2000	MW-68 2/14/2001	MW-68 10/3/2001	MW-68 4/10/2002	MW-68 10/1/2002	MW-68 4/8/2003	MW-68 10/28/2003	MW-68 4/29/2004	MW-68 10/21/2004
1,1,2,2-Tetrachloroethane	µg/L	-	<1	6.55	<1	<1	4.15	1.01	<1	<1	<1	0.85 J	81
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2.5	<33
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	**9.01**	<1	**9.01**	<1	<1	1.5	<33
Carbon tetrachloride	µg/L	5	0.89 J	<1	<1	<1	<1	<1	<1	<1	<1	0.21 J	<33 J
Chloroform	µg/L	80	6.44	<1	<1	<1	3.5	<1	7.88	<1	<1	0.78 J	<33
Tetrachloroethene	µg/L	5	2.07	**8.35**	0.4 J	0.92 J	4.3	<1	4.3	<1	<1	2.1	<33
Trichloroethene	µg/L	5	**44.5**	**48.9**	3.21	**9.67**	**6.56**	<1	3.85	<1	<1	1.4	**20 J**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2.5	<33

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-68

Analyte	**Well** **Date** **Unit**	MCL	MW-68 6/15/2005	MW-68 11/17/2005	MW-68 4/12/2006	MW-68 10/19/2006	MW-68 4/11/2007	MW-68 5/17/2007	MW-68 10/8/2007	MW-68 4/14/2008	MW-68 8/20/2008	MW-68 10/17/2008	MW-68 4/14/2009
1,1,2,2-Tetrachloroethane	µg/L	-	1.52 B	<1	<1	5.67	1.45	5.5	1.51	0.24 B	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	ND	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	<1	ND	<1	<1	<1	0.727 J	1.82
Carbon tetrachloride	µg/L	5	<1	<1	<1	0.951 J	<1	ND	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<1	<1	0.564 B	1.57	0.263 J	0.43	0.775	<0.3	<0.3	<0.3	0.147 J
Tetrachloroethene	µg/L	5	<1 J	<1	0.696 J	1.63	0.506 J	0.69	0.738 J	<1	<1	0.482 J	1.75
Trichloroethene	µg/L	5	0.512 J	<1	0.608 J	**5.76**	2.58	**14**	4.73	0.36 J	<1	0.573 J	1.41
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	ND	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-68

Analyte	**Well** **Date** **Unit**	MCL	MW-68 10/14/2009	MW-68 4/19/2012	MW-68 4/13/2013	MW-68 4/26/2014	MW-68 4/10/2015	MW-68 5/23/2016	MW-68 4/23/2017
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	1.16	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	0.159 J	<0.3	<0.3	<0.3	<0.3	0.137 J	0.137 J
Tetrachloroethene	µg/L	5	1.55	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	5	1.16	<1	<1	<1	<1	<1	<1
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-78

Analyte	**Well** **Date** **Unit**	MCL	MW-78 2/14/2001	MW-78 10/3/2001	MW-78 4/10/2002	MW-78 10/1/2002	MW-78 4/8/2003	MW-78 10/28/2003	MW-78 4/29/2004	MW-78 10/21/2004	MW-78 11/17/2005	MW-78 11/8/2007
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<1	<1	<1	<1	5.2	0.74 J	<1	<1
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethene	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	5	<1	<1	<1	<1	<1	<1	0.36 J	0.59 J	<1	<1
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL

DQE Flags:
J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-78

Analyte	**Well** **Date** **Unit**	MCL	MW-78 4/21/2009	MW-78 3/29/2010	MW-78 4/28/2011	MW-78 4/12/2013	MW-78 4/10/2015	MW-78 4/23/2017
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	5	<1	<1	<1	<1	0.307 JB	<1
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL

DQE Flags:

J: Estimated based on QC data or reported below RL
B: Possibly bias high or false positive based on blank data

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-129

Analyte	**Well** **Date** **Unit**	MCL	MW-129 7/28/2003	MW-129 10/28/2003	MW-129 4/29/2004	MW-129 10/22/2004	MW-129 11/22/2005	MW-129 7/14/2007	MW-129 11/8/2007	MW-129 11/13/2008	MW-129 4/19/2012
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<1	<2.5	0.19 J	<5.0	<1	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<2.5	<1	<5.0	<1	<0.5	<1
1,1-Dichloroethene	µg/L	7	**41**	**42**	**27**	**32**	**36**	**22**	**32.7**	**25**	**13.7**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<2.5	<1	<5.0	<1	<0.5	<1
Chloroform	µg/L	80	<1	<1	<1	<2.5	<1	<5.0	<1	<0.5	<0.3
Tetrachloroethene	µg/L	5	**8.85**	**26.1**	**9.6**	**9.2**	**25.4**	**25**	**30.2**	**25**	**15**
Trichloroethene	µg/L	5	**9.71**	**13.4**	**12**	**14**	**19.3**	**20**	**19.1**	**21**	**13.4**
Vinyl chloride	µg/L	2	<1	<1	<1	<2.5	<1	<5.0	<1	<0.5	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-129

Analyte	**Well** **Date** **Unit**	MCL	MW-129 4/13/2013	MW-129 4/28/2014	MW-129 4/9/2015	MW-129 5/23/2016	MW-129 4/23/2017	MW-129 4/8/2018
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**16.8**	**13.2**	**13.9**	**9.47**	**10.9**	**8.17**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	**18**	**16.2**	**18.2**	**8.61**	**13.3**	**9.73**
Trichloroethene	µg/L	5	**14.5**	**12.5**	**15.9**	**13**	**15**	**12.6**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-130

	Well	MCL	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130
	Date		7/28/2003	10/28/2003	4/29/2004	10/22/2004	6/15/2005	11/17/2005	4/12/2006	10/20/2006	4/10/2007	7/13/2007
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	<1	<1	<5	<3.3	<1	<1	<1	<0.5	<0.5	<5.0
1,1,2-Trichloroethane	µg/L	5	<1	<1	<5	<3.3	<1	<1	<1	<1	<1	<5.0
1,1-Dichloroethene	µg/L	7	**41.1**	**42.2**	**57**	**35**	**22.6**	**28.3**	**52.8**	**61.6**	**70**	**71**
Carbon tetrachloride	µg/L	5	<1	<1	<5	<3.3	<1	<1	<1	<1	<1	<5.0
Chloroform	µg/L	80	<1	<1	<5	<3.3	<1	<1	<1	0.256 J	0.315	<5.0
Tetrachloroethene	µg/L	5	**71.6**	**80.3**	**88**	**63**	**48.8**	**57.4**	**114**	**112**	**154**	**160**
Trichloroethene	µg/L	5	**54**	**64**	**76**	**50**	**37.9**	**43.5**	**57.7**	**60.5**	**71.2**	**78**
Vinyl chloride	µg/L	2	<1	<1	<5	<3.3	<1	<1	<1	<1	<1	<5.0

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-130

	Well	MCL	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130	MW-130
	Date		10/5/2007	4/11/2008	10/20/2008	11/13/2008	4/15/2009	10/15/2009	4/19/2012	4/13/2013	4/28/2014	4/11/2015	5/23/2016
Analyte	**Unit**												
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**74**	**73.4**	**80.2**	**63**	**60.3**	**29 J**	**25.7**	**38.6**	**22.6**	**14.3**	**9.76**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	0.47 J	<1
Chloroform	µg/L	80	0.291 J	0.27 J	0.296 J	<0.5	0.237 J	0.206 J	0.227 J	0.274 J	0.219 J	0.317	0.371
Tetrachloroethene	µg/L	5	**147**	**196**	**140**	**110**	**127**	**68.5 J**	**72.5**	**98.5**	**60.6**	**35.6**	**21.7**
Trichloroethene	µg/L	5	**67.4**	**71**	**71.8**	**76**	**75.1**	**61.7 J**	**62.6**	**79.5**	**58.8**	**64.7**	**47**
Vinyl chloride	µg/L	2	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-130

	Well	MCL	MW-130	MW-130
	Date		4/23/2017	4/8/2018
Analyte	**Unit**			
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1
1,1-Dichloroethene	µg/L	7	**9.5**	**7.29**
Carbon tetrachloride	µg/L	5	<1	<1
Chloroform	µg/L	80	0.333	0.323
Tetrachloroethene	µg/L	5	**22.5**	**19.1**
Trichloroethene	µg/L	5	**49.1 J**	**43.7**
Vinyl chloride	µg/L	2	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.
2) Samples collected during DDMT investigation and LTM activities except Jul2007 and Nov2008 samples collected by TDEC.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-180

Analyte	Well Date Unit	MCL	MW-180 11/20/2005	MW-180 5/21/2007	MW-180 11/8/2007	MW-180 4/16/2008	MW-180 8/20/2008	MW-180 10/21/2008	MW-180 4/15/2009	MW-180 10/13/2009	MW-180 3/26/2010	MW-180 4/26/2011
1,1,2,2-Tetrachloroethane	µg/L	-	44.2 J	21	<1	0.763	1.35	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	0.558	2.04	0.766 J	<1	<1	<1
Carbon tetrachloride	µg/L	5	0.72 J	0.26	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	2.04	1.6	<1	<0.3	<0.3	<0.3	0.136 J	0.154 J	<0.3	<0.3
Tetrachloroethene	µg/L	5	**5.02**	2.8	<1	<1	0.766	1.88	0.948 J	<1	<1	<1
Trichloroethene	µg/L	5	**24.4**	**78**	<1	<1	0.978	1.8	0.893 J	<1	<1	<1
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-180

	Well	MCL	MW-180	MW-180	MW-180	MW-180	MW-180	MW-180
	Date		4/19/2012	5/9/2013	4/25/2014	4/11/2015	4/24/2016	4/22/2017
Analyte	**Unit**							
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	<1	<1	<1	<1	<1	<1
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	<1	<1	<1	<1	<1	<1
Trichloroethene	µg/L	5	<1	<1	<1	<1	<1	<1
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-220

	Well	MCL	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220
	Date		5/18/2007	11/9/2007	4/15/2008	8/20/2008	10/21/2008	4/23/2009	10/13/2009	7/19/2011	4/19/2012	10/17/2012
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	780	<1	<0.5	<0.5	0.267 J	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	**9.3**	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**18**	**7.93**	4.54	**37**	**44.3**	**45.9**	**33.1**	2.66	3.08	2.47
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	2.5	<1	<0.3	0.201	0.217 J	0.238 J	0.184 J	<0.3	<0.3	<0.3
Tetrachloroethene	µg/L	5	**16**	**7.67**	**8.14**	**16.4**	**13.7**	**19.8**	**19**	1.95	4.61	3.78
Trichloroethene	µg/L	5	**530**	**6.73**	4.61	**14.6**	**15.2**	**20.2**	**18.7**	4.94	**6.56**	**6.65**
Vinyl chloride	µg/L	2	0.63	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:

J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-220

	Well	MCL	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220	MW-220
	Date		4/13/2013	10/10/2013	4/25/2014	10/18/2014	4/11/2015	10/5/2015	4/24/2016	10/16/2016	4/22/2017	4/7/2018
Analyte	**Unit**											
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	0.543	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	1.76	1.16	3.19	3.18	1.16	3.89	**10.9**	5.61	**7.66**	**8**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	0.138 J	0.126 J	<0.3	<0.3	0.135 J	0.216 J	0.185 J	0.208 J	0.203 J	0.192 J
Tetrachloroethene	µg/L	5	3.37	2.92	3.51	4.19	3.07	**7.47**	**12.7**	**9.15**	**14.8**	**11.6**
Trichloroethene	µg/L	5	4.97	4.24	**6.01**	**6.57**	4.34	**7.75**	**20**	**12**	**17.4**	**17.3**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-230

	Well	MCL	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230	MW-230
	Date		10/18/2007	4/15/2008	10/22/2008	4/15/2009	10/14/2009	4/19/2012	5/9/2013	4/25/2014	4/11/2015	4/24/2016	4/22/2017
Analyte	**Unit**												
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethene	µg/L	7	**27.1**	**18.2**	**32.7**	**30.3**	**28.1**	**13.2**	**12.6**	**14.8**	**10.8**	**11.1**	**7.7**
Carbon tetrachloride	µg/L	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform	µg/L	80	0.199 J	0.192 J	0.276 J	0.236 J	0.188 J	0.225 J	0.288 J	0.307	0.226 J	0.277 J	0.264 J
Tetrachloroethene	µg/L	5	**87.2**	**76.1**	**100**	**89.9**	**88.4**	**35.9**	**33.7**	**42.8**	**33.8**	**34.5**	**22**
Trichloroethene	µg/L	5	**83.3**	**74.6**	**98.4**	**98.2**	**83.5**	**54.3**	**60.1**	**63.7**	**47.1**	**39.4**	**28.2**
Vinyl chloride	µg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.2
HISTORICAL CVOC RESULTS - ACTIVE LTM WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

MW-230

	Well	MCL	MW-230
	Date		4/7/2018
Analyte	**Unit**		
1,1,2,2-Tetrachloroethane	µg/L	-	<0.5
1,1,2-Trichloroethane	µg/L	5	<1
1,1-Dichloroethene	µg/L	7	**8.59**
Carbon tetrachloride	µg/L	5	<1
Chloroform	µg/L	80	0.302
Tetrachloroethene	µg/L	5	**23.5**
Trichloroethene	µg/L	5	**27.2**
Vinyl chloride	µg/L	2	<1

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: reporting limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.3
HISTORICAL CVOC RESULTS - TDEC WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

	Well	MCL	CS-01	CS-01	CS-01	CS-02	CS-02	CS-02	CS-03	CS-03	CS-03
	Date		7/16/2007	11/11/2008	10/9/2017	7/15/2007	11/12/2008	10/8/2017	7/16/2007	11/10/2008	10/7/2017
Analyte	**Unit**										
1,1,2,2-Tetrachloroethane	µg/L	-	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<5.0	<0.5	<1.0	<5.0	<0.5	<1.0	<5.0	<0.5	<1.0
1,1-Dichloroethene	µg/L	7	<5.0	<0.5	<1.0	**43**	**48**	**16.3**	<5.0	**23**	6.13
Carbon tetrachloride	µg/L	5	<5.0	<0.5	<1.0	<5.0	<1.0	<1.0	<5.0	<0.5	<1.0
Chloroform	µg/L	80	<5.0	<0.5	<0.3	<5.0	<0.3	<0.3	<5.0	<0.5	<0.3
Tetrachloroethene	µg/L	5	<5.0	0.26 J	<1.0	<5.0	<0.5	0.439 J	<5.0	<0.5	<1.0
Trichloroethene	µg/L	5	1.9 J	<0.5	<1.0	4.4 J	3.9	1.63	<5.0	<0.5	<1.0
Vinyl chloride	µg/L	2	<5.0	<0.5	<1.0	<5.0	<0.5	<1.0	<5.0	<0.5	<1.0

Notes:
µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: Reporting Limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:
J: Estimated based on QC data or reported below RL

TABLE A-1.3
HISTORICAL CVOC RESULTS - TDEC WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

	Well	MCL	CS-04	CS-04	CS-04	CS-05	CS-05	CS-06	CS-06	CS-07	CS-07
	Date		7/15/2007	11/12/2008	10/7/2017	12/29/2008	10/8/2017	12/30/2008	10/8/2017	12/29/2008	10/9/2017
Analyte	**Unit**										
1,1,2,2-Tetrachloroethane	µg/L	-	<5.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	µg/L	5	<5.0	<0.5	<1.0	<0.5	<1.0	<0.5	<1.0	<0.5	<1.0
1,1-Dichloroethene	µg/L	7	<5.0	<0.5	<1.0	5.2	1.24	0.72	<1	<0.5	<1.0
Carbon tetrachloride	µg/L	5	<5.0	<0.5	<1.0	<0.5	0.574 J	<0.5	1.18	<0.5	<1.0
Chloroform	µg/L	80	<5.0	<0.5	<0.3	<0.5	<0.3	0.37 J	<0.3	<0.5	<0.3
Tetrachloroethene	µg/L	5	<5.0	<0.5	<1.0	**9.2**	2.61	2.5	0.480 J	<0.5	<1.0
Trichloroethene	µg/L	5	<5.0	<0.5	<1.0	1.4	1.68	0.38 J	0.405 J	<0.5	<1.0
Vinyl chloride	µg/L	2	<5.0	<0.5	<1.0	<0.5	<1.0	<0.5	<1.0	<0.5	<1.0

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: Reporting Limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:

J: Estimated based on QC data or reported below RL

TABLE A-1.3
HISTORICAL CVOC RESULTS - TDEC WELLS
OFFSITE GROUNDWATER INVESTIGATION QAPP
Defense Depot Memphis, Tennessee

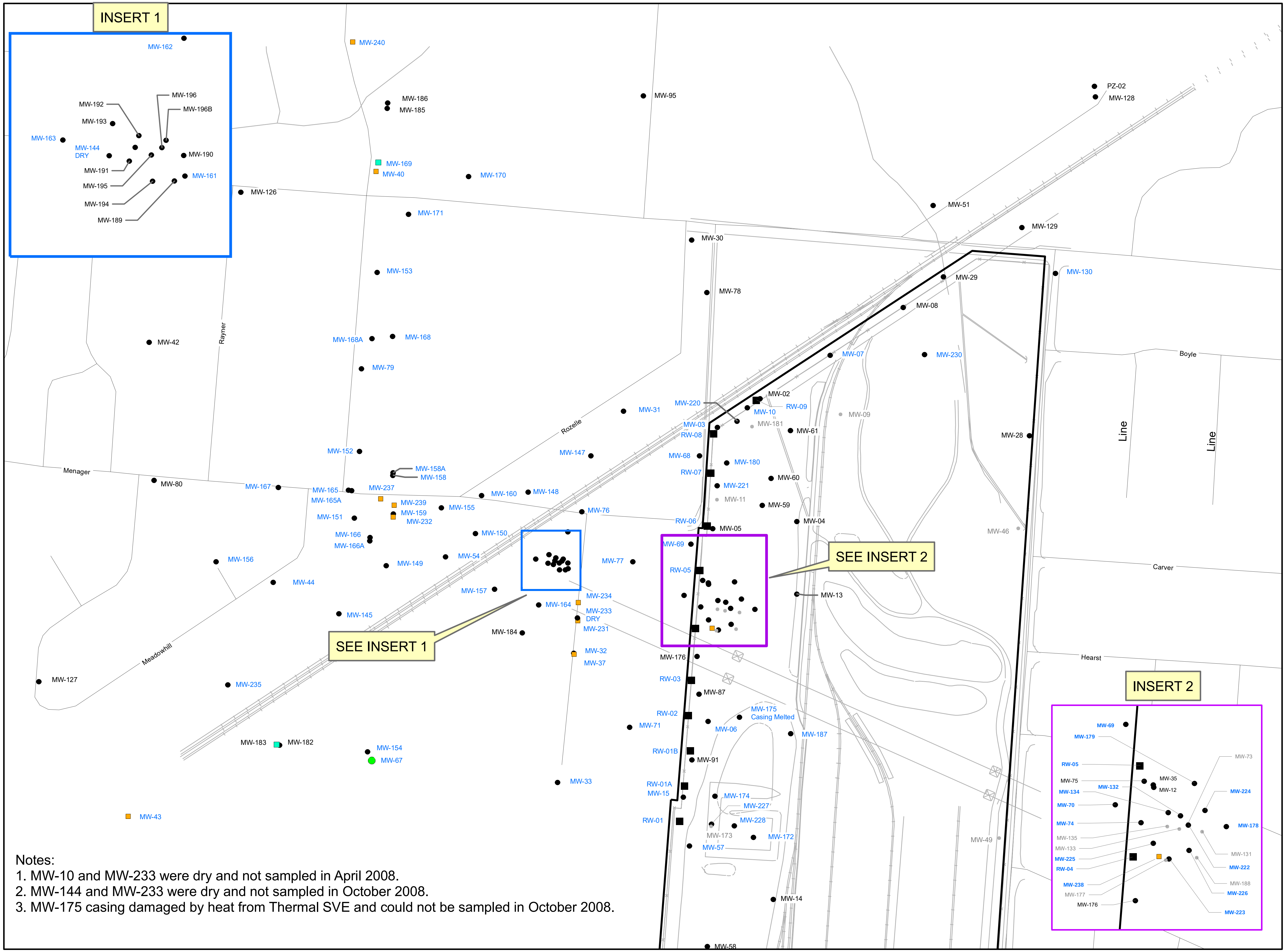
Analyte	**Well** **Date** **Unit**	MCL	WB-01 12/8/2005	WB-01 11/12/2008	WB-01 10/8/2017	WB-02 12/8/2005	WB-02 11/12/2008	WB-02 10/8/2017	WB-03 12/9/2005	WB-03 10/10/2017	WB-04 12/8/2005
1,1,2,2-Tetrachloroethane	µg/L	-	<1.0	<0.5	<0.5	<1.0	<0.5	<0.5	<1.0	<0.5	<1.0
1,1,2-Trichloroethane	µg/L	5	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	µg/L	7	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0
Carbon tetrachloride	µg/L	5	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0
Chloroform	µg/L	80	<1.0	<0.5	<0.3	<1.0	<0.5	<0.3	<1.0	<0.3	<1.0
Tetrachloroethene	µg/L	5	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0
Trichloroethene	µg/L	5	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	µg/L	2	<1.0	<0.5	<1.0	<1.0	<0.5	<1.0	<1.0	<1.0	<1.0

Notes:

µg/L: micrograms per liter
MCL: Maximum Contaminant Level
RL: Reporting Limit
<: Not detected at sample RL
1) Results above MCL shown in **bold**.

DQE Flags:

J: Estimated based on QC data or reported below RL



Notes:
1. MW-10 and MW-233 were dry and not sampled in April 2008.
2. MW-144 and MW-233 were dry and not sampled in October 2008.
3. MW-175 casing damaged by heat from Thermal SVE and could not be sampled in October 2008.

N
W E
S

Figure 1-1

WELL LOCATION MAP

ANNUAL OPERATIONS
REPORT - 2008

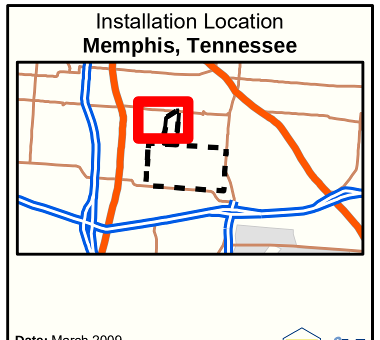
DUNN FIELD
GROUNDWATER IRA
YEAR TEN

DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

- ● Monitoring Well Screened in the Fluvial Aquifer
- ■ Recovery Well Screened in the Fluvial Aquifer
- 🟧 Monitoring Well Screened in the Intermediate Aquifer
- 🟩 Monitoring Well Screened in the Transition Zone
- ● Monitoring Well Screened in the Memphis Aquifer
- ● MW-11 Abandoned
- ● MW-33 2008 Sample Location
- — Dunn Field Boundary

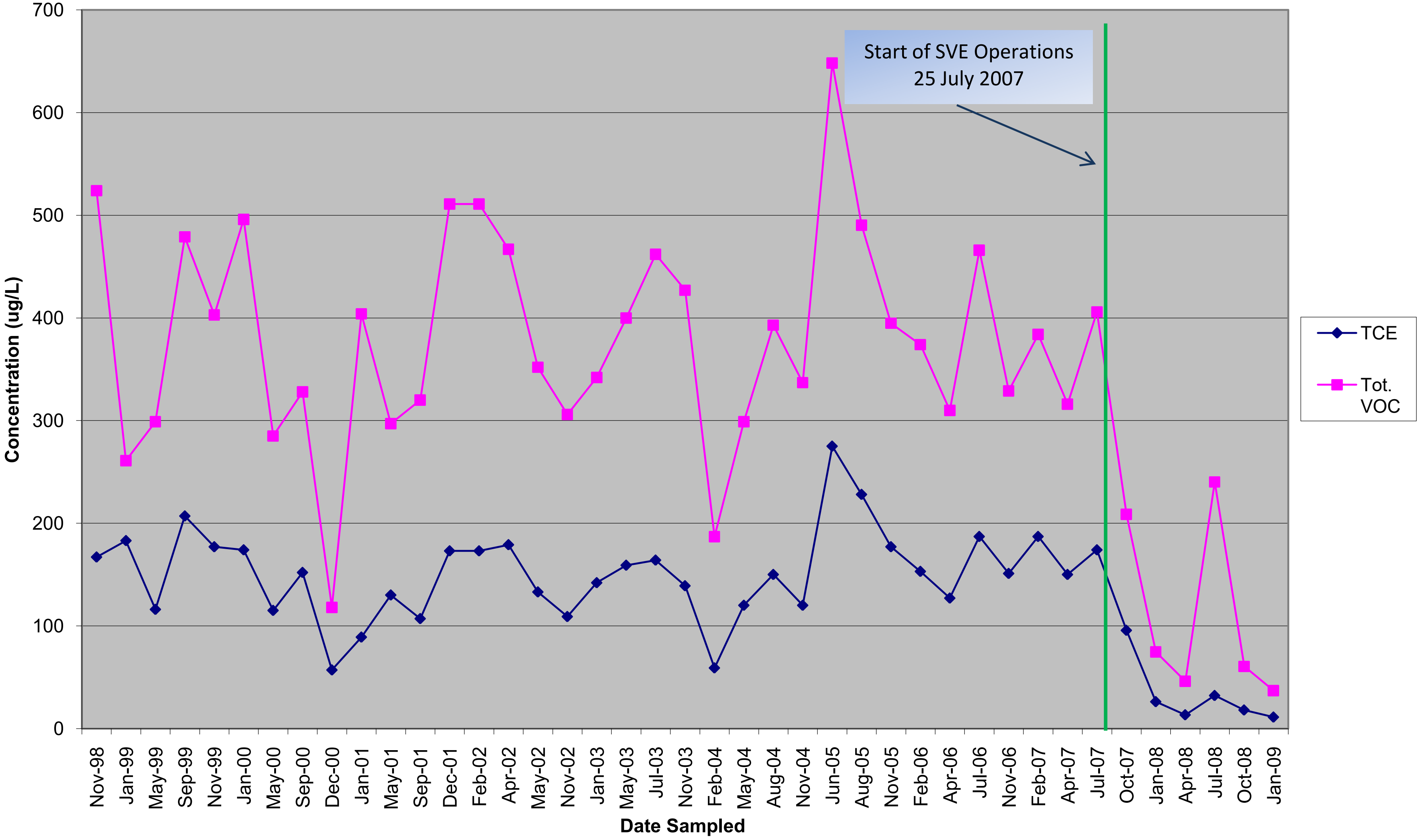
0 150 300 450 600
Feet



Date: March 2009
Edition: Rev 0

G:\3202\016\IRAIS-5\GIS

FIGURE 5-1
TCE AND TOTAL VOC CONCENTRATIONS IN EFFLUENT
ANNUAL OPERATIONS REPORT - 2008
DUNN FIELD GROUNDWATER IRA - YEAR TEN
Defense Depot Memphis, Tennessee



December 2008 Monthly Discharge Report
Groundwater Recovery System
Dunn Field, Memphis Depot, Tennessee
e^{2}M Project Number 3202-043-01-11

Groundwater Recovery System (GWRS) Operation - December 2008

Duration of System Operation: 1-Dec-08
31-Dec-08

Site visits During Month:

Site visits were performed by e^{2}M on 4 December, 12 December, 18 December, 23 December, and 31 December. Tasks included collection of flow rates, reviewing system operations, and performing system maintenance and repair.

System Operational Notes:

RW-5 through RW-9 remain offline per agreement from the BCT due to low concentrations from the April 2008 IRA sampling event. The offline wells will remain operational and checked bi-weekly. All other recovery wells were continuously online during December 2008**.** Also, an additional 6,624 gallons of water was discharged from thermal soil vapor extraction (T-SVE) remedial action activities. Approval for discharge was granted by the City of Memphis on 7 October 2007.

System Maintenance and Repairs Summary:

All wells were online without interruption in December 2008. On 31 December, a crack was discovered in the aboveground portion of the pipe used to discharge water to the City of Memphis POTW. New parts were obtained and the pipe repaired the same day.

Alarm Summary:

No alarms noted.

Upcoming Activities

Weekly site visits to the groundwater recovery system for operations and maintenance are scheduled for January 2009.

December 2008 GWRS Discharge (gallons):	864,958
Approved One-Time Discharges (gallons)	6,624
December 2008 Effluent Discharge Volume (gallons):	**871,582**
December 2008 Average Discharge Flow Rate (GPM)	19.4
December 2008 Maximum Discharge Flow Rate (GPM)	20.4
December 2008 Minimum Discharge Flow Rate (GPM)	18.6

Explanations for deviations from 100% recovery well operation run times are provided in the above "System Maintenance Summary". On-site recordings were compiled to estimate each well's performance using recorded flow rates, totalized discharged volumes and low level cycling to yield the following recovery well operational run time percentages:

Well I.D.	Percent Uptime	Average Operating Flow Rate (GPM)	Total Flow (Gallons) - Based on Average Flow Rate During Operational Period
RW-1	100	0.2	9,635
RW-1A	100	1.0	43,465
RW-1B	100	2.6	116,390
RW-2	100	3.6	161,422
RW-3	100	2.4	107,114
RW-4	100	9.6	426,931
RW-5	0.0	0.0	0
RW-6	0.0	0.0	0
RW-7	0.0	0.0	0
RW-8	0.0	0.0	0
RW-9	0.0	0.0	0

System Effluent Samples Collected:

The most recent effluent analytical results are from Oct 2008.

Mass removal is calculated based on daily flow rates and the most recent analytical data. Cumulative amounts reflect contaminant removal since initial system startup.

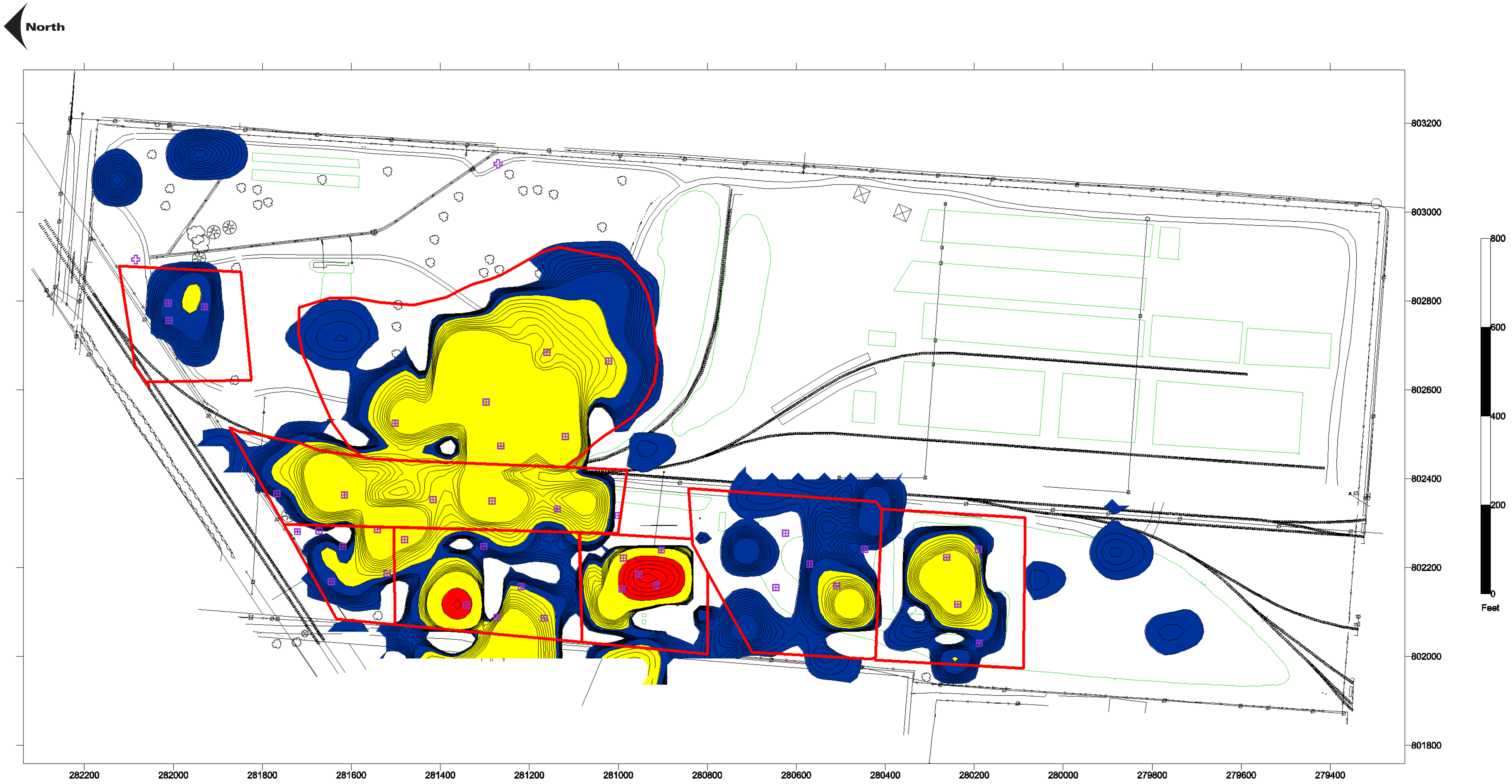
Contaminant Mass Removal:

December 2008: 0.13 lbs TCE; 0.44 lbs Total VOCs

Cumulative: 369.34 lbs TCE; 918.25 lbs Total VOCs

Total System Effluent through 31 December 2008 (gallons): **312,015,593**

Prepared by: SLH 01/09/09



Projection: Tennessee State Plane
Zone: 5301
Datum: NAD 27
X,Y Units: Feet

Passive Soil Gas
Concentration Contours

🟥 High (> 3.0 ug)

🟨 Moderate (0.3 - 3.0 ug)

🟦 Low (0.03 - 0.3 ug)

Suspected Burial Sites

Site Consolidation Locations

FIGURE 4-2
PASSIVE SOIL GAS SURVEY
TETRACHLOROETHYLENE (PCE)
REV. 0 MEMPHIS DEPOT DUNN FIELD RI

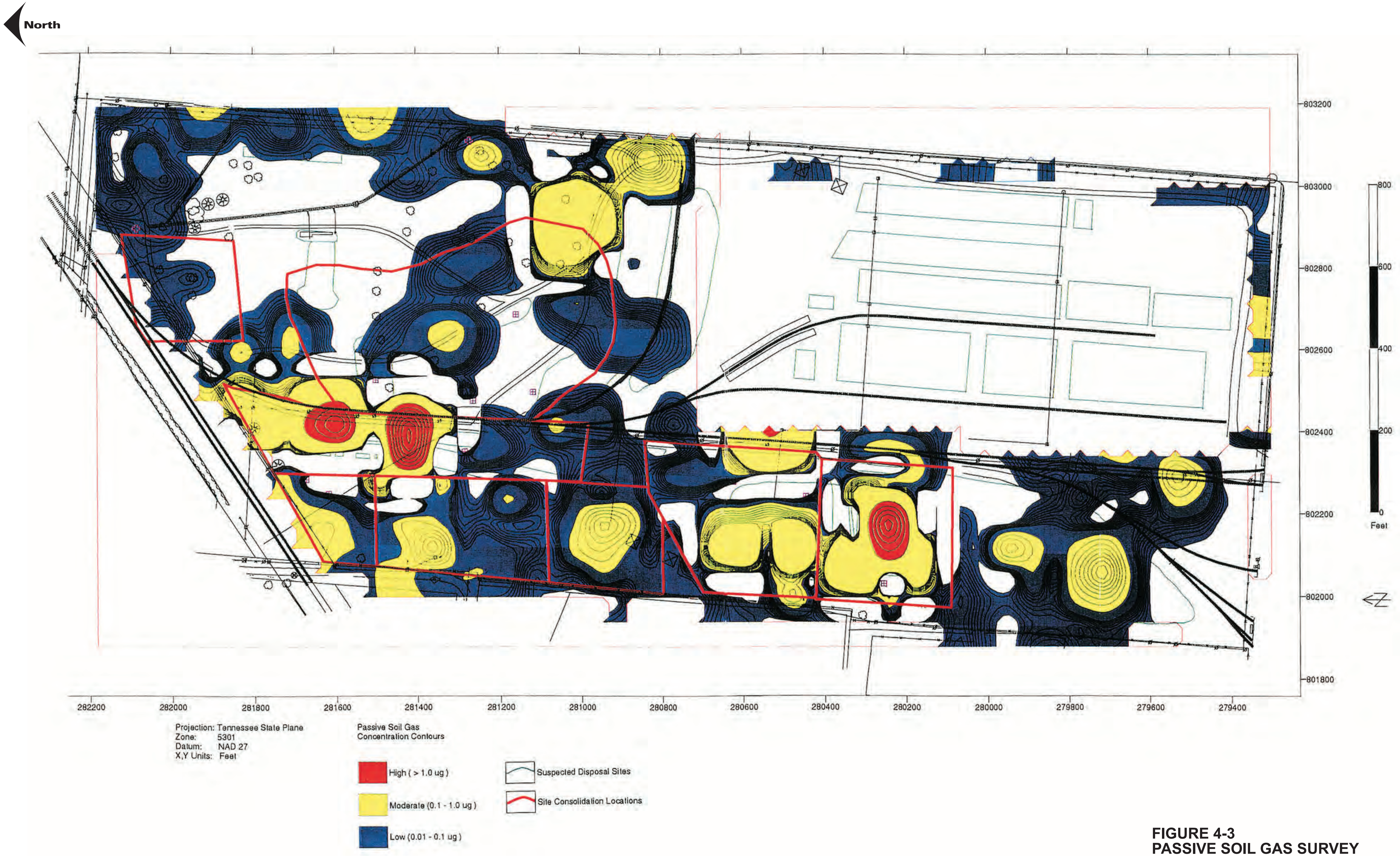
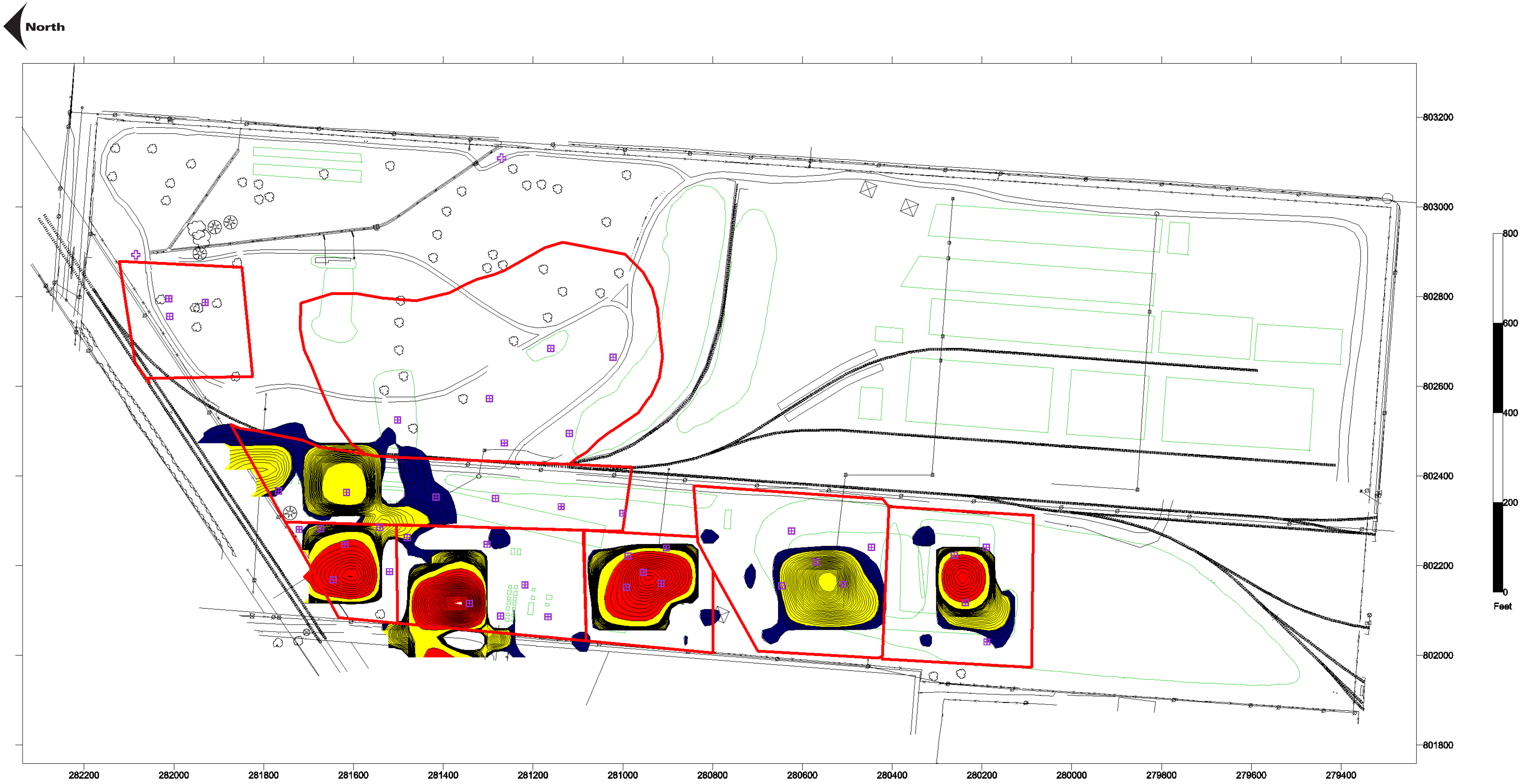


FIGURE 4-3
PASSIVE SOIL GAS SURVEY
TRICHLOROETHYLENE (TCE)
REV. 0 MEMPHIS DEPOT DUNN FIELD RI



Projection: Tennessee State Plane
Zone: 5301
Datum: NAD 27
X,Y Units: Feet

Passive Soil Gas
Concentration Contours

🟥 High (> 3.0 ug)

🟨 Moderate (0.2 - 3.0 ug)

🟦 Low (0.02 - 0.2 ug)

Suspected Burial Sites

Site Consolidation Locations

FIGURE 4-4
PASSIVE SOIL GAS SURVEY
TOTAL 1,2-DICHLOROETHENE (1,2-DCE)

REV. 0 MEMPHIS DEPOT DUNN FIELD RI

E032002012ATL/Memphis Depot 116.FH8

CH2MHILL

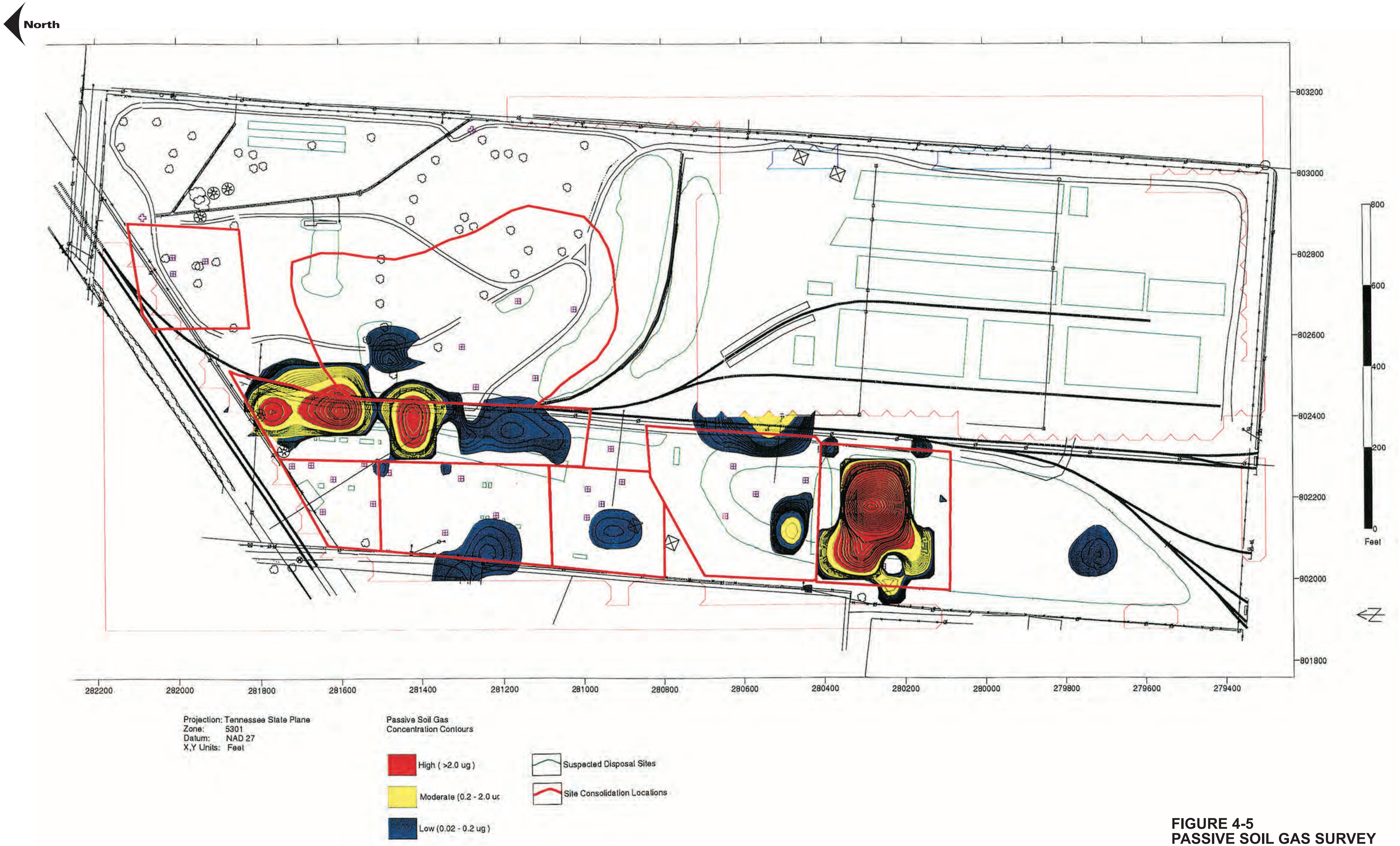
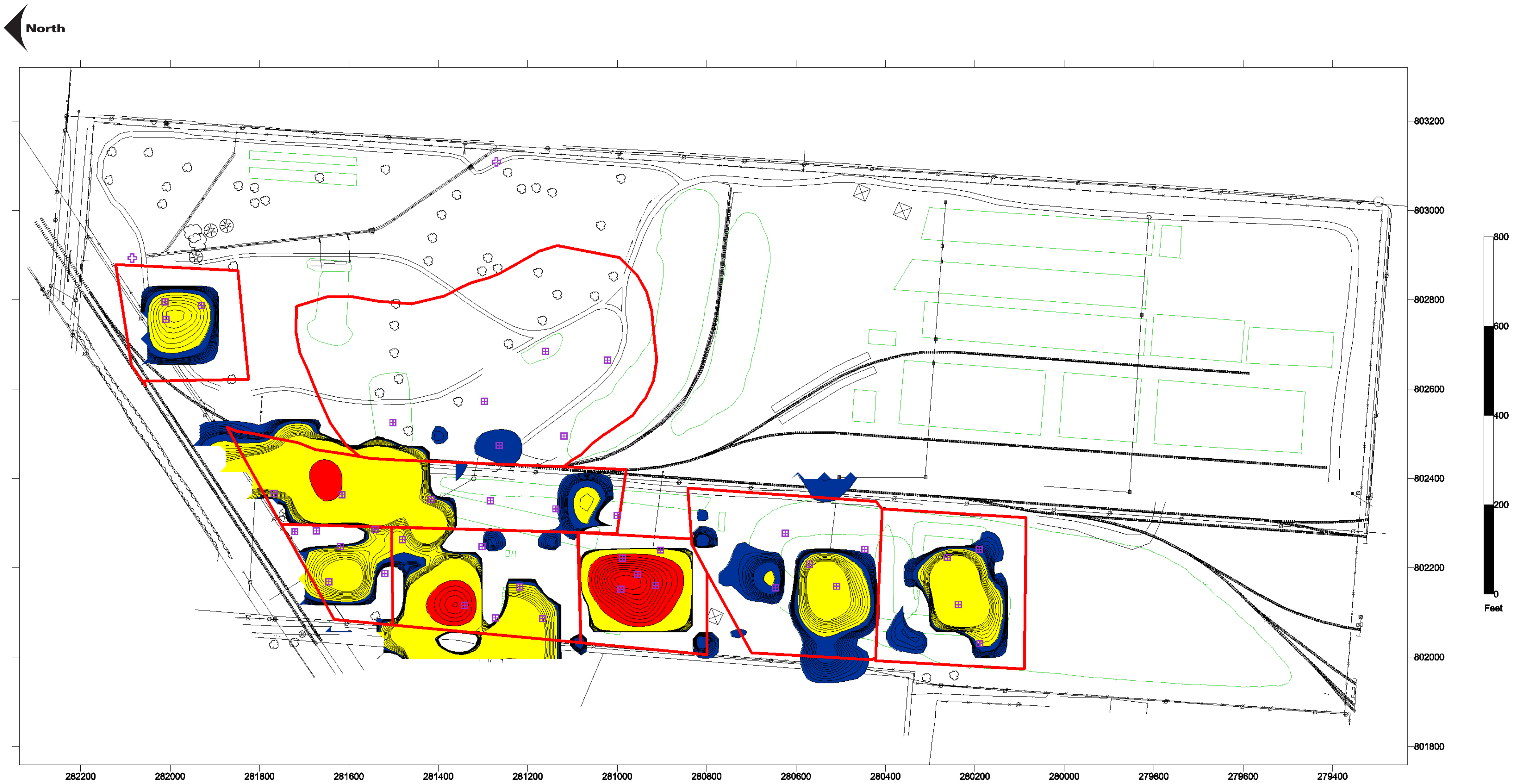


FIGURE 4-5
PASSIVE SOIL GAS SURVEY
CARBON TETRACHLORIDE
REV. 0 MEMPHIS DEPOT DUNN FIELD RI



Projection: Tennessee State Plane
Zone: 5301
Datum: NAD 27
X,Y Units: Feet

Passive Soil Gas
Concentration Contours

🟥 High (> 3.0 ug)

🟨 Moderate (0.3 - 3.0 ug)

🟦 Low (0.03 - 0.3 ug)

Suspected Burial Sites

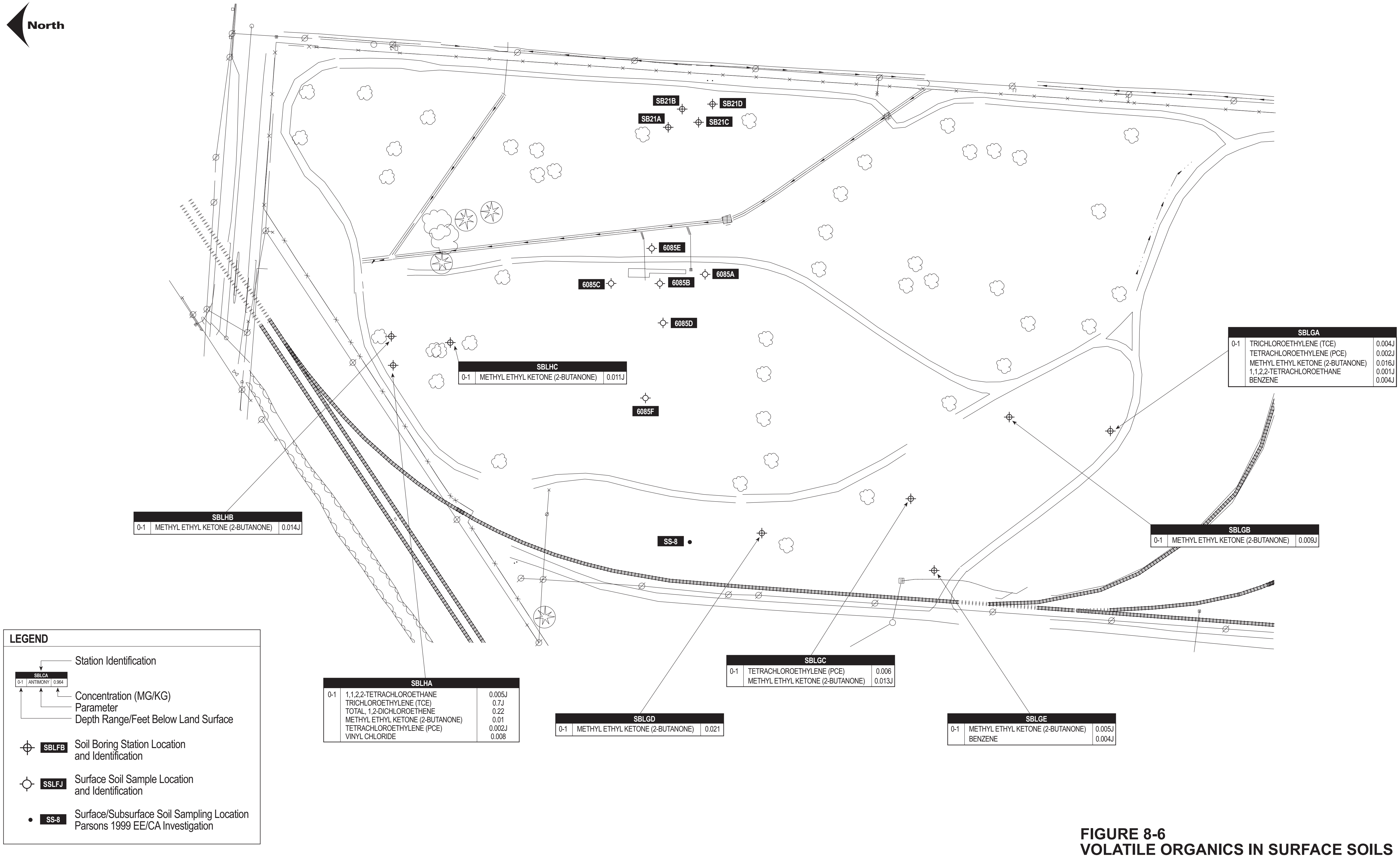
Site Consolidation Locations

FIGURE 4-6
PASSIVE SOIL GAS SURVEY CHLOROFORM

REV. 0 MEMPHIS DEPOT DUNN FIELD RI

E032002012ATL/Memphis Depot 117.FH8

CH2MHILL



SBLHC

0-1	METHYL ETHYL KETONE (2-BUTANONE)	0.011J

SBLGA

0-1	TRICHLOROETHYLENE (TCE)	0.004J
	TETRACHLOROETHYLENE (PCE)	0.002J
	METHYL ETHYL KETONE (2-BUTANONE)	0.016J
	1,1,2,2-TETRACHLOROETHANE	0.001J
	BENZENE	0.004J

SBLHB

0-1	METHYL ETHYL KETONE (2-BUTANONE)	0.014J

SBLGB

0-1	METHYL ETHYL KETONE (2-BUTANONE)	0.009J

SBLGC

0-1	TETRACHLOROETHYLENE (PCE)	0.006
	METHYL ETHYL KETONE (2-BUTANONE)	0.013J

SBLHA

0-1	1,1,2,2-TETRACHLOROETHANE	0.005J
	TRICHLOROETHYLENE (TCE)	0.7J
	TOTAL, 1,2-DICHLOROETHENE	0.22
	METHYL ETHYL KETONE (2-BUTANONE)	0.01
	TETRACHLOROETHYLENE (PCE)	0.002J
	VINYL CHLORIDE	0.008

SBLGD

0-1	METHYL ETHYL KETONE (2-BUTANONE)	0.021

SBLGE

0-1	METHYL ETHYL KETONE (2-BUTANONE)	0.005J
	BENZENE	0.004J

LEGEND

SBLCA

0-1	ANTIMONY	0.964

Station Identification
Concentration (MG/KG)
Parameter
Depth Range/Feet Below Land Surface

⌖ SBLFB Soil Boring Station Location and Identification

⌖ SSLFJ Surface Soil Sample Location and Identification

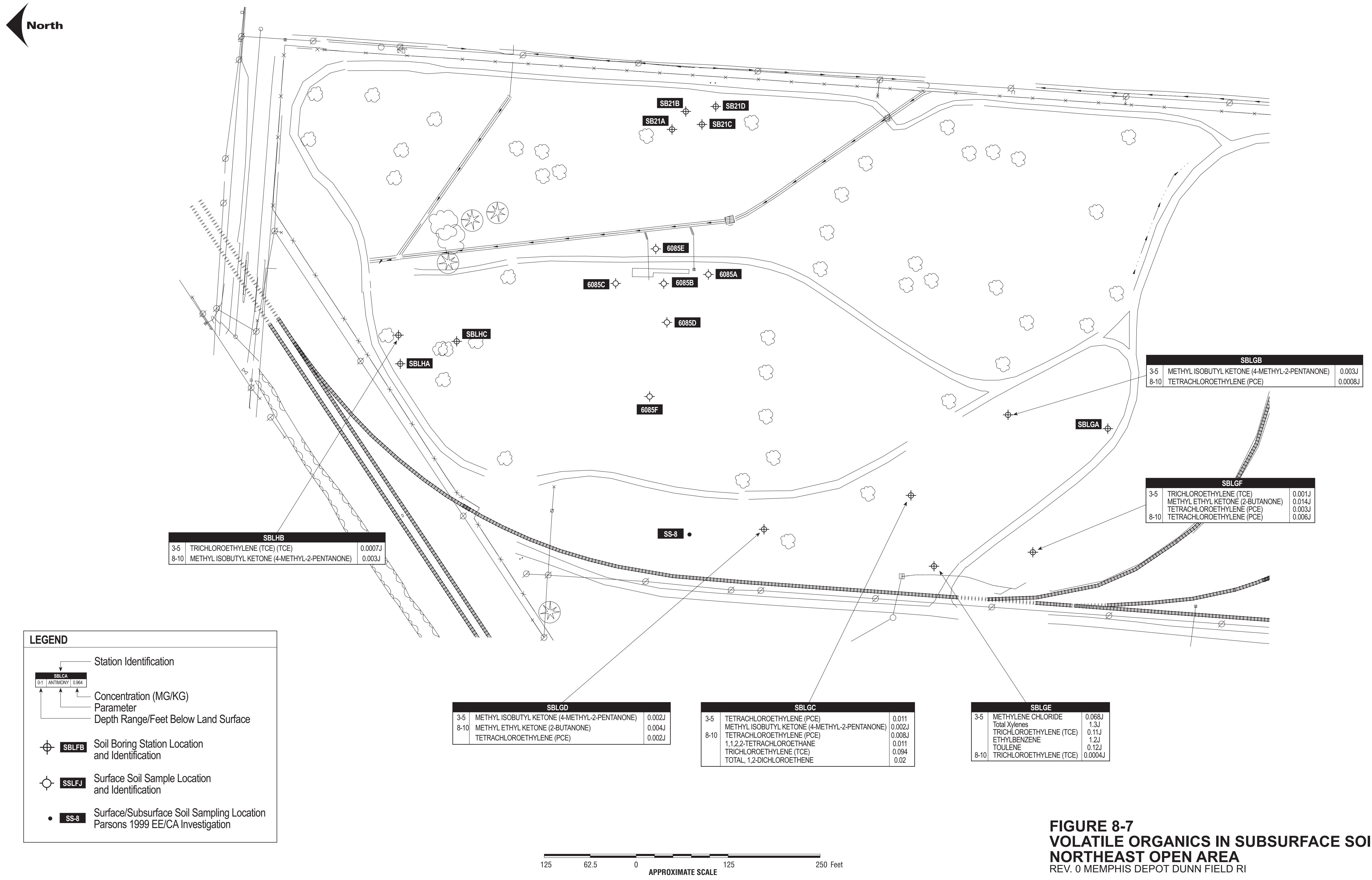
● SS-8 Surface/Subsurface Soil Sampling Location Parsons 1999 EE/CA Investigation

FIGURE 8-6
VOLATILE ORGANICS IN SURFACE SOILS NORTHEAST OPEN AREA

REV. 0 MEMPHIS DEPOT DUNN FIELD RI

E072001017ATL \ Dunn120.FH8

CH2MHILL



SBLHB

3-5	TRICHLOROETHYLENE (TCE) (TCE)	0.0007J
8-10	METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	0.003J

SBLGB

3-5	METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	0.003J
8-10	TETRACHLOROETHYLENE (PCE)	0.0008J

SBLGF

3-5	TRICHLOROETHYLENE (TCE)	0.001J
	METHYL ETHYL KETONE (2-BUTANONE)	0.014J
	TETRACHLOROETHYLENE (PCE)	0.003J
8-10	TETRACHLOROETHYLENE (PCE)	0.006J

SBLGD

3-5	METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	0.002J
8-10	METHYL ETHYL KETONE (2-BUTANONE)	0.004J
	TETRACHLOROETHYLENE (PCE)	0.002J

SBLGC

3-5	TETRACHLOROETHYLENE (PCE)	0.011
	METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	0.002J
8-10	TETRACHLOROETHYLENE (PCE)	0.008J
	1,1,2,2-TETRACHLOROETHANE	0.011
	TRICHLOROETHYLENE (TCE)	0.094
	TOTAL, 1,2-DICHLOROETHENE	0.02

SBLGE

3-5	METHYLENE CHLORIDE	0.068J
	Total Xylenes	1.3J
	TRICHLOROETHYLENE (TCE)	0.11J
	ETHYLBENZENE	1.2J
	TOULENE	0.12J
8-10	TRICHLOROETHYLENE (TCE)	0.0004J

LEGEND

Station Identification

SBLCA

0-1	ANTIMONY	0.964

Concentration (MG/KG)
Parameter
Depth Range/Feet Below Land Surface

⌖ **SBLFB** Soil Boring Station Location and Identification

○ **SSLFJ** Surface Soil Sample Location and Identification

● **SS-8** Surface/Subsurface Soil Sampling Location Parsons 1999 EE/CA Investigation

FIGURE 8-7
VOLATILE ORGANICS IN SUBSURFACE SOILS NORTHEAST OPEN AREA

REV. 0 MEMPHIS DEPOT DUNN FIELD RI

CH2MHILL

E072001017ATL \ Dunn121.FH8

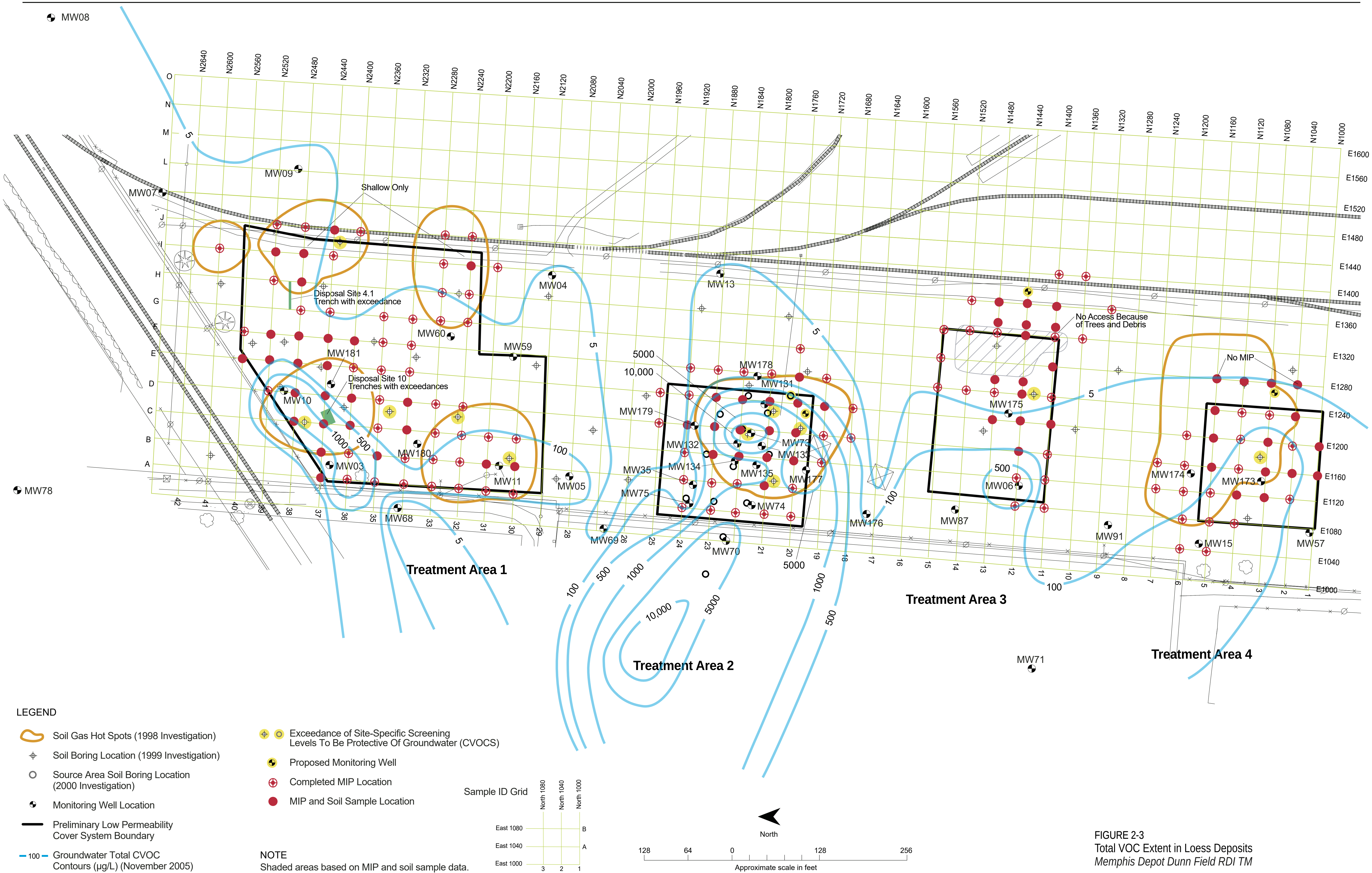
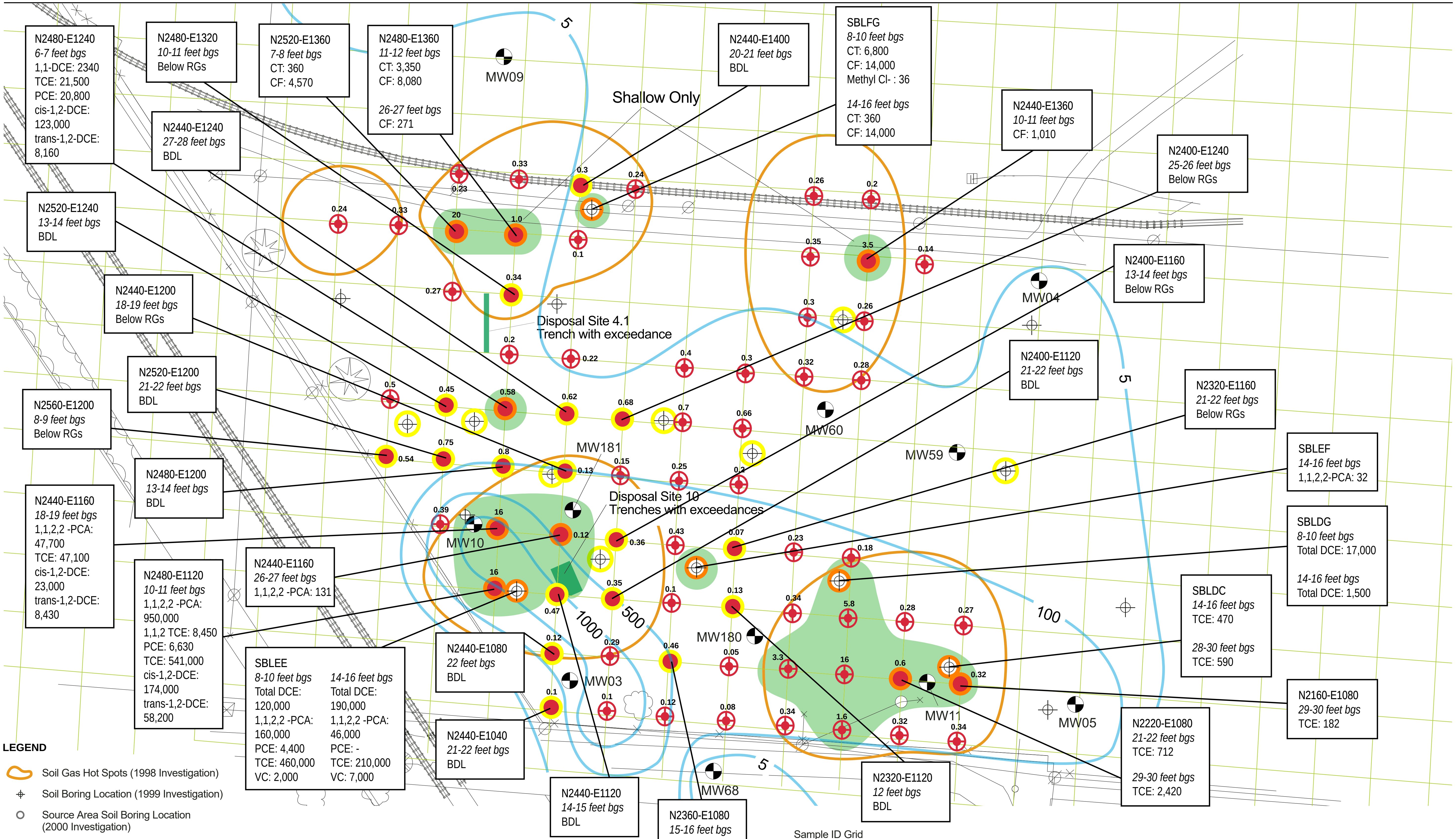


FIGURE 2-3
Total VOC Extent in Loess Deposits
Memphis Depot Dunn Field RDI TM



LEGEND

- Soil Gas Hot Spots (1998 Investigation)
- ⌖ Soil Boring Location (1999 Investigation)
- ○ Source Area Soil Boring Location (2000 Investigation)
- ◐ Monitoring Well Location
- Preliminary Low Permeability Cover System Boundary
- 100 Groundwater Total CVOC Contours (µg/L) (November 2005)
- 🟩 Estimated Extent of Areas Requiring Remedial Action
- ⊕ Proposed Soil Sample Location
- ⊕ Completed MIP Location
- ● MIP and Soil Sample Location
- 0.32 Maximum ECD Response

bgs	Below Ground Surface
BDL	Below Detection Limits
RG	Remedial Goals
○	Below RGs
○	Above RGs

NOTE
1) Shaded areas based on MIP and soil sample data.
2) Soil concentrations in µg/kg.

Sample ID Grid
North 1080 North 1040 North 1000
East 1080
East 1040
East 1000

North

0 40 80
Approximate scale in feet bgs

FIGURE 3-1a
Total VOC Extent in Loess Deposits - Treatment Area 1
Memphis Depot Dunn Field Remedial Design

CH2MHILL

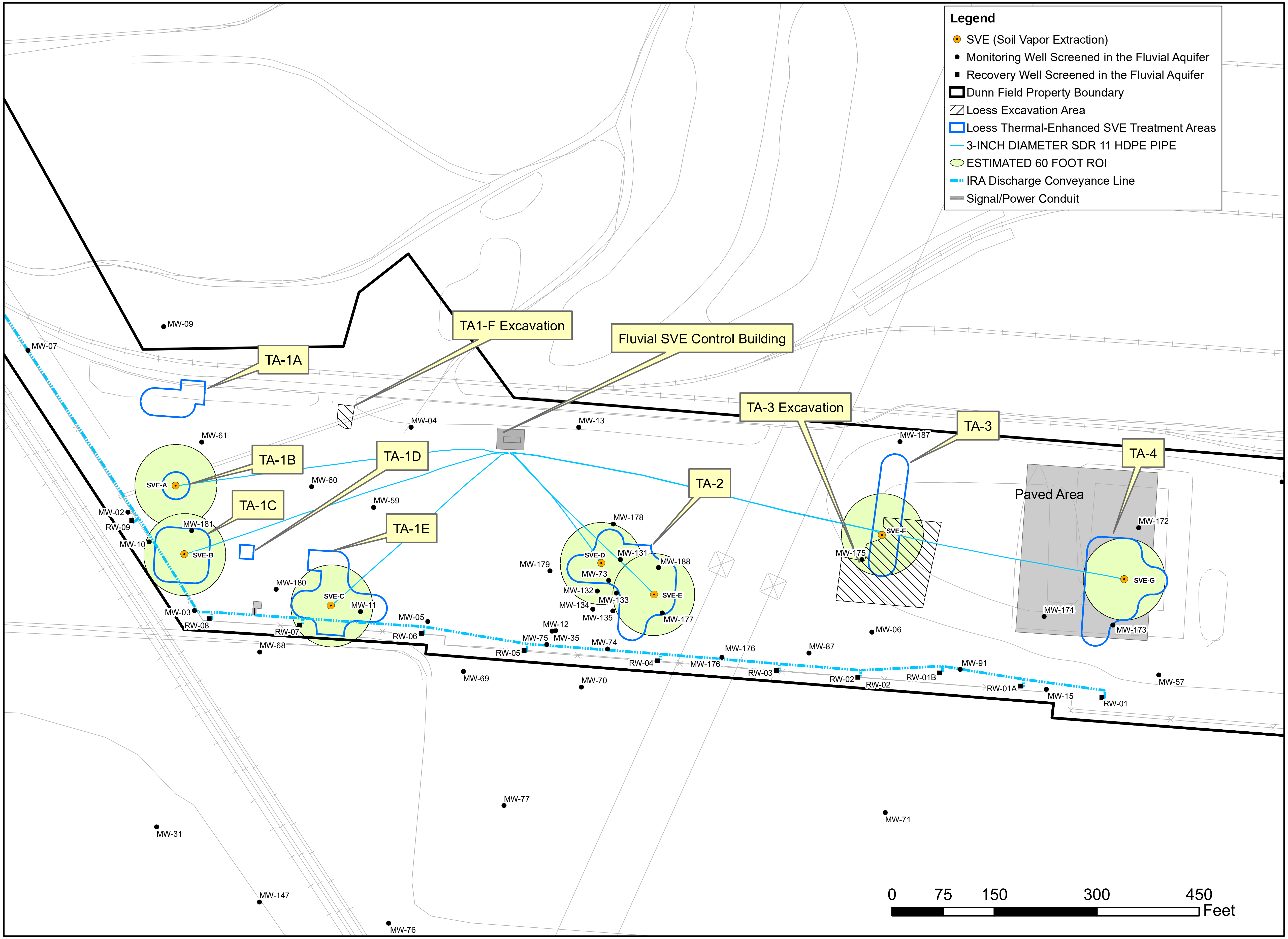


Figure 6

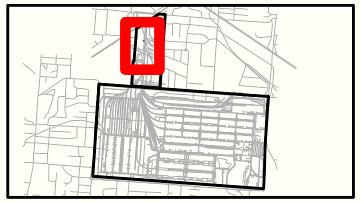
SOURCE AREAS SUBSURFACE SOIL REMEDY

SOURCE AREAS INTERIM
REMEDIAL ACTION
COMPLETION REPORT

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

Installation Location
Memphis, Tennessee



Date: September 2009
Edition: Rev 1

G:\3202019\01-15\IRACR Report\GIS\Figure 6.mxd

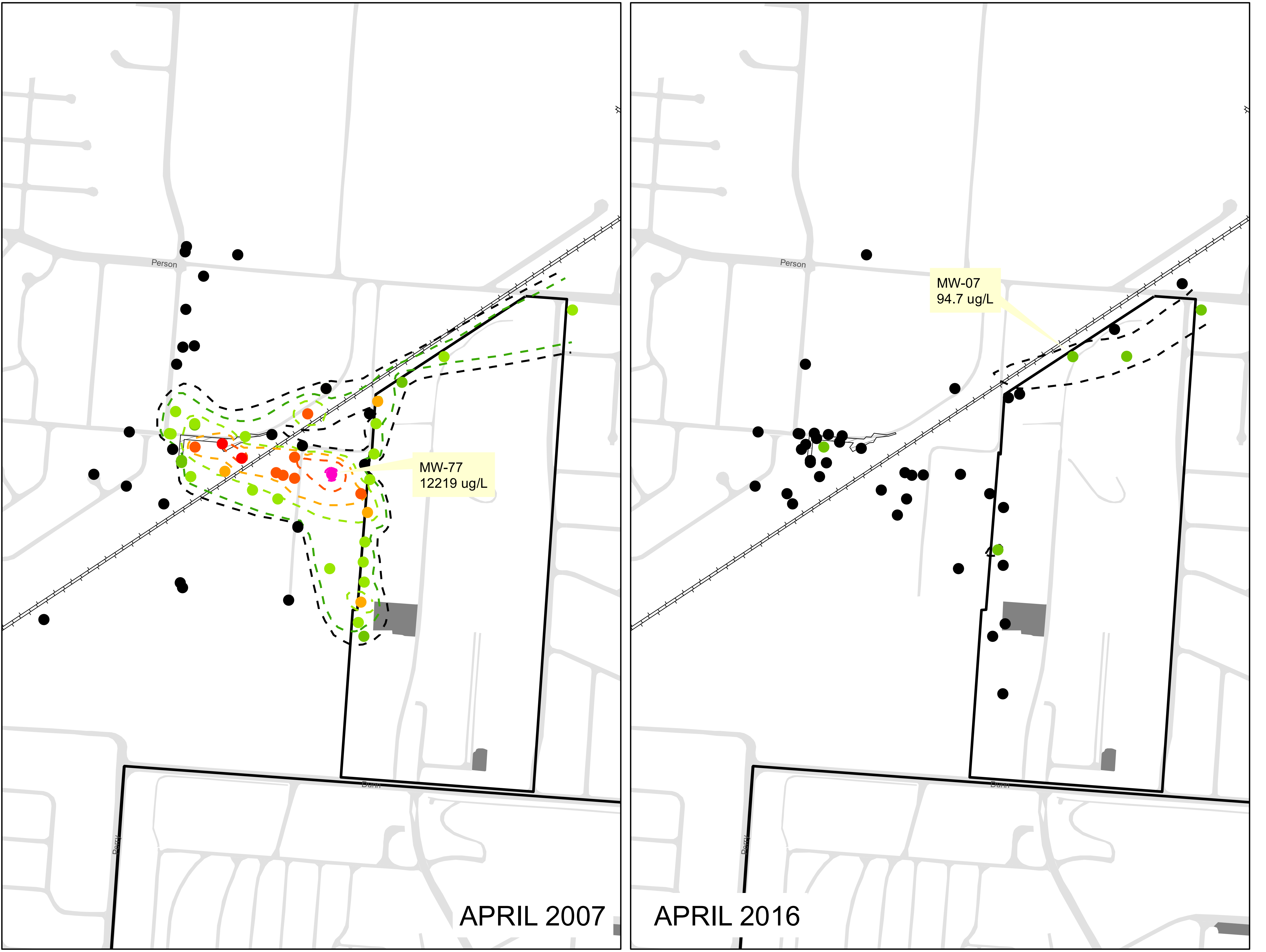


Figure 19

Dunn Field Total CVOC Concentrations, 2007 - 2016

2017 Site Management Plan

Defense Depot
Memphis, Tennessee

Legend

Total CVOC Isopleth (ug/L)

- ● 0-50
- ● 50-100
- ● 100-500
- ● 500-1000
- ● 1000-5000
- ● 5000-10000
- ● 10000-50000

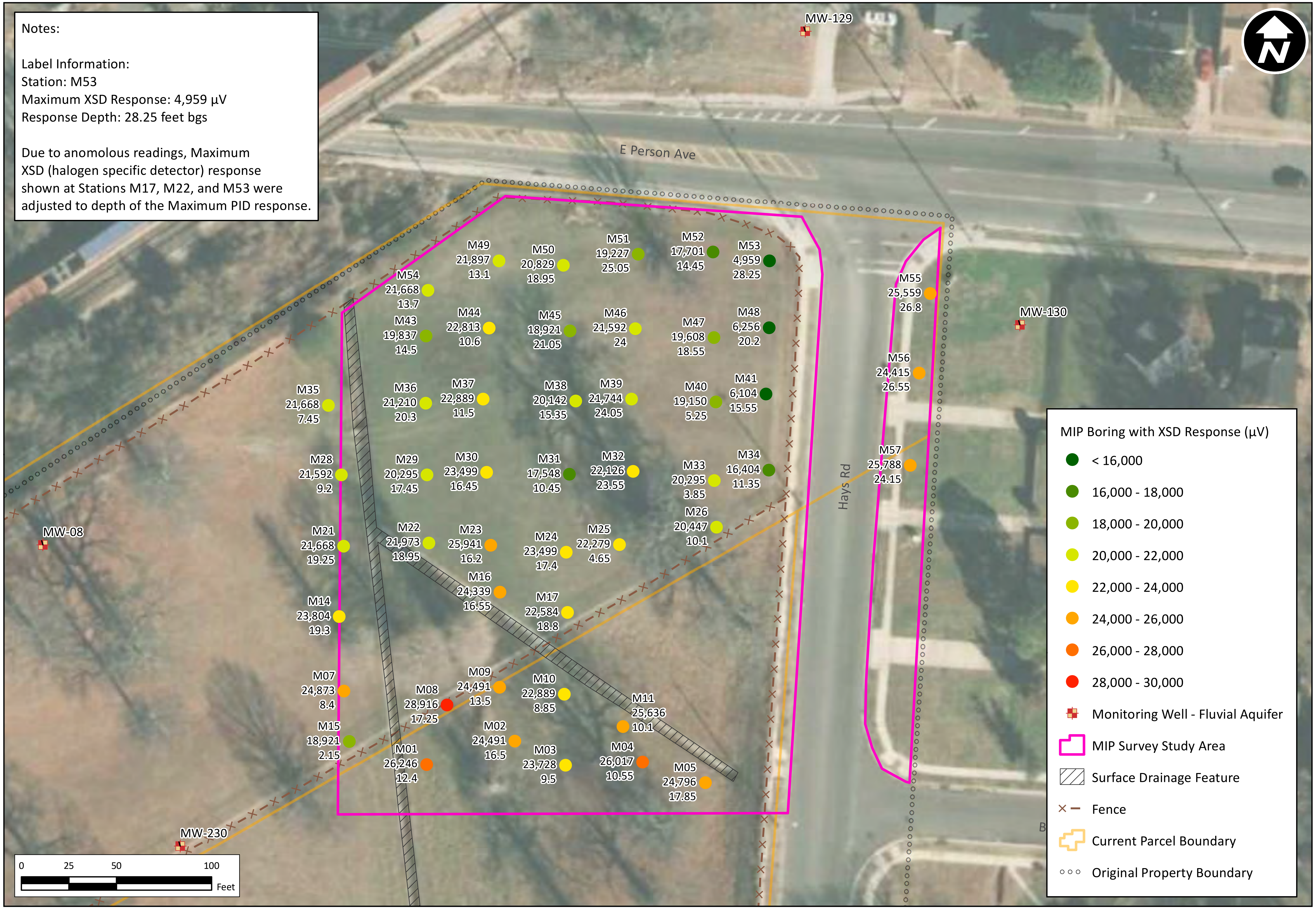
Total CVOC Ranges (ug/L)

- 50
- 100
- 500
- 1000
- 5000
- 10000
- Original Property Boundary
- ▨ Off Depot Air Sparge Area
- ■ Paved Area
- □ Roads
- Railroad

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet , mean sea level

Date: 11/9/2016
Edition: Rev 0

Path: W:\SMP\2017\19_Figure_19.mxd



Notes:

Label Information:
Station: M53
Maximum XSD Response: 4,959 µV
Response Depth: 28.25 feet bgs

Due to anomolous readings, Maximum XSD (halogen specific detector) response shown at Stations M17, M22, and M53 were adjusted to depth of the Maximum PID response.

