Memorandum

To: John Hill, CIV AFCEE/EXA
Mike Dobbs, DES-DDC-EE

From: John Sperry
Steven Herrera
Tom Holmes

Date: 20 October 2010

Re: **Work Plan for Fluvial Soil Vapor Extraction Confirmation Sampling, Revision 1**
Dunn Field – Defense Depot Memphis, Tennessee

HDR|e^{2}M has prepared this work plan to describe the rebound test and confirmation soil sampling to be performed for the Fluvial soil vapor extraction (SVE) system on Dunn Field at Defense Depot Memphis, Tennessee (DDMT). This work plan was prepared for the Defense Logistics Agency under Contract FA8903-08-D-8771, Task Order (TO) 0069 to the Air Force Center for Engineering and the Environment (AFCEE).

The selected remedy from the *Dunn Field Record of Decision* (ROD) (CH2M HILL, 2004) included SVE to reduce volatile organic compound (VOC) concentrations in subsurface soils to levels that are protective of the intended land use and groundwater. Remediation goals (RGs) from the ROD are shown on Table 1 for the primary chlorinated volatile organic compounds (CVOCs) reported at Dunn Field. The SVE component of the remedy was later amended to incorporate thermal SVE (in situ thermal desorption) in the shallow fine-grained soils (loess) with conventional SVE used in the deeper coarse-grained fluvial soils. Implementation of the Fluvial SVE system proceeded while the remedy for the shallow subsurface soil (loess) was still under review. The remedial action was implemented as described in the *Memphis Depot Dunn Field Source Areas Final Remedial Design* (CH2M HILL, 2007) and the *Dunn Field Source Areas Fluvial Soil Vapor Extraction Remedial Action Work Plan, Rev.1* (RAWP) (e²M, 2007).

The Fluvial SVE system was constructed from April to July 2007 and consists of two 13.1 horsepower regenerative blowers connected to seven SVE wells (SVE-A through SVE-G) screened at depths of 32 to 66 feet below ground surface (bgs). The blowers provide a vacuum to the subsurface and remove soil vapor containing CVOCs through individual conveyance lines from the SVE wells to the system compound. Condensate from the extracted vapor is removed via a 140-gallon air/water separator (AWS) located upstream of the blowers and a 240-gallon AWS located downstream of the blowers. The condensate is stored in a 535-gallon tank for analysis prior to discharge to the City of Memphis sewer system. When required, the extracted air flows through two 2,000-pound granular activated carbon (GAC) vessels prior to discharge to the atmosphere. There are 10 paired vapor monitoring points (VMPs) (VMP-1A/B through VMP-10A/B) located 15 to 80 feet from the SVE wells to monitor vacuum influence from the SVE wells and CVOC concentrations in the subsurface vapor. The Fluvial SVE system layout is shown on Figure 1.

Performance monitoring of the Fluvial SVE system consists of field measurements and laboratory analysis of vapor samples. Field measurements at SVE wells and the system effluent are currently collected weekly and consist of flow and pressure measurements and photoionization detector (PID) readings. Field measurements at VMPs consist of vacuum measurements collected monthly and PID readings collected quarterly. Vapor samples are collected quarterly from the SVE wells and the system effluent and annually from the VMPs. Off Depot long-term groundwater monitoring is used to evaluate effectiveness of the Fluvial SVE system in reducing impacts to groundwater.

Baseline Soil Sampling

Fluvial soil samples were collected during drilling of the SVE well borings and the deep VMP borings in May and June 2007; samples were collected at 8 feet, 18 feet and 28 feet below the bottom of the loess, using a 24-inch long 3-inch diameter split spoon advanced in front of the drill casing. The soil was screened and samples collected by the field geologist. The samples did not have staining or other visual signs of contamination and PID readings were not elevated. The soil core from SVE-B at 16 to 31 feet bgs did have a chlorine odor. Samples for VOC analysis were collected using three EnCore® syringe-type samplers and analyzed for VOCs by United States Environmental Protection Agency (USEPA) Method 8260B.

There were no concentrations above RGs in samples from three borings (SVE-A, VP-01 and SVE-E). In the other borings, RGs were exceeded for 1,1,2,2 tetrachloroethane (TeCA) in 39 samples with a maximum concentration of 17 milligrams per kilogram (mg/kg) in SVE-B-M; for trichloroethene in 5 samples with a maximum concentration of 0.67 mg/kg in VP-05-T; for 1,1,2 trichloroethane in 2 samples with a maximum concentration of 0.095 mg/kg in SVE-C-T; and for chloroform in 1 sample at a concentration of 0.55 mg/kg in SVE-G-T. The only RG exceeded by a factor of 10 or more was TeCA in 24 samples. RG exceedances for fluvial soils are shown on Figure 2.

The VOC analytical results were used to estimate the CVOC mass in the fluvial soils within an 80-foot radius of influence (ROI) for the SVE wells. The sample results were used to determine an average total CVOC concentration for the three sample intervals (top, middle and bottom). The volume of soil within each interval assumed an 80-foot cylinder over the SVE screen length plus an additional 5 feet above and below. The volume was adjusted in treatment area (TA)-2 based on the overlap in the ROI for SVE-D and SVE-E. The soil density was assumed to be 100 pounds per cubic foot. The interval average concentration in mg/kg was multiplied by the kilograms of soil for the interval resulting in total milligrams of CVOCs in the interval which in turn was converted to pounds. The CVOC mass estimate is summarized on Table 2. Total CVOC mass per location ranged from 1.4 pounds at SVE-A to 505.1 pounds at SVE-D and -E. The total estimated CVOC mass in the fluvial soils at Dunn Field was 979 pounds.

Fluvial SVE Operations

Fluvial SVE operations began on 25 July 2007. The system has generally been operated with all SVE wells in the 100% open position. System operations and monitoring results have been described in two annual monitoring reports, *Annual*

Operations Report – 2007/8, Dunn Field Source Areas Fluvial SVE System, Year One (e^2M, 2009) and *Annual Operations Report – 2008/9, Dunn Field Source Areas Fluvial SVE System, Year Two* (e^2M, 2009). Fluvial SVE construction, system operations and monitoring were described in the *Source Areas Interim Remedial Action Completion Report* (e^2M, 2009) and the *Operating Properly and Successfully (OPS) Demonstration, Source Areas Remedial Action* memorandum dated 3 June 2009. The OPS demonstration was approved by USEPA on 21 October 2009.

Fluvial SVE system influent concentration trends are shown on Figure 3. Influent emission rates have decreased from 17 pounds per hour (lb/hr) at system startup to 0.006 lb/hr in July 2010. The emissions were treated with GAC during initial operations from July to October 2007. Treatment was discontinued due to low VOC concentrations in the vapor.

The Fluvial SVE system has removed approximately 4,004 pounds of VOCs from start-up through July 2010. The difference between the estimated mass of approximately 980 pounds and the mass removed to date is considered to result from the mass being underestimated due to the limited samples and to mass extracted from the overlying loess.

Rebound Test

An initial rebound test in 2008 included the temporary shutdown of selected SVE wells to allow contaminants sorbed to the soil matrix to come to equilibrium with surrounding soil gas. Field PID measurements and samples for laboratory analysis were collected periodically during the shutdown period. Shutdown and sampling procedures followed general practices in *Guidance on SVE Optimization* (AFCEE, 2001) and the remedial design. The test results were presented in the 2007/8 annual operations report.

Three SVE wells (SVE-B, SVE-E, and SVE-F) were offline for a four-week period (20 March to 18 April 2008) to evaluate contaminant rebound from wells that had declined to near or below RGs; the January 2008 quarterly samples indicated these SVE wells were contributing less than 2% of the VOC mass removed. The four other SVE wells remained online during the rebound study with both blowers in operation. Laboratory samples were collected from the three offline wells and associated VMPs (VMP-2A/B, VMP-6A/B, VMP-7A/B, and VMP-8A/B) at two weeks and four weeks into the shut down. VMPs were purged prior to laboratory sampling with a sampling pump. Analytical results for SVE well samples collected during the shut-down were lower than in samples during 1Q08 (the previous sampling event) and were relatively stable in the two events. Higher VOC concentrations at VMP-2B and -6B indicated significant mass remains in these areas, even through the associated SVE wells had low VOC concentrations.

System Shutdown

The RAWP included the following guidelines for system shutdown. When the reduction in VOC concentrations in an SVE well becomes asymptotic at a low level, system operations will be evaluated to increase mass removal rates by pulsing, through periodic shutdown and startup of extraction wells. If mass removal rates remain asymptotic in a TA, the system will be shutdown temporarily and periodic vapor concentration measurements will be made to observe the vapor concentration rebound. If the concentration rebound is sufficiently small, the SVE well will be de-activated and confirmation soil sampling will be performed. If soil concentrations are below the RGs for fluvial soils (Table 1), the SVE wells and VMPs in that TA will be abandoned; if soil concentrations are above RGs, continued SVE operation with enhancements, such as installation of additional SVE and/or injection wells will be evaluated.

Planned Activities

VOC concentrations for the system influent have become asymptotic at low levels (less than 0.5 parts per million by volume of total VOCs), as shown on Figure 3. A rebound test will be performed to determine an appropriate period for pulsed operations. Soil confirmation samples will be collected to evaluate progress to date in achieving RGs for fluvial soils, rather than waiting for completion of a period of pulsed operation.

In addition, borings installed for confirmation samples will be converted to SVE wells at selected locations and used as additional extraction wells or passive vent wells. The SVE wells will be installed at locations not adjacent to existing SVE wells or VMPs (FSB-1, FSB-4, FSB-8, FSB-12, FSB-13 and FSB-20); at VMPs with higher baseline sample results or vapor concentrations (FSB-6, FSB-11 and FSB-16); and at existing SVE wells with low flow rates (FSB-18). Following installation and completion of the rebound test, the new wells will be connected to the SVE blowers via temporary conveyance lines to measure vapor extraction flow rates.

The following project-specific data quality objectives were developed for the planned activities:

- Determine shutdown period required for CVOCs in fluvial sands soil vapor to reach stable concentration (screening level data required)
    - Collect PID measurements at all SVE wells and VMPs at least bi-weekly for 8 weeks
    - Confirm stable concentrations at each location by three consecutive measurements within 10%
- Determine shutdown period required for soil vapor pressure to return to background conditions (screening level data required)
    - Collect vacuum measurements at all VMPs at least weekly until pressure reaches background
    - Confirm background conditions by pressures near 0 inches water and within 10% for three consecutive measurements
- Determine concentration of CVOCs in soil vapor to evaluate progress of cleanup and provide confirmation data for PID measurements (definitive data required)
    - Collect vapor samples at all SVE wells and VMPs following final PID measurements at end of 8 week shutdown
    - Submit samples for laboratory analysis using TO-15
    - Compare analytical results to final PID measurements
    - Compare analytical results to fluvial soil protective soil vapor concentrations from ROD

- Determine progress toward meeting RGs for fluvial soils (definitive data required)
  - Collect soil samples at specified locations and depths
  - Submit samples for laboratory analysis using 8260B
  - Compare analytical results to fluvial soil RGs from ROD
  - Confirm achievement of remediation goals in each TA by approved procedure: average for TA samples less than each RG and no individual sample greater than 10 times any RG
- Evaluate ability of additional SVE wells to improve vapor extraction rates and removal of CVOCs (screening level data required)
  - Install additional SVE wells at selected soil boring locations
  - Connect each new SVE well to a conveyance line
  - Record vapor flow rate at manifold and pressure at associated VMPs during initial hour, after 6-12 hours and after 24 hours of operation
  - Collect PID measurements at the manifold when measuring flow rate

SAMPLING AND ANALYTICAL PROCEDURES

Sampling procedures are described in the *Remedial Action Sampling and Analysis Plan* (RA SAP) *Volume I: Field Sampling Plan* (FSP) and analytical procedures are described in *Volume II: Quality Assurance Project Plan, Rev. 1* (QAPP) (MACTEC, 2005). Work and Test Procedures (WTPs) to be utilized were included in the FSP Appendix B with additional procedures taken from Appendix E of the *Off Depot Groundwater RAWP, Rev.2* (HDR|e2M, 2009). Specific WTPs to be utilized are included in Appendix A and listed below:

- WTP 1 General Procedures for Field Personnel
- WTP 2 Drilling Operations
- WTP 6 Investigation Derived Waste Disposal
- WTP 7 Sample Control and Documentation
- WTP 8 Sample Containers and Preservation
- WTP 9 Sample Packing and Shipping
- WTP 10 Sampling Equipment Decontamination
- WTP 11 Soil Sampling
- WTP 13 Health and Safety Monitoring
- WTP 14 Soil Vapor Extraction Wells
- WTP 18 Vapor Sample Collection

REBOUND TEST

All Fluvial SVE wells will be shut-down for up to two months. PID measurements will be collected at SVE wells and VMPs, at least bi-weekly. When PID readings have stabilized or 8 weeks have passed, final PID readings will be collected and vapor samples will be collected for laboratory analysis at SVE wells and VMPs. Laboratory samples will be collected into Summa canisters and submitted for laboratory analysis via USEPA Method TO-15. The system will be re-started with all wells operating until rebound test results have been reviewed and recommendations made.

Field Measurements

Procedures for field PID measurements are described in WTP 18.

VOC concentrations will be estimated through field measurements at individual SVE wells and VMPs using a MiniRae 2000 (10.6 eV lamp) PID. The PID monitors VOCs in real time and is calibrated with a 100 parts per million concentration of isobutylene prior to each use. Vapor samples for field measurements will be collected in a dedicated Tedlar® bag using a portable, oil-less high vacuum pump (such as a rotary vane pump) with a vacuum capability exceeding that of the SVE blower. Vapor samples will not be collected at the discharge of the pump, because hydrocarbon vapors may be entrained in the exhaust. The PID meter will be connected to the Tedlar® bag for the measurement. All measurements will be recorded in field logbooks with date, time, and location.

Field measurements at VMPs will be collected first. The VMPs will be purged of three tubing volumes using the sampling pump prior to measurements. Multiple PID readings will be collected at each VMP using dedicated a Tedlar® bag until three consecutive readings are within 10%. Following PID measurements, a single blower will be started with the unused manifold legs open and the SVE wells closed. SVE wells will be opened individually to purge the well conveyance piping and collect vapor samples; once the sample is collected, the SVE well will be closed and the next SVE well will be opened. Blower run-time will be kept to a minimum.

The period needed for subsurface pressure to return to background conditions will be evaluated through pressure measurements collected at VMPs prior to the blower being started. A portable magnehelic differential pressure gauge will be used to collect vacuum measurements at each VMP at least weekly. The magnehelic gauge will be connected to each VMP using flexible Tygon (or equivalent) tubing, equipped with a small isolation (ball) valve. If pressure transducers are used, a magnehelic gauge can be used for verification purposes. The gauge should be attached to the probe/transducer using a three-way joint with isolation valves, so that pressure transducer readings are not disturbed during gauge changes or during the collection of gas samples. Non-oil-based grease will be used to improve the vacuum seal.

Vapor Samples

Procedures for vapor sampling are described in WTP 18.

Following the final field measurements, vapor samples will be collected for laboratory analysis in 6-liter Summa canisters with a flow regulator at 200 milliliters per minute. The flow regulators may be removed if there are problems from moisture in the vapor stream as in previous sample events. The Summa canisters are shipped from the laboratory with negative pressure; thus, a sampling pump is not required for sample collection. Samples will be collected at all SVE wells and VMPs and shipped to Columbia Analytical in Simi Valley, California for analysis of VOCs by USEPA Method TO-15.

Field quality control (QC) samples will be collected during the sampling event to consist of one additional (duplicate) Summa canister for every 10 vapor sample locations. Laboratory quality assurance (QA)/QC samples included surrogate spikes, method blanks, laboratory control samples (laboratory control duplicates). Sampling and analytical methods followed procedures in the *USEPA Method TO-15 Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry* (USEPA, 1999).

Documentation will be completed in the field to ensure that the Summa canister samples collected, chain-of-custody, and request for analysis were in agreement. Custody seals were placed on the shipping container for each canister before shipment by common carrier. Samples will be shipped the day collected for overnight delivery to the laboratory.

CONFIRMATION SOIL SAMPLING

The RAWP states confirmation sample locations and depths will be selected based on results from previous samples in the fluvial soils (samples from SVE wells and VMPs) and the loess.

Sample Locations

The baseline soil sample locations and analytical results for CVOCs detected above RGs are shown on Figures 4 to 6. Loess confirmation sample locations for thermal SVE are also shown on the figures; the loess sample locations were selected due to high CVOC concentrations in previous investigations and have potential for high CVOC concentrations in the underlying fluvial deposits. Fluvial SVE soil confirmation samples will be collected at locations where previous fluvial soil samples exceeded RGs and at the loess sample locations which had the highest CVOC concentrations in each TA. Sample borings adjacent to SVE wells will be shifted 7 to 10 feet to provide results more representative of the TA, and sample borings adjacent to VMPs will be shifted 3 to 5 feet to avoid damage to the VMP. The proposed sample locations are listed on Table 3 and shown on Figures 4 to 6 and are described below.

In **TA-1B**, the baseline soil samples did not exceed RGs and the SVE well was placed at the location of the only loess data. No further soil samples will be collected in this area (Figure 4).

In **TA-1C**, the baseline soil samples exceeded RGs at both locations. SVE-B and VMP-2 are each located near a loess sample locations. Of the other two loess sample locations, loess soil boring (LSB)-5 had much higher CVOC concentrations and fluvial soil samples will also be collected at that location (Figure 4).

In **TA-1E**, the baseline soil samples exceeded RGs at all three locations. SVE-C is located at a loess sample location. Of the other loess sample locations, LSB-28 appears to have the highest CVOC concentrations and fluvial soil samples will also be collected at that location (Figure 4).

In **TA-2**, the baseline soil samples exceeded RGs at SVE-D, VMP-5 and VMP-6 but not at SVE-E. Neither SVE wells nor VMPs are located at a loess sample location. LSB-14 and LSB-16 had much higher CVOC concentrations than the other locations and LSB-12 had the highest of the remaining loess sample locations; fluvial soil samples will also be collected at those locations. SVE-D is located near LSB-14 and had high CVOC concentration in the baseline samples; the sample boring will be located between these two locations as shown on Figure 5.

In **TA-3**, the baseline soil samples exceeded RGs at all three locations. Neither the SVE well nor VMPs are located at a loess sample location. LSB-17 had the highest CVOC concentrations; fluvial soil samples will also be collected at that location. SVE-E is located near LSB-18; the sample boring will be located between these two locations as shown on Figure 6.

In **TA-4**, the baseline soil samples exceeded RGs at all three locations. SVE-G is located at LSB-23 but the VMPs are not located at a loess sample location. LSB-23 had much higher CVOC concentrations than the other locations, but is located at SVE-G. LSB-32 had high CVOC concentrations in the initial thermal SVE confirmation sample and fluvial soil samples will also be collected at that location (Figure 6).

Preparation

Preparations for sampling activities are described in WTP 1. The primary activities are coordination with field personnel, subcontract drillers and the subcontract analytical laboratory.

The subcontract analytical laboratory will be notified of the planned sample event, including number of samples and analyses. Sample containers will be scheduled to arrive a few days before sampling begins. Procedures for sample containers and preservation are provided in WTP 8.

An initial site survey will be performed to mark locations for new monitoring wells. The survey will be performed by a Tennessee-licensed Registered Professional Land Surveyor. The well locations will be cleared for underground utilities, general access and overhead obstructions.

Soil Sampling

Procedures for drilling and soil sampling are provided in WTPs 2 and 11, respectively.

Soil samples will be collected from soil borings advanced using rotasonic drilling methods; samples will be collected from 20 borings (FSB-1 to FSB-20) at three depths, 8 feet, 18 feet and 28 feet below the bottom of the loess. The location coordinates, estimated depth of loess and sample depths for each boring are shown on Table 3.

At each location, 6-inch diameter soil borings will be advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously beginning at the ground surface. Borings will be halted 1 foot above each sample depth, soil removed from the core barrel and a 24-inch long, 3-inch diameter split-spoon sampler hydraulically advanced in undisturbed soil below the drill rod. The sampler will be opened at the surface and screened with a PID by the field geologist; a soil sample will then be collected from the middle of the sampler using three EnCore® syringe-type samplers. Samples will be shipped to Microbac Laboratories in Marietta, Ohio for analysis of VOCs by USEPA Method 8260B. The HDR|e^{2}M field geologist will prepare boring logs for each location. The soil core will not be archived.

The evaluation of the analytical results to determine whether the remedial action objective for the fluvial deposits has been met will be the same as for the loess. The average concentration in a TA (defined as TA-1, TA-2, TA-3 and TA-4) for each CVOC must be below the RG, and no individual sample result may exceed the RG by a factor of 10 or more. For samples that are non-detect, the average will be calculated using one-half the sample quantitation limit (laboratory reporting limit). Results for baseline samples will be included in average concentration calculations if confirmation samples were not collected at that location.

Additional SVE Wells

Procedures for installation of SVE wells are described in WTP 14.

SVE wells will be constructed in selected soil borings upon completion of soil sampling. The SVE wells will be constructed with new, unused, decontaminated, 2-inch inside-diameter Schedule 40 polyvinyl chloride screen and riser, with internal flush-jointed threaded joints. A 25-foot section of 0.006-inch slot screen will be installed at the base of the sample boring and a centralizer will be used at the top of the screened section. The riser will extend approximately two feet above ground surface.

Filter pack will be placed in the annular space around the well screen. The filter pack material will be washed and bagged sand with an appropriate grain-size distribution. The filter pack will be gravity-placed through the outer drill casing in lifts of 1 to 2 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 vibrated as it is withdrawn between lifts to compact the sand filter pack. The filter pack will extend from the bottom of the borehole below the screen interval to approximately 5 feet above the top of the well screen.

