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THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 1032

HDR | e2M

Memorandum

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

From: Kevin Sedlak
Tom Holmes

Date: 24 March 2010

Re: **Work Plan for Deep Wells and 2010 Long Term Monitoring Main Installation - Defense Depot Memphis, Tennessee**

HDR|e²M has prepared this work plan to describe installation of deep monitoring wells and long-term monitoring (LTM) during 2010 on the Main Installation (MI) at Defense Depot Memphis, Tennessee (DDMT). This work plan was prepared for the Defense Logistics Agency (DLA) under Contract FA8903-08-D-8771, Task Order 0069 to the Air Force Center for Environmental Excellence.

INTRODUCTION

Selected Remedy

Remedial action objectives (RAOs) and the selected remedy were presented in the *Memphis Depot Main Installation Record of Decision* (CH2M HILL, 2001). The groundwater RAOs are:

- to prevent human ingestion of water contaminated with volatile organic compounds (VOCs) in excess of maximum contaminant levels (MCLs) from potential future onsite wells;
- to reduce concentrations of chemicals of concern to MCLs or lower; and
- to prevent horizontal and vertical offsite migration of groundwater contaminants in excess of MCLs.

The selected remedy included:

- enhanced bioremediation of chlorinated volatile organic compounds (CVOCs) in the most contaminated part of the groundwater plume; and
- long-term groundwater monitoring to document changes in plume concentrations and to detect potential plume migration to off-site areas or into deeper aquifers.

Summary of Remedial Action

Enhanced bioremediation treatment (EBT) was performed from Sept 2006 through February 2009 and consisted of biweekly and then monthly injections of sodium lactate solutions with modifications to the solution and injection procedures over time. Groundwater monitoring consisted of EBT performance monitoring in the treatment areas and LTM throughout the MI. LTM was initiated in April 2004 and will continue until the RAOs for groundwater are achieved.

The MI *Interim Remedial Action Completion Report, Rev.1* (IRACR) (HDR|e^{2}M, 2010) which describes the EBT and performance monitoring and LTM through 2009, was submitted to the Base Realignment and Closure Cleanup Team on 26 February 2010. The findings are summarized below.

Average concentrations in EBT areas for tetrachloroethene (PCE) decreased 94% in injection wells and 67% for performance monitoring wells, while trichloroethene (TCE) decreased 85% in injection wells and 69% for performance monitoring wells. If only wells with baseline concentrations above 100 micrograms per liter (µg/L) are considered, CVOC concentrations for parent compounds (PCE, TCE, carbon tetrachloride and chloroform) were reduced over 90 percent in injection wells and over 80 percent in monitoring wells.

CVOC isopleths maps and trend analysis of the LTM wells indicated plumes were stable and CVOC concentrations had decreased outside the EBT areas. Offsite migration of CVOCs in excess of MCLs was not indicated on the isopleth maps. LTM results for 2009 indicated results of reductive dechlorination were present well beyond the EBT areas.

The IRACR included results of additional studies performed because of contingencies that arose during the MI remedial action (RA): contaminants of concern were detected above MCLs in sentinel wells with the highest concentration in MW-90; and additional source areas/plumes were identified on the MI, primarily the West-central and Building 835 plumes. Following field investigation, groundwater monitoring and trend analysis presented in *Main Installation Source Area Investigation* (HDR|e^{2}M, 2009), DLA concluded that RA was not necessary in the West-central or Building 835 plumes. DLA halted injections at TTA-1 and TTA-2 based on significant reduction in PCE and TCE concentrations in the EBT areas, the lack of significant source areas in soil and the presence of similar low-level PCE concentrations in the West-central plume between TTA-1 and the window in the underlying clay.

Additional deep monitoring wells were recommended in the IRACR to support the groundwater model results. Proposed locations of two Intermediate aquifer wells and two Memphis aquifer wells are shown on Figure 1. The Memphis aquifer well locations will be finalized following review of the hydrogeologic information and analytical results from the two Intermediate aquifer wells. In addition, a third Intermediate aquifer well may be installed further downgradient near the property line based on the analytical results from the earlier wells. The wells are planned to be installed by June 2010 and will be incorporated into the LTM program. Additional information on site hydrogeology and the location and screen depths for the new wells is provided in the following sections.

Site Hydrogeology

The geologic units of interest at DDMT are (from youngest to oldest): loess, including surface soil; fluvial deposits; Jackson formation/Upper Claiborne group; and Memphis Sand.

The loess consists of wind-blown and deposited brown to reddish-brown, low-plasticity clayey silt to silty clay. The loess deposits are about 20 to 30 feet thick and are continuous throughout the DDMT area.

The fluvial (terrace) deposits consist of two general layers. The upper layer is a silty, sandy clay that transitions to a clayey sand and ranges from about 10 to 40 feet thick. The lower layer is composed of interlayered sand, sandy gravel, and gravelly sand, and has an average thickness of approximately 40 feet. The uppermost aquifer is the unconfined fluvial aquifer, which consists of saturated sands and gravelly sands in the lower portion of the fluvial deposits. Recharge to this unit is mainly from rainfall infiltration; discharge is to underlying units or laterally into adjacent stream channels. The saturated thickness ranges from 0 feet (dry) to approximately 60 feet, and is controlled by the uppermost clay configuration in the Jackson formation/Upper Claiborne group. Groundwater flow in the fluvial aquifer is toward the gap in the uppermost clay in the northwest area of the MI. The flow is toward the low point on the gap's southeast side, and the fluvial aquifer is dewatered (or "pinches out") elsewhere on the gap's perimeter. Water level elevations in the fluvial aquifer at the MI range from a high of approximately 240 feet mean sea level (msl) in the northeast to a low of approximately 195 feet msl in the central area. Water level measurements and groundwater contours for the fluvial aquifer from October 2009 are shown on Figure 2.

The intermediate aquifer is locally developed in Jackson formation/Upper Claiborne group deposits, which contain laterally extensive, thick clay deposits. The uppermost clay unit appears to be continuous, except for a large gap (window) in the MI's northwestern area and Dunn Field's southwestern area. There are other possible gaps in the clay off-site, west and northwest of Dunn Field. Where present, these gaps create connections to the underlying intermediate aquifer from the fluvial deposits. Water level elevations in the intermediate aquifer, away from areas of recharge from the fluvial aquifer, are approximately 160 feet msl with a general westward flow.

The Memphis Sand primarily consists of thick-bedded, white to brown or gray, very fine-grained to gravelly, partly argillaceous and micaceous sand. The Memphis Sand ranges from 500 to 890 feet in thickness and begins at a depth below ground surface (bgs) of approximately 120 to 300 feet. The top of the Memphis Sand was identified at 255 feet bgs (elevation of 21 feet above msl) in MW-67, the only monitoring well completed in the Memphis Sand at DDMT. The Memphis aquifer is confined by overlying clays and silts in the Cook Mountain formation (part of the Jackson/Upper Claiborne group) and contains groundwater under strong artesian (confined) conditions regionally. The City of Memphis obtains the majority of its drinking water from this unit. The Allen Well Field, which is operated by Memphis Light, Gas and Water, is located approximately 2 miles west of DDMT. The top of the Memphis aquifer potentiometric surface at MW-67 is approximately 160 feet msl.