MIP Boring with XSD Response (µV)

- ● < 16,000
- ● 16,000 - 18,000
- ● 18,000 - 20,000
- ● 20,000 - 22,000
- ● 22,000 - 24,000
- ● 24,000 - 26,000
- ● 26,000 - 28,000
- ● 28,000 - 30,000
- ✚ Monitoring Well - Fluvial Aquifer
- ▭ MIP Survey Study Area
- ▨ Surface Drainage Feature
- ×— Fence
- ▭ Current Parcel Boundary
- ∘∘∘ Original Property Boundary

Service Layer Credits: TN Department of Transportation

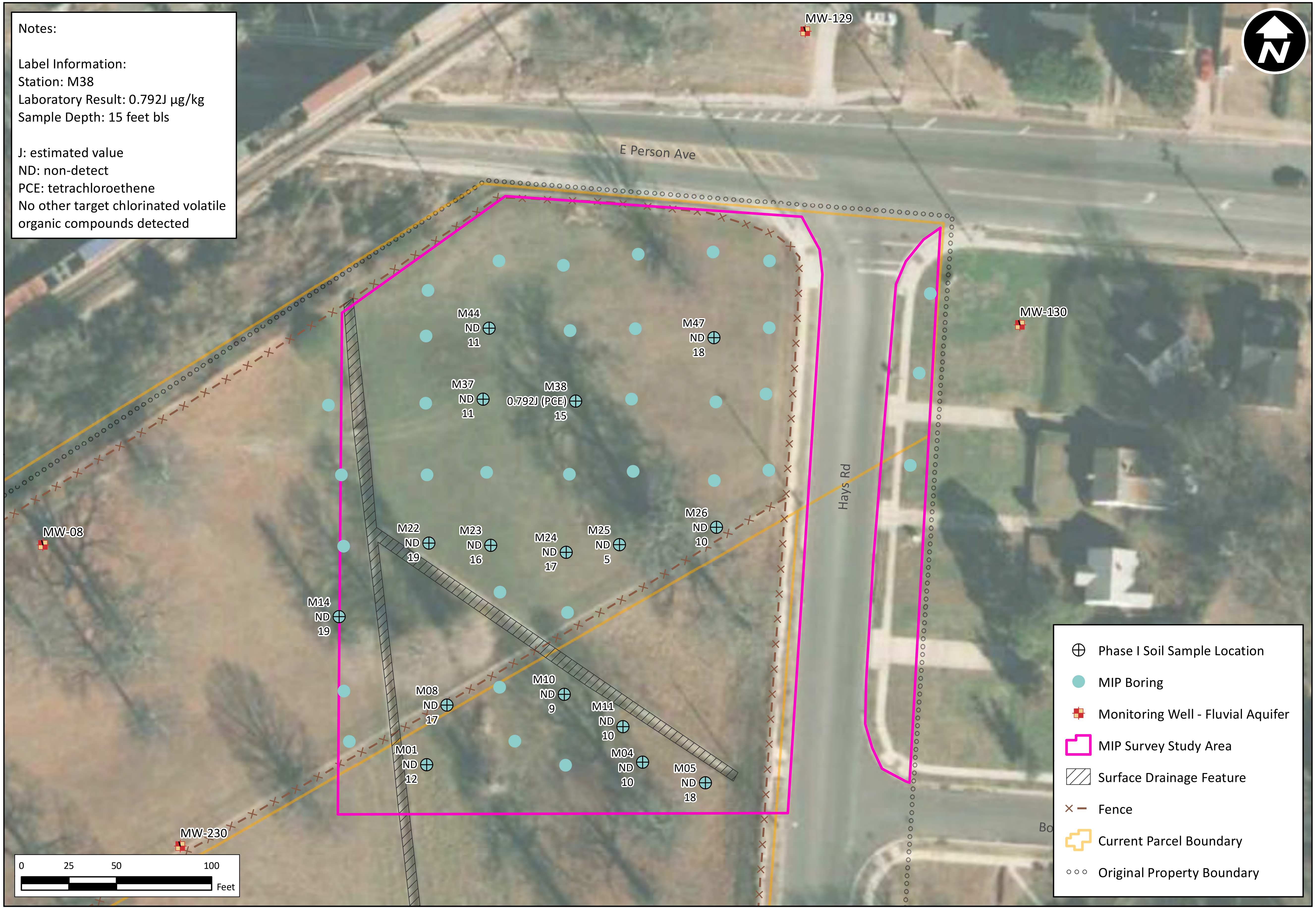
Trinity Analysis & Development Corp.

Figure 5
MIP Survey Results
Distribution of Maximum XSD Response

Dunn Field
Defense Depot Memphis, Tennessee
Memphis, Shelby County, Tennessee

DRAWN BY:	JTC
DATE:	11/01/2017
SCALE:	AS SHOWN
PROJECT NO:	W9128F-11-D-0029 CK01

U.S.ARMY



Notes:

Label Information:
Station: M38
Laboratory Result: 0.792J µg/kg
Sample Depth: 15 feet bls

J: estimated value
ND: non-detect
PCE: tetrachloroethene
No other target chlorinated volatile organic compounds detected

⊕ Phase I Soil Sample Location
● MIP Boring
🟥 Monitoring Well - Fluvial Aquifer
☐ MIP Survey Study Area
▨ Surface Drainage Feature
×— Fence
☐ Current Parcel Boundary
○○○ Original Property Boundary

Service Layer Credits: TN Department of Transportation

Trinity Analysis & Development Corp.

Figure 6
Phase I Confirmation Soil Sampling Location and Results

Dunn Field
Defense Depot Memphis, Tennessee
Memphis, Shelby County, Tennessee

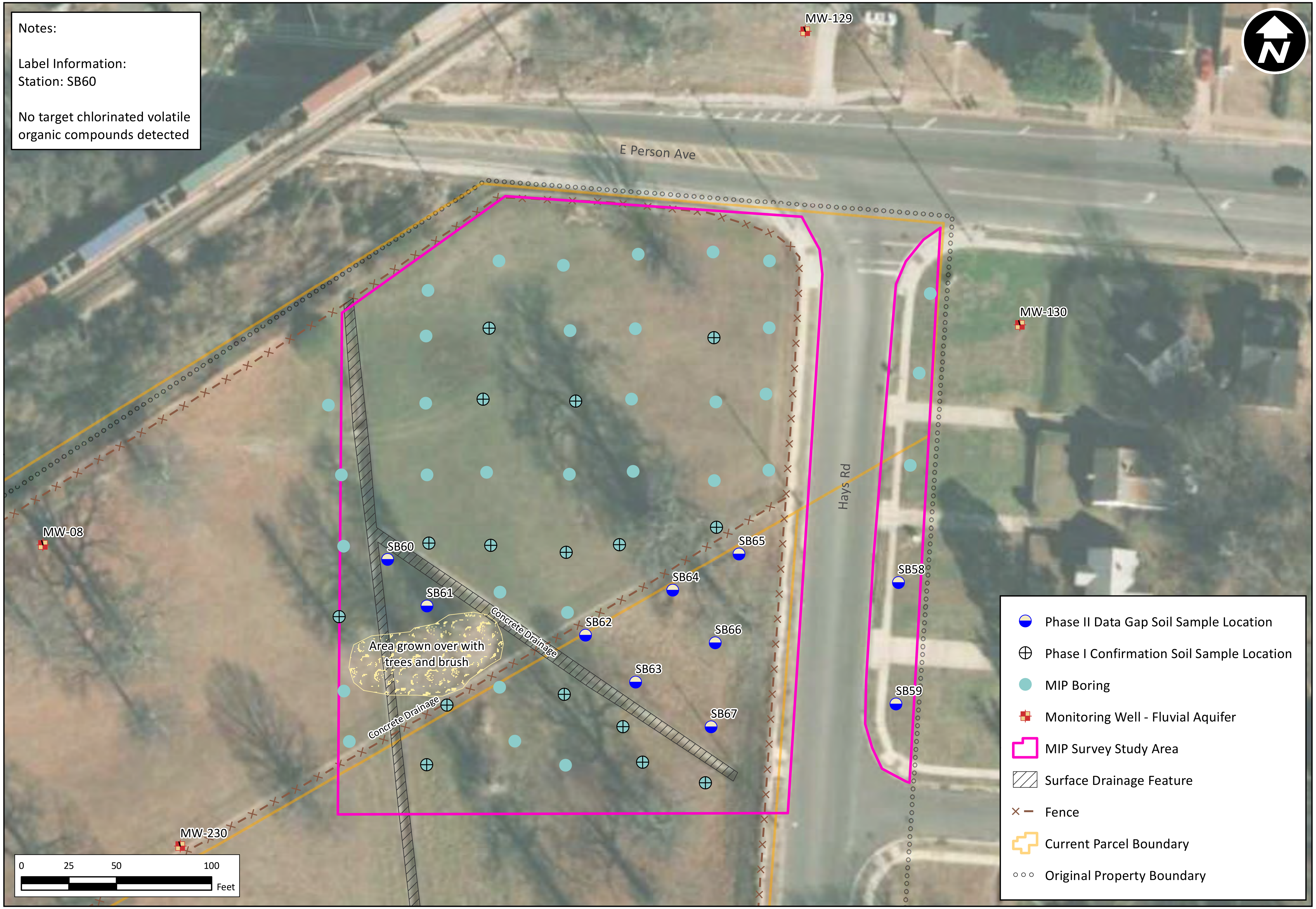
DRAWN BY: JTC
DATE: 11/01/2017
SCALE: AS SHOWN
PROJECT NO: W9128F-11-D-0029 CK01

U.S.ARMY

Figure 7
Phase II Data Gap Soil Sampling Locations and Results

Dunn Field
Defense Depot Memphis, Tennessee
Memphis, Shelby County, Tennessee

DRAWN BY: JTC
DATE: 11/01/2017
SCALE: AS SHOWN
PROJECT NO: W9128F-11-D-0029 CK01



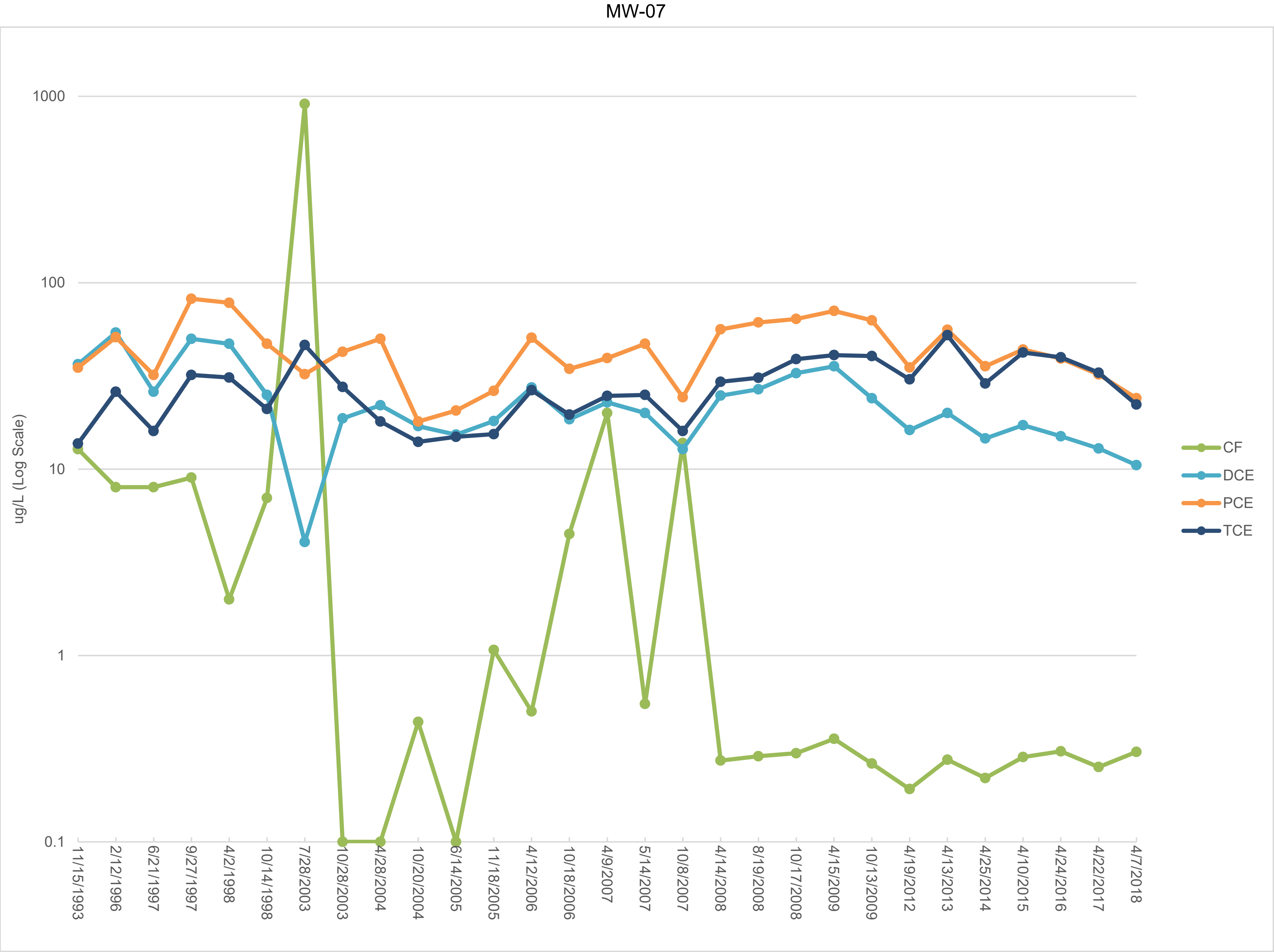
Notes:

Label Information:
Station: SB60

No target chlorinated volatile organic compounds detected

Service Layer Credits: TN Department of Transportation

Trinity Analysis & Development Corp.


MW-07
ug/L (Log Scale)
1000
100
10
1
0.1
11/15/1993
2/12/1996
6/21/1997
9/27/1997
4/2/1998
10/14/1998
7/28/2003
10/28/2003
4/28/2004
10/20/2004
6/14/2005
11/18/2005
4/12/2006
10/18/2006
4/9/2007
5/14/2007
10/8/2007
4/14/2008
8/19/2008
10/17/2008
4/15/2009
10/13/2009
4/19/2012
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4/25/2014
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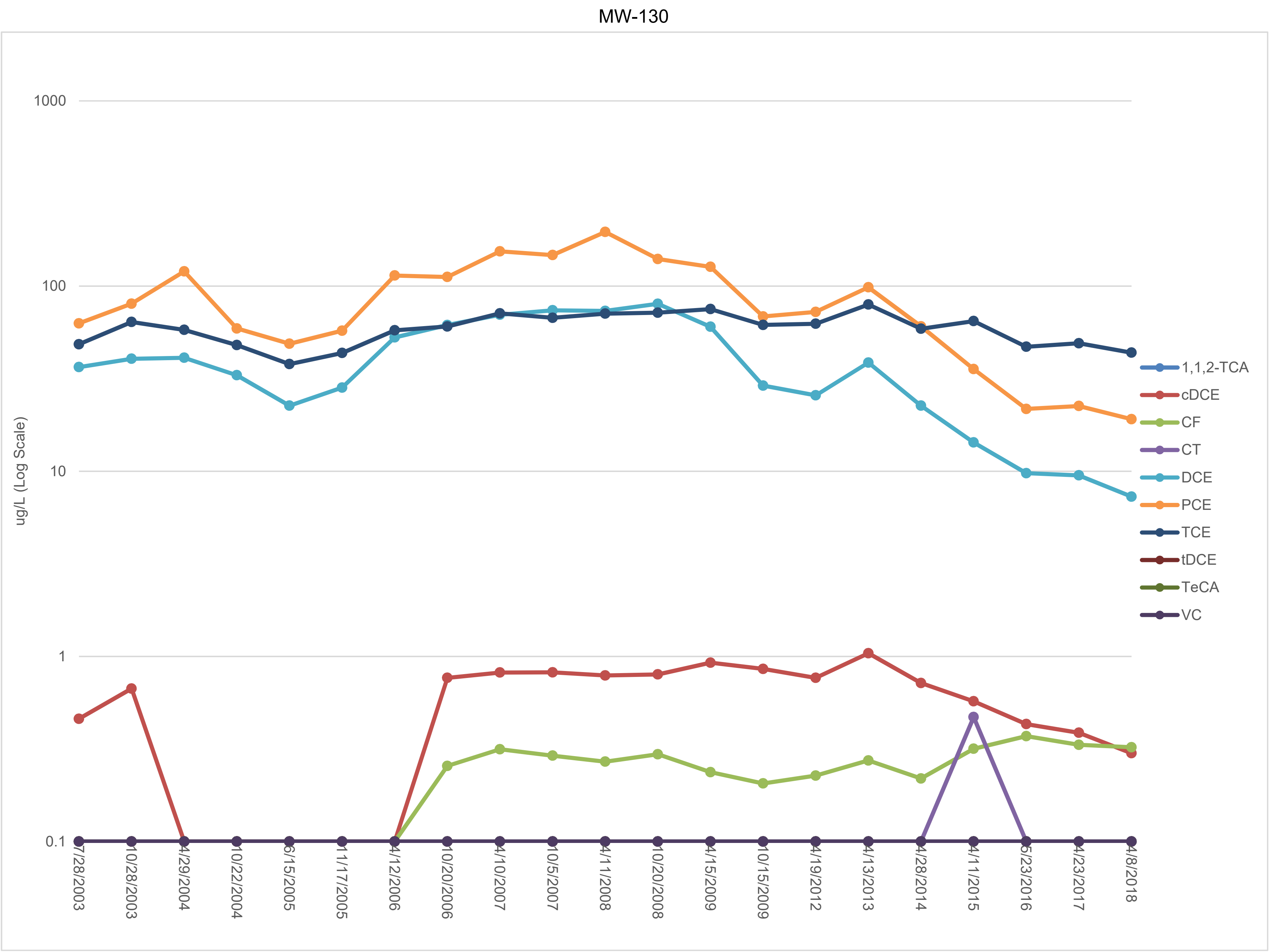
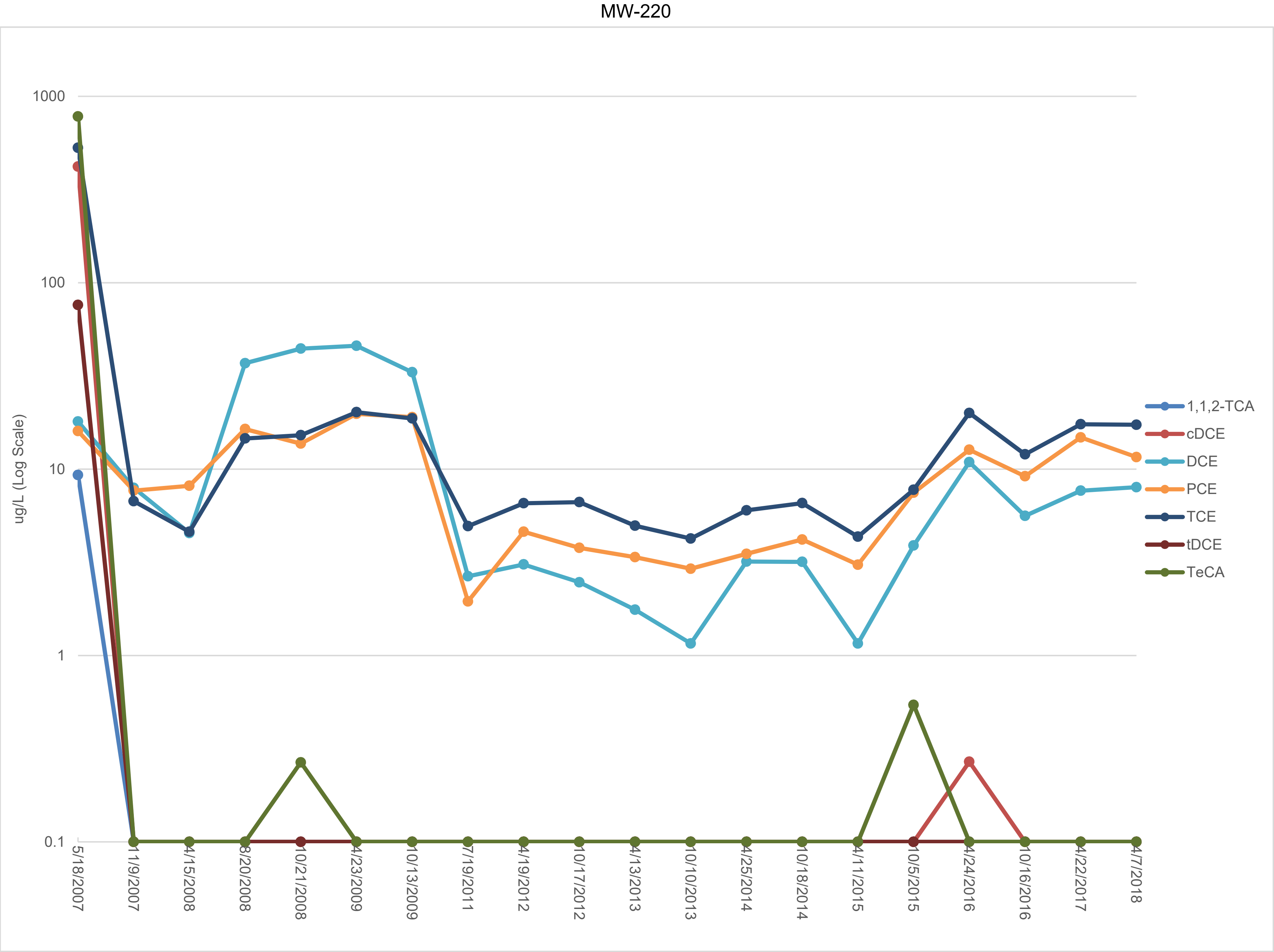
4/24/2016
4/22/2017
4/7/2018
CF
DCE
PCE
TCE


MW-130
1000
100
10
1
0.1
ug/L (Log Scale)
7/28/2003
10/28/2003
4/29/2004
10/22/2004
6/15/2005
11/17/2005
4/12/2006
10/20/2006
4/10/2007
10/5/2007
4/11/2008
10/20/2008
4/15/2009
10/15/2009
4/19/2012
4/13/2013
4/28/2014
4/11/2015
5/23/2016
4/23/2017
4/8/2018
1,1,2-TCA
cDCE
CF
CT
DCE
PCE
TCE
tDCE
TeCA
VC


MW-220
ug/L (Log Scale)
1000
100
10
1
0.1
5/18/2007
11/9/2007
4/15/2008
8/20/2008
10/21/2008
4/23/2009
10/13/2009
7/19/2011
4/19/2012
10/17/2012
4/13/2013
10/10/2013
4/25/2014
10/18/2014
4/11/2015
10/5/2015
4/24/2016
10/16/2016
4/22/2017
4/7/2018
1,1,2-TCA
cDCE
DCE
PCE
TCE
tDCE
TeCA

Appendix B
Field 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, 2017a. *2017 Uniform Federal Policy-Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 0*. Prepared for the U.S. Army Corps of Engineers, Mobile District. May 2017.

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 SOIL 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 soil 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, 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 soil 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 soil samples for field 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 soil 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 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 FTL.

All 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 all aboveground or underground on-site utilities.

Prior to the start of drilling activities, the drilling subcontractor will hand auger at each drilling location to a depth of 4 ft bgs, in order to verify that no underground utilities or objects are 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, nitrile gloves, field drill log forms, camera, 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. Have a surveyor 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) 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 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 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 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 sonic 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 (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; the liners will be laid out for visual logging and sampling for headspace readings and laboratory analysis.
- The drilling subcontractor will place all soil cores on the ground near the drill rig in order for the HDR geologist/engineer to safely examine, log, and collect samples from the recovered soil core.
- 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 of a given 10 foot section of soil core, the drilling subcontractor will place the core in an approved soil cutting disposal container.
- 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.
- All drilling equipment will be decontaminated prior to drilling activities in accordance with SOP 9 *Equipment Decontamination*.
- Any investigative-derived waste (i.e., drill cuttings, drilling fluid) that is contaminated will be disposed as specified in the project work plan.
- Soil cuttings will be examined for contamination. If contamination is suspected, they will be noted on the boring log form and the suspect 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

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 and wells at DDMT are completed 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 or to the target well depth. 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 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 galvanized or PVC tremie pipe connected to a grout pumping unit through the inner annulus of the casing. The driller will pump grout through the injection 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.

6.2.5 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 advancement of the soil borings, the following sampling devices may also be used:

- Chemical Sample Collection: 2 or 3-inch diameter carbon steel split-barrel sampler lined with California brass rings (CBRs)
- Geotechnical Sample (disturbed) Collection: 2-inch diameter carbon steel split-barrel sampler
- 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 Unified Soil Classification System (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 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.
- Partially fill two decontaminated 16-ounce containers with soil using the stainless steel spoon.
- Cover the jars immediately with aluminum foil and fasten the jar lids.
- Allow the sample vapors to equilibrate in the jars (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)
- Collect a reading from the first sample jar by puncturing the aluminum foil with the tip of a calibrated PID and recording the highest reading.
- If the reading is > 10 parts per million, collect a reading with the activated charcoal filter on the calibrated FID for the second jar. 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, any 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 any 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 any problems encountered during sampling in the Field Sampling Report Form and Daily Quality Control Report Form.

- For borings where a monitoring well will be installed, a sample for total organic carbon (TOC) analysis may be collected from the interval to be screened. The TOC samples will be collected from the soil core using a pre-cleaned stainless steel spoon and placed in the appropriate laboratory supplied container.

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 5-gram 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 a) through e) for the remaining 5-gram and 25-gram sampler.
- Collect a bulk soil sample for screening and moisture determination in a 2 or 4-ounce wide mouth glass 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 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.

6.2.6 Post Run Tubing Boring Construction

The post run tubing (PRT) drill rod will be advanced into the subsurface to 5.5 feet bgs by a direct-push drill rig. After reaching 5.5 feet bgs, the PRT rod will be retracted approximately 6 inches exposing the soil interval (5 feet bgs to 5.5 feet bgs) 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 Closeout

6.3.1 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.

6.3.2 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. 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, 2018a. 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 RA SAP (MACTEC, 1995) 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 at least 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 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 foot below the target depth and backfilled with filter sand before installing the VMP. A 12-inch section of #100 mesh stainless steel screen implants will be installed to the surface with ¼-inch ID Teflon tubing. Well screen and tubing will be new, unused, decontaminated, material.

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 hydrated bentonite with a thickness of approximately one foot will be placed above the filter pack at each well. 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 one foot of the ground surface. The grout will be allowed to cure for a minimum of eight hours before further grouting or well construction.

6.2.4 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.

6.2.5 Surface Completion

Surface completion (flush-mount or stick-up) will be selected by the PM based on well 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. The 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 well casing will be extended 2 or 3 feet above ground surface and secured with a water-tight cap. The protective casing will be a steel sleeve placed over the casing and cap; the steel sleeve diameter will be at least 4 inches greater than the casing diameter or at least 8-inches diameter for nested wells. 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 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 using a 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.

6.2.6 Location Survey

Following installation of the surface completion for each well, the wells will be surveyed for horizontal locations and elevations at top of casing, 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.

6.2.7 Well Installation Diagrams

The HDR geologist/engineer will maintain suitable logs detailing drilling and well 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 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 well construction materials used.

6.2.8 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.

6.2.8.1 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.

6.2.8.2 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.

6.2.9 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

MACTEC, *RA SAP Volume I: Field Sampling Plan, Defense Depot Memphis, Tennessee, Revision 1*, *WTP-3 Well Installation, Development and Sampling*. November, 2005.

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 4 – GROUNDWATER 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 groundwater sample collection at Defense Depot Memphis, Tennessee (DDMT). 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 Health and Safety Plan (HASP) for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for groundwater sampling include the use of lead-acid batteries with bladder pumps, contact with contaminated groundwater, and contact with sample container preservatives. Safety data sheets (SDS) will be available on site for each chemical to be utilized during sampling activities. Staff will wear appropriate personal protective equipment (PPE), as outlined in the site safety health plan. Many of the wells are located in or near streets and parking lots with traffic; field staff should wear vests with reflective stripes or other high visibility clothing while sampling. Some wells may be located in areas with biological threats such as spiders, fire ants, snakes, and wasp nests; the wells should be checked for hazards before starting sampling activities.

3 Personnel Qualifications and Responsibilities

Groundwater sampling will be directed by a Field Team Leader (FTL), a mid- or senior level environmental professional (engineer, geologist or scientist) with appropriate experience. Field staff will be junior to mid-level environmental professionals or environmental technicians overseen by the FTL. Sampling will be performed by two-person teams and at least one person on each team will have a current certification in first aid and CPR.

4 Equipment and Supplies

The required equipment and supplies will be identified in the work plan for the specific field activities to be performed. Field activities should not proceed until the proper tools and equipment are available and in good working order. Usual equipment/supplies for groundwater sampling will include: a photoionization detector (PID), nitrile gloves, pump controller, portable bladder pump, compressor, water quality meter, water level indicator tape, camera, and purge 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.

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 PM, project chemist (PC) and analytical laboratory.
- PC will prepare the sampling plan detail (SPD) listing the wells and sample bottles for planned analyses. FTL will review the SPD, discuss any questions with PC and confirm shipment of laboratory-supplied sample containers and equipment for arrival prior to the start of sampling.
- The FTL will update the list of wells to be included in the water level sweep. An example list is provided in **Attachment 4-1**.
- Confirm availability and condition of DDMT-owned equipment and order additional equipment/supplies for delivery prior to the start of sampling event.
- Obtain well location maps and prepare tables showing screened interval and previous water level measurements to confirm planned sample depths.
- Prepare field forms and other documentation for the planned event.
- Schedule time and location for the initial meeting with field staff to review project information and begin work.

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.
- View well locations and confirm the wells are accessible and well IDs are clearly marked.

- Review locations for planned field activities for hazards. Determine requirements for site preparation and clearance, and select location for storage of decontamination and purge waters. Confirm sufficient storage capacity for wastewater.
- Confirm the location and length of the screened interval and the total depth of the well to be sampled if not equipped with a diffusion bag.
- Conduct site set up activities to include posting of signage (if applicable) and delineation of work zones as required in the HASP.
- Review sampling activities and assignments with field staff.
- Prior to groundwater sampling, visually inspect laboratory supplied trip blanks (TBs) for headspace. TBs without headspace will be placed into the refrigerator at DDMT and chilled overnight. Visually inspect the TBs for headspace the following day and discard TBs with headspace. Have the laboratory provide new TBs as necessary.

5.2 Field Operations

Field records will be prepared in accordance with SOP 7 – Sample Control and Documentation. Each sampling site will be characterized by the following factors:

- Location of work
- Weather conditions: rainfall, temperature, and wind direction
- Ongoing activities that may influence or disrupt sampling efforts
- Accessibility to the sampling locations (e.g., rough terrain, fallen trees, flooding, etc.)

5.2.1 Water Level Sweep and Monitoring Well Inventory

Prior to sampling, a water level sweep will be made at listed monitoring wells to produce an accurate potentiometric map.

1. Determine if the water level probes are working properly by using two or more in one well to confirm the same depth is measured. If the depths differ by more than 0.1 feet, determine which one is malfunctioning and replace it for the project.
2. Arrive at the monitoring wells and inspect the surroundings for hazards (e.g., traffic, wasps, trip hazards)
3. Using the water level sweep list proceed to the wells requiring water level readings. Confirm the well location by checking the well ID on the pad.
4. Assess the well condition and note cracks in the pad, missing bolts, missing caps, etc. on the well inventory (**Attachment 4-2**).
5. Remove water or debris from the well box as necessary and remove the monitoring well cap. Note appearance of positive or negative pressure in casing when cap is removed (air pressure lifting cap or suction on cap). Multiple wells within an area can be inspected and opened to make efficient use of field time, but each open well must be within clear sight of field staff or within a secured area.

6. Allow the water level to equilibrate for at least 3 minutes after removing the well cap prior to measurement. If pressure is noted, re-measure water level at least 3 minutes after the initial measurement; if the two measurements vary by more than 0.05 feet, make a third measurement.
7. Turn the water level indicator on and slowly lower it into the well until it alerts to the water level.
8. Bring up the probe slowly until the beeping stops and slowly lower it again until it beeps; do this three times and record the average level recorded. All readings should be taken at the location marked on top of the casing; if no mark is present, use the north side of the casing.
9. Record depth measurement to the nearest 0.01 feet.
10. Put the cap and lock back on the well casing and then close the well box.
11. Decontaminate the water level probe before proceeding to the next well. The decontamination procedure for the water level indicator is: Hand wash the calibrated tape and probe with Alconox solution (or equivalent) and rinse with deionized (Reagent Grade II) water.

5.2.2 Monitoring Well Sampling

Field measurements of groundwater parameters are used for groundwater sampling and for independent measurements during remedial actions. At the beginning of each day, field equipment will be properly calibrated per manufacturer’s instructions and throughout the day as necessary if abnormal readings are observed. Calibration activities will be recorded on **Attachment 4-3**.

5.2.2.1 Sampling Using a Passive Diffusion Bag (PDB) Sampler

Groundwater samples will be collected for VOC analyses using PDB sampling from most monitoring wells. A typical PDB sampler consists of a low-density polyethylene tube closed at both ends and filled with deionized water. The PDB is positioned in the well screen interval at the desired target depth by attaching it to a weighted tether. The water within the PDB is allowed to equilibrate with the ambient groundwater for at least 14-days before retrieval. The PDB water is decanted into 40 mL volatile organic analysis (VOA) vials and sent to the lab for analysis. Detailed procedures for using PDB samplers in wells can be found in “User’s Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells” (USGS, 2001). The following is a generalized summary of PDB sampling:

1. The top and bottom of the PDB sampler will be attached to 3/16” polyester or similar non-buoyant rope strong enough to support the weight of the sampler and subject to minimal stretch. The PDB will be suspended within the well screen at selected depths based on the depth to water, location of the screen and total depth of the well. Weights will be attached to the bottom of the sampler to keep it in place in the well. The sampler will be allowed to equilibrate for at least two weeks before being carefully retrieved with the attached line and the sample collected.
2. The PDBs will carefully be withdrawn from the well and inspected. Evidence of algae or other coatings on the bag or tears in the membrane will be noted in the field book. If there are tears, the sample will be rejected.

3. The contents of the intact bag will then be transferred to pre-preserved VOA vials causing as little agitation of the sample as possible.
4. A new PDB will be filled with deionized water, attached to the tether with zip ties, then carefully lowered into the well. The well cap, lock, and cover will be securely fastened once the PDB is in place.

5.2.2.2 Sampling Using a Bladder Pump

The sampling protocol will be as follows for the collection of groundwater samples using low-flow sampling with a portable bladder pump. Detailed low flow sampling procedures listed below.

1. Wells should be sampled in order of increasing contamination (i.e. - samples that are expected to be least contaminated will be collected before those that are more highly contaminated).
2. The bladder pump will be decontaminated prior to use in each well.
3. Slowly and carefully lower the pump inlet to the mid-point of the screened interval. In cases where the entire screen is not saturated, place the pump inlet near the middle of the saturated screen, keeping in mind the limitations stated below.
4. Do not place pump inlet less than 2 feet above the bottom of the well, as this may cause the mobilization of bottom sediments. If saturated screen length is 3 feet or less, collect sample using disposable bailer.
5. Place pump inlet at least 1-foot below the water level so there is little risk of entrainment or air in the sample.
6. Begin purging the well at a rate of 200 to 500 milliliters per minute (mL/min). Purge water will be containerized as investigation derived waste (IDW). The appropriate purge rate will be determined by monitoring groundwater drawdown.
7. The discharge during purging and sampling should flow with minimal turbulence or agitation.
8. The water level should stabilize and the pump rate should allow water to recharge the well so that little or no water level drawdown is observed. Adjust discharge rate to limit drawdown.
9. Record groundwater level frequently until water level stabilization occurs. After stabilization, measure water levels at regular intervals.
10. If drawdown is greater than 0.3 feet, decrease the discharge rate of the pump and repeat discharge and water level measurements. Repeat until the water level stabilizes to closely match the recharge rate. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging (USEPA, 2017). Record pumping rates and depths to water on the Sample Collection Data sheet (**Attachment 4-4**).
11. An in-line multi-probe flow-through cell will be used to monitor water quality parameters. During purging, water quality indicator parameters (pH, turbidity, temperature, ORP, specific conductivity, and DO) will be measured every 5-10 minutes until the parameters have stabilized. Measurement should be recorded on **Attachment 4-4**. A minimum of 5 sets of water quality indicator parameters should be recorded.
12. 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)

13. Specific conductance and DO usually take the longest to stabilize. Up to 2 hours of purging may be required to reach stabilization. Stabilized purge indicator trends are generally obvious and follow either an exponential or asymptotic change to stable parameter values during purging.
14. The pump will not be turned off between the purging and sampling processes.
15. If stabilization does not occur within 2 hours the FTL should be contacted for direction.
16. Groundwater samples will be collected by gently filling the sample bottles with minimum turbulence once equilibrium is established. Lower the flow rate to 100 mL/min and fill sample containers as described in Section 5.2.3.4.

5.2.2.3 Sampling using a Disposable Bailer

Wells will be sampled with bailers where necessary due to small diameter casing in piezometers, slow groundwater recharge or thin saturated layer in wells. A new disposable Teflon bailer will be used for sampling at each well. Purging and sampling will be conducted in a manner that minimizes the agitation of sediments in the well and formation; the bailer will not be allowed to free fall into a well.

The sampling protocol will be as follows for the collection of groundwater samples using a disposable Teflon bailer:

1. Measure the static water level prior to purging using a decontaminated electronic water level indicator. The probe of the water level indicator will be lowered into the well casing and the water level will be recorded.
2. Calculate the saturated well volume.
3. Lower the bailer into the well using new nylon twine, until it contacts the water surface. Allow the bailer to sink and fill with a minimum of water surface disturbance. Slowly withdraw the bailer from the well, preventing the bailer and bailing line from touching the ground.
4. The well should be purged until a minimum of three well volumes is removed from the well, and the water quality indicators of pH, DO, and specific conductivity have stabilized and turbidity is less than 10 NTU. At a minimum, readings will be taken after each well volume is removed or more frequently if sufficient purge volume is removed and recorded on the Sample Collection Data sheet (**Attachment 4-4**). Stabilization is achieved after three successive readings are within ± 0.1 for pH, ± 5% for specific conductance, ± 10% saturated or ± 0.2 mg/L for DO, and <10 NTU for turbidity. Temperature and ORP will also be measured and recorded, but will not be used as stabilization parameters. Sampling may begin once the minimum well volume has been removed and water quality indicators have stabilized. If stabilization does not occur or turbidity cannot be reduced below 10 NTU after three well volumes have been removed, additional purging (up to five well volumes), should be performed. If the parameters have not stabilized within five volumes, the FTL should be contacted for direction.

5. If the well is purged dry, a sample will be collected as soon as sufficient recharge has occurred and within 24 hours. Temperature, specific conductance, turbidity, pH, and DO will also be measured and recorded, along with a notation that the well was bailed dry and the conditions did not stabilize; however, stabilization of these parameters is not required.
6. After water quality indicators stabilize or the well recharges, collect samples by pouring the water from the bailer into the appropriate sample containers. This process will be repeated as necessary to fill each container.
7. After samples have been collected, replace the well cap and lock the security casing.

5.2.2.4 Sample Collection

Groundwater samples will be collected by gently filling the sample bottles with minimum turbulence. Fill the sample bottles in the following order, as needed for the required analyses:

- Volatile organic compounds (VOCs) (no headspace)
- Carbon Dioxide, Methane, Ethane, Ethene (no headspace)
- Metabolic fatty acids (MFAs) (no headspace)
- Total organic carbon (TOC) (no headspace)

Collect the samples to be analyzed for volatile organics first, leaving zero headspace. Once the VOC sample is filled, carefully secure the cap to the vial. Turn the container upside down, tap the container against the palm of a hand, and look for any bubbles inside the vial. If bubbles are observed, gently remove the cap and carefully add a small amount of sample water to the container until a meniscus forms above the rim of the vial. Gently place the cap over the meniscus and secure to the vial. Re-inspect the container for any air bubbles. If air bubbles are observed again, repeat the sample process using a new clean VOC container. Proceed with the collection of samples for the remaining analyses, collecting the more volatile parameters first.

At the end of each day, as sample containers are placed into the refrigerator or cooler for shipment to the laboratory, containers will be inspected for headspace. Samples with excessive headspace may be discarded after discussion with the project manager, laboratory, and project chemist. The samples may need to be recollected.

5.3 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.
- Store purge water in the designated area.
- Make arrangements for shipment of samples (if applicable) and follow-up with the analytical laboratory to confirm samples arrived in good condition in accordance with SOPs 7 and 8.
- Complete the Daily Field Report (SOP 1, Attachment 1-2) and submit to PM.

Upon the completion of groundwater sampling activities, the FTL will perform closeout activities per SOP 1 and complete Closeout Report (SOP 1, Attachment 1-3) and submit to PM.

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. All photographs taken during the field event will be uploaded along with a typed photograph log (date, project and subject) to the “Z” drive.

7 Quality Control and Quality Assurance

All work will be performed in accordance with the 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

United States Environmental Protection Agency (USEPA) 2017. Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. September 2017.

USEPA Region 4 Science and Ecosystem Support Division (SESD) 2013. SESDPROC-301-R3, *Operating Procedure: Groundwater Sampling*. January 2013.

USEPA Region 4 SESD 2013. SESDPROC-105-R2, *Operating Procedure: Groundwater Level and Well Depth Measurement*. January 2013.

United States Geological Survey, 2001. *User’s Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells*. Water-Resources Investigations Report 2001-4060.

Attachment 4-1

Water Level Measurements

Well ID	Aquifer	Area	Measurement Date	Depth to Water (ft, btoc)	Latitude (DD)	Longitude (DD)	Screen Length (ft)	Total Well Depth (ft, btoc)	6 Month Depth to Water (ft, btoc)	12 Month Depth to Water (ft, btoc)

Notes:
ft, btoc: feet below top of casing
DD: decimal degrees
NM: Not measured
--: Well not installed
6 Month and 12 Month Depth to Water are provided from recent sampling events so that field teams can evaluate if the current measurement is consistent with historic results.

Attachment 4-2

Well Maintenance Inspection Form

Site: ______________________ Date: ______________________

Client: ______________________ Technician: ______________________ Page: ______ of ______

		Entry Indicates Deficiency													
Inspection Point	Well Inspected - No Corrective Action Required	Cap non-functional	Lock Non Functional	Lock Missing	Bolts Missing (# missing / # total tabs)	Tabs Stripped (# stripped / # total tabs)	Tabs Broken (# broken / # total tabs)	Annular seal incomplete	Apron damaged	Rim / Lid broken	Trip Hazard	Below grade	Survey Mark/Notch not Visible	Well not inspected (explain in notes)	**Notes** (Note repairs made onsite)

Attachment 4-3

Meter Calibration Log

EQUIPMENT MAKE	EQUIPMENT MODEL	SERIAL NUMBER	DATE	TIME	TEMP OF CALIBRATION STANDARD (°C or °F)	pH STANDARD	pH STANDARD	pH STANDARD	SPECIFIC CONDUCTANCE	ORP	DISSOLVED OXYGEN
						4	7	10	________ µs/cm	________ mV	________ mg/L or %

Attachment 4-4

Purging and Sampling Data Sheet

Job#:	**Sampler(s):**	**Site:**
Well ID:	**Date:**	**Sample Event:**
Well diam: 1/4" 1" 2" 4" 6" Other:	**Static DTW:**	**Total Depth:**

Purge equip (circle): Bladder-pump Peri-pump DC-pump PE bailer Teflon bailer Other: ____________

Tubing (circle): New Dedicated **Tubing Type (circle):** Teflon lined HDPE Other:_______________

Purge Method (Circle): 3-5 Case Volume Micro/Low-Flow Extraction Well Other:____________________

Pump intake depth (ft):

Multipliers: 1"=0.04 2"=0.16 3"=0.37 4"=0.65 5"=1.02 6"=1.47 Radius^2 x 0.163

{TD-DTW X Multiplier = 1 Volume

1 Volume =_________ X 3 =______________gallons (total Purge)

Time	Temp (°C)	pH	Cond (mS/cm)	Turb. (NTU)	DO (mg/L)	ORP (mv)	DTW (feet)	Vol. Removed (gal / L)	Notes

Did well dewater? YES NO

Total volume removed: _____________ (gal / L)

Sample method: Disp Bailer Ded. Tubing New Tubing Ext. Port Other:

Sample date:	Sample time:	DTW at sample:

Sample ID:	Number of bottles:
QC Sample IDs:	Analysis:

Stabilization Parameters: ± 0.1 for pH, ± 3% for specific conductance, ± 10% for DO > 0.5 mg/L or three readings < 0.5 mg/L, ± 10mv for ORP, ±3% for temperature, and 10% for turbidity > 5 NTU or three successive values < 5 NTU

Attachment 4-4

Purging And Sampling Data Sheet (continued)

Job#:		**Sampler(s):**							**Site:**
Well ID:		**Date:**		**Sample Event:**					
Time	**Temp (°C)**	**pH**	**Cond (mS/cm)**	**Turb. (NTU)**	**DO (mg/L)**	**ORP (mv)**	**DTW (feet)**	**Vol. Removed (gal / L)**	**Notes**

Stabilization Parameters: ± 0.1 for pH, ± 3% for specific conductance, ± 10% for DO > 0.5 mg/L or three readings less than 0.5 mg/L, ± 10mv for ORP, ±3% for temperature, and 10% for turbidity greater than 5 NTU or three successive values less than 5 NTU

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.

Custody Seals: 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

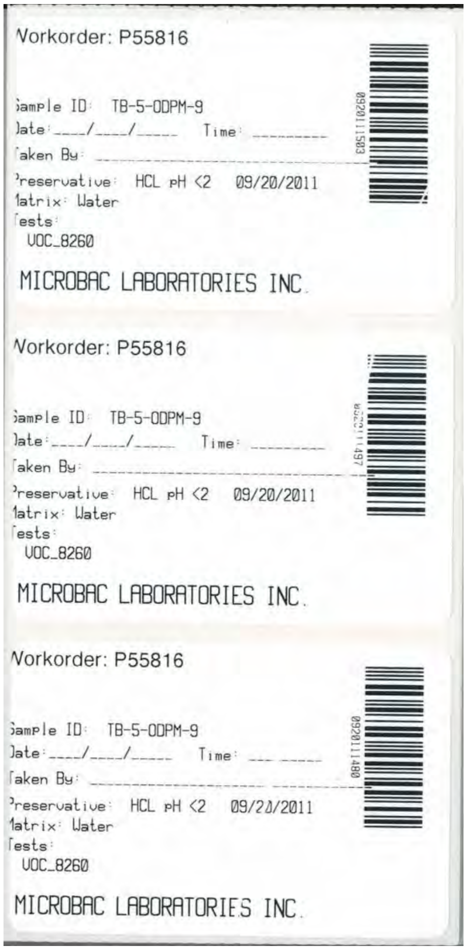
SAMPLING PLAN DEFAIL (OFF DEPOT PM WELLS September 2011) - ODPM-9

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

EXAMPLE: 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

ALS

2655 Park Center Drive, Ste. A
Simi Valley, CA 93065
+1 805 526 7161 | +1 805 526 7270 (fax)

Canister Sampling Information

DO NOT adhere any type of label to the canister. **DO NOT** over tighten the valve and remember to replace the brass cap.

Field Readings:

Pi_________ Pf_________

Initials:________Date:____________

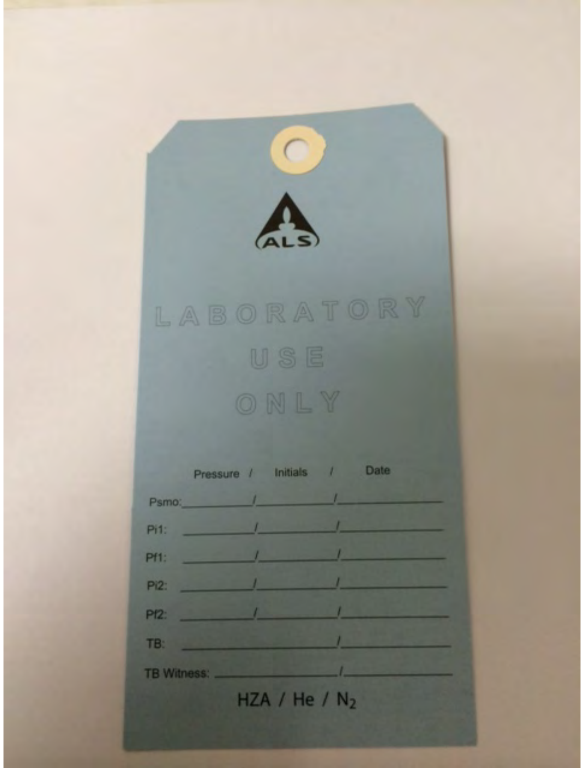
Client Name:

Sample ID:

Analysis:

Date / Time: Sampler's Int.:

Comments:



ALS

LABORATORY
USE
ONLY

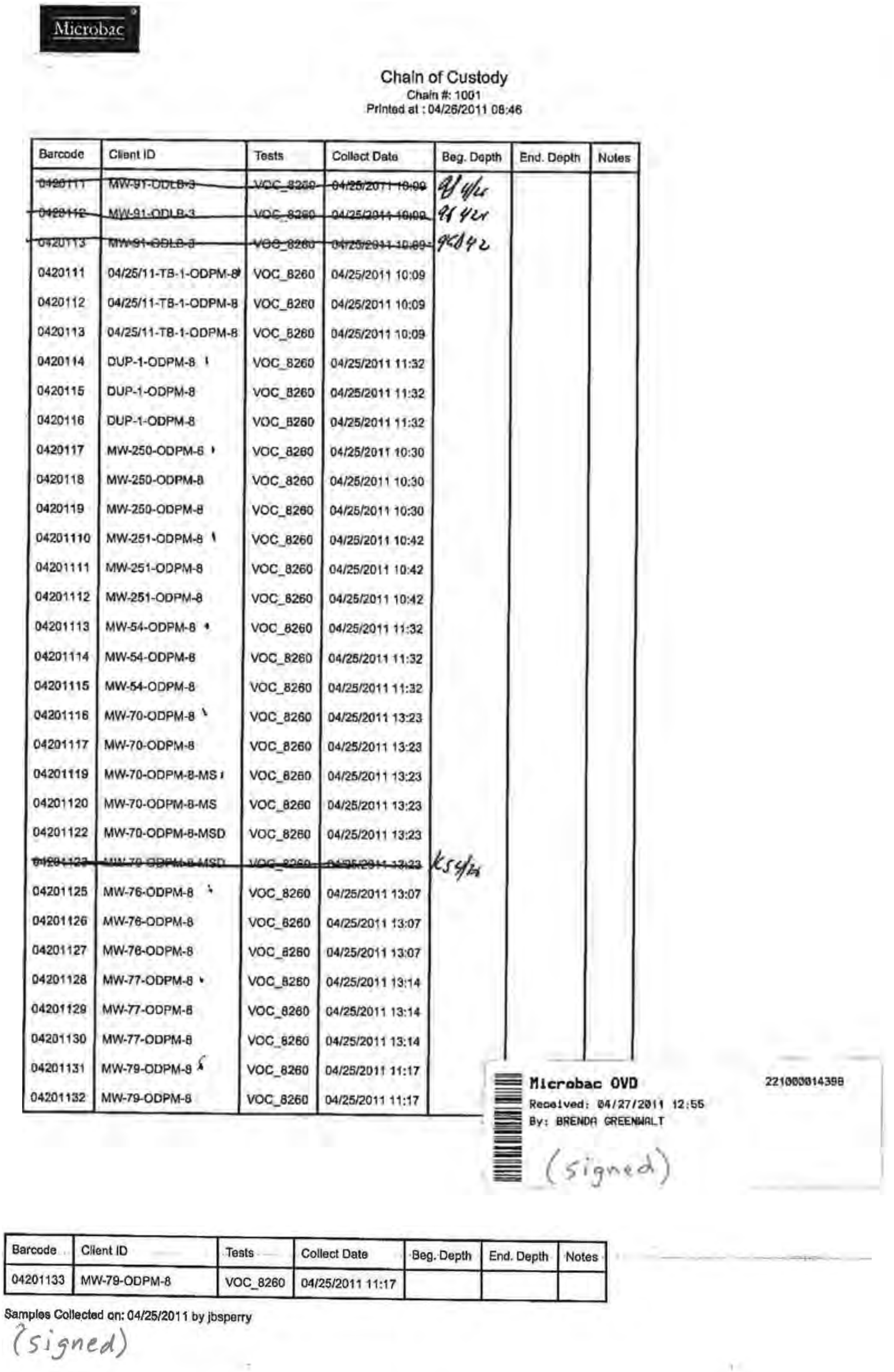
Pressure / Initials / Date

Psmo:________/________/__________
Pi1: ________/________/__________
Pf1: ________/________/__________
Pi2: ________/________/__________
Pf2: ________/________/__________
TB: ________________/__________
TB Witness: ____________/__________

HZA / He / N_2

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~~	[illegible]		
~~0420112~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	[illegible]		
~~0420113~~	~~MW-91-ODLB-3~~	~~VOC_8260~~	~~04/25/2011 10:09~~	[illegible]		
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			

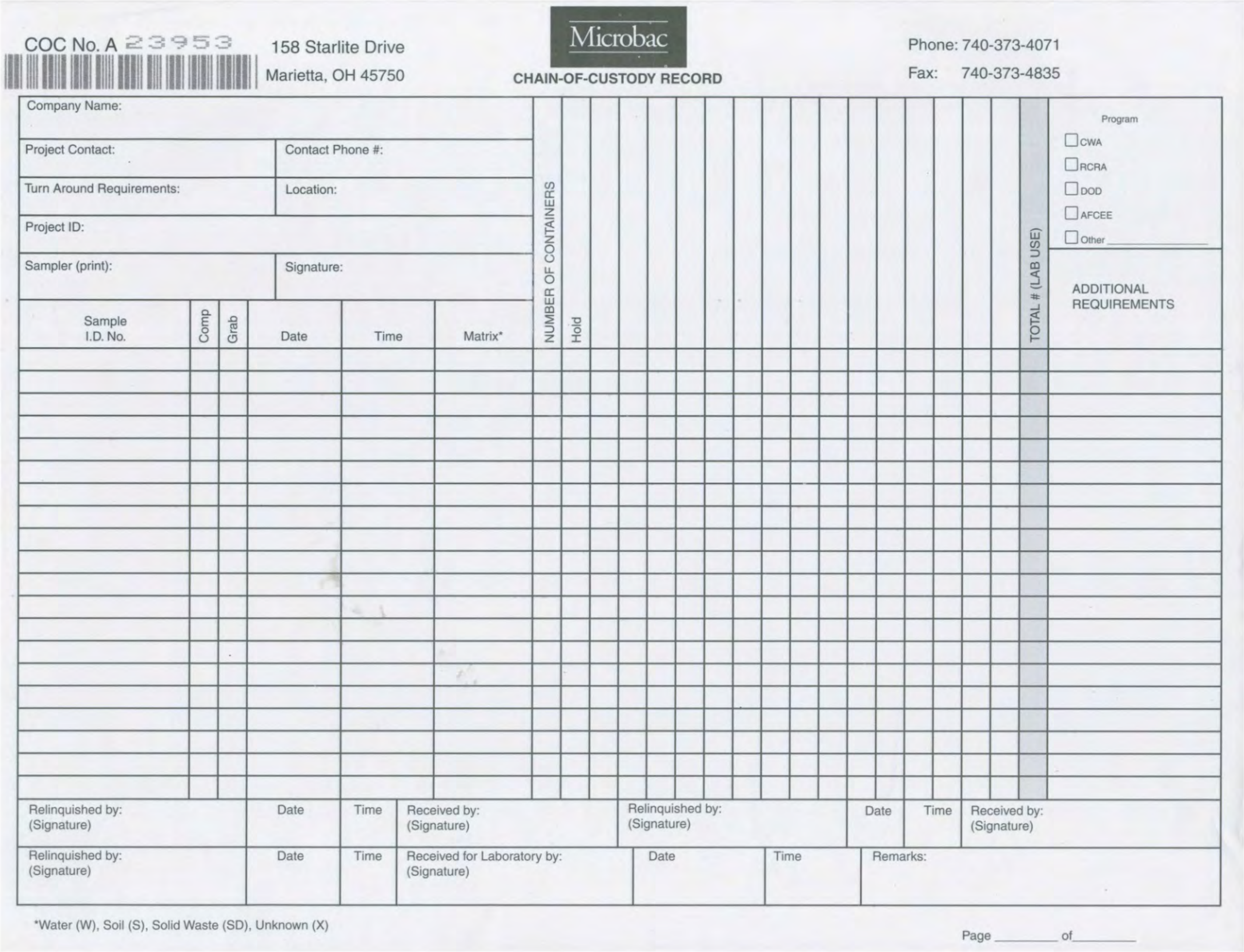
Microbac OVD 221000014398
Received: 04/27/2011 12:55
By: BRENDA GREENWALT
(signed)

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 ______________

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

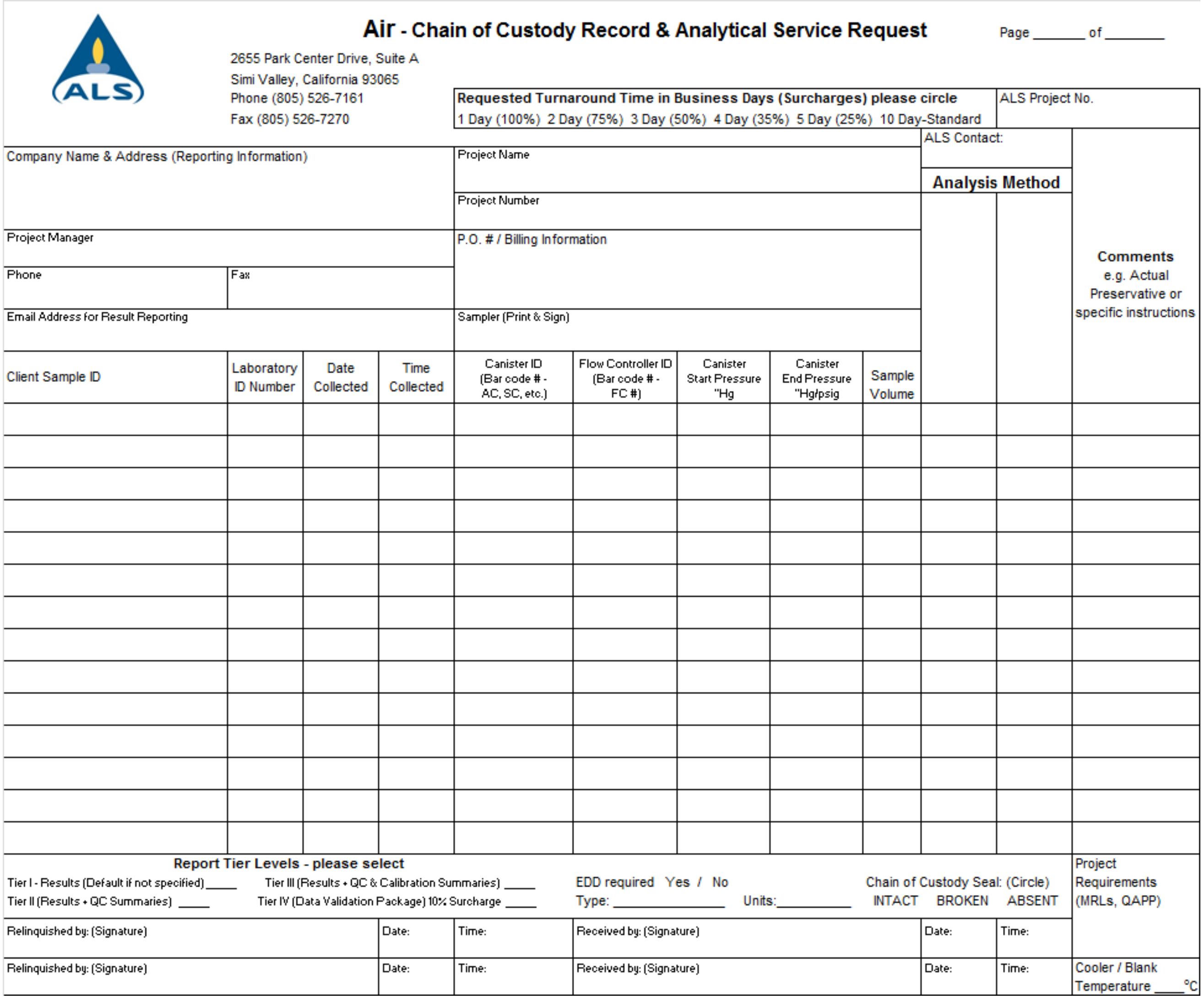
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:	

*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

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	Analysis Method		**Comments** e.g. Actual Preservative or specific instructions

Report Tier Levels - please select
Tier I - Results (Default if not specified) ____
Tier II (Results + QC Summaries) _____
Tier III (Results + QC & Calibration 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 8 – SAMPLE PACKING AND SHIPPING

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

The purpose of this Standard Operating Procedure (SOP) is to provide guidance for packing and shipping environmental samples to the laboratory for analysis. The goals for sample packing and shipping are that: 1) the integrity of the sample is maintained, and 2) no exposure to the sample contents occurs during transit. These goals should be met regardless of the method by which the samples were shipped.

Samples will usually be shipped as either environmental samples or as hazardous materials based on the expected contaminant concentrations. While the concentration of constituents in the sample is not generally known prior to shipment of the sample, inferences can be made based on the site location and knowledge of past activities, observations during collection, and past sample results. Hazardous materials are generally considered to be samples of highly contaminated media collected at or near an observed release and can consist of pure product or a mixture. Environmental samples are generally media with low-level contamination.

Relevant regulations include Department of Transportation (DOT) regulations for ground transportation (49 Code of Federal Regulations [CFR]) and the International Air Transport Association (IATA) regulations for air transportation. Common carriers (e.g., FedEx, and UPS etc.) must abide by these regulations. This SOP provides specific guidance on how to package and ship samples to achieve the stated objectives and remain in compliance with shipping regulations. If field personnel are unsure regarding current shipping regulations, they will immediately contact the selected carrier (e.g., FedEx, UPS, etc.) for guidance.

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 Health and Safety Plan (HASP) for the specific project activity and signed the acknowledgement sheet confirming their review.

Health and safety concerns for sample shipment 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 packing and shipping activities will be directed by the Field Team Leader (FTL), a mid- or senior level environmental professional (engineer, geologist or scientist) with experience in sampling activities. Field staff, environmental professionals or technicians, are responsible for proper sample handling and compliance with these guidelines.

4 Equipment and Supplies

The required equipment and supplies will consist of ice chests from the laboratory, clear tape, filament tape, gallon size Ziploc bags, trash bags, custody seals, bubble bags, cushion for bottom of cooler, and FedEx handle label hangers.

5 Procedure

5.1 Start-Up Activities

5.1.1 Office

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

- Ensure that sufficient sample containers, shipping containers/coolers and packing material are shipped to the site based on the analytical parameters, total number of samples and average number of samples to be collected per day.
- Develop guidelines on the number/type of samples per shipper based on sample type and past analytical results (i.e. volatile organic compounds [VOCs] in one cooler to limit the number of trip blanks needed and samples from high concentration wells packed in separate cooler to prevent cross contamination)
- Coordinate sample shipments to ensure laboratory personnel will be available to receive the samples if weekend or holiday shipments are planned.

5.1.2 Field

After arrival on site, but prior to commencement of operations, the FTL will confirm that the required sample containers, sample coolers, packing material and ice are available on-site.

5.2 Field Operations

On specific projects, protocols for sample shipment will be specified in the work plan. This SOP provides general guidelines for sample packing and shipping.

- Samples will be shipped to the laboratory by an overnight courier service.
- Samples will not remain on site for more than 24 hours after collection, unless samples were collected on a weekend or there were not enough samples to make a shipment. These

samples will be stored in the refrigerator at 4 degrees Celsius (°C) in a locked office until the next shipment.

- Glass sample containers will be placed inside sealed plastic bubble wrap bags or wrapped in bubble wrap and placed in plastic bags as a precaution against cross-contamination due to leakage or breakage.
- Sample bottles will be placed in coolers in a manner to limit the breakage and/or leakage during shipment. All coolers will have a bottom cushion/absorbent placed in prior to placing the samples in the cooler.
- Coolers will be lined with a heavy duty plastic garbage bag.
- Segregate highly contaminated samples, if known, by placement in a separate cooler or in separate plastic zip-lock bags.
- All coolers will have the drain plug taped closed, if present.
- Sufficient ice in plastic bags (double-bagged) will be placed in the coolers to keep the samples at 4°C throughout shipment.
- The top of the garbage bag, lining the cooler and containing the samples and ice, will be tied or adequately sealed as to prevent leakage.
- Chain-of-Custody (COC) documents will be placed in zip-lock bags and taped to the inside lid of each cooler.
- Cooler lids will be secured by wrapping with filament tape.
- The air bill will be secured to the handle of the cooler for the shipment label.
- Place Fragile and perishable stickers on all coolers. If shipping for Saturday delivery, place multiple Saturday Delivery stickers on each cooler and contact the laboratory to confirm receiving staff will be present.
- Confirm arrangements with the laboratory point-of-contact for Saturday delivery samples so that hold times and/or sample preservation are not compromised.

Custody seals will be used for sample shipments in accordance with SOP 7, Sample Control and Documentation. Custody seals are adhesive labels that are placed in such a manner that they will be visibly disturbed upon opening the shipping container or cooler. The seals will be initialed and dated upon placement. Upon receipt at the laboratory, the sample custodian will note the condition of custody seals and will also check the sample temperature, recording these items on the laboratory receipt form.

5.3 Closeout

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

- Ensure that the sample transport containers are properly packed and are in compliance with DOT and IATA regulations.
- Complete the Sample Handling, Packing & Shipping Checklist (Attachment 8-1).

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. The Sample Handling, Packing & Shipping Checklist will be completed each day that samples are shipped. No erasures or mark outs will be made on the checklist. 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, 2018a. 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-209-R2, *Operating Procedure: Packing, Marking, Labeling and Shipping of Environmental and Waste Samples,* 2011.

Attachment 8-1

Sample Handling, Packing & Shipping Checklist

When preparing samples for shipment to the laboratory, complete this checklist to ensure that samples, documents, and materials are properly packed in the sample shipper.

Sample Event: ______________________

Date: ______________

PROJECT SAMPLES

☐ All samples, duplicates, MS/MSDs, equipment blanks, ambient blanks, and trip blanks should be included in the cooler that are listed on the COC.

☐ Verify that the proper number of bottles with appropriate preservative(s) were collected for each sample

☐ Verify that samples were checked for pH (except volatile samples)

DOCUMENTS

☐ **Chain-of-Custody (COC)** generated for *each* cooler

☐ COC reviewed for completeness, including appropriate signature(s) and date(s), and include the **courier tracking/shipping number** on the COC

☐ **COC** placed in a Ziploc bag and taped to the underside of the cooler lid

☐ **Custody seals** placed on the front and back of each cooler, or across the sealing tape for Summa canister cartons.

☐ Coolers for Saturday delivery have “Saturday Delivery” stickers and “Saturday Delivery” box checked on the airbill

☐ Shipments are insured

PACKING MATERIALS

☐ Ice is “double-bagged” and is sufficient to maintain a temperature of 4°C

☐ Glass bottles placed in a bubble bag to prevent breakage and leakage

☐ All coolers have a bottom cushion in place prior to placing samples in the cooler.

☐ Highly contaminated samples (if known) placed together

☐ **Trip blank** placed in each cooler that contains samples for VOC analyses at beginning of day

☐ All VOC samples placed in same cooler to minimize the number of trip blanks,

☐ Each cooler contains a **temperature blank**

Comments: (special handling or delivery requirements, highly contaminated samples, etc.)
____
____

Number of coolers shipped: ________________

Checklist Completed By: ______________________________ Date: ____________

Note: Place the completed checklist in the project file with the associated COCs and airbill.

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.

Sampling Equipment: 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. Label Sample Container - Label the sample container as outlined in SOP 7 – Sample Control and Documentation.

b. Collect Sample - 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 and usability assessment (hereafter called “data review” to denote all three 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 from these documents have been incorporated:

- Project Quality Assurance Project Plan (QAPP) (*DDMT Uniform Federal Policy – Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1* [HDR, March 2018])

- *General Data Validation Guidelines* (United States Department of Defense [DoD] Environmental Data Quality Workgroup [EDQW], February 09, 2018);
- *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (Intergovernmental Data Quality Task Force, 2005);
- United States Environmental Protection Agency (USEPA) National Functional Guidelines (USEPA, 2017); and
- Quality Systems Manual (QSM) 5.1.

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)

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. 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 RLs/MDLs

The correct methods 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), or 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 of 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) 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) 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 LOQ. Analytes detected above the LOQ 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) or will not be qualified, in accordance with the qualification as discussed in the applicable National Functional Guidelines (USEPA, 2017).

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 may be biased high and will be qualified as estimated (J) when detected; non-detect results will not be qualified. Analytes with lower recoveries may be biased low and will be qualified as estimated with possible high bias (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) and the EDD to the project database manager. The database manager will prepare preliminary tables of results to be used in reports.

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 prepare a final validation report and note any qualifiers. An example of this report is included as Attachment 10-1 to this SOP.

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” at the end of the fields and record final qualifiers as described in Section 5.6.1 of this SOP.

When all the EDDs have been completed for a sampling event, the PC will email the PM and the database manager the files, to create final 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

Intergovernmental Data Quality Task Force, 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (2005).

MACTEC Engineering and Consulting, Inc. (MACTEC), 2005. *Remedial Action Sampling and Analysis Plan, Volume II: Quality Assurance Project Plan, Defense Depot Memphis, Tennessee, Revision 1*. November 2005.

United States Department of Defense (DoD), 2018. *General Data Validation Guidelines* (Environmental Data Quality Workgroup [EDQW]. February 09, 2018).

United States Environmental Protection Agency (USEPA), 2017a. *National Functional Guidelines for Organic Superfund Methods Data Review (EPA-540-R-2017-002).* January 2017.

USEPA, 2017b. *National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA-540-R-2017-001).* January 2017.