A seal of hydrated bentonite with a thickness of approximately 5 feet 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. Since the bentonite seal will be above the water table, sufficient water will be added to allow complete hydration of the bentonite. The bentonite seal will be allowed to hydrate for 2 hours prior to installation of cement grout.

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 the ground surface. The grout will be allowed to cure for a minimum of eight hours before further grouting or well construction. Prior to installation of the surface completion, grout in the borehole will be topped-off to ground surface. Wells will be set within a one-foot by one-foot by 0.3-foot thick concrete pad.

The SVE wells will be completed with a threaded coupling approximately 2 feet above ground surface to allow installation of a well cap, vent cover or connection to SVE conveyance piping using flexible hose. Each well will be connected individually to the nearest conveyance line and the vapor flow rate will be measured over a 24-hour period. The HDR|e^{2}M field geologist will prepare construction diagrams for the SVE wells.

Equipment Decontamination

Procedures for decontamination of sampling equipment are provided in WTP 10.

Field equipment that may become contaminated as a result of field sampling activities will be cleaned prior to use at each boring. Equipment rinsate samples will be collected to evaluate decontamination procedures.

Health and Safety

Health and safety during field activities will be monitored in accordance with the procedures in WTP 13 and the *Remedial Action Health and Safety Plan* (HDR|e^{2}M, 2006).

Quality Assurance/Quality Control Samples

QA/QC samples are described in the RA SAP QAPP Section 2.4. Field QC samples will be collected during each sampling event, including duplicates and matrix spikes/matrix spike duplicates (MS/MSD). One duplicate will be collected for approximately every 10 samples (10%) and 1 MS/MSD was collected for every 20 samples (5%). Trip blanks will be included in coolers delivered from the laboratory. Laboratory QA/QC samples included surrogate spikes, method blanks, laboratory control samples, in addition to MS/MSD analysis. The field QC samples to be collected during each event are listed on Table 4.

Sample Control and Shipping

Procedures for sample control and shipping are provided in WTPs 7 and 9.

Sample documentation is completed in the field to ensure that the samples collected, labels, chain-of-custody, and request for analysis are in agreement. Custody seals are placed on each cooler before shipment by common carrier. Samples are typically shipped the day collected for overnight delivery to the laboratory.

The vapor samples will be sent to Columbia Analytical in Simi Valley, California for analysis of VOCs by USEPA Method TO-15.

The soil samples will be sent to Microbac Laboratories in Marietta, Ohio for VOC analysis by USEPA Method SW8260B.

IDW Management

The waste generated during the rebound test and soil sampling will be classified as either non-investigative waste or investigative derived waste (IDW). Non-investigative waste, such as packaging materials, personal protective equipment, disposable sampling supplies, and other inert refuse, is collected, containerized, and transported to a designated collection bin for disposal at a municipal landfill.

The IDW will consist of soil cuttings from drilling and waste water from equipment decontamination. Soil cuttings will be spread on Dunn Field; if PID readings or visual observations indicate contamination, those soils will be placed in a roll-off for testing prior to disposal.

The waste water will be collected and added to the Fluvial SVE condensate water storage tank on Dunn Field. The water will be sampled prior to disposal in accordance with the City of Memphis discharge permit. Following approval from the city, the water will be pumped into the interim remedial action conveyance line and discharged to the city sewer.

DATA QUALITY EVALUATION

Data quality evaluation (DQE) will be performed to evaluate the analytical data as described in the RA SAP QAPP Section 5.1. Level III DQE of laboratory analytical results will be conducted following each sampling event to ensure the data are satisfactory and defensible and to validate the precision and accuracy of the data. The analytical results will be flagged as usable, usable with qualification, or unusable in accordance with the criteria stated in the standard operating procedures in the RA SAP QAPP Appendix E for each analytical method performed. Upon final review the data will be incorporated into the project database. Laboratory quality control data and the DQE narratives will be included in the annual report. Reference limits and evaluation levels for vapor samples and soil samples are provided in Tables B-1 and B-2, respectively.

REPORTING

Summary reports will be submitted approximately six weeks after each event and will include preliminary data results prior to DQE. The reports will include a brief introduction and scope of work, description of field activities, discussion of preliminary analytical results, and a summary of findings. The rebound test and soil sampling will also be included in the Fluvial SVE annual operations report which will fully document the field activities, DQE and analytical results for the sample events.

TABLES

TABLE 1
REMEDIATION GOALS FROM DUNN FIELD RECORD OF DECISION
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

	Remedial Goal Objectives				
	Site-Specific Soil Screening Levels to be Protective of Groundwater		Protective Soil Vapor Concentration		Groundwater Target Concentrations at 10-4 Target Risk Levels and Target HI=1.0 (µg/L)
Parameter	Loess Specific Values (mg/kg)	Fluvial Deposit Specific Values (mg/kg)	Loess Specific Values (ppbv)	Fluvial Deposit Specific Values (ppbv)	
Carbon Tetrachloride	0.2150	0.1086	28.14	14.22	3.0
Chloroform	0.9170	0.4860	61.57	32.63	12.0
Dichloroethane, 1,2-	0.0329	0.0189	1.12	0.64	—
Dichloroethene, 1,1-	0.1500	0.0764	57.00	29.03	7/340
Dichloroethene, cis-1,2-	0.7550	0.4040	73.86	39.52	35.0
Dichloroethene, trans-1,2-	1.5200	0.7910	256.53	133.50	50.0
Methylene Chloride	0.0305	0.0169	5.14	2.85	—
Tetrachloroethane, 1,1,2,2-	0.0112	0.0066	0.03	0.55	2.2
Tetrachloroethene	0.1806	0.0920	15.18	0.99	2.5
Trichloroethane, 1,1,2	0.0627	0.0355	0.84	2.03	1.9
Trichloroethene	0.1820	0.0932	10.56	2.06	5.0
Vinyl Chloride	0.0294	0.0150	28.94	14.77	—

Notes:
HI = hazard index
MCL = maximum contaminant level
mg/kg = milligrams per kilogram
µg/L = micrograms per liter
ppbv = parts per billion per volume
— = Not available for groundwater cleanup goals because of low number of detections or detected values consistently less than MCLs.

TABLE 2
CVOC MASS ESTIMATE IN FLUVIAL SOILS
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Treatment Area	SVE Wells	Screen Length	Addition to Column	Interval Length	Interval	Total CVOC Results (mg/kg)				Average Concentration (mg/kg)	Total VOCs per Interval (mg)	Total VOCs per Interval (lbs)	Total VOCs (lbs)
						SVE-A	**VMP-01**						
				13.3	Top	0	0.1077			0.0539	654554	1.4	
TA-1B	**SVE-A**	30	10	13.3	Mid	0	0			0.0000	0	0.0	1.4
				13.3	Bottom	0	0			0.0000	0	0.0	
						SVE-B	**VMP-02**						
				13.3	Top	5.5305	0.2638			2.8972	35215252	77.6	
TA-1C	**SVE-B**	30	10	13.3	Mid	17.34212	0.3051			8.8236	107252180	236.5	333.3
				13.3	Bottom	1.3159	0.1144			0.7152	8692746	19.2	
						SVE-C	**VMP-03**	**VMP-04**					
				15	Top	9.8123	0.1867	0.0275		3.3422	45817094	101.0	
TA-1E	**SVE-C**	35	10	15	Mid	0.575	0.0733	0.0676		0.2386	3271377	7.2	115.0
				15	Bottom	0.5393	0.09706	0.0359		0.2241	3071959	6.8	
						SVE-D	**SVE-E**	**VMP-05**	**VMP-06**				
				15	Top	5.3973	0.0404	6.21	2.0905	3.4346	78916592	174.0	
TA-2	**SVE-D and E**	35	10	15	Mid	13.2525	0.00086	1.1771	1.5015	3.9830	91518248	201.8	505.1
				15	Bottom	3.0824	0.07243	0.84651	6.21	2.5528	58657186	129.3	
						SVE-F	**VMP-07**	**VMP-08**					
				15	Top	0.02488	0.05591	0.10407		0.0616	844736	1.9	
TA-3	**SVE-F**	35	10	15	Mid	0.0054	0.04436	0.1654		0.0717	983195	2.2	5.0
				15	Bottom	0.012	0.0194	0.06848		0.0333	456412	1.0	
						SVE-G	**VMP-09**	**VMP-10**					
				15	Top	0.9437	0.03665	0.05791		0.3461	4744433	10.5	
TA-4	**SVE-G**	35	10	15	Mid	0.02393	0.162	0.15636		0.1141	1564128	3.4	19.3
				15	Bottom	0.37117	0.01	0.1504		0.1772	2429062	5.4	
											Total		**979.0**

Notes:
CVOC - chlorinated volatile organic compound
lbs - pounds
mg - milligrams
mg/kg - milligrams per kilogram
SVE - soil vapor extraction
TA - Treatment Area
VMP - vapor monitoring point
VOC - volatile organic compound

TABLE 3
SOIL CONFIRMATION SAMPLE LOCATIONS
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Well ID	Area	Northing	Easting	Ground Elevation (ft, msl)	Top of Fluvial (ft, bgs)	Sample Depths: Top (ft, bgs)	Sample Depths: Middle (ft, bgs)	Sample Depths: Bottom (ft, bgs)	Total Boring Depth (ft, bgs)	Adjacent Monitoring Well	March 2010 Depth to Water (ft, bgs)
FSB-1	TA-1	281629.4	802203.7	291.1	31	39	49	59	60	MW-220	62.0
FSB-2	TA-1	281628.7	802161.5	289.6	30	38	48	58	59	MW-220	60.5
FSB-3	TA-1	281606.9	802177.0	290.6	31	39	49	59	60	MW-220	61.5
FSB-4	TA-1	281420.9	802171.2	299.1	33	41	51	61	62	MW-221	70.7
FSB-5	TA-1	281396.0	802115.9	298.6	33	41	51	61	62	MW-221	70.2
FSB-6	TA-1	281413.1	802088.7	297.5	33	41	51	61	62	MW-221	69.1
FSB-7	TA-1	281343.0	802125.1	299.4	31	39	49	59	60	MW-221	71.0
FSB-8	TA-2	281030.9	802161.2	301.8	32	40	50	60	61	MW-222	72.7
FSB-9	TA-2	280993.3	802163.4	301.4	32	40	50	60	61	MW-222	72.3
FSB-10	TA-2	280994.2	802139.4	301.3	32	40	50	60	61	MW-222	72.2
FSB-11	TA-2	280958.5	802144.7	300.8	29	37	47	57	58	MW-222	71.7
FSB-12	TA-2	280952.5	802114.8	301.2	30	38	48	58	59	MW-222	72.1
FSB-13	TA-3	280586.2	802173.6	292.1	26	34	44	54	55	MW-175	62.4
FSB-14	TA-3	280598.9	802201.2	293.3	26	34	44	54	55	MW-175	63.6
FSB-15	TA-3	280583.1	802217.5	293.4	27	35	45	55	56	MW-175	63.7
FSB-16	TA-3	280573.0	802287.1	301.5	32	40	50	60	61	MW-175	71.8
FSB-17	TA-4	280252.4	802104.0	297.2	27	35	45	55	56	MW-227	67.2
FSB-18	TA-4	280226.4	802141.5	298.2	31	39	49	59	60	MW-228	68.1
FSB-19	TA-4	280225.7	802202.0	300.2	31	39	49	59	60	MW-228	70.1
FSB-20	TA-4	280187.9	802144.4	297.2	30	38	48	58	59	MW-228	67.1

Notes:
ft, bgs - feet below ground surface
ft, msl - feet mean sea level
FSB - fluvial soil boring
MW - monitoring well
TA - treatment area

TABLE 4
QUALITY CONTROL SAMPLES
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Event	Matrix	Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Duplicate	Trip Blanks	Equipment Blanks	Total	Analyses
FSVE Rebound Test	Vapor	27	3	0	0	0	0	30	VOCs
FSVE Soil Confirmation Samples	Soil	60	6	3	3	0	0	72	VOCs
	Water					3	1	4	VOCs

Notes:

FSVE - fluvial soil vapor extraction

VOC - volatile organic compound

FIGURES

Figure 1

FLUVIAL SVE SYSTEM

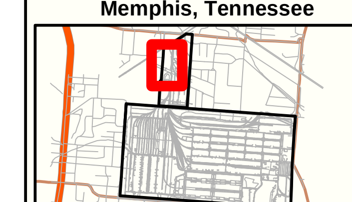
DUNN FIELD SOURCE AREAS
REMEDIAL ACTION

DEFENSE DEPOT
MEMPHIS, TENNESSEE

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

0 50 100 150 200 Feet

Installation Location
Memphis, Tennessee



Date: September 2010
Edition:

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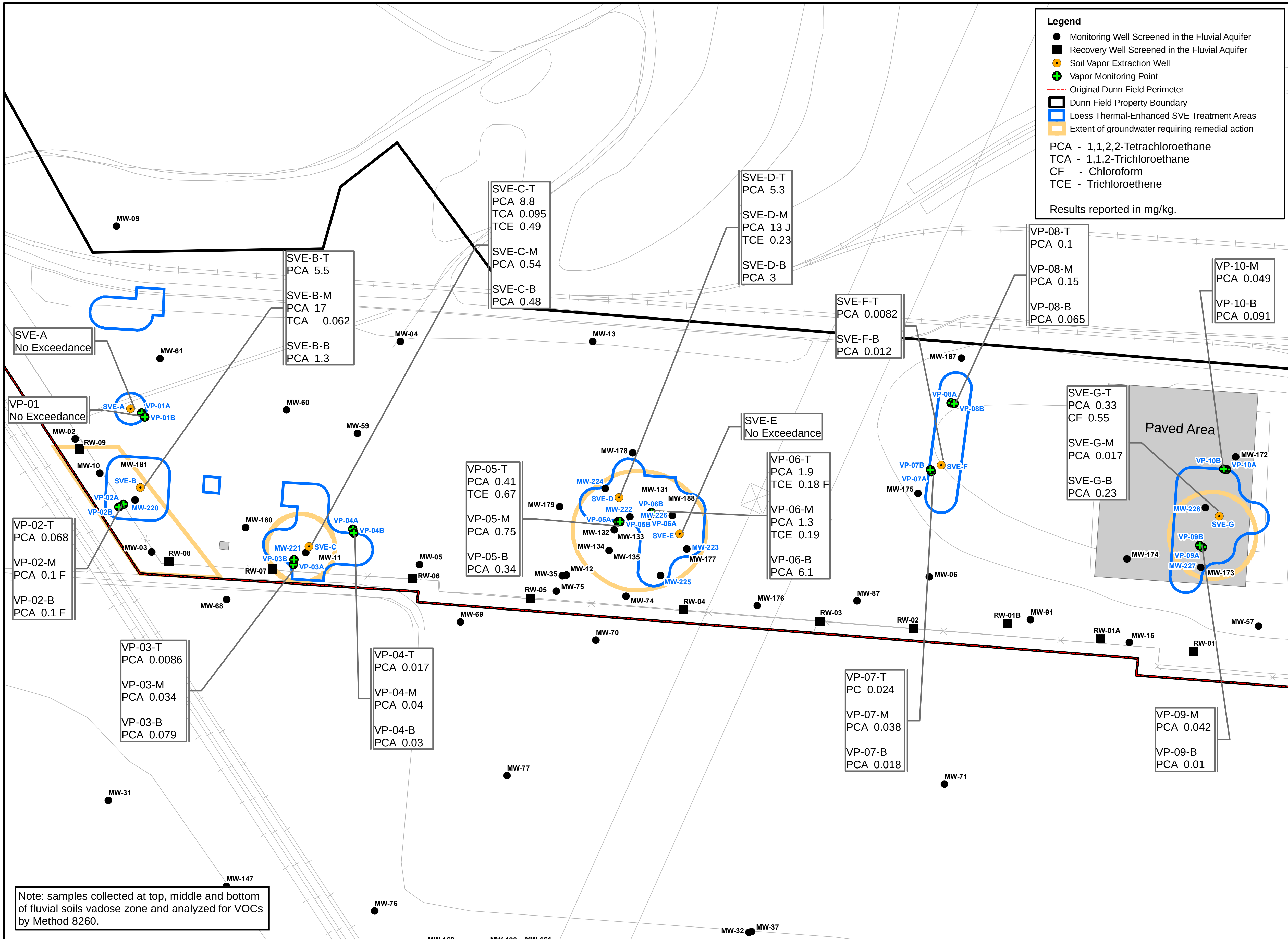

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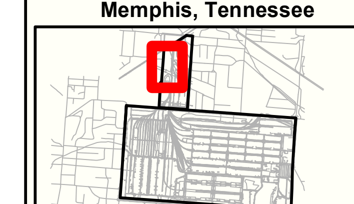
Figure 2

BASELINE FLUVIAL SOIL RG EXCEEDANCES

FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

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



Date: September 2010
Edition: Rev 0

HDR | eM

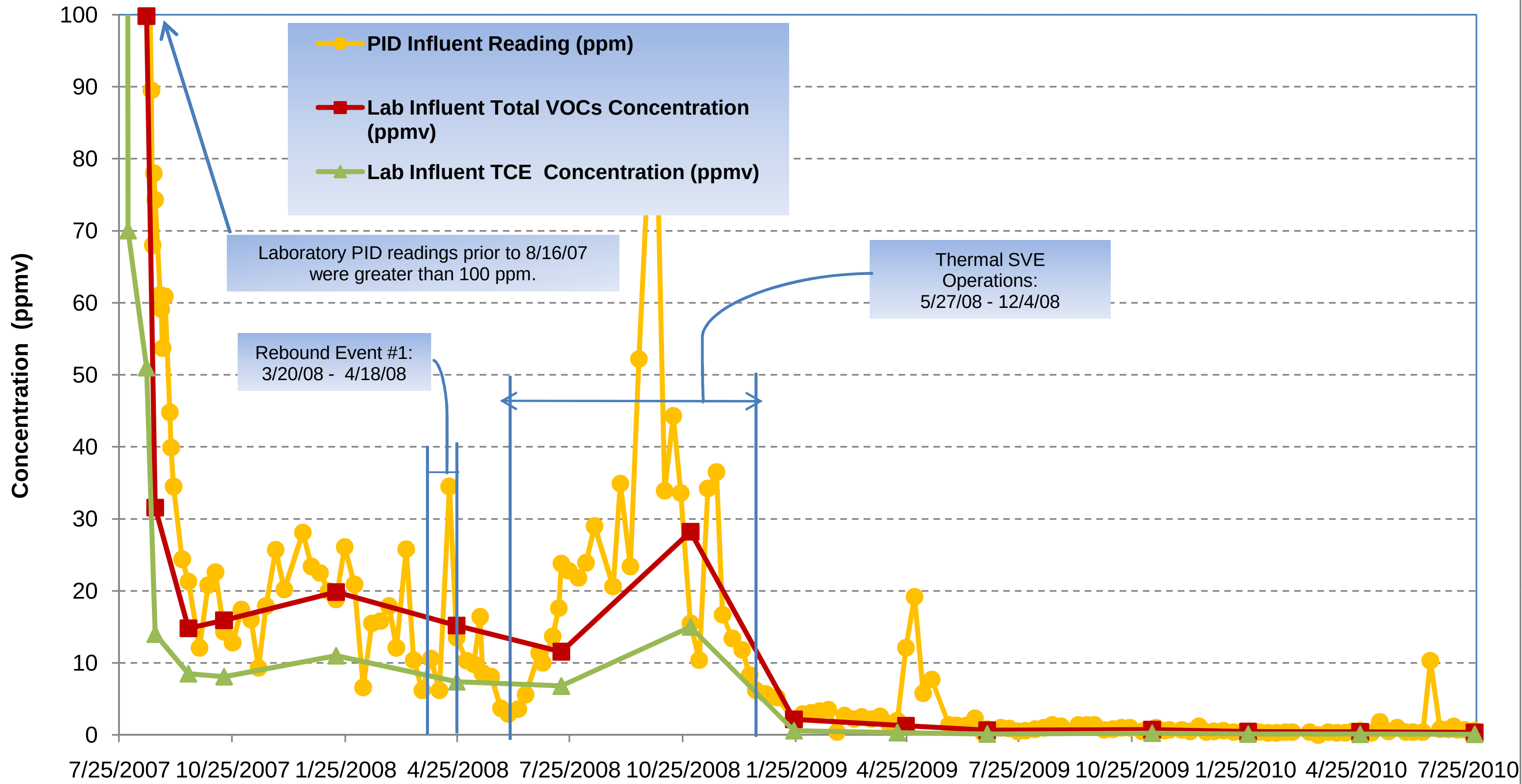
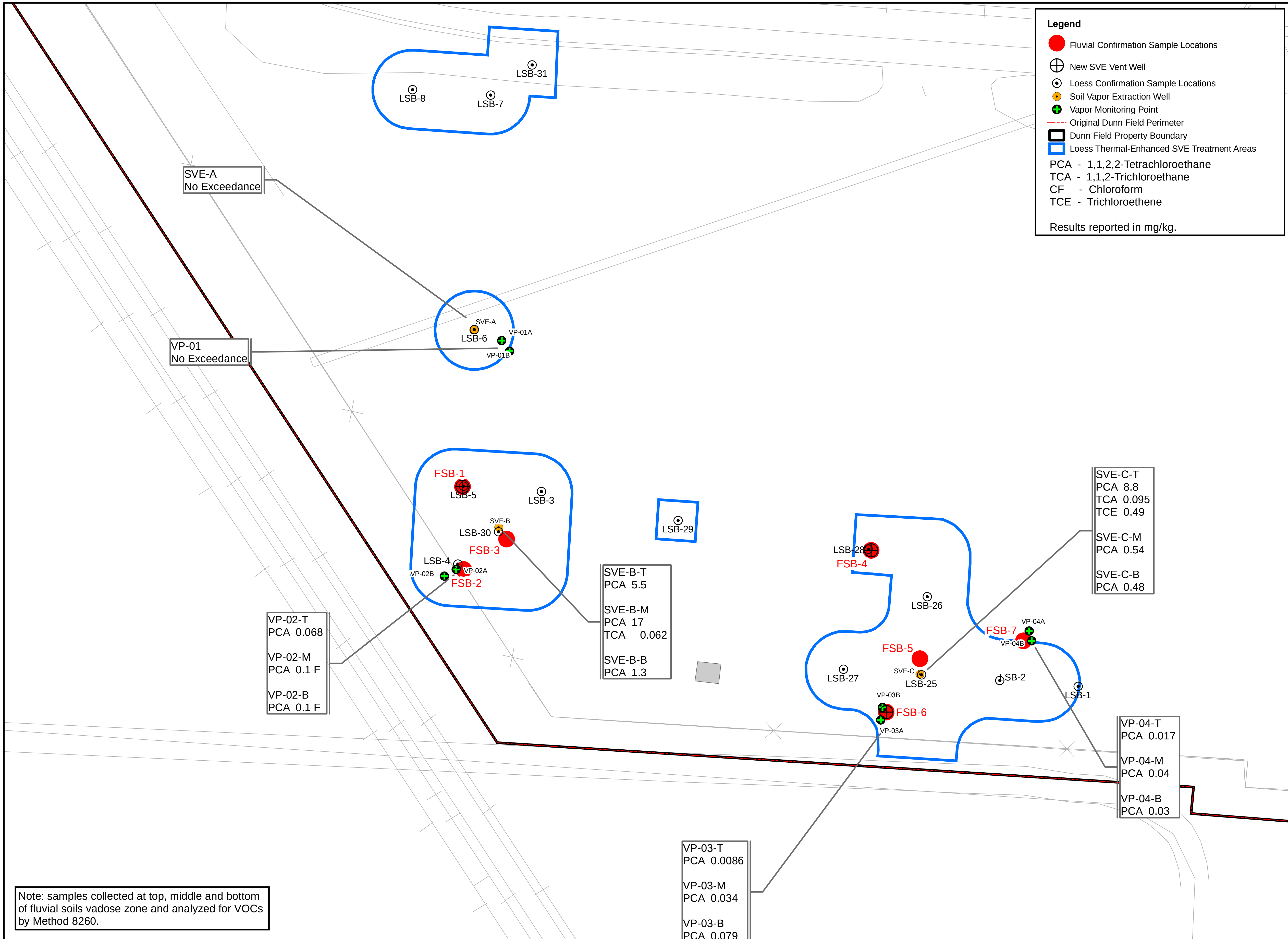