Additional well installation was performed in 2006 and 2007 to provide additional information on the top of clay and groundwater flow directions on the MI and to improve delineation of the groundwater plumes. The current top of clay contour map is shown on Figure 3; the figure shows the location of a lithologic cross-section through the area of interest. Cross-section A-A' is shown on Figure 4.

The top of clay contour map shows both the gap in the upper clay in the northwestern MI near MW-107 and the increasing depth of the clay in the central MI near MW-108. The cross-section shows the corresponding increase in saturated thickness in the central MI. Where the upper clay is absent, the sand and gravel of the fluvial aquifer and the fine sand of the intermediate aquifer act as a single water table aquifer. Where the upper clay is present, as in the northern portion of cross-section A-A' (Figure 4), the water levels in the two units diverge and the downward gradient in the intermediate aquifer is observed. This cross-section illustrates the configuration of the different aquifer and aquitard layers, and supports the conceptual model of shallow fluvial aquifer groundwater moving below the aquitard separating the fluvial and intermediate aquifers and into the intermediate aquifer. Once the contamination reaches the intermediate aquifer, it provides a permeable conduit for groundwater to reach the window and migrate vertically downward into the Memphis Sand aquifer.

The groundwater contours for the fluvial aquifer on Figure 2 show groundwater flow from north-east to south-west and from south-west to north-east converging at a low point in the area of greatest saturated thickness in the central MI. The groundwater gradient indicates most of the flow in to the window is from the northeastern MI. Most of the groundwater that accumulates in the central MI appears to flow toward the south. However, there is apparently some groundwater flow to the north into the window.

New Well Locations

The new wells will improve the LTM network's utility in achieving the RAO to prevent horizontal and vertical offsite migration of groundwater contaminants in excess of MCLs. More specifically, the new intermediate aquifer well locations are intended to determine the extent of CVOCs detected in MW-90 and other sentinel wells, and the new Memphis aquifer well locations are intended to support the groundwater model results indicating CVOC plumes on the MI will not impact groundwater quality in the Memphis aquifer.

Water level measurements and groundwater contours for the intermediate aquifer from October 2009 are shown on Figure 5. The groundwater contours from this and previous water level measurements and recent PCE concentrations in sentinel wells (Figure 6) were used to select locations for the two new intermediate aquifer wells, MW-252 and MW-253. The well screens for MW-252 and MW-253 will be installed in the first saturated zone beneath the upper clay as indicated on the cross-section, Figure 4. The wells screened in the upper part of the Intermediate aquifer have much higher PCE concentrations than the adjacent deep wells (MW-90/MW-89 and MW-202B/MW-202A).

Wells MW-254 and MW-255 are to be installed in the Memphis aquifer near the MI property boundary and downgradient of intermediate aquifer wells with elevated CVOC concentrations. The well locations will be reviewed following installation of the two Intermediate aquifer wells. The screen depths indicated on Figure 4 are based on the boring log for MW-67. Staff from the University of Memphis Groundwater Institute will assist in reviewing soil core and identifying the depth of the Memphis aquifer at these wells. The planned well depths are shown on Table 1.

WELL INSTALLATION AND LTM PROCEDURES

Well installation, sampling and analytical procedures are described in the *Remedial Action Sampling and Analysis Plan Volume I: Field Sampling Plan and Volume II: Quality Assurance Project Plan, Rev. 1* (RA SAP) (MACTEC, 2005). Specific Work and Test Procedures (WTPs) to be utilized are included in Appendix A and listed below:

- WTP 1 General Procedures for Field Personnel
- WTP 2 Drilling Operations
- WTP 3 Well Installation, Development and Abandonment
- WTP 4 Groundwater Sampling
- 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 13 Health and Safety Monitoring

DEEP WELLS

Preparation

Preparations for field activities are described in WTP 1. The primary activities are clearance for the drilling locations and coordination with field personnel and the drilling contractor for well installation. In accordance with past practice, well construction permits will not be obtained from the Memphis Shelby County Health Department since all wells will be installed on the MI.

A pre-construction conference will be held with the drilling subcontractor immediately prior to drilling operations and will cover: roles and responsibilities of HDR|e^{2}M and subcontractor personnel; general project scope, work area security and safety, and project schedule; documentation of field activities; and procedures for project completion including final well development.

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.

Well Installation

Procedures for drilling and well installation are provided in WTPs 2 and 3. The activities are summarized below. All field activities will be supervised and data recorded by the HDR|e^{2}M field geologist with oversight by the site manager.

Borings will be advanced by rotasonic drilling and Type III wells will be installed with surface casing grouted into the clay at the base of the fluvial aquifer.

At each location, a 10-inch borehole will be advanced 10 feet into the uppermost clay at the top of the Jackson Formation/Upper Claiborne Group (base of fluvial aquifer) and a 6-inch diameter surface casing will be installed, either welded sections of carbon steel or threaded Schedule 80 polyvinyl chloride (PVC) with the bottom section containing a seal and check valve. The driller will pump grout through an injection pipe connected to the check valve until it returns to the ground surface. Following grouting, potable water will be pumped into the inner annulus of the casing. The grout will cure for 24 hours before continuing to advance the borehole. Water present in the inner annulus of the casing will be pumped to a holding tank before the borehole is advanced.

Well casings will be new, unused, decontaminated, 2-inch I.D. schedule 80 PVC pipe with internal threaded flush joints. The well screens will be 20 feet of schedule 80 PVC, 0.010 inch continuous slotted screen with a threaded PVC cap or point at the bottom. Centralizers will be used every 50 feet along the riser, but will not be attached in the well screen or bentonite seal section.

The filter pack will consist of 10-20 grade filter pack of inert, hard, well rounded sand (less than 2 percent flat particles). The sand will be certified free of contaminants by the vendor. The filter pack will extend from the bottom of the boring to at least 5 feet above the top of the well screen and will be installed in 1 to 2 foot lifts as the casing is vibrated from the hole.

A minimum 5-foot-thick bentonite seal will be placed above the filter pack. The bentonite seal will be allowed to hydrate for a minimum of 1 hour prior to installation of the cement grout.

Cement grout will be placed in the annular space above the bentonite seal to ground surface. The grout will be pumped through a side-discharge tremie pipe. Due to the well depths, care must be taken to avoid over-heating the casing as the grout cures; grout will be paced in lifts as determined by the drilling contractor and grouting events will by approximately 12 hours. The grout seal will be Type II Portland cement or American Petroleum Institute Class A cement with no more than 4 percent bentonite. Prior to installation of the surface completions, the boreholes will be topped off with grout to approximately 1 to 2 feet bgs.

Wells will be set as stick-up completions. The well casing will be extended 2 or 3 feet above ground surface and a locking cap will be installed. A 6-inch diameter steel sleeve will be placed over the casing and seated in a 3-foot by 3-foot by 4-inch concrete surface pad. The pad will be sloped away from the well sleeve and a lockable cap or lid will also be installed. Three-inch diameter concrete-filled steel guard posts will be installed around each well and set in concrete outside the well pad. The protective sleeve and guard posts will be painted orange.

The field geologist will prepare boring logs, construction diagrams, and development records for the newly constructed wells. The soil core from the capillary fringe and screened interval of the aquifer will be archived in labeled cardboard core boxes.