Attachment 10-1

EXAMPLE: Data Validation and Usability Report

Water Samples

DATA VALIDATION AND USABILITY REPORT

VOLATILES by USEPA SW-846 Method 8260B

Project:	Former Defense Depot Memphis, Tennessee (DDMT) Main Installation Long Term Monitoring, LA-30 event
Project/Task Number:	10101451 - 7
Sample Data Package:	L19100114, L19100115, L19100119, L19100120, L19110019, L19110054, L19110061, L19120006
Laboratory:	Microbac Laboratories, Inc., Marietta, Ohio
Sample Matrix:	Groundwater
Sampling Dates:	October to December 2019
Validation Guidelines:	-Project Quality Assurance Project Plan (QAPP) (*DDMT Uniform Federal Policy – Quality Assurance Project Plan, Environmental Restoration Support at Former Defense Depot Memphis, Tennessee, Revision 1* [HDR, March 2018]); -United States Environmental Protection Agency (USEPA) *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, 3rd edition (SW-846); -*General Data Validation Guidelines* (United States Department of Defense [DoD] Environmental Data Quality Workgroup [EDQW], February 09, 2018); -*Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual* (Intergovernmental Data Quality Task Force, 2005); -professional judgment
Validation Level:	Steps I (verification), IIa and IIb (validation) per the *UFP-QAPP*; Stages 2BVM (100% of data) and 3VM (10% of data) per the *DoD General Validation Guidelines* (IDW sample results not validated)
Data Reviewer:	Lynn K. Lutz, HDR

Sample ID	Date Collected	Matrix	Lab ID	VOCs
DR1-3-LA-30	10/12/2019	GW	L19100120-44	X
DR1-4-LA-30	10/11/2019	GW	L19100115-43	X
DR1-5-LA-30	10/10/2019	GW	L19100115-17	X
DR1-5A-LA-30	10/10/2019	GW	L19100115-19	X
DR1-6-LA-30	10/10/2019	GW	L19100115-25	X
DR1-6A-LA-30	10/10/2019	GW	L19100115-23	X
DR1-7-LA-30	10/11/2019	GW	L19100115-41	X
DR2-1-LA-30	10/12/2019	GW	L19100119-18	X
DR2-2-LA-30	10/12/2019	GW	L19100119-19	X
DR2-3-LA-30	10/12/2019	GW	L19100120-41	X
DR2-4-LA-30	10/12/2019	GW	L19100119-20	X
DR2-5-LA-30	10/11/2019	GW	L19100119-01	X
DR2-6-LA-30	10/12/2019	GW	L19100119-21	X
MW-21-LA-30	10/10/2019	GW	L19110061-07	X
MW-21-LA-30-RE	12/03/2019	GW	L19120006-03	X
MW-21-LA-30-RE-MS	12/03/2019	GW	L19120006-04	X
MW-21-LA-30-RE-MSD	12/03/2019	GW	L19120006-05	X

Sample ID	Date Collected	Matrix	Lab ID	VOCs
MW-25A-LA-30	10/11/2019	GW	L19100119-06	X
MW-26-LA-30	10/12/2019	GW	L19100119-44	X
MW-34-LA-30	10/12/2019	GW	L19100120-06	X
MW-39-LA-30	10/12/2019	GW	L19100120-07	X
MW-39A-LA-30	10/12/2019	GW	L19100120-08	X
MW-52-LA-30	10/11/2019	GW	L19100119-16	X
MW-62-LA-30	10/10/2019	GW	L19100114-36	X
MW-63A-LA-30	10/10/2019	GW	L19100115-13	X
MW-63B-LA-30	10/10/2019	GW	L19100115-11	X
MW-64-LA-30	10/12/2019	GW	L19100120-09	X
MW-85-LA-30	10/12/2019	GW	L19100120-10	X
MW-85-LA-30-MS	10/12/2019	GW	L19100120-11	X
MW-85-LA-30-MSD	10/12/2019	GW	L19100120-12	X
MW-88-LA-30	10/12/2019	GW	L19100120-13	X
MW-89-LA-30	10/9/2019	GW	L19100114-20	X
MW-90-LA-30	10/9/2019	GW	L19100114-22	X
MW-92-LA-30	10/12/2019	GW	L19100120-14	X
MW-94A-LA-30	10/12/2019	GW	L19100120-15	X
MW-96-LA-30	10/11/2019	GW	L19100119-17	X
MW-97-LA-30	10/12/2019	GW	L19100120-40	X
MW-98-LA-30	10/12/2019	GW	L19100120-16	X
MW-100B-LA-30	10/10/2019	GW	L19100115-14	X
MW-100B-LA-30-MS	10/10/2019	GW	L19100115-15	X
MW-100B-LA-30-MSD	10/10/2019	GW	L19100115-16	X
MW-101T-LA-30	10/11/2019	GW	L19100115-32	X
MW-101B-LA-30	10/11/2019	GW	L19100115-33	X
MW-103-LA-30	10/9/2019	GW	L19100114-14	X
MW-104-LA-30	10/9/2019	GW	L19100114-16	X
MW-104-LA-30-MS	10/9/2019	GW	L19100114-17	X
MW-104-LA-30-MSD	10/9/2019	GW	L19100114-18	X
MW-107T-LA-30	10/12/2019	GW	L19100119-29	X
MW-107B-LA-30	10/12/2019	GW	L19100119-28	X
MW-108-LA-30	10/12/2019	GW	L19100119-30	X
MW-113-LA-30	10/12/2019	GW	L19100119-31	X
MW-140-LA-30	10/9/2019	GW	L19100114-10	X
MW-141-LA-30	10/10/2019	GW	L19100114-23	X
MW-142-LA-30	10/10/2019	GW	L19100114-39	X
MW-143-LA-30	10/10/2019	GW	L19100114-46	X
MW-197A-LA-30	10/12/2019	GW	L19100120-25	X
MW-197B-LA-30	10/12/2019	GW	L19100120-26	X
MW-198-LA-30	10/10/2019	GW	L19100114-33	X
MW-199A-LA-30	10/10/2019	GW	L19100114-25	X
MW-199B-LA-30	10/10/2019	GW	L19100114-26	X
MW-200-LA-30	10/12/2019	GW	L19100119-32	X
MW-202A-LA-30	10/9/2019	GW	L19100114-15	X

Sample ID	Date Collected	Matrix	Lab ID	VOCs
MW-202B-LA-30	10/9/2019	GW	L19100114-19	X
MW-203A-LA-30	10/10/2019	GW	L19100115-18	X
MW-203B-LA-30	10/10/2019	GW	L19100115-20	X
MW-203B-LA-30-MS	10/10/2019	GW	L19100115-21	X
MW-203B-LA-30-MSD	10/10/2019	GW	L19100115-22	X
MW-204A-LA-30	10/12/2019	GW	L19100119-33	X
MW-204B-LA-30	10/12/2019	GW	L19100119-34	X
MW-205A-LA-30	10/12/2019	GW	L19100119-35	X
MW-205B-LA-30	10/12/2019	GW	L19100119-36	X
MW-206A-LA-30	10/12/2019	GW	L19100119-37	X
MW-206B-LA-30	10/12/2019	GW	L19100119-38	X
MW-207A-LA-30	10/10/2019	GW	L19100115-02	X
MW-207B-LA-30	10/10/2019	GW	L19100115-04	X
MW-208A-LA-30	10/10/2019	GW	L19100115-26	X
MW-208B-LA-30	10/10/2019	GW	L19100115-24	X
MW-209A-LA-30	10/10/2019	GW	L19100114-29	X
MW-209B-LA-30	10/10/2019	GW	L19100114-30	X
MW-210A-LA-30	10/12/2019	GW	L19100119-39	X
MW-210B-LA-30	10/12/2019	GW	L19100119-40	X
MW-212-LA-30	10/10/2019	GW	L19100114-35	X
MW-213-LA-30	10/11/2019	GW	L19100119-05	X
MW-214A-LA-30	10/10/2019	GW	L19100114-47	X
MW-214B-LA-30	10/10/2019	GW	L19100114-44	X
MW-215A-LA-30	10/12/2019	GW	L19100120-27	X
MW-215B-LA-30	10/12/2019	GW	L19100120-28	X
MW-217-LA-30	10/12/2019	GW	L19100119-41	X
MW-218-LA-30	10/12/2019	GW	L19100119-42	X
MW-219-LA-30	10/12/2019	GW	L19100119-43	X
MW-254-LA-30	10/9/2019	GW	L19100114-03	X
MW-255-LA-30	10/9/2019	GW	L19100114-12	X
MW-256-LA-30	10/9/2019	GW	L19100114-05	X
MW-256-LA-30-MS	10/9/2019	GW	L19100114-06	X
MW-256-LA-30-MSD	10/9/2019	GW	L19100114-07	X
MW-258-LA-30	10/10/2019	GW	L19100114-34	X
MW-259-LA-30	10/12/2019	GW	L19100120-29	X
MW-260-LA-30	10/9/2019	GW	L19100114-08	X
MW-262-LA-30	10/9/2019	GW	L19100114-01	X
MW-263-LA-30	10/12/2019	GW	L19100120-30	X
MW-264-LA-30	10/9/2019	GW	L19100114-09	X
MW-265-LA-30	10/10/2019	GW	L19100114-31	X
MW-266-LA-30	10/12/2019	GW	L19100120-31	X
MW-267-LA-30	10/10/2019	GW	L19100114-28	X
MW-268-LA-30	10/10/2019	GW	L19100114-27	X
MW-269-LA-30	10/11/2019	GW	L19100119-07	X
MW-270-LA-30	10/12/2019	GW	L19100120-32	X

Sample ID	Date Collected	Matrix	Lab ID	VOCs
MW-271-LA-30	10/12/2019	GW	L19100119-45	X
MW-272-LA-30	10/12/2019	GW	L19100119-46	X
MW-273-LA-30	10/12/2019	GW	L19100120-01	X
MW-274-LA-30	10/11/2019	GW	L19100119-08	X
MW-275-LA-30	10/11/2019	GW	L19100119-09	X
MW-276-LA-30	10/12/2019	GW	L19100120-33	X
MW-277-LA-30	10/12/2019	GW	L19100120-02	X
MW-278-LA-30	10/11/2019	GW	L19100119-10	X
MW-279-LA-30	10/10/2019	GW	L19100115-03	X
MW-280-LA-30	10/10/2019	GW	L19100114-24	X
MW-281-LA-30	10/10/2019	GW	L19100114-38	X
MW-282-LA-30	10/9/2019	GW	L19100114-11	X
MW-283-LA-30	10/9/2019	GW	L19100114-02	X
MW-284-LA-30	10/12/2019	GW	L19100120-03	X
MW-285-LA-30	10/10/2019	GW	L19110061-06	X
MW-285-LA-30-RE	12/03/2019	GW	L19120006-06	X
MW-286-LA-30	10/12/2019	GW	L19100120-06	X
MW-287-LA-30	10/10/2019	GW	L19100114-40	X
MW-288-LA-30	10/10/2019	GW	L19100114-41	X
MW-289-LA-30	10/9/2019	GW	L19100114-21	X
MW-290-LA-30	10/12/2019	GW	L19100120-05	X
MW-291-LA-30	10/9/2019	GW	L19100114-04	X
MW-292-LA-30	10/11/2019	GW	L19100119-11	X
MW-293-LA-30	10/10/2019	GW	L19110061-08	X
MW-293-LA-30-RE	12/03/2019	GW	L19120006-07	X
MW-294-LA-30	10/11/2019	GW	L19100119-12	X
MW-295-LA-30	10/11/2019	GW	L19100119-13	X
MW-295-LA-30-MS	10/11/2019	GW	L19100119-14	X
MW-295-LA-30-MSD	10/11/2019	GW	L19100119-15	X
MW-296-LA-30	10/12/2019	GW	L19100120-34	X
MW-296-LA-30-MS	10/12/2019	GW	L19100120-35	X
MW-296-LA-30-MSD	10/12/2019	GW	L19100120-36	X
MW-297-LA-30	10/12/2019	GW	L19100120-37	X
MW-298-LA-30	10/12/2019	GW	L19100120-38	X
MW-299-LA-30	10/10/2019	GW	L19100114-42	X
MW-300-LA-30	10/10/2019	GW	L19100114-43	X
MW-301-LA-30	10/11/2019	GW	L19100115-42	X
MW-302-LA-30	10/12/2019	GW	L19100120-39	X
PMW21-01-LA-30	10/10/2019	GW	L19100115-05	X
PMW21-02-LA-30	10/10/2019	GW	L19100115-10	X
PMW21-03-LA-30	10/10/2019	GW	L19100115-09	X
PMW21-04-LA-30	10/10/2019	GW	L19100115-12	X
PMW21-05-LA-30	10/11/2019	GW	L19100115-34	X
PMW-85-01-LA-30	10/12/2019	GW	L19100120-17	X
PMW-85-05-LA-30	10/12/2019	GW	L19100120-18	X

Sample ID	Date Collected	Matrix	Lab ID	VOCs
PMW92-02-LA-30	10/12/2019	GW	L19100120-19	X
PMW92-03-LA-30	10/12/2019	GW	L19100120-20	X
PMW101-02A-LA-30	10/10/2019	GW	L19100115-30	X
PMW101-02B-LA-30	10/10/2019	GW	L19100115-31	X
PMW101-03A-LA-30	10/11/2019	GW	L19100115-35	X
PMW101-03B-LA-30	10/11/2019	GW	L19100115-36	X
PMW101-04A-LA-30	10/11/2019	GW	L19100115-37	X
PMW101-04B-LA-30	10/11/2019	GW	L19100115-38	X
PMW101-06A-LA-30	10/10/2019	GW	L19100115-28	X
PMW101-06B-LA-30	10/10/2019	GW	L19100115-29	X
PMW101-07A-LA-30	11/4/2019	GW	L19110019-01	X
PMW101-07B-LA-30	10/10/2019	GW	L19100115-27	X
DUP-1-LA-30	10/12/2019	GW	L19100120-42	X
DUP-2-LA-30	10/12/2019	GW	L19100119-24	X
DUP-3-LA-30	10/10/2019	GW	L19100114-45	X
DUP-4-LA-30	10/12/2019	GW	L19100119-25	X
DUP-5-LA-30	10/12/2019	GW	L19100120-23	X
DUP-6-LA-30	10/11/2019	GW	L19100115-39	X
DUP-7-LA-30	10/10/2019	GW	L19100114-32	X
DUP-8-LA-30	10/10/2019	GW	L19100114-48	X
DUP-9-LA-30	10/11/2019	GW	L19100119-03	X
DUP-10-LA-30	10/12/2019	GW	L19100119-22	X
DUP-11-LA-30	10/12/2019	GW	L19100120-21	X
DUP-12-LA-30	10/12/2019	GW	L19100119-23	X
DUP-13-LA-30	10/12/2019	GW	L19100120-22	X
DUP-14-LA-30	10/10/2019	GW	L19110054-37	X
DUP-15-LA-30	10/11/2019	GW	L19100119-02	X
DUP-16-LA-30	12/3/2019	GW	L19120006-01	X
LTM-TB1-LA-30	10/9/2019	Water	L19100114-13	X
LTM-TB2-LA-30	10/9/2019	Water	L19100114-49	X
LTM-TB3-LA-30	10/10/2019	Water	L19100114-50	X
LTM-TB4-LA-30	10/10/2019	Water	L19100114-51	X
LTM-TB5-LA-30	10/10/2019	Water	L19100115-01	X
LTM-TB6-LA-30	10/10/2019	Water	L19100115-40	X
LTM-TB7-LA-30	10/11/2019	Water	L19100115-44	X
LTM-TB8-LA-30	10/11/2019	Water	L19100119-04	X
LTM-TB9-LA-30	10/12/2019	Water	L19100119-27	X
LTM-TB10-LA-30	10/12/2019	Water	L19100119-26	X
LTM-TB11-LA-30	10/12/2019	Water	L19100120-24	X
LTM-TB13-LA-30	10/14/2019	Water	L19100120-43	X
LTM-TB14-LA-30	11/4/2019	Water	L19110019-02	X
LTM-TB15-LA-30	12/3/2019	Water	L19120006-02	X

SUMMARY

All laboratory data were acceptable with qualification.

I. SAMPLE RECEIPT / CHAIN OF CUSTODY

Samples were received within the correct temperature range of 0-6°C. No qualification was required.

II. HOLDING TIMES AND PRESERVATION

Holding time and preservation criteria were generally met except as discussed below.

All samples were at pH <2 at the time of analysis. Most samples were analyzed within 14 days of collection. Due to being overlooked by the lab, sample DUP-14-LA-30 was analyzed 18 days past the 14 day holding time, and samples MW-21-LA-30, MW-285-LA-30, and MW-293-LA-30 were analyzed 19 days past the 14 day holding time for the samples collected on 10/11/2019, and these results have been qualified as estimated (J) or non-detect estimated (UJ). These samples (except for DUP-1-4LA-30) were collected again on 12/03/2019, after allowing sufficient time for the passive diffusion bags (PDBs) to re-equilibrate in the wells, and the second collection of these samples were designated MW-21-LA-30-RE, MW-285-LA-30-RE, and MW-293-LA-30-RE respectively.

III. INSTRUMENT PERFORMANCE

GC/MS BFB tuning criteria were met. All sample analyses were begun within 12 hours of the 4-bromofluorobenzene (BFB) tune except for MW-263-LA-30, which began 23 minutes late; all results for this sample have been qualified as estimated (J) or non-detect estimated (UJ). Some QCMRL standards were analyzed after the 12 hours had passed, but no qualification was required because of this.

IV. INSTRUMENT CALIBRATION

INITIAL CALIBRATIONS

The calibration curve included a standard at or below the reporting limit (RL). Initial calibration criteria were met. No qualification was required.

SECOND SOURCE STANDARDS

Several analytes had %D values outside the required limit of 20% and detected results have been qualified as shown in the table below.

Analytical run	Analyte	%D	Associated samples	Qualification
WG712052	Acetone	+28%	50 samples	J
WG712212	Dichlorodifluoromethane	+53%	MW-272-LA-30	J

CONTINUING CALIBRATIONS

Several analytes had %D values outside the required limit of 20% and have been qualified as shown in the table below.

Analytical run	Analyte	%D	Associated samples	Qualification
WG712228	Acetone	-23%	9 samples	J-
WG712312	2-Hexanone	-22%	17 samples	UJ
	Acetone	-25%	12 samples	J-
	2-Butanone	-22%	17 samples	UJ
	4-Methyl-2-pentanone (MIBK)	-21.2%	17 samples	UJ
WG712392	Acetone	-21%	11 samples 3 samples	J- UJ
WG714114	1,2-Dibromo-3-chloropropane (DBCP)	-20.1%	5 samples	UJ

V. BLANKS

METHOD BLANKS

Some VOCs were detected at trace levels in some method blanks. Associated sample results were non-detect and no qualification was required.

TRIP BLANKS

VOCs were detected in some trip blanks, and some qualification was required as shown below.

Trip Blank ID	Analyte	Conc (µg/L)	Associated sample	Sample conc (µg/L)	Qualifier
LTM-TB8-LA-30	Chlorobenzene	0.145 J	MW-25A-LA-30 MW-274- LA-30 MW-292- LA-30 MW-294- LA-30 MW-52- LA-30 MW-96- LA-30 DR2-1- LA-30 DUP-9- LA-30	Trace	ND (0.5U)
LTM-TB11-LA-30	Methylene chloride	1.48	MW-273-LA-30 MW-284-LA-30 PMW-85-01-LA-30 PMW92-02-LA-30 PMW92-03-LA-30	Trace	ND (1.0U)
LTM-TB13-LA-30	Methylene chloride	0.29 J	MW-259-LA-30 MW-302-LA-30 DUP13--LA-30	Trace	ND (1.0U)

EQUIPMENT RINSE BLANKS

Equipment rinse blanks were not collected. No qualification was required.

VI. LABORATORY CONTROL SAMPLES (LCS)

The recoveries of 2-chlorotoluene and 1,2,3-trichlorobenzene in two LCS/LCSDs were slightly above the control limits. These analytes were non-detect in the associated samples and no qualification was required.

VII. SURROGATES

All surrogate recoveries were within control limits. No qualification was required.

VIII. MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS/MSD)

The samples shown below were designated on the COCs for MS/MSD analysis.

MW-21-LA-30-RE
MW-85-LA-30
MW-100B-LA-30
MW-104-LA-30
MW-203B-LA-30
MW-256-LA-30
MW-295-LA-30
MW-296-LA-30

Some results were outside control limits and have been qualified in the parent sample as shown below.

Parent sample	Analyte	Recovery	Control limits	Sample Qualifier
MW-21-LA-30-RE	Trichloroethene	4X spike, but spiked values nearly the same as unspiked		J
	Tetrachloroethene	38%, 71%	74-129%	J
MW-85-LA-30	1,2,3-Trichlorobenzene	138%, 134%	69-129%	None - ND
	Carbon tetrachloride	OK, 62%	72-136%	J
	cis-1,2-Dichloroethene	OK, 58%	78-123%	J
	Naphthalene	131%, OK	61-128%	None - ND
	Trichloroethene	OK, 73%	79-123%	J
	Tetrachloroethene	44%, 35%	74-129%	J
MW-100B-LA-30	Methyl tert-butyl ether (MTBE)	70%, OK	71-124%	J
MW-104-LA-30	Trichloroethene	73%, 75%	79-123%	J
MW-203B-LA-30	Trichloroethene	66%, 58%	79-123%	J
	Vinyl chloride	56%, OK	58-137%	J
MW-256-LA-30	Acetone	4X spike, RPD 135%	RPD 30%	J
	Trichloroethene	OK, 138% RPD 35%	79-123% RPD 30%	J

Parent sample	Analyte	Recovery	Control limits	Sample Qualifier
	Tetrachloroethene	OK, 11% RPD 54%	74-129% RPD 30%	J
MW-295-LA-30	All OK			
MW-296-LA-30	All OK			

IX. DUPLICATES

FIELD DUPLICATES

Field duplicate (FD) samples were collected as identified in the following table.

Field Duplicate Sample	Parent Sample	Matrix
DUP-1-LA-30	DR2-3-LA-30	GW
DUP-2-LA-30	MW-219-LA-30	GW
DUP-3-LA-30	MW-62-LA-30	GW
DUP-4-LA-30	MW-94A-LA-30	GW
DUP-5-LA-30	MW-97-LA-30	GW
DUP-6-LA-30	MW-101T-LA-30	GW
DUP-7-LA-30	MW-199A-LA-30	GW
DUP-8-LA-30	MW-214B-LA-30	GW
DUP-9-LA-30	MW-269-LA-30	GW
DUP-10-LA-30	MW-108-LA-30	GW
DUP-11-LA-30	MW-197B-LA-30	GW
DUP-12-LA-30	MW-286-LA-30	GW
DUP-13-LA-30	MW-302-LA-30	GW
DUP-14-LA-30	MW-267-LA-30	GW
DUP-15-LA-30	MW-52-LA-30	GW
DUP-16-LA-30	MW-285-LA-30-RE	

One FD RPD was above the 30% control limit and the parent and FD samples have been qualified as shown below.

Parent/FD samples	Analyte	RPD	Sample/FD concs (µg/L)	Qualifiers
MW-62-LA-30 DUP-3-LS-29	Vinyl chloride	57%	12.7 / 22.9	J / J

X. INTERNAL STANDARDS (ISTD)

All ISTD criteria were met. No qualification was required.

XI. LIMITS OF QUANTITATION (LOQ), LIMITS OF DETECTION (LOD) AND DETECTION LIMITS (DL)

The LOQs for the contaminants listed in the QAPP were below the project action limits (PALs).

XII. SAMPLE RESULTS / TRANSCRIPTION VERIFICATION

Transcription between the data package and the EDDs was verified. Sample results reported between the DL and LOQ were qualified as estimated (J).

Samples MW-21-LA-30, MW-285-LA-30, and MW-293-LA-30 were analyzed 19 days past the 14 day holding time. These samples were collected again and analyzed as MW-21-LA-30-RE, MW-285-LA-30-RE, and MW-293-LA-30-RE respectively. The results and RPDs are shown below.

Sample	Analyte	Concentration (initial / resampled), µg/L	RPD
MW-21-LA-30 MW-21-LA-30-RE	Acetone	165 – ND	**200%**
	MTBE	19.1 – 9.74	**65%**
	Tetrachloroethene	11.0 – 3.10	**112%**
	Toluene	0.283 J - ND	OK
	Trichloroethene	15.2 – 20.7	**31%**
	cis-1,2-Dichloroethene	79.8 – 84.5	6% - OK
	trans-1,2-Dichloroethene	0.460 J – 0.604 J	OK
MW-285-LA-30 MW-285-LA-30-RE	1,1-Dichloroethane	0.573 J – 0.500 J	OK
	Acetone	147 - ND	**200%**
	Chloroform	0.330 J – 0.249 J	OK
	Methylene chloride	0.261 J - ND	OK
	Tetrachloroethene	11.2 – 9.69	14% - OK
	Trichloroethene	3.52 – 3.21	9% - OK
	cis-1,2-Dichloroethene	0.435 J – 0.502 J	OK
MW-293-LA-30 MW-293-LA-30-RE	Acetone	113 – ND	**200%**
	Tetrachloroethene	1.49 – 1.22	20% - OK
	Trichloroethene	0.819 J – 0.651 J	OK

XIII. DATA USABILITY

Data were usable as discussed below.
No data were rejected. Data required minimal qualification. All data are usable as qualified.

Appendix C
Analytical Standard Operating Procedures

LOGIN01 – Microbac - Sample Receiving and Login

STANDARD OPERATING PROCEDURE
SAMPLE RECEIVING AND LOGIN

Issue/Implementation Date: 02 November 2018

Last Review Date: 02 January 2019

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Document Control # 239

Issued to: Document Master File

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

1.1 This document outlines procedures for sample handling, custody, container preparation, preservation, receipt, inspection/pH, login, Internal Chain of Custody, and storage. The document also addresses Temperature Monitoring and IR gun calibration.

1.2 Except as noted in Section 7.0, the support services supervisor shall have primary responsibility for implementation of these policies and procedures. Section 6.0 describes the duties of the sample custodians. Section 7.0 describes the specific duties of the customer service staff with respect to the procedures for logging samples into the LIMS.

1.3 Definitions and Acronyms

The following is a list of terms, definitions, and acronyms referenced in this SOP that are unique to the method.

COC	Chain of Custody
DI water	Deionized water
ICOC	Internal Chain of Custody
IR gun	Infrared Temperature Gun
LIMS	Laboratory Information Management System
LQAP	Laboratory Quality Assurance Plan
MD	Marietta Division
SDS	Safety data sheet
SOP	Standard Operating Procedure
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds

For a more comprehensive list of common terms and definitions, consult Appendix A in Microbac SOP LQAP.

2.0 SAFETY PRECAUTIONS

2.1 Safety glasses with side shields, gloves, and lab coats are worn when samples are being handled. (Safety glasses are worn at all times in the laboratory.) Additional personal safety equipment (respirators and dust masks) are available in the login area.

2.2 Occasionally samples are received broken. When this occurs, the cooler is placed immediately under the hood and samples are removed. When possible, the broken sample is placed in another container. The client is then notified by his/her Account Manager to confirm what appropriate action to take.

2.3 Broken glass is disposed of in the proper containers provided in the laboratory.

2.4 The cooler is cleaned by waste disposal personnel. All contaminated material is disposed of properly using proper waste disposal procedures. See Microbac SOP 33, “Laboratory Waste Management”.

2.5 Unknown waste samples that are received broken are placed in a container and taken to sample archive for proper disposal.

2.6 Radiological screening of samples may be performed on coolers received for special projects if required by the project QAPP. The screening is performed by the login personnel and noted in receipt information.

2.7 When highly contaminated samples are received, special precautions are taken. These samples receive special handling and storage and are tagged with a “Special Instructions” sticker. Any comments available are entered into the LIMS for the laboratory.

2.8 SDSs for each analyte and reagent used within the laboratory are available to all employees. Consult SDSs prior to handling chemicals.

3.0 EQUIPMENT AND SUPPLIES

3.1 Thermometers

3.2 pH strips: Low range 0.0 - 6.0; High range 7.5 - 14.0

3.3 Hood

3.4 IR Temperature Guns

3.5 Pipets - disposable

3.6 Geiger Counter

3.7 Gloves - disposable

3.8 PDA, Laptop or notebook computer (equipped for bar coding)

4.0 REAGENTS

4.1 20% Nitric Acid (HNO_3) Baker Instra-analyzed, or equivalent; prepared when needed in the metals laboratory. A 1000 mL glass dispenser is used to store and dispense the preservative. When HNO_3 is used as a preservative, a red label with HNO_3 is placed on the lid of the container. Label container with expiration date of 6 months after date prepared.

4.2 1:1 Hydrochloric Acid (HCL) Baker Instra-analyzed, or equivalent; prepared in the metals laboratory. 500 mL of concentrated HCL is added to 400 mL of DI water and diluted to 1L. A 1000 mL glass dispenser is used to store and dispense the preservative. When HCL is used as a preservative, a blue label with HCL is placed on the lid of the container. Label container with expiration date of 6 months after date prepared.

4.3 1:1 Sulfuric Acid (H_2SO_4) Baker Instra-analyzed or equivalent; prepared when needed in the conventional lab. 500 mL of concentrated H_2SO_4 is added to 400 mL of DI water and diluted to 1 L. A 4 L glass container is used to refill to 1000 mL glass dispenser. When H_2SO_4 is used as a preservative, a yellow label with H_2SO_4 is placed on the lid of the container. Label the container with expiration date of 6 months after date prepared.

4.4 50% Sodium Hydroxide (NaOH) comes in a ready to use solution, or equivalent. No mixing is required. A 250 mL glass container is used to store and dispense this preservative. When NaOH is used as a preservative, a blue label with NaOH is placed on the lid of the container. A sterile pipet is used to add preservative to the container. Use expiration date from the manufacturer.

4.5 Zinc Acetate/Sodium Hydroxide (ZnAc/NaOH). Zinc Acetate: prepared when needed in the conventional lab. 88 g of Zinc Acetate dihydrate crystal is dissolved in 200 mL of DI water and diluted to 250 mL. A 250 mL amber glass container is used to store and dispense the preservative. To make ZnAc/NaOH, 2 mL of ZnAc is added to the container using a sterile pipet. Add 2 mL of NaOH with another sterile pipet. Then a gold dot with ZnAc/NaOH is placed on the lid of the container. This preservative is only used for sulfide. Label container with expiration date for 6 months after date prepared.

4.6 Ascorbic Acid (C6H806) comes ready to use Ascorbic Acid, Fine Powder. No mixing is required. A 125 mL pre-cleaned wide mouth glass container is used to store and dispense the preservative. A spatula is used to add 25 mg to a 40 mL, pre-cleaned vial with septa lid. Use expiration date from the manufacturer.

4.7 Hexane: 95% ULTRA resi-Analyzed; used in PCB – wipes.

4.8 Methylene Chloride (CH2CL2) ULTRA – Resi – Analyzed used in PAH – wipes.

4.9 Sodium Thiosulfate (Na2S2O3) tablets come ready to use in a sterile plastic container. No preparation is needed.

4.10 Methanol (MeOH): EDM OmniSolv or equivalent grade suitable for purge and trap.

5.0 CUSTOMIZED SAMPLE KITS

5.1 Microbac prepares customized sampling kits for many environmental sampling projects for wastewater, groundwater, soil and waste. The process for preparing a sample kit begins when an Account Manager generates a work order (B Number) and the associated kit request/packing list.

5.1.2 The support service staff member uses the packing list to assemble the specified containers for the work order.

5.1.3 Staff member then prints out labels from the LIMS database table that states client, test, preservative and the site where the samples will be taken.

5.1.4 Containers are then set up on the work station table to be labeled and preserved.

5.1.5 Sample containers are then packed in coolers with packing material, packing lists, custody seals and chain of custody forms.

5.1.6 Cooler is then sealed with the custody seal and shipped or delivered to client.

5.1.7 Container Preparation:

All sample containers are received pre-cleaned. Pre-cleaned containers are received in cases that are labeled. Lot numbers and analyte certification records are tracked and filed with start and end dates of the Certificate of Analysis. Sample containers are never reused.

5.2 Sample Containers, Volume and Preservative

Tables 1-6 list the container type, minimum volume, and type of preservative for each analysis parameter or method. Additional instructions are provided below for conventional and wet chemistry parameters.

5.2.1 Acidity (acid) – by itself in 250 mL plastic. No preservative.

5.2.2 Alkalinity (Alk) – by itself in 250 mL plastic. No preservative.

5.2.3 Biochemical Oxygen Demand (BOD) – by itself in 500 mL plastic. No preservative

5.2.4 Bromide (Br) – by itself in 250 mL plastic. No preservative.

5.2.5 Cyanide (CN) – by itself in 250 mL plastic with 3.5 mL of 50% NAOH = pH > 12.

5.2.6 Cyanide, Amenable (CN-A) – by itself in 250 mL plastic or with CN with 3.5 mL of 50% NAOH pH > 12.

5.2.7 Coliform Fecal (Col-FC) – by itself in sterile plastic container with pellet of $Na_2S_2O_3$. (These sterile containers come prepared.)

5.2.8 Coliform Total (Col-TC) – by itself plastic container with pellet of NA2S2O3. (These sterile containers come prepared.)

5.2.9 Dissolved Oxygen (DO) – by itself in 500 mL lab glass bottle with glass stopper. When sampling be sure there is no headspace. No preservative.

5.2.10 Fluoride, Total (distilled) (F-Dist.) – by itself in 250 mL plastic. No preservative.

5.2.10.1 Distilled (subbed out) 250 mL plastic by itself – no preservatives

5.2.10.2 Non –Distilled, 250 mL, no preservative

5.2.11 Hardness (Hard) – by itself in 250 mL plastic with 3 mL of 20% HNO_3 pH < 2.

5.2.12 Iodide (I) – by itself in 250 mL plastic. No preservative. Can be included with Br.

5.2.13 Coliform Fecal/MPN – by itself in sterile plastic container with pellet of $Na_2S_2O_3$.

5.2.14 Nitrogen Organic (N_ORG) –250 mL plastic with H_2SO_4 pH<2. Can be combined with other preservative parameters.

5.2.15 Oil and Grease (OG) – by itself in 1000 mL glass with 5 mL of 1:1 HCL pH<2.

5.2.16 Phenolics, Total (T-Phen) – by itself in 250 mL amber glass with 1 mL of 1:1 H_2SO_4= pH<2.

5.2.17 Sulfite (SO_3) – by itself in 250 mL plastic. No preservative. Must notify lab.

5.2.18 Settleable Solids (Set –S) – need two bottles in 1000 mL plastic. No preservative.

5.2.19 Silica Dissolved (Silica) – by itself in 250 mL plastic. No preservative.

5.2.20 Sulfide (S) – by itself in 500 mL plastic with 4 mL of ZnAce/NaOH – pH > 9.

5.2.21 Total Dissolved Solids (TDS) – by itself in a 250 mL plastic or together with TSS in a 500 mL plastic. No preservative.

5.2.22 Total Organic Carbon (TOC) – can be put with other parameters with the same preservative. If by itself it goes into 250 mL plastic with 1 mL 1:1 H_2SO_4. Other requirements for TOC are as follows: TOC-4 used 4x250 mL plastic with 1:1 H_2SO_4, TOC -14 uses 1x250 mL glass with 1:1 H_2SO_4, TOC-44 uses 4x250 mL glass with 1:1 H_2SO_4.

5.2.23 Total Organic Halides (TOX) – by itself in 250 mL amber glass, septa lid with 1 mL of 1:1 H_2SO_4. No headspace in sample. Other requirements for TOX are TOX-4 uses 4x250 mL amber glass, septa lid with 1:1 H_2SO_4. No headspace in sample.

5.2.24 Total Suspended Solids (TSS) – by itself in a 250 mL plastic or together with TDS in a 500 mL plastic. No preservative.

5.3 Volume of Preservative use for Container Sizes:

H_2SO_4:	40 mL	½ mL = pH < 2
	250 mL	1 mL = pH < 2
	500 mL	2 mL = pH < 2
	1000 mL	4 mL = pH < 2
HNO_3:	250 mL	3 mL = pH < 2
	500 mL	5 mL = pH < 2
	1000 mL	10 mL = pH < 2
HCL:	40 mL	3 drops = pH < 2
	1000 mL	5 mL = pH < 2
NAOH:	250 mL	3.5 mL = pH > 12
MeOH:	40 mL	10 mL used in 5035 Field Prep/tare weight

5.4 Special Procedures for Volatile Organics Analysis (VOA)

5.4.1 General

Samples for VOA analysis should always be collected in separate containers. If this is not possible, the VOA analyses should be performed first or split into a separate VOA container to avoid contamination of the sample with common lab solvents.

5.4.2 Water

All water VOA containers must be filled completely with no headspace/bubbles >6mm. Preservatives, if required, consist of 3 drops of 1:1 HCl per each 40 mL vial (pH should be < 2). Pre-preserved vials are also purchased from our container vendor. These include the HCl pre-preserved as well as the $Na_2S_2O_3$ pre-preserved.

5.4.3 Oils and Waste Samples

No preservative is required for waste samples. Depending on the client and project, waste and oil samples may be collected in various glass bottles or vials. Sample volume of 5-10 mL is normally sufficient for VOA analysis of wastes and oils.

5.5 Procedure for Method 5035 – Methanol Preserved Vials

Methanol preserved vials are obtained from a container vendor when possible. If out of stock, we will employ the following procedures to prepare these in-house. Contact the Quality Assurance Officer before proceeding.

5.5.1 Print labels with client's name, parameter and preservative (MeOH).

5.5.2 Go to volatiles lab and get 40 mL VOA vial for prep of 5035 method, place label on bottles.

5.5.3 Using a calibrated volumetric dispenser, add 10 mL of MeOH to each vial. Replace cap and septum.

5.5.4 Determine the tare weight to 0.01 g and record on the vial label (beside the parameter) using a permanent marker.

5.5.5 The kit request will specify the number of containers to be provided. Place the containers in bubble bags and pack them in shipping cooler. Label the outside of the cooler with a label that states "This package conforms to 49CFR – 173.4".

5.6 Storage blanks are placed in sample refrigerators and freezers to monitor potential cross contamination. Storage blanks consists of 40 mL of analyte free DI water or

5 mL DI water and 5.00 g of sand stored for 14 days in each VOA refrigerator/freezer. Analyses are performed via Method 8260 with results quantitated to the MDL. Storage blanks are prepared weekly and logged into the LIMS laboratory account. Weekly, (after storage blanks have been stored for two full weeks) storage blanks are analyzed via 8260 (storage blanks must be analyzed within the 12 hour tune time).

5.7 Special Instruction for Coliform fecal/MPN

5.7.1 When a new lot number of sterile plastic containers is received, a container will be pulled and logged into our LIMS system. This will alert the lab of a new lot number in house that is in need of a sterility check.

6.0 SAMPLE HANDLING AND CUSTODY PROCEDURES

6.1 This section describes the procedures for receipt, inspection/pH, labeling, storage internal custody and handling of laboratory samples. These are the primary duties and responsibilities of the sample custodian(s) under the direction of the support services supervisor. Many of the processes in this section require knowledge of the Microbac-MD LIMS and specific training in the use of electronic devises including the IR temperature guns, barcode scanning devices, and PDAs, or laptop/notebook style computers. The following sections provide more details on these procedures and the tools required.

6.2 Sample Receipt Checklist/Discrepancies

The cooler inspection form (Record of Sample Receipt and Inspection) contains the following details: the cooler received date, client identification, shipping agency and time received, opened by, login number, which IR gun was used, the assigned cooler number, the cooler temperature, the air bill number, the cooler seal information, was the chain of custody provided, were samples received intact, labels legible/complete, were correct containers used, were the correct preservatives used, was the pH range acceptable, were VOA's free of head space, is the chain of custody signed and dated, were samples received within EPA hold times, were the temperatures required for each type of sample in the cooler, any discrepancies are documented on cooler inspection form and the Account Manager is notified. An example of the Record of Sample Receipt and Inspection is presented in Figure 1.

6.3 Sample Receipt and Inspection, General

6.3.1 Samples are received through shipping and receiving and moved directly to the login area. Coolers and/or boxes are checked to determine if they are sealed with tape or bandings when received.

6.3.2 When samples are returned through Microbac couriers, coolers are not sealed unless requested by client.

6.3.3 Coolers are opened in the login area. When coolers are identified as Radiological projects, the custodian will open them under the fume hood. Radiological screening will occur as outlined in the Microbac Radsafety SOP for known radiological projects before opening the coolers. This practice must be followed for all coolers containing potentially hazardous samples, unknowns, or any broken or leaking containers.

6.3.4 Samples that are delivered to the laboratory on the same day they are collected may not meet requirements of ≤6°C and not frozen. In these cases, the samples shall be considered acceptable if the samples were received on ice. The allowance for samples exceeding temperature requirements when delivered shortly after sampling does not alleviate the requirement to record a temperature, even in the presence of ice. Documentation of receipt on ice is not sufficient to meet method requirements, since methods require the temperature upon receipt. Methods and regulations require that the temperature upon receipt be recorded, regardless of whether that information is in compliance or out of compliance. A temperature blank or sample is immediately removed from the cooler and the temperature is taken with the IR Temperature Gun and recorded in the Record of Sample Receipt and Inspection. The temperature is taken by shooting the bottom of a sample. Upon receipt, samples that originate from the State of West Virginia are required to have the temperature of every bottle checked for preservation requirements. If a cooler temperature or bottle temperature requirement is not met, the affected samples must be tracked using the Discrepancy field on the inspection form. Each container must be listed from the cooler when out of temperature. See Section 9.0 for details of this procedure.

6.3.5 Samples are removed from coolers and lined up in order on carts with the Chain of Custody. When discrepancies occur between the Chain of Custody and the sample container labels, it is noted and the appropriate Account Manager is notified. The Account Manager then notifies the client. The client decides what information is correct. Corrections are noted in the discrepancy section of the Cooler Inspection Form. Corrected data is logged into the LIMS system.

6.3.6 Sample ID, date and time of collection is checked with the Chain of Custody versus sample container label. The login assistant will check the pH of all preserved water samples, with the exception of volatile organics and method 1664 (OG-HEM). These are checked at the bench by the analyst. In addition, the pH of unpreserved water samples submitted for the analyses listed in Table 7 will also be checked in order to assure that they were not inadvertently preserved. The pH for unpreserved samples must be 2<pH<10 and samples logged for method 608.3 must be within the pH range of 5-9. The pH is checked by inserting a pipet into the sample and placing a drop of the sample onto pH paper of the appropriate range (see Section 3.2). A glass pipet is used for checking pH of organic parameters and plastic pipets are used to check inorganic parameters. The assistant will verify that the pH is acceptable. The LIMS will create and update the pH record for each sample container checked in the sample delivery group (L#). If there are pH exceptions to the default acceptance criteria, the assistant/analyst will edit the pH data in the LIMS Container Records, and forward the exceptions/discrepancies to the client representative. If additional preservative is added to the container, the amount, concentration, and adjusted pH shall be recorded in the comments field in Container Records table. If the pH is out of range, the sample ID and product of the sample are recorded in the ROR System sample discrepancy section of the Cooler Inspection Form as a discrepancy by login personnel. Prior to the adjusting and storing of the samples, approval must be determined from the client through the Account Manager. The approval is noted, as well as how much, which type and lot number of the preservative was for the adjustment. Metals also requires date and time of the preservation to be recorded on the bottle and documented.

6.3.7 If a sample is received out of hold, or is improperly preserved, the client is notified and the sample is analyzed according to the client's request. The discrepancy is noted in the Cooler Inspection Form (Document Control #1957- see Figure 4) and in the LIMS system along with the client instructions. Minimum volume, container type, preservation and hold time are listed in Table 1-6. VOA Samples which are indicated on the COC as being unpreserved must have the “VOA-Unpreserved” product logged on the relevant samples with the analysis products.

6.3.8 If a single sample container of soil is received and multiple analyses including VOA are requested, a sub-sample for VOA analysis is removed by the VOA laboratory and placed in an appropriate sample container. This sub-sample for VOA analysis shall be taken prior to the sample container being opened for any other reason. Care is taken to eliminate as much headspace as possible in the new VOA sample container. This sub-sample is then handled, stored and otherwise treated the same as any other volatile sample.

6.3.9 The custodian will inspect all water samples collected in VOA vials for the acceptable levels of headspace. If any containers contain bubbles larger than 6mm, this information must be noted on the Cooler Inspections Form as a discrepancy.

6.3.10 Trip Blank hold times

Microbac Marietta – Trip Blank Collection Date Policy
The collection date and time of trip blank(s) should be the same as the last sample collected on the chain of custody with which the trip blank(s) is associated. Microbac records the date and time the trip blank(s) are prepared at the laboratory, this date and time should not be used as the collection date and time on the chain of custody. If the prepared date and time are mistakenly entered on the chain of custody for the trip blank, we will edit the date and time of collection of the trip blank to coincide with the last sample listed on the chain of custody. If the collection date and time listed on the chain of custody for the trip blank is within the collection date and time of the first and last sample on the chain of custody we will use the collection date and time as presented for hold time evaluation.

This policy has been established at the recommendation from the MICE interpretation regarding hold times for trip blanks and is consistent with EPA guidance "… a trip blank has the same "life" as a sample with which they are sent. Trip blanks are the same age as the sample set and are used to determine if the sample MAY have been contaminated in transit."

This policy may be superseded by project specific or state specific requirements. Compliance with this policy will contribute to the production of valid data.

6.3.11 When all information is correct, the samples are logged into the LIMS system. The LIMS automatically assigns a unique login number. See Sections 7.0 and 8.0 for logging procedures.

6.4 Electronic Checklist – Procedures for Using the PDA / Laptop / Notebook

This section describes the use of a PDA / Laptop or equivalent, (Section 3.8) to automate many of the cooler and sample checking procedures presented in Section 6.3. The system incorporates a barcode reader and a wireless connection to the LIMS, allowing the checklist to be completed in paperless mode. The screen displays an electronic facsimile of Figure 1, and the user is prompted to enter the information in a logical, step-wise manner. Staff must not attempt these procedures until they have been trained in the use of the PDA / Laptop or equivalent.

6.4.1 Turn the unit on and open a new receipt. The system will automatically assign a unique number for later tracing of the cooler and samples to a specific delivery group (B, P and final L number(s)).

6.4.2 Select the mode of delivery by pressing the appropriate radio button.

6.4.3 Go to “Add cooler information”

6.4.4 Scan the barcode that identifies the carrier’s airbill number.

6.4.5 Scan the barcode that identifies the cooler’s tracking number.

6.4.6 Remove the COC(s) and scan or record the COC number(s). (This can also be done later in the sequence if there are multiple COCs.). This scan of the COC will be included in the final report to our customer(s). It is important the scan be an accurate reflection of the COC as received. Therefore, maintenance of the scanning device is critical. No markings must be allowed to be introduced by the scanning process. For example, lines introduced by dust or debris on the scanner’s internal parts are not permitted. Careful and timely maintenance of the scanner is important. See Figure 2 for scanner maintenance and cleaning instructions.

6.4.7 Determine the cooler temperature with the IR Gun and enter temperature.

6.4.8 Complete the remaining checklist items using the keypad.

6.4.9 Note each exception or problem in the discrepancy files, and the preservation form. In addition, if no problems are found, note this on the form along with the pH paper lot number. (Document Control #1957, Figure 4)

6.4.10 Some samples will require priority due to short hold time or turnaround time. Use the “Priority” drop-down menu to select appropriate priority need. The short hold time may not be readily determined by information on the chain of custody. Tables 1 through 6 list hold times for each analysis. An abbreviated list is presented in Figure 3; this list is posted at the cooler inspection areas.

6.4.11 Proceed as in Section 6.3.5.

6.4.12 When you have finished this process, you may edit any checklist entry, add comments, or address discrepancy details at the login computer keyboard.

6.5 Sample Labeling

Labels for containers and mailing reports are then printed, label bottles, and put mailing report labels along with chain of custody form in folder.

6.6 Sample Storage

Samples are stored according to analyses. In the walk-in cooler (W-1) shelves are designated by departments. These identify the sample storage location for easy retrieval by the laboratory. Volatile samples (V-1) are stored in a separate refrigerator with the exception of waste samples. These are kept in the walk-in cooler or on a holding shelf in archive until analyses can be performed.

6.7 Internal Chain of Custody Procedures

If a client requests samples to be tracked throughout the lab, an ICOC form is generated through a computer program. “ICOC” prints out on the label. This label also contains a unique bar code. The analyst is responsible for scanning out the samples using his/her bar coded badges. The samples are then relinquished by the appropriate personnel in the login area. Other information as to the location of the sample, which department the sample is going to can be scanned from a bar coded template. When the analyst is ready to return the samples, it is scanned back into the computer by the relinquishing employee using his/her bar coded badges, one login personnel’s badge and the location to which the sample is being returned (walk-in/archive/disposal). It is not always possible to have a custodian present when samples are removed from storage. The analyst will scan a special barcode designated for all “after hours” removal of samples from the login area storage unit.

6.8 Sample Disposal

After all analyses have been completed, the sample custodians will move the sample residuals to the archive storage units, where they will remain for the time specified in the client agreement. At regular intervals the sample custodian or other trained staff member will dispose of aqueous, solid, and organic-matrix samples in accordance with Microbac SOP 33 (Laboratory Waste Management). Alternatively, the laboratory may return selected sample residuals to the client.

6.9 Saturday Receipt of Short Hold Time Samples

It is the responsibility of the Account Managers and their assistants to notify the laboratory and the sample custodians if samples with short hold times (Figure 3) are to be received on Saturdays. The notification will be in the form of an email addressed to “OVD-Headsup” which reaches all of the relevant personnel. Samples for which the laboratory has been notified of shipment do not require any specials actions on the part of the sample custodian receiving the cooler(s). In the case that unannounced short hold time samples are received on Saturday, it is the responsibility of the sample custodian to notify the affected department supervisor or designee by telephone so that the appropriate action can be taken to process the samples within the holding time.

6.10 After Hours Receipt from Clients

When a client cannot drop off sample(s) to the lab during normal business hours, we provide a locked drop box at the shipping/receiving area. The client can contact their Account Manager to notify them that they need to use the drop box; the box will be left unlocked for the client to drop off their cooler. Once they drop off the cooler, they will lock the box. If needed, the cooler will be received later that night or first thing the next morning by the login personnel. If the project is an ongoing event, the client will be provided a key to unlock and lock, on an as needed basis during their project.

7.0 OVERVIEW OF LOGGING PROCESS

This section describes the duties of the sales/service team, specifically the Account Managers and their assistants, as they pertain to logging of project and sample information into the LIMS. These duties are summarized below:

7.1 The sales/service department must enter account and project information into the LIMS as a prerequisite to preparing quotations and work-orders or to the actual logging of samples. The LIMS assigns unique serial numbers for each account and for the associate project.

7.2 Quotations (Q number)

Quotations are used to enter special pricing in the LIMS and are often included as part of the sales proposal. The LIMS assigns a unique serial number for each quotation. (Q-number)

7.3 Work-orders (B number)

The service team creates a work order upon new project award, or when sample containers are requested for an existing project. The work order includes sample, matrix and product information in sufficient detail to generate a packing list for sample kits and for the efficient logging of samples once received at the laboratory and to create templates for repetitive sampling events. The LIMS assigns a unique serial number (B number) for each work order.

7.4 Sample Pre-logging (P number)

Pre-logging is the preliminary process of logging samples into the LIMS either upon receipt of the samples, or when chain of custody forms are provided to the lab in advance of sample receipt. The LIMS assigns a unique serial number

(P number) for each sample in the pre-log status, and information is subject to review and editing by the sales/service teams.

7.5 Final Logging (L number)

After the information in the pre-log number is reviewed and deemed accurate, the Sample Custodian or designated client representative will perform the final login procedure. In this step the LIMS assigns a unique serial number (L number) and generates sample labels for each container in the sample delivery group.

7.6 Other Data Entry

Most of the analytical data is entered into the LIMS via automatic data upload from the laboratory instrumentation, or through other LIMS tools such as electronic bench sheets used by the analyst. The custodian or Account Manager must employ manual data entry procedure for a few methods, primarily field data provided by the samplers. Examples include pH, dissolved oxygen, and conductivity.

7.7 Login Folder Review and Client Communication

The Client Representative or team chemist is responsible for accuracy of the information entered into LIMS for accounts, projects, and login numbers. This review must occur prior to release of the samples to the laboratory and is normally performed after the pre-log step of the process. The service team is also responsible for communication and resolution of any discrepancies identified at the time of sample receipt and inspection. Other duties of the service teams are presented in Microbac SOP 44 and Microbac SOP MISDATA01.

8.0 DETAILED LOGGING PROCEDURE

8.1 Log into the LIMS.

8.2 Go to Sample Management; Login; Login ID – enter the correct work order (B number) or template (T number); Check Pre-Login and click OK.

8.3 Check all products in the matrix for each client ID. **DO NOT CHANGE ANY INFORMATION IN THE B# SCREEN.** Check all projects/products, etc. in this screen to make sure they match the chain of custody. **Read Login information in the top right corner for specific instructions.**

8.4 Go to Copy; Copy Template; Source Template B number; Pre-Login; Collect Date (Change date if needed); then click OK.

8.5 The pre-log (P number) Screen will come up at this time. This is the screen you edit if necessary. For example: If unpreserved VOA samples were received and the B number does not include the “VOA-Unpreserved” code, it can be added to samples on this screen.

8.6 Place your cursor on the Client ID. Check the matrix below to see if it is correct against the chain of custody and the bottles lined up. If the matrix matches the chain of custody and the bottles, go back to the client ID.

- You may have to change the client ID to match the bottle or chain of custody ID.
- Tab over to the received date; enter 0 and tab for the current date and add the time received from the printed barcode label that the ROR system generates.
- Tab over to the collect date; the date should be filled in but you will need to add the time. If no time is given, default to 00:01.
- Tab over to the TAT; do not change this number; if the TAT is different from the chain of custody, put this information in the “Prelim” button, not the TAT.
- Tab to the end of the line checking for any errors and also to check comments and QC tags.

8.7 Move your cursor down to the next fraction (line) and start over with these instructions from Section 8.6. When tabbing to the receive and collect dates/times use the F3 key and the dates/times will copy from the above fraction ***or*** you can also “Copy Duplicate Fractions” or “Copy Products” by going to the Copy tab on the Toolbar, and clicking on one or the other. To delete fractions or products, shift F6.

8.8 If nothing else needs added or deleted go to Copy; order fractions; click on the Auto Calc due dates button and the F10 to save. This will automatically fill in the due dates and client dates. Click on the add prods button at the bottom of the page. Be sure to add prods on LAST fraction.

8.9 At this point, your folder which is now a P number needs to go through Peer Review or given to the client representative for review. When the folder is returned to you after review, you may make corrections if needed and then take it to an L number. Be sure to take care of discrepancies if needed.

8.10 In order to take a P number to an L number go to copy; source template P# _____; Login.

8.11 The L number screen will come up at this time. If a green button comes up at the top of the screen, click on it at this time.

8.12 Click on Reports; The L number will come up automatically at this time in the Login Reports screen; go to Login Labels; Printer; Go and your labels will print with address labels attached. Watch for the ICOC on label. Use pen to color labels for help with archiving.

8.13 Label the bottles and put them away in their appropriate walk-in, refrigerator or freezer.

8.14 Place the client Chain of Custody form, and the extra client address labels in a manila master folder.

8.15 Place the client address label on the folder tab and in the bottom right hand side, on the front of the folder, facing out (sideways).

8.16 If the TAT is less than 7 days or these are short hold, make a note on the outside of the master folder to help in prioritizing review.

8.17 Folders are then taken to the Service team.

9.0 CALIBRATION AND QUALITY CONTROL

9.1 IR Gun Calibration

9.1.1 The IR Temperature Guns are calibrated once a year by Cole-Parmer and a certificate is supplied and are maintained in the QA office. The guns are calibrated quarterly (every 3 months) by Wet Lab personnel.

9.1.2 The calibration of the IR temperature guns are checked once daily, in the morning before use against the ROR system Quality Control probe thermometer in the 1005/WI walk-in cooler by Support Service personnel. Readings are recorded in the temperature log books. The IR gun must read within 0.5° C of the probe reading. If this is unsuccessful, the IR Temperature Gun is returned to the manufacturer for maintenance.

9.2 Coolers are received into the Login area. A temperature blank is removed and held near the IR Temperature Gun. (If a temperature blank is not available, any size container can be used.) A temperature reading is taken for each cooler or bottle if required, see 6.3.4.

9.2.1 The IR Temperature Gun is pointed at the bottom of the bottle. The trigger on the gun is pulled immediately and a reading appears on the readout of the gun. The temperature is then recorded in the Cooler Inspection section of the ROR.

9.2.2 If the temperature exceeds 6° C, the Account Manager is notified so that the client may be advised that their samples were received with the temperature out of range. All sample containers in a cooler with a temperature exceeding the 6ºC when required or received frozen must be listed in the Discrepancy section of the inspection report and on Form #1957(Figure 4). Clients will then decide if the samples are to be analyzed or not. (Acceptance criteria can be adjusted at the request of the client). If the samples are received frozen, then this is noted in the discrepancy section of the Cooler Inspection Form and the Account Manager is notified.

9.3 Procedure for Tracking When Cooler Temperature is not Within Guidelines

9.3.1 Login Staff

When cooler or bottle temperature is determined to be out of the regulatory guidelines:

1. Label each container from the cooler with a “Cooler Temp Out” or “Bottle Temp Out” sticker.
2. If the cooler is to be unpacked at a later time, label the cooler with a “Cooler Temp Out” sticker.
3. Place a “Cooler Temp Out” sticker on the front of the project folder to notify project management.
4. When bottle temperature is out for WV samples, NOTE EACH BOTTLE on the form and label each bottle that is out with “Bottle Temp Out” sticker.

The temperature discrepancy still needs noted in the receipt and inspection forms.

9.3.2 Analysts

When analyzing a sample with a container labeled with a “Cooler Temp Out” or “Bottle Temp Out” sticker.

1. Indicate on your bench sheets and extraction logs the sample being analyzed was received out of regulatory guidelines with “CT1” in the comment section.

9.3.3 Data Reviewers and Supervisors

1. Data must be qualified at the analyte level for samples received in coolers with the temperatures outside of regulatory guidelines.
2. Address the temperature out of regulatory guidelines in the case narrative

using the appropriate phrase below.

9.3.4 Case Narrative Comments (Helpful Hints)

1. The temperature at receipt was XX C, but samples were received within 15 minutes of collection.
2. The temperature at receipt was XX C, exceeding the regulatory guidelines for testing.
3. Although samples were on ice, the temperature at receipt was XXXC, exceeding the regulatory guidelines of 0°-10°C for microbiological testing.
4. Although samples were received on ice, the temperature at receipt was XX C, exceeding the regulatory guidelines of 0°-6°C for chemical testing.

9.4 Temperature of Storage Units

The temperatures of the walk-in cooler, archive walk-in, V1 storage refrigerator, and the F-1 freezer are checked every four hours via electronic temperature probes. This system sends an email alert to the login supervisor and staff if a temperature is out of range. In the event of a temperature excursion for the walk-in coolers, Microbac notes the discrepancy and takes appropriate actions to relocate the samples if the problem persists.

10.0 REFERENCES

10.1 Microbac SOP LQAP “Laboratory Quality Assurance Plan”

10.2 Microbac SOP RADSAFETY “Radiation Safety Program Manual”

10.3 Microbac SOP33 “Laboratory Waste Management”

10.4 Microbac SOP44 “Project Management, Technical Service and Subcontracting”

10.5 Microbac SOP MISDATA01”Data Entry, Data Review and Reporting”

Table 1
Sample Containers, Preservation and Hold Times
CONVENTIONALS - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
Acidity	100	P, G	Cool, ≤ 6° C	14 Days
Alkalinity	100	P, G	Cool, ≤ 6° C	14 Days
Total Solids	50	P, G	Cool, ≤ 6° C	7 Days
Ash Content @ 750° C	25	P, G	Cool, ≤ 6° C	---
Biochemical Oxygen Demand	500	P, G	Cool, ≤ 6° C	48 Hours
BTU	10	P, G	Cool, ≤ 6° C	---
Formaldehyde	20	G	Cool, ≤ 6° C	3 Days
Chloride	25	P, G	Cool, ≤ 6° C	28 Days
Chloride, Total Residual	100	P, G	Cool, ≤ 6° C	6 Hours
Cyanide (midi)	50	P, G	Cool, ≤ 6° C, NaOH, pH>12	14 Days
Cyanide, Amenable to Chlorination (midi)	100	P,G	Cool, ≤ 6° C, NaOH, pH>12	14 Days
Chemical Oxygen Demand	25	P, G	Cool, ≤ 6° C, H_2SO_4, pH<2	28 Days
Color, Platinum-Cobalt	50	P, G	Cool, ≤ 6° C	48 Hours
Coliform, Fecal	120	Sterile P, G	Cool, < 10° C, $Na_2S_2O_3$	8 Hours
Coliform, Total	100	Sterile P, G	Cool, < 10° C, $Na_2S_2O_3$	8 Hours
Specific Conductance	100	P, G	Cool, ≤ 6° C	28 Days
Corrosivity (pH)	50	P, G	Cool, ≤ 6° C	---
Chromium, Trivalent (calc)	-	P, G	Cool, ≤ 6° C	---
Chromium, Hexavalent	150	P, G	Cool, ≤ 6° C	24 Hours
Dissolved Oxygen	300	G	Cool, ≤ 6° C	6 Hours
Fluoride	25	P, G	Cool, ≤ 6° C	28 Days
Ignitability	75	P, G	Cool, ≤ 6° C	28 Days
Fluoride, Total (Distilled/Non-Distilled)	200	P, G	Cool, ≤ 6° C	28 Days
Hardness	100	P, G	Cool, ≤ 6° C, HNO3, pH<2	6 Months
Surfactants (MBAS)	100	P, G	Cool, ≤ 6° C	48 Hours
Coliform Fecal (MPN)	100	Sterile P, G	Cool, < 10° C, $Na_2S_2O_3$	8 Hours
Nitrogen, Ammonia (Distilled/Non-Distilled)	100	P, G	Cool, ≤ 6° C, H_2SO_4, pH<2	28 Days
Nitrogen, Nitrite	50	P, G	Cool, ≤ 6° C	48 Hours
Nitrogen, Nitrate	75	P, G	Cool, ≤ 6° C	48 Hours
Nitrogen, Nitrate-Nitrite	25	P, G	Cool, ≤ 6° C, H_2SO_4, pH<2	28 Days
Nitrogen, Organic (calc)	100	P, G	Cool, ≤ 6° C, H_2SO_4, pH<2	28 Days
Oil and Grease	1000	G	Cool, ≤ 6° C, HCl, pH<2	28 Days

1. P = Polyethylene (preferred when acceptable)
2. G = Borosilicate glass with Teflon lined cap
3. For more current list of method and preservations, see LIMS tables, Products/Containers

Table1 (continued)
Sample Containers, Preservation and Hold Times
CONVENTIONALS - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
Phenolics, Total	100	Amber, G	Cool, ≤ 6° C, H_2SO_4, pH< 2	28 Days
Phosphorus, Total	50	P, G	Cool, ≤ 6° C, H_2SO_4, pH< 2	28 Days
pH Lab	50	P , G	Cool, ≤ 6° C	6 Hours
Orthophosphate	50	P, G	Cool, ≤ 6° C	48 Hours
Reactivity, Cyanide	10	P, G	Cool, ≤ 6° C	---
Reactivity, Sulfide	10	P, G	Cool, ≤ 6° C	---
Sulfite	50	P, G	Cool, ≤ 6° C	6 Hours
Settleable Solids	1000	P, G	Cool, ≤ 6° C	48 Hours
Sulfate	25	P, G	Cool, ≤ 6° C	28 Days
Specific Gravity	50	P, G	Cool, ≤ 6° C	---
Total (Organic) Sulfur	10	P, G	Cool, ≤ 6° C	---
Sulfide	500	P, G	Cool, ≤ 6° C, Zinc Acetate, NaOH, pH> 9	7 Days
Total Dissolved Solids	50	P, G	Cool, ≤ 6° C	7 Days
Total Suspended Solids	200	P, G	Cool, ≤ 6° C	7 Days
Turbidity	50	P, G	Cool, ≤ 6° C	48 Hours
Volatile Dissolved Solids	50	P, G	Cool, ≤ 6° C	7 Days
Total Volatile Solids	50	P, G	Cool, ≤ 6° C	7 Days
Volatile Suspended Solids	200	P, G	Cool, ≤ 6° C	7 Days
UCMR4 546	40	Amber, G	Cool, ≤ 10° C Sodium thiosulfate	14 Days

1. P = Polyethylene (preferred when acceptable)
2. G = Borosilicate glass with Teflon lined cap
3. For more current list of method and preservations, see LIMS tables, Products/Containers

Table 2
Sample Containers, Preservation and Hold Times
VOLATILE ORGANICS (VOA) - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
Gasoline Range Organics	40 mL	G, Septa Caps	Cool, ≤ 6° C, HCl, pH< 2	14 Days
Volatile Aromatics	40 mL	G, Septa Caps	Cool, ≤ 6° C, HCl, pH< 2	14 Days
Volatile Organics (VOA)	40 mL	G, Septa Caps	Cool, ≤ 6° C, HCl, pH< 2	14 Days
VOA – Method 624.1	40 mL	G, Septa Caps	Cool, ≤ 6° C	7 Days
VOA – Method 624.1 (chlorinated)	40 mL	G, Septa Caps	Cool, ≤ 6° C, $Na_2S_2O_3$	7 Days

*Provided upon client request when samples contain chlorine.

Table 3
Sample Containers, Preservation and Hold Times
SEMIVOLATILE ORGANICS - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
Diesel Range Organics	1000 mL	G	Cool, ≤ 6° C	7 Days
Pesticides/PCBs	1000 mL	G	Cool, ≤ 6° C	7 Days
Polyaromatic Hydrocarbons	1000 mL	G	Cool, ≤ 6° C	7 Days
Herbicides	1000 mL	G	Cool, ≤ 6° C	7 Days
EDB/DBCP	3.40 mL	G	Cool ≤ 6° C	7 Days
Semivolatile Organics	1000 mL	G	Cool, ≤ 6° C	7 Days
PFAS by LCMS Compliant with QSM.1 Table B-15	250 mL	HDPE bottle With unlined HDPE screw cap	Cool ≤10°C when received; store at ≤6°C	14 Days
537 Drinking Water	250 mL	Polypropylene Bottle with an Polypropylene Screw-cap	Trizma 5.0g/L; Cool ≤ 10°C when received; Store at ≤ 6°C	14 Days
UCMR4 544	500 mL	Amber, G	Cool ≤ 10°C Trizma, 2-chloroacetamide, Ascorbic acid, EDTA Trisodium salt	28 Days
UCMR4 545	60 mL	Amber, G	Cool ≤ 10°C Sodium Bisulfate, Ascorbic acid	28 Days

* Sodium thiosulfate is added for DE chlorination when Method EPA 608 is requested.

1. P = Polyethylene (preferred when acceptable)
2. G = Borosilicate glass with Teflon lined cap
3. For more current list of method/preservatives, see LIMS tables, containers and product

Table 4
Sample Containers, Preservation and Hold Times
METALS - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
All Metals (26)	500 mL	P, G	HNO_3, pH< 2	6 Months*
Mercury	50 mL	P, G	HNO_3, pH< 2	28 Days
Furnace Metals	100 mL	P, G	HNO_3, pH< 2	6 Months

Table 5
Sample Containers, Preservation and Hold Times
TCLP - WATER

PARAMETER	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
TCLP Volatiles	100 mL	G	Cool, ≤ 6° C	14 Days
TCLP Semi-Volatiles	100 mL	G	Cool, ≤ 6° C	14 Days
TCLP Pesticides	100 mL	G	Cool, ≤ 6° C	14 Days
TCLP Herbicides	100 mL	G	Cool, ≤ 6° C	14 Days
TCLP Metals	100 mL	P, G	Cool, ≤ 6° C	6 Months*

* For (1) TCLP parameter 100 mL required; for full TCLP (2) 1000g
* Mercury is 28 days

NOTE:

1. P = Polyethylene (preferred when acceptable)
2. G = Borosilicate glass with Teflon lined cap
3. Triple the volumes above for MS/MSD samples

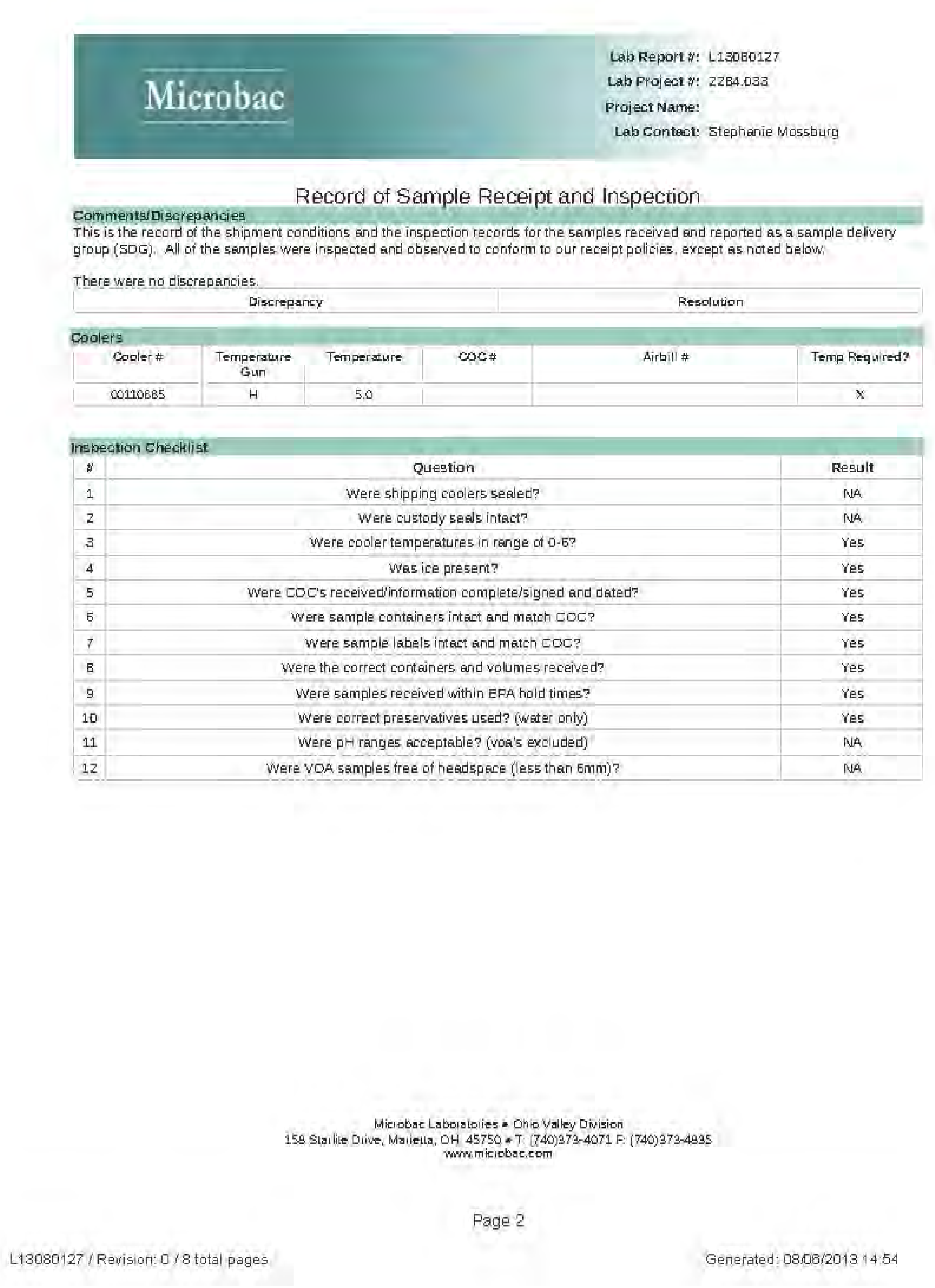
Table 6
Sample Containers, Preservation and Hold Times
SOIL

METHOD	MINIMUM VOLUME	CONTAINER TYPE	PRESERVATIVE	HOLD TIME
Coliform Fecal	1g	G	Cool, < 10° C	8 Hours
Chromium, Hexavalent	50g	G	Cool, ≤ 6° C	24 Hours
5035	5 g	P, G	Cool, ≤ 6° C	48 Hours
TCLP-VOA	105g	G	Cool, ≤ 6° C	14 Days
TCLP-SV	105g	G	Cool, ≤ 6° C	14 Days
TCLP-Pest/Herb	105g	G	Cool, ≤ 6° C	14 Days
TCLP-Metals	105g	G	Cool, ≤ 6° C	6 Months *
Total Metals (except Hg)	3g	G	N/A	6 Months
Hg	2g	G	Cool, ≤ 6° C	28 Days
DRO	30g	G	Cool, ≤ 6° C	28 Days
Semi-Volatiles	30g	G	Cool, ≤ 6° C	14 Days
Herbicides	50g	G	Cool, ≤ 6° C	14 Days
Volatiles	1g	G	Cool, ≤ 6° C	14 Days
Conventionals (where applicable)	1g – 100g	G	Cool, ≤ 6° C	14 Days
Petroleum Hydrocarbons	30g	G	Cool, ≤ 6° C	14 Days
Percent Moisture	25 g	P, G	Cool, ≤ 6° C	---
Percent Solids	25 g	P, G	Cool, ≤ 6° C	---
Paint Filter Liquids Test	100 g	P, G	Cool, ≤ 6° C	---
TPH 9071	100 g	G	Cool, ≤ 6° C	28 Days

Table 7
Analyses Requiring Unpreserved pH Checks

Test	Method
Alkalinity	SM 2320B
Alkalinity, Automated	EPA 310.2
Acidity	SM 2310B
Chloride	SM 4500CL E
Ferrous Iron	SM 3500FE B
Sulfate	SM 4500S04 E
	EPA 375.4
Solids, Total Dissolved, TDS	SM 2540C
Residue, Volatile	EPA 160.4
Residue, Total TSS	SM 2540B
Residue, nonfilterable TSS	SM 2540D
Reside, Settleable	SM 2540F
IC Anions	EPA300.0
	EPA 9056
Conductivity	SM 2510
	EPA 120.1
MBAS	SM 5540C
Turbidity	SM 2130B
	EPA 180.1
Fluoride, Electrode	SM 4500FC
Chlorine	SM 3400CL G
Perchlorate	EPA 6850
Acetate/Formate	SOP- HPLC12
Fluroborate	SOP-K9305
Organic Analysis of Pesticides	EPA 608.3

Figure 1



Microbac

Lab Report #: L13080127
Lab Project #: 2284.033
Project Name:
Lab Contact: Stephanie Mossburg

Record of Sample Receipt and Inspection

Comments/Discrepancies

This is the record of the shipment conditions and the inspection records for the samples received and reported as a sample delivery group (SDG). All of the samples were inspected and observed to conform to our receipt policies, except as noted below.

There were no discrepancies.

Discrepancy	Resolution

Coolers

Cooler #	Temperature Gun	Temperature	COC #	Airbill #	Temp Required?
00110685	H	5.0			X

Inspection Checklist

#	Question	Result
1	Were shipping coolers sealed?	NA
2	Were custody seals intact?	NA
3	Were cooler temperatures in range of 0-6?	Yes
4	Was ice present?	Yes
5	Were COC's received/information complete/signed and dated?	Yes
6	Were sample containers intact and match COC?	Yes
7	Were sample labels intact and match COC?	Yes
8	Were the correct containers and volumes received?	Yes
9	Were samples received within EPA hold times?	Yes
10	Were correct preservatives used? (water only)	Yes
11	Were pH ranges acceptable? (voa's excluded)	NA
12	Were VOA samples free of headspace (less than 6mm)?	NA

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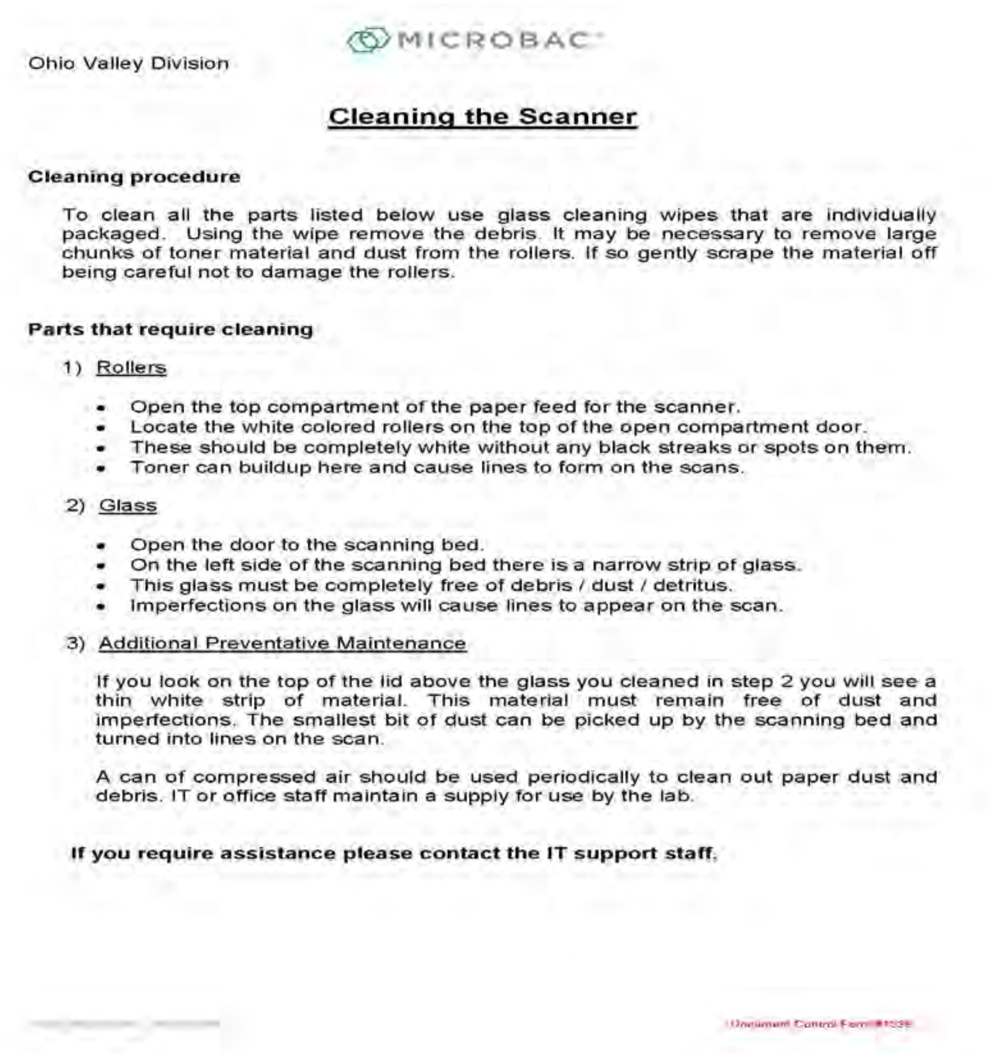
Figure 2



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Cleaning the Scanner

Cleaning procedure

To clean all the parts listed below use glass cleaning wipes that are individually packaged. Using the wipe remove the debris. It may be necessary to remove large chunks of toner material and dust from the rollers. If so gently scrape the material off being careful not to damage the rollers.

Parts that require cleaning

1) Rollers

- Open the top compartment of the paper feed for the scanner.
- Locate the white colored rollers on the top of the open compartment door.
- These should be completely white without any black streaks or spots on them.
- Toner can buildup here and cause lines to form on the scans.

2) Glass

- Open the door to the scanning bed.
- On the left side of the scanning bed there is a narrow strip of glass.
- This glass must be completely free of debris / dust / detritus.
- Imperfections on the glass will cause lines to appear on the scan.

3) Additional Preventative Maintenance

If you look on the top of the lid above the glass you cleaned in step 2 you will see a thin white strip of material. This material must remain free of dust and imperfections. The smallest bit of dust can be picked up by the scanning bed and turned into lines on the scan.

A can of compressed air should be used periodically to clean out paper dust and debris. IT or office staff maintain a supply for use by the lab.

If you require assistance please contact the IT support staff.

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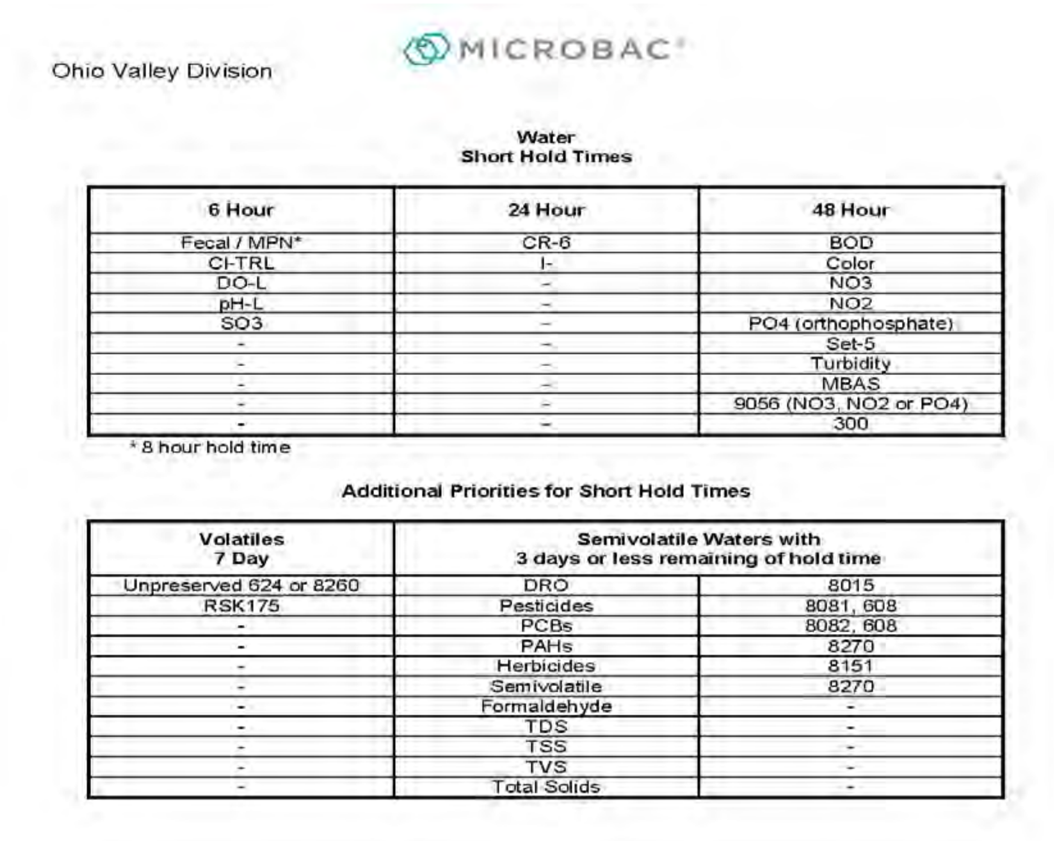
Figure 3



Ohio Valley Division

MICROBAC®

Water
Short Hold Times

6 Hour	24 Hour	48 Hour
Fecal / MPN*	CR-6	BOD
Cl-TRL	I-	Color
DO-L	-	NO3
pH-L	-	NO2
SO3	-	PO4 (orthophosphate)
-	-	Set-5
-	-	Turbidity
-	-	MBAS
-	-	9056 (NO3, NO2 or PO4)
-	-	300

* 8 hour hold time

Additional Priorities for Short Hold Times

Volatiles 7 Day	Semivolatile Waters with 3 days or less remaining of hold time	
Unpreserved 624 or 8260	DRO	8015
RSK175	Pesticides	8081, 608
-	PCBs	8082, 608
-	PAHs	8270
-	Herbicides	8151
-	Semivolatile	8270
-	Formaldehyde	-
-	TDS	-
-	TSS	-
-	TVS	-
-	Total Solids	-

Figure 4

COOLER TEMP >6° C LOG

Cooler ID______

SAMPLE ID	Bottle 1 °C	Bottle 2 °C	Bottle 3 °C	Bottle 4 °C	Bottle 5 °C	Bottle 6 °C

pH Exceptions

pH Lot #________

SAMPLE ID	Bottle 1	Bottle 2	Bottle 3	Bottle 4	Bottle 5	Bottle 6

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MSV01 – Microbac - Analysis of Volatile Organic Analytes by Method 8260

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MICROBAC SOP #: MSV01
PAGE: 1 of 57
REVISION: 26

STANDARD OPERATING PROCEDURES ANALYSIS OF VOLATILE ORGANIC ANALYTES BY METHOD 8260

Issue/Implementation Date: 15 January 2019

Last Review Date: 15 January 2019

Microbac Laboratories, Inc.
Marietta Division
158 Starlite Drive
Marietta, Ohio 45750

Approved By:

Anthony Canter
Anthony D. Canter, Volatile Lab Supervisor

1-10-19
Date

Adriane Steed
Adriane L. Steed, Quality Assurance Officer

1-10-19
Date

Wade T. [illegible] for LSB
Leslie S. Bucina, Operations Manager

01-11-19
Date

Document Control # 288

Issued to: Document Master File

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SECTION **PAGE**

1.0 SCOPE AND APPLICATION

1.1 Microbac SOP MSV01 pertains to the determination of volatile organic compounds in solid and liquid matrices using purge and trap GC/MS. This method references USEPA SW846 Methods 8000D (July 2014), 8260B (December 1996), 8260D (June 2018), 5030C (May 2003), and 5035A (July 2002). SOP MSV01 applies to all volatile mass spectral analyses except where client specific Quality Assurance Project Plan's (QAPP) overrides this method's quality assurance plan.