Figure 3.
INFLUENT CONCENTRATION TREND - ANALYTICAL RESULTS AND FIELD PID MEASUREMENTS
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee



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N E S W

Figure 4

FLUVIAL SOIL SAMPLE LOCATIONS, TA-1

FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

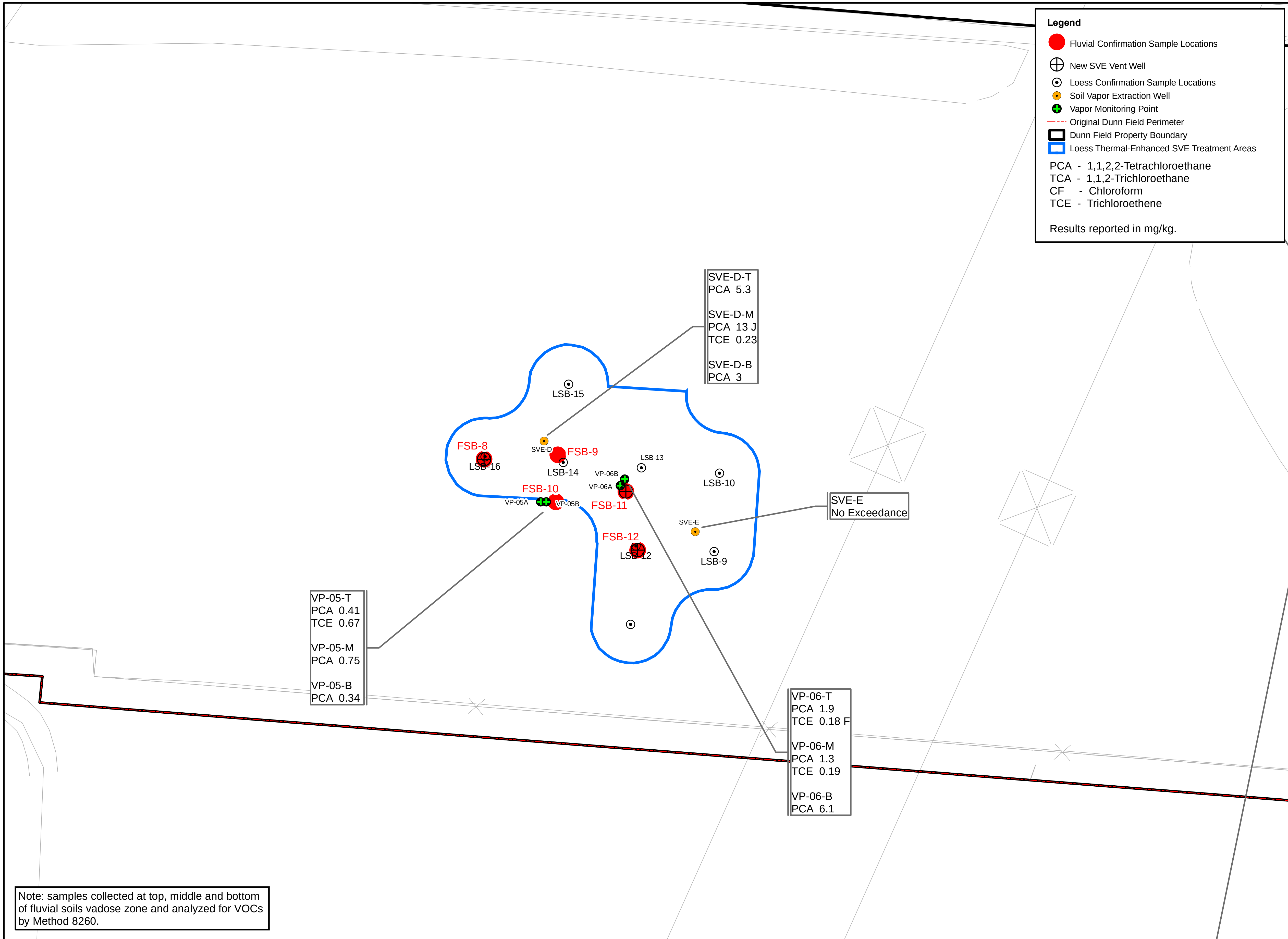
Projection: NAD 1927 StatePlane Tennessee
Datum : WGS 84
Units: Feet

0 20 40 60 80 Feet

Installation Location
Memphis, Tennessee

Date: September 2010
Edition: Rev 0

HDR | eM



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N E S W

Figure 5

FLUVIAL SOIL SAMPLE LOCATIONS, TA-2

FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN

DUNN FIELD DEFENSE DEPOT MEMPHIS, TENNESSEE

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

0 20 40 60 80 Feet

Installation Location
Memphis, Tennessee

Date: September 2010
Edition: Rev 0

HDR eM

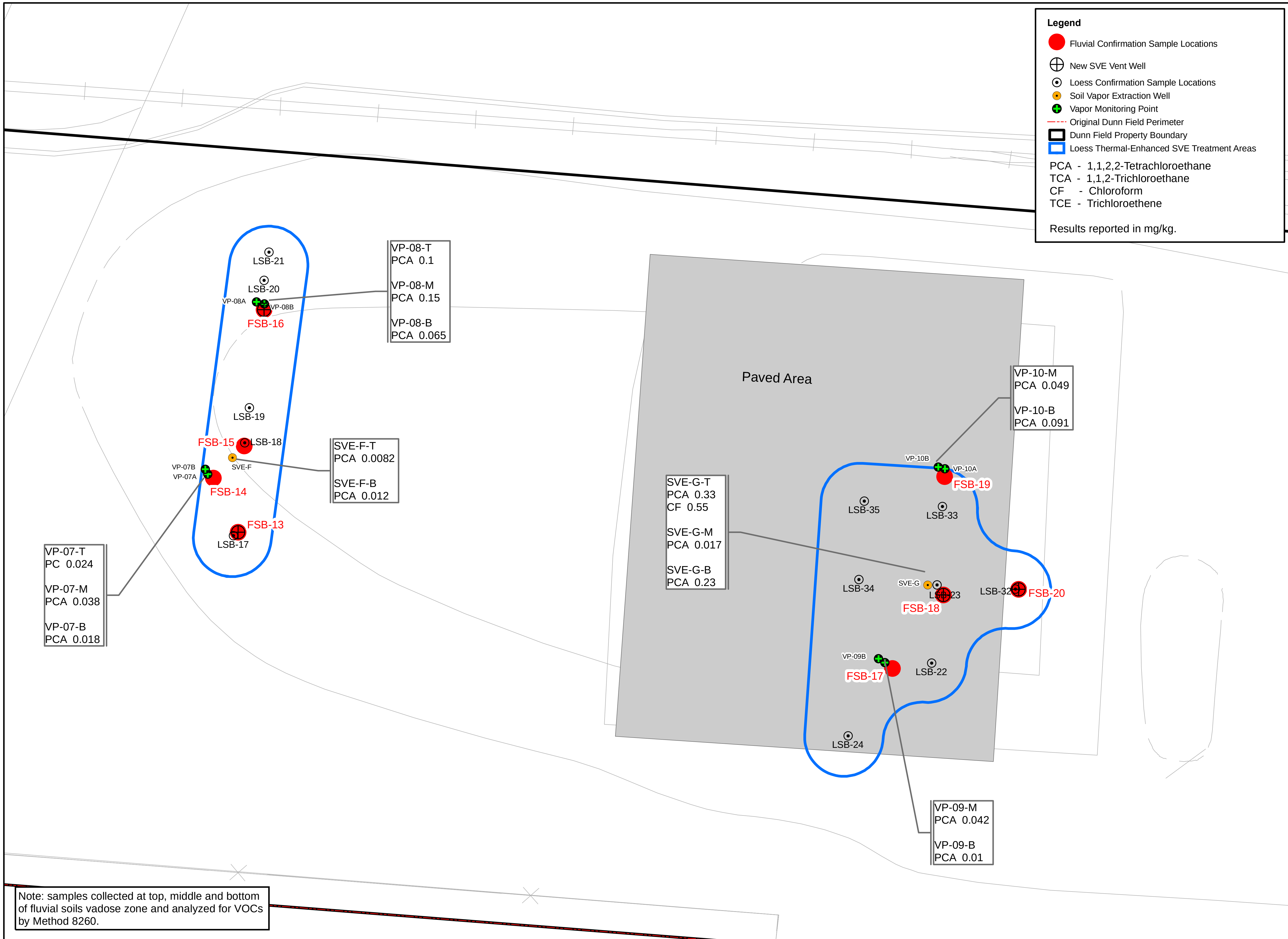

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Figure 6

FLUVIAL SOIL SAMPLE LOCATIONS, TA-3 AND TA-4

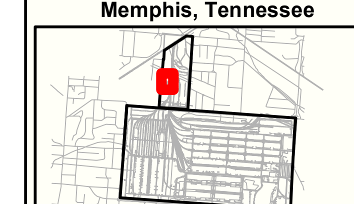
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN

DUNN FIELD
DEFENSE DEPOT
MEMPHIS, TENNESSEE

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

0 20 40 60 80 Feet

Installation Location
Memphis, Tennessee



Date: September 2010
Edition: Rev 0

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Appendix A

Applicable Work and Test Procedures

WTP 1 General Procedures for Field Personnel

WTP 2 Drilling Operations

WTP 6 Investigation Derived Waste Disposal

WTP 7 Sample Control and Documentation

WTP 8 Sample Containers and Preservation

WTP 9 Sample Packing and Shipping

WTP 10 Sampling Equipment Decontamination

WTP 11 Soil Sampling

WTP 13 Health and Safety Monitoring

WTP 14 Soil Vapor Extraction Wells

WTP 18 Vapor Sample Collection

WORK AND TEST PROCEDURE 1
GENERAL PROCEDURES FOR FIELD PERSONNEL

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the general field practices to be followed by MACTEC personnel while in the field at DDMT. A review of this WTP is mandatory prior to any field activities.

2.0 DISCUSSION

This WTP provides general guidance for field operations. The project-specific work plan will be referred to in order to determine the exact requirements for a specific project.

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

Minimum required personal protective equipment (PPE) for all employees involved in field work are steel-toed work boots. Additional PPE will be discussed in project specific work plans and in the site Health and Safety plan. A general checklist of personal supplies and equipment is presented as Attachment 1.1.

3.0 PROCEDURES

The following WTPs should be considered in conjunction with this WTP:

NUMBER	NAME
1	General Procedures for Field Personnel
2	Drilling Operations
3	Well Installation, Development, and Abandonment
4	Groundwater Sampling
5	Hydraulic Conductivity Testing
6	Investigation Derived Waste Disposal
7	Sample Control and Documentation

NUMBER	NAME
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sampling Equipment Decontamination
11	Soil Sampling
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.1 PREPARATION

This section discusses the procedures to be used prior to beginning the field activities at each site.

3.1.1 Office

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

1. The Project/Task Manager will assign a Field Team Leader to direct field activities and coordinate with project/task managers, and personnel. Task specific responsibilities of the Field Team Leader will be addressed in the appropriate WTP; general responsibilities include;

    - Reviewing project-specific work plan, Health and Safety Plan (HSP), and Quality Assurance Project Plan (QAPP).
    - Notifying site personnel to arrange site access and coordinate schedules; contacts include DRC, affected tenants, and/or offsite property owners.
    - Coordinating field efforts with the project chemist and analytical laboratory
    - Generating appropriate paperwork for each event. Shipping appropriate paperwork and field books to the site.
    - Ordering appropriate supplies and equipment for delivery prior to the start of each event.
    - If any work is to be subcontracted, a review of the subcontractor contract, work plan, and Health and Safety plan.
    - Ensure that all employees traveling to the site have Driver's License (or other picture identification) and an OSHA Certification Card in their possession prior to leaving the office.

3.1.2 Field

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

- Verify that all required paperwork and equipment for field activities is on site. Inventory all rental equipment.
- Conduct site set up activities to include posting of signage (if applicable), delineation of work zones as specified by the SHSO or the Field Team Leader.
- Calibrate monitoring equipment (as needed).
- Conduct team safety meetings as required by the HASP.
- Conduct team review of the WTP and procedures to be followed.

3.2 FIELD OPERATIONS

Prior to commencement of operations at each of the sites, a site reconnaissance will be performed to determine requirements for site preparation and clearance, such as clearing of brush and other identifying obstructions. Proposed drilling and sampling locations will be clearly marked. Clearance for utilities at drilling locations will then be conducted by utility operators or locating services such as Tennessee One-Call. No intrusive activities will be conducted until utility clearance has been completed. The MACTEC Field Team Leader will also select appropriate locations for the decontamination area, emergency equipment, and a drum staging area through consultation with DRC and site tenants as necessary.

The responsibilities incumbent on field personnel at DDMT are project and task specific. At a minimum, the field personnel are required to

1. Maintaining a logbook that describes field activities, and other information. In the logbook or on various forms that may be required, the following information must be recorded for each activity:
   - Location
   - Date and time
   - Identity of persons performing the activity
   - 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 casings)

2. Completing any required data collection/sample control forms (e.g., Chain-of-Custody, Field Sampling Report, etc.).
3. Communication with the MACTEC project/task manager regarding site conditions and out of scope work to be performed.
4. Before leaving the site daily, the following procedures will be performed by on-site personnel:

   - Decontaminate field equipment.
   - Field Team Leader is responsible for checking that all personnel have completed logbooks and field forms daily
   - Properly dispose of soiled PPE.
   - Ensure that any drums containing investigation-derived waste or PPE are sealed nightly and clearly labeled with the contents, date, and site/location name.
   - Make arrangements for shipment of samples (if applicable). Check daily with the analytical laboratory to ensure samples arrived in good condition.

3.3 POST-OPERATION

This section discusses the procedures to be followed after field activities have been completed.

3.3.1 Field

Upon the completion of field activities, the MACTEC Field Team Leader will visit each site to verify that 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, such as wheel ruts caused by the drilling and support equipment, will be repaired.

- Ensure that equipment and associated supplies have been shipped back to the office.

3.3.2 Office

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

- Submit logbook and original forms to Project/Task Manager for review.
- Check equipment and supplies shipped back to the office.
- Arrange for proper disposal of investigation-derived waste.
- Contact the analytical laboratory to ensure that the samples arrived in good condition (e.g., temperature is within acceptable ranges).

4.0 REFERENCES

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 1.1 **-** Personal Field Equipment and Supplies Checklist

ATTACHMENT 1.1

PERSONAL FIELD EQUIPMENT AND SUPPLIES GENERAL CHECKLIST

Steel Toe Workboots ___________

Full Face Respirator (with appropriate cartridges) ___________

Safety glasses ___________

Logbook ___________

Pens ___________

Data Collection Forms ___________

Respirator Cartridges ___________

OSHA Certification Card ___________

Tape Measure ___________

Hard Hat ___________

Hammer ___________

First Aid Kit and Emergency Eyewash Station ___________

Overshoes ___________

Sun Screen ___________

Work Gloves ___________

Disposable Gloves ___________

WORK AND TEST PROCEDURE 2

DRILLING OPERATIONS

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for drilling operations used in support of investigative activities at DDMT. Intrusive drilling activities will enable collection of subsurface soil samples and allow the installation of monitoring and injection wells.

2.0 DISCUSSION

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 and for the installation of monitoring wells. Sonic drilling is the recommended method of drilling at DDMT because it has proven to be the most effective method for boring advancement and well installation under the site geologic and hydrogeologic conditions. The depth to water (i.e. 75-105 ft bgs on average) and geologic characteristics of the fluvial aquifer (i.e. tight sands mixed with gravel up to cobble size) present more problems for well installation using other drilling methods.

Drilling activities that require the use of a truck-mounted drill rig will be subcontracted. Specific requirements for drilling subcontractors include:

- Provision of a Health and Safety Plan in compliance with that of the project
- Subcontractor employees must have completed the OSHA 40-Hour course with the OSHA 8-Hour refresher, as necessary
- Subcontractor employees must be in a medical surveillance program
- Equipment sufficient to carry out the work as specified in the time allotted
- All required licenses to drill and install wells in the state of Tennessee
- Appropriate experience on similar projects.

MACTEC Engineering and Consulting (MACTEC) personnel will provide on-site support for drilling activities. This support will consist of the following:

- Oversight of the drilling operation
- Preparation of the soil boring log (see Attachment 2.1) with lithologic interpretations and observations relevant to investigative activities
- Physical collection of the soil samples for field or laboratory analysis (if any).
- Site monitoring in accordance with the HSP.

MACTEC personnel on site will include, at a minimum, a qualified geologist/engineer. Drill rig equipment and other field supplies and equipment will be decontaminated as described under Section 3.2.3 of this WTP.

3.0 PROCEDURES

The following WTPs should be considered for review in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
3	Well Installation and Development
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.1 PREPARATION

The following subsections list the procedures to be followed prior to beginning of drilling operations.

3.1.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Coordinating with the analytical laboratory to ensure that the sample containers, and preservatives based on the expected number of samples and days on site are shipped to the site and arrive prior to the start of drilling.

- Generating appropriate paperwork for each event including HTW drilling logs. Shipping appropriate paperwork and field books to the site prior to the start of sampling.
- Ordering appropriate supplies and equipment for delivery prior to the start of sampling. A generalized list of sampling equipment and supplies is provided as Attachment 2.2.
- Provide drilling subcontractor with number and depth of boring to be drilled and ensure that sufficient material quantities will be available. Confirm drilling schedule.
- Arrange for surveyor to locate drilling locations, as necessary
- Notify utility locating services at least three business days prior to drilling activities.

3.1.2 Field

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

- Meet with site contacts, as necessary to confirm drilling locations and IDW storage (roll-off boxes)
- Verify that required equipment for drilling operations is on-site and functional
- Conduct site set up activities to include; posting of signage, provision of drums to contain drill cuttings and other IDW (PPE, decon water), delineation of the drilling area with hazard/caution tape, and marking/staking of the locations to be drilled
- Tour the site and check the decontamination area
- Calibrate monitoring equipment (as needed)
- Conduct team review of the WTP and procedures to be followed (subcontractor and MACTEC personnel)

3.2 FIELD OPERATIONS

A qualified geologist or engineer will oversee the drilling activities. Modifications to boring locations will be approved by the Project/Task Manager prior to implementation.

3.2.1 Drilling Procedures

Prior to setting up on the drilling location, the field team leader will confirm that the location has been cleared with appropriate utility companies and with the property owner/tenant. Drilling will only proceed where no aboveground or subsurface obstructions exist. Locations will be offset if these obstructions are identified 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.

The following requirements will apply to drilling activities:

1. Drilling will conform to Shelby County rules and regulations, and Rules of TDEC, Division of Water Supply, Chapter 12-4-10, Well Construction and Abandonment Standard. Activities will also conform to EPA Region 4, Science and Ecosystems Services Division EISOPQAM (2001).
2. 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.
3. The only acceptable drilling fluid is water. However, water will be used only when necessary as approval by the project/task manager, and will be from an approved source. Any bentonite that may be added to the water will be 100 percent sodium bentonite.
4. If water is used as a drilling fluid, a water sample from the drilling water supply tank will be collected and analyzed for the contaminants of concern.

3.2.1.1 Drilling Procedures

The following procedures will be followed for completing each soil boring/well:

1. Advance boring to the target depth. Water sources used during drilling will be sampled as outlined in 3.2.1.2.
2. Monitor the breathing zone for organic vapors in accordance with the procedures contained in the HSP. The tops of the boreholes will be monitored for percent oxygen and combustible gases (LEL) using a combination explosimeter/oxygen meter.
3. 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.
4. Determine and record the depth to groundwater observed during drilling.