Following well completion, as-built locations will be surveyed for each monitoring well. Horizontal control will be within 0.1 foot and vertical control will be within 0.01 foot. All disturbed areas will be graded to match the surrounding areas and will be seeded and mulched. Debris and solid waste generated during field activities will be disposed properly.

Well Development

Procedures for well development are provided in WTP 3.

Each monitoring well will be developed no sooner than 24 hours after installation to allow adequate grout curing time. Wells will be developed using pumps equipped with surge rings. Pumping and periodic surging will continue until fluids lost to the formation during well installation have been removed; well water is clear to the unaided eye; and pH, temperature, turbidity, and specific conductance have stabilized. In general, field parameters are stable when nephelometric turbidity units (NTUs) are less than 10, pH is within 0.1 on consecutive readings, and temperature and specific conductance are within 10 percent of previous readings. The total quantity of water removed will be recorded.

Equipment Decontamination

Procedures for decontamination of drilling equipment and well construction materials equipment are provided in WTP 10.

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).

IDW Management

The waste generated during well installation is 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 generated during drilling the well borings, groundwater from well development, and wastewater and solids from decontamination of drilling equipment. The soil will be used to fill low areas on the MI or Dunn Field and the waste water and groundwater will be added to the fluvial soil vapor extraction (FSVE) condensate water storage tank on Dunn Field. The waste water will be discharged in accordance with the City of Memphis discharge permit.

2010 LONG TERM MONITORING

MI LTM is performed to document changes in plume concentrations and to detect potential plume migration to off-site areas or into deeper aquifers. Groundwater monitoring requirements are described in *Long-Term Groundwater Monitoring Plan* (LTM Plan) in Appendix B of the *Main Installation Final Remedial Design* (CH2MHILL, 2004) and the *Main Installation Remedial Action Work Plan* (MACTEC, 2005a). MI LTM wells are classified in four categories:

- Background – wells screened in the fluvial aquifer located along or outside the MI boundary; wells upgradient of or at a distance from groundwater plumes on the MI and Dunn Field; and wells with no, or low, previous detections of site constituents.
- Boundary – wells screened in the fluvial aquifer located along or outside the MI boundary to monitor constituent migration from off-site sources.
- Sentinel – wells screened within either the fluvial or intermediate aquifer adjacent to or within the window to the intermediate aquifer.
- Performance – wells screened in the fluvial aquifer and within the limits of known groundwater plumes.

Existing wells are sampled semiannually, annually or biennially; new wells are sampled quarterly for one year to develop a trend prior to selection of a sample frequency in accordance with the LTM Plan. Recommendations for changes to LTM are presented in the annual LTM reports, as necessary. The latest recommendations for changes to LTM wells and sample frequency were made in the *Annual Long-Term Monitoring Report-2009, Main Installation Rev.0* (HDR|e²M, 2010) and were approved by United States Environmental Protection Agency (USEPA) and Tennessee Department of Environment and Conservation.

Currently, 105 wells are included in the MI LTM: 7 background wells, 7 boundary wells, 72 performance wells and 19 sentinel wells. The wells currently have the following sample frequency: biennial (13 wells), annual (33 wells) and semiannual (59 wells). The current well classification, sample frequency and well information for MI LTM wells are shown on Table 2 and the well locations are shown on Figure 7.

There are 66 LTM performance wells screened in the fluvial aquifer and within the limits of designated groundwater plumes: TTA-1 North (MW-21 Area), TTA-1 South (MW-101 Area), TTA-2, West Central, Building 835 and North Central. The designated plumes, primary CVOCs and compliance well networks are listed below.

Plume	CVOC	Compliance Well Networks
TTA-1 North	PCE	DR1-2, DR1-7, DR1-8, MW-21, MW-100B, PMW21-03, PMW21-05
TTA-1 South	PCE, TCE	DR1-1, DR1-1A, DR1-3, DR1-4, DR1-5, DR1-5A, DR1-6, DR1-6A, MW-101, PMW101-4A/B
TTA-2	PCE, CT, CF	DR2-1, DR2-2, DR2-3, DR2-4, DR2-5, DR2-6, MW-26, MW-64, MW-85, MW-88, MW-92, MW-96, MW-113, MW-217, MW-218, PMW92-03, PMW92-06
West-Central	PCE	MW-39/39A, MW-94A, MW-98, MW-197A/B, MW-200, MW-203A/B, MW-204A/B, MW-205A/B, MW-206A/B, MW-208A/B, MW-210B, MW-214A/B, MW-215A/B, PZ-03
Bldg 835	TCE	MW-62, MW-142, MW-198, MW199B, MW-209B, MW-212
North-Central	TCE	MW-103, MW-104

There are three isolated LTM performance wells with CVOC concentrations above MCLs outside designated plumes (MW-25A, MW-52 and MW-97). Further delineation of CVOC extent at these locations is not considered necessary due to the low concentrations. The three remaining performance wells are dry (MW-213) or are located near plumes but with CVOCs not detected (MW-216 and PZ-06).

The next MI LTM event will be conducted in April 2010. Sample events during 2010 are listed on Table 3.

Groundwater samples are collected from LTM wells using low-flow purging methods except where prevented by small diameter casing in piezometers or slow recharge and thin saturated layer in wells. Groundwater levels in LTM wells are measured prior to sampling during each sample event.

Preparation

Preparations for sampling activities are described in WTP 1. The primary activities are coordination with field personnel for sampling 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.

Water Level Sweep

Prior to each LTM event, water level measurements will be made in all LTM wells. Measurements will be taken using Solinst Model 101 water level meters with electronic sensors and tapes graduated in 0.01-foot increments. The water level measuring tape will be decontaminated, by hand washing and rinsing with de-ionized water before use and between wells.

The probe will be lowered until an audible tone is heard signaling the water surface. The probe is then withdrawn until the tone stops and then lowered very slowly until the tone is heard and the depth is measured at marked top of casing. This measurement is repeated twice and recorded on the field sheet.

The condition of each well will be recorded, including the pad and locks, during the water level sweep. Replacement of well caps or locks, if necessary, will be made the same day.

Groundwater Sampling

Procedures for groundwater sampling are provided in WTP 4.

Sampling will be performed by 2-person crews and supervised by the site manager. Groundwater samples will be analyzed for VOCs by USEPA Method SW8260B.

Low-flow sampling is performed using a portable bladder pump with dedicated Teflon® bladder and Teflon®-lined polyethylene tubing. The majority of LTM well have dedicated pumps which remain in the wells between sample events. For wells without dedicated pumps, the bladder and tubing for the well are placed in sealed plastic bags after sampling and stored for future sample events.

The pumping rate at the well is set such that the water levels do not decline more than 1.2 inches (0.1 foot). Water quality parameters are measured at 5 to 10 minute intervals during purging using a flow-through cell. The units are calibrated each morning prior to sampling, and if abnormal readings are observed during the day, the instruments are recalibrated in the field. All measurements will be recorded on the field sampling forms.

Purging will continue at the well for up to two hours to meet the stabilization criteria: three successive readings within 0.1 for pH, 10 milliVolts for oxygen reduction potential, 10 percent for specific conductance, 10 percent for dissolved oxygen and <20 NTUs for turbidity. Temperature will also be recorded but is not used as a stabilization parameter. The samples are collected in preserved 40-mL vials when stabilization criteria are met or the site manager approves a variance.