1.2 Table 1 contains the target compound list for this method.

1.3 Appendix I contains suggested primary and secondary quantitation ions. Section 11.13 contains information regarding the analysis of wipe samples.

1.4 Definitions and Acronyms

The following is a list of terms, definitions, and acronyms referenced in this SOP that are unique to the method.

BFB	Bromofluorobenzene
BS	Blank Spike
BSD	Blank Spike Duplicate
CCV	Continuing calibration verification
DI water	Deionized water
GC	Gas Chromatography
GC/MS	Gas Chromatograph/Mass Spectrometer
HCI	Hydrochloric acid
ICAL	Initial calibration
ICV	Initial calibration verification
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LIMS	Laboratory Information System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MB	Method blank
MDL	Method detection limit
MS	Mass Spectrometer
MS	Matrix spike
MSD	Matrix spike duplicate
NCR	Nonconformance report
PFTBA	Perfluorotributylamine
PPE	Personal Protective Equipment

QC	Quality control
RGT	Reagent
RL/LLOQ	Reporting limit/lower limit of quantitation
RT	Retention time
SDS	Safety Data Sheets
SOP	Standard Operating Procedure
STD	Standard
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds

For a more comprehensive list of common terms and definitions, consult Appendix A in Microbac SOP LQAP.

2.0 SAFTY PRECAUTIONS

2.1 Standard laboratory safety procedures must be followed when working with unknown samples. Gloves must be worn while handling any chemicals, standards, or samples. Other required PPE includes lab coats and safety glasses with side shields.

2.2 **WARNING:** The following VOC's have been tentatively classified as known or suspected human or mammalian carcinogens:

benzene
carbon tetrachloride
chloroform
vinyl chloride

The toxicity or carcinogenicity of the other reagents and analytes used in this method have not been precisely defined, therefore, each chemical and sample must be treated as a potential health hazard and exposure reduced to the lowest possible level. Procedures involving primary standards and sample preparation shall be performed in a fume hood.

2.3 SDS for each analyte and reagent used within the laboratory are available to all employees. Consult SDSs prior to handling chemicals.

2.4 Thermal Hazards

Several zones on the GC are heated to high temperatures. Care must be exercised when working around these areas to avoid severe burns to the skin.

2.5 Broken Glassware Hazards

All dilutions that require the use of glassware must be made with care to reduce the possibility of cuts from broken glass. All broken or defective glassware must be disposed of in the broken glass container located in the laboratory.

3.0 SAMPLE PRESERVATION AND STORAGE

3.1 Pre-cleaned 40 mL glass screw-cap VOA vials with Teflon-faced silicone septa must be used for both liquid and solid matrices utilizing methods 5030 and 5035. Soil samples not utilizing Method 5035 must be collected in 125 mL pre-cleaned glass screw cap jars with teflon-lined lids. Soil samples collected via 5035 must also be collected in Encore (or equivalent) containers then transferred to 40 mL VOA vials for analysis. Refer to Microbac SOP PAT01 for additional requirements.

3.2 Water samples preserved with HCl (pH < 2) must be analyzed within 14 days of sample collection. Unpreserved water samples (pH ≥ 2) must be analyzed within 7 days of sample collection. Waste, soil, and sludge samples do not require the addition of preservative but must be stored at 0 to 6° C. Solid samples utilizing Method 5035 require preservation if analysis cannot be performed within 48 hours of collection. Waste, soil, oil, and sludge samples have a holding time of fourteen days from the date of collection. Soil samples collected in wide mouth bottles, are stored at 0 to 6° C. Samples collected via 5035 must be stored at -10° C to -20° C. Concentrated waste, oil, soil, sludge, or any other matrix can be stored in an ambient location segregated from low-level environmental samples.

3.3 Sample hold time is defined as time elapsed from sample collection date and time to sample analysis date and time.

3.4 Samples are stored in assigned locations until expiration of hold times. After hold-time expiration, samples are removed from storage refrigerators and returned to sample archive. Samples requiring internal chain-of-custody are returned to the sample receiving custodian.

3.5 Temperature logs are maintained for all refrigerator and freezer storage units. Refer to Microbac SOP GP-TEMP-SSU for temperature monitoring of sample storage units.

3.6 Sample preservation should be 0 to 6°C. Samples exceeding the upper temperature limit are to be flagged CT1.

4.0 METHOD PERFORMANCE

4.1 Table 2 summarizes the performance data for water analysis; Table 3 summarizes performance data for soil/solid waste analysis. These tables include the analyte list, ranges for accuracy and precision, current laboratory MDL, nominal laboratory RLs/LLOQs, true values, and suggested calibration range.

4.2 The laboratory performed an initial assessment of the MDL using the procedures outlined in 40 CFR Part 136. Results are filed electronically at H:\DATA\COMMON\MDL.

4.3 The LOD, or verified MDL, are presented in Tables 2 and 3 were established using verification procedures outlined in Microbac SOP 45.

4.4 The LOQ are the nominal laboratory RLs/LLOQs and were established per Microbac SOP 45. Actual project RLs/LLOQs may be higher. The LLOQ is verified quarterly by analysis of duplicate samples spiked at 0.5-2 times the established LLOQ. The verification is performed per instrument and in both solid and aqueous matrices. The recovery of target analytes should be within the LCS criteria ±20%.

4.5 Precision and accuracy data were derived from an initial demonstration of capability using spiked control samples. The laboratory uses results from LCS to assess precision/accuracy and to annually evaluate the associated control limits.

4.6 Other specific QA objectives may be found in the appropriate Statement-of-Work or QAPP.

4.7 All new analysts are certified in the methodology by performing a successful initial demonstration of capability (DOC) using spiked control samples and assessing the resultant precision and accuracy data. Thereafter an on-going DOC must be performed annually to retain certification.

5.0 INTERFERENCES AND CORRECTIVE ACTION

5.1 Samples for volatile organics analyses are susceptible to laboratory contaminants (e.g.: methylene chloride, acetone, n-hexane). To eliminate the potential for interferences from other areas of the laboratory, the Volatiles Laboratory has an independent air intake system and positive air pressure is maintained in the laboratory.

5.2 Samples preserved with HCl or sodium bisulfate may result in the loss of 2-chloroethylvinylether as a target or spiked analyte due to its reactivity with the preservatives.

5.3 Soil analyses may result in low internal and/or surrogate standard recovery due to the poor purging efficiencies of some matrices. Reanalysis must be performed to confirm matrix interference.

5.4 Carry-over contamination may occur when a sample containing low levels of VOC's is analyzed immediately following a sample containing high levels of VOC's. If this situation occurs during a non-monitored analysis, the sample containing the low concentration VOC's may require reanalysis.

5.5 Samples may become contaminated by diffusion of volatile organics through the septum seal into the sample during shipment and storage. A trip blank prepared from organic-free reagent water and carried through the sampling, handling, and analysis steps serves as a check on such contamination.

5.6 Storage blanks are placed in refrigerator and freezer units used for the storage of samples for volatiles analysis. Refer to Section 13.0 for storage blank procedures.

6.0 EQUIPMENT AND SUPPLIES

6.1 GC/MS: Hewlett-Packard (HP), Agilent 6890 Gas Chromatograph equipped with HP, Agilent 5973 Mass Spectrometer, Agilent 7890 GC equipped with Agilent 5977 MSD.

Chemstation: HP, Agilent Eviroquant; Agilent Mass Hunter

6.2 Purge-and-trap: Tekmar liquid sample concentrator (LSC), 3000, Stratum; Varian, Archon auto-sampler; Tekmar Atomx liquid sample concentrator/ autosampler.

6.3 Top loading balance: Ohaus Navigator, Mettler PE600,

6.4 Capillary column: Restek 502.2: 60 m, 0.32 mm ID, 1.8 μm film thickness. Restek RTX-VMS: 20 m, 0.18 mm, 1 mm film thinkness.

6.5 Trap: Supelco Vocarb 3000; Tekmar trap #9.

6.6 Volumetric flask: Class A; 1 mL to 200 mL

6.7 Mininert vial with septum valve: 1 mL to 10 mL

6.8 40 mL VOA vial: I-Chem, Thermo Scientific

6.9 Syringe: Hamilton Gas tight with Luer lock tip: 25 mL, 5 mL; Gas tight with fixed needle: 10 uL, 25 uL, 50 uL, 100 uL, 250 uL, 500 uL, 1000 uL (Hamilton syringes accuracy: ±1% at or above 10% of syringe volume)

6.10 Steel and wooden spatulas

6.11 Disposable Pasteur pipets

6.12 Equivalent equipment and supplies may be used.

6.13 Refer to Table 4 for suggested GC/MS and purge-and-trap operating parameters.

6.14 Computer, software, hardware:

Instrument	Operation System	Computer Name	Connection Type	Instrument Software
HPMS6	Windows XP Professional	C10028	1 Gbps	Enviroquant Chemstation C.00.00
HPMS8	Windows 7	HPMS8	10/100 Mbps	Enviroquant Chemstation C.00.00
HPMS9	Windows XP Professional	HPMS9	10/100 Mbps	Enviroquant Chemstation C.00.00
HPMS11	Windows XP Professional	HPMS11	10/100 Mbps	Enviroquant Chemstation C.00.00
HPMS17	Windows 7 Professional	Microbac-HP	1 Gbps	Masshunter B.07.00; MSD Chemstation F.01.00.1903

7.0 STANDARDS AND REAGENTS

All purchased stock standards and reagents are logged into the LIMS system and assigned certificate of analysis (COA) numbers. All intermediate and working solutions are similarly logged into the LIMS and assigned STD or RGT numbers. Detailed information regarding solution concentrations, aliquot volumes and final volumes and concentrations are included under the STD or RGT number.

7.1 Primary calibration standards:

STANDARD	VENDOR	PART NUMBER	CONCENTRATION
502.2 Mega Mix with MTBE	Ultra	DWM-596	2000 ug/mL
Custom VOC Mix 3	Restek	567801	2000 ug/mL
2-Chloroethyl vinyl ether (2-CVE)	Ultra	EPA-1016	5000 ug/mL
Acrolein-Acrylonitrile Mix	Ultra	AMN-623	2000 ug/mL
Custom Concentrated Ketones #2	Restek	567523	2000 ug/mL
Vinyl Acetate	Restek	30216	2000 ug/mL
Custom 8260 VMS CCV ADDS Standard	Restek	569679	2000-4000 ug/mL
502.2 Mix #1	Restek	30042	2000 ug/mL
Freon 113	Restek	30462	2000 ug/mL
Mass. Oxygenates Standard	Supelco	21624806	2000-4000 ug/mL
1,3-Butadiene	Accustandard	S-406A-10X	2000 ug/mL
1-Bromopropane	Ultra	CUS-12711	10000 ug/mL

7.2 Primary internal and surrogate standard mixtures:

STANDARD	VENDOR	PART NUMBER	CONCENTRATION
Method 8260 Internal Standards	Ultra	STM-520	2500 ug/mL (fluorobenzene, chlorobenzene-d5, 1,4-dichlorobenzene-d4)
Method 8260 Surrogate Standard Mixture	Ultra	STM-530	2500 ug/mL (dibromofluorobenzene, 1,2-dichloroethane-d4, toluene-d8, 4-bromofluorobenzene)

7.3 Primary laboratory control sample (LCS) / matrix spike (MS), alternate source (ICV) standards:

STANDARD	VENDOR	PART NUMBER	CONCENTRATION
Volatile Organic Compound (VOC) Mixture	Accustandard	M-502A-R-PAK	200 ug/mL
Volatile Organic Compounds (VOC) Additional Mixture 8260 Calibration Mix 2	Supelco	21678315	200 ug/mL
Ma. Oxygenates Standard	CPI	Z-G34-120696-02	2000/4000 ug/mL
Gas Mix	CPI	Z-120313-02	2000 ug/mL
Vinyl Acetate	Accustandard	APP-9-211-20X	2000 ug/mL
Acrolein	Restek	30645	5000 ug/mL
1,3-Butadiene	Supelco	21696443	200 ug/mL
1-Bromopropane	Sigma-Aldrich	B78106-5mL	99%
Custom VMS LCS ADDS	Supelco	2195749	200-2000 ug/mL

NOTE: Source of LCS/MS/ICV standards different than primary calibration standards.

7.4 Primary 4-bromofluorobenzene (BFB) standard: Ultra STS-112, 2500 ug/mL

7.5 Intermediate calibration standards: Primary calibration standards diluted to prepare intermediate standards as follows:

INTERMEDIATE STANDARD	PRIMARY STANDARD	CONCENTRATION (ugmL)	VOLUME (uL)	FINAL VOLUME (mL methanol)	FINAL CONCENTRATION (ugmL)
VOA Mix 1	502.2 Mega Mix with MTBE	2000	500	5	200
	502.2 Calibration Mix #1	2000	500		
	Freon 113	2000	500		
VOA Mix 2	Custom Concentrated Ketones #2	2000	500	5	200
	2-Chlorethylvinyl ether (2-CVE)	5000	200		
VOA Mix 3	1,3-Butadiene	2000	500	5	200
	Custom VOC Mix 3	2000	500		
	1-Bromopropane	10000	100		
VOA Mix 4	Acrolein-Acrylonitrile Mix	2000	500	10	100-400
	MA Oxygentates Standard	2000-4000	1000		
Vinyl Acetate	Vinyl Acetate	2000	500	5	200

VMS Column

INTERMEDIATE STANDARD	PRIMARY STANDARD	CONCENTRATION (ugmL)	VOLUME (uL)	FINAL VOLUME (mL methanol)	FINAL CONCENTRATION (ugmL)
VOA Mix 1	502.2 Mega Mix with MTBE	2000	500	5	200
	Custom Standard (Gases)	2000	500		
VOA Mix 2	Custom Concentrated Ketones #2	2000	500	5	200
	2-Chlorethylvinyl ether (2-CVE)	5000	200		
VMS CCV STD	1,3-Butadiene	2000	500	5	200-400
	Acrolein-Acrylonitrile Mix	2000	500		
	Custom RTX-VMS Standard	200-400	500		
Vinyl Acetate	Vinyl Acetate	2000	500	5	200

7.6 Intermediate internal and surrogate standards preparation:

PRIMARY STANDARD	CONCENTRATION (ug/mL)	VOLUME (uL)	FINAL VOLUME (mL METHANOL)	FINAL CONCENTRATION (ug/mL)
Intermediate internal and surrogate standards	2500	1000	10	250

7.7 Intermediate LCS / MS / ICV standards prepared as follows:

INTERMEDIATE STANDARD	PRIMARY STANDARD	CONCENTRATION (ug/mL)	VOLUME (uL)	FINAL VOLUME (mL MEHTANOL)	FINAL CONCENTRATION (ug/mL)
Gases & Adds	Custom Gases	250	1800	10	20
	VOC Adds Mix	200	1000	10	20
Mega	VOC Mega Mix	200	1000	10	20
	1-Bromopropane Intermediate*	1000	20	10	20
1,3-Butadiene and Vinyl Acetate Mix	Vinyl acetate	2000	100	10	20
	1,3-Butadiene	200	1000	10	20
Oxygenates LCS Mix	MA Oxygenates	2000-4000	500	10	100-200
	Acrolein	5000	200	10	100

1-Bromopropane Intermediate solution is prepared by diluting 0.1g of 99% 1-Bromopropane into 10mL of methanol.

VMS Column

INTERMEDIATE STANDARD	PRIMARY STANDARD	CONCENTRATION (ug/mL)	VOLUME (uL)	FINAL VOLUME (mL MEHTANOL)	FINAL CONCENTRATION (ug/mL)
8260 LCS Mix	VOC Mix	200	1000	10	20
	Custom Gases	250	800	10	20
VMS ADDS Mix	Custom VMS LCS ADDS	200-2000	500	5	20-200
1,3-Butadiene and Vinyl Acetate Mix	Vinyl acetate	2000	100	10	20
	1,3-Butadiene	200	1000	10	20
Acrolein Alt	Acrolein	5000	100	5	100

7.8 50 ug/mL BFB intermediate solution preparation:

PRIMARY STANDARD	CONCENTRATION (ug/mL)	VOLUME (uL)	FINAL VOLUME (mL METHANOL)	FINAL CONCENTRATION (ug/mL)
BFB Intermediate Solution	2000	125	5	50

7.9 Working standards preparation

7.9.1 Working standards used for initial calibration and calibration verification are prepared by diluting intermediate standards in DI water as follows:

Soil Initial Calibration Standards, ug/Kg(suggested preparation)

STOCK STANDARD, CONCENTRATION	**WORKING STANDARDS CONCENTRATIONS (ug/Kg)**								
	0.5	**1 [5]**	**2 [25]**	**5 [50]**	**20 [80]**	**50* [100]**	**100 [200]**	**200**	**300 [300]**
VOA Mix 1 (200 ug/mL)	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	N/A
VOA Mix 2 (200 ug/mL)	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
VOA Mix 3 (200 ug/mL)	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
VOA Mix 4 (200-400 ug/mL)	N/A	2.5 uL	6.25 uL	12.5uL	20 uL	25 uL	50 uL	N/A	75 uL
20 ppm mix 1+2+3 Intermediate Std	2.5 uL	5 uL	5 uL	12.5uL	N/A	N/A	N/A	N/A	N/A
Surrogate Standard (20 ug/mL)	N/A	5 uL	5 uL	12.5uL	N/A	N/A	N/A	N/A	N/A
Surrogate Standard (200 ug/mL)	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
Final Volume, DI Water (mL)	100	100	50	50	50	50	50	50	50

20 ppm intermediate = Mix 1 + Mix 2 + Mix 3

$\left(20\,ppm\ intermediate = 50uL\ Mix1 + 50uL\ Mix2 + 50uL\ Mix3 + 350uL\ MeOH\right)$*

Denotes CCV

[ ] Denotes Oxygenates

Water Initial Calibration Standards, ug/L
(suggested preparation)

STOCK STANDARD, CONCENTRATION	WORKING STANDARDS CONCENTRATIONS (ug/L)									
	0.3	**0.4**	**1 [5]**	**2 [25]**	**5 [50]**	**20 [80]**	**50* [100]**	**100 [200]**	**200**	**300 [300]**
VOA Mix 1 (200 ug/mL)	N/A	N/A	N/A	N/A	N/A	5 uL	12.5 uL	25 uL	50 uL	N/A
VOA Mix 2 (200 ug/mL)	N/A	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
VOA Mix 3 (200 ug/mL)	N/A	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
VOA Mix 4 (200-400 ug/mL)	N/A	N/A	2.5 uL	6.25 uL	12.5uL	20 uL	25 uL	50 uL	N/A	75 uL
20 ppm mix 1+2+3 Intermediate Std	3 uL	2 uL	5 uL	5 uL	12.5uL	N/A	N/A	N/A	N/A	N/A
Surrogate Standard (10 ug/mL)	N/A	N/A	5 uL	5 uL	12.5uL	N/A	N/A	N/A	N/A	N/A
Surrogate Standard (100 ug/mL)	N/A	N/A	N/A	N/A	N/A	5 uL	12.5uL	25 uL	50 uL	75 uL
Final Volume, DI Water (mL)	200	100	100	50	50	50	50	50	50	50

20 ppm intermediate = Mix 1 + Mix 2 + Mix 3

$$\left(20ppm\ intermediate = 50uL\ Mix1 + 50uL\ Mix2 + 50uL\ Mix3 + 350uL\ MeOH\right)$$

* Denotes CCV
[ ] Denotes Oxygenates

7.9.2 Procedure for preparing working standard in volumetric flask: The appropriate volume of intermediate standard is injected into the expanded area of a volumetric flask containing DI water. The flask is adjusted to volume then inverted three times. An aliquot is transferred to a 5 mL Luer lock syringe or 40 mL VOA vial and placed on the autosampler.

7.9.3 Procedure for preparing standard in 5 mL Luer lock syringe: The volume of stock standard is injected into a 5 mL Luer lock syringe containing DI water.

7.10 Working standards used for LCS/MS/ICV are prepared by diluting intermediate standards in DI water as follows:

Water Analyses

STOCK STANDARD, CONCENTRATION	LCS/MS VOLUME (uL)	ICV VOLUME (uL)	FINAL VOLUME DI Water (mL)	LCS/MS FINAL CONCENTRATION (ug/L)	ICV FINAL CONCENTRATION (ug/L)
Gases & Adds (20 ug/mL)	50	125	50	20	50
Mega (20 ug/mL)	50	125	50	20	50
1,3-Butadiene Vinyl acetate (20 ug/mL)	50	125	50	20	50
Oxygenates (50-100 ug/mL)	50	50	50	100-200	100-200

Soil Analyses

STOCK STANDARD, CONCENTRATION	LCS/MS VOLUME (uL)	ICV VOLUME (uL)	FINAL VOLUME DI Water (mL)	LCS/MS FINAL CONCENTRATION (ug/Kg)	ICV FINAL CONCENTRATION (ug/Kg)
Gases & Adds (20 ug/mL)	5	12.5	5	20	50
Mega (20 ug/mL)	5	12.5	5	20	50
1,3-Butadiene Vinyl acetate (20 ug/mL)	5	12.5	5	20	50
Oxygenates (50-100 ug/mL)	5	5	5	100-200	100-200

7.11 50ng BFB: Prepared by diluting 10 uL of BFB intermediate solution in 50 mL of DI water then purging 5 mL (else 1 uL of BFB intermediate solution is injected into the GC injection port).

7.12 Purge and trap grade methanol: (Fisher Scientific)

7.13 Reagent water (ASTM Type II DI water, UV treated)

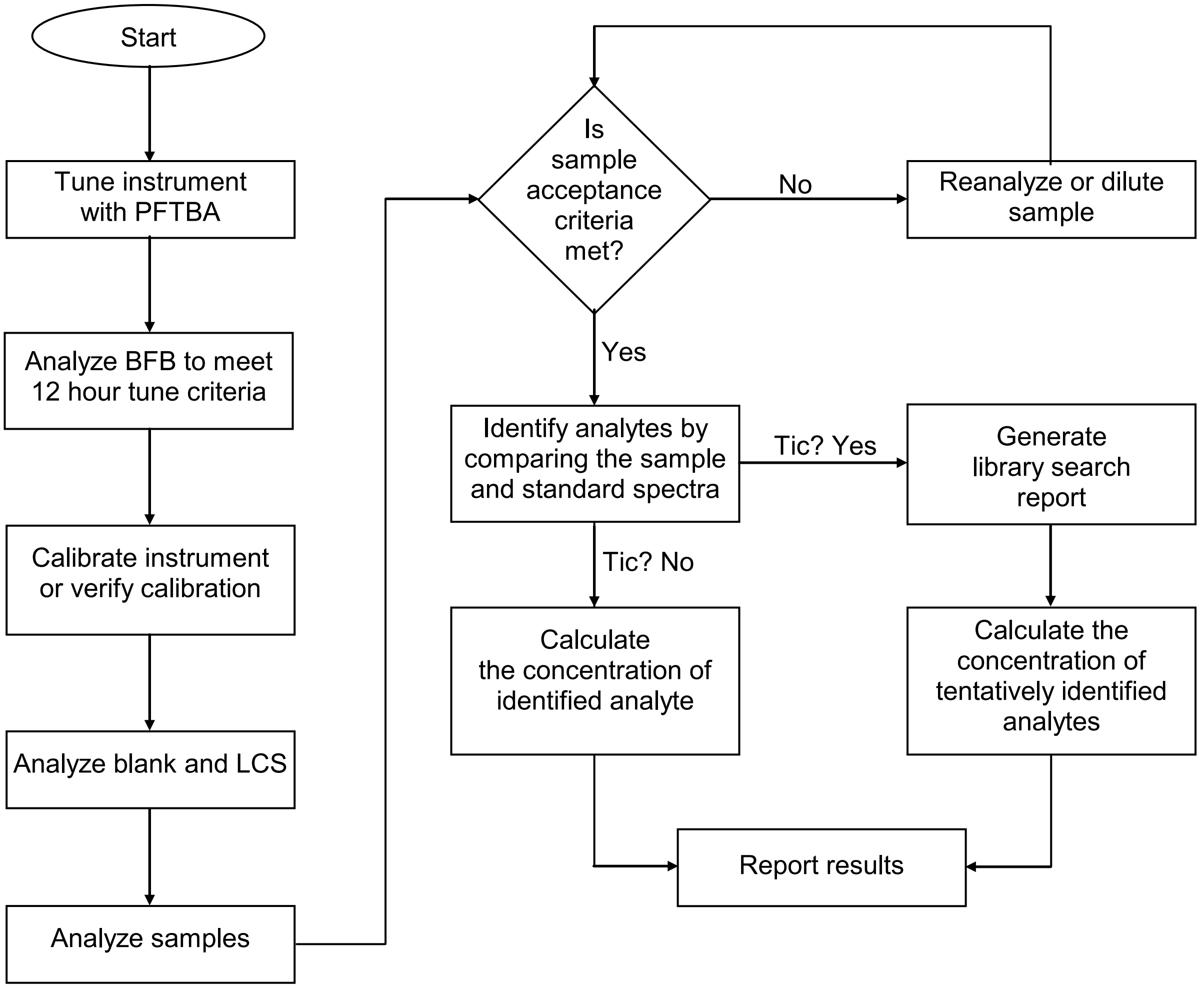
7.14 Purified Sand: J.T. Baker (Baked 150°C)

7.15 Concentration of calibration standards may vary depending on, but not limited to, availability, purity, and project requirements, therefore, recipes for standards preparation will be adjusted accordingly. Autosampler adds 1 uL of 250 ug/mL internal standards mixture.

7.16 Equivalent standards and reagents may be used.

7.17 Standards are stored at < 0°C or per manufacturer's instructions. Standards are stored in glass vials with Teflon-lined lids and/or mininert vials. Expiration dates for primary standards are per manufacturer's instructions; intermediate standards have a 30 day expiration date from the preparation date.

8.0 DIAGRAM OR TABLE TO OUTLINE PROCEDURES



9.0 SAMPLE PREPARATION

9.1 Purge-and-trap procedures are found in Microbac SOP PAT01 for 5030C and 5035A.

10.0 CALIBRATION PROCEDURES

10.1 The GC/MS is hardware-tuned via auto-tune or manual tune.

10.2 50ng of BFB is analyzed via direct inject or purging and the mass spectrum is compared to acceptance criteria in Table 5. Evaluation is performed using the “Autofind” option of the Enviroquant software [the average of the apex, 1(-)apex, 1(+)apex is calculated and a background scan is then subtracted]. Once acceptance criteria is met, an initial calibration or calibration verification is performed. All standards, samples, and QC samples associated with a BFB analysis must use identical mass spectrometer instrument conditions.

10.3 For Initial calibration a minimum of five calibration levels containing target analytes and surrogate standards is required. The lowest calibration level must be equal to or below the required reporting limit/lower limit of quantitation for each analyte.

10.4 Standards used for soil calibration are loaded into 40 mL VOA vials containing 5.00 g (±0.1g) of oven baked reagent sand and utilize a heated purge (40° C).

10.5 Following analysis of the initial calibration, relative response factors (RRF) and average RRF for each surrogate and target analyte are calculated. The accuracy of the calibration curve is assessed by calculating the percent error (12.7) for each level of the curve. A maximum percent error of ± 50% (residual test) of the standard’s true concentration should be achieved if it is the lowest point, and within ± 30% for all others.

10.6 Five analytes designated as system performance check compounds (SPCC) must meet minimum average response factor criteria ($\overline{RRF}$) as follows:

COMPOUND	MINIMUM $\overline{RRF}$
chloromethane	0.10
1,1-dichloroethane	0.10
bromoform	0.10
chlorobenzene	0.30
1,1,2,2-tetrachloroethane	0.30

10.7 The percent relative standard deviation (%RSD) is calculated for all surrogates and target analytes. The %RSD for all target analytes must be less than 15%, however 6 analytes designated calibration check compounds (CCC) must have %RSD less than or equal to 30%. The CCC's are:

COMPOUND	ICAL MAX %RSD	CCV MAX %D
1,1-dichloroethene	± 30	± 20
chloroform	± 30	± 20
1,2-dichloropropane	± 30	± 20
toluene	± 30	± 20
ethyl benzene	± 30	± 20
vinyl chloride	± 30	± 20

10.8 Method 8260 Calibration Options

Linear – Using Average RF with RSD ≤ 15%

If the % RSD for all target analytes is less than or equal to 15%, then the response factor is assumed constant over the calibration range. Average response factor, therefore, may be used for quantitation. If the CCC's are not target analytes for a specific project, all required analytes must be ≤ 30% RSD.

If more than 5 calibration levels were analyzed, high and/or low points for poor responding and/or saturated compounds can be removed. The low calibration levels must be at or below the required reporting limit/lower limit of quantitation. The curve still must contain a minimum of 5 levels.

The average RF option is the preferred method of GC/MS calibration, since linearity may be assumed throughout the full calibration range. However, linear and quadratic models may be used under the conditions discussed in the following sections. If the % RSD for any target analyte is greater than 15%, one of the following procedures may be employed.

Linear Regression with Coefficient of Determination (COD) rˆ2 ≥ 0.99

Linear regression is an alternative to average RF, but has the potential for significant bias at the lower concentration levels .It should only be used when refitting the lowest calibration standard yields a maximum % error (12.7) of 30% (residual test). If a particular analyte exceeds 15% RSD, then linear regression may be utilized for that analyte. The fit for the equation (r^2) must be ≥ 0.99.

Quadratic Calibration with COD (rˆ2) ≥ 0.99

Several compounds on the 8260/8270 extended lists and the EPA Appendix IX list do not display consistently linear behavior. Quadratic calibration, employing at least six calibration points, may be used to improve accuracy for these analytes, particularly at the lower calibration levels, and is a better alternative than linear regression when linear fails the residual (% error) test. Quadratic calibration must never be used to compensate for a poorly maintained GC/MS system, and should not be used for analytes with a previous history of linear performance. Quadratic regression can be employed provided the COD (r^2) is $\geq$ 0.990. Those analytes utilizing first and/or second order calibration are noted on the initial calibration report.

NOTE: Origin not forced when using linear and quadratic regressions. Quadratic regression cannot be used to extend the calibration range.

For samples received from California, quadratic models for analytes that normally display linear responses in the calibration ranges will not be employed. Listed below are 8260 compounds that do not consistently exhibit linear behavior:

8260 Compounds

vinyl acetate
vinyl chloride
2-chloroethylvinyl ether
naphthalene
acetone

Additional 8260 Compounds

t-butyl alcohol
1,4-dioxane
propionitrile
tetrahydrofuran
acrolein
iodomethane

paraldehyde
1-bromopropane
isobutyl alcohol
1-butanol
1-chlorohexane

10.9 Following the initial calibration an ICV is performed. Acceptance criteria is ± 30% drift. Criteria may be different depending on the sample's state of origin or a project specific QAPP.

10.10 The mid-point standard of the calibration curve must be used to establish the relative retention time window position for each analyte and surrogate.

10.11 A CCV is performed every 12 hours of analysis time following an acceptable BFB. Acceptance criteria:

10.11.1 SPCC's meet minimum $\overline{RRF}$ criteria in Section 10.6.

10.11.2 CCC's in Section 10.7 $\leq$ 20 % difference when using average response factor or $\leq$ 20 % drift when using regression fit. Non-CCC's must be $\leq$ 20% difference/drift. Some compounds are historically poor performing analytes and may not meet ≤ 20% difference/drift criteria. Any compound not meeting criteria must be addressed in the case narrative. These compounds are listed below:

dichlorodifluoromethane	dimethyl disulfide
chloromethane	t-1,4-dichloro-2-butene
bromomethane	1,3-butadiene
chloroethane	acetonitrile
trichlorofluoromethane	2-chloro-1,3-butadiene
2-chloroethyl vinyl ether	ethyl acetate
acetone	methacrylonitrile
vinyl acetate	isobutyl alcohol
2-butanone	1-butanol
2-hexanone	methyl methacrylate
4-methyl-2-pentanone	2-nitropropoane
1,2-dibromo-3-chloropropane	cyclohexanone
bromoform	paraldehyde
acrolein	1-bromopropane
iodomethane	acrylonitrile

10.11.3 CCV internal standard response and retention times within –50% to +100% and ±30 seconds, respectively, compared to the same calibration standard in the initial calibration.

10.11.4 Target analytes that do not meet the CCV criteria and are reported in the associated samples must be qualified to indicate the reported concentrations are potentially estimated or biased values. In cases where compounds fail low, they may be reported as non-detect if it can be demonstrated that there was adequate sensitivity to detect the compounds at the LOQ or project specific level of interest by analyzing a standard near that level to confirm the analyte could be qualitatively identified if it were present.

Alternatively, the non-detect could be qualified or the LOQ raised to a higher level. In cases where compounds fail high in the CCV and are not found in the associated field samples, they may be reported without qualification.

10.12 Single-point calibration may be performed for Appendix IX and F list analytes. Analytes detected above reporting limits/lower limit of quantitation require reanalysis using a multi-point calibration curve.

10.13 The separation of 2-chlorotoluene and 4-chlorotoluene will be evaluated for standards and QC samples using the “evaluation resolution” option in Chemstation. The resolution between 2-chlorotoluene and 4-chlorotoluene must be greater than 25% as evaluated by Chemstation.

10.14 Refer to Section 13.0 for quality control requirements and corrective action.

10.15 Calibration training materials are available on the intranet home page in the "General" links section, "Calibration Training". Review of "Calibration Models" and "The Effect that Saturation of the Detector has Upon Calibration" are recommended training for all new analysts. There are additional calibration training materials available through the same link on the homepage.

11.0 ANALYTICAL PROCEDURES

11.1 Prior to sample analysis, instruments must pass tuning and calibration criteria per Section 8.0.

11.2 Method blank: Analyzed prior to environmental samples. Method blanks are matrix specific.

11.2.1 Preparation of method blank

Water blank preparation: Fill a 40 mL VOA vial with UV-treated DI water (headspace not present). Place vial in Autosampler. Autosampler adds 1 uL of 250 ug/mL internal and surrogate standard mixtures.

Soil blank preparation: 5.00 g (±0.1g) of oven baked reagent sand is weighed into a tared 40 mL VOA vial containing a stir bar. 5 mL of UV-treated DI water is added to the vial. The vial is placed on the Autosampler. The Archon autosampler adds 5 mL of UV-treated DI water containing 1 uL of 250 ug/mL internal and surrogate standards mixtures. A 2 minute preheat (40° C) and heated purge (40° C) is utilized.

Middle-level extraction blank: 5.00 g (±0.1g) of oven baked reagent sand is weighed into a tared 40 mL VOA vial. 10 mL of methanol is added to the vial. The vial is shaken then allowed to settle. A 50x dilution is performed on the extract. The Autosampler adds 1 uL of 250 ug/mL internal standard mixture and surrogate standards mixtures.

11.3 Following the method blank a matrix specific LCS containing selected 8260 target analytes is analyzed. An LCS/LCS duplicate analyses is performed when the client does not provide sufficient volume for MS/MSD analyses.

Water and low-level soil LCS preparation: Refer to Section 7.0. **NOTE:** For low-level soil LCS, 2 minute preheat and heated purge (40° C) is utilized.

Middle-level extraction LCS: 5.00 g (±0.1g) of oven baked reagent sand is weighed into a tared 40 mL VOA vial. 8.5 mL of methanol and 0.5 mL of the LCS mixtures are added to the vial (**NOTE:** 8.5 mL methanol volume is dependent upon the number of LCS mixtures added; extract final volume is 10 mL). The vial is shaken then allowed to settle. A 50x dilution is performed on the extract. The dilution is loaded on the autosampler and analyzed.

11.4 MS/MSD are analyzed when the client provides appropriate sample volume.

11.4.1 Water MS/MSD preparation: Refer to Section 7.0 with the exception of sample used in place of DI water.

11.4.2 Low-level and mid-level soil MS/MSD preparation: Refer to Section 7.0 with the exception of 5.00 g (± 0.1 g) sample used in place of reagent sand.

11.5 Sample/sample duplicate analyses may be analyzed providing there is appropriate volume. Sample/sample duplicate analyses are generally associated with concentrated soil/waste samples and oils and are used to determine precision.

11.6 Samples are prepared per Microbac SOP PAT01.

11.7 Samples are analyzed within the 12 hour tune, which begins with the injection of BFB. At the end of tune time, a new BFB, blank, CCV, and LCS must be injected.

11.8 Once sample analysis is complete, a computer generated quantitation report containing all target analytes and their concentrations is generated. Also, detailed spectrum are generated for all target analytes detected above a nominal amount.

11.9 Qualitative analysis

An analyte is identified by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). These standard reference spectra are obtained through analysis of the calibration standards. Two criteria must be satisfied to verify identification: (1) elution of the sample component at the same GC relative retention time (RRT) as the standard component; and (2) correspondence of the sample component and the standard component mass spectrum.

11.9.1 The sample component RRT must compare within ± 0.06 RRT units of the RRT of the standard component. For reference, the standard must be run within the same 12 hours as the sample. If coelution of interfering components prohibits accurate assignment of the sample component RRT from the total ion chromatogram, the RRT must be assigned by using extracted ion current profiles for ions unique to the component of interest.

11.9.2 All ions present in the standard mass spectrum at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) must be present in the sample spectrum. The relative intensities of the characteristic ions must agree within 30% of the relative intensities of these ions in the reference spectrum. Analyst judgment is permitted even if these criteria are not met. The positive identification of a hit should not be made based solely on the criteria mentioned above.

11.10 If the response for any target analyte exceeds the initial calibration range, the sample must be diluted. Dilutions are prepared so that the majority of compounds above the calibration range fall near the midpoint of the calibration. Water and mid-level soil dilutions are prepared by using syringes or pipets to transfer aliquots of sample into a volumetric flask containing DI water. Examples of water dilutions are presented below.

DILUTION	SAMPLE VOLUME (mL)	DI WATER VOLUME (mL)	FINAL DILUTION VOLUME (mL)
10x	5	45	50
50x	1	49	50
100x	0.5	49.5	50
1000x	0.05	49.95	50

Low-level soil dilutions are prepared by weighing an aliquot less than 5.00 g in a 40 mL VOA vial. Examples of low-level soil dilutions:

DILUTION	SAMPLE AMOUNT (g)	DI WATER VOLUME (mL)
2x	2.5	5
2.5x	2.0	5
5x	1.0	5

11.10.1 Low level soils collected via 5035 must utilize the mid-level aliquot for dilutions.

Mid-level soil dilutions are prepared by diluting an aliquot of the methanol extract in a volumetric flask. Examples of mid-level soil dilutions:

DILUTION	METHANOL EXTRACT VOLUME (mL)	DI WATER VOLUME (mL)	FINAL VOLUME (mL)
50x	1	49	50
100x	0.5	49.5	50
500x	0.1	49.9	50
1000x	0.05	49.95	50

11.11 The raw data is processed using the chem station software and the data is uploaded into the LIMS. The laboratory then performs a primary and secondary review of the raw data and quality control forms.

11.12 Tentatively identified compounds (TIC): For samples containing components not associated with the calibration standards, a library search may be performed for the purpose of tentative identification. Guidelines for making tentative identification are:

Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) must be present in the sample spectrum.

The relative intensities of the major ions must agree within ± 40% for TIC's. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30% -70%.)

Molecular ions present in the reference spectrum must be present in the sample spectrum.

Ions present in the sample spectrum but not in the reference spectrum must be reviewed for possible background contamination or presence of coeluting compounds.

Ions present in the reference spectrum but not in the sample spectrum must be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks. Data system library reduction programs can sometimes create these discrepancies.

11.13 Wipe Sample analysis: Wipes must be stored in 40 mL VOA vials containing 10 mL of methanol after collection. Prior to analysis, a glass rod (or similar) is inserted through the septum to completely immerse the wipe in methanol. Vortex the vial for 20 seconds. Remove ample volume of methanol by inserting the needle of a syringe (or similar) through the septum for a 50x dilution. Prepare as per the mid-level extraction procedures.

12.0 DETAILS OF CALCULATIONS

12.1 Relative response factor (RRF):

$$RRF = \frac{(A_x)(C_{is})}{(A_{is})(C_x)}$$

where:

A_x = Area of the characteristic ion for the surrogate or compound being measured.
A_{is} = Area of the characteristic ion for the specific internal standard.
C_{is} = Concentration of the specific internal standard.
C_x = Concentration of the surrogate or compound being measured.

12.2 Average RRF $\left(\overline{RRF}\right)$:

$$\overline{RRF} = \frac{\sum_{1}^{n} RRF}{n}$$

12.3 Standard deviation (s):

$$s = \sqrt{\frac{\sum \left(x - \bar{x}\right)^2}{n-1}}$$

12.4 Percent relative standard deviation (%RSD):

$$\%RSD = \left(\frac{s}{\bar{x}}\right)100$$

where:

$\bar{x} = \overline{RRF}$: $\overline{RRF} = \frac{\sum_{1}^{n} RRF}{n}$

s = standard deviation(s): $s = \sqrt{\frac{\sum \left(x - \bar{x}\right)^2}{n-1}}$

12.5 Percent recovery (%R)

LCS, surrogate:

$$\%R = \left(\frac{C_x}{C_t}\right)100$$

where:

C_x = the concentration of the analyte in the LCS
C_t = the theoretical spike concentration.
$\%R$ = percent recovery

MS/MSD:

$$\%R = \left[\frac{(C_{spk} - C_x)}{C_t}\right]100$$

where:

C_{spk} = the concentration of the analyte in the spiked sample
C_x = the concentration of the analyte in the reference (parent) sample
C_t = the theoretical spike concentration.
$\%R$ = percent recovery

12.6 Relative percent difference (RPD):

$$RPD = \left[\frac{|C_1 - C_2|}{(C_1 + C_2)/2}\right]100$$

where:

C_1 = concentration of the first sample
C_2 = concentration of the second sample

12.7 Percent difference (%D), percent drift (% drift), percent error (% error):

$$\%D = \left[\frac{(C_t - C_x)}{C_t}\right]100$$

where:

C_t = True concentration of the analyte or surrogate in the standard
C_x = Measured concentration of analyte or surrogate in the standard

12.8 Coefficient of correlation (r):

$$\frac{\sum XY - \sum X \sum Y / n}{\sqrt{\left(\sum X^2 - \left(\sum X\right)^2 / n\right)\left(\sum Y^2 - \left(\sum Y\right)^2 / n\right)}}$$

where:

X = individual values of the independent variable, i.e. concentration
Y = individual values of the dependent variable, i.e. response
n = number of pairs of data

12.8 Coefficient of determination (COD):

$$\left[\frac{\sum XY - \sum X \sum Y / n}{\sqrt{\left(\sum X^2 - \left(\sum X\right)^2 / n\right)\left(\sum Y^2 - \left(\sum Y\right)^2 / n\right)}}\right]^2$$

12.9 Sample concentration using $\overline{RRF}$:

Water (ug/L):

$$ug/L = \frac{(A_x)(I_s)(DF)}{(A_{is})(\overline{RRF})(V_o)}$$

where :

A_x = area of characteristic ion for compound being measured
I_s = amount of internal standard injected (250ng)
A_{is} = area of characteristic ion for the internal standard
$\overline{RRF}$ = mean relative response factor for compound being measured
V_o = volume of water purged (10mL)
DF = dilution factor

Low-level soil/sediment:

$$ug/Kg = \frac{(A_x)(I_s)}{(A_{is})(\overline{RRF})(W_s)(D)}$$

where :

A_x, I_s, A_{is}, $\overline{RRF}$, = same as for water
W_s = weight of sample purged in grams
D = % dry weight of sample divided by 100, or 1 for a wet-weight basis

Medium-level soil/sediment:

$$ug/kg = \frac{(A_x)(I_s)(V_i)(DF)}{(A_{is})(\overline{RRF})(V_o)(V_t)(D)}$$

where :

A_x, I_s, A_{is}, $\overline{RRF}$, V_o, DF= same as for water
W_s = weight of sample extracted in grams
V_t = volume of total extract (mL) = $V_m + \left[(W_s)\left(\frac{100-D}{100}\right)\right]$
V_m = adjusted volume of solvent
V_i = volume of extract added (mL) for purging
D = % dry weight of sample (not applicable for a wet-weight basis)

12.10 Linear calibration calculations:

The response ratio is plotted vs. the concentration ratio giving a linear equation:

$$y = mx + b$$

where:

y = Response ratio = Response(x)/Response(istd) = R_x/R_{istd}
x = Concentration ratio = Conc(x)/Conc(istd) = C_x/C_{istd}
And m and b are the slope and intercept from the regression equation

For a given response ratio we can solve for C_x/C_{istd} :

$$C_x/C_{istd} = [R_x/R_{istd} - b]/m$$

Use equations 12.13 or 12.14 to calculate the unknown concentration, C_x.

12.11 Quadratic calibration calculations:

The response ratio is plotted vs. the concentration ratio giving a quadratic equation:

$$y = ax^2 + bx + c$$

OR

$$ax^2 + bx + (c - y) = 0$$

Solving for x using the quadratic equation:

$$x = \frac{b \pm \sqrt{(b^2 - 4a(c - y))}}{2a}$$

where:

y = Response ratio = Response(x)/Response(istd) = R_x/R_{istd}
x = Concentration ratio = Conc(x)/Conc(istd) = C_x/C_{istd}
a ,b, c are constants from the regression equation
Use equations 12.13 or 12.14 to calculate the unknown concentration, C_x

12.12 Solving for the concentration in water sample:

For a given concentration ratio, compute the unknown, C_x

$$C_x = (C_{is})(C_x/C_{istd})(V_f/V_i)(DF)(1000)$$

where:

C_{istd} = concentration of the internal standard (ug/mL)
V_f = final sample (extract) volume (mL)
V_i = initial sample volume (mL)
DF = dilution factor
C_x = concentration of the sample in ug/L

12.13 Solving for the concentration in soil sample:

$$C_x = (C_{is})(C_x/C_{istd})(V_f/W_i)(DF)(1000)$$

where:

C_{istd} = concentration of the internal standard (ug/mL)
V_f = final sample (extract) volume (mL)
W_i = initial sample volume (mL)
DF = dilution factor
C_x = concentration of the sample (ug/Kg) (as received)

12.14 Tentatively identified compounds (TIC) estimated concentration determination:

TIC water (ug/L):

$$ug/L = \frac{(A_x)(I_s)(DF)}{(A_{is})(\overline{RRF})(V_o)}$$

where :

A_x = total area of the peak from the total ion chromatogram
I_s = amount of internal standard injected (250ng)
A_{is} = total area of the internal standard from the total ion chromatogram
$\overline{RRF} = 1$
V_o = volume of water purged (10mL)
DF = dilution factor

TIC low-level soil/sediment:

$$ug/Kg = \frac{(A_x)(I_s)}{(A_{is})(\overline{RRF})(W_s)(D)}$$

where :

A_x, I_s, A_{is}, $\overline{RRF}$, = same as for water
W_s = weight of sample purged in grams
D = % dry weight of sample divided by 100, or 1 for a wet-weight basis

TIC medium-level soil/sediment:

$$ug/Kg = \frac{(A_x)(I_s)(V_t)(DF)}{(A_{is})(\overline{RRF})(V_o)(W_s)(D)}$$

where :

A_x, I_s, A_{is}, $\overline{RRF}$, V_o = same as for water
W_s = weight of sample extracted in grams

V_t = volume of total extract (mL) = $V_m + \left[(W_s)\left(\frac{100-D}{100}\right) \right]$
V_i = volume of extract added (mL) for purging
D = % dry weight of sample divided by 100, or 1 for a wet-weight basis
DF = dilution factor
V_m = volume of methanol added (mL)

12.15 Wipe:

$$ug/_{wipe} = (C)(D_F)(E_V)$$

where:

C = extract concentration, ug/L
D_F = dilution factor
E_V = extract volume, L/wipe

NOTE: E_V assumed to be 0.01 L

13.0 QUALITY CONTROL REQUIREMENTS

13.1 The quality control procedures discussed in this section are intended to monitor and control the entire analytical process. Batch quality samples are specified for ICAL, MB, LCS, MS, MSD, laboratory duplicates (LD), and surrogate compounds. Additional procedures were defined in Section 8.0 for initial calibration, ICV using a second source, and CCV, and are included in the overall review process. The procedures, required frequency, acceptance criteria, and the required corrective action measures are outlined in Table 7.

13.2 Workgroups are analytical batches that contain instrument performance checks (BFB), calibration standards (ICAL, ICV, CCV), QC samples, and client samples.

13.3 Workgroups are comprised of:

- Instrument performance check: BFB tune evaluation to verify detector is working properly
- ICAL/CCV standards: used to calibrate instrument or verify accuracy of the calibration curve

- ICV: standard from an alternate source used to verify accuracy of the calibration curve
- Method blank: verify system is free of contaminants and interferences
- LCS/LCSD: verify precision and accuracy of the system
- MS/MSD: measure matrix effect of environmental sample on target analytes; measure precision
- Sample/sample duplicate: dual analysis of environmental system to measure precision
- Environmental sample: samples submitted for analysis

13.4 Method blank analyzed per method requirements. Target analytes must be less than ½ the RL/LLOQ. Exceptions may include common laboratory solvents which must be less than the RL/LLOQ or the exceptions of section 13.11.3. All blanks are evaluated down to the current MDL for the presence of target analytes. Any amount of target analytes found in the blank at a level greater than the current MDL are reported in the LIMS and these values will appear on the QC summary sheet for the batch.

13.5 The LCS must be evaluated using acceptance criteria listed in Tables 2 and 3, as well as any project specific criteria. Upon completion of a batch of samples, LCS summary reports are generated by the analyst, which compare the actual recoveries to the applicable acceptance ranges for the samples in the batch. The standard laboratory limits specified in Tables 2 and 3 are used in the absence of a project QAPP or program specified control limits. If more than 10% of the LCS analytes are out of the laboratory limits, the analyst must stop the analysis, prepare an NCR, and contact the department supervisor for the appropriate corrective action. If any of the identified project specific chemicals of concern (COC) are outside the control limits, the analyst must stop the analysis and prepare an NCR to be reviewed by the department supervisor.

13.6 The MS/MSD is analyzed per method requirements. MS/MSD results are included in the QC summary report and are used to monitor matrix accuracy and precision. For MS/MSD, Sample/sample duplicate, failure to meet surrogate and internal standard areas acceptance criteria does not necessarily warrant corrective action. Sample MS/MSD or sample/duplicate results can be used to confirm sample matrix interference. In obvious cases of error, reanalysis would be performed.

13.7 When ICAL acceptance criteria are not met, corrective action may include (but is not limited) to the following:

- Evaluate individual data points and reanalyze
- Evaluate calibration standards and reanalyze

- Prepare fresh calibration standards and reanalyze
- Perform instrument maintenance to include but not limited to:
  - Reanalyze calibration curve
  - Tune instrument
  - Replace trap
  - Bake analytical system
  - Replace column
  - Replace transfer line(s)
  - Service auto-sampler, sample concentrator, gas chromatograph, and/or mass spectrometer
- Qualify results and address in case narrative

13.8 When CCV acceptance criteria are not met, corrective action may include (but not, limited to) the following:

- Reanalyze CCV
- Prepare fresh standards
- Bake analytical system
- Perform instrument maintenance

13.9 Surrogate is added to all standards, QC samples, and environmental samples. Table 6 lists surrogate acceptance limits.

13.10 Storage blanks are placed in sample refrigerators and freezers to monitor potential cross contamination. Storage blanks consists of 40 mL of analyte free DI water or 5 mL DI water and 5.00 g of sand stored for 14 days in each VOA refrigerator/freezer. Analyses are performed via Method 8260 with results quantitated to the MDL. Storage blanks are prepared weekly and logged into the LIMS laboratory account. Weekly, (after storage blanks have been stored for two full weeks) storage blanks are analyzed via 8260 (storage blanks must be analyzed within the 12 hour tune time).

Target analytes must be less than ½ the reporting limit/lower limit of quantitation with the exception of common lab contaminants. Common lab contaminants must be less than the reporting limit/lower limit of quantitation. During primary review of the data, the analyst will review storage blank results to ensure acceptance criteria are met. If acceptance criteria are not met the analyst must initiate corrective action. Corrective action begins with determining the non-compliant analyte(s) and recording any known reason for the failure then reanalysis of the duplicate vial of the storage blank. If reanalysis of the storage blank yields results within acceptance criteria then no further corrective action is required. If the reanalysis results confirm the initial analysis results or the reason for the initial failure is not evident then a Form NC02 is initiated. After primary review, results are uploaded to the LIMS. The laboratory will conduct an internal investigation and assess impact on associated samples if these criteria are not met with the next group of storage blanks analyzed. The laboratory will attempt to identify the source of contamination, and evaluate the impact on data reported for the contaminant during the period of storage. Clients may be contacted based on the investigation, if the QAO judges that to be necessary.

13.10.1 Storage blanks held in VOAX (waste sample storage) are allowed up to 10 times normal blank limits due to waste samples held in this storage unit running no more concentrated than a tenfold dilution.

13.11 Control of Nonconforming Data

The laboratory implements general procedures to be followed when departures from documented policies, procedures and quality control have occurred. The policies and procedures are found in Section 13.0 of Microbac SOP LQAP (Laboratory Quality Assurance Program), Microbac SOP GP-CAPA (Corrective Action/Preventive Action: Initiating, Tracking and Monitoring) and Microbac SOP GP-RCA (Root Cause Analysis).

13.11.1 Nonconformances Requiring Corrections

A nonconformance occurs when any aspect of the method QC in an analysis, as outlined in Table 7 does not meet acceptance criteria. When nonconforming data occurs the employee initiates an NCR and proceeds with indicated corrections as per Table 7.

All data shall be scrutinized by the analysts for method and project specific compliance. Checklists are utilized and accompany each data batch Figure 1. A nonconformance shall be documented in the NCR followed by one or more of the following actions.

- Reanalysis of the sample(s) in question
- Discussion and qualification of data (report and narrative)
- Client notification with approval
- Data qualification (Q-flagging)
- Re-sampling and reanalysis (client decision)

13.11.2 Nonconformances Requiring Corrective Action

Corrective action is required when a nonconformance is recurring, if the correction is ineffective or if the departure is so significant that it negatively effects data quality, sample integrity or customer satisfaction. When an event requiring corrective action is identified, the employee shall initiate a Corrective Action/ Preventive Action form as per Microbac SOP GP-CAPA. The corrective action process includes a root cause analysis as per Microbac SOP GP-RAC, corrections, corrective action(s) and evidence of effectiveness.

13.11.3 Nonconformances Not Requiring Corrections

There are some standard contingencies to the traditional corrections that maybe invoked, provided they comply with the project QAPP requirements. In many situations it may not be necessary to perform sample reanalysis or re-extraction for the following quality control departures, provided they are not a chronic problem or indicative of a trend, and the laboratory provides documentation in the report narrative and project files. In addition, the employee is required to initiate an NCR to record the event.

- An LCS or surrogate recovery exceeds the upper control limit, but the corresponding sample results are non-detect.
- A method blank exceeds the upper limit, but the corresponding sample results are non-detect.
- A method blank exceeds the upper limit, but the corresponding sample results are greater than ten (10) times the level in the blank.

13.12 Table 7 contains method 8260B quality control criteria.

13.13 LCS control limits are reviewed annually.

14.0 DATA REVIEW AND REPORTING REQUIREMENTS

14.1 Data review:

14.1.1 All data undergoes a 100% primary review to ensure method and project specific compliance, reduce the data into reportable results, and generate appropriate QC forms. All items in Figure 1 (data review checklist) are reviewed and results are uploaded to the LIMS.

14.1.1.1 Data may be reviewed by an analyst other than the primary analyst provided the reviewing analyst's initials are recorded on the "Data Checklist".

14.1.2 Following the primary review the data undergoes a 100% peer review. All items in 14.1.1 are repeated by the peer. The peer review is performed by the supervisor or designee.

14.2 Data reporting:

14.2.1 Following peer review all uploaded results are reviewed, verified, and qualified.

14.2.2 Default reporting units are “ug/L” for water and “ug/Kg” for soil/sediments/oils.

14.2.3 All uploaded results are uploaded to a maximum number of significant figures dictated by the LIMS. The number of significant figures in the final report vary per project requirements.

14.2.4 Dilution and sample matrix confirmation analyses are uploaded into the LIMS and per the client’s request may be reported as separate analyses or combined (concatenated) into one set of results.

14.3 Quantitative results between the MDL and RL/LLOQ are qualified as “estimated” if requested by the client.

14.4 Refer to Microbac SOP 41 for acceptable procedure on manual integration if necessary.

14.5 Electronic run logs and preparation logs are reviewed electronically.

15.0 PREVENTIVE MAINTENANCE

15.1 Gas pressures are monitored daily. Other maintenance performed as needed. Laboratory maintenance log books maintained per instrument.

15.2 Instrument configuration and maintenance is recorded in the instrument maintenance log book.

15.3 Trouble-shooting involves, but is not limited to, direct injections, chromatography review, evaluating contamination, standards recoveries, injection port maintenance, and leak check.

15.4 Vendor instrument repair reports will be included in maintenance log.

16.0 WASTE MANAGEMENT AND POLLUTION CONTROL

16.1 Microbac is dedicated to eliminating or minimizing any and all laboratory waste which requires disposal or contributes to pollution of any type. To that extent

Microbac has implemented new technology and converted to micro techniques when available to facilitate these goals.

Each laboratory generates specific waste streams which are segregated and collected in labeled satellite containers. The analysts in each department are responsible for proper disposal of the spent samples and chemical waste in the specified satellite waste collection vessel. The waste management technician checks the satellite containers either daily, or as needed. They are then combined into waste drums in our explosion-proof waste building located outside of the Microbac laboratory facility. These drums are labeled with start date and a manifest is created for each. They are picked up on a regular basis for disposal at a licensed disposal facility.

16.2 The waste streams are as follows:

- Volatile Laboratory – non-halogenated solvents, solid waste (methanol)

16.3 Laboratory policies and procedures for management of hazardous waste are found in Microbac SOP 33, Laboratory Waste Management and the waste management section of the analytical SOPs contain procedures specific to each method. Our procedures comply with all federal and state laws and regulations. Each employee receives training in the proper handling and disposal hazardous waste that this is specific to their job description. As a hazardous generator, we are subject to inspection from the Ohio EPA.

17.0 REFERENCES

17.1 *Test Methods for Evaluating Solid Waste,* SW-846, US-EPA, Office of Solid Waste, including updates I, II, III, IV, and V:

8000D	July 2014
8260B	December 1996
5030C	May 2003
5035A	July 2002
8260D	June 2018

17.2 U.S. EPA, 40 CFR, Part 136, October 26, 1984

17.3 Microbac SOP PAT01 “Methods 5030 and 5035 Purge and Trap for Volatile ` Organics”

17.4 Microbac SOP 45 “Method Validation Procedures”

17.5 Microbac SOP 41 “Manual Integration of Chromatographic Peaks”

17.6 Microbac SOP 33 “Laboratory Waste Management”

17.7 Microbac SOP LQAP “Laboratory Quality Assurance Plan”

17.8 Microbac SOP GP-TEMP-SSU “Temperature control Systems for Sample Storage Units”

Appendix I
Suggested 8260B Quantitation Ions

COMPOUND NAME	SUGGESTED PRIMARY ION	SUGGESTED SECONDARY ION	MICROBAC'S PRIMARY ION
fluorobenzene (internal std)	**96**	**77**	**96**
dichlorodifluoromethane	85	87	85
chloromethane	50	52	50
vinyl chloride	62	64	62
1,3-butadiene	54	39.53	54
bromomethane	94	96	94
chloroethane	64	66	64
Trichlorofluoromethane	101	151, 153	101
diethyl ether	59	45, 74	59
isoprene	67	53	67
acrolein	56	55, 58	56
trichlorotrifluoromethane	101	151	101
Acetone	43	58	43
1,1-dichloroethene	96	61, 63	96
t-butyl alcohol	59	41, 47	59
dimethyl sulfide	62	47	62
iodomethane	142	127, 141	142
methyl acetate	43	74, 59	43
acetonitrile	41	40, 39	41
methylene chloride	84	86, 49	84
carbon disulfide	76	78	76
acrylonitrile	53	52, 51	53
methyl-tert-butyl ether	73	57	73
3-chloro-1-propene	41	76	41
trans-1,2-dichloroethene	96	61, 98	96
n-hexane	57	43	57
diisopropyl ether	45	43, 87	45
vinyl acetate	43	86	43
1,1-dichloroethane	63	65, 83	63
ethyl-t-butyl ether	59	87, 57	59
2-butanone	43	72	43
2-chloro-1,3-butadiene	53	88, 90, 51	53
propionitrile	54	52, 55, 40	54
2,2-dichloropropane	77	97	77
cis-1,2-dichloroethene	96	61, 98	96
chloroform	83	85	83
1-bromopropane	122	124	122
bromochloromethane	128	49, 130	128
methacrylonitrile	41	67, 39, 52, 66	67
isobutyl alcohol	43	41, 42, 74	73
Tetrahydofuran	42	72, 71	42
dibromofluoromethane **(surrogate)**	111	113	111
1,1,1-trichloroethane	97	99, 61	97
cyclohexane	56	84	56
1,1-dichloropropene	75	110, 77	75
t-amyl-methyl ether	73	55, 87	73
carbon tetrachloride	117	119	117
1,2-dichloroethane-d4 **(surrogate)**	65	67	65
1,2-dichloroethane	62	98	62
1-butanol	56	43	56

Appendix I (continued)

COMPOUND NAME	SUGGESTED PRIMARY ION	SUGGESTED SECONDARY ION	MICROBAC'S PRIMARY ION
benzene	78	77, 52	78
Trichloroethene	130	95, 97, 132	130
Methylcyclohexane	83	55, 198	83
1,2-dichloropropane	62	112	62
Methyl methacrylate	41	100, 39, 69	41
1,4-dioxane	88	58, 43, 47	88
bromodichloromethane	83	85, 127	83
2-nitropropane	43	41	43
ethyl acetate	43	61	43
methyl methacrylate	41	69, 100	41
dibromomethane	93	95, 174	93
2-chloroethylvinyl-ether	63	65, 106	63
4-methyl-2-pentanone	100	43, 58, 85	58
cis-1,3-dichloropropene	75	77, 39	75
dimethyl disulfide	79	94	79
chlorobenzene-d5 (internal std)	**117**	**82**	**117**
toluene-d8 **(surrogate)**	98	100	98
toluene	92	91	91
ethyl methacrylate	69	41, 99, 86, 114	69
Paraldehyde	89	87	89
trans-1,3-dichloropropene	75	77, 39	75
1,1,2-trichloroethane	83	97, 85	97
2-hexanone	43	58, 58, 57, 100	43
1,3-dichloropropane	76	78	76
tetrachloroethene	164	129, 131, 166	164
dibromochloromethane	129	127	129
1,2-dibromoethane	107	109, 188	107
1-chlorohexane	91	55	91
chlorobenzene	112	77, 114	112
1,1,1,2-tetrachloroethane	131	133, 119	131
Ethylbenzene	106	91	106
m+p-xylene	106	91	106
Cyclohexanone	55	42, 98	55
o-xylene	106	91	106
styrene	104	78	104
bromoform	173	175, 254	173
isopropylbenzene	105	120	105
1,4-dichlorobenzene-d4 (internal std)	**152**	**115, 150**	**152**
1,1,2,2-tetrachloroethane	83	131, 85	83
p-bromofluorobenzene **(surrogate)**	95	174, 176	95
1,2,3-trichloropropane	75	77, 110	110
trans-1,4-dichloro-2-butene	53	88, 75	53
n-propyl-benzene	91	120	91
bromobenzene	156	77, 158	156
1,3,5-trimethylbenzene	105	120	105
2-chlorotoluene	91	126	91
4-chlorotoluene	91	126	91
alpha-methyl-styrene	118	103	118
tert-butyl-benzene	119	91, 134	119
1,2,4-trimethylbenzene	105	120	105
sec-butyl-benzene	105	134	105
p-isopropyl-toluene	119	134, 91	119

Appendix I (continued)

COMPOUND NAME	SUGGESTED PRIMARY ION	SUGGESTED SECONDARY ION	MICROBAC'S PRIMARY ION
1,3-dichlorobenzene	146	111, 148	146
1,4-dichlorobenzene	146	111, 148	146
n-butyl-benzene	91	92, 134	91
1,2-dichlorobenzene	146	111, 148	146
1,2-dibromo-3-chloropropane	75	115, 157	157
1,2,4-trichlorobenzene	180	182, 145	180
hexachlorobutadiene	225	223, 227	225
naphthalene	128	127	128
1,2,3-trichlorobenzene	180	182, 145	180

Appendix II

8260D Criteria

Initial calibration

The RSD should be ≤ 20% for each target analyte. The CCV may be omitted if samples are analyzed within 12 hours of an ICAL, and injection of the last ICAL standard may be used as the starting time reference for evaluation.

Table 8 contains minimum RFs that may be used as guidance in determining whether the system is behaving properly and as a check to see if calibration standards are prepared correctly. Because the minimum RFs in Table X were determined using specific ions and instrument conditions that may vary, it is neither expected nor required that all analytes meet these minimum RFs. The information in the table is proved as guidance only.

BFB Tune

Tune checks are only required prior to ICAL.

Structural Isomer Resolution

Unresolved structural isomers with similar mass spectra are identified as isomeric pairs. Isomers are considered resolved if the peaks are at least 50% resolved. The resolution should be verified on the mid-point concentration of the ICAL as well as the laboratory-designated CCV level if closely eluting isomers are to be reported. It is important to check the separation of structural isomers in the ICV and the daily CCV check standards to verify if the instrument performance is adequate regarding separation of compounds of interest which are structural isomers.

Table 1
Method Analytes for MSV01

ANALYTE	CAS NUMBER
1,1,1,2-tetrachloroethane	630-20-6
1,1,1-trichloroethane	71-55-6
1,1,2,2-tetrachloroethane	79-34-5
1,1,2-trichloro-1,2,2-trifluoroethane	76-13-1
1,1,2-trichloroethane	79-00-5
1,1-dichloroethane	75-34-3
1,1-dichloroethene	75-35-4
1,1-dichloropropene	563-58-6
1,2,3-trichlorobenzene	87-61-6
1,2,3-trichloropropane	98-18-4
1,2,4-trimethylbenzene	95-63-6
1,2,4-trimethylbenzene	95-63-6
1,2-dibromo-3-chloropropane	96-12-8
1,2-dibromoethane	106-93-4
1,2-dichlorobenzene	95-50-1
1,2-dichloroethane	107-06-2
1,2-dichloropropane	78-87-5
1,3,5-trimethylbenzene	108-67-8
1,3-butadiene	106-99-0
1,3-dichlorobenzene	541-73-1
1,3-dichloropropane	142-28-9
1,4-dichlorobenzene	106-46-7
1,4-dioxane	123-91-1
1-bromopropane	106-94-5
1-butanol	71-36-3
1-chlorohexane	544-10-5
2,2-dichloropropane	594-20-7
2-butanone	78-93-3
2-chloroethylvinylether	110-75-8
2-chlorotoluene	95-49-8
2-hexanone	591-78-6
2-nitropropane	79-46-9
4-chlorotoluene	106-43-4
4-methyl-2-pentanone	108-10-1
acetone	67-64-1
acetonitrile	75-05-8
acrolein	107-02-8
acrylonitrile	107-13-1
allylchloride (3-chloroprene)	107-05-1
a-methyl styrene	98-83-9
benzene	71-43-2
bromobenzene	108-86-1
bromochloromethane	74-97-5
bromodichloromethane	75-27-4
bromoform	75-25-2
bromomethane	74-83-9
carbon disulfide	75-15-0
carbon tetrachloride	56-23-5
chlorobenzene	108-90-7
chloroethane	75-00-3
chloroform	67-66-3
chloromethane	74-87-3

ANALYTE	CAS NUMBER
chloroprene (2-chloro-1,3-butadiene)	126-99-8
cis-1,2-dichloroethene	156-59-2
cis-1,3-dichloropropene	10061-01-5
cyclohexane	110-82-7
cyclohexanone	108-94-1
dibromochloromethane	124-48-1
dibromomethane	74-95-3
dichlorodifluoromethane	75-71-8
diethyl ether	60-29-7
diisopropyl ether	108-20-3
dimethyl disulfide	624-92-0
dimethylsulfide	75-18-3
ethyl acetate	141-78-6
ethyl ether	60-29-7
ethyl methacrylate	97-63-2
ethyl t-butyl ether	637-92-3
ethylbenzene	100-41-4
hexachlorobutadiene	87-68-3
iodomethane	74-88-4
isobutanol	78-83-1
isoprene	78-79-5
isopropyl benzene	98-82-8
m+p-xylene	179601-23-1
methacrylonitrile	126-98-7
methyl acetate	79-20-9
methyl cyclohexane	108-87-2
methylene chloride	75-09-2
methylmethacrylate	80-62-6
methyl-tert-butyl-ether	1634-04-4
naphthalene	91-20-3
n-butyl-benzene	104-51-8
n-hexane	110-54-3
n-propyl benzene	103-65-1
o-xylene	95-47-6
paraldehyde	123-63-7
p-isopropyl-toluene	99-87-6
propionitrile (ethyl cyanide)	107-12-0
sec-butyl-benzene	135-98-8
styrene	100-42-5
t-amylmethyl ether	994-05-8
t-butanol	75-65-0
tert-butyl-benzene	98-06-6
tetrachloroethene	127-18-4
tetrahydrofuran	109-99-9
toluene	108-88-3
trans-1,2-dichloroethene	156-60-5
trans-1,3-dichloropropene	10061-02-6
trans-1,4-dichloro-2-butene	110-57-6
trichloroethene	79-01-6
trichlorofluoromethane	75-69-4
vinyl acetate	108-05-4
vinyl chloride	75-01-4

Table 2
MICROBAC'S QA OBJECTIVES AND ANALYTICAL METHODS FOR VOLATILE ORGANIC ANALYSES OF GROUNDWATER

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/L)	REPORTING LIMITS (ug/L)	LCS, MS/MSD, TRUE VALUE (ug/L)	SUGGESTED CALIBRATION RANGE (ug/L)
1,1,1,2-tetrachloroethane	630-20-6	80-130	20	0.25	1	20	1-300
1,1,1-trichloroethane	71-55-6	80-134	20	0.25	1	20	1-300
1,1,2,2-tetrachloroethane	79-34-5	79-125	20	0.2	1	20	1-300
1,1,2-trichloro-1,2,2-trif	76-13-1	40-160	20	1	5	20	1-300
1,1,2-trichloroethane	79-00-5	80-125	20	0.25	1	20	1-300
1,1-dichloroethane	75-34-3	80-125	20	0.125	1	20	1-300
1,1-dichloroethene	75-35-4	80-132	20	0.5	1	20	1-300
1,1-dichloropropene	563-58-6	75-130	20	0.25	1	20	1-300
1,2,3-trichlorobenzene	87-61-6	80-120	20	0.125	1	20	1-300
1,2,3-trichloropropane	96-18-4	75-125	20	0.75	1	20	1-300
1,2,4-trichlorobenzene	120-82-1	80-120	20	0.2	1	20	1-300
1,2,4-trimethylbenzene	95-63-6	80-125	20	0.25	1	20	1-300
1,2-dibromo-3-chloropropane	96-12-8	65-135	20	1.0	2	20	1-300
1,2-dibromoethane	106-93-4	80-129	20	0.25	1	20	1-300
1,2-dichlorobenzene	95-50-1	80-125	20	0.125	1	20	1-300
1,2-dichloroethane	107-06-2	80-129	20	0.25	1	20	1-300
1,2-dichloroethene (total)	540-59-0	80-124	20	0.25	1	40	1-300
1,2-dichloropropane	78-87-5	80-120	20	0.2	1	20	1-300
1,3,5-trimethylbenzene	108-67-8	80-127	20	0.25	1	20	1-300
1,3-butadiene	106-99-0	10-200	20	1	5	20	1-300
1,3-dichlorobenzene	541-73-1	80-120	20	0.25	1	20	1-300
1,3-dichloropropane	142-28-9	80-120	20	0.2	1	20	1-300
1,4-dichlorobenzene	106-46-7	80-120	20	0.125	1	20	1-300
1,4-dioxane	123-91-1	20-160	20	50	100	200	1-300
1-bromopropane	106-94-5	50-150	20	1	2	20	1-300
1-chlorohexane	544-10-5	80-127	20	0.125	1	20	1-300
2,2-dichloropropane	594-20-7	80-133	20	0.25	1	20	1-300
2-butanone	78-93-3	40-160	20	2.5	5	20	1-300
2-chloroethyl vinyl ether	110-75-8	45-160	20	2.0	5	20	1-300
2-chlorotoluene	95-49-8	80-127	20	0.125	1	20	1-300
2-hexanone	591-78-6	55-130	20	2.5	5	20	1-300
2-nitropropane	79-46-9	10-150	20	5	50	100	1-300
3-chloro-1-propene	107-05-1	70-130	20	2.5	10	20	1-300
4-chlorotoluene	106-43-4	80-126	20	0.25	1	20	1-300
4-methyl-2-pentanone	108-10-1	64-140	20	2.5	5	20	1-300
acetone	67-64-1	40-180	20	2.5	5	20	1-300
acetonitrile	75-05-8	70-130	20	5	100	100	1-300
Acrolein	107-02-8	10-200	20	20	10	20	1-300
acrylonitrile	107-13-1	50-150	20	2.5	10	20	1-300
alpha-methyl-styrene	98-83-9	50-150	20	0.5	5	20	1-300
benzene	71-43-2	80-121	20	0.125	1	20	1-300
bromobenzene	108-86-1	80-120	20	0.125	1	20	1-300
bromochloromethane	74-97-5	65-130	20	0.2	1	20	1-300
bromodichloromethane	75-27-4	80-131	20	0.25	1	20	1-300
bromoform	75-25-2	70-130	20	0.5	1	20	1-300

Table 2 (continued) 1-300

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/L)	REPORTING LIMITS (ug/L)	LCS, MS/MSD, TRUE VALUE (ug/L)	SUGGESTED CALIBRATION RANGE (ug/L)
bromomethane	74-83-9	50-150	20	0.50	1	20	1-300
carbon disulfide	75-15-0	58-128	20	0.50	1	20	1-300
carbon tetrachloride	56-23-5	65-140	20	0.25	1	20	1-300
chlorobenzene	108-90-7	80-120	20	0.125	1	20	1-300
chloroethane	75-00-3	60-135	20	0.5	1	20	1-300
chloroform	67-66-3	80-125	20	0.125	1	20	1-300
Chloromethane	74-87-3	60-140	20	0.5	1	20	1-300
chloroprene	126-99-8	70-130	20	2.5	100	100	1-300
cis-1,2-dichloroethene	156-59-2	75-125	20	0.25	1	20	1-300
cis-1,3-dichloropropene	10061-01-5	75-125	20	0.25	1	20	1-300
cyclohexane	110-82-7	70-130	20	0.58	1	20	1-300
cyclohexanone	108-94-1	10-140	20	5	100	100	1-300
dibromochloromethane	124-48-1	70-130	20	0.25	1	20	1-300
dibromomethane	74-95-3	75-125	20	0.25	1	20	1-300
dichlorodifluoromethane	75-71-8	40-160	20	0.25	1	20	1-300
diethyl ether	60-29-7	70-130	20	5	10	100	1-300
diisopropyl ether	108-20-3	70-130	20	5	10	100	1-300
dimethyl disulfide	624-92-0	70-130	20	1.0	5	20	1-300
dimethyl sulfide	75-18-3	70-130	20	0.5	5	20	1-300
ethyl acetate	141-78-6	70-130	20	5	50	100	1-300
ethyl benzene	100-41-4	80-122	20	0.25	1	20	1-300
ethyl methacrylate	97-63-2	70-130	20	1.0	10	20	1-300
ethyl-tert-butyl ether	637-92-3	70-130	20	5	10	100	1-300
hexachlorobutadiene	87-68-3	72-132	20	0.25	1	20	1-300
iodomethane	74-88-4	10-160	20	0.5	1	20	1-300
Isobutanol	78-83-1	10-180	20	50	100	200	1-300
isoprene	78-79-5	70-130	20	0.53	10	20	1-300
isopropylbenzene	98-82-8	80-122	20	0.25	1	20	1-300
m+p-xylene **	179601-23-1	80-122	20	0.5	1	40	1-300
methacrylonitrile	126-98-7	70-130	20	1	1	100	1-300
Methyl acetate	79-20-9	50-190	20	1	1	20	1-300
Methyl cyclohexane	108-87-2	80-130	20	1	1	20	1-300
1-300methyl methacrylate	80-62-6	70-130	20	1	1	100	1-300
methylene chloride	75-09-2	80-123	20	0.25	1	20	1-300
methyl-tert-butyl ether	1634-04-4	75-130	20	0.5	1	20	1-300
naphthalene	91-20-3	59-130	20	0.2	1	20	1-300
n-butylbenzene	104-51-8	80-131	20	0.25	1	20	1-300
n-hexane	110-54-3	74-137	20	0.56	1	20	1-300
o-xylene	95-47-6	80-122	20	0.25	1	20	1-300
p-isopropyl-toluene	99-87-6	80-122	20	0.25	1	20	1-300
propionitrile	107-12-0	50-150	20	1	1	100	1-300
propylbenzene	103-65-1	80-129	20	0.125	1	20	1-300
sec-butylbenzene	135-98-8	80-127	20	0.25	1	20	1-300
styrene	100-42-5	80-123	20	0.125	1	20	1-300
tert-amyl-methyl ether	994-05-8	70-130	20	5	10	100	1-300
tert-butyl alcohol	75-65-0	10-180	20	50	100	200	1-300

Table 2 (continued)

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/L)	REPORTING LIMITS (ug/L)	LCS, MS/MSD, TRUE VALUE (ug/L)	SUGGESTED CALIBRATION RANGE (ug/L)
tert-butylbenzene	98-06-6	80.126	20	0.25	1	20	1-300
tetrachloroethene	127-18-4	80-124	20	0.25	1	20	1-300
tetrahydrofuran	109-99-9	60-140	20	5	50	100	1-300
Toluene	108-88-3	80-124	20	0.25	1	20	1-300
trans-1,2-dichloroethene	156-60-5	80-127	20	0.25	1	20	1-300
trans-1,3-dichloropropene	10061-02-6	80-130	20	0.5	1	20	1-300
trans-1,4-dichloro-2-butene	110-57-6	50-150	20	2.0	2	20	1-300
trichloroethene	79-01-6	80-122	20	0.25	1	20	1-300
trichlorofluoromethane	75-69-4	62-151	20	0.25	1	20	1-300
vinyl acetate	108-05-4	10-190	20	2.5	5	20	1-300
vinyl chloride	75-01-4	50-150	20	0.25	1	20	1-300
xylenes (total)	1330-27-7	80-121	20	0.5	15	60	1-300

** Unresolvable compound

Table 3
MICROBAC'S QA OBJECTIVES AND ANALYTICAL METHODS FOR VOLATILE ORGANIC ANALYSES OF SOLID WASTE

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/Kg)	REPORTING LIMITS (ug/Kg)	LCS, MS/MSD, TRUE VALUE (ug/Kg)	SUGGESTED CALIBRATION RANGE (ug/Kg)
1,1,1,2-tetrachloroethane	630-20-6	71-137	30	0.5	5	20	5-200
1,1,1-trichloroethane	71-55-6	70-135	30	0.5	5	20	5-200
1,1,2,2-tetrachloroethane	79-34-5	55-130	30	0.5	5	20	5-200
1,1,2-trichloro-1,2,2-trif	76-13-1	70-130	30	1.0	10	20	5-200
1,1,2-trichloroethane	79-00-5	60-125	30	0.5	5	20	5-200
1,1-dichloroethane	75-34-3	75-125	30	1.0	5	20	5-200
1,1-dichloroethene	75-35-4	65-135	30	0.5	5	20	5-200
1,1-dichloropropene	563-58-6	57-138	30	0.5	5	20	5-200
1,2,3-trichlorobenzene	87-61-6	60-135	30	0.5	5	20	5-200
1,2,3-trichloropropane	96-18-4	65-130	30	1.0	5	20	5-200
1,2,4-trichlorobenzene	120-82-1	65-130	30	0.5	5	20	5-200
1,2,4-trimethylbenzene	95-63-6	75-132	30	0.5	5	20	5-200
1,2-dibromo-3-chloropropane	96-12-8	40-135	30	2.0	5	20	5-200
1,2-dibromoethane	106-93-4	69-128	30	0.5	5	20	5-200
1,2-dichlorobenzene	95-50-1	70-130	30	0.5	5	20	5-200
1,2-dichloroethane	107-06-2	63-133	30	0.5	5	20	5-200
1,2-dichloroethene (total)	540-59-0	74-127	30	0.5	5	40	5-200
1,2-dichloropropane	78-87-5	72-130	30	0.5	5	20	5-200
1,3,5-trimethylbenzene	108-67-8	74-133	30	0.5	5	20	5-200
1,3-butadiene	106-99-0	40-160	30	1	10	20	10-200
1,3-dichlorobenzene	541-73-1	70-130	30	0.5	5	20	5-200
1,3-dichloropropane	142-28-9	65-128	30	0.5	5	20	5-200
1,4-dichlorobenzene	106-46-7	70-130	30	0.5	5	20	5-200
1,4-dioxane	123-91-1	50-150	30	50	100	200	5-200
1-butanol	71-36-3	50-150	30	50	100	200	50-400
1-chlorohexane	544-10-5	40-160	30	0.5	3	20	5-200
2,2-dichloropropane	594-20-7	66-135	30	0.5	5	20	5-200
2-butanone	78-93-3	37-180	30	2.5	10	20	5-200
2-chloroethyl vinyl ether	110-75-8	35-154	30	2.0	10	20	5-200
2-chlorotoluene	95-49-8	63-147	30	0.5	5	20	5-200
2-hexanone	591-78-6	45-145	30	2.5	10	20	5-200
2-nitropropane	79-46-9	60-140	30	5	50	100	5-200
3-choro-1-propene	107-05-1	50-150	30	2.5	10	20	5-200
4-chlorotoluene	106-43-4	70-138	30	0.5	5	20	5-200
4-methyl-2-pentanone	108-10-1	47-146	30	2.5	10	20	5-200
Acetone	67-64-1	20-160	30	5.0	10	20	5-200
acetonitrile	75-05-8	50-150	30	50	100	100	5-200
acrolein	107-02-8	50-150	30	20	100	20	5-200
acrylonitrile	107-13-1	60-140	30	2.5	100	20	5-200
alpha-methyl-styrene	98-83-9	70-130	30	0.5	10	20	5-200
benzene	71-43-2	70-130	30	0.5	5	20	5-200
bromobenzene	108-86-1	72-131	30	0.5	5	20	5-200
bromochloromethane	74-97-5	70-130	30	0.5	5	20	5-200
bromodichloromethane	75-27-4	72-137	30	0.5	5	20	5-200
bromoform	75-25-2	49-136	30	0.5	5	20	5-200
bromomethane	74-83-9	37-143	30	1.0	10	20	5-200

Table 3 (continued)

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/Kg)	REPORTING LIMITS (ug/Kg)	LCS, MS/MSD, TRUE VALUE (ug/Kg)	SUGGESTED CALIBRATION RANGE (ug/Kg)
carbon disulfide	75-15-0	39-139	30	0.5	5	20	5-200
carbon tetrachloride	56-23-5	59-136	30	0.5	5	20	5-200
chlorobenzene	108-90-7	70-130	30	0.5	5	20	5-200
chloroethane	75-00-3	52-135	30	1.0	10	20	5-200
chloroform	67-66-3	74-129	30	0.5	5	20	5-200
chloromethane	74-87-3	30-131	30	2.0	10	20	5-200
chloroprene	126-99-8	50-150	30	2.5	5	100	5-200
cis-1,2-dichloroethene	156-59-2	70-130	30	0.5	5	20	5-200
cis-1,3-dichloropropene	10061-01-5	70-142	30	0.5	5	20	5-200
Cyclohexane	110-82-7	70-130	30	1.0	10	20	5-200
cyclohexanone	108-94-1	60-140	30	5	50	100	5-200
dibromochloromethane	124-48-1	59-136	30	0.5	5	20	5-200
dibromomethane	74-95-3	69-130	30	0.5	5	20	5-200
dichlorodifluoromethane	75-71-8	25-130	30	1.0	5	20	5-200
diethyl ether	60-29-7	60-140	30	5	10	100	5-200
diisopropyl ether	108-20-3	60-140	30	5	10	100	5-200
dimethyl disulfide	624-92-0	60-140	30	0.5	10	20	5-200
dimethyl sulfide	75-18-3	60-140	30	0.5	10	20	5-200
ethyl acetate	141-78-6	60-140	30	5	50	100	5-200
ethyl benzene	100-41-4	70-130	30	0.5	5	20	5-200
ethyl methacrylate	97-63-2	60-140	30	1.0	10	20	5-200
ethyl-tert-butyl ether	637-92-3	60-140	30	5	10	100	5-200
hexachlorobutadiene	87-68-3	65-135	30	0.5	5	20	5-200
iodomethane	74-88-4	20-288	30	1.0	10	20	5-200
isobutanol	78-83-1	50-150	30	50	100	200	10-400
Isoprene	78-79-5	40-140	30	2.0	10	20	5-200
isopropylbenzene	98-82-8	68-129	30	0.5	5	20	5-200
m+p-xylene **	179601-23-1	70-130	30	0.5	5	40	5-200
methacrylonitrile	126-98-7	60-140	30	2.5	5	100	5-200
methyl acetate	79-20-9	70-130	30	1	10	20	5-200
methyl cyclohexane	108-87-2	70-130	30	1	10	20	5-200
methyl methacrylate	80-62-6	70-130	30	2.5	5	100	5-200
methylene chloride	75-09-2	74-128	30	1.0	5	20	5-200
methyl-tert-butyl ether	1634-04-4	54-151	30	0.5	5	20	5-200
naphthalene	91-20-3	50-146	30	0.5	5	20	5-200
n-butylbenzene	104-51-8	70-136	30	0.5	5	20	5-200
n-hexane	110-54-3	58-142	30	0.5	10	20	5-200
o-xylene	95-47-6	70-130	30	0.5	5	20	5-200
p-isopropyl-toluene	99-87-6	72-128	30	0.5	5	20	5-200
propionitrile	107-12-0	60-140	30	2.5	5	100	5-200
propylbenzene	103-65-1	72-136	30	0.5	5	20	5-200
sec-butylbenzene	135-98-8	71-132	30	0.5	5	20	5-200
styrene	100-42-5	74-130	30	0.5	5	20	5-200
tert-amyl-methyl ether	994-05-8	60-140	30	5	10	100	5-200
tert-butyl alcohol	75-65-0	50-150	30	50	100	200	50-400
tert-butylbenzene	98-06-6	72-130	30	0.5	5	20	5-200

Table 3 (continued)

PARAMETER	CAS #	ACCURACY (% REC)	PRECISION (RPD)	MDL (ug/Kg)	REPORTING LIMITS (ug/Kg)	LCS, MS/MSD, TRUE VALUE (ug/Kg)	SUGGESTED CALIBRATION RANGE (ug/Kg)
tetrachloroethene	127-18-4	72-130	30	0.5	5	20	5-200
tetrahydrofuran	109-99-9	50-150	30	25	50	100	5-200
toluene	108-88-3	77-126	30	0.5	5	20	5-200
trans-1,2-dichloroethene	156-60-5	72-127	30	0.5	5	20	5-200
trans-1,3-dichloropropene	10061-02-6	65-139	30	0.5	5	20	5-200
trans-1,4-dichloro-2-butene	110-57-6	50-150	30	1.0	10	20	5-200
trichloroethene	79-01-6	72-126	30	0.5	5	20	5-200
trichlorofluoromethane	75-69-4	48-154	30	1.0	5	20	5-200
vinyl acetate	108-05-4	10-150	30	2.5	10	20	5-200
vinyl chloride	75-01-4	45-140	30	1.0	10	20	5-200
xylenes (total)	1330-27-7	70-130	30	0.5	5	60	5-600

** Unresolvable compound

Table 4*

GC/MS PURGE AND TRAP PARAMETERS	
purge time	9 – 11 minutes
dry purge time	0 – 2 minutes
desorb preheat	245° C
desorb	0.5 – 1 minute at 250° C
bake	9 -12 minutes at 260° C
LSC temp	valve 150˚ C, lines: 150° C
Archon temp	valve 95˚ C, lines 110° C
Soil Vial Temp	40° C
GAS CHROMATOGRAPH PARAMETERS	
carrier gas	helium, 99.999 %
injector temperature	220° C
oven temperature program	35° C for 4 minutes 10° C/minute to 240° C (hold 2 minutes)
MASS SPECTROMETER PARAMETERS	
beginning mass	35
ending mass	265
scan rate / sampling	8 scans/sec

* Suggested parameters: Adjustments may be made to improve efficiency.