3.2.1.2 Drilling Water Source

Water used during the drilling program will be clean, non-chlorinated water, where possible. Clean, potable water will be used if a non-chlorinated source is not readily available. MACTEC's drilling supervisor will record the amount of water used. One sample of the water used will be collected from the water source. Each water transportation vehicle will also be sampled once during the drilling program. These samples will be analyzed for the same parameters specified for the groundwater samples. Information regarding the source of water used and any impact on analytical results will be included in the field notes.

3.2.1.3 Drilling Logs

The geologist/engineer will log the subsurface conditions encountered in the boring, and record the information on a Hazardous and Toxic Waste (HTW) Drilling Log (Attachment 2.1) and the logbook. Additional pertinent information will also be recorded on the logbook, 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 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
- OVA, Draeger tube and explosimeter readings above background (including depth of each reading)
- Recovery length of each sample
- Visual description of soil using the Unified Soil Classification system (ASTM-D-2488-00)
- Depth at which soil sample was collected for chemical analysis
- Depth at which soil sample was collected for physical analysis
- Total number of samples taken
- Total depth of boring
- Boring refusal
- Water losses (if applicable)
- Depth, thickness, identification and description of stratum
- 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
- Changes in drilling fluid properties
- Drilling rate
- Drill rig reactions such as chatter, rod drops, or bouncing
- Location of the boring relative to an easily identifiable landmark.

3.2.2 The Borehole

For a nominal 2-inch outside diameter well casing, borehole diameter will be a minimum of 6 inches. The borehole shall provide a minimum of two inches of annular space between the outside diameter of the well casing and the borehole wall. Therefore, the sonic drill casing will require an inner annulus that is 6 inch diameter or larger. In cases where a hollow-stem auger is used, the inside diameter will be at least four inches larger than the outside diameter of the casing and well screen.

3.2.3 Drill Rig Decontamination

3.2.3.1 Decontamination Area

The location of the decontamination area will be cleared with DRC personnel. The decontamination pad will consist of a wooden frame lined with minimum 6-mil plastic sheeting. The pad will slope so that water can be temporary containerized in DOT-approved, 55-gallon, closed-top steel drums or other approved containers. A schematic of the proposed equipment/vehicle decontamination layout is presented in Attachment 2.3.

3.2.3.2 Decontamination Water Source

Potable water from the municipal water system will be used as a rinse in the decontamination procedure. The Field Team Leader will be responsible for coordinating with DRC personnel to secure an adequate supply of tap water for decontamination procedures.

3.2.3.3 Drill Rig and Support Equipment

The following procedure will be used to decontaminate drill rigs and support equipment.

1. Wash the external surface of equipment or materials with high-pressure hot water and scrub with brushes and Liquinox or equivalent, if necessary, until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been rinsed from the equipment.
2. Rinse with potable water.
3. This decontamination procedure will be performed prior to each use and between each well and sampling location. Decontamination solutions will be placed in DOT-approved, 55-gallon, closed-top steel drums or other approved containers, maintained at the site, and labeled.
4. Decontamination water is considered investigation-derived wastes (IDW). Therefore, the containers will be permanently labeled in a waterproof manner and inventoried as to their contents and source. The containers will be stored in the temporary staging area until proper disposal is arranged.

3.2.4 Borehole Abandonment

Boreholes will be abandoned in accordance with both project-specific requirements and the applicable TDEC, Shelby County and USEPA guidance and requirements referenced in section 3.2.1.

Soil borings that encounter groundwater will be abandoned by filling the boring with grout (cement/bentonite) until undiluted grout is visible at the surface. The grout will be tremied into the boring, keeping the tremie pipe below the grout surface. The tremie pipe should have side discharge holes, not end discharge. The side discharge will help to maintain the integrity of the underlying material. The grout will serve to seal off the aquifer from contamination from surface influences. The remaining annular space created by the settlement of the grout will be finished to the ground surface with the surface cap material present prior to drilling (i.e., soil, concrete, asphalt, etc.).

3.2.5 Investigative-Derived Waste

Any investigative-derived waste (i.e., drill cuttings, drilling fluid) that is contaminated will be disposed of in an approved fashion as specified in the FSP.

3.3 POST-OPERATION

The following subsections list the procedures to be followed after drilling operations have been completed.

3.3.1 Field

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

- Decontaminate all field equipment that has come in contact with soil or groundwater
- Ensure that each drilling location is clearly marked for surveying.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete HTW Drilling Log (Attachment 2.1).
- Ensure that equipment and associated supplies are shipped back to the office.
- Ensure that IDW containers (e.g. drill cuttings, decontamination water) or PPE are sealed and have been labeled clearly with the date, name, contents and source.
- Ensure that the site is returned to its condition prior to drilling operations to the extent feasible (i.e., trash related to drilling operations must be disposed of prior to departure from the site).

3.3.2 Office

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

- Submit logbook and any original forms to Project/Task Manager for review.
- Inventory equipment and supplies shipped back to the office.
- Make arrangements for the proper disposal of IDW.

4.0 REFERENCES

USACE, 1998, Monitoring Well Design, Installation, and Documentation at Hazardous Toxic and Radioactive Waste Sites. November 1998.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

USEPA, 1991. Guidance on Oversight of Potentially Responsible Party Remedial Investigations and Feasibility Studies. Final, OSWER Directive 9835.1 Document 070191-1, July 1991.

USEPA, 1992. RCRA Groundwater Monitoring: Draft Technical Guidance. EPA530-R-93-001. United States Environmental Protection Agency, November 1992.

USEPA, 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document. OSWER-9950.1. United States Environmental Protection Agency, September 1986.

5.0 ATTACHMENTS

Attachment 2.1 - HTW Drilling Log
Attachment 2.2 – General Field Supply Checklist-Drilling Activities
Attachment 2.3 - Vehicle/Equipment Decontamination Layout

ATTACHMENT 2.1

HTW DRILLING LOG

HTW DRILLING LOG						HOLE NO.
1. COMPANY NAME		2. DRILLING SUBCONTRACTOR				SHEET OF SHEETS
3. PROJECT			4. LOCATION (CITY, STATE)			
5. NAME OF DRILLER			6. MANUFACTURER'S DESIGNATION OF DRILL			
7. SIZE AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			9. HOLE LOCATION (SITE)			
			10. SURFACE ELEVATION			
8. WEATHER			11. DATE STARTED			12. DATE COMPLETED
13. OVERBURDEN THICKNESS			16. DEPTH GROUNDWATER ENCOUNTERED			
14. DEPTH DRILLED INTO ROCK			17. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
15. TOTAL DEPTH OF HOLE			18. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
19. GEOTECHNICAL SAMPLES (#)	DISTURBED	UNDISTURBED	20. TOTAL NUMBER OF CORE BOXES			
21. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	22. TOTAL CORE RECOVERY %
23. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	24. SIGNATURE OF INSPECTOR		
25. CHECKED BY:			26. NAME OF INSPECTOR			

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS (ppm) d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h
	1.0						
	2.0						
	3.0						
	4.0						

MRK FORM JUN 89	55-1	PROJECT NAME & NO.	HOLE No.

**ATTACHMENT
2.1 (continued)**

HTW DRILLING LOG

HTW DRILLING LOG			HOLE NO.
PROJECT	INSPECTOR		SHEET OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS (ppm) d	GEOTECH SAMPLE OR CORE BOX No. e	ANALYTICAL SAMPLE No. f	BLOW COUNTS g	REMARKS h
	6.0						
	7.0						
	8.0						
	9.0						
	0.0						
	1.0						
	2.0						
	3.0						
	4.0						
	5.0						

MRK	FORM JUN 89	55-2	PROJECT NAME & NO.	HOLE No.

PREPARED BY/DATE: JAH 10/11/02
CHECKED BY/DATE: WPB 11/08/02

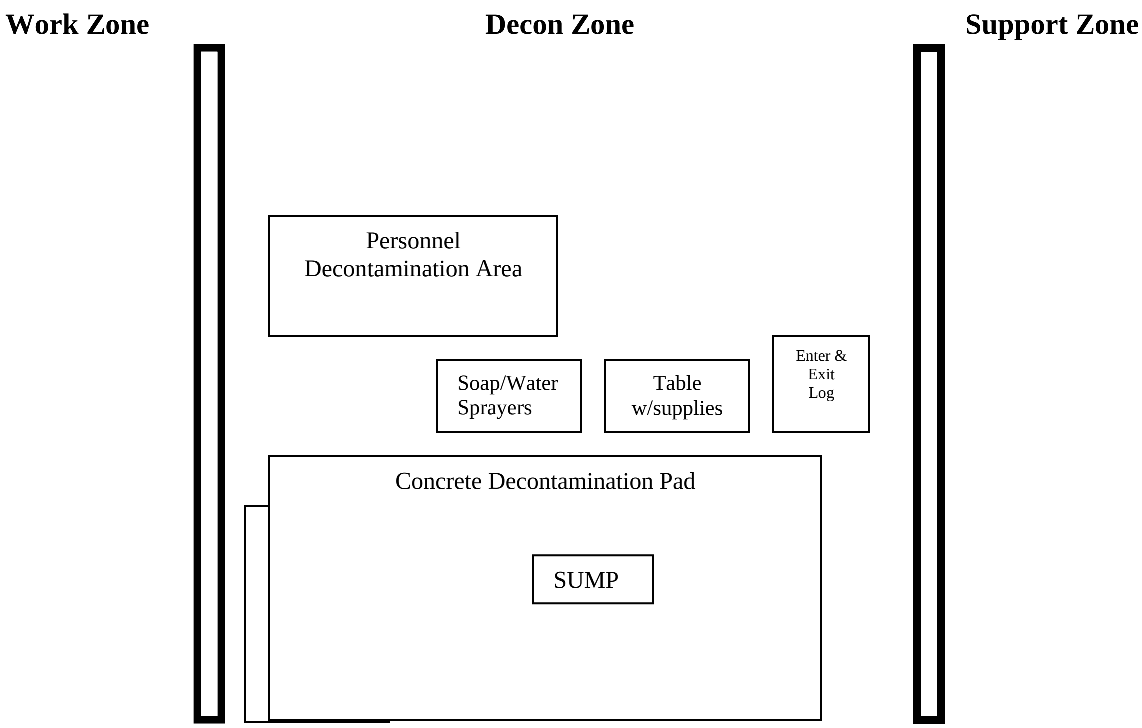
ATTACHMENT 2.2

General Field Supply Checklist-Drilling Activities

Steel Toe Workboots	___________
Full Face Respirator (with appropriate cartridges)	___________
Safety Glasses	___________
Logbook	___________
Pens	___________
Data Collection Forms	___________
OSHA Certification Card	___________
Tape Measure	___________
Hard Hat	___________
Hammer	___________
First Aid Kit and Emergency Eyewash Station	___________
Overshoes	___________
Sun Screen	___________
Work Gloves	___________
Disposable Gloves	___________
FID	___________
LEL	___________
Water Level Indicator	___________

ATTACHMENT 2.3

VEHICLE/EQUIPMENT DECONTAMINATION LAYOUT
Defense Depot, Memphis, Tennessee



WORK AND TEST PROCEDURE 6
INVESTIGATION DERIVED WASTE SAMPLING AND DISPOSAL

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for collection of samples of investigation derived waste (IDW) to be analyzed for use in the proper disposal of IDW material.

2.0 DISCUSSION

This WTP specifies details and procedures for collecting IDW samples. The project-specific workplan will be referred to in order to determine the exact requirements. The sampling objectives will be to allow for efficient and proper disposal of the IDW.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be considered in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipment
10	Sample Equipment Decontamination
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Determine appropriate sampling methods and ensure that sufficient supplies are shipped to the site;

- Ensure that sufficient preprinted sample and container storage labels are shipped to the site;
- Review the existing data to determine the probable identity of various compounds that may be present in the waste.

3.2.2 Field

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

- Check that required sampling equipment has arrived on site in operating order;
- Check that monitoring equipment is functioning properly, calibrated as needed and that respective manuals are present.

3.3 FIELD OPERATIONS

Four categories of IDW are anticipated to be generated during the RA field activities:

- Soil cuttings from borings drilled for monitoring well installation
- Development and purge water from monitoring well development and groundwater sampling activities
- Decontamination fluids resulting from cleaning of heavy equipment and from decontamination of sampling equipment
- Miscellaneous waste, consisting of disposable supply containers and used personal protective equipment (PPE) (i.e., Tyvek coveralls, boot covers, gloves and respirator cartridges)

Disposal options for the DDMT IDW are based primarily on contaminant concentrations of the waste Non-hazardous wastes may be disposed of at the investigation site or off-site at a RCRA Subtitle D facility. Hazardous wastes must be containerized and disposed off-site in accordance with RCRA Subtitle C requirements. Attachment 6.1 illustrates the factors that will be considered in deciding how the IDW will be managed.

IDW will be containerized at each site in 55-gallon drums or alternative storage containers which meet the requirements of 40 Code of Federal Regulation (CFR) Subpart I – Use and Management of Containers, including:

- Keeping the container in good condition
- Using containers made of material that is compatible with the waste
- Keeping the container closed during storage

A label will be placed on each drum identifying the site where the waste was generated, the matrix of the waste in the drum, and the date that accumulation of the waste began. Drum labels will be kept simple and easy to read. Attachment 6.2 provides an example of a typical label. Further, drums containing hazardous waste will be labeled in accordance with applicable DOT regulations, including 49 CFR Parts 172, 173, 178 and 179.

At DDMT, purge water from purging wells prior to sampling, developing wells, and equipment decontamination will be transported from the well in drill rig support trucks or sealed 5-gallon buckets to a Baker tank at Dunn Field or 55-gallon drums in the decontamination area. At the completion of activities, the waste water will sampled from the midpoint of the Baker tank or the drums using disposable Teflon bailers. If the concentrations are below those listed in the City of Memphis Industrial Wastewater Discharge Requirements under Permit No. S-NN3-097, the water is pumped directly from the tank into the City of Memphis Sewer system via the Dunn Field treatment system. Waste methanol generated during decontamination procedures will be stored separately and treated as a hazardous waste.

Soil from borings and material from well abandonment will be placed into 20-cubic-yard roll-off boxes. Material in the boxes will be sampled at approximately four locations in each box using a pre-cleaned stainless steel spoon or hand auger. The material to be analyzed for TCLP VOCs for final disposal purposes will be deposited directly into the appropriate labeled laboratory supplied containers. If TCLP analyses other than VOCs are required, the material collected from the different locations in the box will be composited into one sample in a pre-cleaned stainless steel bowl. It will then be placed in the appropriate labeled laboratory supplied containers and analyzed for the additional analyses as needed. Upon receipt of the results of the laboratory analyses, the material will be disposed of in accordance with the analytical results. If the results are less than the TCLP regulatory levels, the soil will be disposed of as non-hazardous Investigation Derived Waste at a landfill approved to accept CERCLA off-site waste. If the results exceed TCLP regulatory levels, the material will be disposed of in accordance with hazardous waste requirements.

3.4 POST-OPERATION

3.4.1 Field

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

- Decontaminate or dispose of sampling equipment;
- Complete logbook, making notations as to site conditions, anomalous readings, etc.;
- Ensure that drums or containers containing investigative-derived waste are properly labeled with the date and drum contents.

3.4.2 Office

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

- Submit logbook and any original forms to Task/Project Manager for review;
- Inventory all equipment and supplies shipped back to the office;
- Make provisions for proper disposal of investigative derived waste.

4.0 REFERENCES

ASTM, 1984. Annual Book of ASTM Standards, American Society of Testing and Materials, 1986.

CH2M Hill, 2004. Main Installation Pre-Final Remedial Design. Prepared for the U.S. Army Engineering and Support Center, Huntsville. February 2004.

USACE, 2001. Engineering and Design Requirements for Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

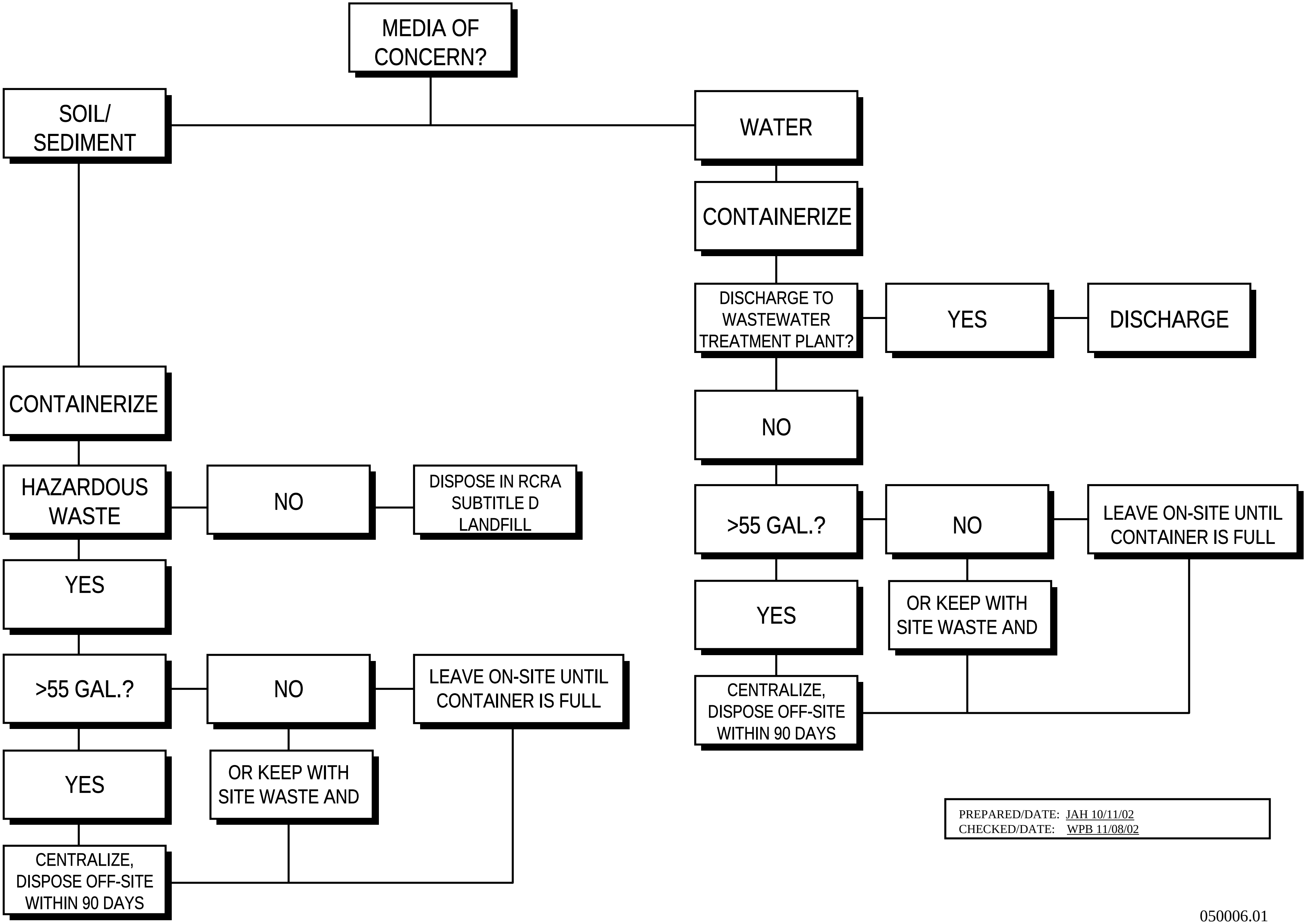
USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 6.1 - IDW Decision Tree
Attachment 6.1 - Example Drum Label

Attachment 6-1

IDW DECISION TREE



PREPARED/DATE: JAH 10/11/02
CHECKED/DATE: WPB 11/08/02

050006.01

Attachment 6.2

INVESTIGATION DERIVED WASTE LABEL

Drilling and Sampling Waste

These materials may be hazardous or special waste, pending laboratory analysis, and/or other evaluation.

The contents should not be disposed or removed without consent of the generator listed below.

CONTENTS:
____ Drill Cuttings
____ Purge and/or Development Water
____ Other ______________________

Date Placed
in Container: ______________

Drum No. ____________
Source I.D. ____________
(Boring #, Well #, etc.)

Generator Name: ______________________
Contact: ______________________
Phone: ______________________

WORK AND TEST PROCEDURE 7
SAMPLE CONTROL AND DOCUMENTATION

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for sample control and identification, data recording, and the proper completion of Chain-of-Custody (C-C) forms.

2.0 DISCUSSION

This WTP specifies details and procedures for sample control and documentation. The project-specific work plan will be referred to in order to determine exact requirements for the sampling activities. Sample control and documentation are required to support the legal defensibility of data generated from sampling activities. Required documents include the sampling logbooks, sample labels and seals, analytical reports, C-C forms, and daily field sampling reports.

Relevant information will be recorded in the project logbook. This information will include weather conditions, sample description, and whether any unusual odors were noticed upon sample collection.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be considered for review in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
4	Groundwater Sampling
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sample Equipment Decontamination

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Work in conjunction with the project chemist to create a sampling plan detail
- Create a sample tracking sheet (Attachment 7.1)
- Coordinating with the analytical laboratory to ensure that proper documentation including chain of custody forms and custody seals are shipped to the site.

3.2.2 Field

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

- Check that required supplies are on-site;
- Record relevant data in the logbook (including ambient air temperatures, weather conditions, sample appearance, odor, etc.).

3.3 FIELD OPERATIONS

3.3.1 Sample Location and Identification

This section details sample nomenclature procedures to be used in general field investigations.

3.3.1.1 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 C-C form. Additional information to be written on the label includes location ID, time and date of sample, sampler's initials, and the analytical methods to be performed (Attachment 7.2).

During sampling events during the field effort, nomenclature will be used to distinguish between categories of sampling events, sample locations, and, where appropriate, depth of sample collection.

The extenders will consist of a two-digit matrix code (sample type, if other than ground water), alphanumeric depth codes (if necessary), and quality QA/QC codes where applicable. Field split samples will be labeled the same as the parent sample, with a QA extender added to the end of the name.