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. 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

Quality Assurance/Quality Control (QA/QC) samples are described in the RA SAP Quality Assurance Project Plan (Volume II, Section 2). 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 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 samples will be sent to the subcontract laboratory, Microbac Laboratories in Marietta, Ohio, for VOC analysis by USEPA Method SW8260B.

IDW Management

The waste generated during groundwater sampling is classified as either non-investigative waste or 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 consists of waste water from equipment decontamination and groundwater from purging prior to sampling. The waste water is collected and added to the FSVE condensate water storage tank on Dunn Field. The waste water will be discharged in accordance with the City of Memphis discharge permit.

DATA QUALITY EVALUATION

Data quality evaluation (DQE) will be performed to evaluate the analytical data relative to the data quality objectives described in the RA SAP. 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 RA SAP 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.

REPORTING

Summary reports will be submitted after well installation and each sample event. The reports will include a brief introduction and scope of work, description of field activities, discussion of preliminary analytical results (prior to DQE), and a summary of findings. Report tables will include water level measurements and an analytical results summary. Boring logs and well completion diagrams and updated top of clay maps and cross-sections will be prepared following well installation.

An annual report will fully document the well installation, monitoring activities, DQE and analytical results; recommendations for monitoring optimization will be made in accordance with the LTM plan. Analytical data will be presented in data summary tables, concentration versus time graphs, and maps showing the extent of contaminant plumes.

TABLES

TABLE 1
NEW DEEP MONITORING WELLS
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well	Northing	Easting	Aquifer Screened	Estimated Ground Elevation (ft, msl)	Estimated Top of Clay Elevation (ft, msl)	Planned Boring Depth (ft, bgs)	Planned Surface Casing Depth (ft, bgs)	Estimated Groundwater Elevation (ft, msl)	Estimated Top of Screen Elevation (ft), msl	Planned Riser Length (ft)	Planned Screen Length (ft)
MW-252	278843 6	801450.7	Intermediate	296	209	151	97	160	165	131	20
MW-253	278298 1	801266.1	Intermediate	291	197	146	105	160	165	126	20
MW-254	279324.6	800777.4	Memphis	292	207	292	96	160	20	272	20
MW-255	278581.8	800724.4	Memphis	291	200	291	101	160	20	271	20
MW-256	tbd	tbd	Intermediate	-	-	-	-	-	-	-	-

Notes

1) Ground, top of clay and groundwater elevations based on observations in nearby wells.
2) Surface casing for intermediate aquifer wells to be drilled 10 feet into the uppermost clay
3) Depths for Memphis Aquifer wells estimated from Memphis Sand elevation in MW-67.

TABLE 2
LTM WELLS
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well	Aquifer	Well Classification	Sample Frequency	Northing (feet)	Easting (feet)	Ground Elevation (feet, msl)	Stick Up (feet)	Riser Length (feet)	Screen Length (feet)	Total Well Depth (feet, btoc)
MW-16	Fluvial	Background	Biennial	278837.83	807099 66	300.19	-0.3	57.6	15	72.6
MW-19	Fluvial	Background	Biennial	278945.87	800782.26	290.86	-0.3	83 1	10	93.1
MW-21	Fluvial	Performance	Semiannual	276473.39	800602.39	295.21	-0.2	92 1	15	107.1
MW-22	Fluvial	Boundary	Biennial	275912.38	800702 16	298.49	-0 5	95.4	10	105.4
MW-23	Fluvial	Boundary	Biennial	275791.02	801817 13	299.24	-0.3	101.2	10	111.2
MW-24	Fluvial	Boundary	Biennial	275616.05	803538.81	299.81	-0 3	97.3	15	112.3
MW-25A	Fluvial	Performance	Annual	275975.11	805521 27	270.13	-0 3	73.0	10	83.0
MW-26	Fluvial	Performance	Semiannual	276508.16	805962 09	303.89	-0 2	97.6	10	107.6
MW-34	Intermediate	Sentinel	Annual	279411.21	801917 96	300.80	-0.8	136.6	20	156.6
MW-38	Intermediate	Sentinel	Annual	279141.38	802450.43	308.45	-1.0	139.9	15	154 9
MW-39	Fluvial	Performance	Semiannual	277280.67	802598.11	296.58	-0 3	95.5	20	115 5
MW-39A	Fluvial	Performance	Semiannual	277278.20	802607 72	298.49	0.0	147.9	20	167.9
MW-50	Fluvial	Boundary	Biennial	276455 81	807065.28	299.32	-0 5	115 0	10	125.0
MW-52	Fluvial	Performance	Annual	275371.97	805897.36	279.71	-0 5	94.0	10	104 0
MW-53	Fluvial	Background	Biennial	279176.66	805136 05	305.58	0.8	72.5	10	82 5
MW-55	Fluvial	Background	Biennial	279301.05	801204 62	292.48	-0.4	64 0	10	74.0
MW-62	Fluvial	Performance	Semiannual	278289.89	801858 16	294.10	-0.5	86.0	10	96.0
MW-63A	Fluvial/Intermediate	Sentinel	Annual	278200.31	803572 83	306 33	-0.4	140.0	10	150.0
MW-63B	Fluvial/Intermediate	Sentinel	Annual	278201.32	803557.77	306.22	-0.4	115 0	10	125.0
MW-64	Fluvial	Performance	Semiannual	276951.52	805005 97	304.46	-0.2	102.0	10	112.0
MW-66A	Fluvial	Background	Biennial	276626.02	799792 63	284.34	-0.1	74.6	20	94.6
MW-85	Fluvial	Performance	Semiannual	276704.14	806064.51	304 50	-0.4	95.9	15	110.9
MW-88	Fluvial	Performance	Semiannual	276879.05	806512.88	305.47	-0.3	82.0	15	97.0
MW-89	Intermediate	Sentinel	Annual	278286.97	802555.25	304.38	-0.4	147.0	30	177.0
MW-90	Intermediate	Sentinel	Semiannual	278283.60	802539.51	304.64	-0.5	115.0	30	145.0
MW-92	Fluvial	Performance	Semiannual	276614.20	806489.66	304.78	-0.4	93.0	15	108 0
MW-93	Fluvial	Boundary	Biennial	275542.22	804440.10	294.31	-0.2	92.0	15	107.0
MW-94A	Fluvial	Performance	Semiannual	276805.80	803085.80	303.23	-0.2	109.6	10	119.6
MW-96	Fluvial	Performance	Annual	276310.14	806320.24	289.67	-0 7	75.5	20	95.5
MW-97	Fluvial	Performance	Semiannual	276074.23	802139.23	297.70	-0.3	97 5	20	117.5
MW-98	Fluvial	Performance	Semiannual	276891.37	802572.77	294.93	-0.5	137.0	10	147.0
MW-99	Fluvial	Background	Biennial	277443 37	801114.53	285.69	-0.4	91.5	20	111.5
MW-100B	Fluvial	Performance	Semiannual	276600.65	800854.43	291.60	-0.5	107 5	20	127.5
MW-101T	Fluvial	Performance	Semiannual	276204.27	801110.38	291.99	-0.3	89.0	15	104.0
MW-102B	Fluvial	Boundary	Biennial	275760.59	800707.72	312.07	-0.7	120.5	20	140.5
MW-103	Fluvial	Performance	Annual	278690 88	805159.83	301.89	-0.5	70.0	20	90.0
MW-104	Fluvial	Performance	Annual	278676 47	805417.03	292.18	-0.2	70.5	20	90.5