Table 5
BFB Key Ion Abundance Criteria

MASS	ION ABUNDANCE CRITERIA
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	base peak, 100% relative abundance
96	5 to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95
175	5 to 9% of mass 174
176	greater than 95%, but less than 101% of mass 174
177	5 to 9% of mass 176

Table 6
Surrogate Standards Recovery Limits

SURROGATE COMPOUND	8260 WATER *	8260 SOIL *	8260 OIL
dibromofluoromethane	86-118	80-120	52-122
Toluene-d_8	88-110	81-117	35-127
4-bromofluorobenzene	86-115	74-121	26-158
1,2-dichloroethane-d_4	80-120	80-120	43-128

*Denotes one outlier permitted given % R > 10%. Reanalysis required if two or more recovery results are outside acceptance limits.

Table 7
Quality Control Criteria
Volatile GC/MS Analysis
Method 8260B / 8260D

CONTROL ITEM	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Mass spectral ion intensities (BFB criteria)	Every 12 hours prior to ICAL, ICV or CCV	See Table 5	Retune instrument and repeat BFB check
Initial Calibration (ICAL)	When Continuing Calibration is out of control or when system conditions have been altered.	$\leq$ 30% RSD for CCC compounds, $<$ 15% RSD for all target compounds, if $>$15% RSD, then linear regression, provided $r \geq 0.995$ and % error $\leq$ 30%,then quadratic regression, provided $r^2 \geq 0.990$ SPCC minimum $\overline{\text{RRF}}$	Evaluate cause; repeat calibration; or qualify data and discuss in narrative (1) See section 13.7 for additional corrective action.
Second source calibration verification (ICV)	After each initial calibration	$\leq$ 20% drift for each analyte (1)	Re-analyze ICV; upon second failure, repeat initial calibration (1)
Continuing calibration verification (CCV)	Each 12 hours	SPCC minimum RRF, $\leq$ 20% difference/drift for each analyte	Re-analyze CCV; upon second failure, repeat initial calibration (1) See Section 13.8 for additional corrective action.
Internal standard (IS)	Every sample, standard, and quality control sample	Retention time within 30 seconds of IS retention time in ICAL midpoint STD and area within –50% t +100% of IS midpoint area	Check for MS malfunctions or interference; re-analyze sample
Method Blank (MB)	One per matrix/batch; maximum of 20 samples per batch	Target analytes < ½ RL/LLOQ except common laboratory solvents which must be < RL/LLOQ	Notify supervisor and initiate NCR; investigate; re-analyze samples
Laboratory Control Sample/ Laboratory Control Sample Duplicate (LCS/LCSD)	One per matrix/batch; maximum of 20 samples per batch	Target compounds within the designated ranges; use project QAPP or standard control criteria (1,2)	Notify supervisor and initiate NCR; investigate; re-analyze samples
Matrix Spikes/ Matrix Spike Duplicate (MS/MSD) Sample/Sample Duplicate	One per matrix/batch; maximum of 20 samples per batch	Target compounds within the designated ranges; use project QAPP or standard control criteria (1,2)	Qualify data and/or address in the report narrative
Surrogate spike	Every sample, standard, and quality control sample	Recoveries within designated ranges: use project QAPP or standard control criteria; (one surrogate outlier permitted provided % R > 10%) (1)	Notify supervisor and initiate NCR; investigate; re-analyze samples

(1) Evaluate criteria are often project specific. Check the project QAPP.
(2) Standard criteria are set at three standard deviations from the mean; 10% marginal failure allowed, otherwise re-extract and re-analyze batch; consult supervisor and project QAPP for any exceptions.

Table 8

Guidance response factors criteria from Method SE-846 8260D

Analyte	**RF**
Acetone	0.01
Benzene	0.2
Bromochloromethane	0.1
Bromodichloromethane	0.3
Bromoform	0.1
Bromomethane	0.01
2-Butanone	0.01
Carbon disulfide	0.1
Carbon tetrachloride	0.1
Chlorobenzene	0.4
Chloroethane	0.01
Chloroform	0.3
Chloromethane	0.01
Cyclohexane	0.01
Dibromochloromethane	0.2
1,2-Dibromo-3-chloropropane	0.01
1,2-Dibromoethane	0.2
1,2-Dichlorobenzene	0.6
1,3-Dichlorobenzene	0.5
1,4-Dichlorobenzene	0.6
Dichlorodifluoromethane	0.01
1,1-Dichloroethane	0.3
1,2-Dichloroethane	0.07
1,1-Dichloroethene	0.06
cis-1,2-Dichloroethene	0.2
trans-1,2-Dichloroethene	0.1
1,2-Dichloropropane	0.2
cis-1,3-Dichloropropene	0.3
trans-1,3-Dichloropropene	0.3
Ethylbenzene	0.4
2-Hexanone	0.01
Isopropylbenzene	0.4
Methyl acetate	0.01
4-Methyl-2-pentanone	0.03
Methyl tert-butyl ether (MTBE)	0.1
Methylcyclohexane	0.05

Table 8 (continued)

Methylene chloride	0.01
Styrene	0.2
1,1,2,2-Tetrachloroethane	0.2
Tetrachloroethene	0.1
Toluene	0.3
1,2,3-Trichlorobenzene	0.1
1,2,4-Trichlorobenzene	0.1
1,1,1-Trichloroethane	0.05
1,1,2-Trichloroethane	0.2
1,1,2-Trichlorotrifluoroethane	0.05
Trichloroethene (Trichloroethylene)	0.2
Trichlorofluoromethane	0.01
Vinyl chloride	0.01
m,p-Xylene	0.2
o-Xylene	0.2

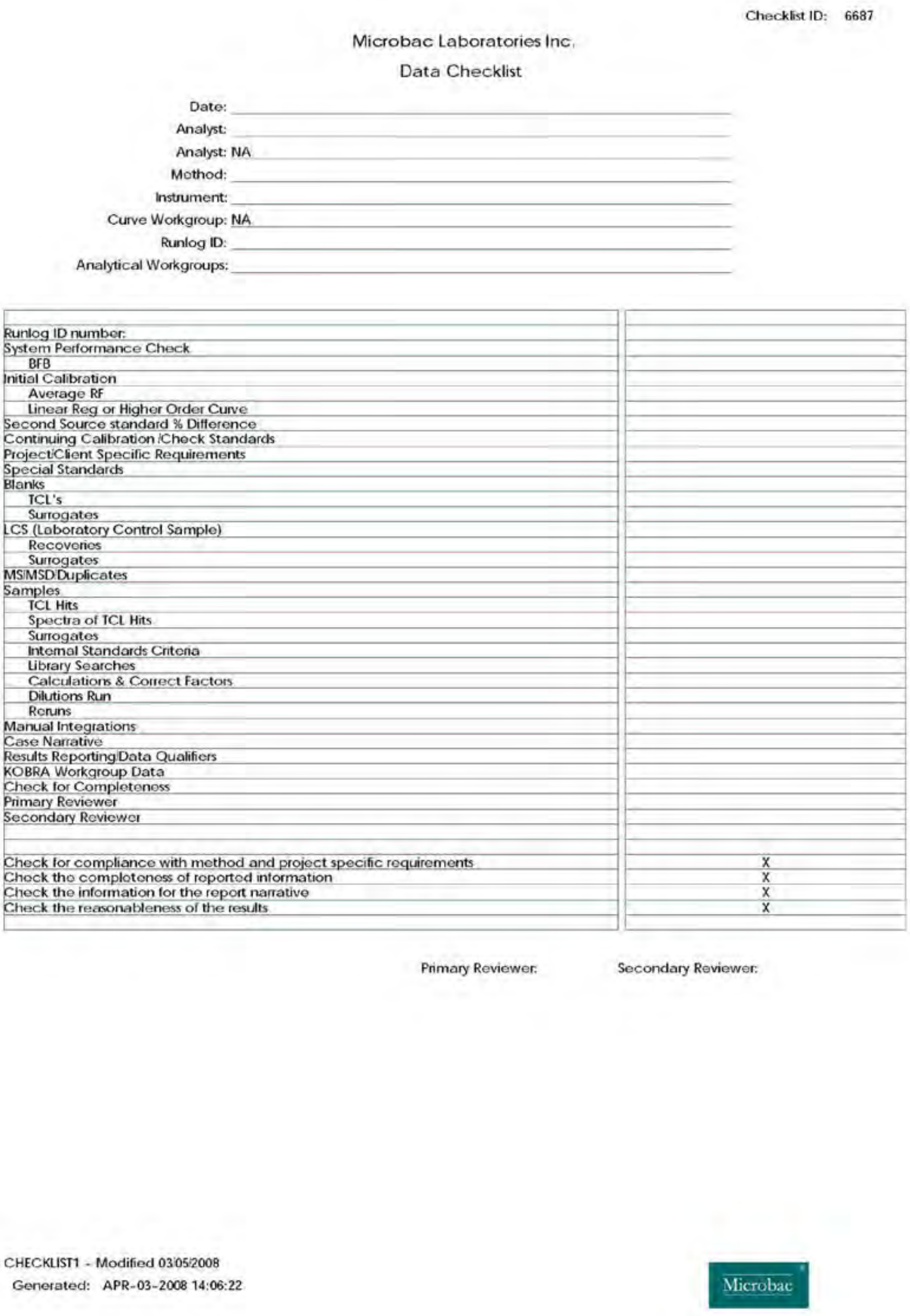
These response factors are provided as guidance only and are not intended to be a requirement.

Table 9

4-Bromofluorobenzene (BFB) suggested criteria 8260D

M/Z	Intensity (relative abundance)
95	50 to 200% of mass 174
96	5 to 9% of m/z 95
173	< 2% of m/z 174
174	50 to 200% of mass 95
175	5 to 9% of mass 174
176	95% to 105% of m/z 174
177	5 to 10% of m/z 176

Figure 1



Checklist ID: 6687

Microbac Laboratories Inc.

Data Checklist

Date:
Analyst:
Analyst: NA
Method:
Instrument:
Curve Workgroup: NA
Runlog ID:
Analytical Workgroups:

Runlog ID number:	
System Performance Check	
BFB	
Initial Calibration	
Average RF	
Linear Reg or Higher Order Curve	
Second Source standard % Difference	
Continuing Calibration /Check Standards	
Project/Client Specific Requirements	
Special Standards	
Blanks	
TCL's	
Surrogates	
LCS (Laboratory Control Sample)	
Recoveries	
Surrogates	
MS/MSD/Duplicates	
Samples	
TCL Hits	
Spectra of TCL Hits	
Surrogates	
Internal Standards Criteria	
Library Searches	
Calculations & Correct Factors	
Dilutions Run	
Reruns	
Manual Integrations	
Case Narrative	
Results Reporting/Data Qualifiers	
KOBRA Workgroup Data	
Check for Completeness	
Primary Reviewer	
Secondary Reviewer	
Check for compliance with method and project specific requirements	X
Check the completeness of reported information	X
Check the information for the report narrative	X
Check the reasonableness of the results	X

Primary Reviewer: Secondary Reviewer:

CHECKLIST1 - Modified 03/05/2008
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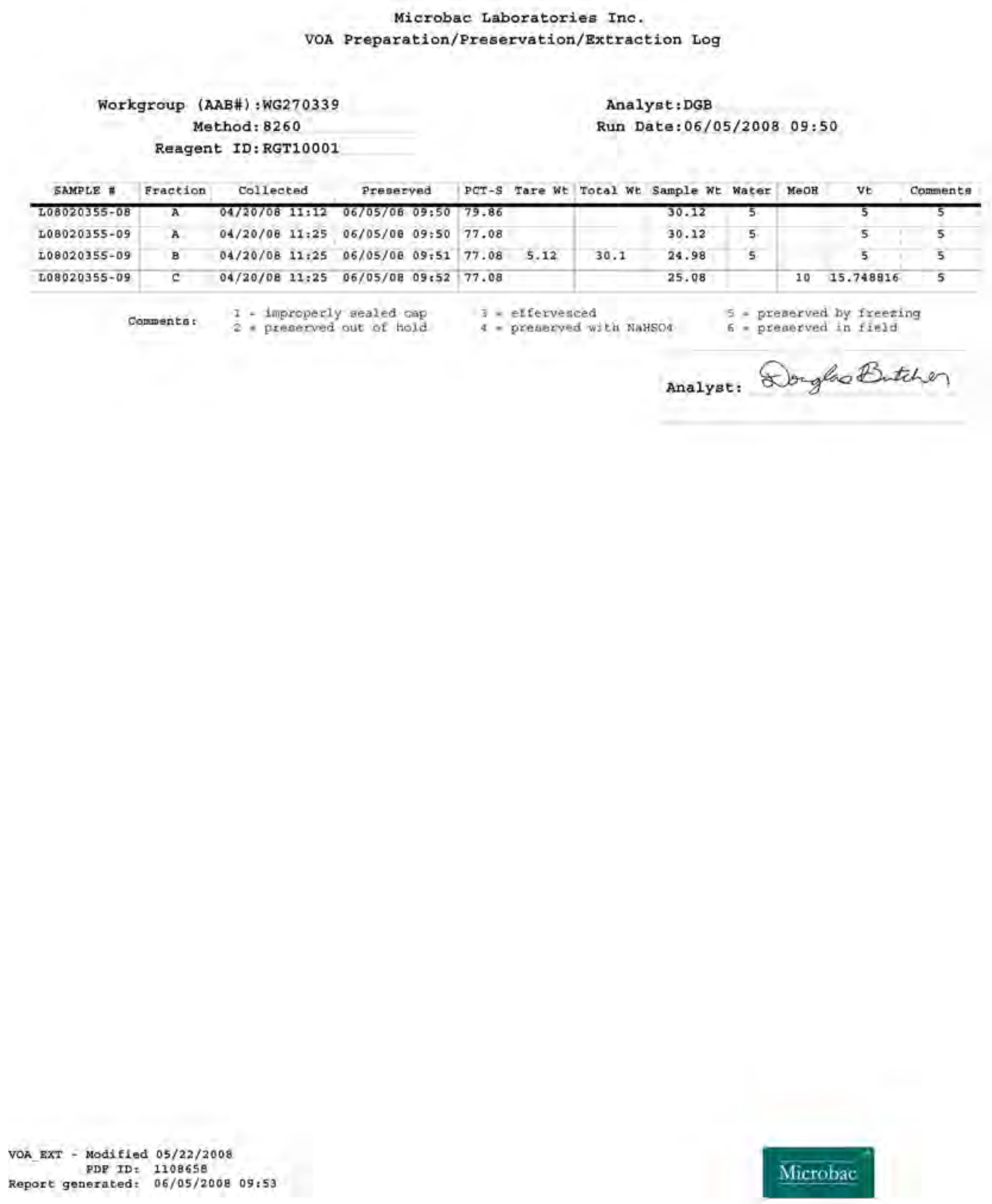
Figure 2
VOA Preparation/Preservation and Extraction Log



Microbac Laboratories Inc.
VOA Preparation/Preservation/Extraction Log

Workgroup (AAB#):WG270339
Method:8260
Reagent ID:RGT10001

Analyst:DGB
Run Date:06/05/2008 09:50

SAMPLE #	Fraction	Collected	Preserved	PCT-S	Tare Wt	Total Wt	Sample Wt	Water	MeOH	Vt	Comments
L08020355-08	A	04/20/08 11:12	06/05/08 09:50	79.86			30.12	5		5	5
L08020355-09	A	04/20/08 11:25	06/05/08 09:50	77.08			30.12	5		5	5
L08020355-09	B	04/20/08 11:25	06/05/08 09:51	77.08	5.12	30.1	24.98	5		5	5
L08020355-09	C	04/20/08 11:25	06/05/08 09:52	77.08			25.08		10	15.748816	5

Comments:
1 - improperly sealed cap
2 = preserved out of hold
3 = effervesced
4 = preserved with NaHSO4
5 = preserved by freezing
6 = preserved in field

Analyst: Douglas Butcher

VOA_EXT - Modified 05/22/2008
PDF ID: 1108658
Report generated: 06/05/2008 09:53

MISDATA01 – Microbac – Data Entry, Data Review, and Reporting

Uncontrolled Copy

STANDARD OPERATING PROCEDURE
DATA ENTRY, DATA REVIEW, AND REPORTING

Issue / Implementation Date: 15 July 2018

Last Review Date: 15 July 2018

Microbac Laboratories, Inc.
Marietta Division
158 Starlite Drive
Marietta, Ohio 45750

Approved by:

Maren M Beery
Maren M. Beery, Quality Assurance Officer

07/03/2018
Date

Leslie S Bucina
Leslie S. Bucina, Managing Director

7/3/18
Date

Document Control # 240 **Issued to: Document Master File**

TABLE OF CONTENTS

1.0 SCOPE AND APPLICATION

1.1 Microbac - Marietta Division SOP MISDATA01 pertains to the procedures used for manual entry into the LIMS data base of inorganic and organic data (which serves as a backup to automated data upload procedures in place for most instrumentation), the editing and review of accuracy for data manually entered or automatically uploaded into LIMS, and the reporting of the final product to the client.

1.2 This SOP covers all functions required to manually enter, edit, and review data in LIMS, update statuses, generate case narratives and TRRP Checklists, generate Microbac Report Forms, determine which reports are ready to print, print reports, and the assembly and delivery of completed data packages to the client.

1.3 Definitions and Acronyms

The following is a list of terms, definitions, and acronyms referenced in this SOP that are unique to the method.

CDS	Chemist/Data Specialist
CRM	Customer Relations Manager
EDD	Electronic Data Deliverables
LQAP	Laboratory Quality Assurance Program
LIMS	Laboratory Information Management System
QA	Quality Assurance
QC	Quality Control
SOP	Standard Operating Procedure
TRRP	Texas Risk Reduction Program

For a more comprehensive list of common terms and definitions, consult Appendix A in Microbac SOP LQAP.

2.0 DATA ENTRY PROCEDURES

2.1 Data is entered into the LIMS by automated data upload directly from the instrument (see Microbac SOP DU01) or by manual entry. The procedures for manual entry are as follows.

2.2 Run ID creation

To begin entering inorganic or organic results into LIMS open Sample Data. In the drop down menu, open Data and then Enter Data. Under Parameter Set enter the list pointer (department number) corresponding to the departmental data.

LIST POINTERS **(Department numbers)**	
Inorganic	
Mercury	6
ICP metals	7
Digestion	5
Conventionals	13, 20
Organic	
Bulk ID	4
Extraction	8
Semivolatile GC	9
Semivolatile GC/MS	10
Volatile GC	11
Volatile GC/MS	12

Under Sample Set enter in Query Workgroup the workgroup number found at the top of the results sheet. Under Run ID Link chose New (Figure 1). LIMS will now assign a Run ID number - write this number on the results sheet.

The following information is required for the Run ID:

- Instrument ID
- Run date: The analysis date formatted as DD-Month-YYYY (space) time in 24hr format (ex: 13:30).
- Department number
- Analyst initials
- Run Type: PREP for digestion or extraction, PREPREP for TCLP extractions, and ANALYTICAL for all others or F9 for a complete list
- Workgroup number

NOTE: Multiple Run ID's will be necessary if the date, instrument, or analyst changes within the workgroup.

Save and choose OK to begin data entry.

2.3 Inorganic and organic sample data entry

2.3.1 The data entry screen consists of a workgroup set of samples (Figure 2). Entry can be by one of two methods Sample by sample or All samples. Choose the method by opening Modes for the Data Entry Modes window (Figure 3), select Parameter Set Option of Per Login, then Results Entry Option according to the chart below.

DATA ENTRY MODES*	
Sample by sample	**All samples**
ICP metals	Mercury
Semivolatile Organics	Conventionals
	Volatile Organics

* The Mode must be selected for each data set entered.

NOTE: The TAB key is used to navigate from field to field. The ENTER key will end the entry screen session resulting in further additions and changes having to be made in the edit screen.

2.3.2 To enter data highlight the sample fraction and test. Choose OK. Enter numerical results in the result column and qualifiers in the Qual column. For an ND (non-detect) result or a < (less than) sign leave blank. When no value is found LIMS automatically reports an ND as the qualifier. To report more than one qualifier, separate with a comma (ex: ND,L). Enter the dilution factor and verify the units and RDL's (reported detection limits) against the data entry sheet and make changes accordingly. When a number comes after a < sign it becomes the new RDL (ex: <0.003).

2.3.3 The header information is entered next for sample by sample only. At the bottom of the entry screen choose Header. Enter the measure date with time, the initial calibration date in the Cal.date, the sample file name in the File ID, the prep date, and the TCLP date if applicable. All dates must be entered in DD-month-YYYY (ex: 01-JAN-2011) format followed by the time in 24-hour format (ex: 11:01). SAVE. Do this process for each sample fraction.

2.3.4 When entering by all samples header information is entered in the edit screen. Complete the data entry portion and SAVE. Close the entry screen and open Sample Data, and in the drop down menu open Data, and then Edit Data. Enter the header information the same as above for sample by sample.

2.2.5 Library Searches are entered sample by sample. The parameter name is entered in the Parameter Synonym field. Enter for each parameter the Result in concentration, Units, Dilution, Retention Time (R.T.), Parameter Type (LIB), Mand Flag (Y), and CAS Number. If "ND" then type in "No Searchable Peaks"

These do not have MDL's or RDL's. Enter the header information as described above.

2.3.6 Bulk ID results are entered on the data entry line labeled Header Information. Units are reported as % and any > signs are entered in the qualifier column. When there is a TOP ID and BOTTOM ID type these headers in uppercase and address in the narrative (see note below). Results too long for the header information line are continued on the next line down. Enter the header information as described above.

NOTE: Address the following:

χ = top + bottom
Top % = top/χ
Bottom % = bottom/χ
Total % = 100

2.3.7 Field and subbed data are entered the same as standard data.

NOTE: All data entered into LIMS must be reviewed for accuracy by a second person.

3.0 DATA EDIT

3.1 To edit results in LIMS open Sample Data. In the drop down menu, open Data and then Edit Data (Figure 4). Querying can be done by the login number, Run ID, or Batch ID number. After entering one of these choices, choose OK. Find the correct fraction and parameter. Enter the necessary changes and choose Save or F10.

3.2 To enter inorganic header information, other than ICP metals, enter the measure date with time on the first sample and the Copy Date button will populate the rest of the fractions. The prep date can also be populated with the same process. Complete the rest of the header and SAVE. Repeat process for each fraction.

3.3 To change a parameter name, delete the entire line that needs fixed by pressing shift F6 on the keyboard. Place the cursor on the line above where you need to re-enter the parameter and press F6 to create a new space and re-enter correctly. Verify that the Parameter Type is REG for regular parameters, SURR for surrogates, and LIB for library searches. Re-enter the RDL, SAVE, and return to the previous screen.

4.0 DATA REVIEW AND STATUS

4.1 Review: All data manually entered or automatically uploaded from an instrument into LIMS must undergo a review for accuracy.

4.1.1 To review data in LIMS open Sample Data. In the drop down menu, open Data and then Edit Data. Querying can be done by the Run ID, Login number, Sample, Workgroup, or Batch ID. The List Type (product code) can also be use to narrow the search. After entering one of these choices, choose OK. The data for each sample fraction must be reviewed for accuracy of the calculations of target results, units, dilution factor, measure date, calibration date, preparation dates, and TCLP extraction dates.

4.2 Statuses: Once the review is complete the status for that department's sample fraction is updated to DONE.

4.2.1 Updating status

The status of each sample fraction must be updated in that department and department 14 once verified for accuracy of entry. In LIMS, open Sample Management and in the drop down menu select Workstat. Statuses are updated in the Work Group Management window (Figure 5). Choose the mode Status Update Only and under Query Criteria enter the department number of the data, new status of DONE (or F9 for a list), product, and Login number or Sample fraction number. To update a fraction place an X on the line needing updated. Choose OK.

4.2.2 Completed status

To check a Login number for a DONE status, repeat the steps for updating status. Once the status window is open, arrow down through the fractions. If everything is marked DONE it is ready for the level package to be completed.

5.0 QUALITY ASSURANCE FORMS

NOTE: All data is reviewed to ensure method and project specific compliance prior to data upload and entry into the LIMS as outlined in Method specific SOP's.

5.1 Microbac Report forms are generated by the analyst and/or data reviewer from LIMS to summarize the QC for each analytical batch.

5.1.1 To generate Forms open Reports and in the drop down menu select Microbac and then Microbac Forms (Figure 7). Enter the Login number, department number, and product (or press F9 for a list) corresponding to the completed data. Choose the individual forms or choose Level two and then Level three to generate all. Choose Regenerate File and Make PDF or for on-screen review choose Preview Report. Each form is generated and saved as an electronic file to the corresponding Master File under Reports for the final report to the client.

6.0 REPORT NARRATIVES AND CHECKLISTS

6.1 Automated Editable Case Narratives

6.1.1 Automated case narratives are generated In Microbac OVD - Official Links. Select the Data Analysis tab and under Case Narratives click Create Narrative using Template (Figure 6A-B). Key in the Login number, select the template and approved by name and then click on Create. Once the Login number shows up on the queue click on Find by Login #, enter the Login number then Find. This generates an information window for that Login number, find the method and then View/Edit for a working version to verify and/or edit. Each section has independent paragraphs and tables that must be edited separately by clicking on Show. This opens either the table or paragraph to be edited. Make appropriate edits then Update. Click on generate PDF and then View PDF to review. This generates an electronic version of the narrative that is automatically saved to the Master file. The narrative can now be printed if necessary.

6.2 TRRP Checklist (equivalent to: Texas Commission on Environmental Quality (TCEQ) Laboratory Review Checklist (LRC))

6.2.1 TRRP forms are generated in the Links. Choose the tab Data Analysis then under Client Requirements choose TRRP Checklist (Figure 6D). From the left side columns choose the appropriate Method and click on the ID#. This will bring up a template (Figure 6D_1) that can be edited to fit the QC results of that case (templates have been created for each method to reflect the appropriate information). Once the template comes up enter the following information: Login number, workgroup numbers without the “WG” separated by commas in the “Prep Batches” field, Reviewer (Name) and click on Update. The template is now ready for any edits needed.

Any QC that is out of limits must be noted as an exception. The statement is typed into the ER Description window using the corresponding ER number then hit Update. The corresponding number is entered into the lines section of the checklist, find the appropriate line and change the Yes to No and add a number to the ER box that will corresponds to the Exception statement. Scroll to the bottom of that section and Update. Once all exceptions are addressed generate pdf, and view pdf.

If all QC were within limits and there were no exceptions the TRRP checklist will default to "There are no exceptions".

"Generate PDF" will create an electronic version and automatically save the TRRP checklist to the Master file. Print if necessary.

7.0 DATA REPORTING, PRINTING AND DELIVERY

7.1 Reporting

7.1.1 Determining which cases are ready to report to the client.

When all data for a specific case has been entered, reviewed, and the level data is completed, all parameters including level statuses will be set to DONE in department 14. The case is now complete and ready to be printed. This is determined by generating a Needs Printed Report.

Needs printed report: In Links choose the Reporting tab and then Needs Printed for the report to generate.

7.2 Generating Reports

7.2.1 Hard copy Master files are kept for each Login number and pulled from the filing cabinet when analyses are completed and the case is ready to be printed.

7.2.2 Final and preliminary reports are generated, assembled, and saved electronically by the following:

Microbac OVD, Reporting tab, Data Assembly, Build Complete Package. Type in L#, click on update. This will bring up the Destination Report. This tells you what you need to build. For example, if you only need to build a PDF, you click on Run Assembler. If you need to build an EDD, click on Run EDD- choose the correct EDD and click on Run EDD. Arrow out of the EDD screen, click on Black Arrow at the top and this will take you back to the first page. If you need more than one PDF, (Level 1 and Level 4) they can only be built, one at a time. Wait until the first one clears the queue before you start building the other one. To go the next report to build, click on Build another Package and type in L#. Repeat the process for all the reports you need to build. When the reports on the Needs Printed List are built, go back to the Needs Printed List and mark each report that you built to done. Be careful not to mark any report off that you did not build. This will cause the report not to be sent because if it is marked to print, it will not come up on the list again. When finished marking to done, click on the Refresh Tab at the top. If it has been 15 minutes there may be new reports to build. Note: When building reports if it comes up in **RED,** saying Chain Not Scanned. Click on Sample receipt, scroll down page to Email Receipt to click uncheck-click on update. Scroll back to top and it will say Sample Receipt was successfully updated. Give some time and then try to build the report. Do not build report if the Chain of Custody comes up in **RED.**

7.2.3 Preliminary case results can be reported to the client by following the printing steps in 7.2.2 and check the preliminary report.

7.2.4 When generating a revised report follow the steps in 7.2.2 until you enter the Create Data Package Screen for the case that needs revised. Check mark the box stating this is a revision; this will allow the report to be notated as revised in the Masterfile once it is built. Be sure to include the revision number to keep track of the different revisions made to a report to avoid overwriting. In the section for cover page comments, document the reason the report needs revised. This will appear on the cover page of the report when it is regenerated. Once those steps are complete, click Run Assembler and the revised report will be generated.

7.2.5 The report undergoes a completeness review by the appropriate CRM or CDS (see Microbac SOP LQAP Section 12.4). It is now ready for delivery to the Client.

7.3 Delivery to the client

Completed reports are routed to clients according to the Destination Report generated in the “Build a Complete Package” section of the Data Assembler via EDD, CD, E-mail, or Mail according to any client’s special instructions.

Log-in to RoR and click on the Reporting tab. In Data Assembly choose Build Complete Package. Under Login number enter the corresponding L number and click on the box titled Update. This will generate the Report Destination page for this Client.

EDD’s are generated by the CRM or CDS according to client specifications (see Microbac SOP MISEDD1). CD’s are generated per Client request.

E-mail: Using the Reports Destination page verify the email address then page click on it and your email will pop up automatically. The L number you are working on will appear in the subject line of this newly created email. Type the body of the email and click send.

Mail: Enclose report, invoice, Chain of Custody and any other applicable documents or materials (CD) per the client's instructions. Package in a shipping envelope or box, label and ship via the project instructions (U.S. Mail, Fed-X, UPS, etc.).

7.4 Once delivery is made to the client the Login number is marked to Mailed. At the top of this Reports Destination page you can click on Printed and it will take this L number to printed or you can take L numbers to printed when you create the needs printed list. You can also take reports to mailed by clicking on mailed at the top of the page. Once the system updates the status to mailed, today's date will appear beside mailed.

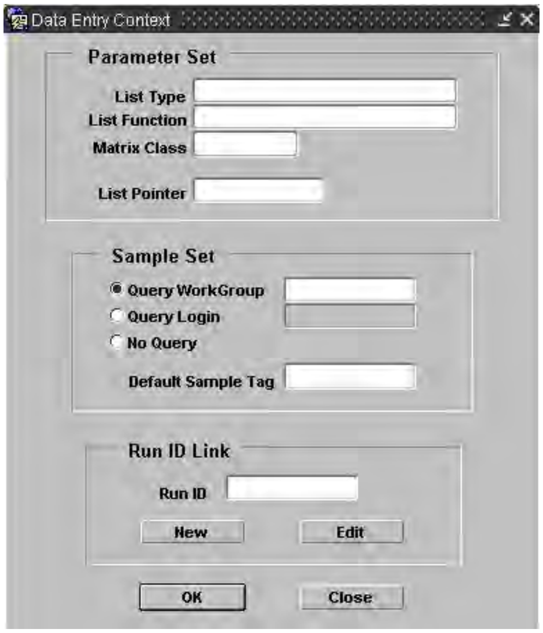
8.0 REFERENCES

8.1 Microbac SOP LQAP "Laboratory Quality Assurance Plan"

8.2 Microbac SOP DU01 "Organic and Inorganic Data Upload Procedure"

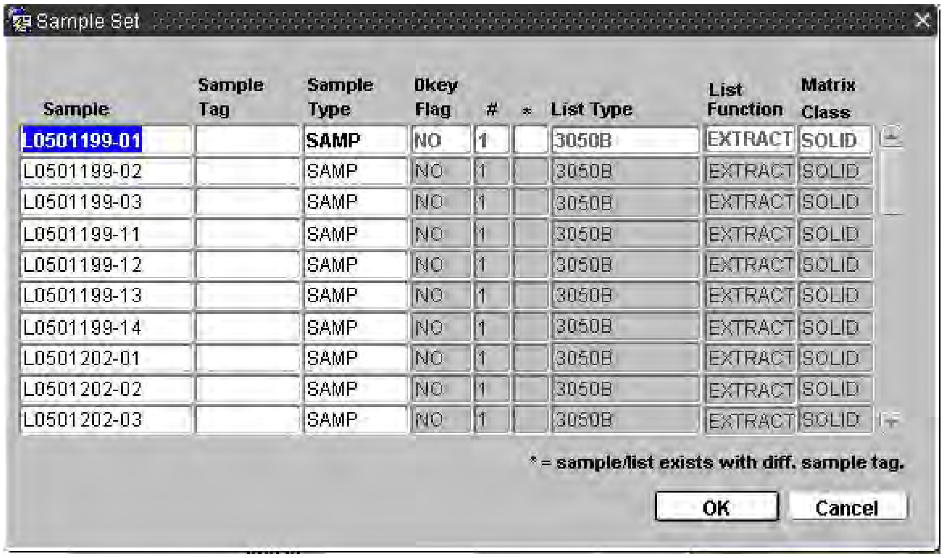
8.3 Microbac SOP MISEDD01 "Development and Maintenance of Electronic data Deliverables (EDD)

Figure 1



- ● Query WorkGroup
- ○ Query Login
- ○ No Query

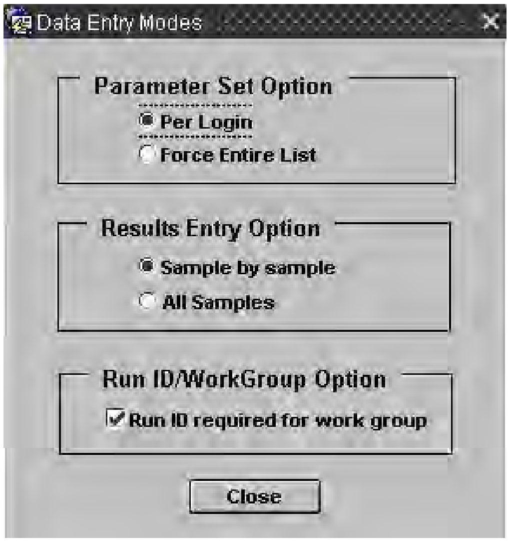
Figure 2



Sample	Sample Tag	Sample Type	Dkey Flag	#	*	List Type	List Function	Matrix Class
L0501199-01		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-02		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-03		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-11		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-12		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-13		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501199-14		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501202-01		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501202-02		SAMP	NO	1		3050B	EXTRACT	SOLID
L0501202-03		SAMP	NO	1		3050B	EXTRACT	SOLID

* = sample/list exists with diff. sample tag.

Figure 3



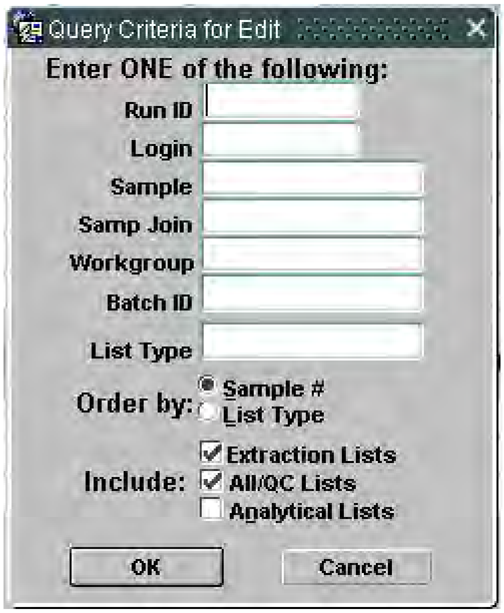
Data Entry Modes

Parameter Set Option
● Per Login
○ Force Entire List

Results Entry Option
● Sample by sample
○ All Samples

Run ID/WorkGroup Option
☑ Run ID required for work group

Figure 4



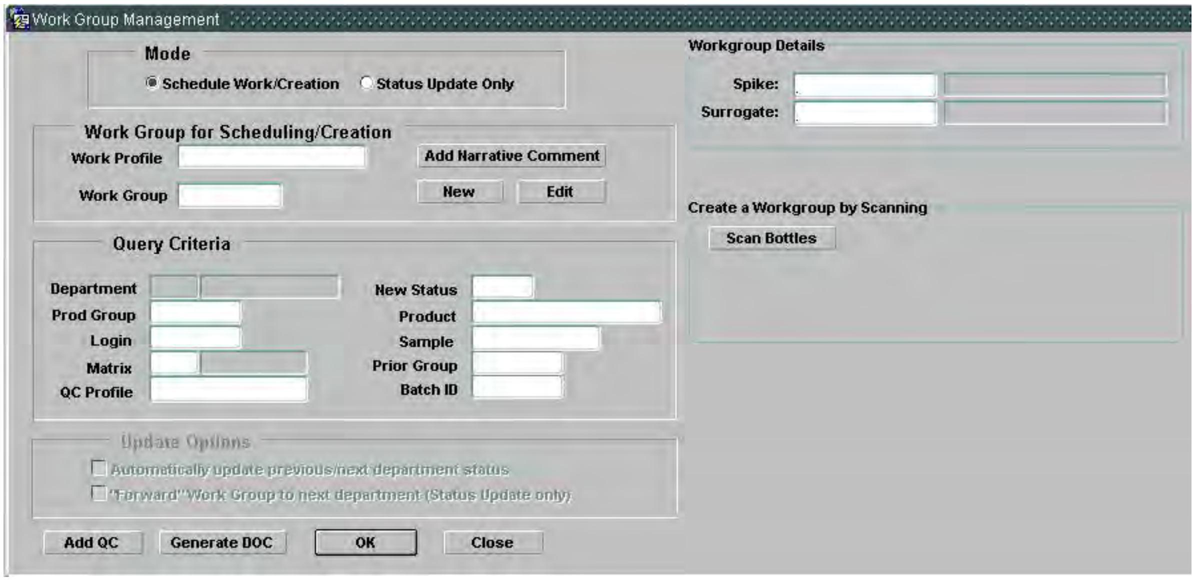
Query Criteria for Edit

Enter ONE of the following:
Run ID
Login
Sample
Samp Join
Workgroup
Batch ID
List Type

Order by: ● Sample # ○ List Type

Include:
☑ Extraction Lists
☑ All/QC Lists
☐ Analytical Lists

Figure 5



Mode
● Schedule Work/Creation ○ Status Update Only

Figure 6A

5/6/2014 Create Narrative by Template

Return Home
Signed in as charissa.winters@microbac.com. Not you? Sign out | Edit Profile |

Create Narrative by Template

Generate from Template | Generate from Department | Find By Login# | Queue | Canned Statements | Data Types | Templates

Login #: L14

Template: 6200

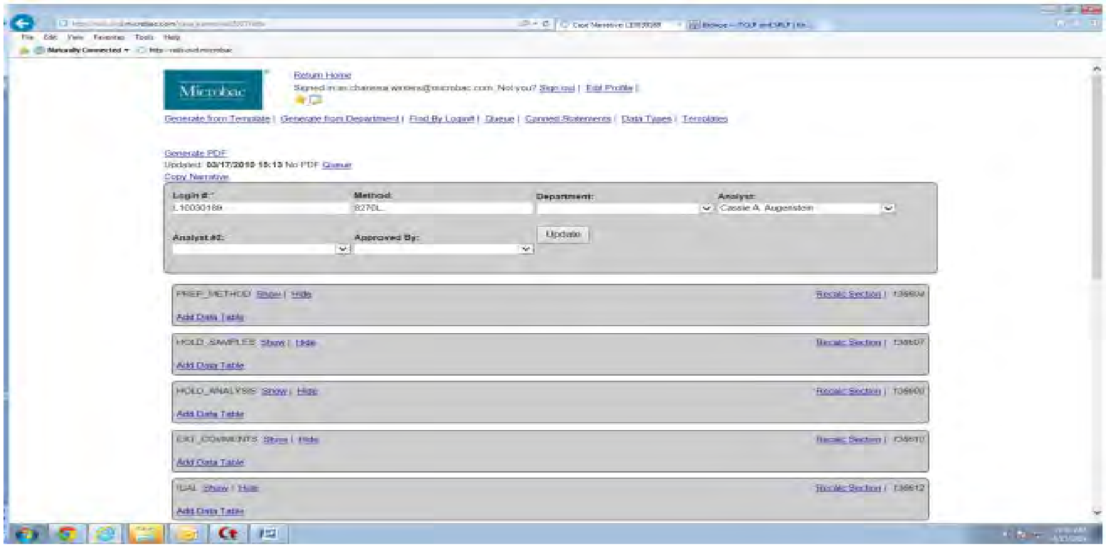
Approved By:

Narrative Worklist

Login #	Product	Due
L14021411	NARR-624	2014-03-06 00:00:00 UTC
L14030165	NARR-8260	2014-03-12 00:00:00 UTC
L14041400	NARR-8260	2014-04-25 00:00:00 UTC
L14041192	NARR-8260	2014-04-28 00:00:00 UTC

http://192.168.4.22/case_narratives/create_from_template 1/7

Figure 6B



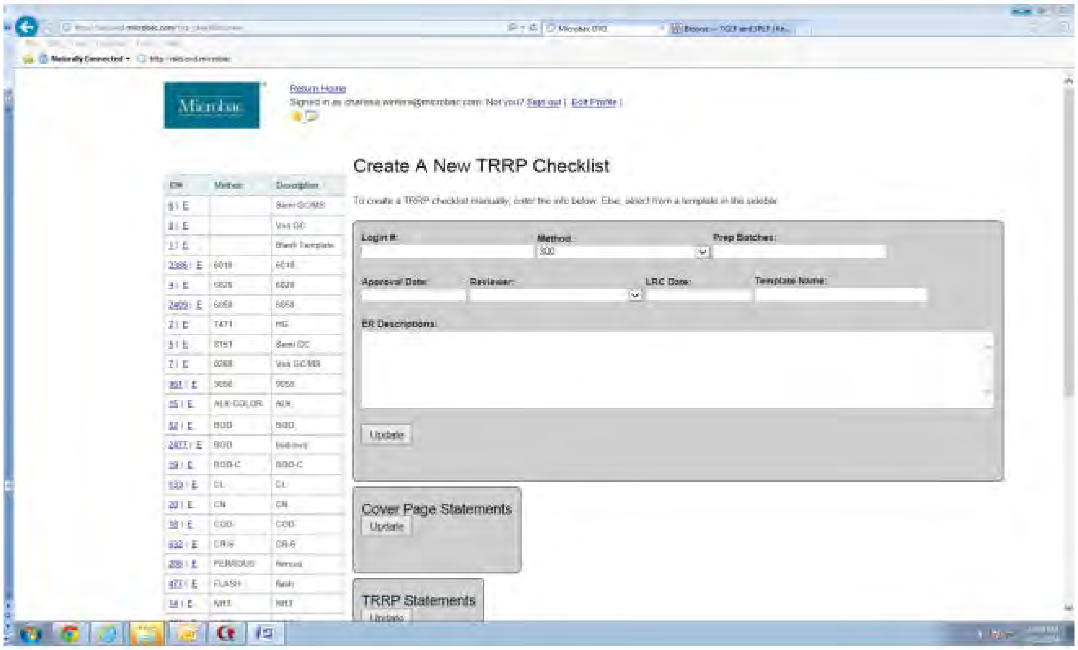
Return Home
Signed in as charissa.winters@microbac.com. Not you? Sign out | Edit Profile |

Generate from Template | Generate from Department | Find By Login# | Queue | Canned Statements | Data Types | Templates

Generate PDF
Updated: 03/17/2010 15:13 No PDF Queue
Copy Narrative

Login #: L10030189
Method: 8270L
Department:
Analyst: Cassie A. Augenstein
Analyst #2:
Approved By:

Figure 6D



Return Home
Signed in as charissa.winters@microbac.com Not you? Sign out | Edit Profile |

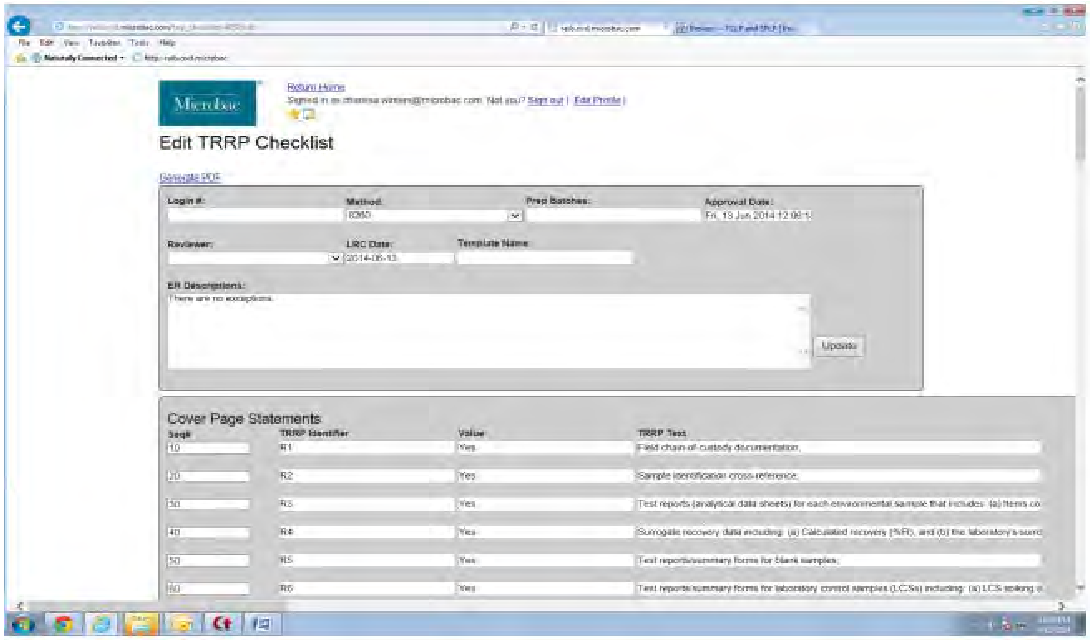
Create A New TRRP Checklist

To create a TRRP checklist manually, enter the info below. Else, select from a template in the sidebar.

ID#	Method	Description
8 | E		Semi GC/MS
4 | E		Vola GC
17 | E		Blank Template
2386 | E	6010	6010
9 | E	6020	6020
2409 | E	6850	6850
2 | E	7471	HG
5 | E	8151	Semi GC
7 | E	8260	Vola GC/MS
361 | E	9056	9056
45 | E	ALK-COLOR	ALK
52 | E	BOD	BOD
2477 | E	BOD	[illegible]
59 | E	BOD-C	BOD-C
533 | E	CL	CL
20 | E	CN	CN
18 | E	COD	COD
532 | E	CR-6	CR-6
208 | E	FERROUS	ferrous
473 | E	FLASH	flash
14 | E	NH3	NH3

Login #:
Method: 300
Prep Batches:
Approval Date:
Reviewer:
LRC Date:
Template Name:
ER Descriptions:

Figure 6D_1



Return Home
Signed in as charissa.winters@microbac.com Not you? Sign out | Edit Profile |

Edit TRRP Checklist

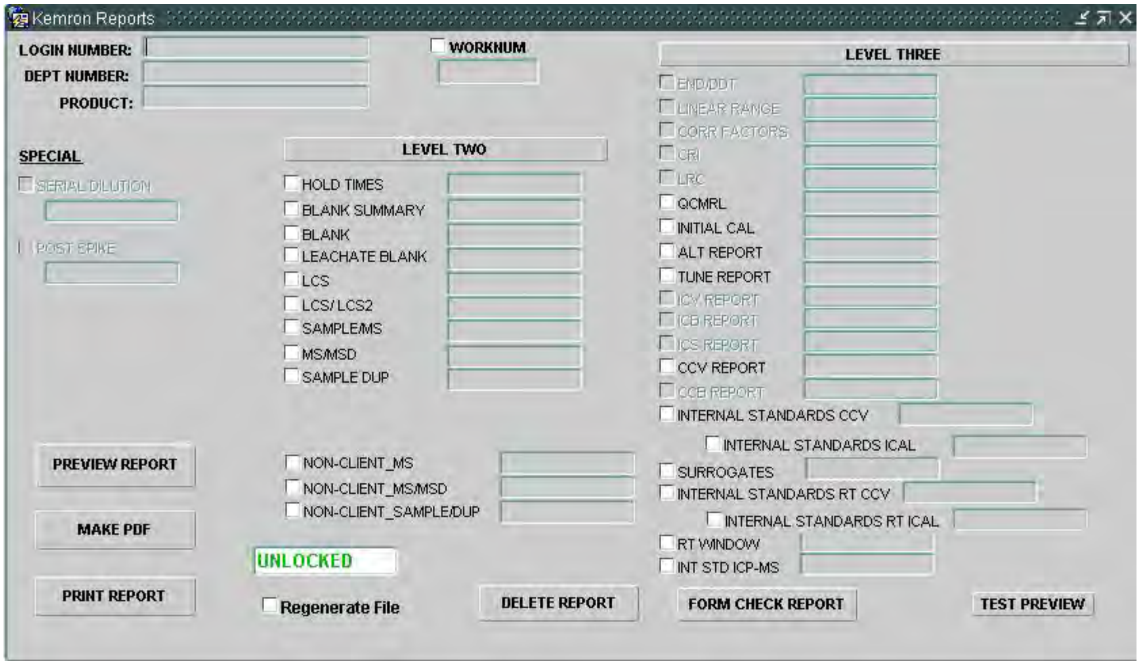
Generate PDF

Login #:
Method: 8260
Prep Batches:
Approval Date: Fri, 13 Jun 2014 12:06:1
Reviewer:
LRC Date: 2014-06-13
Template Name:
ER Descriptions: There are no exceptions.

Cover Page Statements

Seq#	TRRP Identifier	Value	TRRP Text
10	R1	Yes	Field chain-of-custody documentation;
20	R2	Yes	Sample identification cross-reference;
30	R3	Yes	Test reports (analytical data sheets) for each environmental sample that includes: (a) items co
40	R4	Yes	Surrogate recovery data including: (a) Calculated recovery (%R), and (b) the laboratory's surro
50	R5	Yes	Test reports/summary forms for blank samples;
60	R6	Yes	Test reports/summary forms for laboratory control samples (LCSs) including: (a) LCS spiking a

Figure 7


Kemron Reports
LOGIN NUMBER:
DEPT NUMBER:
PRODUCT:
☐ WORKNUM
LEVEL THREE
☐ END/DDT
☐ LINEAR RANGE
☐ CORR FACTORS
☐ CRI
☐ LRC
☐ QCMRL
☐ INITIAL CAL
☐ ALT REPORT
☐ TUNE REPORT
☐ ICV REPORT
☐ ICB REPORT
☐ ICS REPORT
☐ CCV REPORT
☐ CCB REPORT
☐ INTERNAL STANDARDS CCV
☐ INTERNAL STANDARDS ICAL
☐ SURROGATES
☐ INTERNAL STANDARDS RT CCV
☐ INTERNAL STANDARDS RT ICAL
☐ RT WINDOW
☐ INT STD ICP-MS
SPECIAL
☐ SERIAL DILUTION
☐ POST SPIKE
LEVEL TWO
☐ HOLD TIMES
☐ BLANK SUMMARY
☐ BLANK
☐ LEACHATE BLANK
☐ LCS
☐ LCS/LCS2
☐ SAMPLE/MS
☐ MS/MSD
☐ SAMPLE DUP
PREVIEW REPORT
☐ NON-CLIENT_MS
☐ NON-CLIENT_MS/MSD
☐ NON-CLIENT_SAMPLE/DUP
MAKE PDF
UNLOCKED
PRINT REPORT
☐ Regenerate File
DELETE REPORT
FORM CHECK REPORT
TEST PREVIEW

PM003 – CT Labs – Sample Receiving and Processing

CT LABORATORIES
delivering more than data from your environmental analyses

STANDARD OPERATING PROCEDURE

PM 003 Chemistry & Microbiology Sample Receiving and Processing

Review Date: 05/22/18

05/22/18

Technical Review by: Date

Colleen 05/22/18

Approved by: Quality Assurance Date

Table of Contents

1. SCOPE OF APPLICABILITY

1.1. To provide consistency when receiving and logging samples for the analytical laboratory. This document will provide guidance and serve as a resource for information when logging samples.

1.2. This procedure should only be used for the receiving and logging of samples analyzed in the Chemistry and Microbiology laboratory. This procedure should be used as a resource along with pertinent supplemental information to log samples into the LIMS system.

1.3. Sample Receiving Personnel will have general chemistry knowledge, including knowledge of the periodic table of elements, strong computer skills, extensive training in LIMS, and have knowledge of SOPs. Sample Receiving Personnel must also pay close attention to detail, have the ability to multi-task, and provide ample customer service.

2. SUMMARY OF METHOD

2.1. Receive samples from field personnel.

2.2. Documentation of Receipt:

2.2.1. Time
2.2.2. Date
2.2.3. pH
2.2.4. Temperature

2.3. Verify that all relevant information is labeled on sample containers and agrees with the information provided on the Chain of Custody.

2.4. Log-in to the LIMS system.

2.5. Creating a condition report for the project managers.

2.6. Labeling of containers.

2.7. Storing samples properly.

3. DEFINITIONS

3.1. A sample is in your custody if:

3.1.1. It is in your possession, or

3.1.2. It is in your view after being in your possession, or

3.1.3. It was in your possession and you returned it, or

3.1.4. It is in a designated secure area.

3.2. LIMS: Laboratory Information Management System.

3.3. Level II, III and IV Deliverables: Requirements dictated by contract and QAPP for clients that specify detailed data packages, documentation, tests and reporting limits. These are typically government regulated projects and are indicated in the contract found in LIMS.

4. HEALTH AND SAFETY

4.1. All activities performed while following this procedure shall utilize appropriate laboratory safety systems.

5. INTERFERENCES

5.1. Not applicable.

6. EQUIPMENT AND SUPPLIES

6.1. Not applicable.

7. REAGENTS AND STANDARDS

7.1. Not applicable.

8. SAMPLE HANDLING AND PRESERVATION

8.1. Not applicable.

9. PROCEDURE

9.1. Field Custody:

9.1.1. The field sampler or designated field person is personally responsible for the proper care and custody of the field samples until they are properly transferred or dispatched to the laboratory.

9.1.2. Sample labels or tags must be completed for each sample and any sub-sample that make up a sample. At a minimum, the labels or tags shall contain the sampling location, date, time and company or sampler’s name.

9.1.3. Sample containers or shipping containers may be secured with a custody seal. If used, the seal must be made in such a manner that it visually shows a break, destruction or change in nature if the seal is tampered with.

9.1.4. All samples must be accompanied by proper documentation in the form of a *Chain of Custody* record. This document must clearly identify the following:

9.1.4.1. The samples and/or sub-samples.

9.1.4.2. The designation of the desired testing to be performed on each sample.

9.1.4.3. The sampler.

9.1.4.4. The person relinquishing custody of the sample.

9.1.4.5. To whom the samples are relinquished to.

9.1.4.6. The date/time of the events.

9.2. Transfer of Custody and Transport/Shipment:

9.2.1. Samples must be properly packaged for shipment. For samples requiring temperature preservation, sufficient ice should surround the samples to assure ice is present when the samples reach the lab. Internal packaging should be in place to assure container integrity and comply with shipping requirements.

9.2.2. The original completed Chain of Custody needs to accompany the samples. A copy of the form should be retained by the field personnel.

9.3. Sample Arrival:

9.3.1. Samples are received at the west side of the building marked “Receiving”.

9.3.2. Samples are accepted during normal working hours of 8:00 A.M. – 5:00 P.M., Monday through Friday. Exceptions can be made on a case-by-case basis.

9.3.3. Samples may arrive via UPS, Federal Express, US Mail, Dunham Express, SpeeDee, other private contracted delivery services and/or by the client.

9.3.4. Samples arriving will require a signature of the individual receiving the samples. Their signature will verify the number of packages delivered and accepted.

9.3.5. When samples are received (typically in a cooler or other packaging that is acceptable to project or sample specific requirements), personnel must first remove the paperwork or documentation from the contents. The paperwork may be in the form of a Chain of Custody (COC) and/or purchase order. If there is no paperwork accompanying the samples, the project manager is contacted. Missing paperwork is to be documented and later added to the Sample Condition Report.

9.3.6. Exercise caution when opening coolers. Coolers may contain samples of unknown origin and may be hazardous to health. If unsure of the type of samples being delivered, carefully open the cooler in a hood or well-ventilated area.

9.3.7. After the paperwork is verified, record the preservation temperature of samples on the COC. The following steps should be taken to determine the temperature:

  9.3.7.1. If there is a temperature blank associated with the samples (one per cooler), take the temperature of the temperature blank by using a current NIST certified traceable temperature gun. Indicate the thermometer number on the COC and any receiving documents.

  9.3.7.2. If there is no temperature blank, record the temperature from a sample bottle or from the ice/water inside the cooler preserving the sample. A NIST certified traceable probe is to be used if the temperature is not obtainable from a sample container.

  9.3.7.3. Indicate if samples are received on ice (circle “yes” or “no”).

  9.3.7.4. If the samples are submitted directly within 4 hours, note “direct” next to the temperature.

  9.3.7.5. If the samples were previously on ice but it has completely melted, take the temperature of the melt water.

9.3.8. The COC must be checked to verify that it is properly filled out. Login personnel will verify the following on the COC:

  9.3.8.1. COC is filled out in pen.

9.3.8.2. The appropriate project number is present (if applicable).

9.3.8.3. Desired tests are checked.

9.3.8.4. Sample dates and times are within hold time.

9.3.8.5. Signature of sampler or person taking possession of samples is present.

9.3.8.6. Sample descriptions are present.

9.3.8.7. Any damage or leaking shipping containers are documented.

9.3.8.8. Any special instructions, billing information or turnaround requests are followed (if applicable).

9.3.8.9. Any edits to the COC by CT Laboratories requires a single line drawn through the error/change and initialed/dated.

9.3.8.10. Level III and IV Projects require additional documentation:

9.3.8.10.1. Presence or absence of a custody seal on the shipping container.

9.3.8.10.2. The condition of the custody seal (intact, damaged, open, etc.).

9.3.8.10.3. Shipping method and tracking number of shipping container removed from packaging and retained.

9.3.8.10.4. Filled out Cooler Receipt Form (FPM3-02) and included with the COC.

9.3.9. Remove samples from the cooler, matching the sample with the COC. Verify that all samples arrived undamaged and that all samples listed on the COC are present. Any damaged containers and/or discrepancies in the COC and samples are to be reported to the appropriate project manager.

9.3.10. Verify sample preservation by visually identifying that they are received in the proper bottles and that the pH level is within acceptable limits. pH verification is conducted by pH indicator paper and the results will be documented in the log in screen in LIMS.

9.3.11. Additional visual inspections of containers include observations of adequate sample volume provided and the presence/absence of air bubbles in zero headspace required VOA vials.

9.3.12. Once the above steps are completed, any problems or inconsistencies are immediately reported to the project manager and later recorded in the sample condition report.

NOTE: It is not CT Laboratories *policy or obligation* to reject client samples due to possible compromised samples, i.e., frozen or broken containers, not enough ice, etc. It is our obligation to notify the client of any possible compromised sample issue. <u>Ultimately it is the Clients responsibility to make the decision to analyze/not analyze samples.</u> Directions on how to proceed with potentially compromised samples must be documented in writing by the client.

9.4. Log-In using LIMS:

9.4.1. Double click on the LIMS icon on the desktop.

9.4.1.1. Login screen appears.

9.4.1.2. Enter username and password.

9.4.1.3. Select “OK”.

9.4.2. Once into the LIMS main screen, select “Login”.

9.4.2.1. Select “Login Standard”, “Sample Login Extended” (or “Login SEDD”).

9.4.2.2. Select “Add New” in the client section of the window.

9.4.2.3. Select “Client” from the list of clients available.

9.4.2.4. Select “project name” or “number” from the list of projects.

9.4.3. Fill in the project name, project number, report and invoice contacts, name of sampler (In Iowa), PO number and make any necessary changes so that LIMS and the COC coincide.

9.4.4. Fill in the sample date, sample time, matrix and sample description. If applicable, change the lab due date (i.e. “Rush”).

9.4.5. Choose “Add Tests” folder. Scroll through the tests to locate the requested test and double click to select. When all tests for a sample have been selected and all samples have been logged in for their desired tests, commit the folder and record the folder and sample numbers on the COC. The COC will then be signed by personnel responsible for sample login.

9.4.6. Print container labels and affix each label to the appropriate container.

9.5. Handling Sample Documentation and Log-In Problems:

9.5.1. If log-in has encountered any problems during the log-in procedure, proper documentation and notification must be performed. Examples of problems include, but are not limited to:

9.5.1.1. Samples received outside proper temperature parameters of 4°C ± 2°C.

9.5.1.2. Broken containers.

9.5.1.3. Incomplete COC’s.

9.5.1.4. Missing samples.

9.5.1.5. Samples received past hold time.

9.5.1.6. Samples without proper preservation.

9.5.1.7. Inadequate volume to perform test(s).

9.5.1.8. For any situation that may warrant project management notification.

9.5.2. Log-In personnel must fill in the “Sample Condition” form whenever there is any question or problem with samples in our custody. Once the proper information is gathered, the form goes immediately to the project manager for that folder number. The project manager contacts the client for direction on how to proceed. The project manager documents what action will be taken with the samples in question. The form is kept with the original COC and included with the final report to the client. Sample Condition forms are kept within the electronic file folder and are saved electronically for future reference.

Note: Some clients have an ongoing history of noncompliance with sample submission requirements. Regardless of

noncompliance frequency, Log-in personnel must note discrepancies at all times, unless a specific client Protocol Variance Form" is on file (SOP QA018).

9.5.3. Level II, III and Level IV Projects require a SCR to be filled out for each folder. The following documentation **must** apply to each project:

9.5.3.1. Condition of each sample, sub-sample or container will be recorded by the following codes:

1) Intact
2) Too Many Containers
3) Broken Container
4) Missing Bottles
5) Wrong Container
6) Past Hold Time
7) Incorrectly Preserved
8) Insufficient Volume
9) Labels Missing/Unreadable
10) Air Bubbles in VOA Vials

9.5.3.2. Compare documents to verify agreement between the following:

9.5.3.2.1. Chain of Custody Records

9.5.3.2.2. Sample Tags or Labels

9.5.3.2.3. Air Bills or Bills of Lading

9.6. Sample Handling Outside of Quality System Guidelines:

9.6.1. On occasion clients may request special handling, services and/or analysis of samples that fall outside of CT Laboratories' Quality System. These may include, but are not limited to: research or applied science projects with no quality control procedures or limits, analysis without regard to holding time or temperature, or filtering and/or preservation procedures of samples normally formed in the field. The protocol for these samples is detailed in SOP Number QA018 Processing of Samples Outside of Quality System Guidelines. For these samples, Log-in personnel will receive from the Project Manager either documented directions from the client and/or a "Protocol Variance Form," approved by the Laboratory Director and Quality Assurance Coordinator as stipulated in SOP QA018 Sections 3.1.5-3.4.2. The instructions contained in this documentation take precedence over the sample receiving and log-in procedures detailed in this SOP.

9.7. Post Log-In:

9.7.1. In the event that a client notifies CT Laboratories staff, via email, phone call, or notation on the chain of custody that a submitted sample has already been determined to be hazardous, highly contaminated, or dangerous the samples will be dealt with on a case to case basis as directed by the project managers or the safety officer.

9.7.2. Samples may require special storage and/or handling for safety of employees and to prevent any cross contamination of other samples in storage.

9.7.3. Handling and Storage Requirements:

9.7.3.1. Samples are stored in appropriately designated areas and under conditions required for proper preservation.

9.7.3.2. Damaged samples are disposed of and documented.

9.7.3.3. Standards are stored separately from samples and extracts.

9.8. Sample Security:

9.8.1. The laboratory is a secure facility, with strict, limited access to laboratory personnel and approved contractors. Access to the laboratory is through locked doors.

9.8.2. Visitors to the laboratory must enter through a secure door, sign-in and out, and must be escorted at all times while in the laboratory. No visitor will be allowed access to sample or extract storage.

9.9. When all samples are logged in for a given day, login confirmation sheets are printed from LIMS. Login confirmation sheets summarizes of all the information entered regarding each project including the tests assigned to each particular sample. Confirmations are subsequently used to check for log-in errors by comparing with the original chain of custody.

9.10. When sample analysis and reporting is completed by the laboratory, or after thirty days' time, whichever is longer, the sample will be disposed of properly according to the Laboratory Waste Disposal SOP WS001 and the QAM.

10. CALCULATIONS AND DATA ANALYSIS AND REDUCTION

10.1. Not applicable.

11. CALIBRATION AND STANDARDIZATION

11.1. Not applicable.

12. QUALITY CONTROL

12.1. Not applicable.

13. DATA ASSESSMENT/ACCEPTANCE CRITERIA FOR QC MEASURES

13.1. Not applicable.

14. CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

14.1. Not applicable.

15. CONTINGENCIES FOR HANDLING OUT OF CONTROL OR UNACCEPTABLE DATA

15.1. Not applicable.

16. DATA RECORDS MANAGEMENT

16.1. Records are stored for a minimum of 5 years in accordance with the Quality Manual.

16.2. See SOP QA 003 for specifics on document control.

17. WASTE MANAGEMENT

17.1. See QAM.

18. REFERENCES

18.1. CT Laboratories Quality Manual, current revision

18.2. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.1, DoD QSM, January 2017 or most recent revision.

18.3. National Environmental Laboratory Accreditation Conference (NELAC), 2003 *NELAC Standard Chapters 1 to 6*, EPA/600/R-04/003, June 5, 2003 or most recent version.

18.4. ISO. 2005. *General requirements for the competence of testing and calibration laboratories*. ISO/IEC 17025:2005.

18.5. Policies and Procedures, May 1978 (Rev. March 1986)

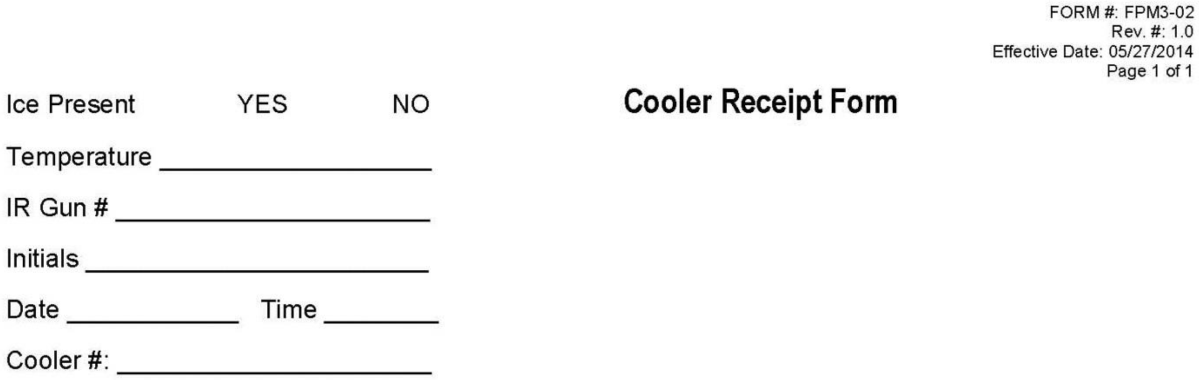
18.6. EPA-330/9-78-001-R

18.7. EPA Central Regional Laboratory (communications)

18.8. US ACOE – EM 200-1-3

19. FIGURES

19.1. Cooler Receipt Form (FPM3-02, Example)



FORM #: FPM3-02
Rev. #: 1.0
Effective Date: 05/27/2014
Page 1 of 1

Cooler Receipt Form

Ice Present YES NO

Temperature ____________________

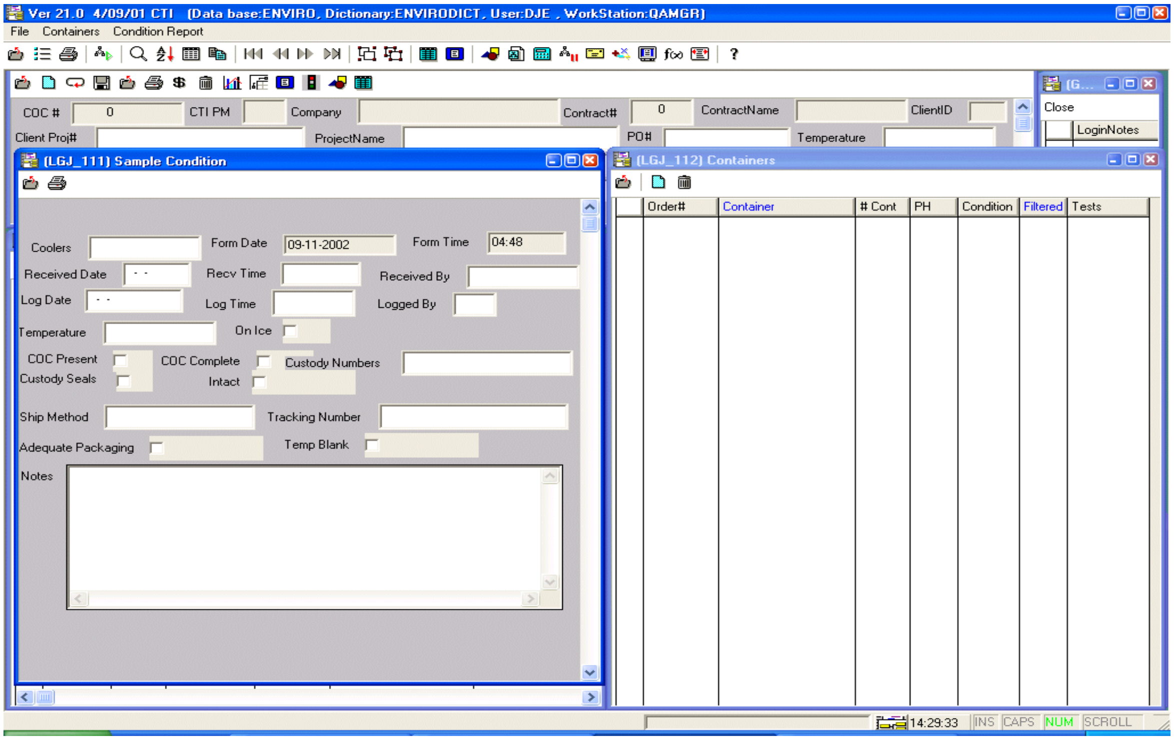
IR Gun # ______________________

Initials _________________________

Date ____________ Time ________

Cooler #: ______________________

19.2. Sample Condition Report (Printed from LIMS, Example)



COC # 0
Contract# 0
Form Date 09-11-2002
Form Time 04:48

LIMS Sample Condition function screen

Sample Condition Report

Folder #: 29071 Coolers: 12345 Date: 9/12/2002 Time:
09:23
Client: CT Laboratories Received Date/Time: 9/12/2002 0930 Received By:
DJE
Project Name: 2002 PT Log-In Date/Time: 9/12/2002 0945 Logged By:
DJE
Project #: WP-92 PM: PML

Temperature: 2.0 C On Ice: Y COC Present: Y Complete: Y
Custody Seals Present: Y Intact: Y Numbers: 123456789
Ship Method: FedEx Tracking Number: 123456789
Adequate Packaging: Y Temp Blank Enclosed: Y

Notes: One of three VOC vials broke in shipping. Client contacted by DJE at 0940 on 09/12/02.