TB	Trip Blank
FB	Field Blank
EB	Equipment Blank
MS	Matrix spike
MSD	Matrix spike duplicate
MW	Monitoring well (groundwater)
SW	Surface water
SB	Soil boring (0-2', 2-4', 4 –6', etc.)
SS	Surface Soil (0-6")

The identity of the trip blanks, field blanks, and equipment blanks will consist of the prefix TB, FB, or EB, respectively, followed by the date without punctuation. When two or more trip, field, or equipment blanks are collected in a day, the date will be followed by a sequential number. QA/QC split sample trip blanks and equipment blanks will be identified by adding the suffix "QA" to the end of the sample ID. If groundwater samples are collected from PDBs, each sample number must reflect the top and bottom depth of the diffusion bag in the well.

The identity of field duplicate samples will be concealed from the laboratory by using a consecutively numbered generic name indicating the area from which the duplicate was collected. For example, the first duplicate sample collected from target treatment area 1 will be named TTA1DUP-1. The true identity of duplicates/replicates will be recorded on the sampling plan detail (SPD) and field notebook. The SPDs will be maintained in the project file and copies will be kept at the on-site field office. Copies of these forms will be provided to the QA Coordinator and the data validation team as needed for their reviews. An example SPD is presented in Attachment 7.3.

3.3.2 Completing the Log Book

The logbook is a written record of sampling activities that is completed in the field during sampling. The purpose of the log book is to record and document field conditions or procedural exceptions that may aid in the analysis of data generated from sampling activities.

Information pertaining to environmental conditions at the site during the field investigation will be noted in the field log book each day. Information will be recorded in indelible ink in a log book with sequentially numbered pages. The recorder will sign and date each page. The following information will be recorded for each activity:

1. Location
2. Date and time
3. Identity of people performing the activity
4. Weather conditions

For field measurements, the following information will be recorded:

1. The numerical value and units of each measurement
2. The identity of and calibration results for each field measurement

For field sampling activities, the following information will be recorded:

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

These criteria will be recorded in the field sampling book and used to assess sampling procedures in relation to the sample data. Information that is contained elsewhere (such as in the Field Sampling Report or the Purge Log) should be repeated in the logbook.

3.3.3 Daily Quality Control Reports (DQCRs)

Each day the Field Team Leader will prepare a DQCR (Attachment 7.7). The DQCR will include weather information at the time of sampling, ID of samples collected, data from field instruments and calibrations, and will reflect any problems that occurred in the field. In addition, the DQCR documents personnel and visitors at the site during field activities. Modifications to field procedures will be requested by a Field Adjustment Form (Attachment 7.8).

3.3.4 Photographs

Photographs taken for the purpose of project documentation must be recorded in the field logbook. When movies, slides, or photographs are taken of a site location, they are numbered to correspond to logbook entries. The name of the photographer, date, time, site location, site description, sequential number of the photograph and the roll number, orientation of photograph and weather conditions are entered in the logbook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image enhancement techniques will be avoided, since they can adversely affect the admissibility of evidence. Adequate logbook notations and receipts will be used to account for routine file processing. Once processed, the slides or photographic prints will be serially numbered and labeled according to the logbook descriptions. For instant photographs , the required information will be entered on the back of each photograph as soon as it is taken.

3.3.5 Completing Sample Labels/Tags

Sample labels will be filled out for each sample with an indelible pen. Where necessary, 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. Each label will contain the following information:

- Name or initials of collector
- Date, place, and time of collection
- Job name and number
- Sample number and/or boring number and depth
- Preservative (if required)
- Analysis requested

3.3.6 Collecting Samples

Proper sampling procedures are vital to the data acquisition process. Once collected, it is also important to maintain the integrity of the samples. Detailed sampling and decontamination protocols are described in WTP 4 - Groundwater Sampling, WTP 7 - Waste Sampling, and WTP 11 - Sampling Equipment Decontamination. A summary of the planned sample containers, sample volumes, preservation and maximum allowable holding times from the time of collection to analysis are presented in WTP 9 - Sample Containers and Preservation.

3.3.7 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 and during the laboratory operations. They will be performed according to the procedures described in the following subsections.

3.3.7.1 C-C Record

C-C records will be provided in each sample cooler. The custody record will be fully completed, in triplicate, by the field technician designated by the Field Team Leader as responsible for sample shipment to the laboratory. The information specified on the C-C 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, among other things, 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 MACTEC person relinquishing samples to a non-MACTEC person (such as a Federal Express agent), with the date and time of transfer noted, and the cooler designation.
- Airbill Number

In addition, if samples are known to require rapid turnaround in the laboratory because of project time constraints or analytical concerns such as extraction time or sample retention period limitations, the person completing the C-C record (Attachment 7.4) should note these constraints in the remarks section of the custody record and the Request for Analysis Form (Attachment 7.5). The same C-C form will be adapted for each subcontract laboratory unless a form is provided by the subcontract laboratory.

If it is not practicable to seal the sample shippers at a Federal Express office, they will be sealed beforehand. The duplicate custody record will, therefore, have the signature of the relinquishing field technician and a statement of intent (for example, to Federal Express P.M. June 30, 2001).

The duplicate custody record will then be placed in a plastic bag, taped to the underside of the cooler lid, and the cooler closed. The container will be tightly bound with filament tape. Finally, seals (see section 3.3.6.2 below) will be signed by the individual relinquishing custody and affixed in such a way that the cooler 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, and it is the responsibility of the Project Manager to ensure that all records are consistent and that they are made part of the permanent job file.

At the laboratory, the Sample Control Coordinator will open the package, retrieve the original record, and complete the "Received at Laboratory by box" by affixing his/her signature. The Sample Control Coordinator will record the condition of samples received on the Cooler Receipt Form (Attachment 7.6).

Custody Seals: Custody seals will be preprinted, adhesive-backed seals designed to break if disturbed. Sample shipping containers (coolers, cardboard boxes, etc., as appropriate) will be sealed in as many places as necessary to ensure security. Seals will be signed and dated before use. Upon receipt by the laboratory, the custodian will check and certify, by completing logbook entries, that the seals on boxes and bottles are intact.

Sample Handling: The sample custodian will receive the samples for the laboratory. He/she will perform the following actions upon sample receipt:

- Document whether the individual samples, boxes, or ice chests were sealed upon receipt and document any damaged condition of custody seals in the appropriate section of the cooler receipt form (Attachment 7.6).
- Check cooler temperature and record on the cooler receipt form.
- Sign C-C records, and identify the date and time of sample receipt.
- Check the pH of all samples except VOC samples. Notify project chemist of discrepancies.
- Log samples into the Receipt Logbook and computer file.
- Place sample numbers (from Receipt Logbook) on sample containers and secure the samples in appropriate refrigeration unit.
- Complete the cooler receipt form.

- The laboratories will submit sample receipt confirmation electronically daily to MACTEC to check for discrepancies.

Sample Log-In: Incoming samples will be accompanied by a MACTEC Request for Analysis Form (Attachment 7.5). In the event that this form does not accompany the incoming samples, it will be completed by the Sample Custodian who logs in the samples, or faxed by MACTEC upon immediate notification of the MACTEC Project Chemist. The custodians will enter the laboratory and test setup information into the computer. The laboratory custodian will have the Request for Analysis Form checked and initialed by a supervisor, and will issue copies to the applicable labs, normally on the day samples are received.

The Internal C-C for the Laboratory: Once a sample is within the custody of the laboratory, the transfer of the sample, its aliquot or extract will be documented in the internal C-C record. Every time a sample is transferred from one person to another, whether it is for distribution, storage, sample preparation, analysis or disposal, it will be relinquished by the person who has custody to the person who will then take new custody of the sample. Date and time of the exchange will be recorded. The sample will be shown and this person is tasked with ensuring secure and appropriate handling of the sample. There will be no lapses in sample accountability. The internal C-C form will be fully signed by each person who had contact with the sample.

3.4 POST-OPERATION

3.4.1 Field

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

- Check that sampling bottles assigned to the specific sampling location have been filled with the prescribed amount of sample and that sample labels contain required and relevant information (date, time, sampler's identification).
- Maintain custody of samples, maintaining them as specified for the analyses to be performed.
- Prepare samples for shipment to the laboratory.
- Complete the C-C forms.

- Contact the laboratory to inform them that samples will be shipped and also remind them of any unusual analytical requirements for the samples to be analyzed (i.e., holding times for hexavalent chromium).
- Verify completion of logbook, ensuring that required information has been recorded.

Upon completion of the field effort, ensure that associated supplies have been shipped back to the office, rental company, or laboratory as needed.

3.4.2 Office

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

- Submit logbook and any original forms to Project Manager for review.
- Inventory equipment and supplies shipped back to the office.
- Contact the laboratory to verify that samples were received in good condition and that requested analyses are understood.

4.0 REFERENCES

CH2M Hill, 2004. Long-Term Groundwater Monitoring Plan. Prepared for the U.S. Army Engineering and Support Center, Huntsville. July 2002.

EIM, 1991a. Installation Restoration Program Information Management Systems Data Loading Handbook. EIM, Brooks Air Force Base, Texas.

EIM, 1991b. Installation Restoration Program Information Management Systems Contractor Data Loading Tool Users Manual. EIM, Brooks Air Force Base, Texas.

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 7.1 – Sample Tracking Sheet
Attachment 7.2 - Example Sample Label
Attachment 7.3 – Sampling Plan Detail
Attachment 7.4 –C-C Form
Attachment 7.5 - Request for Analysis Form
Attachment 7.6 - Cooler Receipt Form
Attachment 7.7 – Daily Quality Control Report
Attachment 7.8 – Field Adjustment Form

ATTACHMENT 7.1
SAMPLE TRACKING SHEET

Sample ID	Comment	Date Sample Collected	Time Collected	Matrix	Number of Containers Collected	Requested Analysis	Type of Pump	Date Sample Shipped	Shipment Tracking Number	Preliminary Data Due	Preliminary Data Received	Laboratory Lot #	EDD Due date	EDD Received	STL SDG Received	Initial DQE Completed	DQE Senior Reviewed	Data Flags Entered	Final Table Checked
MW-31					3	VOCs (SW 8260 B)													
MW-32					3	VOCs (SW 8260 B)													
MW-44					3	VOCs (SW 8260 B)													
MW-54					3	VOCs (SW 8260 B)													
MW-70					3	VOCs (SW 8260 B)													
MW-76					3	VOCs (SW 8260 B)													
MW-77					3	VOCs (SW 8260 B)													
MW-79					3	VOCs (SW 8260 B)													
MW-80	Collect MS/MSD				9	VOCs (SW 8260 B)													
MW-144	Collect DUP				3	VOCs (SW 8260 B)													
MW-145					3	VOCs (SW 8260 B)													
MW-147					3	VOCs (SW 8260 B)													
MW-148					3	VOCs (SW 8260 B)													
MW-149					3	VOCs (SW 8260 B)													
MW-150					3	VOCs (SW 8260 B)													
DUNNDUP-1	Dup of MW-144				3	VOCs (SW 8260 B)													
MW-151					3	VOCs (SW 8260 B)													
MW-152					3	VOCs (SW 8260 B)													
MW-153					3	VOCs (SW 8260 B)													
MW-154					3	VOCs (SW 8260 B)													
MW-155					3	VOCs (SW 8260 B)													
MW-156					3	VOCs (SW 8260 B)													
MW-157	Collect DUP				3	VOCs (SW 8260 B)													
DUNNDUP-2	Dup of MW-157				3	VOCs (SW 8260 B)													
TTA-2-EQB-1	Rinsate				3	VOCs (SW 8260 B)													
TTA-2-EQB-2	Rinsate				3	VOCs (SW 8260 B)													
TTA-2-EQB-3	Rinsate				3	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													
TB-_______	Trip Blank				2	VOCs (SW 8260 B)													

ATTACHMENT 7.1
SAMPLE TRACKING SHEET

Sample ID	Comment	Date Sample Collected	Time Collected	Matrix	Number of Containers	Requested Analysis	Type of Pump	Date Sample Shipped	Shipment Tracking Number
MW-31					3	VOCs (SW 8260 B)			
MW-32					3	VOCs (SW 8260 B)			
MW-44					3	VOCs (SW 8260 B)			
MW-54					3	VOCs (SW 8260 B)			
MW-70					3	VOCs (SW 8260 B)			
MW-76					3	VOCs (SW 8260 B)			
MW-77					3	VOCs (SW 8260 B)			
MW-79					3	VOCs (SW 8260 B)			
MW-80	Collect MS/MSD				9	VOCs (SW 8260 B)			
MW-144	Collect DUP				3	VOCs (SW 8260 B)			
MW-145					3	VOCs (SW 8260 B)			
MW-147					3	VOCs (SW 8260 B)			
MW-148					3	VOCs (SW 8260 B)			
MW-149					3	VOCs (SW 8260 B)			
MW-150					3	VOCs (SW 8260 B)			
DUNNDUP-1	Dup of MW-144				3	VOCs (SW 8260 B)			
MW-151					3	VOCs (SW 8260 B)			
MW-152					3	VOCs (SW 8260 B)			
MW-153					3	VOCs (SW 8260 B)			
MW-154					3	VOCs (SW 8260 B)			
MW-155					3	VOCs (SW 8260 B)			
MW-156					3	VOCs (SW 8260 B)			
MW-157	Collect DUP				3	VOCs (SW 8260 B)			
DUNNDUP-2	Dup of MW-157				3	VOCs (SW 8260 B)			
TTA-2-EQB-1	Rinsate				3	VOCs (SW 8260 B)			
TTA-2-EQB-2	Rinsate				3	VOCs (SW 8260 B)			
TTA-2-EQB-3	Rinsate				3	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			
TB-________	Trip Blank				2	VOCs (SW 8260 B)			

ATTACHMENT 7.2
EXAMPLE LABEL

SampleID#: ______________________
Matrix: _________________________
Analysis: _______________________
Container: ______________________
Preservative: ___________________
Project#: _____________________
Location: _____________________
Date: ___________ Time:____________
Initials: ________________
MACTEC , Inc.

SAMPLING PLAN DETAIL

				Parameter:	**VOCs**		**Anions** (Nitrate & Sulfate)	
				Method:	SW8260B		E 300.0	
				Container:	40 mL VOA vial		250 mL Plastic	
				Preservative:	HCl to pH<2; Cool to 4°C		No Preservative Cool to 4°C	
	Sample ID	Comment	Date	Time	STL	CEMRD	STL	CEMRD
1	PX-1D	Deep Well			3		0	
2	PX-2				3		0	
3	PX-4				3		0	
4	PX-6				3		0	
5	PX-8				3		0	
6	PX-9*				3		1	
7	PX-10*				3		1	
8	PX-11*				3		1	
9	PX-12*				3		1	
10	PX-14*				3		1	
11	PX-15*	Collect Dup/Split			3		1	
12	PX-16*				3		1	
13	PX-17*				3		1	
14	PX-18*	Collect MS/MSD			9		3	
15	PX-19*	Collect Dup/Split			3		1	
16	PX-20				3		0	
17	PX-21				3		0	
18	PX-24*				3		1	
19	PX-25*				3		1	
20	PX-26*				3		1	
21	PX-35*				3		1	
22	PXDup1*	Dup of PX-19			3		1	
23	PXDup2*	Dup of PX-15			3		1	
24	PX-19QA*	Split of PX-19				3		1
25	PX-15QA*	Split of PX-15				3		1
				TOTAL:	75	6	18	2
26	PXEQB-1	***			3		1	
				TOTAL:	3		1	
27	TB-________	Trip Blank (a)			2			
28	TB-________	Trip Blank (a)			2			
29	TB-________	Trip Blank (a)			2			
30	TB-________	Trip Blank (a)			2			
31	TB-________	Trip Blank (a)			2			
32	TB-________	QA Trip Blank (a)				2		
33	TB-________	QA Trip Blank (a)				2		
34	TB-________	QA Trip Blank (a)				2		
				TOTAL:	10	6		

* Wells to be additionally sampled for nitrate, sulfate, methane, and alkalinity.
** The laboratory does not perform MS/MSD on Methane - Do not collect extra vials for MS/MSD.
***Equipment blanks will not be collected on dedicated equipment. However, if for any reason the dedicated equipment cannot be used, an equipment blank will be collected for each analytical method
(a) Actual number of trip blanks based on number of shuttles to be shipped.

Chain of Custody Record

ATTACHMENT 7.4

SEVERN TRENT STL
Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client	Project Manager	Date	Chain of Custody Number 150570
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page ____ of ____
City / State / Zip Code	Site Contact / Lab Contact	Analysis (Attach list if more space is needed)	
Project Name and Location (State)	Carrier/Waybill Number		Special Instructions/ Conditions of Receipt
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		Analysis												Special Instructions/ Conditions of Receipt

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other______________

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Attachment 7.5

Mactec
3200 Town Point Dr, Suite 100
Kennesaw, GA 30144

REQUEST FOR ANALYSIS

Project Manager: Tom Holmes
Project Chemist: Jessica Vickers
Project: DDMT

Matrix: Groundwater
Sample ID: MW-47

Container	No.	Preservation	Parameter	Method	Prep
40 mL VOA w/septum	3	HCL to pH<2 Cool to 4 C	VOCs	SW8260B	SW5030B
500 mL Plastic	1	No Preservative Cool to 4 C	Anions/Sulfate/Bromide/Alk	E310.1/E300.0	
40 mL VOA w/septum	2	HCL to pH<2 Cool to 4 C	Total Organic Carbon	SW9060	
40 mL VOA w/septum	2	HNO3 to pH <2/Cool to 4C Field Filter	Dissolved Organic Carbon	E415.1	
500 mL Plastic	1	ZnAc & NaOH to pH>9 Cool to 4 C	Sulfide	E376.1	
1 L Poly	1	HNO3 to pH <2 Cool to 4 C	Total Metals (As, Mn, Se)	SW6010B	
40 mL VOA w/septum	2	HCL to pH<2 Cool to 4 C	Methane/Ethane/Ethene	RSK 175	
40 mL Amber VOA w/septum	3	No Preservative Cool to 4 C	Metabolic Fatty Acids		

Comments:____
Prepared By:____ Checked By:___________________________________

ATTACHMENT 7.6

COOLER RECEIPT FORM

Contractor Cooler________

LIMS#_________

QA Lab Cooler #_________

Number of Coolers_________

PROJECT:____

Date received:___________

USE BOTTOM OF PAGE 2 OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. PRELIMINARY EXAMINATION PHASE: Date cooler was opened: ____________________
by (print)________________________ (sign)________________________

1. Did cooler come with a shipping slip (air bill, etc.)? .... YES NO
If YES, enter carrier name & air bill number here: ______________________________

2. Were custody seals on outside of cooler? .... YES NO
How many & where ______________, seal date: ______________ seal name:_________

3. Were custody seals unbroken and intact at the date and time of arrival? .... YES NO

4. Did you screen samples for radioactivity using the Geiger counter? .... YES NO

5. Were custody papers in a plastic bag & taped inside to the lid? .... YES NO

6. Were custody papers filled out properly (ink, signed, etc.)? .... YES NO

7. Did you sign custody papers in the appropriate place? .... YES NO

8. Was the project identifiable from custody papers? If YES, enter project name at the top of this form .... YES NO

9. Were temperature blanks used? .... YES NO
Cooler Temperature__________________(°C) Thermometer ID No.______________

10. Have designated person initial here to acknowledge receipt of cooler: ________________________ (date) ________________________

B. LOG-IN PHASE: Date samples were logged in: ______________________________
by (print) ________________________ (sign) ________________________

11. Describe type of packing in cooler: ______________________________________

12. Were all bottles sealed in separate plastic bags? .... YES NO

13. Did all bottles arrive unbroken with labels in good condition? .... YES NO

14. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)? .... YES NO

15. Did all bottle labels agree with custody papers? .... YES NO

16. Were correct containers used for the tests indicated? .... YES NO

17. Were samples preserved to correct pH, if applicable? .... YES NO

18. Was a sufficient amount of sample sent for tests indicated? .... YES NO

19. Were bubbles absent in volatile organic analysis (VOA) samples? If NO, list VOA samples below .... YES NO

20. Was the project manager called and status discussed? If YES, give details on the bottom of this form .... YES NO

20. Who was called? _____________ By whom? _____________ (date)______________

PREPARED BY/DATE: JAH 10/11/02
CHECKED BY/DATE: WPB 11/08/02

ATTACHMENT 7.7

DAILY QUALITY CONTROL REPORT

Report No. ___ **Contract No. _____________** **Date: __________**

Location of Work: Defense Depot, Memphis, Tennessee

Description of Work: ____

Weather:_______________ **Rainfall (inches) Avg._____** **Temp:______**

Activities Performed:

Field Team Leader:

Team # 1:

Team # 2:

Team # 3:

Team # 4:

Collected samples are listed below:

Samples Collected:

Team 1	Team 2	Team 3	Team 4

Personnel On-Site:

Difficulties:

Visitors:

Field Team Leader: __________

ATTACHMENT 7.8

MACTEC

FIELD ADJUSTMENT FORM

Date: ____

Project: Defense Depot Memphis Tennessee

Project Number: __________________________________

Field Effort: ____

Description of field adjustment and rationale:

____

____

____

____

____

____

Prepared by/Title: ____

I have read the above description and rationale and concur with the adjustment

requested: ____
Signature Date

PREPARED BY/DATE: JAH 10/11/02
CHECKED BY/DATE: WPB 11/08/02

WORK AND TEST PROCEDURE 8

SAMPLE CONTAINERS AND PRESERVATION

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the selection of sample containers, required cleaning for the specified containers, required sample volumes for various analyses, preservation requirements, and required holding times.

2.0 DISCUSSION

This WTP specifies details and procedures for selection and preparation of sample containers and for preservation of the samples once they have been collected. The project-specific work plan will be used to determine the exact sampling requirements.