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TABLE 2
LTM WELLS
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well	Aquifer	Well Classification	Sample Frequency	Northing (feet)	Easting (feet)	Ground Elevation (feet, msl)	Stick Up (feet)	Riser Length (feet)	Screen Length (feet)	Total Well Depth (feet, btoc)
MW-107	Fluvial/Intermediate	Sentinel	Annual	278419.07	803009.93	305.18	-0.3	128.0	15	143.0
MW-108	Fluvial/Intermediate	Sentinel	Semiannual	277658.02	802985.53	303.25	-0.2	160.0	10	170.0
MW-113	Fluvial	Performance	Semiannual	276685.34	806279.10	304.92	-0.1	96.0	10	106.0
MW-140	Intermediate	Sentinel	Annual	279061.29	801715.68	298.16	0.0	224.6	20	244.6
MW-141	Intermediate	Sentinel	Semiannual	278019.19	802571.25	303.70	0.0	148.7	20	168.7
MW-142	Fluvial	Performance	Annual	278056.03	801629.12	291.49	-0.3	85.0	20	105.0
MW-143	Fluvial	Background	Biennial	278301.27	801201.33	290.74	-0.2	78.5	20	98.5
MW-197A	Fluvial	Performance	Semiannual	276975.42	802042.30	291.54	-0.3	162.0	15	177.0
MW-197B	Fluvial	Performance	Semiannual	276973.14	802036.92	291.43	-0.4	94.2	15	109.2
MW-198	Fluvial	Performance	Annual	277775.67	802141.93	291.80	-0.3	90.0	15	105.0
MW-199A	Intermediate	Sentinel	Annual	277756.40	802573.52	301.84	-0.3	146.1	15	161.1
MW-199B	Fluvial	Performance	Semiannual	277751.74	802575.66	302.07	-0.3	104.6	15	119.6
MW-200	Fluvial	Performance	Semiannual	277006.10	802859.39	300.51	-0.3	102.9	15	117.9
MW-202A	Intermediate	Sentinel	Annual	278685.74	802111.27	299.69	-0.5	176.2	15	191.2
MW-202B	Intermediate	Sentinel	Semiannual	278692.79	802112.04	299.74	-0.2	118.8	15	133.8
MW-203A	Fluvial	Performance	Semiannual	276841.61	801740.37	290.78	-0.2	142.9	15	158.0
MW-203B	Fluvial	Performance	Semiannual	276821.58	801741.76	290.75	-0.2	92.8	15	107.8
MW-204A	Fluvial	Performance	Semiannual	276724.66	802168.25	292.49	-0.3	133.3	15	148.3
MW-204B	Fluvial	Performance	Semiannual	276707.82	802167.00	292.67	-0.4	94.5	15	109.5
MW-205A	Fluvial	Performance	Semiannual	277157.28	802277.37	292.32	-0.4	141.0	15	156.0
MW-205B	Fluvial	Performance	Semiannual	277173.13	802277.76	292.04	-0.2	97.0	15	112.0
MW-206A	Fluvial	Performance	Semiannual	277219.28	802792.28	300.35	-0.4	127.3	15	142.4
MW-206B	Fluvial	Performance	Semiannual	277200.85	802794.78	300.12	-0.2	96.7	15	111.7
MW-207A	Fluvial	Sentinel	Semiannual	277652.65	803191.86	303.99	-0.2	149.7	15	164.7
MW-207B	Fluvial	Sentinel	Semiannual	277665.39	803193.06	304.03	-0.2	108.3	15	123.3
MW-208A	Fluvial	Performance	Semiannual	277382.04	802799.25	301.91	-0.4	183.4	15	198.5
MW-208B	Fluvial	Performance	Semiannual	277396.90	802814.96	302.08	-0.3	106.7	15	121.7
MW-209A	Intermediate	Sentinel	Annual	277574.28	802507.10	298.36	-0.3	189.0	15	204.0
MW-209B	Fluvial	Performance	Semiannual	277581.50	802520.13	298.72	-0.2	102.3	15	117.3
MW-210A	Intermediate	Sentinel	Semiannual	277238.49	801958.05	289.78	-0.1	177.1	15	192.0
MW-210B	Fluvial	Performance	Semiannual	277228.18	801951.94	289.53	-0.2	97.0	15	112.0
MW-211	Intermediate	Sentinel	Annual	278000.59	802973.69	304.09	-0.4	166.3	15	181.3
MW-212	Fluvial	Performance	Semiannual	278028.36	802225.44	295.68	-0.3	85.7	15	100.7
MW-213	Fluvial	Performance	Semiannual	278426.83	801668.99	294.12	-0.3	76.9	15	91.9
MW-214A	Fluvial	Performance	Annual	277877.62	803906.94	303.96	-0.4	119.1	15	134.1
MW-214B	Fluvial	Performance	Annual	277875.84	803922.20	303.96	-0.3	101.6	15	116.6
MW-215A	Fluvial	Performance	Annual	277298.37	804164.31	304.86	-0.4	128.8	15	143.8