Sample ID/Description		**Container**	**#**	**Condition**		
Filtered		**Tests**		**Code**		
148568	574	AMBER GL	1	1	Y	HG
148569	580	HNO3	1	11	Y	ICP
148570	582	AMBER HCL	1	9	N	O&G
148572	586	HNO3	1	7	Y	ICP
148573	830	VOA HCL	3	3	N	VOC

1 Sample Received OK
3 Broken Container
7 Wrong Container
9 Incorrectly Preserved
11 Label Missing/Unreadable

19.3. Description of Changes

Revision Number	**Description of Changes**	**Date**
04	Document changed to incorporated administrative requirements of ISO/IEC 17025:2005 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	01/10/2014
05	Special requirements for restrictive samples have been removed from the SOP as this requirement is no longer specified in any QAPP's, and our SOP, LIMS & secure facility covers the mandatory handling requirements designated by QSM, DoD and all other governing bodies	12/20/2016
5.1	Document updated to reflect current format and to incorporate requirements of QSM 5.1.	05/22/2018

PR002 – CT Labs – TCLP and SPLP Extraction, Volatile Fraction (ZHE)

STANDARD OPERATING PROCEDURE
PR 002 TCLP and SPLP Extraction, Volatile Fraction (ZHE)

Review Date: 03/16/2018

Randy

03/16/2018

Technical Review by: Date

Colleen

03/22/18

Approved by: Quality Assurance Date

1.0 Identification of Test Method

The Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) are designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes. The following procedure will be used for performing the volatile organic ZHE procedure.

2.0 Applicable Matrix or Matrices

This procedure is used for the extraction of purgeable VOCs for a variety of liquid and solid matrices including soils, sludge, and waste samples.

3.0 Detection Limits

Method Detection Limits (MDLs) are compound, instrument, and matrix dependent. MDL analyses are performed annually for the instruments and matrices applicable to this procedure. The reporting limits (RLs) used are based on whether or not samples have been diluted prior to analyses. Default reporting limits are used for the standard TCLP/SPLP list used for the volatile organic analysis (see Scope and Application, figure 1).

4.0 Scope and Application

This procedure is applicable to a wide range of volatile organic compounds though typically only the standard TCLP/SPLP list is required (see figure 1). The reporting limits used reflect the Maximum Contaminant Level (MCL) allowed for TCLP samples. After performing the TCLP or SPLP extractions, the samples are analyzed by GCMS following the procedures outline in SOP VO-004 (*Analysis of Volatile Organic Compounds by GC/MS 8260C*).

Figure 1.Standard TCLP/SPLP Compound List

Compound	Reporting limit (mg/L)
vinyl chloride	0.2
1,1-dichloroethene	0.7
1,2-dichloroethane	0.5
2-butanone	200
chloroform	6
carbon tetrachloride	0.5
benzene	0.5
trichloroethene	0.5
tetrachloroethene	0.7
chlorobenzene	100

5.0 Method Summary

5.1 TCLP

5.1.1 For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the TCLP extract.

5.1.2 For wastes containing greater than or equal to 0.5% solids, the liquid, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. If the sample is a waste or wastewater, the extraction fluid employed is a pH 4.93 solution. A special extractor vessel (ZHE) is used when testing for volatile analytes. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

5.1.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

5.2 SPLP

5.2.1 For liquid samples (i.e., those containing less than 0.5 % dry solid material), the sample, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the SPLP extract.

5.2.2 For samples containing greater than 0.5 % solids, the liquid phase, if any, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of reagent DI water equal to 20 times the weight of the solid phase. A special extractor vessel (ZHE) is used when testing for volatile analytes. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

5.2.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

6.0 Definitions

6.1 For definitions on all terms applicable to this method, see Appendix 10 of the Quality Assurance Manual (QAM).

6.2 For a list of common acronyms and abbreviations, see QAM Appendix 7.

7.0 Interferences

7.1 Carry over contamination is a problem when a highly contaminated sample is followed by a clean sample. Thorough cleaning and rinsing the ZHE device will eliminate the potential for carry over.

7.2 Other potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

8.0 Safety

8.1 Gloves and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.

8.2 The toxicity and carcinogenicity of the chemicals used in this method are not precisely defined. Each chemical and sample shall be treated as a potential health hazard, so care must be taken to prevent undue or extensive exposure.

8.3 For the ZHE to be acceptable for use, the piston within the ZHE should be able to be moved with approximately 15 psi or less. If it takes more pressure to move the piston, the O-rings in the device should be replaced.

8.4 The ZHE should be checked periodically for leaks. If the device contains a built-in pressure gauge, pressurize the device to 50 psi, allow it to stand unattended for 1 hour, and recheck the pressure. If the device does not have a built-in pressure gauge, pressurize the device to 50 psi, submerge it in water, and check for the presence of air bubbles escaping from any of the fittings. If pressure is lost, check all fittings and inspect and replace O-rings, if necessary. Retest the device.

8.5 All personnel performing this analysis shall be instructed in the use of personal protective equipment prior to beginning analysis.

9.0 Equipment and Supplies

9.1 Rotator apparatus capable of turning at 30 +/- 2 rpm (Lars Land or equivalent).

9.2 ZHE extraction devices (Lars Land or equivalent).

9.3 Pressure filtration apparatus (Millipore or equivalent).

9.4 Glass fiber (GF) filters 0.6-0.8 micron 11.0 cm. (Environmental Express, Cat. # FG75110MM or equivalent).

9.5 Glass fiber (GF) filters 0.6-0.8 micron: 15.0 cm. (Environmental Express, Cat. # FG75150MM or equivalent).

9.6 Fluid pump (FMI Lab Pump, Model QSY or equivalent).

9.7 Gas pressure/vacuum pump (Gast, Model DOA-P104-AA or equivalent).

9.8 250 mL and 500 mL beakers (Pyrex or equivalent).

9.9 Transfer line, 1/8”ID x 1/4”OD (Nalgene, 280 Pur-ester tubing)

9.10 Tedlar Bag

9.11 1000 ml Graduated cylinders, Class A (Kimble or equivalent).

9.12 100mL glass gas tight syringe (Hamilton 7000 series or equivalent).

9.13 40 mL VOA vials (C&G or equivalent).

9.14 Analytical balance (Ohaus, Voyager Pro or equivalent).

9.15 Top-loading balance (Mettler-Toledo, Model BD-202 or equivalent).

9.16 TCLP/SPLP prep log (see Tables 2 & 3).

Note: The interior surface of the ZHE (9.2) and the pressure filtration apparatus (9.3) should be smooth and free of scratches. Clean using only a very soft bristled brush if necessary. In addition, the screen on which the filter is placed should be clear of debris. If any of the holes are clogged they can be cleaned by sonicating for 15 minutes.

10.0 Regents and Materials

10.1 Reagent grade DI water, organic free (Millipore, 18 mega ohm quality).

10.2 Glacial Acetic Acid (CH3CH2OOH), ACS Grade (Fisher, Cat.# A38S-212 or equivalent).

10.3 Sodium Hydroxide (NaOH), pellets

10.3.1 Fisher, Cat.# S318-3 or equivalent.

10.3.2 10 N NaOH solution. Into a 1 liter volumetric flask, add 500 mL of DI water. Dissolve 400g of NaOH pellets (caution: mixture will become very hot). When cool, dilute to volume with D.I. H2O and mix well.

10.4 Extraction Fluids

10.4.1 TCLP extraction fluid #1: (To prepare a 20 liter quantity): Fill a 20 L carboy with 19 L of DI water. Add 114 mL CH3CH2OOH and 128.6 mL 10N NaOH. Dilute to 20 L With D.I. H_2O and mix by stirring. When correctly prepared, the pH of this fluid will be 4.93 +/- 0.05.

Note: This extraction fluid should be monitored frequently for impurities. The pH should be checked prior to use to ensure that the fluid is made up accurately. If impurities are found or the pH is not within the above specifications, the fluid shall be discarded and fresh extraction fluid prepared.

10.4.2 SPLP extraction fluid: Reagent DI water.

11.0 Sample Preservation and Storage

11.1 Preservatives shall not be added to samples before extraction.

11.2 Care shall be taken to minimize the loss of volatiles. Samples shall be collected and stored in a manner intended to prevent the loss of volatile analytes (e.g., samples should be collected in Teflon-lined septum capped vials and stored at 0-6ºC. Samples shall be opened only immediately prior to extraction. Extracts or portions of extracts for organic analyte determinations shall not be allowed to come into contact with the atmosphere (i.e., no headspace) to prevent losses.

11.3 Volatiles have 14 days from the date of collection to be extracted.

11.4 Volatiles have 14 days from the date of extraction to be analyzed.

12.0 Quality Control

12.1 This SOP is designed to follow a variety of different projects and programs requirements. Table 1 is designed to illustrate the control steps and provisions required to adequately producing acceptable data.

12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.3 Program Specific Limits: Samples analyzed under the guidance of certain programs; such as the Department of Defense Quality Systems Manual (DoD/QSM) require their own specified limits. For these samples follow the limits specified in the manuals for that program.

13.0 Calibration and Standardization

See SOP VO-004 (*Analysis of Volatile Organic Compounds by GC/MS 8260C*) for the appropriate analyses calibration.

14.0 Procedure

14.1 Determine sample % solids:

14.1.1 For solid samples which contain no free liquids, proceed to sec. 14.3.

14.1.2 For samples which are liquid, contain free liquids, or are multi-phasic, filtration or liquid/solid separation is required as follows:

14.1.2.1 Preweigh a GF filter and record the weight.

14.1.2.2 Preweigh a receiving beaker and record the weight.

14.1.2.3 Preweigh a transfer beaker and record the weight.

14.1.2.4 Assemble the pressure filtration device with the GF filter, and place the receiving beaker underneath.

14.1.2.5 Weigh out a subsample of the waste (100g minimum) and record the weight. An additional minimum 25g will be needed for the extraction. For low volume samples, consult your supervisor.

14.1.2.6 Transfer the waste to the filtration device and secure the top.

14.1.2.7 Re-weigh the empty transfer beaker and record the weight.

14.1.2.8 Slowly apply air pressure to the filtration device in 10 psi increments up to 50 psi or until air passes through the filter. Hold at each increment for 2 minutes before proceeding to the next higher increment.

Note: Some wastes, such as oily wastes and some paint wastes will contain material that appears to be a liquid. Even after applying pressure to 50 psi, this material may not filter. In this case, for the non-volatile extraction, the material in the filter holder is defined as the solid phase and is carried through the extraction procedure as a solid. However, since the volatile procedure requires utilizing the ZHE device to filter the sample following rotation, the ZHE filter may become plugged and filtration of the extract from the ZHE device may not be possible. Typically the % solids is predetermined in the preparation procedure for the non-volatile constituents.

14.1.2.9 Weigh the receiving beaker and record the weight.

14.1.2.10 The material in the filter holder is defined as the solid phase of the waste, and the material in the receiving beaker is defined as the liquid phase.

14.1.2.11 Determine and record the weight of the liquid phase.

14.1.1.12 Determine the weight of the solid phase by subtracting the weight of the liquid phase from the total weight of the waste.

14.1.1.13 Calculate the % solids as follows:

$$\% \text{ solids} = \frac{\text{weight of solid phase}}{\text{total weight of waste}} \times 100$$

14.2 Evaluation of % solids:

14.2.1 If the % solids are <0.5%, a fresh portion of the waste will be filtered through the ZHE device and collected into a Tedlar bag or 100 mL syringe. This filtrate will be defined as the TCLP extract. Proceed to sec.13.3, then 13.4.4

14.2.2 If the % solids are significantly >0.5%, proceed to section 14.3, then 14.4.1. or 14.4.2.

14.2.3 If the % solids are ≥0.5% or are very close, and it is noticed that the solid material is entrained in the filter, dry the filter at 80-120C until two successive weighings agree within +/- 1%. Determine the % dry solids. If the % dry solids are <0.5%, follow 14.2.1. If the % dry solids are >0.5%, see note below.

Note: There must be a significant level of % solids such that a minimum of 5-10g of solids can be generated for the extraction. This minimum amount of solids will yield 100-200 mL of extract.

14.3 ZHE device preparation:

14.3.1 Assemble the ZHE device as follows:

14.3.1.1 Place two O-rings on the piston.

14.3.1.2 Place an O-ring in the ZHE base.

14.3.1.3 Wet the O-rings of the piston and place the piston inside the ZHE body. Depress the piston into the ZHE body only far enough to allow room for the sample.

14.3.1.4 With the piston installed, place the ZHE body into the base.

14.3.1.5 Place an O-ring on the top of the ZHE body.

14.3.1.6 Place an 11.0 cm. GF filter between the two filter screens and set aside.

14.3.1.7 The ZHE device is now ready to receive a sample.

14.4 Adding sample to the ZHE device:

14.4.1 For samples that are 100% total solids:

14.4.1.1 Weigh out 25.0g of sample into a beaker or other suitable container and record the weight. If particle size reduction if required, chill the sample and reduction equipment to 4^0C to reduce the loss of volatile compounds. Proceed to chop, crush, or grind the sample to a minimum $1cm^2$ size. Minimize exposure to the atmosphere.

14.4.1.2 Transfer the waste material to the ZHE device and secure the top.

14.4.1.3 Attach the air line from the pressure pump to the lower valve. Open the upper and lower valves.

14.4.1.4 Slowly pressurize the ZHE device to 50 psi to force the piston to the top of the ZHE body, thereby removing any headspace. Remove the air line.

14.4.1.5 Determine the amount of extraction fluid to add follows: amount of fluid added = 20 x's the weight of the sample
14.4.1.6 Proceed to sec. 14.5

14.4.2 For samples >5% but <100% total solids:

14.4.2.1 Determine the amount of sample to add to the ZHE as follows:

$$\text{Weight of sample to use} = \frac{25}{\%\text{ total solids (sec. 14.1)}} \times 100$$

14.4.2.2 Proceed to sec. 14.4.3, using the amount of sample determined above.

14.4.3 For samples that are between 0.5% - 5% total solids:

14.4.3.1 Weigh a 500 mL beaker and record the weight.

14.4.3.2 Into the beaker, weigh out 500 g of sample and record the weight.

14.4.3.3 Transfer the waste to the ZHE device and secure the top.

14.4.3.4 Connect the air line to the lower valve. Open upper and lower valves.

14.4.3.5 Slowly pressurize the ZHE to expel any air. Close the top valve when liquid appears.

14.4.3.6 Pre-weigh a Tedlar bag and record the weight.

14.4.3.7 Slowly pressurize the ZHE to expel the liquid into the bag. Do not exceed 50 psi.

14.4.3.8 Close the valves. Remove the bag, weigh the bag and its contents, and record the weight.

14.4.3.9 Determine the amount of extraction fluid to add follows:

$$\text{weight of extraction fluid} = \frac{20 \times \text{weight of sample waste} \times \%\text{ solids}}{100}$$

Proceed to sec. 14.5

14.4.4 For samples that are <0.5% total solids:

14.4.4.1 The liquid portion of the waste, after filtration is defined as the TCLP extract. The ZHE device will be used to filter the sample.

14.4.4.2 Add an appropriate amount of sample to the ZHE device to complete the requested analyses.

14.4.4.3 Secure the top; connect the air line to the lower valve. Open upper and lower valves.

14.4.4.4 Slowly pressurize the ZHE to expel any air. Close the top valve when liquid appears.

14.4.4.5 Connect a 100 mL syringe or evacuated Tedlar bag to the top valve. Slowly pressurize the ZHE to force the liquid into the syringe or bag. Alternatively a transfer line can be connected to the outlet valve on the ZHE and the sample extract can be transferred directly into the VOA vial. If collecting the liquid with a syringe, carefully transfer, (after discarding the first 5 mL) with headspace, to 40 mL VOA vials. If using a bag, allow the liquid to flow into the bag until a sufficient quantity has been collected for analysis. Store the extract at 0-6^{0}C until analysis.

14.5 Adding extraction fluid to the ZHE device:

14.5.1 Transfer via a graduated cylinder the appropriate amount and type of extraction fluid to a 500 mL beaker.

14.5.2 Using the fluid pump, place the intake line into the beaker of extraction fluid. Turn on the pump, and allow the fluid to enter the pump. Stop the pump when the fluid appears at the end of the outlet line.

14.5.3 Connect the outlet line to the ZHE top valve. Turn on the pump, and allow the pump to charge the ZHE with the entire contents of the beaker. Stop the pump before any air reaches the ZHE. Close the top and bottom valves, and remove the inlet line. Manually rotate the ZHE device in an end over end fashion 2 or 3 times.

Note: While the ZHE is filling, check for fluid leaking out of the bottom valve. If this happens, stop the pump and use a different ZHE device with a fresh sample.

14.5.4 Attach the air line to the bottom valve. Open the top valve, and while holding a paper towel at the valve, slowly pressurize the ZHE to expel any remaining air. Close the valve at the first sign of fluid at the valve outlet.

14.5.5 With the air line still attached, re-pressurize the ZHE device to 10 psi. Check for leaks. The ZHE is now ready for the 18 +/- 2 hr. rotation. Proceed to sec. 14.6.

14.6 Extraction:

14.6.1 Secure the samples in the rotation apparatus.

14.6.2 Rotation time is 18 ± 2 hours at 30 ±2 rpm. A room temperature of 23 ±2°C shall be maintained during the extraction period. Begin rotating. Record the time, rotation rate, and room temperature in the Extraction Summary Logbook (Table 3).

14.6.3 Following the rotation period, record the end time of rotation and the room temperature. Proceed to sec 14.7 for filtering the extract.

14.7 Filtration following extraction:

14.7.1 Following the rotation period record the date, time, and temperature. Check the ZHE pressure gauge to ensure that the device did not leak. If pressure was not maintained, the sample must be re-extracted with a new portion of waste sample (Document in prep logbook).

14.7.2 If pressure has been maintained, the material in the ZHE device is separated into liquid and solid phases.

14.7.3 For samples with no initial liquid phase**:**

14.7.3.1 Attach the 100 mL gastight syringe to the ZHE outlet valve. Open the valve and carefully withdraw the extract into the syringe. Do not allow air bubbles into the syringe. Pressurizing the ZHE to 10 psi may help in withdrawing the extract. Alternatively, a transfer line can be connected to the outlet valve on the ZHE and the sample extract can be transferred directly into the VOA vial.

14.7.3.2 Discard the first 5 mL out of the syringe, and then transfer the remaining extract to 40 mL VOA vials (without headspace). Store at 0-6^{0}C until analysis.

14.7.4 For samples containing an initial liquid phase**:**

If an initial liquid phase was collected, determine if the ZHE liquid extract will mix with the initial liquid phase:

14.7.4.1 Using a transfer pipette and a small beaker, add a few drops of the liquid phase to a small quantity of DI water. Observe to see if the two liquids are miscible, or if they separate into layers.

14.7.4.2 If the two phases are miscible, combine the filtered extract with the initial liquid phase and analyze as one sample. Attach the Tedlar bag containing the initial liquid phase to the outlet valve of the ZHE device. Gradually apply pressure to the lower valve and slowly filter all of the extract into the Tedlar bag. Store at 0-6^{0}C until analysis.

14.7.4.3 If the two phases do not mix, the initial liquid phase and the filtered extract will need to be collected and analyzed separately. Collect all of the extract in a separate Tedlar bag.

14.8 Samples are now ready for analysis.

14.8.1 When the standard list and reporting limits are required the samples can be diluted at least 1:100 and still maintain the reporting limits. The dilution is recommended to reduce the amount of glacial acetic acid introduced into the GC/MS system in order to ensure a longer column lifetime. Samples can be analyzed undiluted but this greatly increases the peak for glacial acetic acid and will potentially shorten column lifetime and will increase the chances of background contamination.

14.8.2 Matrix spikes are prepared after extraction of the sample matrix and prior to analysis by Purge & Trap/GM-MS analysis.

14.8.3 Make sure all proper documentation was entered in the TCLP/SPLP Logbook (Table 3).

15.0 Calculations

15.1 Results are directly obtained from the analysis instrument in ug/L. If using the standard TCLP/SPLP list and reporting limits a dilution of 1:100 is typically perform. To obtain the final results calculate as follows:

$$\text{Results mg/L} = \frac{\text{Analytical result (ug/L) x DF}}{1000}$$

15.2 Calculate the results for multiphasic as follows:

$$\text{Final analyte concentration} = \frac{(V1)\,(C1) + (V2)\,(C2)}{V1 + V2}$$

V1 = volume of the first phase liquid
C1 = concentration of the first phase in mg/L
V2 = volume of the second phase liquid
C2 = concentration of the second phase in mg/L

15.3 See Procedure (14.0) for all other applicable calculations.

16.0 Method Performance

Certified standard solutions, properly maintained extraction equipment and instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies.

17.0 Pollution Prevention

See QAM Appendix 9

18.0 Data Assessment & Acceptance Criteria for QC Measures

18.1 If the initial analysis of a sample or a dilution of the sample has a concentration of a particular target analyte that exceeds the calibration range, the sample must be reanalyzed at a dilution that will keep compounds within the calibration range of the instrument.

18.2 Refer to the analysis method (SOP VO-004 : *Analysis of Volatile Organic Compounds by GC/MS8260C*) for additional analysis criteria.

19.0 Corrective Measures for Out-of-Control Data

See QAM Appendix 9

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

See QAM Appendix 9

21.0 Waste Management

See QAM Appendix 9

22.0 Equipment / Instrument Maintenance, Computer Hardware & Software & Troubleshooting

See QAM Appendix 9

23.0 References

23.1 Test Methods for Evaluating Solid Waste, EPA-SW-846. September, 1994. Method 1311.

23.2 Test Methods for Evaluating Solid Waste, EPA-SW-846. September, 1994. Method 1312.

23.3 CT Laboratories Quality Manual, current revision.

23.4 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.

23.5 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.1, January 2017 or most recent revision.

23.6 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.

23.7 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.

24.0 Tables

Table 1
Summary of Quality Control Requirements

Quality Control Item	Frequency	Acceptance Criteria	Corrective Action
ZHE Pressure	Pressure applied and set @ 10 psi for all samples and blanks	Pressure must be maintained throughout the extraction process (pressure may increase due to affect from sample matrices)	Do not proceed with analysis until extraction meets criteria. Document problem and re-prepare sample for extraction.
Sample Rotation	30 rpm for 18 hours for all samples and blanks	Rotation rate: 30 ± 2 rpm. Rotation time: 18 ± 2 hours	Do not proceed with analysis until extraction meets criteria. Document problem and re-prepare sample for extraction.
Method Blank (MB)	1 / 20 samples per matrix or at contact/ program specific frequencies. The MB is used to document contamination resulting in the analytical process and shall be carried through the complete sample preparation and analytical procedure.	1. Concentration of analytes of concern shall be less than the highest of either : *Reporting Limit or MDL *Five percent of the measured concentration in the sample. 2. ACOE/QSM: ≤ ½ RL 3. Less than program/project specified limits.	Reanalyze to determine if instrument or laboratory background contamination was the cause. If the method blank is still non-compliant, re-prepare and reanalyze blank and samples.* For ACOE/QSM data if less than ½ MRL no action required.* *If reanalysis of blank still contains contamination above specified limits, affected data shall be qualified (B)

Table 2

FPR2-01
ZHE (Volatiles) Extraction Vessel Usage Log

ZHE (Volatiles)

Usage # >>>>
Blank Analyzed

Vessel #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Date / Batch #
1																					/
2																					/
3																					/
4																					/
5																					/
6																					/
7																					/
8																					/

****After 20 uses the vessel must be used for a blank check**

Table 3

FPR2-02
TCLP/SPLP/ASTM Extraction Summary

TCLP/SPLP/ASTM Extraction Summary

Batch:________ Date:________ *Analyst (set up):________* *Analyst (take down):________*

Sample #	**Parameter**	**Test**			**Vessel / ZHE**	**Buffer Determination**			**Sample wt.**	****Free Liquids Present (Y/N)**	**Vol. Ext. Fluid**	**Initial pH**	**ZHE Initial Press**	**Time In**	**Date / Time Out**	**Ext. Time**	**End pH**	**ZHE End Press**	**Date / Time Filtered**	**Volume Filtered**
	(M / SV / V / WC)	TCLP	SPLP	ASTM	#	Initial pH	End pH	*Ext. Fluid	(g)		(mL)		(psi)			(hrs)		(psi)		(mL)
															/				/	
															/				/	
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**Extraction Fluid Used:___________* *Ext. Fluid ID #:___________* *Ext. Fluid pH:________* *Ext. Start Temp (°C):________*

Ext. End Temp(°C):__________ *(min:_______ / max:________)* *Filter Manufacturer:________________* *Filter Lot #:___________*

Balance:___________ *pH Meter:___________* 1N HCL:__________ *Tumbler Unit #(s):__________*

Acceptable rotation rate: 30 ±2 rpm *Verified Rotation rate: _______ rpm*

M=Metals, SV=Semi Volatiles, V=Volatiles, WC=Wet Chemistry

Table 4

FPR2-03
% Solids Calculation Worksheet

% Solids Calculation Worksheet

Tare weights (g) *Transfer weights (g)* *Separation weights (g)* *% Solids Calculations*

Sample #	A Filter wt.	B Filtrate Vessel wt.	C Transfer Vessel wt.	D Sample + Transfer Vessel	E Sample wt {D - C}	F Vessel wt. Post Transfer	G Residue wt. {F – C)	H Total Waste Amount {E – G}	I Filtrate Vessel + Filtrate	J Liquid Phase of Sample {I – B}	K Solid Phase of Sample {H – J}	L. % Solids (**) (K/H*100)	M Waste + Filter (Dry) wt. (g)	% Solids (Dry) ({M – A}/H)*100

(**) If Solids = <0.5%, treat filtrate as TCLP extract, if free liquid present use % Solids Calculation Worksheet

Revision Number	**Description of Changes**	**Date**
02	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/12/2014
03	Added section 14.8.2 as to when matrix spikes can be prepared for analysis. And updated the TCLP/SPLP/ASTM Extraction Summary form to include min/max temperatures (Table 3).	03/31/2016
3.1	Added QSM 5.1 reference.	03/16/2018

VO004 – CT Labs – Analysis of Volatile Organic Compounds by GC/MS (8260C)

CT LABORATORIES
delivering more than data from your environmental analyses

STANDARD OPERATING PROCEDURE

VO 004 Analysis of Volatile Organic Compounds by GC/MS (8260C)

Review Date: 01/3/2019

01/03/2019

Technical Review by: Date

Christelle Newsome

01/03/2019

Approved by: Quality Assurance Date

Table of Contents

1. SCOPE OF APPLICABILITY

1.1. This method is used to quantify Volatile Organic Compounds (VOCs) with boiling points below 200° Celsius (°C) in water and soils. See Table 1 for typical target analyte list (TAL). This method is designed to follow procedures and QC requirements found in EPA SW-846 method's EPA 624, 5030B, 5035, 8000C and 8260C in order to determine quantities of volatile organic compounds found in a variety of different sample.

1.2. The scan mode is utilized by the instrument's software to identify and quantitate analysis results. When collecting data in the full scan mode, a target range of mass fragments is determined and put into the instrument's method. An example of a typical broad range of mass fragments to monitor would be *m/z* 35 to *m/z* 300. The determination of what range to use is largely dictated by what one anticipates being in the sample while being cognizant of the solvent and other possible interferences. A MS should not be set to look for mass fragments too low or else one may detect air (found as *m/z* 28 due to nitrogen), carbon dioxide (*m/z* 44) or other possible interferences. Additionally if one is to use a large scan range then sensitivity of the instrument is decreased due to performing fewer scans per second since each scan will have to detect a wide range of mass fragments. Full scan is useful in determining unknown compounds in a sample. It provides more information than Selected Ion Monitoring (SIM) when it comes to confirming or resolving compounds in a sample. During instrument method development it may be common to first analyze test solutions in full scan mode to determine the retention time and the mass fragment fingerprint before moving to a SIM instrument method.

1.3. Volatile organic compounds are quantitated from a variety of matrices. This method is applicable to nearly all types of samples regardless of water content, including ground water, surface water, wastewater, soils, sediments, and TCLP/SPLP extracts; as well as, other matrices noted in SW-846 method 8260C.

1.4. Examples of other compounds which have been analyzed by this method include: iodomethane, 2,3-dichloro-1-propene, 1-chlorohexane, acrolein, acrylonitrile, 1,1,2-trichloro-1,2,2-trifluoroethane, ethyl ether, hexane, ethyl acetate, 1-chlorohexane, 2-Chloroethylvinyl ether, methyl acetate, methyl methacrylate, cyclohexane, and cyclohexanone. Ethanol, 2-propanol, tert-butylalcohol, 1,4-dioxane may also be analyzed using this method but are poor responders. To achieve lower detection limits for these types of compounds, the SIM mode can be utilized. In selected ion monitoring certain ion fragments are entered into the instrument method and only those mass fragments are detected by the mass spectrometer. The advantages of SIM are that the detection limit is lower since the instrument is only looking at a small number of fragments (e.g. three fragments) during each scan. More scans can take place each second. Since only a few mass fragments of interest are being monitored, matrix interferences are typically lower. To additionally confirm the likelihood of a potentially positive result, it is relatively important to be sure that the ion ratios of the various mass fragments are comparable to a known reference standard.

1.5. SW-846 method 8260C notes a number of other compounds amenable to this test.

2. SUMMARY OF METHOD

2.1. A Purge & Trap system (including autosampler), a Gas Chromatograph (GC), and a Mass Spectrometer (MS) are utilized for the detection of VOCs. The autosampler introduces the sample to the purge and trap concentrator. The concentrator then removes the volatile constituents by purging the sample with an inert gas (helium or nitrogen). The constituents are then collected onto an adsorption trap. The trap is then rapidly heated and the volatilized compounds are introduced to the GC. The GC is temperature programmed to facilitate separation of the individual organic compounds. Finally the separated compounds enter the MS (which is interfaced with the GC) for quantitative and qualitative analyses.

2.2. Utilizing computer software, identification of target analytes is accomplished by comparing the mass spectra of the sample constituent with that of commercially purchased standards. Quantitation is achieved by comparing the response of a quantitation ion relative to an internal standard using a five point (minimum) calibration curve.

3. DEFINITIONS

3.1. For definitions on all terms applicable to this method, see Section 25.1 of the Quality Assurance Manual (QAM).

3.2. For a list of common acronyms and abbreviations, see QAM.

4. HEALTH AND SAFETY

4.1. Gloves and protective clothing shall be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure must utilize appropriate laboratory safety systems.

4.2. The toxicity and carcinogenicity of the chemicals used in this method are not precisely defined. Each chemical and sample shall be treated as a potential health hazard, so care must be taken to prevent undue or extensive exposure.

5. INTERFERENCES

5.1. Volatile materials in the laboratory and impurities in the purging gas and sorbent trap can cause significant amounts of background contamination. Improper tubing such as certain plastics and rubber shall not be used. The analysis of IBs and MBs will indicate as to whether or not this type of contamination is present. Since subtraction on background contamination is not allowed, care must be taken to eliminate this type of contamination.

5.2. Carry over contamination is a problem when a highly contaminated sample is followed by a clean sample. Rinsing the autosampler and concentrator and adequate baking of the trap can greatly reduce contamination from carry over.

5.3. Some samples contain a lot of water soluble materials, suspended solids, compounds with high boiling points, or target analytes with very high concentrations which may contaminate some or all of the analytical system. Removing components of the system for cleaning or cleaning of the entire system may be required to eliminate the interferences.

5.4. Compounds with poor purging efficiencies may remain in the purge system, particularly with 25 ml purges. Ensuring adequate rinsing and increased line temperatures will help reduce this problem.

5.5. All chromatography gas/purge lines shall be stainless steel or copper to prevent permeation from possible background contaminants (i.e. Methylene chloride). Background levels of Methylene chloride are possible so care needs to be taken to reduce this possibility. Analyst clothing previously exposed to Methylene chloride must not be worn and isolating the instruments from possible air born contamination is essential in reducing Methylene chloride background contamination.

5.6. A trip blank normally accompanies sample in shipment and storage as a check on possible contamination from volatile organics by diffusion through the septum seal in sample vials/containers.

5.7. Mass spectrometer sensitivity, column degradation, and contamination can also contribute to background interferences. A proper maintenance procedure on instrumentation is essential to continually producing quality data. Maintenance manuals are provided with each piece of equipment and are essential for proper instrument care. The presence of semi-volatile hydrocarbons need also be taken into consideration, so appropriate post analysis bake out times need to be incorporated.

5.8. Cross-contamination can be a possibility when samples containing high concentrations of target analytes are stored in the same location as other samples. To prevent cross-contamination, samples suspected of containing high concentrations of volatiles organics should be isolated from other volatile organics samples. Storage Blanks are analyzed bi-weekly to determine whether cross-contamination has occurred.

6. EQUIPMENT AND SUPPLIES

6.1. 40 ml screw cap “VOA” vials-borosilicate glass with a Teflon faced silicone septum (C&G or equivalent)

6.2. 2 oz., 4 oz., or 60- ml Teflon lined screw top sample jars (C&G or equivalent).

6.3. 5 g or 25 g samplers for low level soils (Encore).

6.4. Top loading balance sensitive to 0.01 g (Mettler-Toledo, BD202).

6.5. pH paper to confirm water sample preservation(Color pHast, EM Reagents).

6.6. Stainless steel spatulas.

6.7. 10, 25, 50, 100, 500, and 1000 ul gas tight syringes for sample dilutions and standard preparation (Hamilton or equivalent).

6.8. 5.0, 10.0, 25.0, 50.0 ml syringes with luer-lok tips for methanol preserved soil sample preparation and sample dilutions (Hamilton/SGE or equivalents).

6.9. 10, 50 100, 200, 1000, and 2000 ml Volumetric flask for sample dilutions and standard preparation (Class A, Pyrex/Kimble or equivalents).

6.10. Auto pipetter – 2.5 to 25.0 ml – for dispensing methanol (Dispensette).

6.11. Sonicator used for methanol-preserved soil sample extraction (Fisher, FS-28 or equivalent).

6.12. Auto sampler used for sample introduction to the Purge and Trap (Archon, EST-Centurion or equivalents).

6.13. 3 ml standards vial (Mininert or equivalent).

6.14. Purge and Trap concentrator (EST-Encon Evolution or equivalent).

6.14.1. The glass purging tubes are of 5 ml or 25mL size. The all-glass purging device shall be designed to accept 5 or 25 ml samples with a water column at least 5 cm deep. The smaller (5 ml) purging device is recommended if the GC/MS system has adequate sensitivity to obtain the method detection limits required for a specific project or program.

6.14.2. The traps currently used are Supelco Type K or EST-EV1. As required by SW-846 methods, the trap must be at least 25 cm long and have an inside diameter of at least 0.105 inches. Starting from the inlet, the trap contains 1.0 cm of methyl silicone coated packing and the following amounts of adsorbents: 33% of 2,6-diphenylene oxide polymer, 33% of silica gel, and 33% of coconut charcoal.

6.15. Gas Chromatograph/Mass Spectrometer Data Systems (GC/MS).

6.15.1. Hewlett Packard Gas Chromatographs (5890 & 6890).

6.15.1.1. Columns, Supelco (SPB-624), Agilent (DB-624UI), or Zebron (ZB-624).

6.15.1.2. 30 Meter x 0.25 mm ID, 1.4 um film thickness or equivalents.

6.15.2. Hewlett Packard 5972 & 5973 Mass Spectrometers.

6.15.3. Hewlett Packard Chemstation Data Management System (version G1701AA v. A.03.02 for the 5972's) and MSD Chemstation (version D.01.02.16.15 for the 5973) with Enviroquant and Prolab data processing software.

7. REAGENTS AND STANDARDS

7.1. Purge and trap grade methanol: (Fisher, Purge & Trap grade or equivalent), stored in laboratory warehouse.

7.2. Reagent grade water, organic free (Milipore, 18 mega ohm quality).

7.3. Certified Calibration Standards:

7.3.1. (VOC Mix--2000 ug/ml, Ultra Scientific--#DWM-588; Addition mixes--1000/10,000 ug/ml, SPEX Certiprep--#'s VO-CTWI-4 & VO-CTWI-5 or equivalents), stored in VOC Standards Freezer in Volatiles laboratory at ≤ -10 °C.

7.3.2. A 100 ug/mL[1] Continuing Calibration Verification (CCV/Calib.) working standard is prepared by adding 150 ul of the VOC mix and 300 ul of

---

Addition mix VO-CTWI-4 and 300 ul of Additions Mix VO-CTWI-5 to 2250 ul of methanol into a 3 ml Mininert vial.

7.3.3. Calibration standards used for SIM mode calibrations can be prepared by further dilution of the working standards (7.3.2) or by purchasing individual compound standards (ea. 1000 ug/mL 1,4-dioxane, SPEX Certiprep--#S175 or equivalent). For t-butyl alcohol and 1,2-dioxane the working CCV/Calib. standard concentration is 100 ug/ml.

7.4. Certified Calibration Check Standards:

7.4.1. (VOC Mix--2000 ug/ml, Accustandard--#M-502-10X; Addition mixes--1000/10,000 ug/ml, SPEX Certiprep--#'s VO-CTWI-4 & VO-CTWI-5 or equivalents), stored in VOC Standards Freezer in Volatiles laboratory at ≤ -10 °C.

7.4.2. A 100 ug/mL[1] Initial Calibration Verification (ICV/Spiking) working standard is prepared by adding 150 ul of the VOC mix and 300 ul of Addition mix VO-CTWI-4 and 300 ul of Additions Mix VO-CTWI-5 to 2250 ul of methanol into a 3 ml Mininert vial. The ICV standard is prepared from standards of a different manufacturer or different lot than the standards used for calibration.

7.4.3. ICV standards used for SIM mode calibrations can be prepared by further dilution of the working standards (7.4.2) or by purchasing individual standards (e.q. 1000 ug/mL 1,4-dioxane, SPEX Certiprep--#S175 or equivalent). For t-butyl alcohol and 1,2-dioxane the working ICV/Spiking standard concentration is 100 ug/ml.

7.5. Certified Internal Standards (ISTD) and Surrogate Standards (SSTD):

7.5.1. ISTD/SSTD Mix (2500µg/mL): Ultra Scientific catalog # STM-540 or equivalent, stored in the Volatiles Standards Freeze at ≤ 10°C.

7.5.2. SSTD [2] 1,2-Dichlorobenzene-d_4 (2000µg/mL): Ultra Scientific catalog # STS-210 or equivalent, stored in the Volatiles Standards Freezer at ≤ 10°C.

7.5.3. A 20µg/mL ISTD/SSTD Working Standard is prepared by adding 200µL of ISTD/STD Mix and 250µL of SSTD 1,2-Dichlorobenzene-d_4 to 25mL of MeOH.

7.6. Certified Internal Standards (alternative to section 7.5 and used only with the Archon autosamplers):

7.6.1. (ISTD Mix--2500 ug/ml, Restek--#30241 or equivalent), stored in VOC Standards Freezer in Volatiles laboratory at ≤ -10 °C.

7.6.2. An 80 ug/ml ISTD working standard is prepared by adding 320 ul of the ISTD mix to a 10 ml volumetric flask and brought to volume with methanol.

7.7. Certified Surrogate Standards (alternative to section 7.5 and used only with the Archon autosamplers currently not in use for 8260 analyses):

7.8.

7.8.1. (SSTD Mix—2500 ug/ml, Restek--#30240; 1,2-DCA-d_4 --2000 ug/ml, Ultra Scientific--#STS210, or equivalents[2]), stored in VOC Standards Freezer in Volatiles laboratory at ≤ -10 °C.

7.8.2. A 100 ug/ml SSTD working standard is prepared by adding 120 ul of the SSTD mix and 150 ul of 1, 2-DCA-d_4 to 2730 ul of methanol in a 3 ml mininert vial.

7.8.3. An 80 ug/ml ISTD/SSTD working standard is prepared by adding 320 ul of the ISTD Mix (sec. 10.5), 320 ul of the SSTD Mix (sec. 10.6), and 400 ul of 1,2-DCA-d_4 (sec. 10.6) to a 10 ml volumetric flask and brought to volume with methanol.

7.8.4. A 16 ug/ml ISTD/SSTD working standard is prepared by adding 2 ml of the 80 ug/ml ISTD/SSTD (sec. 10.6.2) to a 10 ml volumetric flask and brought to volume with methanol.

7.9. Certified Tuning Standard:

7.9.1. 4- bromofluorobenzene {BFB} (Ultra Scientific—2000 ug/ml, #STS-110N or equivalent), stored in VOC Standards Freezer in Volatiles laboratory at ≤ -10 °C.

7.9.2. A 50 ug/ml working standard is prepared by adding 75 ul of the certified standard to 2925 ul of methanol in a 3 ml mininert vial.

7.10. Sodium bisulfate (JT Baker--#3534-01 or equivalent), stored in cabinet in Volatiles laboratory.

7.11. All certified stock standards use the expiration date provided by the manufacturer/supplier.

7.11.1. The working standards (not including gases) expire one month after preparation. These standards include the BFB, ISTD, SSTD, and/or ISTD/SSTD.

7.11.2. The working standards (which include gases) expire one week after preparation. These standards include the ICV and CCV. When standards used for calibration are prepared from freshly open stock standard vials, the expiration of working standards used from that point on can be extended if the integrity of those standards can be confirmed and documented. For example, if a CCV/ICV standard continues to produce acceptable results after one week from preparation, it can be assumed still valid.

[1] Due to lower response or purging efficiencies, a number of compounds are purchased and prepared at concentrations greater than 100 ug/ml. Those compounds and concentrations are noted on the calibration curve.

[2] This surrogate compound is needed for Method 524.2 and is not used for this method/SOP.

8. Sample Handling and Preservation.

8.1. Water samples are stored at 0-6°C. The sample storage area must be free of organic solvent vapors and direct or intense light. Samples are stored in the Volatiles lab in a double door refrigerator (separate from analytical standards).

8.1.1. Analyze properly preserved samples (pH <2) samples within 14 days of collection. Samples not analyzed within this period must be discarded and recollected. If samples are not preserved then they must be noted (or qualified) as improperly preserved if not analyzed within 7 days.

8.1.2. Samples analyzed for Acrolein and Acrylonitrile are to be preserved at a pH of 4-5 and analyzed within 14 days (3 days if unpreserved).

8.1.3. If reactive compounds such as 2-Chloroethyl vinyl ether are target compounds than no preservatives are added and the sample needs to be analyzed as soon as possible.

8.1.4. Samples containing residual chlorine require alternative preservation (ascorbic acid or sodium thiosulfate) to reduce the chlorine. These sample shall be reduced to a pH of <2 (using HCL or $NaHSO_4$) to meet the 14 day is the hold time.

8.2. Soil samples are stored at 0-6° C. The sample storage area must be free of organic solvent vapors and direct or intense light. Samples are stored in a double door refrigerator located in the laboratory warehouse.

8.2.1. Samples received for low level analysis in "Encore" samplers must be preserved within 48 hours from time of collection. To preserve a sample, weigh it into a 40 ml VOA vial, record the weight, and then add 0.2 grams of sodium bisulfate per 1.0 gram of sample. Finally add 5.0 ml of DI H2O and a stir bar. Analyze all samples within 14 days of collection. Samples not analyzed within this period must be discarded and recollected.

8.2.2. Samples received for low level analysis in "Terra Core" sampler vials are already preserved with bisulfate at 0.1 g per 1.0 gram of sample. Samples that are received for low level analysis in DI water are placed in a freezer at ≤-10° C. The pre-weighed vial weight (tare weight which includes the weight of vial + 5 ml of preservative/DI water & a stir bar) is subtracted from the total weight of the vial to determine sample weight. Analyze all samples within 14 days of collection. Samples not analyzed within this period must be discarded and recollected.

8.2.3. Samples received in filled 2 oz. or 4 oz. jars can be weighed and prepared for low level analysis as described in section 11.2.1. or they can be weighed into a VOA vial and preserved at a 1:1 ratio with methanol for medium/high- level analysis. Analyze all samples within 14 days of collection. Samples not analyzed within this period must be discarded and recollected.

8.2.4. Samples collected and preserved with methanol in the field in pre-weighed 60-ml jars are weighed as is. The pre-weighed jar weight, as well as the methanol weight (19.8 grams for 25 ml of methanol) is subtracted from the total weight of the jar to determine sample weight. For Wisconsin LUST samples if the weight to volume ratio is more than 1:1 then methanol is added using the auto-pipetter to correct the ratio to 1:1. Unless instructed by the client to do otherwise, the maximum acceptable weight for volume correction is 35 grams. If samples are being analyzed for the Wisconsin LUST program then the hold time is 21 days from collection. Otherwise hold time is 14 days.

8.2.5. Samples collected and preserved in the field using "Terra Core" sample vials are weighed as is. The pre-weighed jar weight (tare weight which includes weight of the vial + MeOH) is subtracted from the total weight of the vial to determine sample weight. Unless instructed to do so samples are not adjusted for volume to weight differences. Analyze sample within 14 days from collection.

8.2.6. All soil samples are weighed on the top loading balance which is connected to a computer so that all weights can be automatically entered onto an Excel spread sheet. The Excel spreadsheet is set up to record the weights as well as calculate the methanol to weight differences. The spreadsheets are saved so the data can be transferred electronically to the LIMS system. See forms FVO4-(2-7) for examples of the sample weight spreadsheets.

8.2.7. Each prepared methanol soil sample is then placed on a shaker table for 2 minutes and then sonicated for 20 minutes prior to preparation for analysis.

8.3. Most samples received are accompanied with a Trip Blank (TB). In most cases the TBs are prepared by the lab and are sent along with the vials used for sample collection. The intent of the TB is to accompany the sample vials through all collection, preservation, shipping, and storage procedures. The infusion of outside contamination in the TB is not common, but can be an indicator of incorrect preparation/sampling procedures or inadequate sample storage.

9. PROCEDURE

9.1. Prior to sample analysis a GC/MS tune and calibration check must be analyzed. Verify the MS tune and initial calibration at the beginning of each 12-hour work shift during which analyses are performed.

9.1.1. Introduce into the GC (by direct injection) 25 to 50 ng of BFB and acquire a mass spectrum that includes data for m/z 35-260. If the spectrum does not meet all criteria, the MS must be retuned and adjusted to meet all criteria before proceeding with the continuing calibration check.

9.1.2. The calibration curve integrity for each analyte must be confirmed with the use of a CCV standard once every 12 hours of analysis time. The CCV standard is prepared at concentrations near the midpoint of the calibration curves (10/100 ug/L for water-5 ml purge, 4.0/40 ug/L for water-25 ml purge, 0.010/0.10 mg/kg for low level soils, and 0.50/5.0 mg/kg for MeOH preserved soils). WI DNR. work requires a 2nd CCV (CCV2)/20 samples for those compounds using quadratic fit for calculating results (usually above the inflection point at 30 ppb). A typical sequence schedule for WI samples includes the 1st CCV @ 10 ppb and a 2nd CCV @ 30 ppb. QSM recommends the CCV's to be varied throughout an analytical run. Typically the concentrations used are 10, 20, and 30 ppb for Low Level soil and water-5 ml purged; 0.5, 1.0 1.5 mg/kg for MeOH preserved soil; and 1.0, 2.0, and 4.0 ppb for water-25 ml purged (preparation procedures are the same as listed 14.1.3, using the appropriate amount of the 100/1000 ug/ml CCV Std).

9.1.3. QSM 5.0/5.1 states a CCV must be analyzed at the beginning of the sequence, every 12 hours, and at the end of each analytical batch. The criteria for the ending CCV is all targets analytes within 50%. If a compound in the ending CCV fails, then 2 additional CCV's may be analyzed within a 60 minute timeframe. If both CCV's have acceptable recoveries, then the data can be reported without qualification.

9.1.4. The CCV is placed on the autosampler in the same manner as the samples (sec. 14.2.3). Preparation of CCV's is as follows:

9.1.4.1. **Water (5 ml purge)** -- Spike 50 ml of DI water (volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer to a VOA vial for analysis.

9.1.4.2. **Water (25 ml purge)** -- Spike 50 ml of DI water (volumetric flask) with 2.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer into a VOA vial for analysis.

9.1.4.3. **Low-level Soils** -- Spike 50 ml of DI water(volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer 5.0 ml into a VOA vial (containing and a stir bar) for analysis. As an alternative, prepare a 10.0/100 ug/ml working standard, then add 5.0 ul of this to 5.0 ml of DI water and transfer into a VOA vial (containing and a stir bar) for analysis.

9.1.4.4. **Med/high-level soils --** Spike 49 ml of DI water (volumetric flask) with 1.0 ml of MeOH and 5.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer into a VOA vial for analysis.

9.1.5. Each of the most common target compounds in the CCV should meet the minimum RFs as noted in Table 4. This is the same check that is applied during the initial calibration (sec. 13.4). If the minimum RFs are not met, the system must be evaluated, and corrective action must be taken before sample analysis begins.

9.1.6. All target compounds of interest must be evaluated using a 20% variability criterion. Use percent deviation when performing the ARF model calibration. Use percent drift when calibrating using a regression fit model. If the percent difference or percent drift for a compound is less than or equal to 20%, then the initial calibration for that compound is assumed to be valid. Due to the large number of compounds that are analyzed by this method, it is expected that some compounds will fail to meet the criterion. In cases where compounds fail, they can still be reported as non-detects if it can be demonstrated that there was adequate sensitivity to detect the compound at the applicable quantitation limit. For situations where the failed compound is present, the concentrations must be reported as estimated values.

9.1.7. The internal standard responses and retention times in the CCV standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 seconds from the last check calibration (12 hours), the chromatographic system must be inspected for malfunctions and corrections must be made, as required. If the EICP area for any of the internal standards changes by a more than a factor of two (-50% to +100%), when compared to the average from the calibration, then the mass spectrometer must be inspected for malfunctions and corrections must be made. Reanalysis of CCV's and associated samples while the system was malfunctioning is necessary.

9.1.8. Samples can be directly injected after the successful analysis of the initial calibration curve, ICV, BFB, and CCV. There can be up to 20 samples in an analytical batch. A MS/MSD and LCS must be analyzed with every analytical batch. Recoveries shall be compared to laboratory generated QC limits or client specified limits for all surrogate, MS/MSD and LCS injections.

9.2. Sample Introduction and Purging.

9.2.1. BFB tuning criteria and daily GC/MS calibration criteria must be met before analyzing samples. Currently 18-25 (depending on the temperature program used) purged samples including QC can be analyzed within 12 hours of the BFB injection. The Archon or the Centurion autosampler can be programmed to accommodate the number of samples needed per analytical shift.

9.2.2. After the continuing calibration is verified, the system must be proven to be free of contamination by analyzing a MB. The MB shall not contain detects above the detection limits for any given compound. Some programs allow detects up to but not exceeding one half the MRL. If the MB contains detects above the detection limits or RL's, then corrective actions must be performed to ensure the system is free from contamination; all affected samples shall also reanalyzed. The MBs are also placed on the autosampler in the same manner as the samples. For QSM, 5.0 common contaminants must not be detected above the LOQ.

9.2.3. Analysis of samples begins by allowing the sample to come to ambient temperature prior to analysis. The VOA vials containing the water samples are placed on the autosampler where a 5.0 to 25.0 ml aliquot is withdrawn from the vial and added into the appropriate purge vessel. The same procedure is followed for methanol preserved soils (1.0 ml of soil extract/49.0 ml DI H2O is prepared and added into a 40 ml VOA vial prior to adding the samples to the autosampler). Low level soils are prepared by adding the VOA vial containing a magnetic stir bar and ≈5 g sample/5.0 ml DI H2O to the autosampler (2-5 grams of sample is required for low-level analysis). The autosampler then adds an additional 5.0-mL of H2O containing the ISTD/SSTD mixture. The sample is heated to 40°C and purged in the VOA vial while being stirred, and the volatiles are collected onto the trap.

9.2.3.1. The ISTD/SSTD is added automatically by the Archon or the Centurion autosampler as the sample is transferred from the 40 ml sample vial to the sparge tube; the exception is for low level soils as noted above.

9.2.3.2. The sample is purged for 11 minutes at 32°C for waters and MeOH-preserved soils and 40°C for low-level soils using helium or nitrogen with a flow of 35-40 ml/min.

9.2.3.3. During the 11-minute purge time, the purge able volatile organics are adsorbed onto the Supelco Carbosieve K trap.

9.2.3.4. During desorption the trapped materials are rapidly heated while back-flushing the trap with helium or nitrogen at 35-40 ml/min. for 1 minute at 260°C and introduced in the GC/MS. After the valve to the GC is closed the trap is then baked and back flushed with helium for ≈8 minutes at 265°C.

9.2.3.5. The GC is temperature programmed at 32°C for 2.5 minutes, then ramped to 165°C at 10°C/min, and finally ramped to 220°C at 15°C/min. The column flow is set at 1 ml/min. constant flow using helium as the carrier gas.
The transfer line to the MS is maintained at 250°C and the ion source is maintained at ≈260°C while under constant vacuum. The GC injector is set at 200°C.

Note: Samples suspected of containing high levels of contamination or samples with known historical data may need to be diluted prior to analysis. Multiple dilutions may be needed to cover the entire working range of the current calibration

9.2.4. For each sample batch a MS, MSD, and LCS is prepared and analyzed. The concentrations for water spikes are 10.0/100 ug/L for 5 ml purge and 4.0/40.0 ug/L for 25 ml purge. The spiked concentrations for soil samples are ≈0.010/0.10 mg/kg for low level and ≈0.50/5.0 mg/kg for MeOH preserved depending on sample weights and percent solids. One exception is for the analysis of samples with low sample volume. These samples may be analyzed with a LCS and a LCSD upon client request. All spikes are transferred into 40 ml VOA vials and added to the autosampler. The spike concentrations may vary depending on program/project specific criteria, but the preparation volumes are constant and only the spiking amount changes. 14.2.4.1 lists examples of spike preparation based on the concentrations above.

9.2.4.1. The preparation of the matrix spikes is performed as follows:

9.2.4.1.1. **Water (5 ml purge)**--Spike 40 ml of sample with 4.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer to a VOA vial for analysis. As an alternative the sample VOA vial may be spiked with 4.2 ul of the 100/1000 ug/ml CCV standard. When adequate sample amounts are not provided, one 40 ml aliquot of sample is spiked and split into two separate VOA vials containing 15 ml glass inserts.

9.2.4.1.2. **Water (25 ml purge)**-- Spike 50 ml of sample with 2.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer into a VOA vial for analysis. Alternatively, A MS/MSD can be prepared by spike ~1.6 ul of the 100/1000 ug/ml CCV standard directly into the sample vial. The sample is then inverted three times and then placed on the autosampler for analysis.

9.2.4.1.3. **Low-level Soils**--Spike 50 ml of DI water(volumetric flask) with 5.0 ul of the 100/100 ug/ml CCV standard, invert three times and transfer 5.0 ml into a VOA vial containing ≈5 g of sample and a stir bar for analysis. As an alternative, prepare a 10.0/100 ug/ml working standard, then add 5.0 ul of this to 5.0 ml of DI water and transfer into a VOA vial containing ≈5 g of sample and a stir bar for analysis.

9.2.4.1.4. **Med/high-level soils--**Spike ≈10 g of sample contained in a VOA vial with 50 ul of the 100/1000 ug/ml CCV standard. Add 9.95 ml of methanol to the spiked sample and sonicate for 20 minutes. Add 1.0 ml of methanol extract to 49.0 ml DI water in a 50 ml syringe and then transfer into a VOA vial for analysis. For samples that are MeOH preserved in the field, take 1.0 mL of sample into 49 mL of DI water and add 5.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer to a VOA vial for analysis.

9.2.4.2. The preparation of a LCS is performed as follows:

9.2.4.2.1. **Water (5 ml purge)**--Spike 50 ml of DI water (volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer to a VOA vial for analysis. The LCS and the CCV may be run as a single analysis.

9.2.4.2.2. **Water (25 ml purge)**-- Spike 50 ml of DI water (volumetric flask) with 2.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer into a VOA vial for analysis. The LCS and the CCV may be run as a single analysis.

9.2.4.2.3. **Low-level Soils**--Spike 50 ml of DI water(volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV standard, invert three times and transfer 5.0 ml into a VOA vial containing 5 g of control and a stir bar for analysis. As an alternative, prepare a 10.0/100 ug/ml working standard, then add 5.0 ul of this to 5.0 ml of DI water and transfer into a VOA vial containing 5 g of control sand and a stir bar for analysis.

9.2.4.2.4. **Med/high-level soils--**Spike 10 g of control sand contained in a VOA vial with 50 ul of the 100/1000 ug/ml CCV standard. Add 9.95 ml of methanol to the spiked sand and sonicate for 20 minutes. Add 1.0 ml of methanol extract to 49.0 ml DI water in a

50 ml syringe and then transfer into a VOA vial for analysis.

9.2.5. The data is collected by the Chemstation software using the RFs (or linear/second order regressions when necessary), and results are calculated using the internal standard method of quantitation. Response factors for each detected compound are compared with that obtained in calibration, and based on those comparisons, results are generated. Software manuals define the procedures for creating and understanding a specific method (Understanding Your Chemstation, Hewlett Packard, G2070-90100, October, 1994, Environmental Forms Software, Hewlett Packard, G1032-90021, November, 1992, and Productivity Enhancement Software for HP Chemstation, Prolab Resources Inc., XMS01A-002, Rev. G, 2001).

10. CALCULATIONS, DATA ANALYSIS AND REDUCTION.

10.1. The Chemstation software (using response factors) calculates the initial concentration (or raw result) of target compounds as follows:

10.1.1. **Liquids**

$$\text{Initial Concentration (ug/L)} = \frac{A_x \times I_{is}}{A_{is} \times RF}$$

Where:
A_X = Area of characteristic ion for compound being measured in the sample.
I_{IS} = Amount of internal standard injected (ug/L). Typical concentrations used are 20.0 ug/L for 5.0 ml purge, and 4.0 ug/L for 25.0 ml purge
A_{IS}= Area of characteristic ion for the internal standard.
RF = Response factor for compound being measured.

10.1.2. **Solids**

$$\text{Initial Concentration (ug/L)} = \frac{A_x \times I_{is}}{A_{is} \times RF}$$

Where:
A_X = Area of characteristic ion for compound being measured in the sample.
I_{IS} = Amount of internal standard injected (ug/L). Typical concentrations used are 20.0 ug/L for 5.0 ml purge, and 4.0 ug/L for 25.0 ml purge
A_{IS}= Area of characteristic ion for the internal standard.

RF = Response factor for compound being measured.

10.2. The Chemstation software (using linear regression) calculates the initial concentration of target compound as follows:

Response Ratio = slope * amount ratio + intercept
Where: Response Ration = response of target compound/response of associated ISTD.
Amount Ratio = target compound concentration/associated ISTD concentration.

Example: $Tr / ISr = m * Tc / ISc + b$

Where: Tr = response of target compound
ISr = Internal Standard Response
M = slope of the curve (for the target compound)
ISc = Internal Standard Concentration
Tc = Target compound concentration
B = y-intercept of the curve (for the target compound)

<u>Solve for "Tc"</u>

10.3. The initial concentration results are then transferred to the laboratory's LIMS system where the final concentrations are calculated.

10.3.1. The final concentration for water samples is calculated as follows:

Final Concentration (ug/L) = Initial concentration x Dilution Factor

10.3.2. The final concentrations for low-level and med/high-level soils are calculated by the following equation:

Final concentration (mg/kg) =

$$\frac{\text{Initial concentration} \times \text{Sample Volume} \times \text{Dilution factor}}{\text{Sample weight} \times \%\ \text{solids}}$$

Where:
<u>Sample volume</u> = 5.0 mL for low –level soils, or volume of MeOH used for med/high-level soils preservation.
<u>Sample weight</u> = grams of sample in VOA vial for low level soils, or total grams of sample preserved for med/high-level soils.
<u>% Solids</u> = fraction equivalent (e.g. 97.1% = 0.971)

10.4. The spike percent recoveries (%R) and relative percent differences (RPD) are calculated in LIMS as follows:

10.4.1. Liquids – Concentration of spike added:

$$\text{ug/L} = \frac{\text{mL of spike added x concentration of spiking standard}}{\text{mL of sample (or DI } H_2O\text{) spiked}} \times 100$$

10.4.2. Solids – Concentration of spike added:

$$\text{mg/kg} = \frac{\text{mL of spike added x concentration of spiking standard}}{\text{grams of sample (or control sand) spiked}}$$

10.4.3. Final Calculations:

$$\text{MS/MSD \%R} = \frac{\text{Concentration of spike obtained - concentration of sample obtained}}{\text{Concentration of spike added}} \times 100$$

$$\text{MS/MSD RPD} = \frac{[\text{Concentration MS – Concentration MSD}]}{(\{\text{Concentration MS + concentration MSD}\}/2)} \times 100$$

$$\text{*LCS \% R} = \frac{\text{Concentration of Spike obtained}}{\text{Concentration of Spike added}} \times 100$$

Notes:

--Concentrations (conc.) of samples, MS/MSD, and LCS spikes are obtained directly from calibration curve.
--Soil spike concentrations and recoveries are calculated on a dry weight basis.
-- [ ] Signifies absolute values
--* Equation can also be used to calculate surrogate recoveries

11. Calibration and Standardization

11.1. To facilitate appropriate separation and provide adequate sensitivity, the entire operating system must be correctly set up and maintained before calibration and analyses can occur. Proper settings and programming of the GC/MS volatile system greatly increase the likelihood that calibrations will be acceptable. Generating and reproducing results will also be affected favorably in a well-maintained system.

11.1.1. The following tables provide instrument settings for the daily use of the Archon/Encon or Centurion/ Encon Purge and Trap Systems. Any modifications are noted in the specific instrument's maintenance log:

PARAMETER SETTINGS FOR ENCON EVOLUTION	
Trap Ready Temp.	≈35° C
Mort Ready Temp.	≈39° C
Purge Flow	40 ml/minute
Purge Time	11.00 minutes
Dry Purge Time	2.00 minutes
Desorb Preheat	255° C
Desorb Temp.	1.00 minutes at 260 ° C
Trap Bake Temp.	265° C
MoRT Bake Temp.	235 ° C
Bake Flow Rate	45 ml/minute
Gas	Helium or Nitrogen
Sample Purge Temp.	32 ° C
Sample Bake Temp.	75-90 ° C
Valve and Line Temp.	150 ° C

11.1.2. An example of the GC temperature program for the SPB/DB/ZB-624 columns used for the analysis of samples is as follows:

Start temp °C	End temp °C	Rate °C/minute	Time minutes
32	32	0.0	2.5
32	165	10.0	0.00
165	220	15.0	1.00

11.1.3. The injector is a split/split less injector operated in split mode ranging from 1:10 to 1:60. The injector temperature is 200 °C.

11.1.4. The MS detector parameters are subject to change to achieve optimum chromatography. See instrument maintenance logbook for recent changes regarding source maintenance, as well as filament and multiplier replacements. Current tune values and EM voltage settings are documented and can be found in the appropriate instrument's tuning logbook.

11.1.5. 4-Bromofluorobenzene (BFB) Standard:

11.1.5.1. A standard solution containing 50 ug/ml is used for the daily tune check. The BFB is directly injected onto the column in 25 to 50 ng injections (0.5 to 1.0 ul).

11.1.5.2. The GC/MS system tune must be verified at the beginning of any calibration or a sequence run and verified every 12 hours thereafter. The tuning compound is BFB which is injected directly onto the GC column The software is set up to check the tune by using the mean of three scans across the apex. Background subtraction is performed using a single scan no more than 20 scans prior to the elution of BFB. Manual scans can be checked by taking an average of scans across the BFB peak. The tuning acceptance criteria are listed below (m/z range 35-260):

Mass (m/z)	Abundance criteria
50	15 to 40% of mass 95.
75	30 to 60% of mass 95.
95	Base Peak, 100% Relative Abundance
96	5 to 9% of mass 95.
173	<2% of mass 174.
174	>50% of mass 95.
175	5 to 9% of mass 174.
176	>95% but <101% of mass 174.
177	5 to 9% of mass 176.

11.1.6. The preparation of working standards is routinely performed each week unless integrity is shown to be intact. All standards are assigned a unique identification number and preparations are documented in a Standards Logbook.

11.1.6.1. Calibration Standards - Calibration standards are prepared at a minimum of five concentration levels (in most instances, eight levels are currently used) and are prepared from the working standard dilutions of stock standards. One of the concentration levels shall be at a concentration near, but above, the detection limit and at or below the reporting limit. The remaining concentration levels shall correspond to the expected range of concentrations found in real samples and shall contain each analyte for detection by this method. For low-level soil calibrations, sodium bisulfate is added at a 0.2 g/1.0 g sample to the water to match sample matrix /acidity if the samples were collected and preserved with sodium bisulfate. Med/high-level soil calibrations have MeOH added at a 0.1 ml/5.0 ml H_2O to match sample matrix/preservation. All final concentrations are brought to volume with DI water. The following tables outline the preparation calibration curves for water and soil samples (all calibration standards are transferred into 40 ml VOA vials for placement on the auto sampler):

1) Waters Curve (5.0 ml Purge)

Concentration (ug/L)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	Final Volume (ml) (Volumetric flask)
0.5	1.0	200
2.0	2.0	100
5.0	5.0	100
10.0	10.0	100
20.0	20.0	100
30.0	30.0	100
40.0	40.0	100
80.0	80.0	100

2) Waters Curve (25.0 ml Purge)

Concentration (ug/L)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	Final Volume (ml) (Volumetric flask)
0.1	0.5	500
0.5	1.0	200
1.0	1.0	100
2.0	2.0	100
4.0	4.0	100
6.0	6.0	100
8.0	8.0	100
16.0	16.0	100

3) Low Level Soils Curve

Concentration (mg/kg)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	Grams of sodium bisulfate added (if needed)	Final Volume (ml) (Volumetric flask)
0.001	1.0	1.0	100
0.002	2.0	1.0	100
0.005	5.0	1.0	100
0.010	10.0	1.0	100
0.020	20.0	1.0	100
0.030	30.0	1.0	100
0.040	40.0	1.0	100
0.080	80.0	1.0	100

4) Medium/High Soils Curve

Concentration (mg/kg)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	ul of MeOH added	Final Volume (ml) (Volumetric flask)
0.050	1.0	999	100
0.100	2.0	998	100
0.250	5.0	995	100
0.500	10.0	990	100
1.000	20.0	980	100
1.500	30.0	970	100
2.000	40.0	960	100
4.000	80.0	920	100

5) Waters Curve (5.0 ml Purge-SIM)

Concentration (ug/L)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	Final Volume (ml) (Volumetric flask)
1.0	1.0	100
2.0	2.0	100
5.0	5.0	100
10.0	10.0	100
20.0	20.0	100
40.0	40.0	100
80.0	80.0	100

6) Medium/High Soils Curve (SIM)

Concentration (mg/kg)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	ul of MeOH added	Final Volume (ml) (Volumetric flask)
0.050	1.0	999	100
0.100	2.0	998	100
0.250	5.0	995	100
0.500	10.0	990	100
1.000	20.0	980	100
2.000	40.0	960	100
4.000	80.0	920	100

7) Low Level Soils Curve (SIM)

Concentration (mg/kg)	Amount added of the 100 ug/ml CCV/Calib. Std. (in ul)	Grams of sodium bisulfate added (if needed)	Final Volume (ml) (Volumetric flask)
0.001	1.0	1.0	100
0.002	2.0	1.0	100
0.005	5.0	1.0	100
0.010	10.0	1.0	100
0.020	20.0	1.0	100
0.040	40.0	1.0	100
0.080	80.0	1.0	100

11.1.6.2. Internal Standards - The internal standards used are Chlorobenzene-d_5, 1,4-Difluorobenzene, 1,2-Dichloroethane-d_4 and Fluorobenzene (sec. 7.6.1). Other compounds may be used as internal standards as long as they have retention times similar to the compounds being detected by GC/MS.

11.1.6.3. Surrogate Standards - The surrogate standards used are toluene-d_8, 1,2-dichloroethane-d_4, 4-bromofluorobenzene, and dibromofluoromethane. Other compounds may be used as surrogates, depending upon the analysis requirements. The

100 ug/ml working surrogate standard (sec. 7.7.2) may be used for calibration added at the same concentrations as the target compounds (see above).

11.1.6.4. ISTD/SSTD Combined Standard - A combination of internal standard and surrogate standard at 80ug/ml (sec. 7.7.3), or 20 ug/ml for Centurion auto-sampler (sec. 7.5.3) , is automatically added by the autosampler to all calibration levels, samples, blanks, CCV's and spikes used for any given sequence (actual volume for the archon autosamplers is determined by an ISTD/SSTD study and is documented in the maintenance logbooks for each instrument). Limits are generated internally or project/program limits are used.

11.1.6.5. Calibration curves are prepared fresh from newly made working standards to ensure accurate concentrations are maintained.

11.1.6.6. Secondary dilution standards (when necessary) - secondary dilution standards containing the compounds of interest (usually at 10.0/100 ug/ml) for SIM, low level, and MDL analyses may be prepared in methanol and stored with minimal headspace and shall be checked frequently for degradation. They are to be stored for one week only.

11.1.6.7. Preparation of standards is documented in the Volatile standards logbook. Each standard solution is documented with the standard name, concentration, preparation date, expiration date and a unique number given to that standard for future traceability.

11.2. The curve is generated using the relative response factor (RRF or RF). The data system tabulates the area response of the characteristic ions against the concentration of each compound and each internal standard. Calculate RFs for each compound relative to one of the internal standards. The internal standard selected for the calculation for the RF for a compound is the internal standard that has a retention time closest to the compound being measured.

11.2.1. The RF is calculated by the data system as follows:

$$RF = \frac{A_S \times C_{IS}}{A_{IS} \times C_S}$$

Where:

A_s = Area of the characteristic ion for the compound being measured in the calibration standard.
A_{IS} = Area of the characteristic ion for the specific internal standard.
C_{IS} = Concentration of the specific internal standard.
C_s = Concentration of the compound being measured in the calibration standard.

11.2.2. The average response factor (ARF) for all calibration levels is used when determining sample concentration and is calculated (along with the standard deviation) to evaluate the linearity of the curve (SW-846 Method 8000C. Sec. 11.5.1).

11.3. When ARFs are not acceptable, results are sometimes calculated using linear (1^{st} order) regression curves and/or quadratic (2^{nd} order) curves. Internal standard quantitation is also used when generating linear and non-linear calibrations. All equations and acceptance criteria follow the examples in SW-846, Method 8000C (sec. 11.5.2 and sec. 11.5.3).

11.4. If the RSD of the RFs is less than 20%, then the RF is assumed to be constant over the calibration range, and the average response factor may be used for quantitation. If the RSD of any analyte or surrogate mean RF exceeds 20% than linear regression or second order curves may be used for quantitation.

11.4.1. Linear Calibration: If the RSD of the calibration factor is greater than 20% over the calibration range, then the linearity through the origin cannot be assumed. If this is the case, the analyst can employ a regression equation that does not pass through the origin. This approach can also be employed based on the past experience of the instrument response.

11.4.2. The use of origin (0,0) as a calibration point is not allowed. However, most data systems and many commercial software packages will allow the analyst to “force” the regression through zero. This is not the same as including the origin as a fictitious point in the calibration. It can be appropriate to force the regression through zero for some calibrations (SW-846 Method 8000C sec. 11.5.2.1). The use of linear regression cannot be used as a rationale for reporting results below the calibration range.

11.4.3. The method of linear regression analysis has a potential for a bias to the lower portion of a calibration curve. If linear regression is used, then the lowest point in the calibration curve is calculated using the new curve. The recalculated concentration of the low calibration point should be within +/- 30% of the standard's true concentration.

11.4.4. Non-Linear Calibration: In situations where the analyst knows that the instrument response does not follow a linear model over a sufficiently wide working range, or when the other approaches described here have not met the acceptance criteria, a non-linear calibration model can be employed. When using a calibration model for quantitation, the curve must be continuous, continuously differentiable and monotonic over the calibration range. The model chosen shall have no more than four parameters, i.e., if the model is polynomial, it can be no more than third order.

11.4.4.1. The statistical considerations in developing a non-linear calibration model require more data than the more traditional linear approaches described above. Linear regression employs five calibration standards for the linear model; a quadratic model requires a minimum of six calibration standards.

11.4.4.2. Under ideal conditions, with a "perfect" fit of the model to the data, the coefficient of the determination (COD) will equal 1.0. In order to be an acceptable non-linear calibration, the COD must be greater than or equal to 0.99 Weighting in a calibration model can significantly improve the ability of the least squares regression to fit the data calibrations (SW-846 Method 8000C sec. 11.5.3).

11.5. Each of the most common target compounds ARFs in the ICV and the CCV should meet the minimum RF as noted in Table 4.

11.5.1. A number of compounds (primarily the ketones) do not respond well at normal concentrations, especially for low level analyses, resulting in RF's below the minimum requirement. These compounds are purchased at concentrations 10x the normal concentration to ensure adequate responses for working calibrations. Other poor responding compounds are commonly requested to be analyzed by this procedure and are purchased at concentrations that best ensure adequate responses to achieve successful calibrations.

11.5.2. If the minimum response factors are not met, the system should be evaluated, and corrective action should be taken before sample analysis begins. Examples of possible occurrences are as follows:

	Comment

Chloromethane	This compound is the most likely compound to be lost if the purge flow is too fast.
Bromoform	This compound is one of the compounds most likely to purge poorly if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response. Response of the quantitation ion (m/z 173) is directly affected by the tuning of BFB at ions m/z 174/176. Increasing the m/z 174/176 ratio relative to m/z 95 may improve bromoform response.
1,1,2,2-Tetrachloroethane	The response of this compound is degraded by contaminated transfer lines in purge and trap systems and/or active sites in trapping materials.
1,1-Dichloroethane	The response of this compound is also degraded by contaminated transfer lines in purge and trap systems and/or active sites in trapping materials.

11.6. All calibrations are confirmed by the analysis of a “second source” ICV standard before daily checks and analyses are performed. The RSD limit for all target compounds is ±20%, unless specified differently by any other applicable program or project’s criteria (QSM: ±25% RSD for all analytes). If these criteria are not met and a reanalysis of the ICV confirms the nonconformities, then corrective actions must be taken and the instrument recalibrated. Any outliers suggest a problem and poor performers shall be addressed. The concentrations of the ICV are near the midpoint of the curve (10/100 ug/L for water-5 ml purge, 4.0/40 ug/L for water-25 ml purge, 0.010/0.10 mg/kg for low level soils, and 0.50/5.0 mg/kg for MeOH preserved soils). The preparation of ICV’s is as follows:

Water (5 ml purge)--Spike 50 ml of DI water (volumetric flask) with 5.0 ul of the 100/1000 ug/ml ICV/Spiking standard, invert three times and transfer to a VOA vial for analysis.

Water (25 ml purge) -- Spike 50 ml of DI water (volumetric flask) with 2.0 ul of the 100/1000 ug/ml ICV/Spiking standard, invert three times and transfer into a VOA vial for analysis.

Low-level Soils--Spike 50 ml of DI water(volumetric flask) with 5.0 ul of the 100/1000 ug/ml ICV/Spiking standard, invert three times and transfer 5.0 ml into a VOA vial (containing and a stir bar) for analysis. As an alternative, prepare a 10.0/100 ug/ml working standard, then add 5.0 ul of this to 5.0 ml of DI water and transfer into a VOA (containing a stir bar) for analysis.

Med/high-level soils-- Spike 49 ml of DI water (volumetric flask) with 1.0 ml of MeOH and 5.0 ul of the 100/1000 ug/ml ICV/Spiking standard, invert three times and transfer into a VOA vial for analysis.

11.7. An Initial Calibration Blank (ICB) is analyzed to confirm that the instrument is free from contamination. Any detects in the ICB shall be less than the method detection limit and/or less than ½ the program/project limits. Any detects above MDL or program limits must be addressed before sample analyses begin. To prepare an ICB fill a 40 ml VOA vial preserved with 5% HCL with DI water.

11.8. Demonstration and documentation of an acceptable initial calibration is required before any samples are analyzed. Refer to EPA SW-846, Method 8000B, Section 7, for a detailed discussion of calibration procedures.

12. QUALITY CONTROL

12.1. Method Performance

12.1.1. Certified standard solutions, properly maintained instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies. Internal blind spikes are also utilized to check analyst performance.

12.1.2. Initial demonstration of capability (IDC) is another technique used to ensure acceptable method performance.

12.1.2.1. An analyst must demonstrate initial precision and accuracy through the analysis of 4-5 laboratory control spikes for each matrix and sample type. After analysis, the analyst calculates the average recovery (x) in μg/L and the relative standard deviation (RSD) of the recoveries for each analyte. In the absence of specific criteria found in the SW-846 methods or project specific limits, the default criteria of 70-130% recovery and 20 % RSD are used until internal limits are generated (Method 8000C, sec. 9.4.9)

12.1.3. Examples of the preparation of IDCs are as follows:

Water (5 ml purge)--Spike 50 ml of DI water (volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer to a VOA vial for analysis.

Water (25 ml purge) -- Spike 50 ml of DI water (volumetric flask) with 2.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer into a VOA vial for analysis.

Low-level Soils--Spike 50 ml of DI water (volumetric flask) with 5.0 ul of the 100/1000 ug/ml CCV/Calib. standard, invert three times and transfer 5.0 ml into a VOA vial containing 5 g of control and a stir bar for analysis. As an alternative, prepare a 10.0/100 ug/ml working standard, then add 5.0 ul of this to 5.0 ml of DI water and transfer into a VOA vial containing 5 g of control sand and a stir bar for analysis.

Med/high-level soils--Spike 10 g of control sand contained in a VOA vial with 50.0 ul of the 100/1000 ug/ml CCV/Calib. standard. Add 9.95 ml of methanol to the spiked sand and sonicate for 20 minutes. Add 1.0 ml of methanol extract to 49.0 ml DI water in a 50 ml syringe and then transfer into a VOA vial for analysis.