The selection of suitable containers will prevent contamination of sample from container materials. Adequate preservation of the samples by prescribed methods will ensure that no biological or chemically mediated changes in sample integrity/concentration occurred while the sample was in transit. Both the selection of suitable containers and the proper preservation will support the legal defensibility of data generated as a component of investigative activities. Container type and preservation methods are analytical method-specific.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be considered for review in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
4	Groundwater Sampling
7	Sample Control and Documentation
9	Sample Packing and Shipping
10	Sample Equipment Decontamination

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Work with the project chemist to generate a sampling plan detail listing the wells and constituents to be sampled
- Coordinate with the analytical laboratory to ensure that the sample containers, and preservatives are shipped to the site and arrive prior to the start of sampling event

3.2.2 Field

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

- Check that sufficient sample containers, preservatives and coolers are present on site for storage and shipment.

3.3 FIELD OPERATIONS

3.3.1 Sample Container Selection/Preparation

The sample container to be selected is matrix and method specific. Sample containers are specified and selected to ensure that little, if any chemicals are transferred from the sample containers to the sample itself, thereby skewing the results. The sample containers will be pre-cleaned and provided to MACTEC by the laboratory. Cleaning procedures will be performed according to USEPA guidelines. A summary of recommended sample containers is provided by method in Attachment 8.1.

3.3.2 Sample Preservation

Samples are generally collected into containers containing preservative in the field prior to shipping to the laboratory to minimize any chemical or physical changes to the sample contents during shipment. Sample preservation and temperature will be checked immediately upon receipt of samples at the laboratory. The results of these checks will be recorded on the cooler receipt form. A summary of recommended preservation techniques by matrix by method is summarized in Attachment 8.1.

It should be noted that the USEPA (1992) do not recommend filtration of samples. However, where required by the scope of work, samples for dissolved metals will be collected and filtered with an in-line 0.45 micron filter at each well location, then preserved with appropriate preservatives.

3.3.3 Holding Times

Project samples will be preserved and analyzed within the time intervals specified for each method and matrix listed in Attachment 8.1. For samples analyzed by gas chromatography, first column analysis and second column confirmations will be completed within the maximum holding times specified in Attachment 8.1.

With regard to holding time requirements and definitions presented in Attachment 8.1, extraction is defined as completion of the sample preparation process as described in the applicable method. Analysis completion is defined as completion of analytical runs, including dilutions, second column confirmations, and any required reanalyzes.

3.4 POST OPERATION

3.4.1 Field

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

- Check that sampling bottles assigned to the specific sampling location have been filled with the prescribed amount of sample, contain the proper type and amount of preservative and that all sample labels contain relevant information (date, time, sampler's identification, and whether the sample has been preserved).
- Maintain custody of samples, maintaining them as specified for the analyses to be performed.
- Prepare samples for shipment to the laboratory.
- Complete the C-C forms and other relevant information.
- Contact the laboratory to verify that samples are received in good condition and that request for analyses are understood.

Upon completion of the field effort ensure that associated supplies have been properly stored, disposed of or shipped back to the office as appropriate.

3.4.2 Office

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

- Submit logbook and any original forms to Task/Project Manager for review.
- Inventory equipment and supplies shipped back to the office.
- Contact the laboratory to verify that samples were received in good condition and that requested analyses are understood.

4.0 REFERENCES

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 8.1 - Requirements for Containers, Preservation Techniques, and Holding Times for Groundwater Samples

Attachment 8.2 - Requirements for Containers, Preservation Techniques, and Holding Times for Soil Samples

ATTACHMENT 8.1

CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
MATRIX: GROUNDWATER SAMPLES

Parameter	Units	Method	Container	Minimum Recommended Quantity (mL)	Preservative	Holding Time
Groundwater						
Volatile Organics	µg/L	SW 5030B/8260B	VOA w/ Teflon®-lined septum	3 X 40 (no headspace)	4°C; HCl to pH<2	14 days/7 days if unpreserved
Dissolved Gases: Methane, Ethane, Ethene	µg/L	STL SOP COI-GC-005 (EPA RSK SOP-175M)	VOA w/ Teflon®-lined septum	3 X 40 (no headspace)	4°C: HCl to pH<2	14 days
Carbon Dioxide	mg/L	STL SOP COI-GC-005 (EPA RSK SOP-175M)	VOA w/ Teflon®-lined septum	2 X 40 (no headspace)	4°C	7 days
Semi-Volatile Organics	µg/L	SW 3520C/8270C	G-TLC (amber)	1000	4° C	7 d Extraction/ 40 d Analysis
Pesticides	µg/L	SW 3520C/8081A	G-TLC (amber)	1000	4°C	7 d Extraction/ 40 d Analysis
PCBs	µg/L	SW 3520C/8082	G-TLC (amber)	1000	4°C	7 d Extraction/ 40 d Analysis
Herbicides	µg/L	SW 3520C/8151A	G-TLC (amber)	1000	4°C	7 d Extraction/ 40 d Analysis
Metals ICP	mg/L	SW 3005A/6010B Trace	P	1000	HNO_3 to pH<2 (dissolved – filter on site)	6 months
Mercury	mg/L	SW 7470A	P	500	HNO_3 to pH<2 (dissolved – filter on site)	28 days
Anions: Bromide, Chloride, Nitrate, Nitrite, and Sulfate	mg/L	EPA 300.0/SW 9056	P, G	250	4°C	28 days (Br, Cl, SO_4) 48 hours (NO_2, NO_3)

ATTACHMENT 8.1

CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
MATRIX: GROUNDWATER SAMPLES

Parameter	Units	Method	Container	Minimum Recommended Quantity (mL)	Preservative	Holding Time
Alkalinity	mg/L	EPA 310.1	P	250 (no headspace)	4°C	48 hours
Sulfide	mg/L	EPA 376.1	P	500 (no headspace)	4°C; Zinc Acetate & NaOH to pH>10	7 days
TOC	mg/L	SW 9060/EPA 415.1	P, G	2 X 40 (no headspace)	4°C; H_2SO_4 to pH<2	28 days
Dissolved Organic Carbon	mg/L	EPA 415.1	P, G	2 X 40 (no headspace) (dissolved – filter on site)	4°C; H_2SO_4 to pH<2	28 days
Volatile Fatty Acids	mg/L	ASTM D 1552	VOA w/ Teflon® lined septum	1x40 (no headspace)	4°C;	28 days
CONTAINER AND SAMPLE HANDLING GUIDE MATRIX: FIELD TESTS FOR GROUNDWATER						
pH	units	EPA 150.1	P, G	50	N/A	ASAP
Specific Conductance	mS/cm	EPA 120.1	P, G	250	4°C	24 hours
Temperature	°C	EPA 170.1	P, G	50	N/A	ASAP
Turbidity	NTUs	EPA 180.1	P, G	250	N/A	ASAP

ATTACHMENT 8.1

CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
MATRIX: GROUNDWATER SAMPLES

Parameter	Units	Method	Container	Minimum Recommended Quantity (mL)	Preservative	Holding Time
Redox Potential	mV	SM 2580	P, G	50	N/A	ASAP
Dissolved Oxygen	mg/L	MCAWW 360.1	P, G	50	N/A	ASAP
Ferrous Iron	mg/L	HANNA Kits 38039/38041	P, G	50	N/A	ASAP
Carbon Dioxide	mg/L	HANNA Kit 3818	P	50	N/A	ASAP

<u>Acronym Definitions</u>:

P = Polyethylene
G = Glass
G-TLS = Glass with Teflon®-lined septum
G-TLC = Glass with Teflon®-lined cap
PTFE = Fluoropolymer Resin/Teflon®

PREPARED BY:	
CHECKED BY:	

ATTACHMENT 8.2

CONTAINER AND SAMPLE HANDLING GUIDE
MATRIX: SOIL

Parameter	Units	Method	Container	Minimum Recommended Quantity	Preservative	Holding Time
Volatile Organics Compounds – Encores*	µg/kg	SW 5035/8260B	G-TLC/ Encores ™	4 X 5 gram Encores ™	4°C	48 hrs for preservation/ 14 days Analysis
Semi-Volatile Organics	µg/kg	SW 3550B/8270C	G-TLS	8 oz.	4°C	14 day Extraction/ 40 day Analysis
Pesticides	µg/kg	SW 3550B/8081A	G-TLS	8 oz.	4°C	14 day Extraction/ 40 day Analysis
PCBs	µg/kg	SW3540/8082	G-TLS	8 oz.	4°C	14 day Extraction/ 40 day Analysis
Herbicides	µg/kg	SW 8151A	G-TLC	8 oz.	4°C	14 day Extraction/ 40 day Analysis
Metals ICP	mg/kg	SW 3050A/SW 6010B	P, G	8 oz.	4°C	6 months
Mercury	mg/kg	SW 7471A	P, G	8 oz.	4°C	28 days
TOC	mg/kg	Walkley Black	G	8 oz.	4°C	28 days
TCLP	mg/L	SW 1311	G-TLS/ Encore™	Extractables, metals-16 oz. VOCs-25g Encore™ or 4 oz.	4°C	VOCs-14 days Ext/NA/14 days Analysis, Extractables-14 days Ext/7 days Prep/40 days Analysis, Metals-6 months Ext/NA/6 months Analysis, Mercury-28 days Ext/NA/28 days Analysis

* If collecting for volatile organic compounds only, an additional aliquot of soil must be obtained in a one 4-oz wide mouth jar for moisture content determination.

Acronym Definitions:

P = Polyethylene
G = Glass
G-TLS = Glass with Teflon®-lined septum
G-TLC = Glass with Teflon®-lined cap
PTFE = Fluoropolymer Resin/Teflon®

PREPARED BY:	
CHECKED BY:	

WORK AND TEST PROCEDURE 9
SAMPLE PACKING AND SHIPPING

1.0 PURPOSE

The purpose of this WTP is to provide guidance for packing and shipping environmental samples to the laboratory for analysis. A Sample Handling, Packing and Shipping Instructions Checklist is included as Attachment 9.1.

2.0 DISCUSSION

This WTP specifies details and procedures for packing and shipment of samples to the laboratory for analysis. The project-specific work plan will be used to identify the exact shipping requirements for a specific project.

The goals for sample packing and shipping are that: 1) the integrity of the sample is maintained, and 2) no personnel exposure to the sample container 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 CFR) and the International Air Transport Association (IATA) regulations for air transportation. Common carriers (e.g., Federal Express, UPS, DHL, etc.) must abide by these regulations. This WTP 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 shipping regulations, they will immediately contact the carrier of choice (e.g., Federal Express, UPS, DHL, etc.) for shipping guidance.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs will be reviewed in conjunction with this field effort:

NUMBER	NAME
1	General Instructions for Field Personnel
4	Groundwater Sampling
6	Investigation Derived Waste Disposal
7	Sample Control and Documentation
8	Sample Containers and Preservation
10	Sample Equipment Decontamination
11	Soil Sampling

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Work with the project chemist to ensure that a sufficient amount of sample containers, sample transportation containers, and sample packing material have been shipped to the site based on the 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 type of samples being collected and analytical results from past sampling events at the site(i.e. VOCs in one cooler to limit the number of trip blanks needed, samples from high concentration wells packed in separate cooler to prevent cross contamination)

3.2.2 Field

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

- Check that required sample containers, sample transport containers, and packing material are on-site.

3.3 FIELD OPERATIONS

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

- The 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. These samples will be stored on ice at 4°C until the first possible courier shipment.
- Glass sample containers will be placed inside sealed plastic bubble wrap bags or wrapped in bubble wrap and placed in sealable plastic bags as a precaution against cross-contamination due to leakage or breakage.
- All sample bottles will be placed in coolers supplied by the laboratory in such a manner as to eliminate the chance of breakage and/or leakage during shipment.
- Sufficient ice in plastic bags (double-bagged) will be placed in the coolers to keep the samples at 4°C throughout shipment.
- Special arrangements will be made with the laboratory's point-of-contact for samples that are to be delivered to a laboratory on a Saturday so that hold times and/or sample preservations are not compromised.

In order to demonstrate that the samples and coolers have not been tampered with during shipment, custody seals will be used. Custody seals are adhesive labels that are placed across the cooler lids in such a manner that they will be visibly disturbed upon opening of the sample 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 cooler receipt form.

In no instance will a highly contaminated sample (such as waste or pure product) be shipped in the same container as a low level contaminated sample (such as environmental soil and groundwater samples). This procedure is to minimize the possibility of cross-contamination.

3.4 POST-OPERATION

3.4.1 Field

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

- Ensure that the sample transport containers are properly packed and are in compliance with DOT and IATA regulations.

- Confirm receipt of samples at laboratory.

- Fill out sample tracking form noting sample shipment

3.4.2 Office

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

- Submit logbook and any original forms to Project Manager for review.
- Inventory all equipment and supplies shipped back to the office.

4.0 REFERENCES

Code of Federal Regulations, Part 49, Sections 100-199.

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 9.1 – Sampling Handling, Packing & Shipping Instructions Checklist

ATTACHMENT 9.1

SAMPLE HANDLING, PACKING & SHIPPING INSTRUCTIONS CHECKLIST

When packing samples for shipment to the laboratory, review this list to ensure that all project samples, documents, and materials are included in the sample shipper.

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
- ☐ Review the COC for completeness, including appropriate signature(s) and date(s), and include the **courier tracking/shipping number** on the COC
- ☐ **Request for Analysis (RFA)** form for every sample included in the cooler
- ☐ The **COC and RFAs** should be placed in a Ziploc bag and taped to the underside of the cooler lid
- ☐ **Custody seals** should be placed on the front and back of each cooler

PACKING MATERIALS

- ☐ Verify that ice is "double-bagged" and is sufficient to maintain a temperature of 4°C
- ☐ Glass bottles should be placed in a bubble bag to prevent breakage and leakage
- ☐ Place highly contaminated samples (if known) together
- ☐ Place a **trip blank** in each cooler that contains samples for VOC analyses at beginning of day
- ☐ To minimize the number of trip blanks, place all VOC samples in the same cooler
- ☐ Each cooler contain a **temperature blank**
- ☐ All sample coolers insured by shipper ($1000.00)

Comments:____

____

____

Checklist Completed By:____________________________ Date:____________

Note: This Checklist should be included in the project file with the field documents.

WORK AND TEST PROCEDURE 10
FIELD EQUIPMENT DECONTAMINATION

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the proper decontamination of field equipment. This WTP also provides guidance for collection of equipment rinsates that will measure the quality of the decontamination procedure.

2.0 DISCUSSION

This WTP specifies details and procedures for decontamination of field equipment that may become contaminated as a result of field sampling activities. The decontamination of sampling equipment will help prevent cross-contamination of samples collected at one location with residual contamination from samples collected at another location; will help prevent exposure of individuals to residual contamination present on the equipment; and will help prevent the spread of contamination via sampling equipment. Proper decontamination procedures will also support the legal defensibility of data generated as a component of investigative activities.

Decontamination procedures will be evaluated by the collection of equipment rinsates. 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.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling
3	Well Installation, Development, and Abandonment
4	Groundwater Sampling
5	Hydraulic Conductivity Testing

NUMBER	NAME
6	Investigative Derived Waste Disposal
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipping
11	Soil Sampling

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Ensure that sufficient quantities of decontamination supplies and materials have been shipped to the site based on expected number of samples and days at site.

3.2.2 Field

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

- Verify that decontamination supplies and equipment have arrived on site.
- Set up decontamination area(s).

3.3 FIELD OPERATIONS

3.3.1 Decontamination Area

The location of the decontamination area, used primarily for larger pieces of equipment, will be determined in consultation with DRC personnel. The decontamination pad will consist of a sump lined with 6-mil polyethylene sheeting. The sump will be constructed by either excavating a small area to create a depression to collect the decontaminated water or by elevating the edges of the sheeting to create a pool-like structure to collect the decontaminated water.

3.3.2 Decontamination Water Source

Tap water from the municipal water treatment system will be used as a rinse in the decontamination procedure. The Field Team Leader will be responsible for coordinating with DRC personnel to secure an adequate supply of tap water for decontamination procedures. One sample of each water source used will be analyzed for the full range of parameters as the field samples to be collected. If water supply is a portable water tank, a sample must be collected from each tank used.

3.3.3 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 rinsed from the equipment into a collection structure.
2. Air dry.
3. Decontamination solutions will be stored in tanks or drums and maintained at the site until analyses have been completed.

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

1. Wash and scrub with Alconox or equivalent detergent.
2. Double tap water rinse.
3. Rinse with American Society for Testing and Materials (ASTM) Type II Reagent - Grade Water
4. A pesticide grade methanol spray rinse (all solvents must be pesticide grade or better) in a stainless steel bowl. The methanol waste will be containerized separate from purge water and disposed of as a hazardous waste.
5. Rinse with ASTM Type II Reagent - grade water.
6. Wrap in oil free aluminum foil for transport.

The decontamination procedure for the water level indicator and the oil/water interface probe is:

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

3.3.4 Equipment Rinsate Collection

When field cleaning equipment is required during a sampling investigation, a piece of the field-cleaned equipment is selected for collection of a equipment rinsate. At least one equipment rinsate will be collected for each sampling protocol (i.e. soil sampling, pumps used for groundwater sampling) during each week of sampling operations. Equipment rinsates will be conducted in a manner which allows proper representation of field decontamination procedures.

<u>Sampling Equipment:</u> Equipment rinsates will be obtained from decontaminated bladder pumps, bailers, HydroPunch sampler, stainless steel split-spoons, hand augers, sludge samplers, Ponar dredges, stainless steel bowls, and beakers with ASTM Type II water or better.

The equipment rinsate protocol will be as follows:

a. <u>Label Sample Container</u> - Label the sample container as outlined in WTP 7

b. <u>Collect Sample</u> - Equipment rinsates will be collected on all equipment types used to collect samples. The collection procedure is described below:

   After sample collection 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 sampling equipment (i.e., split-spoon, bailer, stainless steel beaker) into a cleaned stainless steel bowl (preferably the equipment and bowl to be used on a specifically identifiable sample location). Water collected will then 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. <u>Custody, Handling and Shipping</u> - Complete the procedures as outlined in WTPs 8 - Sample Control and Documentation and 10 - Sample Packing and Shipping.

3.4 POST OPERATION

3.4.1 Field

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

- Decontaminate all equipment.
- Properly store decontamination derived waste (i.e., decontamination water).
- Ensure that sampling equipment and associated decontamination supplies have been shipped back to the office.

3.4.2 Office

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

- Submit logbook and any original forms to Task/Project Manager for review.
- Inventory equipment and supplies shipped back to the office.
- Arrange for proper disposal of the decontamination derived waste after determination of its contents.

4.0 REFERENCES

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001.

5.0 ATTACHMENTS

None

WORK AND TEST PROCEDURE 11
SOIL SAMPLING

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for collection of soil samples for analytical analysis.

2.0 DISCUSSION

This WTP specifies details and procedures for collecting soil samples for chemical analysis at DDMT. Soil samples will be collected from surface soils, soil borings, soil piles, and from the sidewalls and floor of excavations. Samples may be collected using split-spoons, Shelby tubes, hand augers, Encore or Terracore Samplers, or stainless steel spoons. Sampling will be conducted at locations and depths specified in the project specific work plan. The soil samples will be analyzed to identify chemical constituents and their concentrations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sampling Equipment Decontamination
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1. A general list of supplies needed for soil sampling is given as Attachment 11.1.

3.2.2 Field

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

- Ensure that required sampling equipment has arrived on site.
- Ensure that sufficient drums or other containers are on site to containerize any excess sample material collected.

3.3 FIELD OPERATIONS

Soil excavation and sampling procedures will be supervised by a qualified geologist or engineer. The sample locations will be specified in the project specific work plan. Soil sampling and Quality Assurance/Quality Control procedures will be supervised by the senior/project chemist.

3.3.1 Soil Sampling

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.

During advancement of the soil borings, the following sampling devices may 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

3.3.1.1 Sample Collection during Sonic Drilling

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.

At five-foot intervals within the soil cores, the headspace will be screened with an FID or PID. The headspace samples will be brought (if necessary) to a temperature of between 20°C (68°F) and 32°C (90°F), and the reading will be obtained 5 minutes thereafter. The soil sample will be split into two jars and readings will be made with the PID/FID (unfiltered) on one jar. If the reading is greater than 10 parts per million (ppm), a reading will be made on the second jar with an activated charcoal filter on the FID. A total corrected hydrocarbon measurement of the sample will be calculated by subtracting the filtered reading from the unfiltered reading.

The headspace samples will be collected and analyzed using the following procedure:

1. From the sampling location within the soil core, remove the top 1 to 2 inches of soil using a decontaminated stainless steel spoon.
2. Fill ½ of two decontaminated 16-ounce containers with soil from the resulting hole using the stainless steel spoon.
3. Cover the jars immediately with aluminum foil and fasten the jar lids.
4. Allow the sample vapors to equilibrate in the jars (approximately 5 minutes).
5. Punch a hole in the aluminum foil with the tip of a calibrated PID/FID.
6. Record the highest reading.
7. If the reading is > 10 ppm, repeat Steps 5 and 6 with the activated charcoal filter on the calibrated FID for the second jar.

Selected soil samples may be collected for laboratory analysis based upon the results of the headspace screening. At these selected locations, samples for VOC analysis will be collected using an Encore or Terracore sampler, or acceptable equivalent.

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

1. Remove sampler and cap from package and attach T-handle to the 5-gram sampler body.
2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full.
3. Carefully wipe the exterior of the sampler head with a clean disposable paper towel so that the cap can be tightly attached.
4. Push cap on with a twisting motion to attach and seal the sampler.
5. Attach the label onto the sampler body, place the sampler into a plastic Ziploc™ bag and place into a cooler with ice.
6. Repeat steps 1 through 5 for the remaining 5-gram and 25-gram sampler.
7. 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.
8. Thoroughly mix remaining soil and place into specified labeled containers for remaining parameters.
9. Place sample bottles into Ziploc or bubble bag and in an iced cooler.