TABLE 2
LTM WELLS
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well	Aquifer	Well Classification	Sample Frequency	Northing (feet)	Easting (feet)	Ground Elevation (feet, msl)	Stick Up (feet)	Riser Length (feet)	Screen Length (feet)	Total Well Depth (feet, btoc)
MW-215B	Fluvial	Performance	Annual	277298.27	804177.33	304.98	-0.4	105.4	15	120.4
MW-216	Fluvial	Performance	Annual	276024.68	801995.93	297.63	-0.3	99.9	15	115.0
MW-217	Fluvial	Performance	Semiannual	276670.60	805213.69	304.51	-0.3	101.8	15	116.8
MW-218	Fluvial	Performance	Semiannual	276936.70	805628.44	306.00	-0.4	98.9	15	114.0
MW-219	Fluvial	Boundary	Semiannual	276429.60	800460.96	295.07	-0.2	97.7	15	112.8
MW-229	Intermediate	Sentinel	Annual	279293.98	802836.28	311.99	-0.2	188.4	20	208.4
DR1-1	Fluvial	Performance	Annual	276300.45	800855.38	293.26	-0.2	121.7	20	141.7
DR1-1A	Fluvial	Performance	Annual	276307.37	800863.15	293.29	-0.2	89.3	20	109.3
DR1-2	Fluvial	Performance	Annual	276536.56	801152.64	290.28	-0.2	97.8	20	117.8
DR1-3	Fluvial	Performance	Semiannual	276527.27	801415.91	291.11	-0.2	109.7	20	129.7
DR1-4	Fluvial	Performance	Annual	276231.20	801399.53	293.00	-0.2	106.3	20	126.3
DR1-5	Fluvial	Performance	Semiannual	276079.76	800828.18	294.88	-0.4	125.2	20	145.2
DR1-5A	Fluvial	Performance	Semiannual	276086.88	800835.32	294.88	-0.3	89.7	20	109.7
DR1-6	Fluvial	Performance	Semiannual	276044.05	801103.49	293.44	-0.5	115.8	20	135.8
DR1-6A	Fluvial	Performance	Semiannual	276035.13	801103.29	293.52	-0.4	90.8	20	110.8
DR1-7	Fluvial	Performance	Annual	276791.26	801441.36	289.46	-0.3	108.3	20	128.3
DR1-8	Fluvial	Performance	Annual	276752.46	800875.44	290.37	-0.4	92.7	20	112.7
DR2-1	Fluvial	Performance	Semiannual	276772.10	806497.62	305.08	-0.2	73.9	20	93.9
DR2-2	Fluvial	Performance	Semiannual	276771.06	806658.74	304.49	-0.1	79.0	20	99.0
DR2-3	Fluvial	Performance	Semiannual	276539.12	806203.16	303.66	-0.2	93.0	20	113.0
DR2-4	Fluvial	Performance	Annual	276455.68	806632.64	303.80	-0.3	88.0	20	108.0
DR2-5	Fluvial	Performance	Semiannual	276830.90	806180.36	305.55	-0.1	85.0	20	105.0
DR2-6	Fluvial	Performance	Semiannual	276643.99	805860.91	304.92	-0.2	94.6	20	114.6
PMW21-03	Fluvial	Performance	Semiannual	276573.43	800742.52	292.72	-0.6	90.3	20	110.3
PMW21-05	Fluvial	Performance	Semiannual	276628.32	801129.72	288.92	-0.4	94.3	20	114.3
PMW92-03	Fluvial	Performance	Semiannual	276678.91	806438.66	304.17	-0.3	92.5	10	102.5
PMW92-06	Fluvial	Performance	Semiannual	276766.94	806270.66	304.97	-0.3	91.6	10	101.6
PMW101-04A	Fluvial	Performance	Semiannual	276299.41	801182.12	291.43	-0.4	117.9	20	137.9
PMW101-04B	Fluvial	Performance	Semiannual	276296.40	801186.86	291.75	-0.3	98.6	20	118.6
PZ-03	Fluvial	Performance	Annual	276379.33	802941.05	298.98	-0.5	108.9	10	118.9
PZ-06	Fluvial	Performance	Annual	278855.84	805099.54	304.56	-0.2	89.4	10	99.4

TABLE 3
LTM SCHEDULE
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well ID	Well Type	Current Sample Frequency	SA Apr-2010	Biennial Oct-2010
MW-16	Background	Biennial	-	P
MW-19	Background	Biennial	-	P
MW-21	Performance	Semiannual	P	P
MW-22	Boundary	Biennial	-	P
MW-23	Boundary	Biennial	-	P
MW-24	Boundary	Biennial	-	P
MW-25A	Performance	Annual	-	P
MW-26	Performance	Semiannual	P	P
MW-34	Sentinel	Annual	-	P
MW-38	Sentinel	Annual	-	P
MW-39	Performance	Semiannual	P	P
MW-39A	Performance	Semiannual	P	P
MW-50	Boundary	Biennial	-	P
MW-52	Performance	Annual	-	P
MW-53	Background	Biennial	-	P
MW-55	Background	Biennial	-	P
MW-62	Performance	Semiannual	P	P
MW-63A	Sentinel	Annual	-	P
MW-63B	Sentinel	Annual	-	P
MW-64	Performance	Semiannual	P	P
MW-66A	Background	Biennial	-	P
MW-85	Performance	Semiannual	P	P
MW-88	Performance	Semiannual	P	P
MW-89	Sentinel	Annual	-	P
MW-90	Sentinel	Semiannual	P	P
MW-92	Performance	Semiannual	P	P
MW-93	Boundary	Biennial	-	P
MW-94A	Performance	Semiannual	P	P
MW-96	Performance	Annual	-	P
MW-97	Performance	Semiannual	P	P
MW-98	Performance	Semiannual	P	P
MW-99	Background	Biennial	-	P
MW-100B	Performance	Semiannual	P	P
MW-101[1]	Performance	Semiannual	P	P
MW-102B	Boundary	Biennial	-	P
MW-103	Performance	Annual	-	P
MW-104	Performance	Annual	-	P
MW-107[1]	Sentinel	Annual	-	P
MW-108	Sentinel	Semiannual	P	P
MW-113	Performance	Semiannual	P	P
MW-140	Sentinel	Annual	-	P
MW-141	Sentinel	Semiannual	P	P
MW-142	Performance	Annual	-	P
MW-143	Background	Biennial	-	P
MW-197A	Performance	Semiannual	P	P
MW-197B	Performance	Semiannual	P	P
MW-198	Performance	Annual	-	P
MW-199A	Sentinel	Annual	-	P
MW-199B	Performance	Semiannual	P	P
MW-200	Performance	Semiannual	P	P
MW-202A	Sentinel	Annual	-	P
MW-202B	Sentinel	Semiannual	P	P
MW-203A	Performance	Semiannual	P	P
MW-203B	Performance	Semiannual	P	P
MW-204A	Performance	Semiannual	P	P
MW-204B	Performance	Semiannual	P	P
MW-205A	Performance	Semiannual	P	P

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TABLE 3
LTM SCHEDULE
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Well ID	Well Type	Current Sample Frequency	SA Apr-2010	Biennial Oct-2010
MW-205B	Performance	Semiannual	P	P
MW-206A	Performance	Semiannual	P	P
MW-206B	Performance	Semiannual	P	P
MW-207A	Sentinel	Semiannual	P	P
MW-207B	Sentinel	Semiannual	P	P
MW-208A	Performance	Semiannual	P	P
MW-208B	Performance	Semiannual	P	P
MW-209A	Sentinel	Annual	-	P
MW-209B	Performance	Semiannual	P	P
MW-210A	Sentinel	Semiannual	P	P
MW-210B	Performance	Semiannual	P	P
MW-211	Sentinel	Annual	-	P
MW-212	Performance	Semiannual	P	P
MW-213	Performance	Semiannual	P	P
MW-214A	Performance	Annual	-	P
MW-214B	Performance	Annual	-	P
MW-215A	Performance	Annual	-	P
MW-215B	Performance	Annual	-	P
MW-216	Performance	Annual	-	P
MW-217	Performance	Semiannual	P	P
MW-218	Performance	Semiannual	P	P
MW-219	Boundary	Semiannual	P	P
MW-229	Sentinel	Annual	-	P
DR1-1	Performance	Annual	-	P
DR1-1A	Performance	Annual	-	P
DR1-2	Performance	Annual	-	P
DR1-3	Performance	Semiannual	P	P
DR1-4	Performance	Annual	-	P
DR1-5	Performance	Semiannual	P	P
DR1-5A	Performance	Semiannual	P	P
DR1-6	Performance	Semiannual	P	P
DR1-6A	Performance	Semiannual	P	P
DR1-7	Performance	Annual	-	P
DR1-8	Performance	Annual	-	P
DR2-1	Performance	Semiannual	P	P
DR2-2	Performance	Semiannual	P	P
DR2-3	Performance	Semiannual	P	P
DR2-4	Performance	Annual	-	P
DR2-5	Performance	Semiannual	P	P
DR2-6	Performance	Semiannual	P	P
PMW21-03	Performance	Semiannual	P	P
PMW21-05	Performance	Semiannual	P	P
PMW92-03	Performance	Semiannual	P	P
PMW92-06	Performance	Semiannual	P	P
PMW101-04A	Performance	Semiannual	P	P
PMW101-04B	Performance	Semiannual	P	P
PZ-03	Performance	Annual	-	P
PZ-06	Performance	Annual	-	P