12.1.4. Many projects require the analysis of MRL standards and MDL check samples as another means of checking method performance. The MRLs are analyzed at the beginning and end of each 12 hour shift and are typically prepared at concentrations equal to the lowest standard on the calibration curve. Recovery limits are program specific but are usually set at 70-130%. The MDL check sample is usually spiked at approximately 2x the method detection limit. The MDL check sample is analyzed quarterly (as a minimum) to confirm instrument sensitivity (e.g. to verify that the method detection limits are still achievable). The MDL check samples are taken through all preparation and extraction steps used for actual samples (e.g. spiking/preserving control sand for soil samples). In most instances, a method detection limit check sample is analyzed at the end of each sequence requiring an MRL standard. The recovery criteria for MDL check samples are the ability to detect all compounds. If any given compound is not detected, the MDL check is spiked at a higher level and analyzed again. Detection limits for those compounds not detected on the initial MDL check analysis need to be raised to match the MDL check analysis at which they were detected.

12.1.5. Creating and monitoring control charts is also important for maintaining and improving method performance. Currently all SSTD, MS, MSD, and LCS recoveries are monitored with the use of the LIMS system. The data collected is used to recognize trends in recovery performance, as well as for generating new in-house QC limits. Default accuracy limits of 70-130 % recovery and a precision limit 20 % RSD are used until enough data points are generated to provide usable internal limits.

Other programs such as the WI UST program uses default accuracy and precision limits for surrogates and spikes of 80-120/20 %. Client and/or project specific limits are also used frequently in sample analyses. The Quality Control Requirements chart (Table 2.) also lists recovery limits specific to the method/project/program.

12.1.6. Performance Testing (PT's) must be done on all compounds on the list. If a compound is not available from a PT provider, the LCS studies must be performed and documented (at least 4 reps) twice a year to demonstrate proficiency.

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12.2. This SOP is designed to follow a variety of different projects and programs requirements. Table 2. is designed to illustrate the control steps and provisions required to adequately producing acceptable data.

12.3. Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.4. Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

13. DATA ASSESSMENT/ACCEPTANCE CRITERIA FOR QC MEASURES

13.1. If the initial analysis of a sample or a dilution of the sample has a concentration of a particular analyte that exceeds the calibration range, the sample must be reanalyzed at a dilution. Secondary ion quantitation is allowed only when there are sample interferences with the primary ion. When a sample is analyzed that has saturated ions from a compound, this analysis must be followed by a blank water analysis. If the blank analysis is not free of interferences, the system must be decontaminated. Sample analyses can not resume until a blank can be analyzed that is free of interferences.

13.2. After the analysis of water samples, the pH shall be taken to verify proper field preservation. pH strips are used to verify the pH which is then documented in the bench sheet logbook.

13.3. Qualitative Analysis:

13.3.1. The qualitative identification of compounds determined by this method is based on retention time and on comparison of the sample mass spectrum (ion scans) after background correction with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated (by the laboratory) using the conditions of this method.

The mass spectral library is updated with each new calibration and is continually updated with the mass spectra from CCV's.

13.3.2. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity or any ions over 30% relative intensity if fewer than three such ions occur in the reference spectrum. Table 3 lists compounds along with the Primary Ion (Quantitation ion) used for calculating results, and the Secondary Ions (Qualitative ions) used for qualitatively matching sample spectrums with reference spectrums for positive identifications. Compounds shall be identified as present when the criteria below are met.

13.3.2.1. The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target compound at a compound-specific retention time will be accepted as meeting this criterion.

13.3.2.2. The relative retention time (RRT) of the sample component is within +/- 0.06 RRT units of the RRT of the standard component.

13.3.2.3. The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%).

13.3.2.4. Structural isomers that produce very similar mass spectra shall be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

13.3.2.5. Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra are important. Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra and in qualitative identification of compounds. When analytes co elute (i.e., only one chromatographic peak is apparent), the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the co eluting compound.

13.3.3. For samples containing compounds that are not a part of the normal target list, a library search may be required for the purpose of tentative identification. Tentative identified compounds (TICs) are needed only when requested or required by a particular project or program. Data system library search routines shall not use normalization routines that would misrepresent the library of unknown spectra when compared to each other. Use the following a guidance for reporting TICs.

13.3.3.1. Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) shall be present in the sample spectrum.

13.3.3.2. The relative intensities of the major ions agree within ± 20%.

13.3.3.3. Molecular ions present in the reference spectrum shall be present in the sample spectrum.

13.3.3.4. Ions present in the sample spectrum but not in the reference spectrum shall be checked for possible background contamination. They shall also be reviewed for possible co elution with another compound.

13.3.3.5. Ions present in the reference spectrum but not in the sample spectrum shall be check against the possibility of subtraction from the sample spectrum due to background contamination or co-eluting peaks. Some data reduction programs can create these discrepancies.

13.4. Ions present in the reference spectrum but not in the sample spectrum shall be check against the possibility of subtraction from the sample spectrum due to background contamination or co-eluting peaks. Some data reduction programs can create these discrepancies.

13.5. When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. Once the reference spectrums are compared and the sample spectrums and identifications have been made, the sample data can be reported. Assessments of all spiked and calibration control samples and standards shall also be finalized before reporting the data.

13.5.1. When the analyst has finished processing the analytical batch, the results are electronically transferred to the LIMS system where weight to volume corrections, dilution factors and percent solids adjustments are made. Once the final results have been verified, a checklist (FVO4-01) is filled out and signed confirming that all the data has been thorough scrutinized. At this point the data is turned over to another qualified analyst for final validation. The second analyst confirms the results and electronically marks them validated and signs his or her portion of the checklist. Finally, the validated results are made available to the client services personnel in order for the data to be given to the client or appropriate agencies.

13.5.2. A PDF copy of the data is then electronically filed and archived. The package includes the checklist, the sequence run log, a copy of the bench sheets, the LIMS run log, verification of tuning and system performance data, and verification of calibration data. For each sample, the chromatogram, quantitation and library spectra (ion scans) for all detected target compounds are also included. Each data file header shall contain the sample ID # and the date and time acquired.

14. CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

14.1. See QAM Appendix 9.

15. CONTINGENCIES FOR HANDLING OUT OF CONTROL OR UNACCEPTABLE DATA

15.1. See QAM Appendix 9.

16. DATA RECORDS MANAGEMENT

16.1. Records are stored for a minimum of 5 years in accordance with the Quality Manual.

16.2. See SOP QA 003 for specifics on document control.

17. WASTE MANAGEMENT

17.1. See QAM Appendix 9.

18. REFERENCES

18.1. Determinative Chromatographic Separations, USEPA SW-846 Methods 8000C, Rev. 3, March, 2003

18.2. Volatiles Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), USEPA SW-846 Method 8260C, Rev. 3, August, 2006.

18.3. Purge and Trap for Aqueous Samples, USEPA SW-846 Methods 5030B, Rev. 2, December, 1996.

18.4. Closed System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, USEPA SW-846 Methods 5035 (Inc. App. A), Rev. 0, December, 1996.

18.5. Wisconsin DNR, Lust Guidance, July, 1993.

18.6. USEPA, Method 603, Acrolein and Acrylonitrile, July, 1982.

18.7. CT Laboratories Quality Manual, current revision.

18.8. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.1, January 2017..

18.9. National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.

18.10. ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO/IEC17025:2005.

18.11. Appendix A to part 136, Methods for Organic Chemical Analysis of Municipal and Industrial Wastewaters, EPA method 624-Purgeable, 1984.

19. Attachments.

Table 1

Analyte List

Analyte	Analyte
Acetone Benzene Bromobenzene Bromochloromethane Bromodichloromethane Bromoform Bromomethane 2-Butanone n-Butylbenzene sec-Butylbenzene tert-Butylbenzene Carbon disulfide Carbon tetrachloride Chlorobenzene Chloroethane 2-Chloroethylvinyl ether Chloroform Chloromethane 2-Chlorotoluene 4-Chlorotoluene Dibromochloromethane 1,2-Dibromo-3-chloropropane 1,2-Dibromoethane Dibromomethane 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene Dichlorodifluoromethane 1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichloroethene cis-1,2-Dichloroethene trans-1,2-Dichloroethene 1,2-Dichloropropane 1,3-Dichloropropane	2,2-Dichloropropane 1,1-Dichloropropene cis-1,3-Dichlropropene trans-1,3-Dichloropropene Diisopropyl ether Ethylbenzene Hexachlorobutadiene 2-Hexanone Isopropylbenzene p-Isopropyltoluene Methylene chloride 4-Methyl-2-pentanone Methyl tert butyl ether Naphthalene n-Propylbenzene Styrene 1,1,1,2-Tetrachloroethane 1,1,2,2-Tetrachloroethane Tetrachloroethene Tetrahydrofuran Toluene 1,2,3-Trichlorobenzene 1,2,4-Trichlorobenzene 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trichloroethene Trichlorofluoromethane 1,2,3-Trichloropropane 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene Vinyl chloride Vinyl acetate o-Xylene m/p-Xylene 112Trichloro122trifluoroethane

Table 2
Volatile Organic Compounds by GC/MS
Summary of Quality Control Requirements

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Tune Check	Prior to ICAL and prior to each 12-hour period of sample analysis.	Specific ion abundance criteria of BFB or DFTPP from method.	Retune instrument and verify.	Flagging is not appropriate.	No samples shall be analyzed without a valid tune.
Performance Check (Method 8270 only)	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol shall be present at their normal responses and shall not exceed a tailing factor of 2.	Correct problem, then repeat performance checks.	Flagging is not appropriate.	No samples shall be analyzed until performance check is within criteria. The DDT breakdown and Benzidine/ pentachlorophenol tailing factors are considered overall system checks to evaluate injector port inertness and column performance and are required regardless of the reported analyte list.
Initial calibration (ICAL) for all analytes (including surrogates)	At instrument set-up and after ICV or CCV failure, 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: $r^2 \geq 0.99$; *(continued next page)*	Correct problem then repeat ICAL.	Flagging is not appropriate.	Minimum 5 levels for linear and 6 levels for quadratic. No samples shall be analyzed until ICAL has passed.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial calibration (ICAL) for all analytes (including surrogates) *(Continued)*		Option 3: non-linear least squares regression (quadratic) for each analyte: $r_2 \geq 0.99$.			If the specific version of a method requires additional evaluation (e.g., RFs or low calibration standard analysis and recovery criteria) these additional requirements must also be met.
Retention Time window position establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	NA.	Calculated for each analyte and surrogate.
Evaluation of Relative Retention Times (RRT)	With each sample.	RRT of each reported analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	NA.	After maintenance is performed which may affect retention times, RRTs may be updated based on the daily CCV. RRTs shall be compared with the most recently updated RRTs.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 20% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.

QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Continuing Calibration Verification (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.
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.	NA.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid Method Blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Must contain all surrogates and all analytes to be reported. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	Must contain all surrogates and all analytes to be reported. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference, i.e., matrix effect or analytical error.

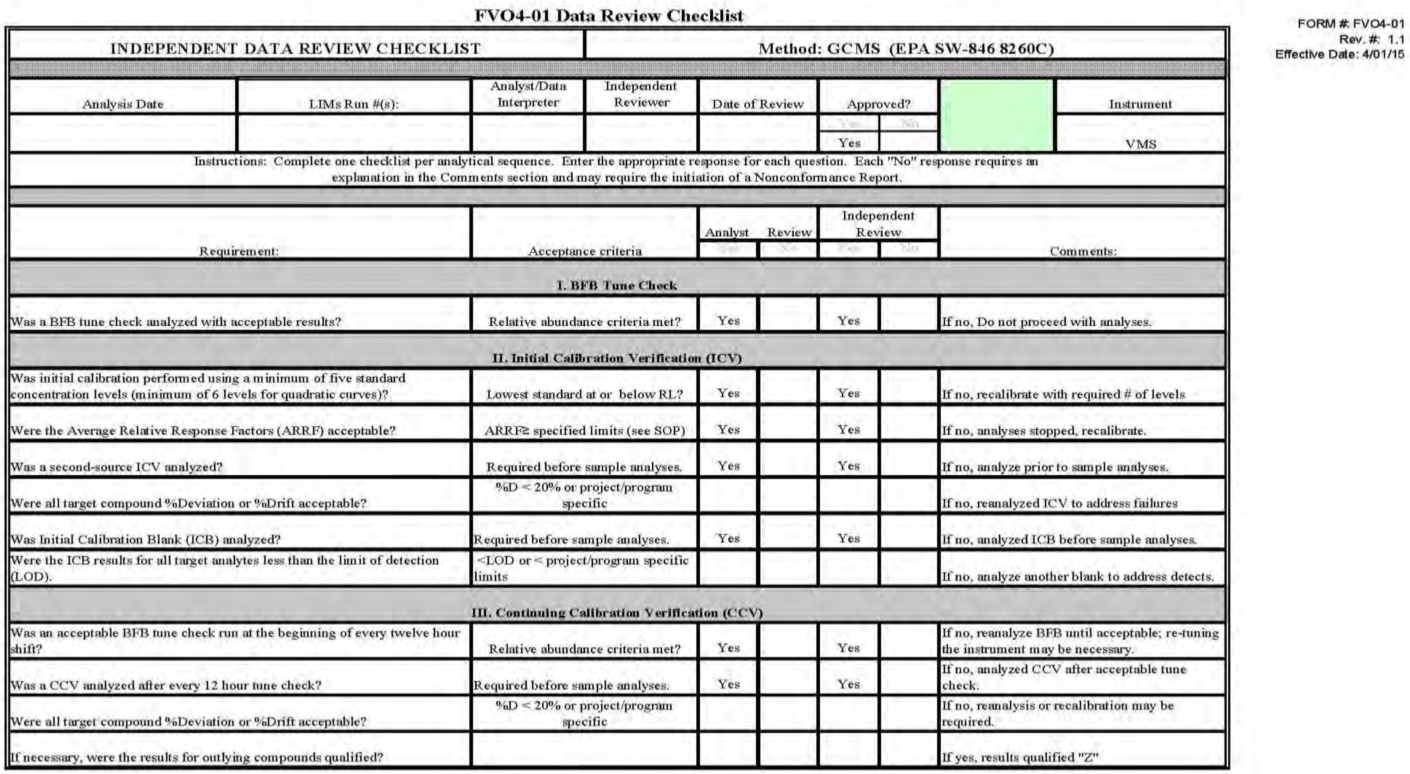
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative.	MSD: Must contain all surrogates and all analytes to be reported. The data shall be evaluated to determine the source of difference. For Sample/MD: RPD criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.
Surrogate Spike	All field and QC samples.	QC acceptance criteria specified by the project if available; otherwise use QSM Appendix C limits or in-house LCS limits if analyte(s) are not listed.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference is present, reanalysis may not be necessary, but the client must be notified prior to reporting data and the failures must be discussed in the Case Narrative.	Apply Q-flag to all associated analytes if acceptance criteria are not met and explain in the Case Narrative.	Alternative surrogates are recommended when there is obvious chromatographic interference.

Table 3
Characteristic ions

Analyte	Primary Ion	Secondary Ion	Analyte	Primary Ion	Secondary Ion
Acetone	43	58	2,2-Dichloropropane	77	97,79
Benzene	78	51,77	1,1-Dichloropropene	110	77,75
Bromobenzene	156	77,158	cis-1,3-Dichlropropene	75	110
Bromochloromethane	128	49,130	trans-1,3-Dichloropropene	75	77,110
Bromodichloromethane	83	85,129	Diisopropyl ether	45	87,43
Bromoform	173	175,171	Ethylbenzene	91	106
Bromomethane	94	96	Hexachlorobutadiene	225	223,227
2-Butanone	43	72,57	2-Hexanone	43	58,57
n-Butylbenzene	91	92,134	Isopropylbenzene	105	120
sec-Butylbenzene	105	134	p-Isopropyltoluene	119	134,91
tert-Butylbenzene	119	91,134	Methylene chloride	84	86,49
Carbon disulfide	76	78	4-Methyl-2-pentanone	43	58,57
Carbon tetrachloride	119	121	Methyl tert butyl ether	73	57,43
Chlorobenzene	112	77,114	Naphthalene	128	51,129
Chloroethane	64	66	n-Propylbenzene	91	120
2-Chloroethylvinyl ether	63	65,106	Styrene	104	78
Chloroform	83	85	1,1,1,2-Tetrachloroethane	131	133,119
Chloromethane	50	52	1,1,2,2-Tetrachloroethane	83	85
2-Chlorotoluene	91	126	Tetrachloroethene	166	168,129
4-Chlorotoluene	91	126	Tetrahydrofuran	42	72,71
Dibromochloromethane	129	127,131	Toluene	92	91
1,2-Dibromo-3-chloropropane	157	155	1,2,3-Trichlorobenzene	180	182,145
1,2-Dibromoethane	107	109	1,2,4-Trichlorobenzene	180	182,145
Dibromomethane	93	95,174	1,1,1-Trichloroethane	97	99,61
1,2-Dichlorobenzene	146	111,148	1,1,2-Trichloroethane	83	97,85,99
1,3-Dichlorobenzene	146	111,148	Trichloroethene	95	130,132
1,4-Dichlorobenzene	146	111,148	Trichlorofluoromethane	101	103,105
Dichlorodifluoromethane	85	87	1,2,3-Trichloropropane	75	110
1,1-Dichloroethane	63	65,83	1,2,4-Trimethylbenzene	105	120
1,2-Dichloroethane	62	98,64	1,3,5-Trimethylbenzene	105	120
1,1-Dichloroethene	96	61,63	Vinyl chloride	62	64
cis-1,2-Dichloroethene	96	61,98	Vinyl acetate	43	86
trans-1,2-Dichloroethene	96	61,98	o-Xylene	106	91
1,2-Dichloropropane	63	76,112	m/p-Xylene	106	91
1,3-Dichloropropane	76	78			
			SSTD		
ISTD			Dibromofluoromethane	113	111,192
Fluorobenzene	96	77	1,2-Dichloroethane-d$_4$	102	104
Chlorobenzene-d$_5$	117		Toluene-d$_8$	98	100
1,4-Dichlorobenzene-d$_4$	152		4-Bromofluorobenzene	95	174,176

***Refer to Method 8260C for characteristic ions not listed here**

FV04-01 (Example)
8260C Checklist



FVO4-01 Data Review Checklist

FORM #: FVO4-01
Rev. #: 1.1
Effective Date: 4/01/15

INDEPENDENT DATA REVIEW CHECKLIST					Method: GCMS (EPA SW-846 8260C)			
Analysis Date	LIMs Run #(s):	Analyst/Data Interpreter	Independent Reviewer	Date of Review	Approved?		🟩	Instrument
					Yes	No		
					Yes			VMS

Instructions: Complete one checklist per analytical sequence. Enter the appropriate response for each question. Each "No" response requires an explanation in the Comments section and may require the initiation of a Nonconformance Report.

Requirement:	Acceptance criteria	Analyst Review		Independent Review		Comments:
		Yes	No	Yes	No	
I. BFB Tune Check						
Was a BFB tune check analyzed with acceptable results?	Relative abundance criteria met?	Yes		Yes		If no, Do not proceed with analyses.
II. Initial Calibration Verification (ICV)						
Was initial calibration performed using a minimum of five standard concentration levels (minimum of 6 levels for quadratic curves)?	Lowest standard at or below RL?	Yes		Yes		If no, recalibrate with required # of levels
Were the Average Relative Response Factors (ARRF) acceptable?	ARRF≥ specified limits (see SOP)	Yes		Yes		If no, analyses stopped, recalibrate.
Was a second-source ICV analyzed?	Required before sample analyses.	Yes		Yes		If no, analyze prior to sample analyses.
Were all target compound %Deviation or %Drift acceptable?	%D < 20% or project/program specific					If no, reanalyzed ICV to address failures
Was Initial Calibration Blank (ICB) analyzed?	Required before sample analyses.	Yes		Yes		If no, analyzed ICB before sample analyses.
Were the ICB results for all target analytes less than the limit of detection (LOD).	<LOD or < project/program specific limits					If no, analyze another blank to address detects.
III. Continuing Calibration Verification (CCV)						
Was an acceptable BFB tune check run at the beginning of every twelve hour shift?	Relative abundance criteria met?	Yes		Yes		If no, reanalyze BFB until acceptable; re-tuning the instrument may be necessary.
Was a CCV analyzed after every 12 hour tune check?	Required before sample analyses.	Yes		Yes		If no, analyzed CCV after acceptable tune check.
Were all target compound %Deviation or %Drift acceptable?	%D < 20% or project/program specific					If no, reanalysis or recalibration may be required.
If necessary, were the results for outlying compounds qualified?						If yes, results qualified "Z"

Page 1 of 3

FORM #: FVO4-01
Rev. #: 1.1
Effective Date: 4/01/15

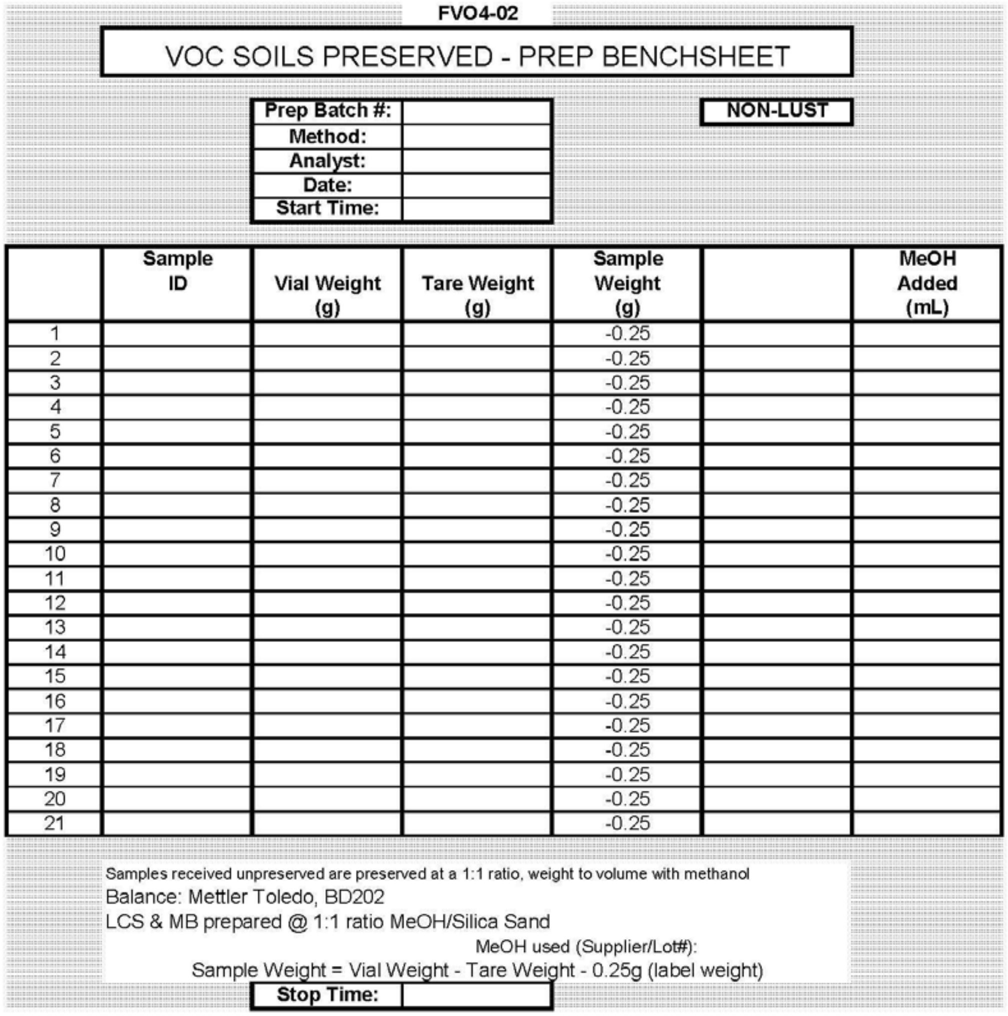
IV. Blanks						
Was a Method Blank (MB) analyzed prior to analysis of samples?	1 per 20 samples or project/program specific.	Yes		Yes		If no, analyze a MB with each sample batch.
Were the MB results for all target analytes less than the limit of detection (LOD)?	*All target analytes <LOD or < project/program specific limits (<1/2 RL for DoD-QSM)					If no, reanalyze MB an all affected data if possible or see SOP for more detailed criteria
If analytes were detected in the MB with no associated positives in the samples, no further action is needed. If the analyte detects in the MB were greater than the acceptance criteria and there were detects in the samples, was the data qualified.?						If yes, affected results qualified "B"
V. Laboratory Control Spike (LCS)						
Was a LCS analyzed at the required frequency?	1 per 20 samples or project/program specific.	Yes		Yes		If no, analyze a LCS with each sample batch.
Were the LCS recoveries for all analytes within acceptance criteria?	Default 70-130%, or see internally generated limits, or project/program specified limits.					If no, Reanalyze LCS and all affected data if possible or data requires qualification.
If applicable, were associated sample detects (and non-detects for low recoveries) qualified?						If yes, affected results qualified "Q"
VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)						
Was a Martrix Spike (MS) and a Matrix Spike Duplicate (MSD) analyzed at the required frequency?	1 per 20 samples or project/program specific.	Yes		Yes		If no, analyze a MS/MSD pair with each sample batch.
Were the MS/MSD recoveries for all analytes within acceptance criteria?	Default 70-130%, or see internally generated limits, or project/program specified limits.					If no, qualify detects (with an "M" flag) in the parent sample, also qualify non-detects if MS/MSD recoveries were low.
Is the relative percent difference (RPD) for each analyte between the MS and MSD acceptable?	generated limits, or client specific limits.					If no, affected results qualified "Y"
VII. Sample Analyses						
Are chromatogram characteristics, including peak shapes and areas, consistent with those of the CCV?		Yes		Yes		If no, instrument maintenance may be required to correct problems.
Were surrogate recoveries for all samples and QC within acceptance criteria?	Default 70-130%, or see internally generated program limits, or client specified limits.					If no, samples with high surrogate recoveries and no associated analyte detects were not reanalyzed. Low surrogate recoveries require reanalysis.
If possible, were the affected samples reanalyzed?		Yes				If no, see below **
**Were reported sample results with failing surrogate recoveries qualified?		Yes				If yes, affected results qualified "S"
Were all samples having analytes detected in amounts exceeding the calibration range diluted and reanalyzed? If not qualify (X).	Target upper middle range of calibration curve.	Yes		Yes		
Did all samples meet hold time and preservation criteria as defined by method/program?	H2O sample: pH < 2 = 14 days, pH >2 = 7 days. Soil samples: 14 days (other criteria may apply)					If no, see below: If analyzed past hold, qualify "H" If improperly preserved qualify "T"
Were all samples and QC injected within 12 hours of BFB tune check?		Yes		Yes		If no, affected samples reanalyzed
Were internal standard recoveries acceptable relevant to associated ICAL?	Response = -50 to +200%; Ret. time = +/- 30 sec.					If no, affected samples reanalyzed

VIII. Records and Reporting						
Is sequence file / injection log present in the data package?		Yes		Yes		If no, include sequence run with raw data.
Were all data, calculations, and values verified in LIMS upon completion of data capture?		Yes		Yes		If no, recapture the data and verify data prior to validation.
Were manual integrations addressed properly and were the audit trails turned on (where applicable)?	Manual integration must be initialed, dated, and reason given, along with before & after chromatograms. Audit trail must be on (if available).	Yes		Yes		IF No, address manual integration and/or turn on audit trail feature and document reason why it may have been turned off.
Are reported results whose amounts exceeded the acceptance criteria flagged with an appropriate qualifier and, if needed, were any non-matrix related nonconformities documented in the NCR spreadsheet?						If No, include proper qualification(s) in LIMS and enter nonconformities into the NCR spreadsheet before data review/validation.

Non-applicable Yes/No cells are left blank

Comments:

FVO4-02 (Example)
VOC Soils Preserved Prep Bench Sheet (Non-Lust)



FVO4-02

VOC SOILS PRESERVED - PREP BENCHSHEET

Prep Batch #:
Method:
Analyst:
Date:
Start Time:

NON-LUST

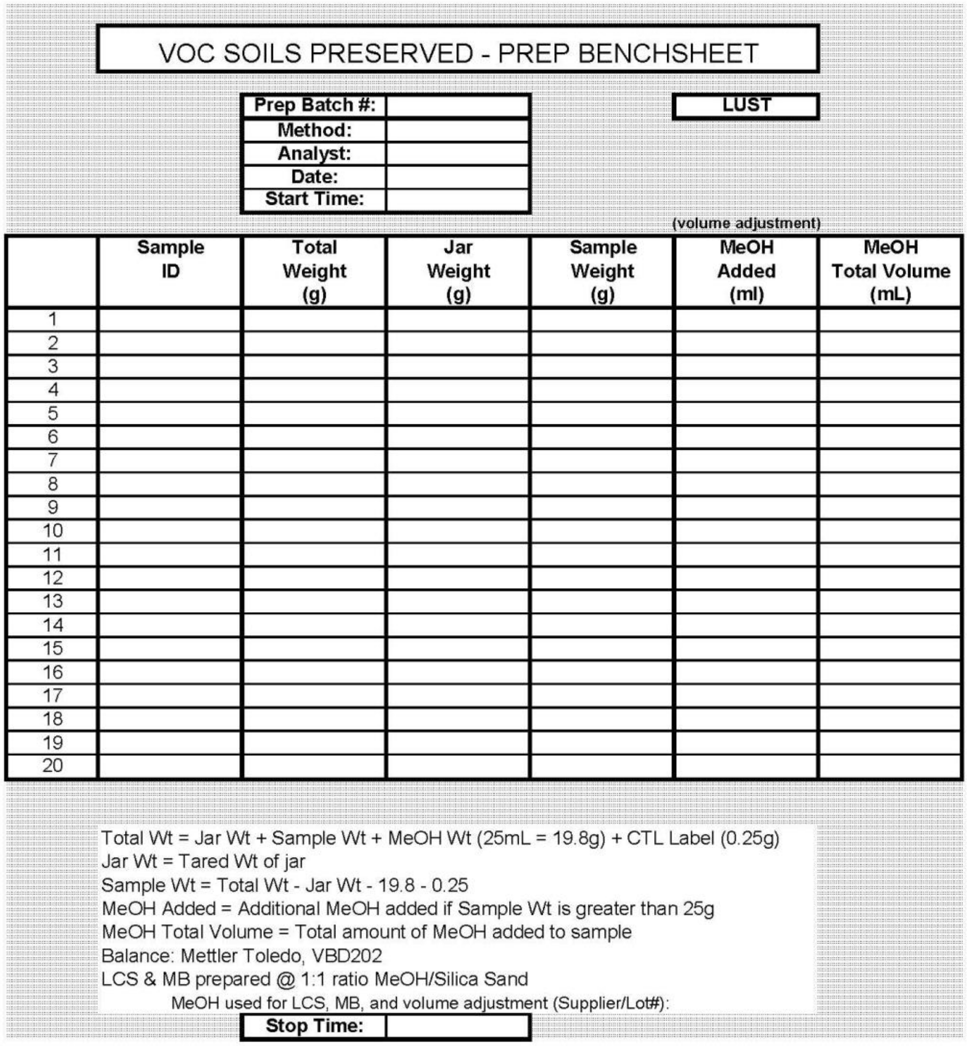
	Sample ID	Vial Weight (g)	Tare Weight (g)	Sample Weight (g)		MeOH Added (mL)
1				-0.25		
2				-0.25		
3				-0.25		
4				-0.25		
5				-0.25		
6				-0.25		
7				-0.25		
8				-0.25		
9				-0.25		
10				-0.25		
11				-0.25		
12				-0.25		
13				-0.25		
14				-0.25		
15				-0.25		
16				-0.25		
17				-0.25		
18				-0.25		
19				-0.25		
20				-0.25		
21				-0.25		

Samples received unpreserved are preserved at a 1:1 ratio, weight to volume with methanol
Balance: Mettler Toledo, BD202
LCS & MB prepared @ 1:1 ratio MeOH/Silica Sand
MeOH used (Supplier/Lot#):
Sample Weight = Vial Weight - Tare Weight - 0.25g (label weight)

Stop Time:

VocSoilPresNonLust_FVO3-02 05/07/201415:07

FVO4-03 (Example)
VOC Soils Preserved Prep Bench Sheet (Lust)



VOC SOILS PRESERVED - PREP BENCHSHEET

Prep Batch #:	
Method:	
Analyst:	
Date:	
Start Time:	

LUST

(volume adjustment)

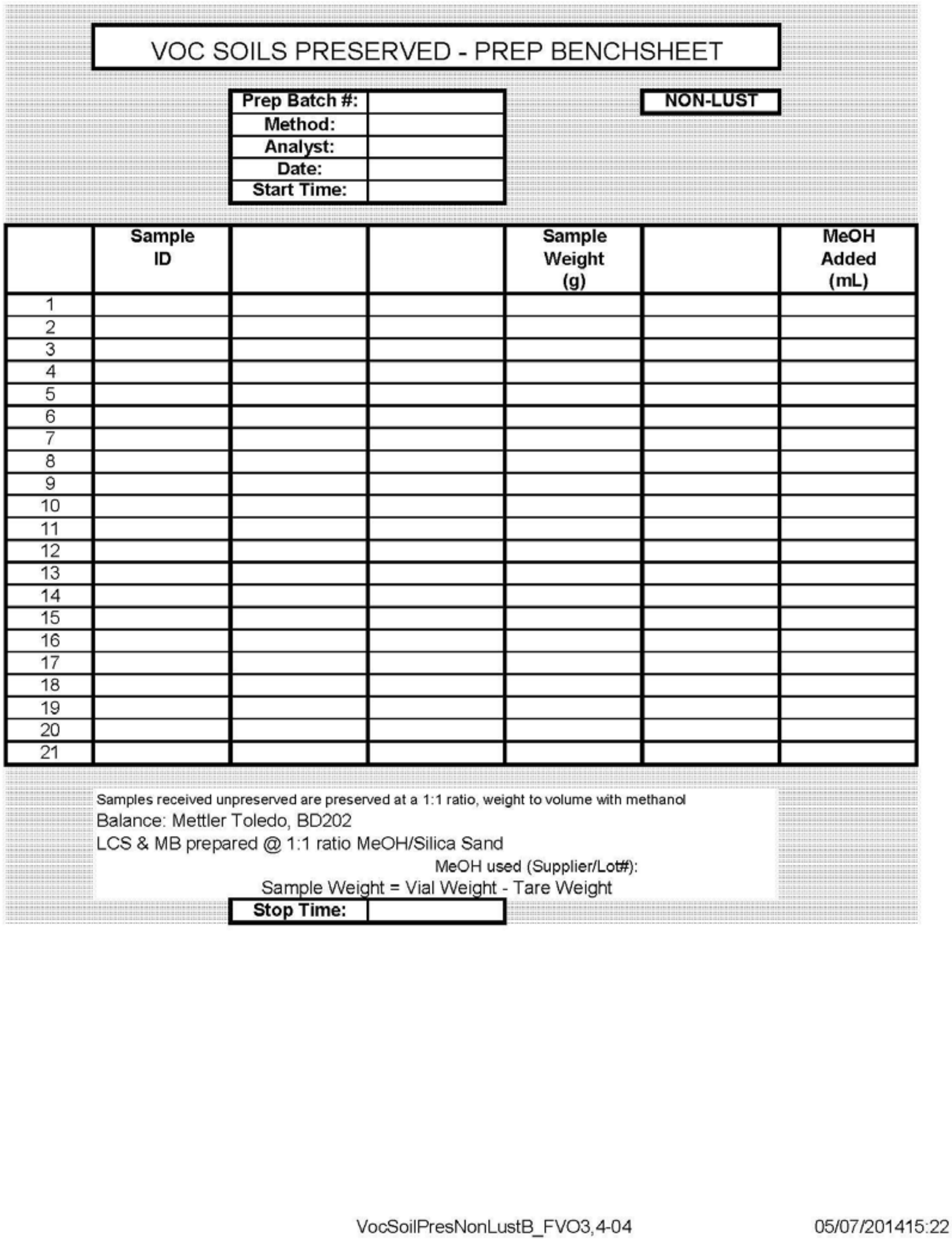
	Sample ID	**Total Weight (g)**	**Jar Weight (g)**	**Sample Weight (g)**	**MeOH Added (ml)**	**MeOH Total Volume (mL)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Total Wt = Jar Wt + Sample Wt + MeOH Wt (25mL = 19.8g) + CTL Label (0.25g)
Jar Wt = Tared Wt of jar
Sample Wt = Total Wt - Jar Wt - 19.8 - 0.25
MeOH Added = Additional MeOH added if Sample Wt is greater than 25g
MeOH Total Volume = Total amount of MeOH added to sample
Balance: Mettler Toledo, VBD202
LCS & MB prepared @ 1:1 ratio MeOH/Silica Sand
MeOH used for LCS, MB, and volume adjustment (Supplier/Lot#):

Stop Time:

VocSoilPresLust_FVO3-03 05/07/201415:13

FVO4-04 (Example)
VOC Soils Preserved Prep Bench Sheet (Non-Lust) B



VOC SOILS PRESERVED - PREP BENCHSHEET

Prep Batch #:	
Method:	
Analyst:	
Date:	
Start Time:	

NON-LUST

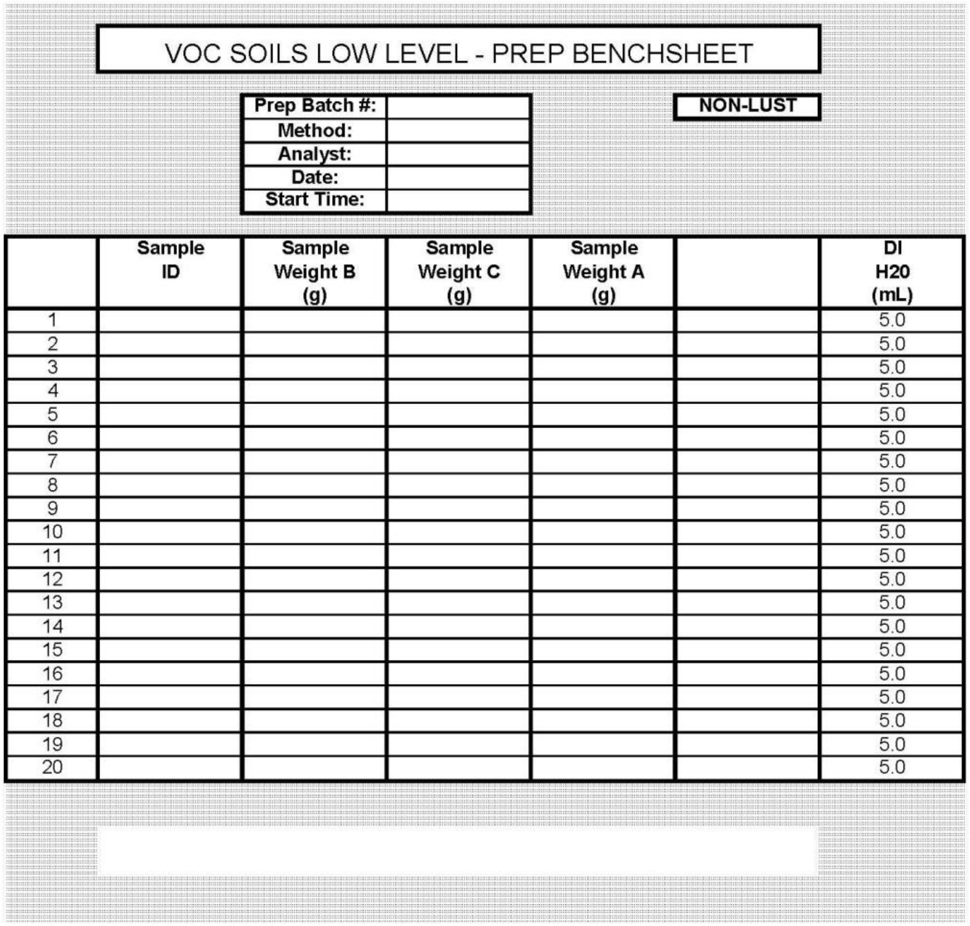
	Sample ID			**Sample Weight (g)**		**MeOH Added (mL)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						

Samples received unpreserved are preserved at a 1:1 ratio, weight to volume with methanol
Balance: Mettler Toledo, BD202
LCS & MB prepared @ 1:1 ratio MeOH/Silica Sand
MeOH used (Supplier/Lot#):
Sample Weight = Vial Weight - Tare Weight

Stop Time:

VocSoilPresNonLustB_FVO3,4-04 05/07/201415:22

FVO4-05 (Example)
VOC Soils Low Level Prep Bench Sheet (Non-Lust)



VOC SOILS LOW LEVEL - PREP BENCHSHEET

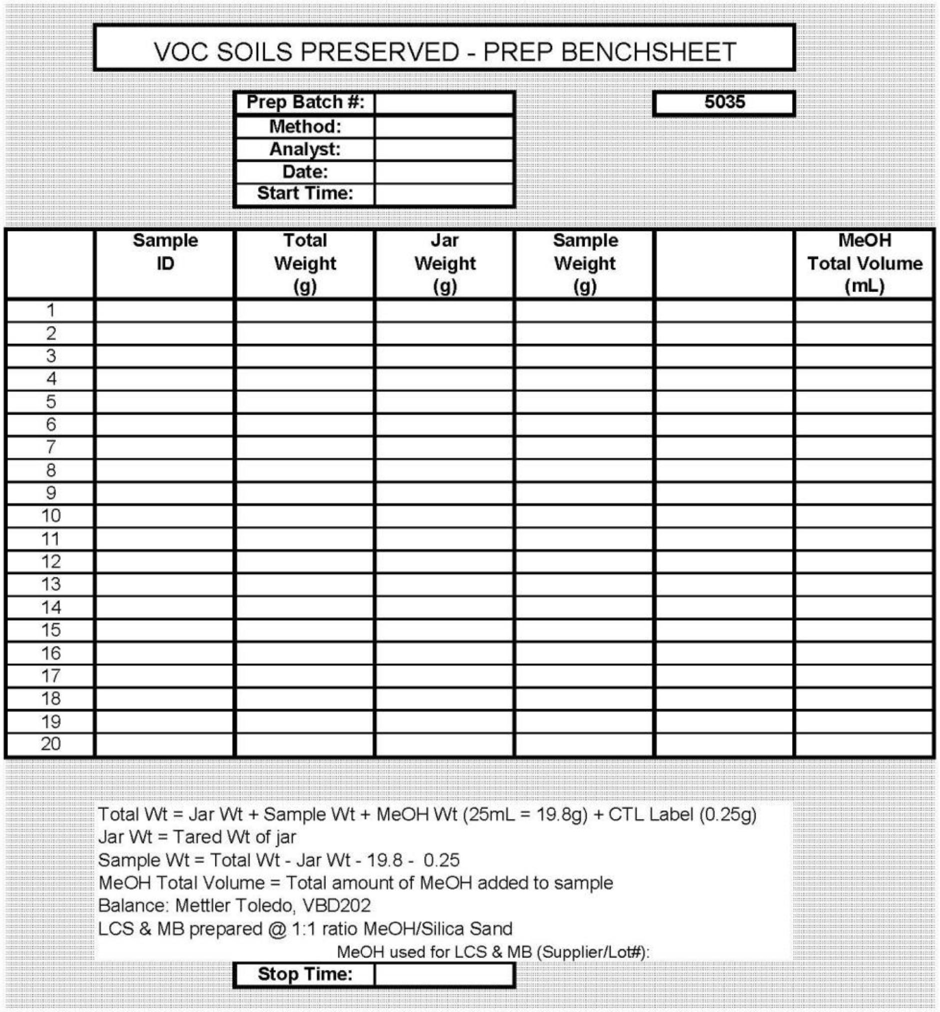
Prep Batch #:	
Method:	
Analyst:	
Date:	
Start Time:	

NON-LUST

	Sample ID	Sample Weight B (g)	Sample Weight C (g)	Sample Weight A (g)		DI H20 (mL)
1						5.0
2						5.0
3						5.0
4						5.0
5						5.0
6						5.0
7						5.0
8						5.0
9						5.0
10						5.0
11						5.0
12						5.0
13						5.0
14						5.0
15						5.0
16						5.0
17						5.0
18						5.0
19						5.0
20						5.0

Voc LLSoil Temp_FVO3-05 05/07/201415:20

FVO4-06 (Example)
VOC Soils Preserved Prep Bench Sheet (5035)



VOC SOILS PRESERVED - PREP BENCHSHEET

Prep Batch #:
Method:
Analyst:
Date:
Start Time:

5035

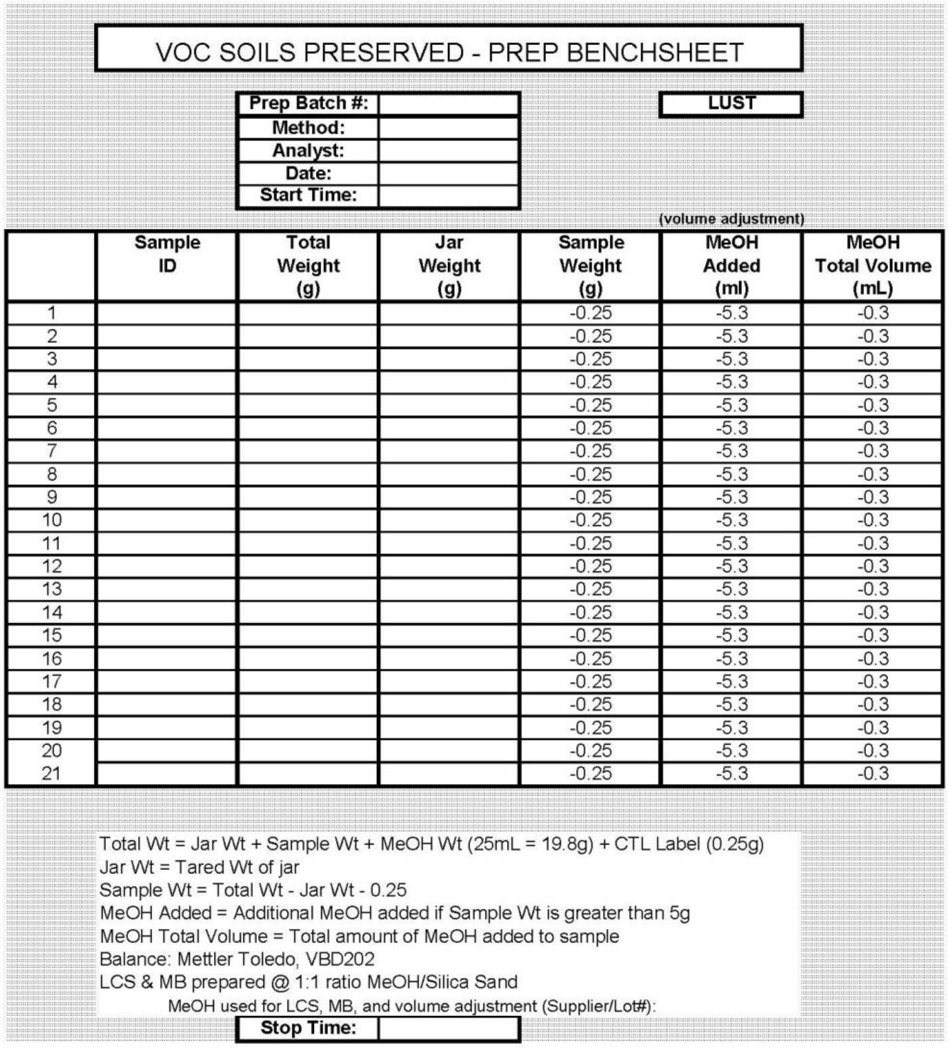
	Sample ID	**Total Weight (g)**	**Jar Weight (g)**	**Sample Weight (g)**		**MeOH Total Volume (mL)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Total Wt = Jar Wt + Sample Wt + MeOH Wt (25mL = 19.8g) + CTL Label (0.25g)
Jar Wt = Tared Wt of jar
Sample Wt = Total Wt - Jar Wt - 19.8 - 0.25
MeOH Total Volume = Total amount of MeOH added to sample
Balance: Mettler Toledo, VBD202
LCS & MB prepared @ 1:1 ratio MeOH/Silica Sand
MeOH used for LCS & MB (Supplier/Lot#):

Stop Time:

VocSoilPres25mL_FVO3-06 05/07/201415:25

FVO4-07 (Example)
VOC Soils Preserved Prep Bench Sheet (Lust) 5 mL



VOC SOILS PRESERVED - PREP BENCHSHEET

Prep Batch #:
Method:
Analyst:
Date:
Start Time:

LUST

	Sample ID	Total Weight (g)	Jar Weight (g)	Sample Weight (g)	(volume adjustment) MeOH Added (ml)	MeOH Total Volume (mL)
1				-0.25	-5.3	-0.3
2				-0.25	-5.3	-0.3
3				-0.25	-5.3	-0.3
4				-0.25	-5.3	-0.3
5				-0.25	-5.3	-0.3
6				-0.25	-5.3	-0.3
7				-0.25	-5.3	-0.3
8				-0.25	-5.3	-0.3
9				-0.25	-5.3	-0.3
10				-0.25	-5.3	-0.3
11				-0.25	-5.3	-0.3
12				-0.25	-5.3	-0.3
13				-0.25	-5.3	-0.3
14				-0.25	-5.3	-0.3
15				-0.25	-5.3	-0.3
16				-0.25	-5.3	-0.3
17				-0.25	-5.3	-0.3
18				-0.25	-5.3	-0.3
19				-0.25	-5.3	-0.3
20				-0.25	-5.3	-0.3
21				-0.25	-5.3	-0.3

Total Wt = Jar Wt + Sample Wt + MeOH Wt (25mL = 19.8g) + CTL Label (0.25g)
Jar Wt = Tared Wt of jar
Sample Wt = Total Wt - Jar Wt - 0.25
MeOH Added = Additional MeOH added if Sample Wt is greater than 5g
MeOH Total Volume = Total amount of MeOH added to sample
Balance: Mettler Toledo, VBD202
LCS & MB prepared @ 1:1 ratio MeOH/Silica Sand
MeOH used for LCS, MB, and volume adjustment (Supplier/Lot#):

Stop Time:

VocSoilPresLust5mL_FVO3,4-07 05/07/201415:29

Table 4
Recommended Minimum relative response factor criteria for Initial and Continuing Calibration Verification

Volatile Compounds	Minimum Response Factor (RF)
Dichlorodifluoromethane	0.100
Chloromethane	0.100
Vinyl chloride	0.100
Bromomethane	0.100
Chloroethane	0.100
Trichlorofluoromethane	0.100
1,1-Dichloroethene	0.100
1,1,2-Trichloro-1,2,2-trifluoroethane	0.100
Acetone[1]	0.100
Carbon disulfide	0.100
Methyl Acetate	0.100
Methylene chloride	0.100
trans-1,2-Dichloroethene	0.100
cis-1,2-Dichloroethene	0.100
Methyl tert-Butyl Ether	0.100
1,1-Dichloroethane	0.200
2-Butanone[1]	0.100
Chloroform	0.200
1,1,1-Trichloroethane	0.100
Cyclohexane	0.100
Carbon tetrachloride	0.100
Benzene	0.500
1,2-Dichloroethane	0.100
Trichloroethene	0.200
Methylcyclohexane	0.100
1,2-Dichloropropane	0.100
Bromodichloromethane	0.200
cis-1,3-Dichlorpropene	0.200
trans-1,3-Dichlorpropene	0.100
4-Methyl-2-pentanone[1]	0.100
Toluene	0.400
1,1,2-Trichloroethane	0.100
Tetrachloroethene	0.200
2-Hexanone[1]	0.100
Dibromochloromethane	0.100
1,2-Dibromoethane	0.100

Volatile Compounds	Minimum Response Factor(RF)
Chlorobenzene	0.500
Ethylbenzene	0.100
Meta-/para-Xylene	0.100
Ortho-Xylene	0.300
Styrene	0.300
Bromoform	0.100
Isopropylbenzene	0.100
1,1,2,2-Tetrachloroethane	0.300
1,3-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.500
1,2-Dichlorobenzene	0.400
1,2-Dibromo-3-chloropropane	0.050
1,2,4-Trichlorbenzene	0.200

[1] Due to low response at standard levels, these compounds are run at a concentration ten times the normal.

20.0 Description of Changes

Revision Number	**Description of Changes**	**Date**
00	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/12/2014
01	Changed SOP to new format, updated for QSM 5.0	01/28/2015
02	Added SIM mode analyses to Scope & Application	03/09/2015
03	Update to reflect requirement of DoD QSM V5.1 -Added CCV2 requirement (2nd CCV level for compounds using Quadratic fit curves), sec. 9.1.2. Added QSM 5.1 to references section and clarified ICV and CCVF requirements and acceptance limits. Update changes to form QSM Table B-4 to Table 2.	01/03/19

QA020 – CT Labs – Data Reporting

STANDARD OPERATING PROCEDURE

QA 020 Data Reporting

Review Date: 08/18/17

Colleen
08/18/17

Approved by: Quality Assurance Date

18Aug2017

Approved by: Laboratory Director Date

Table of Contents

STANDARD OPERATING PROCEDURE

1.0 PURPOSE

CT Laboratories has three different methods for reporting data to our clients. They are analytical reports, data packages and Electronic Data Deliverables (EDD). All CT Laboratories analytical reports and data packages must contain specific information for which the testing was performed. The testing includes, but is not limited to, the National Environmental Laboratory Accreditation Program (NELAP), and the Department of Defense (DoD) programs and individual states which do not follow either of the above programs. Within these agencies are rules and regulations that direct what constitutes a report and what a report must contain. The following procedures specify, at a minimum, what must be included in every analytical report and data package. EDDs are numerous and are either client and or program specified in requirements.

2.0 APPLICATION

This reporting SOP is applicable to all analytical reports and data packages issued by CT Laboratories**.**

3.0 SUMMARY OF PROCEDURE

The goal of this SOP is to define what information needs to be presented in our analytical reports and data packages so that the results are reported accurately, clearly, unambiguously and objectively. Client and or program requests for alternative reports will supersede the established report requirements presented in the SOP as long as the requested format reports the analytical results in an accurate, clear, unambiguous and objective manner. All "required" information will be available to those clients upon request.

4.0 DEFINITIONS

None

5.0 PERSONNEL QUALIFICATIONS

Project Managers

6.0 PROCEDURE

6.1 Basic Report

6.1.1 A basic report is comprised of an analytical report and copy of the chain of custody.

6.2 Analytical Report

A NELAC/DOD analytical report is comprised of the following items: Cover page, analytical report, a copy of the chain of custody, Sample Condition Report, case narrative when applicable, and correspondence when applicable. Each test report must include at least the following information.

6.2.1 A title of "*Analytical Report"* appears on the first page.

6.2.2 The name, address and phone number where the test was carried out is documented on the first page of the analytical report.

6.2.3 The CT Laboratories Folder number which is generated at sample login is used as the unique identification of the analytical report. The Folder number can be found on each page in order to ensure that the page is recognized as part of the analytical report. Each page of the analytical report is numbered as a number of the total reported pages.

6.2.4 The name and address of the client, and project name are present in the analytical report.

6.2.5 Each analyte will have the specified method identified with the analyte result.

6.2.6 A description of, the condition of, and unambiguous identification of the sample(s), including the client identification code is entered into the LIMS system. The information is populated in the report as a header for each sample and also in the Sample Condition Report which can be found in the analytical report.

6.2.7 The date of receipt of the sample(s), the date and time of sample collection, the date(s) and time(s) of sample preparation, if applicable, and analysis is all reported on the analytical report. If the time of sample collection is not provided, the laboratory must assume the most conservative time of day.

6.2.8 Samples are logged in using the analytical tests specified in an individual contract which has been set up to meet the project specifications.

6.2.9 Within the analytical results reporting section of the analytical report the units as well as any dilution factor, where applicable, are documented for each analyte. A statement can also be found on each page of this section if the results have been calculated and reported on a dry weight basis. Any failures associated with the data are qualified either by test and or individual analyte, as applicable. A table with the qualifier definitions can be found at the end of this section. (Note: Data qualifiers for DOD-QSM work will follow the required DOD-QSM definitions.)

6.2.10 The name, function and signature, or electronic equivalent, of the person approving the report can be found on the last page of the results reporting section. The “Report Date” can be found on the first page of the results reporting section.

6.2.11 A statement can be found on the last page of the results reporting section that the results relate only to the sample(s) reported in the analytical report.

6.2.12 A statement can be found on the last page of the results reporting section that the report shall not be reproduced except in full without the written approval of the laboratory.

6.2.13 A statement can be found on the last page of the results reporting section that the test results are certified that they meet the requirements of NELAC and / or DoD-QSM. A “^” character denotes that the laboratory is NELAC accredited for this analyte by the indicated matrix and method. Any exceptions to NELAC requirements will be noted in the analytical report.

6.2.14 A statement can be found on the last page of the results reporting section with the current CT Laboratories certifications.

6.2.15 Any deviations, additions, or exclusions to the analytical method or environmental conditions that may have impacted the analytical results are documented by the analyst(s) as a note with in the analytical report.

6.2.16 A case narrative may also be used to document issues with the sample(s) analysis, sample receipt, or reporting. A narrative shall address the analyses for which manual integrations were necessary. The narrative must address each manual integration by sample and analyte.

6.2.17 A statement has been added to the analytical report that the level of uncertainty measurements can be provided upon request by the client.

6.2.18 Upon request by the client the laboratory can provide opinions and or interpretations of the data which would be documented in a case narrative and would be marked as an opinion and or interpretation.

6.2.19 The chain of custody is included in the analytical report which would include the documentation of the sample date and any field observations which had been documented on the chain of custody.

6.2.20 On occasion the laboratory has to subcontract certain test(s). The analytical results are received in either hard copy or electronic form. If the report is received in hard copy form it is scanned in its entirety and saved as a .pdf document. The entire subcontract report is attached to CT Laboratories analytical report and provided to the client.

6.2.21 Analytical reports are sent to clients in any of the following formats; hard copy, facsimile, e-mail or on electromagnetic media. When analytical reports are being sent via electronic transmission the cover pages and or e-mail signatures have Confidentiality statements within them.

6.2.22 The analytical report(s) format is checked to make sure that different analyses will have all reported data presented clearly so that there is no misunderstanding or misuse of the data.

6.2.23 When an analytical report requires a revision or amendment the report cover page or the initial page of the report is changed to “Revised Analytical Report”. The revised report also includes a reason for the revision and a “Revision Date” which is populated with the date the report is reprinted. The cover page may also include a revision date for certain report formats. These changes in reporting are accomplished in LIMS in the Project Manager module by selecting the folder number associated with the report and then changing the “Rpt Rev Status” to Y, changing the “Rev Rpt Date” to the date of the change, and by including reason for the report revision in the “Rpt Revision Reason”.

6.3 Data Packages

At times clients require more information regarding the sample analysis or need to have a third party data validation performed on the analysis. In those cases a data package is generated and supplied to the client. CT Laboratories offers two levels of a data package. Attachment 1 shows the two different levels, III & IV, and what is supplied in each package. Data packages are generated using proprietary software which takes different queued and validated sections and pulls them together in a specified order and paginates the document upon completion. Once the final data package has been generated the project manager will then review the package to ensure that the previous data reviews were documented properly and for completeness. Below is a summary of the different sections and who is responsible for the section.

6.3.1 Cover Page. The cover page is generated by the project managers and inserted once all of the other sections have been generated and validated.

6.3.2 Table of Contents. The data package software automatically populates and generates the table of contents sheet during the final generation of the data package.

6.3.3 Case Narrative. The project managers are responsible for generating the final case narrative. Each section of the laboratory that had testing in the submission is responsible for generating the narrative notes for the specific analyses. The project manager will then assimilate all of the different sections into the final narrative.

6.3.4 Analytical Results. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator.

6.3.5 Sample Management Records. The project managers are responsible for documenting and generating the Chain of Custody section of the data package. The chain of custody section should include chain of custody records, shipping documents, Sample Condition Report(s), Login Confirmation Report(s), any correspondence with the client regarding the project and this set of samples, and any non-conformance/corrective actions that may have occurred during the analysis of the sample(s).

6.3.6 QA/QC Information. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator.

6.3.7 Information for Third-party Review. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator. The level of documentation that is required will depend on which level of data package has been requested.

7.0 QUALITY CONTROL AND QUALITY ASSURANCE

7.1 None

8.0 REFERENCES

8.1 Wisconsin Administrative Code, NR 149.47
8.2 CT Laboratories Quality Manual, current revision.
8.3 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.
8.4 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.
8.5 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.

Attachment 1
Data Package Deliverable Formats

Level III:

- Cover Page
- Table of Contents
- Case Narrative
- Data Qualifier Sheet
- Sample Delivery Group Summary
- QC Batch Cross Reference
- Analytical Results
- Surrogate Recoveries – where appropriate
- Method Blank
- Laboratory Control Sample (LCS) Summary
- Laboratory Control Sample Duplicate (LCSD) Summary – where appropriate
- Matrix Spike (MS) Summary
- Matrix Spike Duplicate (MSD) Summary – where appropriate
- Replicate/Duplicate – where appropriate
- GC/MS Tune – where appropriate
- Initial Calibration Summary & Raw Data
- Continuing Calibration Verification (CCV) Summary & Raw Data
- Raw Data – Including but not limited to instrument logs, standard prep logs, extraction logs, digestion logs, instrument sequences and data sheets.
- Chain of Custody
- Sample Condition Report
- Login Confirmation Report
- Project/Sample Related Correspondence

Level IV:

- Cover Page
- Table of Contents
- Case Narrative
- Data Qualifier Sheet
- Sample Delivery Group Summary
- QC Batch Cross Reference
- Analytical Results
- Surrogate Recoveries – where appropriate
- Method Blank
- Laboratory Control Sample (LCS) Summary
- Laboratory Control Sample Duplicate (LCSD) Summary – where appropriate
- Matrix Spike (MS) Summary
- Matrix Spike Duplicate (MSD) Summary – where appropriate
- Replicate/Duplicate – where appropriate
- GC/MS Tune – where appropriate
- Initial Calibration Summary & Raw Data
- Continuing Calibration Verification (CCV) Summary & Raw Data
- Raw Data – Including but not limited to instrument logs, standard prep logs, extraction logs, digestion logs, instrument sequences and data sheets. Chromatograms, spectra, raw data files for all samples and associated QC and calibrations.
- Chain of Custody
- Sample Condition Report
- Login Confirmation Report
- Project/Sample Related Correspondence

Revision Number	Description of Changes	Date
02	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	02/14/14
2.1	Updated format and updated section 6.2.22 to include the reason for the revision date of a revised report.	04/28/17

Microbac and CT Labs – Laboratory Certifications

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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ENVIRONMENTAL

Valid To: December 31, 2020 Certificate Number: 2936.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, ISO IEC 17025:2017, the 2009 TNI Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, LC/MS/MS, Ion Chromatography, Misc.- Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Metals		
Aluminum	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Antimony	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Arsenic	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Barium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Beryllium	EPA 200.8 EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C EPA 6020/6020A/6020B
Boron	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Cadmium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Calcium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Chromium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Cobalt	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Copper	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Iron	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Lead	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Lithium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Magnesium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Manganese	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Mercury	EPA 245.1 EPA 7470A	EPA 7471A/7471B
Molybdenum	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Nickel	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Phosphorus	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Potassium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Selenium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Silicon	EPA 200.7 EPA 6010B/6010C	------------------------------------
Silver	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Sodium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Strontium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Thallium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Tin	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Titanium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Thorium	EPA 200.8 EPA 6020/6020A/6020B	
Uranium	EPA 200.8 EPA 6020/6020A/6020B	EPA 6020/6020A/6020B
Vanadium	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Zinc	EPA 200.7/200.8 EPA 6010B/6010C EPA 6020/6020A/6020B	EPA 6010B/6010C EPA 6020/6020A/6020B
Zirconium	EPA 200.7 EPA 6010B/6010C	EPA 6010B/6010C
Prep Methods	EPA 3015A	EPA 3051A
Nutrients		
Ammonia (as N)	EPA 350.1	EPA 350.1
Kjeldahl nitrogen	EPA 351.2	-----------------------------------
Nitrate (as N)	EPA 300.0 EPA 353.2 EPA 9056/9056A SM 4500NO$_3$-F	EPA 300.0 EPA 9056/9056A
Nitrate-nitrite (as N)	EPA 300.0/353.2/9056/9056A SM 4500NO$_3$-F	EPA 9056/9056A
Nitrite (as N)	EPA 300.0 EPA 354.1 EPA 9056/9056A	EPA 300.0 EPA 9056/9056A
Orthophosphate (as P)	EPA 365.2 SM 4500-P E-1999/2011	EPA 365.2
Total Phosphorus	EPA 365.4	-----------------------------------
Demands		
Biochemical Oxygen Demand	SM 5210 B-2001/2011	-----------------------------------
Chemical Oxygen Demand	EPA 410.4MOD HACH 8000	-----------------------------------
Total Organic Carbon	EPA 415.1/9060A SM 5310 C-2000/2011	-----------------------------------
Wet Chemistry		
Acidity	EPA 415.1-9060A SM 2310B-1997/2011 (4a/d)	-----------------------------------
Alkalinity	EPA 310.2 SM 2320 B-1997/2011	-----------------------------------
Bromide	EPA 300.0 EPA 9056/9056A	EPA 300.0 EPA 9056/9056A

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Chloride	EPA 300.0 EPA 325.2 EPA 9056/9056A SM 4500-CL E-2011	EPA 325.2 EPA 9056/9056A SM 4500-CL E-1997/2011
Chlorine, Residual	SM 4500Cl-G 2000/2011	-----------------------------------
Conductivity	EPA 120.1 SM 2510B-1997/2011	-----------------------------------
Cyanide	EPA 9010C EPA 9014 SM 4500 CN-C,E-1999/2011	EPA 9010C EPA 9014
Cyanide, Amenable	EPA 9010C EPA 9014 SM 4500 CN-G/E	EPA 9010C EPA 9014
Ferrous Iron	SM 3500-Fe B-2011	-----------------------------------
Filterable Residue	EPA 160.1 SM 2540 C-2011	-----------------------------------
Flashpoint	EPA 1010A	EPA 1010A EPA 1030
Fluoride	EPA 300.0 EPA 9056/9056A SM 4500 F,C-2011	EPA 300.0 EPA 9056/9056A SM 4500 F,C-1997/2011
Hardness	EPA 130.2 SM 2340C-2011	-----------------------------------
Hexavalent Chromium	EPA 7196A SM 3500-Cr B-2011	EPA 3060A EPA 7196A SM 3500-Cr B -2011
MBAS	SM 5540C-2000/2011	-----------------------------------
Nitrate as N	EPA 300.0	--
Nitrite as N	EPA 300.0	--
Nonfilterable Residue	EPA 160.2 SM 2540 D-1997/2011	-----------------------------------
Total Residue	EPA 160.3 SM2540 B, G-1997	--
Total Volatile Residue	EPA 160.4 SM 2540 E, G-2011	--
Oil and Grease	EPA 1664A/1664B	EPA 9071
Osmotic Pressure	PA-DEP 391-2000-008	-----------------------------------
pH	EPA 9040C SM 4500-H$^+$ B-2000/2011	EPA 9040C EPA 9045D
Percent Solids / Moisture	--	ASTM D2216-10
Phenols	EPA 420.1	EPA 420.1
Sulfate	EPA 300.0 EPA 375.4 EPA 9056/9056A SM 4500 SO4 E-2011	EPA 300.0 EPA 375.4 EPA 9056/9056A SM 4500 SO4 E-2011
Sulfide	EPA 376.1 SM 4500-S F-2000/2011	EPA 9030B EPA 9034
TOC	SM 5310C	-----------------------------------
Turbidity	EPA 180.1 SM 2130B-2011	-----------------------------------

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Purgeable Organics (Volatiles)		
Acetone	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Acetonitrile	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Acrolein	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Acrylonitrile	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Allyl chloride	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
T-amylmethylether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Benzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Bromobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Bromochloromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Bromodichloromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Bromoform	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Bromomethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,3-Butadiene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
2-Butanone	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
n-Butyl alcohol	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
tert-Butyl alcohol	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
n-Butylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
sec-Butylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
tert-Butylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Carbon Disulfide	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Carbon Tetrachloride	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Chloroacetonitrile	EPA 8260B	EPA 8260B
Chlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1-Chlorobutane	EPA 8260B	EPA 8260B
Chloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C

2-Chloroethyl Vinyl Ether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Chloroform	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Chloroprene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1-Chlorohexane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Chloromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
2-Chlorotoluene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
4-Chlorotoluene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Cyclohexane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Cyclohexanone	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dibromochloromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dibromofluoromethane *Surrogate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Dibromo-3-chloropropane (DBCP)	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dibromomethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Dibromomethane (EDB)	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Dichlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,3-Dichlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,4-Dichlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
trans-1,4-Dichloro-2-butene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dichlorodifluoromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1-Dichloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Dichloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1-Dichloroethene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
cis-1,2-Dichloroethene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
trans-1,2-Dichloroethene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Dichloropropane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
1,3-Dichloropropane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
2,2-Dichloropropane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1-Dichloropropene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
cis-1,3-Dichloropropene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
trans-1,3-Dichloropropene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Diethyl Ether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Di-isopropyl Ether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dimethyldisulfide	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Dimethyl Sulfide	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,4-Dioxane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Ethyl Acetate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Ethyl-t-butyl Ether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Ethyl Methacrylate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Ethyl Benzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Gas Range Organics (GRO)	EPA 8015B /8015C/8015D OK-GRO	EPA 8015B/8015C/8015D OK-GRO
2-Hexanone	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Hexachlorobutadiene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Hexachloroethane	EPA 8260B	EPA 8260B
n-Hexane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Isoprene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Isopropylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,4-Isopropyltoluene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Iodomethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Isobutyl Alcohol	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Methacrylonitrile	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Methyl Acetate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Methylcyclohexane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Methyl Methacrylate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
alpha-Methylstyrene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Methyl Tert-Butyl Ether	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Methylene Chloride	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
4-Methyl-2-pentanone	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Naphthalene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
2-Nitropropane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
n-Propylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Propionitrile	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Styrene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1,1,2-Tetrachloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1,2,2-Tetrachloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Tetrachloroethene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Tetrahydrofuran	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Toluene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1,1-Trichloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1,2-Trichloroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Trichloroethene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Trichlorofluoromethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2,3-Trichlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2,3-Trichloropropane	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2,4-Trichlorobenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
1,2,4-Trimethylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,3,5-Trimethylbenzene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Vinyl Acetate	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Vinyl Chloride	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Xylenes, Total	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,2-Xylene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,3-Xylene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
1,4-Xylene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
m,p-Xylene	EPA 624/624.1 EPA 8260B/8260C	EPA 8260B/8260C
Prep Methods	EPA 5030B/5030C EPA 5035/5035A	EPA 5035/5035A
Alcohol Organics		
2-Hexanone	EPA 8015C	EPA 8015C
Butanol	EPA 8015C	EPA 8015C
Ethanol	EPA 8015C	EPA 8015C
Isobutyl Alcohol	EPA 8015C	EPA 8015C
Isopropyl Alcohol	EPA 8015C	EPA 8015C
Methanol	EPA 8015C	EPA 8015C
Propanol	EPA 8015C	EPA 8015C
Headspace Organics		
n-Butane	EPA 5021/RSK175	----------------------------------
Carbon dioxide	EPA 5021/RSK175	----------------------------------
Methane	EPA 5021/RSK175	----------------------------------
Ethane	EPA 5021/RSK175	----------------------------------
Ethene	EPA 5021/RSK175	----------------------------------
Propane	EPA 5021/RSK175	----------------------------------
Acetylene	EPA 5021/RSK175	----------------------------------
Acenaphthene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Acenaphthylene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Acetophenone	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Acetylaminofluorene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Aminobiphenyl	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Aniline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Anthracene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Aramite	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Atrazine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Benzidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Benzoic acid	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Benzo (a) anthracene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo (b) fluoranthene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo (k) fluoranthene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo (g,h,i) perylene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo (a) pyrene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzyl Alcohol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Benzaldehyde	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Biphenyl	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Bis(2-chloroethoxy) Methane	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Bis (2-chloroethyl) Ether	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Bis(2-chloroisopropyl) Ether	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Bis (2-ethylhexyl) Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Bromophenylphenylether	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Butyl benzyl Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Caprolactam	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Carbazole	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
4-Chloroaniline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Chlorobenzilate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Chloro-3-methylphenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1-Chloronaphthalene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Chloronaphthalene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Chlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Chlorophenylphenyl Ether	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Chrysene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Cresols	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Diallate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Dibenzo (a,c) anthracene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Dibenzo (a,h) anthracene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Dibenzofuran	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,2-Dichlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dichlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dichlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
3,3’-Dichlorobenzidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dichlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,6-Dichlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Diethyl Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Dimethoate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Dimethylaminoazobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
7,12-Dimethylbenz(a)anthracene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
3,3’-Dimethylbenzidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	Non-potable Water (1)	Solid and Chemical Materials (2)
Alpha,alpha-dimethylphenethylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dimethylphenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Dimethyl Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Di-n-butyl Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Di-n-octyl Phthalate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrotoluene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,6-Dinitrotoluene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dioxane	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Diphenylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,2-Diphenylhydrazine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Disulfoton	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
DRO/ORO	EPA 8015B/8015C/8015D OK-DRO	EPA 3546/8015B/8015C/8015D OK-DRO
Ethyl Methanesulfonate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Ethyl parathion	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Famphur	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Fluoroanthene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Fluorene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Hexachlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorobutadiene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorocyclopentadiene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Hexachloroethane	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorophene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Hexachloropropene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Indeno (1,2,3-cd) pyrene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Isodrin	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Isophorone	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Isosafrole	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Kepone	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Methapyrilene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
3-Methylcholanthrene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Methyl-4,6-dinitrophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Methyl Methanesulfonate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1-Methylnaphthalene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
2-Methylnaphthalene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Methyl Parathion	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Methyl Phenol	EPA 625 EPA 8270C/8270D	EPA 8270C/8270D
3,4-Methyl Phenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Naphthalene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
1,4-Naphthoquinone	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1-Naphthylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Naphthylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Nitroaniline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
3-Nitroaniline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Nitroaniline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Nitrobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	Non-potable Water (1)	Solid and Chemical Materials (2)
5-Nitro-o-toluidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Nitrophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
4-Nitrophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Nitroquinoline-1-oxide	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosodiethylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosodimethylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitroso-di-n-butylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosodi-n-propylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosodiphenylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosomethylethylamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosomorpholine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosopiperidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
n-Nitrosopyrrolidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Pentachloroethane	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Pentachloronitobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Perylene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Phenacetin	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Phenanthrene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Phenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,4-Phenylenediamine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Phorate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2-Picoline	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Pronamide	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Pyrene	EPA 625/625.1 EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Pyridine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Safrole	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Sulfotepp	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,2,4,5-Tetrachlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,3,4,6-Tetrachlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
o,o,o-Triethyl Phosphorothioate	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Thionazin	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
1,2,4-Trichlorobenzene	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4,5-Trichlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
2,4,6-Trichlorophenol	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
o-Toluidine	EPA 625/625.1 EPA 8270C/8270D	EPA 8270C/8270D
Prep Methods	EPA 3510C/3520C	EPA 3550B/3550C EPA 3580A EPA 3546
Pesticides/Herbicides/PCB		
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011	-----------------------------------
1,2-Dibromomethane (EDB)	EPA 8011	-----------------------------------
Aldrin	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
alpha-BHC	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
beta-BHC	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
delta-BHC	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
gamma-BHC	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Chlordane (technical)	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
alpha-chlordane	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
gamma-chlordane	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
4,4'-DDD	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
4,4'-DDE	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
4,4',-DDT	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Dieldrin	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endosulfan I	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endosulfan II	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endonsulfan Sulfate	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endrin	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endrin Aldehyde	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Endrin Ketone	EPA 8081A/8081B	EPA 8081A/8081B
Heptachlor	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Heptachlor Epoxide	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Methoxychlor	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
Mirex	EPA 608/608.3	
Toxaphene	EPA 608/608.3 EPA 8081A/8081B	EPA 8081A/8081B
PCB-1016 (aroclor)	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1221	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1232	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1242	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1248	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1254	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1260	EPA 608/608.3 EPA 8082/8082A	EPA 8082/8082A
PCB-1262	EPA 8082/8082A	EPA 8082/8082A
PCB-1268	EPA 8082/8082A	EPA 8082/8082A
Prep Methods	EPA 3510C	EPA 3550B/3550C/3546/3580A
Acifluorfen	EPA 8151A	EPA 8151A
Bentazon	EPA 8151A	EPA 8151A
Chloramben	EPA 8151A	EPA 8151A
2,4-D	EPA 8151A	EPA 8151A
3,5-Dichlorobenzoic acid	EPA 8151A	EPA 8151A

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Dalapon	EPA 8151A	EPA 8151A
2,4-DB	EPA 8151A	EPA 8151A
Dicamba	EPA 8151A	EPA 8151A
Dichloroprop	EPA 8151A	EPA 8151A
Dinoseb	EPA 8151A	EPA 8151A
MCPA	EPA 8151A	EPA 8151A
MCPP	EPA 8151A	EPA 8151A
Pentachlorophenol	EPA 8151A	EPA 8151A
Picloram	EPA 8151A	EPA 8151A
2,4,5-T	EPA 8151A	EPA 8151A
2,4,5-TP	EPA 8151A	EPA 8151A
HPLC		
1,3,5-Trinitrobenzene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
1,3-Dinitrobenzene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
2,4,6-Trinitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
2,4-Dinitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
2,6-Dinitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
2-Amino-4,6-dinitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
2-Nitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
3-Nitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
4-Amino-2,6-dinitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
4-Nitrotoluene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
Nitrobenzene	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
Nitroglycerin	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
HMX	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
PETN	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
RDX	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
Tetryl	EPA 8330B/8330A(modified)	EPA 8330B/8330A(modified)
Prep Methods	EPA 3535A	----------------------------------
Formaldehyde	EPA 8315A	EPA 8315A
Acetaldehyde	EPA 8315A	EPA 8315A
Proponal	EPA 8315A	EPA 8315A
Acetic acid	830MBA	-----------------------------------
Butyric acid	830MBA	-----------------------------------
Lactic acid	830MBA	-----------------------------------
Propionic acid	830MBA	-----------------------------------
Pyruvic acid	830MBA	-----------------------------------
Acetate	AOAC 986.13	-----------------------------------
Formate	AOAC 986.13	-----------------------------------
Hazardous Waste Characteristics		
Corrosivity	EPA 9040C	EPA 9040C/9045D
Ignitibility	EPA 1010A	EPA 1010A EPA 1030
Reactive cyanide	EPA SW 846 Ch 7 7.3.3.2-1996	EPA SW 846 Ch 7 7.3.3.2-1996
Reactive sulfide	EPA SW 846 Ch 7 7.3.4.2-1996	EPA SW 846 Ch 7 7.3.4.2-1996
Synthetic precipitation leaching procedure (SPLP)	EPA 1312	EPA 1312

Parameter/Analyte	**Non-potable Water (1)**	**Solid and Chemical Materials (2)**
Toxicity characteristic leaching procedure (TCLP)	EPA 1311	EPA 1311
Water Leach	-----------------------------------	ASTM D3987-06/85
Clean-Up		
---------------------------------	EPA 3620B	EPA 3620B
---------------------------------	EPA 3665A	EPA 3665A
---------------------------------	EPA 3630C	EPA 3630C
---------------------------------	EPA 3660B	EPA 3660B
LC/MS/MS		
Perchlorate	EPA 331/6850	EPA 6850
PFAS by LC/MS/MS		
N-Ethylperfluorooctanesufonamido acetic acid (N-EtFOSAA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
N-Methylperfluorooctanesulfonamido acetic acid (N-MeFOSAA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
6:2 Fluorotelomersulfonate (6:2FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
8:2 Fluorotelomersulfonate (8:2FTS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorotetradecanoic acid (PFTeDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorododecanoic acid (PFDoA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluoroundecanoic acid (PFUdA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorodecanoic acid (PFDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorononanoic acid (PFNA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluoroheptanoic acid (PFHpA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorooctane sulfonate (PFOS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorohexane sulfonate (PFHxS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorobutane sulfonate (PFBS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorooctanoic acid (PFOA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorohexanoic acid (PFHxA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluoropentanoic acid (PFPeA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorobutyric acid (PFBA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluoroheptane sulfonic Acid (PFHpS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------

Parameter/Analyte	Non-potable Water (1)	Solid and Chemical Materials (2)
Perfluorodecane sulfonate (PFDS)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------
Perfluorotridecanoic acid (PFTrDA)	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	-----------------------------------

Parameter/Analyte	Potable Water	Non-potable Water (1)	Solid and Chemical Materials (2)
Radiochemistry			
Gross alpha	EPA 900.0	EPA 900.0	EPA 900.0
Gross beta	EPA 900.0	EPA 900.0	EPA 900.0
Ra-226	EPA 903.0	EPA 903.0	EPA 903.0
Ra-228	EPA 904.0	EPA 9320/904.0	EPA 9320/904.0
Gamma emitters	EPA 901.1	EPA 901.1	EPA 901.1
Total alpha	----------------	EPA 900.0/9310	EPA 900.0/9310
Total beta	----------------	EPA 900.0/9310	EPA 900.0/9310
Total radium	----------------	EPA 903.0/9315	EPA 903.0/9315

(1) Method List includes Clean Water Act and RCRA water parameters.
(2) Method List includes RCRA parameters only.