10. When soil sampling is completed at that location or when time permits, transfer samples to site office for final packaging. Complete C-C documentation and shipping procedures in accordance with WTPs-7 and -9.
11. Record field conditions, any problems encountered during sampling and sample appearance in the field logbook and the Field Sampling Report Form and Daily Quality Control Report Form.

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

1. Label appropriate laboratory containers
2. 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.
3. Carefully wipe the exterior of the sampler head with a clean disposable paper towel.
4. Empty sampler into appropriate laboratory container. The cored samples must be extruded from the selected coring tool to a 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.
5. Place the sample into a plastic Ziploc™ bag and place into a cooler with ice.
6. Complete C-C documentation and shipping procedures in accordance with WTPs 7 and 9.

Additionally, 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.

All measurements will be recorded on the logging form at the corresponding depths. The samples will be handled in such a way as to minimize the loss of volatile compounds. Soil cuttings will be examined for their hazardous characteristics. If suspect samples are encountered, they will be noted on the boring log form for reference during investigation derived waste (IDW) sampling. Soil samples for laboratory analysis will also be collected from the boring for each new monitoring well.

3.3.1.2 Hand Auger/ Spade and Scoop Soil Sample Collection

Surface soil samples collected using a hand auger or spade and scoop will be collected from the floor or sidewalls of the test pits, surface soils from 0 to 6 inches and subsurface soil samples at pre-specified intervals from soil borings.

A boring will be advanced by using a trowel, hand-augering, or using a power-driven hand held auger to the predetermined sample depths at each site. The sample collection procedures are described below.

1. Prior to sampling, don the appropriate PPE and set up safety zones as required.
2. Decontaminate sampling equipment in accordance with the procedures specified in WTP 10 and the project-specific work plan prior to the start of sampling. When not in use, place tools on clean polypropylene sheeting
3. Label sample bottles as described in WTP-7.
4. Excavate using a shovel or garden trowel as necessary to remove gravel, sod or vegetation overlying the soil stratum to expose the sample location. A pry-bar may be required to excavate paving materials present at a site.
5. For surface soils, advance the hand auger to 6 inches and retrieve from boring location.
    a. Place soil in a stainless steel bowl and immediately sample for volatile organic analysis as described in the following procedure:
6. Follow the procedure outlined in 3.3.2.1, Encore ™ Sampler:

3.3.1.3 Soil Sampling Using a Split-Spoon and Shelby Tube Samplers

Subsurface soil samples may be collected using a drill rig and split-spoon and Shelby Tube samplers. Sampling will be completed using drill rig or direct push rig capable of driving the samplers. The drive shoe on the rig will be properly equipped with a basket-retainer/ring assembly, and the drive weight assembly will consist of a 140-pound weight, a driving head, and a guide permitting a free fall of 30-inches.

Procedures for soil sampling using the split-spoon sampler are described below. A standard penetration test, following the guidance of American Society of Testing Methods D1586, will be performed every time a split-spoon sample is taken.

1. A 3-inch or 2-inch split-spoon sampler will be used for borings in which chemical samples will be collected. The split-spoon sampler will be driven at sequential depth intervals and samples will be collected at each interval. At each target depth interval, the split-spoon sampler will be brought to the surface and opened. After the soil is brought to the surface it will immediately put into plastic bags and checked for organic vapors by monitoring with an instrument equipped with a PID/FID. The PID/FID reading will be recorded on the hazardous and toxic waste (HTW) log. The Site Geologist will describe the materials encountered at each depth interval on the HTW drilling log.

2. The soil samples for chemical laboratory analysis, including samples for compositing, will be collected from the split-spoon before any other samples are collected (i.e., geotechnical analyses). If VOC analysis is required the following EnCore ™ Sampler Procedures are to be performed:

   a. Follow the procedure outlined in 3.3.1, Encore ™ Sampler.

   b. Collect samples for VOC analysis as soon as possible after splitting the spoon, taking care to cause as little disturbance to the sample as possible. If split samples are to be collected, use a decontaminated stainless steel spoon to split the tube contents in half longitudinally.

3. Collect a bulk soil sample for screening and moisture determination into a 2 or 4-ounce wide mouth glass jar. Fill the jar completely allowing no headspace. Place the sample in a cooler containing ice.

4. Thoroughly mix remaining soil and place into specified labeled containers for remaining parameters.

5. Place samples for geotechnical analysis into a clear 8-ounce jar. Label the sample containers as specified in the WTP-7. The jars containing the geotechnical samples will be labeled as to the collection date, location, site name, and blow counts.

6. When soil sampling is completed at that location, place the samples on ice and transfer samples to the site office for final packaging. Complete C-C documentation and shipping in accordance with WTPs-7 and -9.

Record field conditions, any problems encountered during sampling and sample appearance in the field logbook and the Field Sampling Report Form.

3.3.2 Soil Excavation

Excavation or test pits are typically advanced with a small backhoe and provide opportunity for visual inspection and to obtain bulk samples if required. Excavation activities will be conducted under the direct supervision of a qualified geologist, or engineer. Excavation equipment will at a minimum be capable of excavating a horizontal surface 8 feet below ground surface. The backhoe should utilize a straight-edge bucket.

Test pits will be excavated to the depth specified in the work plan. If underground utilities are expected, the exact location(s) of the utilities will be determined prior to beginning excavation operations. Underground installations will be protected, supported, or removed while the excavation is open. A barrier or tape should be placed around the pit area to warn personnel of its presence.

Equipment will be placed at least 2 feet from the edge of an excavations, and excavations will be sloped at an angle not steeper than one and one-half horizontal to one vertical [29 CFR Ch. XVII (7-1-92 Edition)]. A ladder, ramp, or other safe means of egress will be located in excavations that are 4 feet or more in depth. If the test pit is to be dug adjacent to a building or other structure, support systems such as shoring, bracing, or underpinning will be provided by the subcontractor. Soil will be removed in lifts. Hand excavation may be necessary to identify buried objects near the surface (approximately upper four feet). Test pits will not extend below the water table.

The approximate extent of excavation will be specified in the work plan. If on-site MACTEC personnel are satisfied that the contents of the anomalous area have been identified, the test pit may be closed prior to reaching the excavation limits set in the work plan. Excavation will not continue beyond the limits estimated in the work plan without approval from the Project/Task Manager.

Air quality tests will be performed before a worker enters an excavation more than 4 feet deep when the potential for a hazardous atmosphere exists. Tests will be conducted as often as necessary to ensure the quality and quantity of the atmosphere. This includes checks for flammable gases and oxygen deficiency.

3.4 POST-OPERATION

3.4.1 Field

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

- Decontaminate all equipment.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.

- Ensure that the site has been cleaned to its pre-sampling state (i.e., ensure that all trash generated as a result of sampling activities is disposed of).

- Ensure that all containers containing any investigative-derived waste are properly sealed and labeled with the date and drum contents. Drums will be sealed.

3.4.2 Office

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

- Submit logbook and any original forms to Task/Project Manager for review.
- Inventory all equipment and supplies shipped back to the office.
- Make provisions for proper disposal of investigative derived waste.

4.0 REFERENCES

ASTM, 1986. Annual Book of ASTM Standards, American Society of Testing and Materials, 1986.

ASTM, 1998. "Draft Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds", D4547, Annual Book of ASTM Standards, American Society of Testing and Materials, February, 1998.

MDNR, 1994. Guidance Document Verification of Soil Remediation. Environmental Response, Waste Management Division. Michigan Department of Natural Resources. July, 1994

USACE, 2001. Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans, Department of the Army, Washington D.C. February 1, 2001

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

USEPA, 1996. "Closed System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples" Method 5035, Test Methods for Evaluating Solid Wastes, EPA SW846, 3rd ed., Volume II, Update III, December, 1996.

5.0 ATTACHMENTS

Attachment 11.1 - General Field Supply Checklist-Soil Sampling Activities

ATTACHMENT 11.1

General Field Supply Checklist-Soil Sampling Activities

Steel Toe Workboots	___________
Full Face Respirator (with appropriate cartridges)	___________
Safety Glasses	___________
Logbook	___________
Pens	___________
Data Collection Forms	___________
OSHA Certification Card	___________
Tape Measure	___________
Hard Hat	___________
Hammer	___________
First Aid Kit and Emergency Eyewash Station	___________
Overshoes	___________
Sun Screen	___________
Work Gloves	___________
Disposable Gloves	___________
Three-inch or five-inch diameter stainless steel bucket hand auger (with extendible handles)	___________
Hand-held power driven auger; to advance boring in deeper or difficult boreholes	___________
Pry bars/digging bars	___________
Shovel	___________
Garden trowel (stainless steel) and stainless steel spoon	___________
Stainless steel bowl(s)	___________
Aluminum foil	___________
Polypropylene sheeting	___________
Decontamination supplies	___________
Sample collection bottles appropriate for the analyses to be performed	___________
EnCore™ samplers, 5-gram and 25-gram core sizes	___________
2-inch outer diameter (OD), 2-foot long carbon steel split-barrel sampler	___________
3-inch or 2-inch OD, 2-foot long carbon steel split-barrel sampler	___________

WORK AND TEST PROCEDURE 13
HEALTH AND SAFETY MONITORING

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for monitoring levels of combustible gas and organic vapors. This monitoring is performed to minimize the risks to field personnel associated with combustible gases and to minimize on-site worker exposure to organic vapors through a preliminary identification of the concentration of organic compounds detectable with a photoionization detector (PID) or Flame Ionization Detector (FID).

2.0 DISCUSSION

Specific monitoring requirements will be provided in the work plan or HSP. Information gathered from air monitoring will be used to determine appropriate protective measures to be taken and assess off-site migration of contaminants released during construction activities or subsequent operation of remedial systems so that appropriate contingency plans and/or control measures can be implemented.

2.1 COMBUSTIBLE GAS

A combination combustible gas/oxygen/hydrogen sulfide indicator (EXOTOX 40) will be used to monitor combustible gas levels. The EXOTOX 40 has the capability to monitor for oxygen, explosive gases, and a “toxic” gas (carbon monoxide or hydrogen sulfide) simultaneously. Only one toxic gas can be fitted to the EXOTOX and is chosen at the time of order. The monitor does not have the capability to detect specific explosive gases, but quantitatively detects % lower explosive limit (LEL) by comparison with a known calibration gas (usually methane). The oxygen sensor calibration is affected by humidity, so calibration of this sensor should take place in conditions similar to the working environment.

The LEL refers to the lowest concentration of a combustible gas in air that will explode or support combustion. The upper explosive limit (UEL) is the highest concentration of a combustible gas in air that will support combustion or detonation. Generally, the combustibility of an atmosphere is defined in terms of a proportion of the LEL or UEL. Most combustible gas meters are calibrated to provide this information.

2.2 PHOTOIONIZATION DETECTOR

A commonly used air monitoring instrument is the PID. The instrument operates under the principle of photoionization, i.e., the absorption of light by a gas molecule resulting in the molecule's ionization. The sensor of the instrument consists of a sealed ultraviolet light source that emits photons at an energy level high enough to ionize most organic compounds, but not high enough to ionize the major components of air (i.e., O_2, N_2, CO, CO_2, or H_2O).

Most PIDs are designed for use with interchangeable probes with lamps of different energies (9.5 eV, 10.2 eV, and 11.7 eV). Lamps are selected based on the ionization potential (IP) of suspected contaminants on-site; the lamp energy must be equal to or greater than the IP of a compound for the compound to be detected. IPs for contaminants expected on-site can be found in the Health and Safety Plan. The PID is sensitive to many organic and inorganic vapors/gases and therefore, cannot be used as a qualitative instrument in unknown situations. It is strictly qualitative except when the nature of the contamination is known, and the instrument has been calibrated to that specific contaminant. High humidity decreases the sensitivity of the PID. Atmospheres with concentrations of gases above the detection limits of the instrument will cause inconsistent behavior.

2.3 FLAME IONIZATION DETECTOR

Another commonly used air monitoring instrument is the flame ionization detector (FID). The instrument operates by drawing in an aliquot of the gas or vapor under consideration into the instrument ionization chamber. The extracted gas is then ionized in a flame. A current is produced that is proportional to the number of carbon atoms present and this information is relayed to a meter or strip chart recorder. In many FID monitoring instruments, the instrument can be operated under two modes: survey mode and gas chromatography (GC) mode. In the survey mode, all organic compounds are detected at the same time; in the GC mode, volatile species are separated, thus enabling tentative identification and measurement of various compounds.

A limitation to the use of this instrument is that it does not detect any inorganic gases or vapors nor some synthetic gases. The instrument should not be used at temperatures less than 40° Fahrenheit. High concentrations of contaminants or oxygen-depleted environments will affect results and will require system modification. In the survey mode, readings reported are relative to the calibration standard used. Specific analyte identification requires calibration with the analyte of interest.

2.4 CHEMICAL-SPECIFIC DRAEGER TUBES

Chemical-specific detector tubes will be used in conjunction with the FID and PID to detect and quantify specific organic vapor levels at the sites. Detector tubes indicate the presence of a specific chemical by a color change in the tubes' packing material. A prespecified sample volume is drawn through the detector tube at a constant flow rate. If the sample contains the vapor or gas in question, it will react with the chemical on the packing material, resulting in a color change. The concentration of the vapor is directly proportional to the length of the stain. Detector tubes are pre-calibrated prior to being shipped from the manufacturer. The pump used in sampling must be checked regularly to verify flow rate and sample volume per pump stroke.

Problems contributing to poor accuracy of the detector tubes include the following: leaking pump, insufficient contact (analysis) time, high humidity and/or temperature, difficulty in reading the scale, interferences from other compounds, improperly stored tubes, outdated tubes, and operator error

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP:

NUMBER	NAME
1	General Instructions for Field Personnel

3.2 PREPARATION

3.2.1 Office

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:.

- Determine monitoring requirements by review of HSP
- Identify site contaminants to target or monitor
- Ship necessary equipment and calibration supplies

3.2.2 Field

After arrival on site, but prior to commencement of operations, the following procedures should be employed:

- Confirm all necessary equipment has arrived at the site
- Calibrate equipment as specified by the manufacturer

3.3 FIELD OPERATIONS

3.3.1 Field Operations

3.3.1.1 Combustible Gases

Combustible gas monitoring will be performed at selected locations during intrusive site activities where vapor accumulation is considered likely, using a calibrated EXOTOX 40 portable multi-gas monitor. Action levels based on Lower Explosive Limit (LEL) readings monitored at the source are as follows:

LEL Level	Action
<10% LEL	None; proceed with work and continue monitoring
10 - 25% LEL	Potential explosion hazard; proceed with caution and monitor LEL levels closely, notify SSO
>25% LEL	Explosion hazard exists; stop work; evacuate site and ventilate area until levels of combustible gases fall below 25% LEL

3.3.1.2 FID/PID

Monitoring for organic vapors will be performed in the breathing zone and/or at the source (as appropriate) to determine appropriate levels of PPE to be used during work. A PID or FID will be used in conjunction with chemical-specific detector tubes to detect and quantify organic vapor levels.

Ambient air in the breathing zone will be monitored for organic vapors at least once every 15 minutes during site operations and with every change in task or work location. Continuous monitoring will be conducted at locations where vapor buildup is a potential hazard. Since the PID/FID only provides non-specific quantitative readings, chemical-specific detector tubes (Draeger tubes) will also be used, as dictated by action levels, during field investigations to monitor for the presence of specific organic vapors. Action levels for organic vapors and chemical detector tubes are project specific and are presented in the site-specific Health and Safety Plan.

Atmospheric monitoring measurements obtained are compared with 50% of the OSHA Permissible Exposure Limits (PELs) and/or 50% of the ACGIH Threshold Limit Values, whichever standard is lower. Site-specific action criteria based on the results of vapor monitoring are specified in the site-specific Health and Safety Plan.

3.3.1.3 Calibration

All atmospheric monitoring equipment will be calibrated a minimum of two times daily in accordance with the manufacturer's instructions: before work begins; and in the afternoon of the work shift. Calibration procedures for each instrument can be found in the manufacturer's instruction manuals. An example of the calibration record form that will be used to record daily calibration is shown in Attachment 13.1.

The EXOTOX is factory-calibrated, but may be recalibrated by following manufacturer’s instructions. H_2S gas (or carbon monoxide), ambient fresh air, and methane gas are used in the calibration procedure.

The PID is factory-calibrated to a benzene gas standard. Calibration will be checked prior to and after each usage following procedures described in manufacturer’s instruction manual. Isobutylene is used as a check gas for the on-site instrument calibration.

The FID is factory-calibrated to a Methane gas standard. Calibration will be checked prior to and after each usage following procedures described in manufacturer’s instruction manual. Methane is used as a check gas for the on-site instrument calibration.

3.4 POST-OPERATION

3.4.1 Field

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

- Decontaminate any contaminated monitoring equipment.

- Complete logbook and required monitoring forms, making notations as to site conditions, anomalous readings, etc.

- Ensure that the site is cleaned to the condition that it was in prior to monitoring operations (i.e., all trash related to monitoring operations must be disposed of prior to departure from the site).

3.4.2 Office

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

- Submit logbook and any original forms to Task/Project Manager for review.
- Inventory all equipment and supplies shipped back to the office.

4.0 REFERENCES

NIOSH/OSHA/USCG/EPA, 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. USDHHS.

5.0 ATTACHMENTS

Attachment 13.1 - Daily Instrument Calibration Form

ATTACHMENT 13.1

DAILY INSTRUMENT CALIBRATION FORM

SITE LOCATION: ____________________________________DATE: _________________________

CALIBRATION PERFORMED BY: ____

CALIBRATION STANDARD: _________________________CONCENTRATION: ______________

INSTRUMENT CALIBRATED (specify model)/serial no.	DATE/ TIME	INSTRUMENT READING	INITIALS	COMMENTS

WORK AND TEST PROCEDURE 14
SOIL VAPOR EXTRACTION WELLS

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation of soil vapor extraction (SVE) wells suitable for removal of volatile organic compounds from the vadose zone. Procedures for abandonment upon completion of remedial action are also included. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for the construction and installation of SVE wells at DDMT. SVE wells allow for the removal of subsurface vapor from pore spaces in the vadose zone by applying a vacuum. The extracted vapor is transported to the surface via conveyance piping and, if necessary, treated at the surface prior to discharge to the atmosphere. SVE well design is provided in the *Memphis Depot Dunn Field Final Off-Depot Groundwater Remedial Design, Rev.1* (Off Depot RD) (CH2M HILL, 2008). SVE well installation will be supervised by qualified environmental professionals according to project specifications. Well installation will be performed by the drilling subcontractor under the direction of a registered geologist/engineer. General requirements for the drilling subcontractor and oversight are provided in WTP 2, Drilling Operations.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination

3.2 PREPARATION

SVE well installation will occur immediately after drilling. Therefore, preparations should be made prior to beginning drilling operations. These preparations are given in WTPs 1 and 2.

3.3 WELL CONSTRUCTION

Well design and construction was set forth in the Off Depot RD.

3.3.1 Well Construction Materials

A 30-foot section of 0.006-inch continuous-slot "Vee-Wire" Schedule 40 PVC screen will be used. Centralizers will be used at the top and bottom of the screened section. Well screen and riser will be new, unused, decontaminated, 2-inch inside-diameter Schedule 40 PVC with internal flush-jointed threaded joints. Use of solvent or glue will not be permitted.

3.3.2 Well Design

SVE wells will be designed and installed in a manner to remove vapors from the vadose zone in excess of the inflow from the air sparge wells. This section describes well installation and construction including the placement of the screen, installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader (FTL) and the Project/Task Manager will collectively decide on adjustment to well depths, locations, screened intervals, etc. Planned locations and depths are provided in Table 6 of this RAWP. Water level elevations from the October 2008 monitoring event and ground surface elevations at the SVE well locations will be used to determine the final depth prior to drilling.

3.3.2.1 Screen Location

The SVE well screens will be installed with the bottom of the screen approximately 5 feet above the water table. The boring will be drilled approximately 1 foot below the planned screen depth in order to install filter sand at the base of the screen.

3.3.2.2 Plumbness and Alignment

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

3.3.2.3 Filter Pack

A filter pack will be installed in the annular space between the boring and the well screen. The filter pack of silica sand will be clean, inert, well rounded 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 10-20 will be used based on SVE wells previously installed on Dunn Field. The filter pack will be placed from the bottom of the hole to a minimum of 4 feet above the top of the well screen. When sonic drilling methods are used, the filter pack will be emplaced through the nominal 6-inch diameter steel casing using the gravity method. The procedure for gravity installation of the filter pack will be as follows: Prior to installation of the well casing, the inside of the 6-inch steel casing will be thoroughly cleared of sediment and cuttings by reaming with the 4-inch sampling barrel and flushing with potable water. The sand filter pack will be gravity-placed through the 6-inch steel casing in lifts of no more than 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.

3.3.2.4 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. Since the seal will be 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 4 hours prior to placement of the grout collar around the well.

3.3.2.5 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 3 feet below the ground surface. The cement-bentonite mixture will consist of the following compounds in proportion to each other: 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.

3.3.2.6 Well Completion Details

The SVE wells will be completed with a 2-inch PVC slip “tee” located approximately 2 feet bgs to facilitate the connection to the HDPE conveyance piping. Connected at 90 degrees to the “tee” will be a 2-inch PVC to high density polyethylene (HDPE) transition fitting and 2-inch x 4-inch reducing coupling. A 2-inch diameter Schedule 40 PVC casing will extend from the slip “tee” to just below the natural ground surface and will then be capped with a Schedule 40 PVC slip cap with threaded plug. The well will be completed with a 18-inch diameter concrete flush mount pad with vault to allow future access to the SVE well.

3.3.3 Well Installation

The SVE wells will be constructed in 6-inch diameter soil borings advanced using rotasonic drilling methods. Lithologic core samples will be collected continuously in 10-foot intervals beginning at the ground surface. All soil borings will be advanced to approximately 5 feet above the water table (approximately 70 to 80 feet below ground surface depending on location). The borehole will be drilled approximately 0.5- to 1-foot below the target depth and backfilled with filter sand before installing the well. Well installation will be supervised by a qualified geologist/engineer.