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 TNI Standard, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Parameter/Analyte	Potable Water
Metals	
Aluminum	EPA 200.7
Antimony	EPA 200.8
Arsenic	EPA 200.7/200.8
Barium	EPA 200.7/200.8
Beryllium	EPA 200.7/200.8
Boron	EPA 200.7
Cadmium	EPA 200.7/200.8
Calcium	EPA 200.7
Chromium	EPA 200.7/200.8
Cobalt	EPA 200.7/200.8
Copper	EPA 200.7/200.8
Iron	EPA 200.7
Lead	EPA 200.7/200.8
Lithium	EPA 200.7
Magnesium	EPA 200.7
Manganese	EPA 200.7/200.8
Mercury	EPA 245.1
Molybdenum	EPA 200.7
Nickel	EPA 200.7/200.8
Potassium	EPA 200.7
Selenium	EPA 200.7/200.8
Silver	EPA 200.7/200.8
Sodium	EPA 200.7

Parameter/Analyte	**Potable Water**
Strontium	EPA 200.7
Thallium	EPA 200.8
Uranium	EPA 200.8
Vanadium	EPA 200.7
Zinc	EPA 200.7/200.8
Wet Chemistry	
Alkalinity	EPA 310.1
Bromide	EPA 300.0
Chloride	EPA 300.0 EPA 325.2 SM 4500-Cl-E
Conductivity	SM 2510B
Dissolved Methane	RSK 175
Hardness	SM 2340B
MBAS	SM 5540C
Nitrate	EPA 300.0 EPA 353.2 SM 4500-NO_3-F
pH	EPA 150.1 SM 4500-H+B
TOC	SM 5310C
Total Dissolved Solids	EPA 160.1 SM 2540C
Total Suspended Solids	EPA 160.2 SM 2540D
PFAS by LC/MS/MS	
N-Ethylperfluorooctanesufonamido acetic acid (N-EtFOSAA)	EPA 537
N-Methylperfluorooctanesulfonamido acetic acid (N-MeFOSAA)	EPA 537
Perfluorobutane sulfonate (PFBS)	EPA 537
Perfluorodecanoic acid (PFDA)	EPA 537
Perfluorododecanoic acid (PFDoA)	EPA 537
Perfluoroheptanoic acid (PFHpA)	EPA 537
Perfluorohexane sulfonate (PFHxS)	EPA 537
Perfluorohexanoic acid (PFHxA)	EPA 537
Perfluorononanoic acid (PFNA)	EPA 537
Perfluorooctane sulfonate (PFOS)	EPA 537
Perfluorooctanoic acid (PFOA)	EPA 537
Perfluorotetradecanoic acid (PFTA)	EPA 537
Perfluorotridecanoic acid (PFTrDA)	EPA 537
Perfluoroundecanoic acid (PFUnA)	EPA 537

Accredited Laboratory

A2LA has accredited

MICROBAC LABORATORIES, INC.
OHIO VALLEY DIVISION

Marietta, OH

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, ISO/IEC 17025:2017, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated *April 2017*).

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Presented this 21st day of December 2018.

Senior Director, Accreditation Services
For the Accreditation Council
Certificate Number 2936.01
Valid to December 31, 2020

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

CT LABORATORIES
1230 Lange Court
Baraboo, WI 53913
Becky Duranceau Phone: (608) 356 2760

ENVIRONMENTAL

Valid To: May 31, 2020 Certificate Number: 3806.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 TNI Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Assay, Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), IR Spectrometry, Titrimetry, Total Organic Carbon, Turbidity

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Classical Chemistry		
Alkalinity	EPA 310.2, SM 2320B	--------------
Ammonia (as N)	EPA 350.1 SM 4500-NH3 H	EPA350.1 SM 4500-NH3 H
Bromide	EPA 300.0/9056A SM 4110B	EPA 9056A
Biological Oxygen Demand	SM 5210B	--------------
Chemical Oxygen Demand	EPA 410.4	EPA 410.4 SM 5220D
Chloride	EPA 300.0/9056A SM 4110 B	EPA 9056A
Conductivity	EPA 9050A	--------------
Fluoride	EPA 300.0/9056A SM 4110B	EPA 9056A
Hardness	EPA 6010C SM 2340B	--------------
Hexavalent Chromium	EPA 7199	EPA 7199
Nitrate + Nitrite	EPA 300.0/353.2/9056 A SM 4110B	EPA 9056A

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Nitrate (as N)	EPA 300.0/9056A SM 4110 B	EPA 9056A
Nitrite (as N)	EPA 300.0/9056A SM 4110 B	EPA 9056A
Nitrogen, Total Kjeldahl	EPA 351.2	EPA 351.2
Orthophosphate (as P)	EPA 300.0/9056A SM 4110 B	EPA 9056A
Phosphorus, Total	EPA 365.1/365.4	EPA 365.1/365.4
Organic Carbon, Total	EPA 415.1/9060A	EPA 9060A/Lloyd Kahn SM 5310B
Oil and Grease /HEM	EPA 1664A	EPA 9070A/9071B
pH	EPA 150.1/9040C SM 4500H^+B	EPA 9045D
Residue, Total	SM 2540B	SM 2540B
Residue Filterable	SM 2540C	SM 2540C
Residue Nonfilterable	EPA 160.2 SM 2540D	--------------
Residue Total Volatile	EPA 160.4	SM 2540G
Sulfate	EPA 300.0/9056A SM 4110B	EPA 9056A
Sulfide	EPA 376.1/9034 SM 4500 S_2F	--------------
Turbidity	EPA 180.1	--------------
Metals		
Aluminum	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Antimony	EPA 200.7/200.9/6010C/7010/6010D	EPA 6010C/6010D
Arsenic	EPA 200.7/200.9/6010C/7010/6010D	EPA 6010C/7010/6010D
Barium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Beryllium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Boron	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Cadmium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Calcium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Chromium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Chromium +3	EPA 6010C~~/~~/6010D	EPA 6010C/6010D
Chromium +6	EPA 7196A	EPA 7196A
Cobalt	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Copper	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Iron	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Iron Ferrous	SM 3500 Fe B	--------------
Lead	EPA 200.7/200.9/6010C/7010/6010D	EPA 6010C/7010/6010D
Lithium	EPA 200.7/6010C/6010D	--------------
Magnesium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Manganese	EPA 200.7/6010C/6010D	EPA 6010C/6010D

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Mercury	EPA 245.1/7470A	EPA 7471B
Molybdenum	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Nickel	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Potassium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Selenium	EPA 200.7/200.9/6010C/7010/ 6010D	EPA 6010C/7010/6010D
Silica	--------------	EPA 6010C/6010D
Silver	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Sodium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Strontium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Thallium	EPA 200.7/200.9/6010C/7010/ 6010D	EPA 6010C/7010/6010D
Tin	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Vanadium	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Zinc	EPA 200.7/6010C/6010D	EPA 6010C/6010D
Purgeable Organics (volatiles) Low Level		
1,1,1,2-Tetrachloroethane	EPA 8260C	EPA 8260C
1,1,1-Trichloroethane	EPA 8260C	EPA 8260C
1,1,2,2-Tetrachloroethane	EPA 8260C	EPA 8260C
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260C	EPA 8260C
1,1,2-Trichloroethane	EPA 8260C	EPA 8260C
1,1-Dichloroethane	EPA 8260C	EPA 8260C
1,1-Dichloroethene	EPA 8260C	EPA 8260C
1,1-Dichloropropene	EPA 8260C	EPA 8260C
1,2,3-Trichlorobenzene	EPA 8260C	EPA 8260C
1,2,3-Trichloropropane	EPA 8260C	EPA 8260C
1,2,4-Trichorobenzene	EPA 8260C	EPA 8260C
1,2,4-Trimethylbenzene	EPA 8260C	EPA 8260C
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260C	EPA 8260C
1,2-Dibromomethane (EDB)	EPA 8260C	EPA 8260C
1,2-Dichloro-1,1,2-trifluoroethane	EPA 8260C	EPA 8260C
1,2-Dichlorobenzene	EPA 8260C	EPA 8260C
1,2-Dichloroethane	EPA 8260C	EPA 8260C
1,2-Dichloropropane	EPA 8260C	EPA 8260C
1,3-Dichlorobenzene	EPA 8260C	EPA 8260C
1,3-Dichloropropane	EPA 8260C	EPA 8260C
1,3,5-Trichlorobenzene	--------------	EPA 8260C
1,3,5-Trimethylbenzene	EPA 8260C	EPA 8260C
1,4-Dichloro-2-butene	EPA 8260C	EPA 8260C
1,4-Dichlorobenzene	EPA 8260C	EPA 8260C
1,4-Dioxane	EPA 8260C	EPA 8260C
1-Chlorohexane	EPA 8260C	EPA 8260C

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
2,2-Dichloropropane	EPA 8260C	EPA 8260C
2,3-Dichloro-1-propene	EPA 8260C	EPA 8260C
2-Butanone	EPA 8260C	EPA 8260C
2-Chloroethyl vinyl ether	EPA 8260C	EPA 8260C
2-Chlorotoluene	EPA 8260C	EPA 8260C
2-Hexanone	EPA 8260C	EPA 8260C
2-Nitropropane	EPA 8260C	EPA 8260C
4-Chlorotoluene	EPA 8260C	EPA 8260C
4-Methyl-2-pentanone	EPA 8260C	EPA 8260C
Acrylein	--------------	EPA 8260C
Acrylonitrile	--------------	EPA 8260C
Acetone	EPA 8260C	EPA 8260C
Ally chloride	--------------	EPA 8260C
Benzene	EPA 8260C	EPA 8260C
Bromobenzene	EPA 8260C	EPA 8260C
Bromochloromethane	EPA 8260C	EPA 8260C
Bromodichloromethane	EPA 8260C	EPA 8260C
Bromoform	EPA 8260C	EPA 8260C
Bromomethane	EPA 8260C	EPA 8260C
Carbon disulfide	EPA 8260C	EPA 8260C
Carbon tetrachloride	EPA 8260C	EPA 8260C
Chlorobenzene	EPA 8260C	EPA 8260C
Chloroethane	EPA 8260C	EPA 8260C
Chloroform	EPA 8260C	EPA 8260C
Chloromethane	EPA 8260C	EPA 8260C
cis-1,2-Dichloroethene	EPA 8260C	EPA 8260C
cis-1,3-Dichloropropene	EPA 8260C	EPA 8260C
Cyclohexane	EPA 8260C	EPA 8260C
Cyclohexanone	--------------	EPA 8260C
Dibromochloromethane	EPA 8260C	EPA 8260C
Dibromomethane	EPA 8260C	EPA 8260C
Dichlorodifluoromethane	EPA 8260C	EPA 8260C
Dichlorofluoromethane	EPA 8260C	EPA 8260C
Diisopropyl ether	EPA 8260C	EPA 8260C
Ethyl acetate	EPA 8260C	EPA 8260C
Ethyl benzene	EPA 8260C	EPA 8260C
Ethyl ether	EPA 8260C	EPA 8260C
Ethyl methacrylate	--------------	EPA 8260C
Ethyl tertiary butyl ether	--------------	EPA 8260C
Hexachlorobutadiene	EPA 8260C	EPA 8260C
Hexane	EPA 8260C	EPA 8260C
Iodomethane	EPA 8260C	EPA 8260C
Isopropylbenzene	EPA 8260C	EPA 8260C
Methyl acetate	EPA 8260C	EPA 8260C
Methyl methacrylate	EPA 8260C	EPA 8260C
Methyl tert butyl ether	EPA 8260C	EPA 8260C
Methylcyclohexane	EPA 8260C	EPA 8260C

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Methylene chloride	EPA 8260C	EPA 8260C
m & p-Xylene	EPA 8260C	EPA 8260C
Naphthalene	EPA 8260C	EPA 8260C
n-Butylbenzene	EPA 8260C	EPA 8260C
n-Propylbenzene	EPA 8260C	EPA 8260C
o-Xylene	EPA 8260C	EPA 8260C
Propylene oxide	EPA 8260C	EPA 8260C
p-Isopropyltoluene	EPA 8260C	EPA 8260C
sec-Butylbenzene	EPA 8260C	EPA 8260C
Styrene	EPA 8260C	EPA 8260C
tert-Butyl alcohol	EPA 8260C	EPA 8260C
tert-Butylbenzene	EPA 8260C	EPA 8260C
tert-amyl methyl ether	--------------	EPA 8260C
Tetrachloroethene	EPA 8260C	EPA 8260C
Tetrahydrofuran	EPA 8260C	EPA 8260C
Toluene	EPA 8260C	EPA 8260C
trans-1,2-Dichloroethene	EPA 8260C	EPA 8260C
trans-1,3-Dichloropropene	EPA 8260C	EPA 8260C
Trichloroethene	EPA 8260C	EPA 8260C
Trichlorofluoromethane	EPA 8260C	EPA 8260C
Vinyl acetate	EPA 8260C	EPA 8260C
Vinyl chloride	EPA 8260C	EPA 8260C
Xylenes, total	EPA 8260C	EPA 8260C
Purgeable Organics (volatiles) Medium Level		
1,1,1,2-Tetrachloroethane	EPA 8260C	EPA 8260C
1,1,1-Trichloroethane	EPA 8260C	EPA 8260C
1,1,2,2-Tetrachloroethane	EPA 8260C	EPA 8260C
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260C	EPA 8260C
1,1,2-Trichloroethane	EPA 8260C	EPA 8260C
1,1-Dichloroethane	EPA 8260C	EPA 8260C
1,1-Dichloroethene	EPA 8260C	EPA 8260C
1,1-Dichloropropene	EPA 8260C	EPA 8260C
1,2,3-Trichlorobenzene	EPA 8260C	EPA 8260C
1,2,3-Trichloropropane	EPA 8260C	EPA 8260C
1,2,4-Trichorobenzene	EPA 8260C	EPA 8260C
1,2,4-Trimethylbenzene	EPA 8260C	EPA 8260C
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260C	EPA 8260C
1,2-Dibromomethane (EDB)	EPA 8260C	EPA 8260C
1,3,5-Trichlorobenzene	EPA 8260C	EPA 8260C
1,3,5-Trimethylbenzene	EPA 8260C	EPA 8260C
1,2-Dichloro-1,1,2-trifluoroethane	EPA 8260C	EPA 8260C
1,2-Dichlorobenzene	EPA 8260C	EPA 8260C

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
1,2-Dichloroethane	EPA 8260C	EPA 8260C
1,2-Dichloropropane	EPA 8260C	EPA 8260C
1,3-Dichlorobenzene	EPA 8260C	EPA 8260C
1,3-Dichloropropane	EPA 8260C	EPA 8260C
1,4-Dichloro-2-butene	EPA 8260C	EPA 8260C
1,4-Dichlorobenzene	EPA 8260C	EPA 8260C
1,4-Dioxane	EPA 8260C SIM	EPA 8260C SIM
1-Chlorohexane	EPA 8260C	EPA 8260C
2,2-Dichloropropane	EPA 8260C	EPA 8260C
2-Butanone	EPA 8260C	EPA 8260C
2-Chloroethyl vinyl ether	EPA 8260C	EPA 8260C
2-Chlorotoluene	EPA 8260C	EPA 8260C
2-Hexanone	EPA 8260C	EPA 8260C
2-Nitropropane	EPA 8260C	EPA 8260C
4-Chlorotoluene	EPA 8260C	EPA 8260C
4-Methyl-2-pentanone	EPA 8260C	EPA 8260C
Acetone	EPA 8260C	EPA 8260C
Acrylein	EPA 8260C	EPA 8260C
Acrylonitrile	EPA 8260C	EPA 8260C
Benzene	EPA 8260C	EPA 8260C
Bromobenzene	EPA 8260C	EPA 8260C
Bromochloromethane	EPA 8260C	EPA 8260C
Bromodichloromethane	EPA 8260C	EPA 8260C
Bromoform	EPA 8260C	EPA 8260C
Bromomethane	EPA 8260C	EPA 8260C
Carbon disulfide	EPA 8260C	EPA 8260C
Carbon tetrachloride	EPA 8260C	EPA 8260C
Chlorobenzene	EPA 8260C	EPA 8260C
Chloroethane	EPA 8260C	EPA 8260C
Chloroform	EPA 8260C	EPA 8260C
Chloromethane	EPA 8260C	EPA 8260C
Chloroprene	EPA 8260C	EPA 8260C
cis-1,2-Dichloroethene	EPA 8260C	EPA 8260C
cis-1,3-Dichloropropene	EPA 8260C	EPA 8260C
Cyclohexane	EPA 8260C	EPA 8260C
Cyclohexanone	EPA 8260C	EPA 8260C
Dibromochloromethane	EPA 8260C	EPA 8260C
Dibromomethane	EPA 8260C	EPA 8260C
Dichlorodifluoromethane	EPA 8260C	EPA 8260C
Dichlorofluoromethane	EPA 8260C	EPA 8260C
Diisopropyl ether	EPA 8260C	EPA 8260C
Ethyl acetate	EPA 8260C	EPA 8260C
Ethyl benzene	EPA 8260C	EPA 8260C
Ethyl ether	EPA 8260C	EPA 8260C
Ethyl methacrylate	EPA 8260C	EPA 8260C
Ethyl tert butyl ether	EPA 8260C	EPA 8260C
Hexachlorobutadiene	EPA 8260C	EPA 8260C

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Hexane	EPA 8260C	EPA 8260C
Iodomethane	EPA 8260C	EPA 8260C
Isopropylbenzene	EPA 8260C	EPA 8260C
Methyl acetate	EPA 8260C	EPA 8260C
Methyl methacrylate	EPA 8260C	EPA 8260C
Methyl tert butyl ether	EPA 8260C	EPA 8260C
Methylcyclohexane	EPA 8260C	EPA 8260C
Methylene chloride	EPA 8260C	EPA 8260C
m & p-Xylene	EPA 8260C	EPA 8260C
Naphthalene	EPA 8260C	EPA 8260C
n-Butylbenzene	EPA 8260C	EPA 8260C
n-Propylbenzene	EPA 8260C	EPA 8260C
o-Xylene	EPA 8260C	EPA 8260C
Propylene oxide	EPA 8260C	EPA 8260C
p-Isopropyltoluene	EPA 8260C	EPA 8260C
sec-Butylbenzene	EPA 8260C	EPA 8260C
Styrene	EPA 8260C	EPA 8260C
Tertiary amyl methyl ether	EPA 8260C	EPA 8260C
tert-Butyl alcohol	EPA 8260C	EPA 8260C
tert-Butylbenzene	EPA 8260C	EPA 8260C
Tetrachloroethene	EPA 8260C	EPA 8260C
Tetrahydrofuran	EPA 8260C	EPA 8260C
Toluene	EPA 8260C	EPA 8260C
trans-1,2-Dichloroethene	EPA 8260C	EPA 8260C
trans-1,3-Dichloropropene	EPA 8260C	EPA 8260C
Trichloroethene	EPA 8260C	EPA 8260C
Trichlorofluoromethane	EPA 8260C	EPA 8260C
Vinyl acetate	EPA 8260C	EPA 8260C
Vinyl chloride	EPA 8260C	EPA 8260C
Xylenes, total	EPA 8260C	EPA 8260C
Dissolved Gasses		
Acetylene	RSK 175	
Carbon Dioxide	RSK 175 SM 4500 CO2 D	--------------
Ethane	RSK 175	--------------
Ethene	RSK 175	--------------
Methane	RSK 175	--------------
Extractable Organics (semivolatiles)		
1,2,4,5-Tetrachlorobenzene	EPA 8270D	EPA 8270D
1,2,4-Trichlorobenzene	EPA 8270D	EPA 8270D
1,2-Dichlorobenzene	EPA 8270D	EPA 8270D
1,3-Dichlorobenzene	EPA 8270D	EPA 8270D
1,4-Dichlorobenzene	EPA 8270D	EPA 8270D
1,4-Dioxane	EPA 8270D SIM	EPA 8270D SIM

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
1,4 -Dithiane	EPA 8270D	--------------
1,4-Oxathiane	EPA 8270D	--------------
1-Methylnaphthalene	EPA 8270D	EPA 8270D
2,3,4,6-Tetrachlorophenol	EPA 8270D	EPA 8270D
2,4,5-Trichlorophenol	EPA 8270D	EPA 8270D
2,4,6-Trichlorophenol	EPA 8270D	EPA 8270D
2,4-Dichlorophenol	EPA 8270D	EPA 8270D
2,4-Dimethylphenol	EPA 8270D	EPA 8270D
2,4-Dinitrophenol	EPA 8270D	EPA 8270D
2,4-Dinitrotoluene	EPA 8270D	EPA 8270D
2,6-Dichlorophenol	EPA 8270D	EPA 8270D
2,6-Dinitrotoluene	EPA 8270D	EPA 8270D
2-Chloronaphthalene	EPA 8270D	EPA 8270D
2-Chlorophenol	EPA 8270D	EPA 8270D
2-Methylnaphthalene	EPA 8270D	EPA 8270D
2-Methylphenol	EPA 8270D	EPA 8270D
2-Nitroaniline	EPA 8270D	EPA 8270D
2-Nitrophenol	EPA 8270D	EPA 8270D
3 & 4-Methylphenol	EPA 8270D	EPA 8270D
3,3'-Dichlorobenzidine	EPA 8270D	EPA 8270D
3-Nitroaniline	EPA 8270D	EPA 8270D
4,6-Dinitro-2-methylphenol	EPA 8270D	EPA 8270D
4-Bromophenyl-phenyl ether	EPA 8270D	EPA 8270D
4-Chloro-3-methylphenol	EPA 8270D	EPA 8270D
4-Chloroaniline	EPA 8270D	EPA 8270D
4-Chlorophenyl-phenyl ether	EPA 8270D	EPA 8270D
4-Nitroaniline	EPA 8270D	EPA 8270D
4-Nitrophenol	EPA 8270D	EPA 8270D
Acenaphthene	EPA 8270D	EPA 8270D
Acenaphthylene	EPA 8270D	EPA 8270D
Acetophenone	EPA 8270D	EPA 8270D
Aniline	EPA 8270D	EPA 8270D
Anthracene	EPA 8270D	EPA 8270D
Atrazine	EPA 8270D	EPA 8270D
Azobenzene & 1,2-Diphenylhydrazene	EPA 8270D	EPA 8270D
Benzaldehyde	EPA 8270D	EPA 8270D
Benzidine	EPA 8270D	EPA 8270D
Benzo(a)anthracene	EPA 8270D	EPA 8270D
Benzo(a)pyrene	EPA 8270D	EPA 8270D
Benzo(b)fluoranthene	EPA 8270D	EPA 8270D
Benzo(g,h,i)perylene	EPA 8270D	EPA 8270D
Benzo(k)fluoranthene	EPA 8270D	EPA 8270D
Benzoic acid	EPA 8270D	EPA 8270D
Benzothiazole	EPA 8270D	--------------
Benzyl alcohol	EPA 8270D	EPA 8270D
1,1’Biphenyl	EPA 8270D	EPA 8270D

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Bis(2-chloroethoxy)methane	EPA 8270D	EPA 8270D
Bis(2-chloroethyl)ether	EPA 8270D	EPA 8270D
Bis(2-chloroisopropyl)ether	EPA 8270D	EPA 8270D
Bis(2-ethylhexyl)phthalate	EPA 8270D	EPA 8270D
Butylbenzylphthalate	EPA 8270D	EPA 8270D
Caprolactam	EPA 8270D	EPA 8270D
Carbazole	EPA 8270D	EPA 8270D
Chrysene	EPA 8270D	EPA 8270D
Dibenzo(a,h)anthracene	EPA 8270D	EPA 8270D
Dibenzofuran	EPA 8270D	EPA 8270D
Diethylphthalate	EPA 8270D	EPA 8270D
Diisopropyl methylphosphonate	EPA 8270D	--------------
Dimethyl methylphosphonate	EPA 8270D	--------------
Dimethylphthalate	EPA 8270D	EPA 8270D
Dimethyl disulfide	EPA 8270D	--------------
Di-n-butylphthalate	EPA 8270D	EPA 8270D
Di-n-octylphthalate	EPA 8270D	EPA 8270D
Fluoranthene	EPA 8270D	EPA 8270D
Fluorene	EPA 8270D	EPA 8270D
Hexachlorobenzene	EPA 8270D	EPA 8270D
Hexachlorocyclopentadiene	EPA 8270D	EPA 8270D
Hexachloroethane	EPA 8270D	EPA 8270D
Indeno(1,2,3-cd)pyrene	EPA 8270D	EPA 8270D
Isophorone	EPA 8270D	EPA 8270D
Naphthalene	EPA 8270D	EPA 8270D
Nitrobenzene	EPA 8270D	EPA 8270D
n-Nitrosodimethylamine	EPA 8270D	EPA 8270D
n-Nitroso-di-n-propylamine	EPA 8270D	EPA 8270D
n-Nitrosodiphenylamine & Diphenylamine	EPA 8270D	EPA 8270D
n-Nitrosopyrrolidine	EPA 8270D	EPA 8270D
Pentachlorophenol	EPA 8270D	EPA 8270D
Phenanthrene	EPA 8270D	EPA 8270D
Phenol	EPA 8270D	EPA 8270D
Pyrene	EPA 8270D	EPA 8270D
Pyridine	EPA 8270D	EPA 8270D
p-Chlorophenyl methyl sulfide	EPA 8270D	--------------
p-Chlorophenyl methyl sulfone	EPA 8270D	--------------
p-Chlorophenyl methysulfoxide	EPA 8270D	--------------
Pesticides/PCBs		
Aldrin	EPA 8081B	EPA 8081B
alpha-BHC	EPA 8081B	EPA 8081B
beta-BHC	EPA 8081B	EPA 8081B

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
delta-BHC	EPA 8081B	EPA 8081B
gamma-BHC (Lindane)	EPA 8081B	EPA 8081B
alpha-Chlordane	EPA 8081B	EPA 8081B
gamma-Chlordane	EPA 8081B	EPA 8081B
DDD (4,4)	EPA 8081B	EPA 8081B
DDE (4,4)	EPA 8081B	EPA 8081B
DDT (4,4)	EPA 8081B	EPA 8081B
DDD (2,4)	EPA 8081B	EPA 8081B
DDE (2,4)	EPA 8081B	EPA 8081B
DDT (2,4)	EPA 8081B	EPA 8081B
Dieldrin	EPA 8081B	EPA 8081B
Endosulfan I	EPA 8081B	EPA 8081B
Endosulfan II	EPA 8081B	EPA 8081B
Endosulfan sulfate	EPA 8081B	EPA 8081B
Endrin	EPA 8081B	EPA 8081B
Endrin aldehyde	EPA 8081B	EPA 8081B
Endrin ketone	EPA 8081B	EPA 8081B
Heptachlor	EPA 8081B	EPA 8081B
Heptachlor Epoxide (beta)	EPA 8081B	EPA 8081B
Methoxychlor	EPA 8081B	EPA 8081B
Chlordane (technical)	EPA 8081B	EPA 8081B
Toxaphene (total)	EPA 8081B	EPA 8081B
Aroclor 1016	EPA 8082A	EPA 8082A
Aroclor 1221	EPA 8082A	EPA 8082A
Aroclor 1232	EPA 8082A	EPA 8082A
Aroclor 1242	EPA 8082A	EPA 8082A
Aroclor 1248	EPA 8082A	EPA 8082A
Aroclor 1254	EPA 8082A	EPA 8082A
Aroclor 1260	EPA 8082A	EPA 8082A
Aroclor 1262	EPA 8082A	EPA 8082A
Aroclor 1268	EPA 8082A	EPA 8082A
Low Level PAH		
Acenaphthene	EPA 8270D SIM	EPA 8270D SIM
Acenaphthylene	EPA 8270D SIM	EPA 8270D SIM
Anthracene	EPA 8270D SIM	EPA 8270D SIM
Benzo(a)anthracene	EPA 8270D SIM	EPA 8270D SIM
Benzo(b)fluoranthene	EPA 8270D SIM	EPA 8270D SIM
Benzo(k)fluoranthene	EPA 8270D SIM	EPA 8270D SIM
Benzo(g,h,i)perylene	EPA 8270D SIM	EPA 8270D SIM
Benzo(a)pyrene	EPA 8270D SIM	EPA 8270D SIM
Chrysene	EPA 8270D SIM	EPA 8270D SIM
Dibenz(a,h)anthracene	EPA 8270D SIM	EPA 8270D SIM
Fluoranthene	EPA 8270D SIM	EPA 8270D SIM
Fluorene	EPA 8270D SIM	EPA 8270D SIM
Indeno(1,2,3-cd)pyrene	EPA 8270D SIM	EPA 8270D SIM
1-Methylnaphthalene	EPA 8270D SIM	EPA 8270D SIM

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
2-Methylnaphthalene	EPA 8270D SIM	EPA 8270D SIM
Naphthalene	EPA 8270D SIM	EPA 8270D SIM
Phenanthrene	EPA 8270D SIM	EPA 8270D SIM
Pyrene	EPA 8270D SIM	EPA 8270D SIM
Explosives		
2-Amino-4,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
4-Amino-2,6-dinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
1,3-Dinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B
2,3-Dinitrotoluene	EPA 8270D SIM	EPA 8270D SIM
2,4-Dinitrotoluene	EPA 8330A/8330B/8270D SIM	EPA 8330A/8330B/8270D SIM
2,5-Dinitrotoluene	EPA 8270D SIM	EPA 8270D SIM
2,6-Dinitrotoluene	EPA 8330A/8330B/8270D SIM	EPA 8330A/8330B/8270D SIM
3,4-Dinitrotoluene	EPA 8270D SIM	EPA 8270D SIM
3,5-Dinitrotoluene	EPA 8270D SIM	EPA 8270D SIM
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	EPA 8330A/8330B	EPA 8330A/8330B
Nitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B
2-Nitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
3-Nitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
4-Nitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330A/8330B	EPA 8330A/8330B
Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	EPA 8330A/8330B	EPA 8330A/8330B
1,3,5-Trinitrobenzene	EPA 8330A/8330B	EPA 8330A/8330B
2,4,6-Trinitrotoluene	EPA 8330A/8330B	EPA 8330A/8330B
3,5-Dinitroaniline	EPA 8330A/8330B	EPA 8330A/8330B
PETN	EPA 8330A/8330B	EPA 8330A/8330B
Nitroguanidine	EPA 8330A/8330B	EPA 8330A/8330B
Nitroglycerine	EPA 8330A/8330B	EPA 8330A/8330B
Nitrocellulose	EPA 9056M	EPA 9056M
Herbicides		
2,4-D	EPA 8151	--------------
2,4,5-TP	EPA 8151	--------------
Glycols		
Ethylene glycol	EPA 8015B	--------------
Propylene glycol	EPA 8015B	--------------
Thiodiglycol	Thiodiglycol by HPLC	--------------
Petroleum Hydrocarbons		
Gas Range Organics (GRO)	EPA 8015C	EPA 8015C
Diesel Range Organics (DRO)	EPA 8015C	EPA 8015C
Wisconsin GRO	WI GRO	WI GRO
Wisconsin DRO	WI DRO	WI DRO

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Extended Range Organics (ERO, ORO, RRO)	EPA 8015C	EPA 8015C
HazardousWaste Characteristics		
Ignitability	EPA 1010A	EPA 1010A
Paint Filter Liquids Test	------------	EPA 9095 B
Reactive Cyanide	EPA SW 846 Ch. 7	EPA SW 846 Ch. 7
Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312	EPA 1312
Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311	EPA 1311
Prep & Clean-up Methods		
VOC	EPA 5030B	EPA 5035
Organic Semi-volatiles	EPA 3510C/3535A/3620C/ 3640A/3660B/3665A	EPA 3540C/3545/3545A/3546/ 3580A/3620C/3640A/3660B/ 3665A
Metals	EPA 3005A/3010 /3015/3020	EPA 3050B

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for technical competence in the field of

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In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated *April 2017*).

Presented this 13th day of September 2018.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3806.01
Valid to May 31, 2020
Revised on April 30, 2020

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

Appendix D
TDEC and USEPA Approval Letters and Responses to USEPA Comments

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

September 20, 2019

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 Offsite Groundwater Investigation QAPP (Rev 0)**
Defense Depot Memphis, Tennessee
TDoR ID # 79-736
TN4210020570

Mr. Foster,

TDEC-DoR has reviewed the **Dunn Field Offsite Groundwater Investigation QAPP (Rev 0)**, as compiled by HDR Inc., and approves of the proposed investigation strategy. If there are additional issues of concern, 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: Joan Hutton (CALIBRE)
T. Holmes (HDR Inc)
D. Lloyd (EPA-PM)
TDoR NCO: file 79-736
TDoR MEFO: file 79-736

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

April 21, 2020

Mr. James C. Foster
Assistant Chief of Staff for Installation Management
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The U.S. Environmental Protection Agency (EPA) has reviewed the Revised Comment Responses for the Department of Army, Defense Depot of Memphis, Tennessee Dunn Field Offsite Groundwater Investigation QAPP/SAP, Revision 0, dated July 2019.

EPA provides approval for the above mentioned document and appreciates the U.S. Army's efforts to address EPA concerns and the potential offsite contamination. Should you have any questions or concerns, please feel free to call me on my cell number 404-229-9500.

Sincerely,

Diedre Lloyd

Diedre Lloyd
Remedial Project Manager
Restoration & Sustainability Branch
Superfund Division

cc: Mr. James Foster, (Signed Original), United Parcel Service, Return Receipt
Mr. Jamie A. Woods, PG, Tennessee, Department of Environment and Conservation, Memphis Environmental Field Office, 8383 Wolf Lake Drive, Bartlett, TN 38133-4119
Ms. Joan Hutton, CALIBRE, 3898 Mountain View Road, Kennesaw, GA 30152
Mr. Thomas Holmes, HDR Environmental, P.O. Box 728, Highlands, NC 28741

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
Dunn Field Offsite Groundwater Investigation QAPP, Revision 0, July 2019
Defense Depot Memphis, Tennessee
Comments Received: 12 November 2019

EPA General Comments:

1. The report title should include that this document is also intended as a sampling analysis plan (SAP) in addition to QAPP.

   Response G1: The document title will be revised to Dunn Field Offsite Investigation QAPP-SAP.

2. Throughout the above referenced Offsite Investigation QAPP/SAP document, it is asserted as fact that the contamination on the N/NW/NE portion of Dunn Field is from to offsite source. However, previous investigations by TDEC and to date have not identified a specific source. There has also been documented contaminant rebound on the Dunn Field OU and some unexplained “hot spots” and this information should also be included in this report or US Army assertions of offsite contamination should be modified by the language that demonstrates this is a potential and not a fact as has been commented upon by EPA many times in previous documents.

   Response G2: Army does not consider an offsite source for the plume along the northern boundary of Dunn Field to be a fact. The purpose of this Offsite Investigation is to obtain additional data on the CVOC concentrations from new and existing wells on Dunn Field and offsite to the north and northeast of Dunn Field in order to evaluate additional lines of evidence for the contaminant source of the CVOCs detected in the monitoring wells. The following text is provided in the report and revisions to the text may not be necessary.
   - Page 15 of the QAPP states TDEC’s conclusion that the Cintas ESI “did not indicate an upgradient source for the CVOCs in MW-129 and MW-130.”
   - Page 16 of the QAPP and elsewhere include statements such as “the North plume is considered to have both onsite and offsite sources”.
   - Other than the DF North plume, the QAPP does not state that groundwater contamination at Dunn Field is due to an offsite source(s). In addition, the DF North plume is unrelated to the contaminant rebound and unexplained ‘hot spots’ referenced in the comment.
   - The only area of contaminant rebound exceeding the treatment goal of 50 µg/L is at MW-87, which is approximately 2,000 feet from the northeast boundary of Dunn Field and not associated with the DF North plume.
   - Wells MW-144 and MW-190 were within the main groundwater plume originating on Dunn Field (see QAPP Figure A-5.2) and had concentrations of TeCA and TCE above 1,000 µg/L in 2006 prior to implementation of the selected remedy; concentrations now greatly reduced, are near 10 µg/L for TeCA and 30 µg/L for TCE. Concentrations have been stable in the past few years.

3. The provided figures are insufficient to determine many items as indicated in the below comments and will be further outlined in this comment. Figures throughout the report are difficult to interpret/determine what is being depicted. The scale used along with the chosen paper size of 8 x 11 and the orientation (portrait instead of landscape) used are such that a magnifying glass is needed to determine where depicted items are located and even with a magnifying glass it is still difficult to see the actual label associated with a depicted item. This is not useful when attempting to determine the placement of potential future monitor wells installations. Please consider this in all future submissions.
   a. Figures 1-4 need to be revised as outlined below, specifically.
      i. Change paper size to next larger size (11 x 14)
      ii. Change orientation to landscape to capture the entire figure and use entire allocated space on the page
      iii. Ensure that the well locations are easily identifiable
      iv. The plumes overlie each other in figure 4 and colors for each plume blend together so much it is difficult to determine one plume from another. It would be beneficial to have a PCE plume map, TCE plume map and DCE plume map.

Response G3: The print copy of the Offsite Investigation QAPP provided to EPA were to have had the following figure dimensions: Figure 1 36x24; Figure 2 17x11; Figure 3 17x11; Figure 4 36x24. Additional plume maps for PCE, TCE and DCE will be provided in the final revision for this QAPP. Comment 3.a.i to iii will be considered in future documents.

4. Worksheet #11 (Project Data Quality Objectives) indicates that the goal of the study is to evaluate potential off-site sources of chlorinated volatile organic compounds (VOCs), and Worksheet #10 (Conceptual Site Model) presents a summary of numerous historical investigations; however, the Dunn Field Offsite Groundwater Investigation QAPP, Revision 0, dated July 2019 (the QAPP) does not clearly identify the data gaps associated with the source determination and nature and extent of contamination investigation at Dunn Field. Therefore, it is unclear how the new well locations proposed in Worksheet #17 (Sampling Design and Rationale) are appropriate and applicable to meet the objective of the investigation.
   a. Revise the QAPP to provide a clear list of data gaps based on historical investigation data and specify how each data gap is being addressed by the proposed investigation.

Response G4a: Worksheet #10 provides a detailed review of previous investigations and groundwater monitoring results and a final Summary. The QAPP will be revised to state: The source of groundwater contamination present in wells upgradient of Dunn Field has not been identified. General data gaps are:

1. Limited distribution of existing monitoring wells upgradient of the Dunn Field North plume.
2. Limited sampling over time for wells upgradient of the Dunn Field North plume.

Specific Data Gaps to be addressed by each well are listed on Table 4 of WS #17.

The planned well locations were selected to augment previous wells installed by TDEC to provide more complete coverage of the area upgradient of the northeast section of Dunn Field. Army's goal is not necessarily to identify specific source(s) but to build sufficient evidence that upgradient sources exist based on the extent of upgradient groundwater contamination. Additional reasons for individual well locations are provided in Worksheet #17.

b. Provide a rationale for ONLY surficial/fluvial monitor well installations. Since the contamination of concern are DNAPLs (PCE/TCE) and are commonly found at depth combined with the potential for leakage and other preferential flow pathways between the aquifer units in this area due to the nearby MLGW well field pumping drawdown along with potential for stratigraphic leakage between units, it seems reasonable and potentially beneficial to consider MW installation beneath the surficial aquifer. Previous investigations have also been limited to shallow soil contamination and surficial groundwater (fluvial aquifer) MWs.

Response G4b: The QAPP will be revised to include the following:

This investigation is evaluating additional lines of evidence for an upgradient off-site source of the Dunn Field North plume, which is in the surficial, Fluvial Aquifer. The Fluvial Aquifer on Dunn Field and in the upgradient area is underlain by clay of the upper Claiborne formation, which limits potential for contaminant migration into deeper aquifers. Downward migration through a window or sink would be indicated by a depressed area of Fluvial Aquifer groundwater elevations, which is not observed in the vicinity of the Dunn Field North plume.

As discussed in the conference call with EPA, TDEC and Army on 3/24/20, the lithology and screen position for LTM wells (existing and abandoned) and TDEC wells in the investigation area were reviewed, as shown on attached Table 1 and addendum. Most of the wells were drilled into the clay at the base of the Fluvial Aquifer. The clay was not reached in three wells (MW-07, MW-08 and MW-29); the depth to the base of the aquifer was estimated at 80 ft bgs based on nearby wells. The saturated thickness was determined based on depth to water level and the base of the clay; the water levels in several TDEC wells were above the fluvial sand and the entire thickness of the sand was taken as the saturated thickness. The saturated thickness (Table 1) ranged from 16 to 34 feet. Well screens were

10 to 20 feet in length and the screened percentage of the saturated thickness ranged from 30% to 100%, based on the saturated thickness and the length of screen within the saturated fluvial sand. (Note: TDEC well CS-07 is excluded. The well diagram for CS-07 showed the screen to be in the clay beneath the fluvial sand).

The majority of wells were screened at the base of the fluvial sand: all TDEC wells except CS-07; existing LTM wells MW-129, MW-130 and MW-230; and abandoned LTM wells MW-51 and MW-128. Existing LTM well MW-07 was screened in the middle of the saturated zone. Existing LTM well MW-08 and abandoned well MW-29 were screened at the water table.

Well screens in the new wells will be installed just above the clay in order to evaluate presence of denser solvent contamination and to be consistent with the existing wells.

c. Please prepare a table to identify each proposed MW installation depth, screen, location and rationale.
    i. Please include the MW screen/aquifer interval that each TDEC MW intersects in this table also.

Response G4c: Planned depths, screen length and locations for the new wells are listed on Table 5 attached to the QAPP. The rationale for each new well location is listed in Table 4 in Worksheet #17. The existing TDEC wells are screened in the Fluvial Aquifer as stated on Table 1 attached to the QAPP.

5. According to Table 4 (Offsite Investigation and Well Locations) in Worksheet #17 (Sampling Design and Rationale), at least two wells are proposed to delineate tetrachloroethene (PCE) contamination; however, a figure depicting the current extent of PCE contamination is not included in the QAPP to demonstrate that the selected well locations are appropriate. Revise the QAPP to include a figure that depicts the current extent of PCE contamination in groundwater.

   Response G5: The QAPP will be revised to include a PCE plume map will be provided as noted in Response G3.

6. Figure 4 (Proposed Offsite Investigation Well Locations) depicts the modeled extent of trichloroethene (TCE) and 1,1-dichloroethene (1,1-DCE) contamination in groundwater; however, no data are presented for the wells on which the plume extents are based to support the depiction. Revise Figure 4 to present the TCE and 1,1-DCE data for each well that was used to model the extent of contamination.

   Response G6: Groundwater data for all wells in the investigation area are provided in Appendix A-1. The data for individual wells used to prepare plume maps for PCE, TCE and 1,1-DCE will be shown on the revised maps to be provided as noted in Response G3.

7. Based on review of Figure 4 (Proposed Offsite Investigation Well Locations), it is unclear why no additional monitoring well locations are proposed to delineate the extent of contamination to the north/northeast of CS-03. Similarly, it is unclear why no additional wells are proposed to the north of MW-08 and south of MW-230 which would bound the lateral extents of the plume. Revise the QAPP to address whether the extent of contamination has been delineated in these areas.

   Response G7: The QAPP will be revised to include the following:

   The extent of contamination north of MW-08 and south of MW-230 has not been fully delineated. However, results from other wells provide data on the extent of the plume in this area: existing wells MW-28, MW-68 and MW-78; and abandoned wells MW-09, MW-51 and MW-61.

   Additional wells to the north/northeast of CS-03 are not proposed because the purpose of this investigation does not require complete delineation of the plume. Army's goal is to provide sufficient evidence of an off-site source for the Dunn Field North plume.

8. Worksheets #3 & 5 (Project Organization and QAPP Distribution), #4, 7 & 8 (Personnel Qualifications and Sign-off Sheet), and #6 (Communication Pathways) identify Ms. Lynn Lutz as both the Project Chemist and the Quality Assurance (QA) Officer; however, the QA function should be independent of all data generation activities. Revise the QAPP to demonstrate the independence of the QA function.

   Response G8: Ms. Lutz has performed as both the QA Officer and the Project Chemist on this project for over 10 years. The QA tasks mainly involve development of the QAPP, oversight of sampling activities to ensure they meet the requirements described in the QAPP, and ensuring that lab activities such as sample containers and preservation are appropriate to the project and meet QAPP requirements. The Project Chemist activities mainly involve data validation, but also interaction with the laboratory when there are issues with sample or data. Of project personnel, Ms. Lutz is most familiar with lab activities, analytical methods, and issues that may arise during sample analysis or data generation. She can conduct both roles with objectivity. The Project Manager reviews the work Ms. Lutz performs both as a QA Officer and as a Project Chemist. Revision of the QAPP is not considered necessary for this comment.

EPA Specific Comments:

1. **QAPP Worksheet #6, Communication Pathways, Pages 6 and 7:** This worksheet does not indicate that regulatory agencies will be notified of significant corrective actions or when changes to the approaches presented in the QAPP occur in the field. In addition, the communication procedures do not consistently specify the forms of communication or timeframes for notifications. Revise Worksheet #6 to specify that the regulatory agencies will be notified of significant corrective actions and when changes to the approaches presented in the QAPP occur. Also, revise Worksheet #6 to include the forms of communication and timeframes for notification for all communication drivers.

   Response S1: The Field Decision driver states “Notify USACE TM and BEC of significant changes to field activities due to site conditions or other factors for discussion with USEPA and TDEC RPMs and regulatory buy-in. Communicate by phone or email within at least 4 hours of identifying the required change.” Ms. Hutton, Army BEC, is the contact for EPA and TDEC as noted in Regulatory Interface driver.
   Worksheet 6 will be revised to add statement to Field Decision driver “The BEC will inform the USEPA and TDEC RPMs of significant corrective actions or when significant changes to procedures in the QAPP occur in the field. The RPMs will be informed of the actions by phone or email within two to six hours of the BEC being informed.“ Similar statements will be added for the Field CAs and Analytical CAs drivers.

2. **QAPP Worksheet #10, Conceptual Site Model Page 19:** It is unclear why the groundwater flow direction and the thickness/depth of the Fluvial Aquifer is not discussed under the Geology and Hydrogeology subsection. Revise Worksheet #10 to provide this information.

   Response S2: The following will be added to Worksheet #10. The groundwater flow direction in the Fluvial Aquifer within the area of investigation is to the southwest; the gradient is 0.01 (CS-01 to MW-78 and CS-05 to MW-03). Groundwater elevations decrease from 259.01 ft NAVD at WB-03 to 231.50 at MW-03. The ground surface elevation in the area of investigation has a high point at CS-06 (301.6 ft NAVD) located northeast of Dunn Field and decreases toward WB-03 (265.6 ft NAVD) and MW-03 (290.4 ft NAVD). The depth to groundwater ranges from 6.3 feet at WB-03 to 60.9 feet at MW-03; the potentiometric surface is in the fine-grained loess or upper fluvial deposits in the northernmost wells (WB-01 to WB-03 and CS-01 to CS-04) and in the coarse-grained lower fluvial deposits in the remaining wells.

3. **QAPP Worksheet #10, Conceptual Site Model Page 10:** Sixty-eight wells have been abandoned because of “damage, or a determination that the well was no longer needed or required abandonment to allow remedial action (RA),” yet it is unclear from the text and Figure 4 (Proposed Offsite Investigation Well Locations) which were abandoned because of damage, the determination that they were no longer needed, or required abandonment to allow the RA. This is of particular note given that Table 4 (Offsite

Investigation Well Locations) indicates that well F-3 is to be installed adjacent to previously abandoned MW-51, but it is unclear why MW-51 was previously abandoned. A similar issue was identified with previously abandoned MW-128/PZ-02 and new well F-6. Revise the QAPP to clarify the reason for the abandonment of the above mentioned monitor wells.

Response S3: The QAPP will be revised to include the following:

Continued sampling of MW-51 and MW-128 was not considered necessary at that time; the wells were located north of Dunn Field and not directly upgradient. The wells were recommended for abandonment in the 2011 Off Depot LTM Report and were abandoned in 2013.

At the time, MW-51 and MW-128 were recommended for abandonment, neither EPA nor TDEC had requested Army provide additional lines of evidence for an off-site source of the groundwater contamination upgradient of Dunn Field. Elevated concentrations of PCE, TCE and/or 1,1-DCE had been observed at MW-51 and MW-128, and replacement wells are planned to provide current data at those locations in order to determine the current extent of contaminants in the upgradient portion of the plume.

4. **QAPP Worksheet #10, Conceptual Site Model, Page 16:** The second paragraph in the Summary subsection of Worksheet #10 states, “Source areas may also be present in other areas upgradient of Dunn Field.” However, it is unclear what these additional source areas may include, if known. Therefore, it is unclear if the scope of the investigation is appropriate to investigate these potential source areas. Revise Worksheet #10 to clarify what these additional source areas include, if known. In addition, ensure the locations of any additional suspected source areas are depicted on Figure 4 (Proposed Offsite Investigation Well Locations).

   Response S4: Will revise Worksheet #10 to note that the only suspected, potential sources, other than the Cintas and Wabash Avenue sites, are spills from the railroad lines that run SW to NE and NW to SE near Dunn Field (see QAPP Figures 1 and 4). This suspicion is not based on reported spills. As stated in Response G4a: “The planned well locations were selected to augment previous wells installed by TDEC to provide more complete coverage of the area upgradient of the northeast section of Dunn Field.”

5. **QAPP Worksheet #11, Project Data Quality Objectives, Pages 17:** This worksheet states, “Following the initial ground water samples from the 10 new wells, water levels and groundwater samples will be collected in four quarterly events.” However, based on review of the QAPP, it appears that both the new wells and 10 existing Tennessee Department of Environment and Conservation (TDEC) wells will be sampled. In addition, the timing of the initial round of sampling relative to the quarterly sampling events is unclear.

   a. Revise Worksheet #11 to clarify that 20 wells (10 new and 10 existing) will be sampled initially, followed by 4 quarterly events, and clarify the timing of the initial round of sampling relative to the quarterly sampling events.

   Response S5a: The referenced text in Worksheet #11 will be revised to “Following installation of the 10 new wells, a water level sweep will be conducted at the new wells and the 10 existing TDEC wells and initial ground water samples will be collected from the new wells. Water levels and groundwater samples will then be collected from the new wells and the TDEC wells in four quarterly events. The first quarterly event will be scheduled one to three months following well installation in order for two of the quarterly events to coincide with semiannual LTM events on Dunn Field.”

   b. Please include language that discussions among the FFA parties (EPA, TDEC and the US Army) to discuss future plans after 4 quarters of sampling above mentioned 20 MWs

   Response S5b: Additional language in the QAPP to address this comment is not considered necessary. Worksheet #14/16 identifies submittal of the Offsite Groundwater Investigation Report and Regulatory Review with submittal of comments or approval. The report will provide conclusions for the investigation with recommendation for additional action, if necessary. Discussion of future plans will naturally follow submittal of the report. Also, discussion of project activities among FFA parties occurs during monthly calls or when requested by any of the parties.

6. **QAPP Worksheet #11, Project Data Quality Objectives, Pages 17:** Step 4 of the data quality objective (DQO) process (Define the Boundaries of the Study) should define the temporal boundaries of the study, as discussed in the *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001, dated February 2006 (EPA QA/G-4); however, this information is not provided in Worksheet #11. Revise Worksheet #11 to define the temporal boundaries of the study.

   Response S6: Will revise Worksheet #11 to add "The temporal boundaries are the 1982 initial investigation including the study area through completion of the four quarterly sample events in 2021."

7. **QAPP Worksheet #11, Project Data Quality Objectives, Pages 17 and 18:** Step 5 of the DQO process (Develop the Analytic Approach) should provide decision statements (i.e., "if…then" statements) for how the project data will be used, as discussed in the EPA QA/G-4; however, Worksheet #11 does not provide decision statements in "if…then" format. Revise Worksheet #11 to provide decision statements for the project data.

   Response S7: Will revise Worksheet #11 to add the following decision statement "If elevated concentrations of the target contaminants (PCE, TCE and 1,1-DCE) are present upgradient of Dunn Field based on flow paths determined from the measured groundwater elevations, then an offsite contaminant source will be confirmed."

8. **QAPP Worksheet #11, Project Data Quality Objectives, Pages 17 and 18:** The Information Inputs of Worksheet #11 indicates that soil analytical data will be collected. Similarly, Worksheet #17 (Sampling Design and Rationale) states that up to five soil samples will be analyzed for VOCs. However, the collection of soil analytical data is not discussed under the Goal of the Study, Analytic Approach, or the Performance or Acceptance Criteria subsections of Worksheet #11. The sampling approach is of particular concern given that the loess consists of low-plasticity clayey silt to silty clay. At a minimum, if clay lens are observed with elevated photo ionization detector results, grab samples should be collected from the top portion of the clay lens. Revise Worksheet #11 to discuss the collection of soil analytical data under all applicable steps of the DQO process.

   Response S8: Collection of soil samples will be added to Worksheet #11 under Information Inputs, Analytical Approach and Performance or Acceptance Criteria, and to Worksheet #14/16.
   Soil samples from the borings will be analyzed for VOCs by Method SW8260. Although the soil analyses will provide definitive results, the overall soil data will be screening level quality because the soil will be disturbed by heat during sonic drilling.

   a. Please provide figure or location identifier where soil samples will be collected and the rationale for this soil sample collection location

      Response S8a: Worksheet # 11 will be revised to include the following. Five samples are planned; the locations will be selected by screening soil core with a PID during drilling for well installation. Samples will be collected if photoionization detector (PID) screening of the soil core exceeds 25 parts per million (ppm). If more than five locations have PID readings greater than 25 ppm, additional samples may be submitted to the laboratory but only the five samples with the highest PID readings will be analyzed. If sample analyses detect elevated CVOC concentrations, then additional sampling will be considered, but is not included in the current statement of work.

9. **QAPP Worksheet #12, Measurement Performance Criteria, Pages 19 and 20, and QAPP Worksheet #28, Analytical Quality Control and Corrective Action, Pages 43 through 47:** Several discrepancies were identified in the measurement performance criteria (MPC) presented in Worksheets #12 and #28.

For example, Worksheet #12 lists the MPC for field duplicates as ≤ 20% relative percent difference (RPD); however, Worksheet #28 lists the MPC for field duplicates as ≤ 30% RPD. As a second example, Worksheet #28 lists the MPC for matrix spike/matrix spike duplicates (MS/MSDs) as ≤ 30% RPD; however, Department of Defense (DoD) Quality Systems Manual (QSM) v. 5.1 lists the MPC for MS/MSDs as ≤ 20% RPD. Note that this list of example discrepancies may not be exhaustive. Revise Worksheets #12 and #28 as applicable to ensure that the MPC are consistently presented for all quality control (QC) sample types.

Response S9: Worksheets #12 and #28 will be revised to list the MPC RPDs for field duplicates and MS/MSD as 20%. This discrepancy was not found elsewhere in the QAPP.

10. **QAPP Worksheet #12, Measurement Performance Criteria, Pages 19 and 20:** Based on review of Worksheet #12, it appears that the collection of QC samples (e.g., field duplicates, MS/MSDs, equipment blanks, trip blanks) is not proposed for soil. It is unclear why this is the case. It is noted that Worksheet #20 (Field QC Summary) indicates that one field duplicate, one MS/MSD pair, five equipment blanks, and five trip blanks will be collected for soil VOCs; however, these are not identified in Worksheet #12. Revise Worksheet #12 to include a list of all applicable QC sample types and MPC for soil. Should select QC sample types be deemed unwarranted, provide rationale for their exclusion.

    Response S10: Worksheet #12 tables will be revised. The first table will refer to all non-IDW field samples for water and soil matrices; these samples require QC samples (MS/MSD, field duplicates, trip blanks, and equipment blanks). The second table now refers to all IDW samples, which do not require QC samples.

11. **QAPP Worksheet #13, Secondary Data Uses and Limitations, Page 21:** Worksheet #13 does not state whether previous data were collected with the same detection limits and QC requirements as those detection limits and QC requirements listed in the current QAPP. Therefore, it is unclear if the historical data will be comparable to the newly generated data. Revise Worksheet #13 to include information about any differences in data collection requirements for historical data compared to the planned data collection, and therefore, whether there will be any limitations on the use of historical data in evaluating site conditions.

    Response S11: Will revise Worksheet #13 by adding the following text: “Note: The data sources listed are for recent groundwater sampling activities with no significant differences to the activities and analytical methods for the planned data collection. There are no limitations on the use of this data in evaluating site conditions.”

12. **QAPP Worksheet #14/16, Project Tasks & Schedule, Page 23:** This worksheet states that well development will occur no sooner than 24 hours after well completion. While Region 4, U.S. Environmental Protection Agency, Science and Ecosystem Support Division, Athens, Georgia, Guidance SESDGUID-101-R1, dated January 29, 2013 states, “The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed,” it is recommended that well development not occur for at least 48 hours after completion of the well in order to allow time for the grout to set. Revise Worksheet #14/16 to state that well development will not occur until the grout has been allowed to set before the surface pad and protective casing are installed.

    Response S12: Text on Worksheet #14/16 will be revised to “During well construction, the grout will be allowed to cure for at least 24 hours before the surface pad and manhole or protective casing are installed. Wells will be developed no sooner than 48 hours after grouting and 24 hours after installation of the well pad. Depending on the project schedule, wells may be developed prior to the well pad being installed.

13. **QAPP Worksheet #14/16, Project Tasks & Schedule, Page 23:** This worksheet does not state when groundwater samples will be collected following well development. It is noted that samples should not be

collected immediately following well development, as surging during well development can introduce oxygen into the aquifer and increase turbidity. The water in the wells should be allowed to equilibrate with the aquifer for at least two weeks. Revise Worksheet #14/16 to state that the water in the wells will be allowed to equilibrate with the aquifer for at least two weeks after well development and prior to sampling.

Response S13: SESDGUID-101-R1, Section 2.7 states "Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well." The following statement will be added in Worksheet #14/16 under sampling "Wells will be sampled no sooner than 24 hours after development."

14. **QAPP Worksheet #14/16, Project Tasks & Schedule, Page 23:** This worksheet states, "Samples will be collected from IDW (soil cuttings by HDR and wastewater by the drilling contractor) to determine disposal requirements. Additional samples will be collected if cuttings with suspected contamination are observed." However, it is unclear what decision criteria will be used to determine if collection of additional soil samples is warranted; therefore, it is unclear how the QAPP can be properly implemented by the field team. Revise Worksheet #14/16 to provide the decision criteria that will be used to determine if collection of additional soil samples is warranted.

    Response S14: The second sentence in the subject paragraph will be revised to: "Soil cuttings with suspected contamination (e.g. stained soil or hydrocarbon or solvent odor) will be stored separately from other soil cuttings." Procedures for sampling IDW soil are described under Investigation Derived Waste on Page 26.

15. **QAPP Worksheet #14/16, Project Tasks & Schedule, Page 25 and Appendix B, Standard Operating Procedures, Standard Operating Procedure 3 – Well Installation, Development and Abandonment, Section 6.2.1.1.3, Bentonite Seal, Page 3-6:** Bentonite should be hydrated based on the manufacturer's instructions which is inconsistent with the timeframe (i.e., "at least one hour") noted in the third paragraph on Page 25 and the SOP (i.e., a "minimum of 4 hours"). Revise the QAPP to address this issue.

    Response S15: The bentonite manufacturer recommends a 1 to 2 hour hydration for 3/8" bentonite chips used during monitoring well construction. The bentonite seal placed above the filter pack of Fluvial Aquifer wells recently constructed at DDMT for the SRI was hydrated with potable water for at least one hour. The minimum 1 hour hydration is consistent with manufacture specifications and is adequate for Fluvial Aquifer wells. SOP 3 will be revised to delete the 4 hour hydration requirement and to state that the bentonite will be hydrated for at least one hour.

16. **QAPP Worksheet #14/16, Project Tasks & Schedule, Page 26 and QAPP Worksheet #17, Sampling Design and Rationale, Page 31:** It is unclear how many grab samples of wastewater per unit of volume will be collected for disposal analysis, as this is not specified. Revise Worksheets #14/16 and #17 to specify the rate at which grab samples will be collected for wastewater disposal analysis.

    Response S16: IDW wastewater will be sampled by the driller in accordance with the requirements of a CERCLA-approved disposal facility. The number of samples for the volume of wastewater will be specified by the facility. The worksheet will be revised to make that clearer.

17. **QAPP Worksheet #15, Project Action Limits and Laboratory-Specific Detection/Quantitation Limits, Pages 27 through 29:** Worksheets #11 and #14/16 indicate that soil and groundwater samples will be analyzed for the full suite of VOCs; however, project action limits (PALs), project quantitation limits (PQLs), and achievable laboratory limits are presented for select VOCs only. Revise Worksheet #15 to provide PALs, PQLs, and achievable laboratory limits for the entire suite of VOCs for both soil and groundwater.

Response S17: The 11 analytes listed in the first and second tables (**Matrix:** Groundwater and **Matrix:** Soil, Soil IDW) are the chemicals of concern (COCs) that have been identified at the site over years of sample analyses; listing of additional VOCs is not considered necessary. The 11 analytes listed in the third table (**Matrix:** Soil IDW, VOCs, TCLP) comprise the full list of TCLP VOC analytes; no other analytes need to be listed.

18. **QAPP Worksheet #15, Project Action Limits and Laboratory-Specific Detection/Quantitation Limits, Pages 27 through 29:** The PALs for several analytes are less than their limits of quantitation (LOQs), but the uncertainty in using the data with PALs less than LOQs is not discussed. The QAPP should discuss the uncertainty associated with results where the PALS are less than the LOQ. For example, when the PAL is between the limit of detection (LOD) and LOQ, the QAPP should include a discussion of sensitivity and uncertainty. This discussion should include (where applicable) why results are sufficient to meet project DQOs. Further, in cases where the PAL is less than the LOQ but above the LOD, this discussion should include why the level of uncertainty associated with detected results less than the LOQ (i.e., results that are not quantifiably reliable) was deemed acceptable and allowed project DQOs to be met. Revise the QAPP to provide a more detailed discussion of uncertainty in cases where the screening level is less than the LOQ.

    Response S18: The following will be added to the Worksheet #15as footnotes to the tables. Groundwater analysis for VOCs is the major focus of this project, and all LOQs for VOCs in groundwater are below the PALs. For VOCs in soil, several LOQs are above the PALs but all DLs are below the PALs. Option 3 listed in the UFP-QAPP manual (“Accept a higher level of uncertainty for data falling between the MDL and QL”) is appropriate for this project, as soil contamination is not the primary focus.

19. **QAPP Worksheet #15, Project Action Limits and Laboratory-Specific Detection/Quantitation Limits, Page 28:** The PALs for soil are described as the “Dunn Field remedial goals.” The source of these remedial goals is unclear as it is not specified. Revise Worksheet #15 to provide or reference the source of the remedial goals for soil.

    Response S19: The note on Worksheet #15 will be revised to “Project Action Limits for soil are the Dunn Field remedial goals – LSV = Loess-Specific Values (LSV) and FDSV = Fluvial Deposit Specific Values (FDSV) from the Dunn Field Record of Decision Table 2-21G.”

20. **Worksheet #17, Sampling Design and Rationale, Page 31:** This worksheet states that up to five soil samples will be analyzed for VOCs; however, the decision criteria that will be used to determine when a sample should be collected is not provided. Therefore, it is unclear if the QAPP can be properly implemented by the field team. Revise Worksheet #17 to clarify the decision criteria that will be used to determine when a soil sample should be collected for VOC analysis.

    Response S20: Soil sampling was described in Response S8a (Worksheet # 11). Worksheet #17 provides the number of samples and analytical methods, the decision criteria in Worksheet # 11 will be sufficient for the field team.

21. **QAPP Worksheet #18, Sampling Locations and Methods/SOP Requirements, Page 32, and QAPP Worksheet #20, Field QC Summary, Page 34:** Worksheets #18 and #20 indicate that four rounds of samples will be collected from the wells; however, Worksheet #9 (Project Planning Session Summary) indicates that five rounds of samples will be collected from the Tennessee Department of Environment & Conservation (TDEC) wells. Revise the QAPP to clarify the number of rounds of samples that will be collected from the TDEC wells.

    Response S21: Worksheets #18 and #20 are correct. Worksheet #9 will be revised to state “… initial groundwater sampling from the 10 new wells, and four subsequent quarterly groundwater monitoring events at the 10 new wells and 10 existing TDEC wells, with analysis for …”

22. **QAPP Worksheet #20, Field QC Summary, Page 34:** This worksheet indicates that water investigation-derived waste samples will be analyzed for metals (copper and zinc); however, metals analysis is not discussed elsewhere in the QAPP. For example, Worksheet #15 (Project Action Limits and Laboratory-Specific Detection/Quantitation Limits) does not provide the Resource Conversation and Recovery Act (RCRA) regulatory limits for copper or zinc. Revise the QAPP to include the required information for metals analysis of water IDW samples.

    Response S22: Metals (copper and zinc) analysis for IDW water samples will be added to Worksheet #12 (Measurement Performance Criteria); Worksheet # 14/16 (Project Tasks & Schedule) under "Analysis"; Worksheet #15 (Project Action Limits and Laboratory-Specific Detection/Quantitation Limits); Worksheet #18 (Sampling Locations and Methods/SOP Requirements); Worksheet #19/30 (Sample Containers, Preservation, and Hold Times); Worksheet #23 (Analytical SOPs); Worksheet #24 (Analytical Calibration); Worksheet #25 (Analytical Instrument and Equipment Maintenance, Testing, and Inspection); and Worksheet #28 (Analytical Quality Control and Corrective Action). Note that the limits for copper and zinc have been provided by the Tennessee Department of Environment & Conservation (TDEC); as the samples are IDW and not investigative samples, they do not fall under RCRA regulatory limits.

23. **QAPP Worksheet #21, Field SOPs, Page 35, and QAPP Worksheet #23 Analytical SOPs, Page 37:** These worksheets note that SOP 4 (of both worksheets) will be modified for project work, but it is unclear how these SOPs will be altered. Revise these worksheets to identify how field and analytical SOPs 4 will be altered for the current investigation.

    Response S23: Worksheet #21 and #23 indicate that SOP 4 was modified for this QAPP, not that it will be modified during field work. The modifications include addition of a Well Maintenance and Inspection Form and Low Flow sampling procedures to comply with *Purging and Sampling Procedure for the Collection of Groundwater Samples for Monitoring Wells*, EQASOP-GW 001, dated July 30, 1996 and revised on September 19, 2017 (Low Flow Guidance). Field and analytical SOPs will not be altered without notification and approval by RPMs (See Response S1).

24. **QAPP Worksheet #29, Project Documents and Records, Page 48:** The data management, reduction, and reporting discussion is insufficiently detailed. For example, it is unclear where hardcopy project documents will be stored and where the project database will be maintained. It is also unclear how long these documents and the database will be stored before archival/disposal. Lastly, it is unclear how analytical data will be entered into the database, if the entry will be reviewed, and how data qualifiers will be added to the final reports. Revise the QAPP to provide greater detail regarding the data management, reduction and reporting tasks as per Section 3.5, Data Management Tasks, of the *Uniform Federal Policy Quality Assurance Project Plan Manual*, dated March 2005.

    Response S24: SOP 10, Data Verification, which addresses data management, reduction and reporting, will be added to Appendix B and referenced in Worksheet #29.

25. **QAPP Worksheet #36, Data Validation Procedures, Pages 53 and 54:** The QAPP does not indicate what will be included in the data verification/validation reports. Revise the QAPP to ensure that data validation and verification reports will present a discussion of all QC parameters evaluated, the acceptance criteria used to evaluate each QC parameter, a list of all QC exceedances, as well as the extent of the exceedance, the samples associated with each exceedance, and the qualifiers applied.

    Response S25: SOP 10, Data Verification will be added to Appendix B and referenced in Worksheet #36. It details the performance of data review and validation and includes an example validation report.

26. **Appendix B, Field Standard Operating Procedures, Standard Operating Procedure 3, Well Installation, Development and Abandonment, Section 6.2.8, Well Development, Page 3-11:** SOP 3 states that well stabilization is defined when the pH is within + or - 0.1, the conductivity is + or - 5%, and

the turbidity is less than 10 nephelometric turbidity units (NTUs); however, the Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples for Monitoring Wells, EQASOP-GW 001, dated July 30, 1996 and revised on September 19, 2017 (Low Flow Guidance) indicates that stabilization is considered to be achieved when three consecutive readings are within the following limits:

- Turbidity: 10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized);
- Dissolved oxygen (DO): 10% for values greater than 0.5 milligrams per liter (mg/L), if three DO values are less than 0.5 mg/L, consider the values are stabilized;
- Specific Conductance: 3%;
- Temperature: 3%;
- pH: +/- 0.1 unit; and,
- Oxidation-reduction potential: +/- 10 millivolts.

Revise SOP 3 to meet the stabilization requirements provided in the Low Flow Guidance

Response S26: Section 6.2.8 of SOP-3 presents stabilization criteria for well development. The stabilization criteria listed above, and presented in SOP-4, Section 5.2.2.2 of the QAPP is for low flow sample collection, not well development. SOP 3 will be updated to adopt the Low Flow Guidance stabilization criteria for consistency with the criteria listed on page 25 of the QAPP.

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
Dunn Field Offsite Groundwater Investigation QAPP, Revision 0, July 2019
Defense Depot Memphis, Tennessee

Addendum
Offsite Wells - Screen Location Review

Abandoned LTM Wells:

MW-29 (Abandoned Jul2009). Lower Fluvial 25 to ~80 ft bgs (boring terminated [BT] @ 56.5 ft bgs). Water level Dec2007 42.0 ft btoc. 20 ft screen @ 34 to 54 ft btoc. Screen water table, upper 25 %.

MW-51 (Abandoned Mar2013). Lower Fluvial 36 to 64 ft bgs. Water level Dec2007 44.1 ft btoc, Sep2011 39.3 ft btoc. 10 ft screen @ 55 to 65 ft btoc. Screen bottom, lower 25%.

MW-128 (Abandoned Mar2013). Lower Fluvial 34 to 76 ft bgs. Water level Dec2007 45.1 ft btoc, Sep2011 41.2 ft btoc. 20 ft screen @ 55 to 75 ft btoc. Screen bottom, lower 60%.

Active LTM Wells:

MW-07. Lower Fluvial 44 to ~80 ft bgs (BT @ 75 ft bgs). Water level Apr2019 60.9 ft btoc. 10 ft screen @ 64 to 74 ft btoc. Screen middle, middle 50%.

MW-08. Lower Fluvial 33.5 to ~80 ft bgs (BT @ 75 ft bgs). Water level Apr2019 56.8 ft btoc. 10 ft screen @ 56.5 to 66.5 ft btoc. Screen water table, upper 30%.

MW-129. Lower Fluvial 39 to 80 ft bgs. Water level Apr2019 50.7 ft btoc. 15 ft screen @ 65 to 80 ft btoc. Screen bottom, lower 50%.

MW-130. Lower Fluvial 33 to 79 ft bgs Water level Apr2019 50.6 ft btoc. 20 ft screen @ 59.5 to 79.5 ft btoc. Screen bottom, lower 65%.

MW-230. Lower Fluvial 33 to 74 ft bgs. Water level Apr2019 50.2 ft btoc. 15 ft screen @ 59 to 74 ft btoc. Screen bottom, lower 65%.

TDEC Wells:

CS-01. Lower Fluvial 30 to 64 ft bgs. Water level Apr2019 29.3 ft btoc. 10 ft screen @ 58 to 68 ft btoc. Screen bottom, lower 30%. Note water level above fluvial sand.

CS-02. Lower Fluvial 42 to 69 ft bgs. Water level Apr2019 34.5 ft btoc. 10 ft screen @ 60 to 70 ft btoc. Screen bottom, lower 30%. Note water level above fluvial sand.

CS-03. Lower Fluvial 34 to 67 ft bgs. Water level Apr2019 25.3 ft btoc. 10 ft screen @ 57 to 67 ft btoc. Screen bottom, lower 30%. Note water level above fluvial sand.

CS-04. Lower Fluvial 35 to 61 ft bgs. Water level Apr2019 22.1 ft btoc. 10 ft screen @ 52 to 62 ft btoc. Screen bottom, lower 30%. Note water level above fluvial sand.

CS-05. Lower Fluvial 34 to 81 ft bgs. Water level Apr2019 48.8 ft btoc. 10 ft screen @ 71 to 81 ft btoc. Screen bottom, lower 30%.

CS-06. Lower Fluvial 44 to 85 ft bgs. Water level Apr2019 56.4 ft btoc. 10 ft screen @ 75 to 85 ft btoc. Screen bottom, lower 30%.

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Addendum
Offsite Wells - Screen Location Review

CS-07. Lower Fluvial 32 to 74 ft bgs. Water level Apr2019 54.3 ft btoc. 10 ft screen @ 74 to 84 ft btoc. Screen in clay beneath fluvial sand.

WB-01. Lower Fluvial 30 to 53 ft bgs. Water level Apr2019 23.8 ft btoc. 20 ft screen @ 35 to 55 ft btoc. Screen bottom, lower 80%. Note water level above fluvial sand.

WB-02. Lower Fluvial 23 to 53 ft bgs. Water level Apr2019 21.2 ft btoc. 20 ft screen @ 35 to 55 ft btoc. Screen bottom, lower 65%. Note water level above fluvial sand.

WB-03. Lower Fluvial 22 to 38 ft bgs. Water level Apr2019 6.3 ft btoc. 20 ft screen @ 20 to 40 ft btoc. Screen bottom, 100%. Note water level above fluvial sand.

TABLE 1
WELL CONSTRUCTION AND LITHOLOGY SUMMARY
RESPONSES TO USEPA COMMENTS ON OSI QAPP
Dunn Field - Defense Depot Memphis, Tennessee

						Depth to Base of Layer												
Well	Date Installed	Northing (ft)	Easting (ft)	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Loess (Clayey Silt) (ft,bgs)	Upper Fluvial (Silty Clayey Sand) (ft,bgs)	Lower Fluvial (Sand and Gravel) (ft,bgs)	Upper Clay (ft,bgs)	Dark Grey Clay (ft,bgs)	Depth to Water 4/6/19 (ft,btoc)	Riser Length (ft)	Screen Length (ft)	Total Well Depth (ft,btoc)	Saturated Thickness (ft)	Groundwater Elevation (ft, NAVD)	Total Boring Depth (ft,bgs)
Abandoned LTM Wells																	
MW-29	11/1/1989	282104.9	802864.0	273.22	273.35	20.0	25.0	BT	-	-	-	34.2	20	54.2	-	-	56.5
MW-51	1/1/1996	282345.9	802828.6	275.23	275.50	16.0	36.0	64.5	BT	-	-	55.0	10	65.0	-	-	70
MW-128	6/1/2003	282712.2	803376.4	284.14	284.77	32.0	34.0	76.0	80.0	BT	-	54.8	20	74.8	-	-	85
Active LTM Wells																	
MW-07	6/1/1982	281839.9	802481.7	295.10	293.10	20.0	44.0	BT	-	-	60.89	64.0	10	74.0	19.1	234.21	75
MW-08	2/1/1989	282001.0	802727.9	292.59	292.74	23.5	33.5	BT	-	-	56.79	56.5	10	66.5	23.2	235.80	75
MW-129	6/24/2003	282271.1	803128.5	293.01	293.33	30.0	39.0	80.0	BT	-	50.70	65.0	15	80.0	29.3	242.31	85
MW-130	6/25/2003	282116.8	803241.5	293.17	293.77	22.0	33.0	79.0	BT	-	50.64	59.5	20	79.5	28.4	242.53	85
MW-230	7/30/2007	281842.8	802800.1	286.57	286.66	25.0	33.0	74.0	80	BT	50.15	59.2	15	74.2	23.9	236.42	90
TDEC Wells																	
CS-01	7/14/2007	282850.4	803576.9	279.76	280.16	21.0	30.0	64.0	76.0	BT	29.31	57.8	10	67.8	34.0	250.45	77
CS-02	7/12/2007	282610.2	803152.0	280.18	280.37	24.0	42.0	69.0	76.0	BT	34.45	60.0	10	70.0	27.0	245.73	88
CS-03	7/13/2007	282927.4	803403.4	275.93	276.23	21.0	34.0	67.0	70.0	BT	25.28	57.0	10	67.0	33.0	250.65	76
CS-04	7/13/2007	283007.1	803119.1	271.30	271.68	20.0	35.0	61.0	68.0	BT	22.10	52.0	10	62.0	26.0	249.20	76
CS-05	12/8/2008	282417.6	803551.2	296.27	296.43	27.0	34.0	81.0	90.0	BT	48.80	71.0	10	81.0	32.2	247.47	91
CS-06	12/10/2008	282248.9	803501.6	301.25	301.59	26.0	44.0	85.0	93.0	BT	56.40	75.3	10	85.3	28.6	244.85	96
CS-07	12/11/2008	281869.7	803590.4	297.51	297.69	29.0	32.0	74.0	84.0	BT	54.26	74.0	10	84.0	19.7	243.25	91
WB-01	12/6/2005	282299.8	804620.1	275.97	276.18	21.0	30.0	53.0	59.0	BT	23.81	35.0	20	55.0	23.0	252.16	66
WB-02	12/7/2005	282427.5	804321.9	272.21	272.34	18.0	23.0	53.0	60.0	BT	21.18	35.0	20	55.0	30.0	251.03	66
WB-03	12/6/2005	282707.2	804642.3	265.33	265.64	16.0	22.0	38.0	45.0	BT	6.32	20.0	20	40.0	16.0	259.01	56
WB-04	12/6/2005	282920.6	804373.1	263.76	264.00	15.0	23.5	42.0	46.0	BT	-	25.0	20	45.0	-	-	66

Notes:

ft:	feet
bgs:	below ground surface
btoc:	below top of casing
NAVD:	North American Vertical Datum