3.3.3.1 Procedures

The following protocols will be used to install the well casing and screen:

1. Remove the PVC screen and riser from packaging and steam clean to remove manufacturing residues.

2. Install a 30-foot section of 2-inch (I.D.), threaded, flush jointed, pre-manufactured PVC screen with PVC centralizers at top and bottom inside the steel drill casing. Screen will be 6 to 12 inches above boring termination.
3. Install 2-inch (I.D.), threaded, flush jointed, PVC riser to 2 feet bgs.
4. Install the filter pack using the gravity method through the annular opening between drill casing and well screen, as the drill casing is removed, to distribute the filter pack around the screen in a uniform height and density. Take care to prevent bridging by measuring the thickness of the filter pack as it is placed.
5. Continue removing drill casing and installing filter pack until at least 4 feet above the top of the well screen. Use the sonic drilling head to vibrate the steel casing as it is slowly withdrawn in order to compact the filter pack and prevent bridging.
6. Install a minimum 5-foot bentonite seal. The bentonite seal will be hydrated with potable water. Allow the bentonite seal a minimum of 4 hours of hydration time before grouting the annulus.
7. Remove remaining drill casing and grout boring annulus to 6-inches below the top of the riser with a grout/bentonite mixture.
8. Install "tee", PVC riser, and surface completion as described in Section 3.3.2.6 of this WTP.

3.3.3.2 Well Installation Diagrams

The e^{2}M field geologist will prepare boring logs and construction diagrams for the SVE wells. The soil core from the vadose zone will be archived in labeled cardboard core boxes. The field supervisor 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 on the SVE Well Installation Diagrams (Attachment 14.1). Details will include:

- Well identification
- Drilling method
- Installation date(s)
- Total boring depth
- Lengths and descriptions of the screen and riser
- Thickness and descriptions of filter pack, bentonite seal, casing grout, and any

backfilled material

- Quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed and reviewed in the field. A final version will be submitted in an appendix of the Technical Report.

3.3.4 Well Abandonment

Upon completion of remedial action operations or if an SVE well is damaged or otherwise not fit for continued use, it will be abandoned in accordance with Memphis Shelby County Health Department regulations. The total depth of each well will be measured to confirm that no obstructions are present that might interfere with placement of the tremie pipe and grout. One-half gallon of bleach will be poured into each and the well will be filled with grout from the bottom up until undiluted grout is visible at the surface. The grout will be tremied into the casing, keeping the side-discharge tremie pipe approximately 1 foot below the grout surface. After allowing at least two days for grout settlement, the grout will be topped off with concrete. The well pad and manhole will be removed and disposed as solid waste. The wellhead location will be restored to match the surrounding area.

3.3.5 Location Survey

Upon completion of the wells, a Tennessee licensed professional surveyor will locate each new SVE well by standard surveying methods. A vertical survey will be conducted to establish the elevation of each SVE well casing. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordinates within 0.1 foot, the ground elevation to within 0.01 foot, and the elevation of the top of casing within 0.01 foot will be recorded. The survey will be referenced to the State Plane coordinate system.

3.4 POST-OPERATION

3.4.1 Field

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

- Decontaminate all field equipment.

- Ensure that installed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete SVE well installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW has been disposed in accordance with the RAWP and WTP 6.
- Ensure that the site is returned to its condition prior to well installation to the extent feasible (i.e., all trash related to well installation must be disposed of prior to departure from the site).

3.4.2 Office

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

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

MACTEC Engineering and Consulting, Inc, 2005a. Remedial Action Sampling and Analysis Plan, Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan. Prepared for the Air Force Center for Environmental Excellence. November, 2005.

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

5.0 ATTACHMENTS

Attachment 14.1 – SVE Well Installation Diagram

ATTACHMENT 14.1

SOIL VAPOR EXTRACTION INSTALLATION DIAGRAM
WORK AND TEST PROCEDURES
OFF DEPOT GROUNDWATER RAWP
Defense Depot Memphis, Tennessee

WELL ID: ______________________

PROJECT: ______________________

E2M FIELD REP. ______________________

INSTALLATION DETAILS
DATE(S) ______________________
START TIME ______________________
END TIME ______________________
DRILLING CONTRACTOR ______________________
DRILLING TECHNIQUE ______________________
DRILL ROD SIZE AND TYPE ______________________

RISER DETAILS
MANUFACTURER: ______________________
MATERIAL: ______________________
DIAMETER: ______________________
LENGTH: ______________________

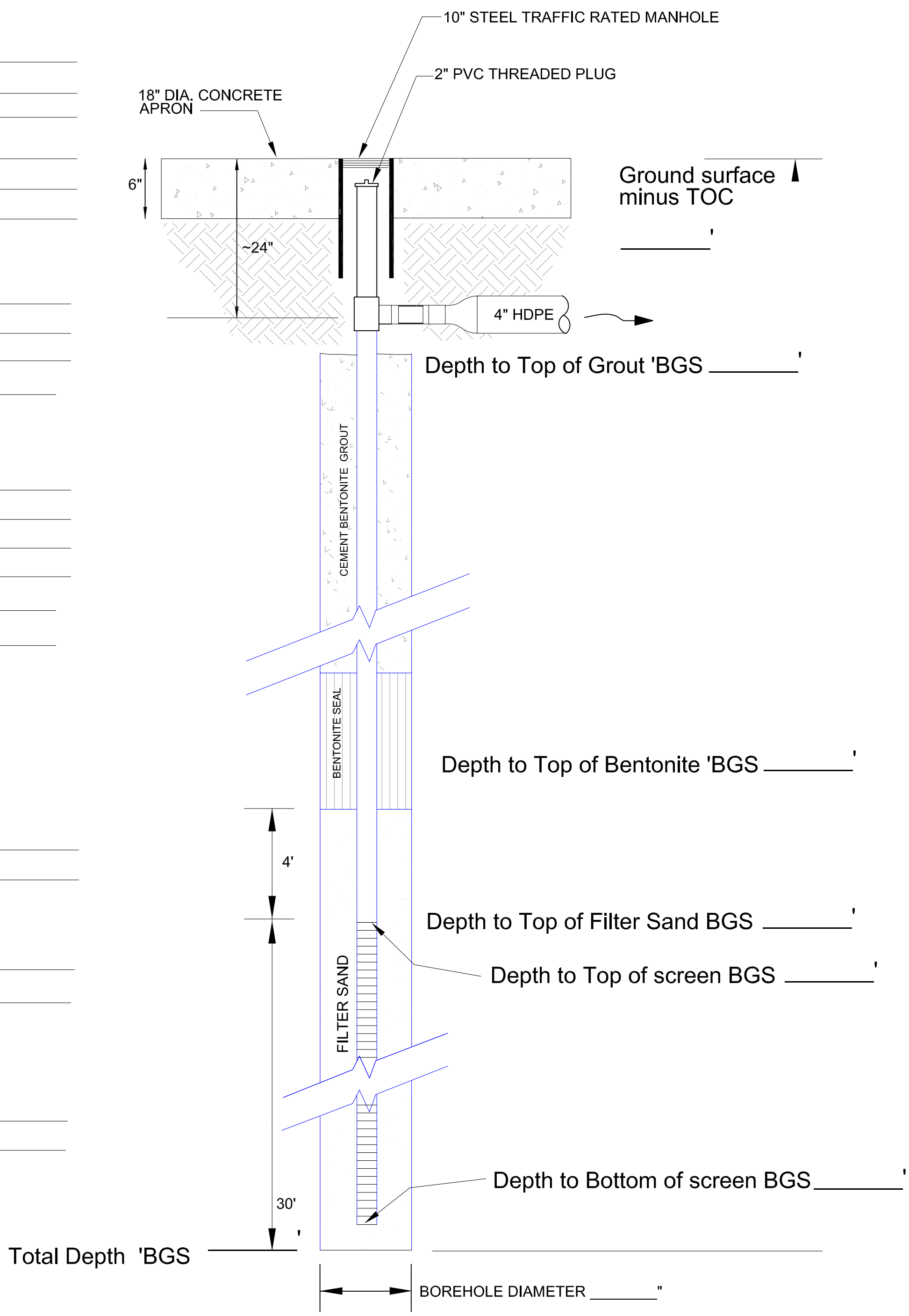
SCREEN DETAILS
MANUFACTURER: ______________________
MATERIAL: ______________________
SLOT SIZE: ______________________
DIAMETER: ______________________
LENGTH: ______________________
SCREENED INTERVAL (FT): ______________________

BOREHOLE DETAILS
TOTAL DEPTH: ______________________
DIAMETER: ______________________

FILTER SAND DETAILS
TYPE/GRADATION: ______________________
AMOUNT(UNITS): ______________________

BENTONITE SEAL DETAILS
TYPE: ______________________
AMOUNT: ______________________

CEMENT BENTONITE GROUT DETAILS
TYPE: ______________________
AMOUNT: ______________________



WORK AND TEST PROCEDURE 18

VAPOR SAMPLE COLLECTION

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for collection of vapor samples from soil vapor extraction (SVE) wells, SVE treatment system effluent, vapor monitoring points (VMPs) and vapor intrusion sampling probes (VSPs). Samples will be used for field measurements with a photoionization detector (PID) and for laboratory analysis. This WTP was prepared for use in the Off Depot Remedial Action at Defense Depot Memphis, Tennessee (DDMT) and as an addendum to the *Remedial Action Sampling and Analysis Plan* (RASAP) (MACTEC, 2005).

2.0 DISCUSSION

This WTP specifies details and procedures for collection of laboratory samples from the SVE component of the air sparging and SVE (AS-SVE) system at DDMT. Field measurements, laboratory results and system measurements will be evaluated and used to make recommendations for system operations.

An SVE system uses blowers connected to extraction wells to extract subsurface vapor from pore spaces in the vadose zone. Periodically, laboratory vapor samples are collected from individual extraction wells or the system to monitor system performance and assess attainment of remedial goals. VMPs are installed in various locations at set distances from SVE wells and are used to determine the vacuum influence of SVE wells; field measurements and laboratory samples are collected to measure VOC concentrations. VSPs are installed near structures in the vicinity of groundwater plumes to monitor for vapor intrusion.

3.0 PROCEDURES

3.1 ASSOCIATED PROCEDURES

The following WTPs should be reviewed in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
7	Sample Control and Documentation
8	Sample Containers and Preservation
9	Sample Packing and Shipping
10	Sampling Equipment Decontamination

12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring
14	Soil Vapor Extraction Wells
16	Vapor Monitoring Points
17	Vapor Sampling Probe

3.2 PREPARATION

Prior to leaving the office for field work, the field team leader is responsible for activities listed in WTP 1, as well as the following actions:

- Working with the project chemist to generate a sampling plan detail listing sample locations and constituents to be sampled.
- Coordinating with the analytical laboratory to ensure that the sample containers, and preservatives are shipped to the site and arrive prior to the start of sampling event.
- Generating paperwork for each event including; sample labels, request for analysis forms, field sampling reports, purge forms. Shipping appropriate paperwork and field books to the site prior to the start of sampling.
- Ordering appropriate supplies and equipment for delivery prior to the start of sampling.
- Confirm the shipping receipts and schedule with lab and equipment suppliers.

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

- Check that required sampling equipment has arrived on site.
- Conduct site set up activities; posting of signage and establishment of a decontamination area, and organization and inventory of supplies in the field storage area.
- Check that monitoring equipment is functioning properly, and calibrated as needed.
- Assign tasks to field teams according to the project work plan.

3.3 SAMPLE COLLECTION

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

- Location of work
- Weather conditions including precipitation, temperature and wind direction

- Ongoing activities that may influence or disrupt sampling efforts
- Accessibility to the sampling locations

All laboratory sampling will be documented in a bound field log. The field log will summarize sampling events include sampling locations and times, field conditions and other significant information related to the sampling event.

3.3.1 Sample Locations and Frequency

Field screening vapor samples will be collected from individual SVE wells, the SVE system effluent (vapor stream from all SVE wells), and vapor monitoring points (VMPs). Samples for field measurements will be collected using an oil-less vacuum pump and captured in Tedlar bags for PID readings. Field measurements from SVE wells and system effluent will be collected following startup, then daily during system shake down, weekly during the first quarter, and monthly thereafter. After the first two years, the measurements may be decreased to quarterly. Field screening measurements from VMPs will be collected prior to system startup, weekly during the first quarter, and monthly thereafter. After the first two years, the measurements may be decreased to quarterly.

Laboratory vapor samples will be collected via Summa canisters from the effluent of the SVE system after startup for a baseline reading, monthly for three months and quarterly for the remainder of the first year of operations. Sample frequency will be evaluated at the end of the first year.

Vapor intrusion samples for laboratory analysis will be collected from VSPs prior to the startup of the AS-SVE systems. At least one additional round of samples will be collected after the first quarter of AS-SVE operations.

3.3.2 Sample Containers

Laboratory samples will be collected by field personnel in accordance with the RAWP and at the direction of the Field Team Leader (FTL) or Project Engineer. The Project Engineer will provide a sample collection schedule to field personnel prior to the sampling event. Sample collection will follow U.S. Environmental Protection Agency (EPA) TO-15 (VOCs) procedures. Laboratory samples from the SVE system effluent will be collected in 6-liter Summa canisters with a 200 milliliter/minute regulator for laboratory analysis. Samples from VSPs will be collected in 1-liter Summa canisters using 200 milliliters per minute regulators. Standard turnaround time (TAT) for laboratory results is 15 days working days.

Summa canisters will be delivered from the analytical laboratory; a pressure gauge and flow regulator for each Summa canister should be included. Arrangement for delivery will be coordinated by the Project Chemist.

3.3.3 SVE Wells and System Effluent

Field measurements and samples for laboratory analysis will be collected to monitor system performance and emissions. Field measurements with a PID will be collected from individual SVE wells and from the system effluent. Samples for laboratory analysis will only be collected for the system effluent

3.3.3.1 Field Measurements

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

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

3.3.3.2 Laboratory Samples

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

- Fill out SUMMA canister tag with sampling information using a ball point pen.
- Remove the Summa canister valve cap.
- Attach regulator to 6-liter SUMMA canister. An individual regulator should be provided by the laboratory for each SUMMA canister.

- Run dedicated tubing from SVE manifold to regulator/canister assembly by connecting swaglock.
- Open appropriate SVE well sample port ball valve.
- Record starting SUMMA canister pressure on chain of custody (COC). The starting SUMMA canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used for sampling.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on COC.
- Allow SUMMA canister to fill until pressure gauge on regulator reads -5 in.Hg. (approximately 30 minutes with a 6-liter canister and a 200 ml/min flow regulator).
- Close sampling port ball valve at SVE well.
- Disconnect SUMMA canister from regulator.
- Record time of sample collection, date, and SUMMA canister serial and regulator numbers on chain of custody form.

3.3.4 VMPs

Field measurements will be collected from VMPs to evaluate system performance and determine SVE well vacuum influence. It is necessary to purge VMPs prior to sample collection. Procedure will be repeated for the 'A' and 'B' screens at each VMP.

<u>Purging:</u>

- Unlock VMP well casing (secured by padlock).
- Attach regulator to "quick connect" on well cap, run line to a "T" connection.
- Run one line out from the "T" to the pump.
- Attach second line to the SUMMA canister via swaglock.
- Turn on sampling pump and allow lines to purge for approximately five minutes. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.

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

- Attach tedlar bag to discharge of sampling pump by inserting nipple of bag into pump discharge tube.
- Allow tedlar bag to fill (approximately 20 seconds).
- Once filled, disconnect tedlar bag from sampling pump.
- Connect calibrated PID Meter to tedlar bag.
- Allow PID Meter to measure VOC concentration. Ensure reading on PID meter stabilizes before recording VOC concentration. This usually takes 10 to 15 seconds

- Record peak VOC concentration and time..
- Open valve on tedlar bag to completely deflate bag.
- Collect additional PID readings following the previous steps until three consecutive readings are within 10% of each other.

3.3.5 VSP Samples

Laboratory samples will be collected at VSPs to monitor for vapor intrusion associated with AS-SVE operations. It is necessary to purge VSPs prior to sample collection. Field (PID) measurements will be collected as part of this procedure to ensure the VSP has been properly purged. Procedure will be repeated for each of the two sample probes.

<u>Purging:</u>

- Unlock VSP well casing (secured by padlock).
- Attach regulator to VSP, run line to a “T” connection.
- Run one line out from the “T” to the pump.
- Attach second line to the SUMMA canister via swaglock.
- Turn on sampling pump and allow lines to purge for approximately five minutes. Purge time is based on tubing diameter and length and is intended to remove three tubing volumes.

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

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

<u>Laboratory Sample Collection:</u>

- Shut off ball valve on pump.
- Turn off sampling pump.

- Remove the 1-liter Summa canister valve cap, attach vacuum gauge to the canister, and open the canister valve.
- Record starting SUMMA canister pressure on chain of custody. The starting SUMMA canister pressure should be at least -25 in. Hg or greater. If not, the canister has leaked and should not be used for sampling.
- Open Summa canister valve located at top of sampling canister.
- Record sampling start time on field sampling sheet.
- Allow SUMMA canister to fill until pressure gauge on regulator reads -5 in.Hg. (approximately 5 minutes with a 1-liter canister and a 200 ml/min flow regulator).
- Close valve at SUMMA canister.
- Close VMP sampling port ball valve.
- Disconnect SUMMA canister from regulator.
- Record time of sample collection, date, and SUMMA canister serial and regulator numbers on chain of custody form.

3.4 POST-SAMPLING

3.4.1 Field

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

- Decontaminate all field equipment.
- Ensure all field documentation is completely filled out. This includes the COC and SUMMA sampling tag. Unless revised by the project manager, standard turn-around time (15 days) will be used. Retain copy of COC for the project file.
- Package SUMMA canisters in sturdy cardboard boxes with packing material to prevent any potential puncture of the canister. In most cases, the boxes and packing material used by the laboratory to ship the SUMMA canisters to the site can be reused.
- Ship SUMMA canisters to laboratory for analysis via Federal Express or other overnight service. Ensure copy of COC is included in shipment.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Ensure that equipment and associated supplies have been shipped back to the office or supplier.
- Ensure that all IDW/trash has been disposed in accordance with the RAWP.

3.4.2 Office

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

- Submit logbook and any original forms to Project/Task Manager for review.

4.0 REFERENCES

CH2M HILL, 2008. Memphis Depot Dunn Field Off Depot Groundwater Final Remedial Design Rev. 1. Prepared for the U.S. Army Engineering and Support Center, Huntsville, September 2008.

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USEPA, 1995. Standard Operating Procedure 1704: Summa Canister Sampling.

USEPA, 1999. Compendium Method TO-15: Determination of Compounds (VOCs) in Air Collected in Specially-Pressured Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (CG/MS).

USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

Appendix B

Reference Limits and Evaluation Levels

TABLE B-1
SOIL VAPOR REFERENCE LIMITS AND EVALUATION LEVELS
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Analyte	CAS Number	Project Action Limit ppbv	Project Quantitation Limit ppbv	Achievable Laboratory Limits MDLs ppbv	Achievable Laboratory Limits QLs ppbv
Carbon Tetrachloride	56-23-5	14.22	0.5	0.030	0.16
Chloroform	67-66-3	32.63	0.5	0.039	0.20
1,2-Dichloroethane	107-06-2	0.64	0.4	0.052	0.25
1,1-Dichloroethene	75-35-4	29.03	0.5	0.076	0.25
cis-1,2-Dichloroethene	156-59-2	39.52	0.5	0.061	0.25
trans-1,2-Dichloroethene	156-60-5	133.5	0.5	0.061	0.25
Methylene Chloride	75-09-2	2.85	0.5	0.058	0.29
1,1,2,2-Tetrachloroethane	79-34-5	0.55	0.4	0.029	0.15
Tetrachloroethene	127-18-4	0.99	0.5	0.028	0.15
1,1,2-Trichloroethane	79-00-5	2.03	0.5	0.044	0.18
Trichloroethene	79-01-6	2.06	0.5	0.039	0.19
Vinyl Chloride	75-01-4	14.77	0.5	0.082	0.39

Notes:
Matrix: soil vapor
Analytical Method: TO-15
ppbv: parts per billion, volume
MDL: method detection limit
QL: quantitation limit

TABLE B-2
SOIL REFERENCE LIMITS AND EVALUATION LEVELS
FLUVIAL SVE CONFIRMATION SAMPLING WORK PLAN
Dunn Field - Defense Depot Memphis, Tennessee

Analyte	CAS Number	Project Action Limit mg/Kg	Project Quantitation Limit mg/Kg	Achievable Laboratory Limits MDLs mg/Kg	Achievable Laboratory Limits QLs mg/Kg
Carbon Tetrachloride	56-23-5	0.1086	0.010	0.0005	0.005
Chloroform	67-66-3	0.4860	0.010	0.0005	0.002
1,2-Dichloroethane	107-06-2	0.0189	0.010	0.0005	0.003
1,1-Dichloroethene	75-35-4	0.0764	0.010	0.0005	0.006
cis-1,2-Dichloroethene	156-59-2	0.4040	0.010	0.0005	0.005
trans-1,2-Dichloroethene	156-60-5	0.7910	0.010	0.0005	0.005
Methylene Chloride	75-09-2	0.0169	0.010	0.0010	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.0066	0.005	0.0005	0.003
Tetrachloroethene	127-18-4	0.0920	0.010	0.0005	0.005
1,1,2-Trichloroethane	79-00-5	0.0355	0.010	0.0005	0.005
Trichloroethene	79-01-6	0.0932	0.010	0.0005	0.005
Vinyl Chloride	75-01-4	0.0150	0.005	0.0010	0.005

Notes:
Matrix: soil
Analytical Method: 8260B
mg/Kg: milligrams per kilogram
MDL: method detection limit
QL: quantitation limit