Notes.
1) Samples collected from two screened intervals in MW-101 and MW-107
P: Sample planned
-: Sample not planned or collected

TABLE 4
QUALITY CONTROL SAMPLES
DEEP WELLS AND 2010 LTM WORK PLAN
Main Installation - Defense Depot Memphis, Tennessee

Event	Date	Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Duplicate	Trip Blanks	Equipment Blanks	Total	Analysis
Semiannual LTM	Apr-10	60	6	3	3	3	2	77	VOCs
New Wells Quarterly Monitoring	Jul-10	5	1	1	1	1	1	10	VOCs
Biennial LTM	Oct-10	107	11	6	6	5	1	136	VOCs
New Wells Quarterly Monitoring	Oct-10	5	1	1	1	1	1	10	VOCs
New Wells Quarterly Monitoring	Jan-11	5	1	1	1	1	1	10	VOCs
New Wells Quarterly Monitoring	Apr-11	5	1	1	1	1	1	10	VOCs

FIGURES

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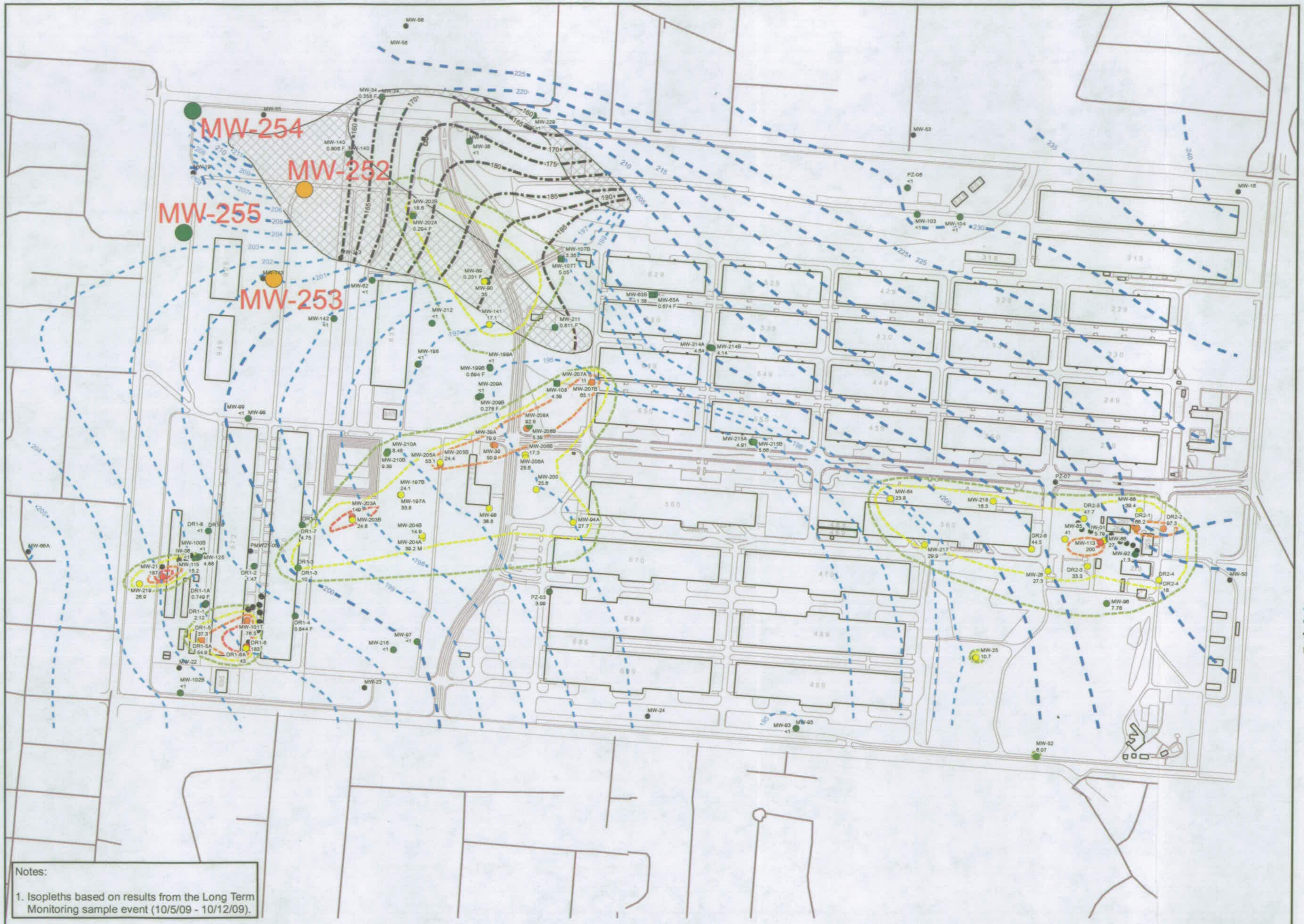

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Figure 1

PROPOSED DEEP MONITORING WELLS

DEEP WELLS AND 2010
LTM WORK PLAN

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

PCE Ranges
ug/L
- 0 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 300

PCE Isopleth
ug/L
- 5
- 10
- 50
- 100

Proposed Monitoring Well in the Memphis Aquifer

Proposed Monitoring Well in the Intermediate Aquifer

Potentiometric surface of the Fluvial Aquifer 1-ft. contour
Potentiometric surface of the Fluvial Aquifer 5-ft. contour
Potentiometric surface of the Intermediate Aquifer 5-ft. contour
Clay Elevation Exceeds Groundwater Elevation

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

HDR | eM

Figure 2

FLUVIAL AQUIFER GROUNDWATER ELEVATIONS, OCTOBER 2009

DEEP WELLS AND 2010 LTM WORK PLAN

MAIN INSTALLATION DEFENSE DEPOT MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Intermediate Aquifer 5-ft. contour
- Clay Elevation Exceeds Groundwater Elevation

MW-03 100.12 Blue: value used for Fluvial Aquifer groundwater contours

MW-237 100.15 Black: value used for Intermediate Aquifer groundwater contours

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 250 500 1,000 Feet

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

HDR | eM

Notes:

1. Water level measurements made 10/2/2009.

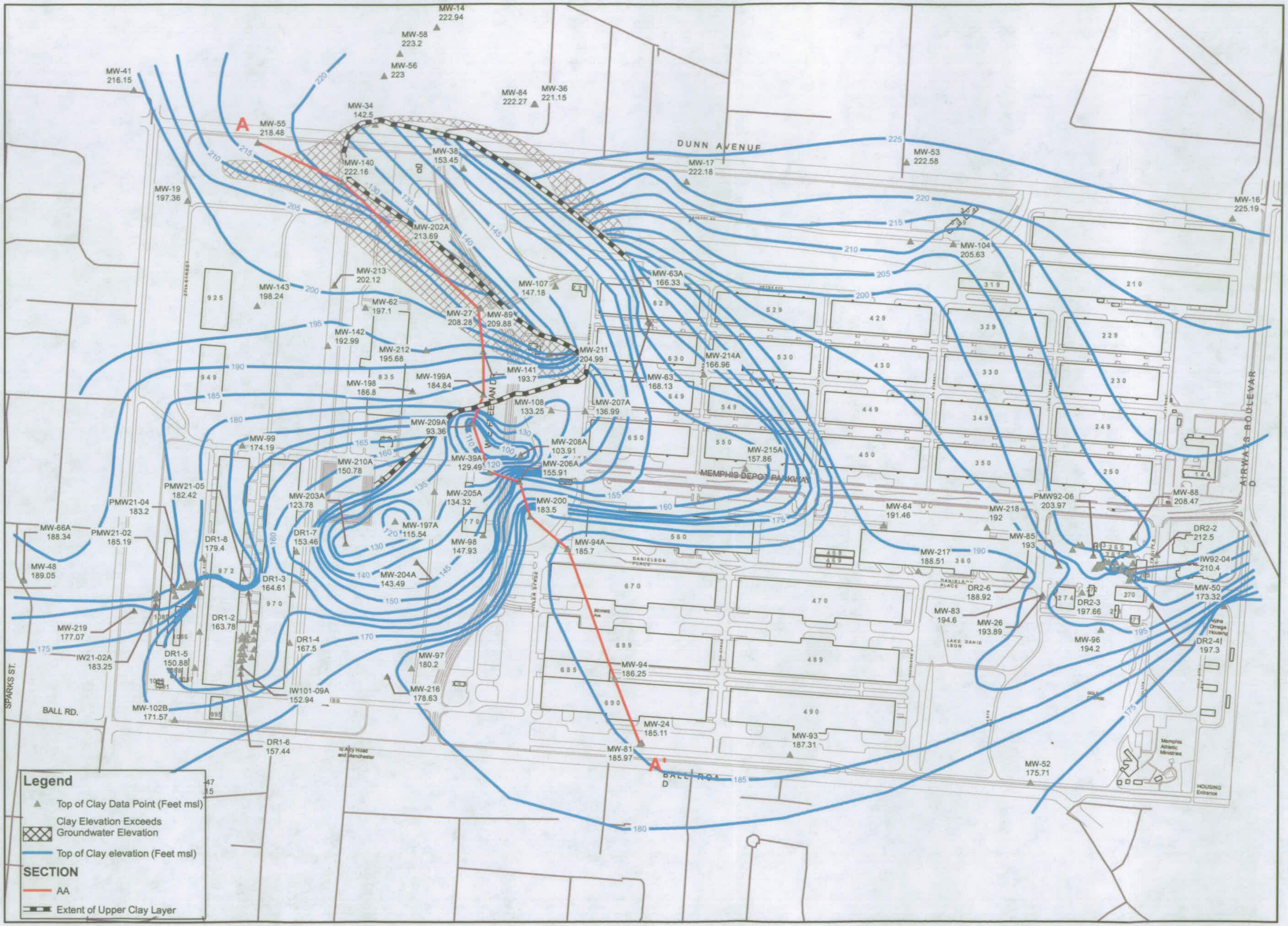


Figure 3

TOP OF CLAY ELEVATION MAP

DEEP WELLS AND 2010
LTM WORK PLAN

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

G:\121842\005\MI LTM_DEEP WELL WORK PLAN

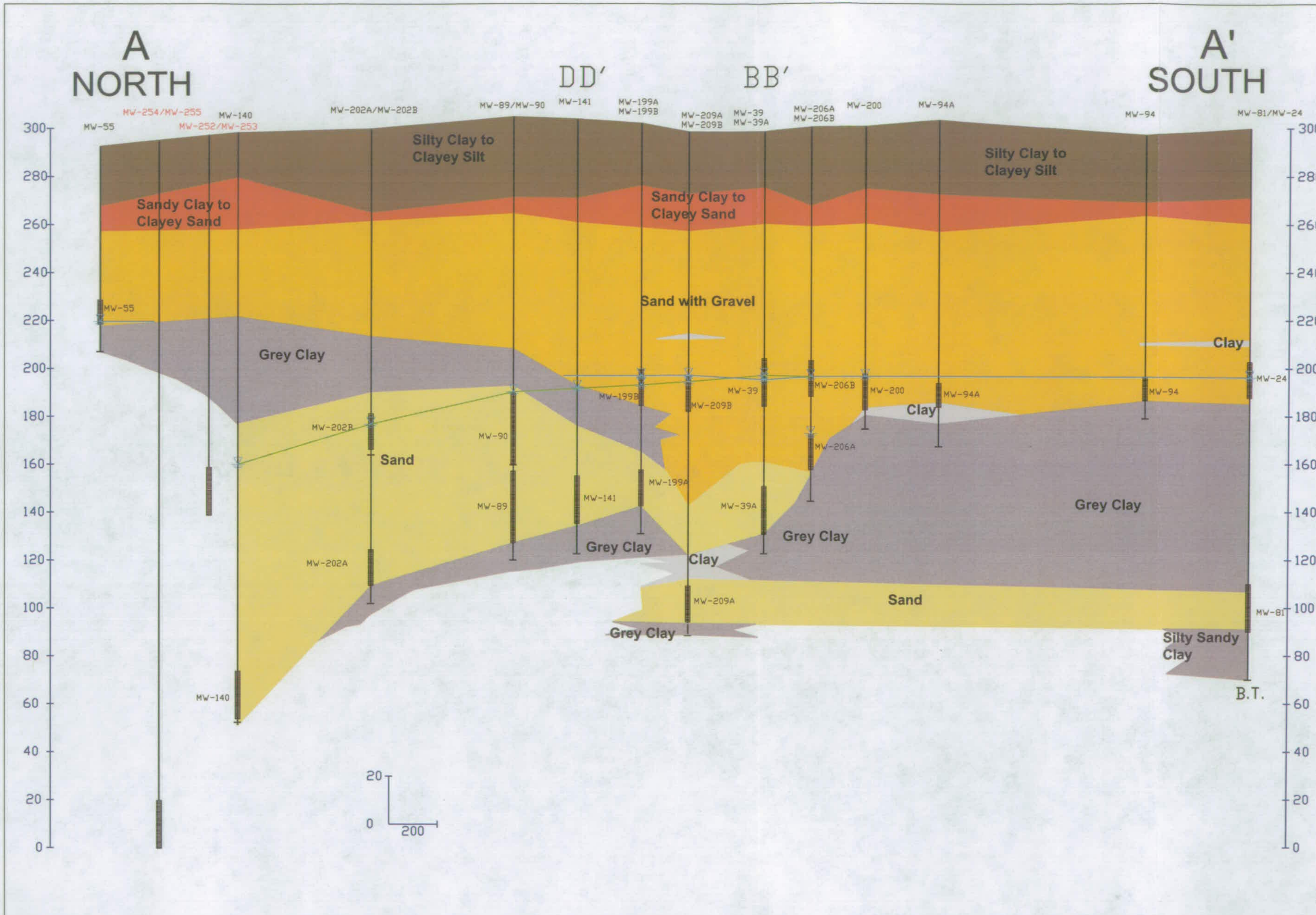


Figure 4

LITOLOGIC CROSS-SECTION AND PROPOSED WELL DEPTHS

DEEP WELLS AND 2010 LTM WORK PLAN

MAIN INSTALLATION DEFENSE DEPOT MEMPHIS, TENNESSEE

- Silty Clay to Clayey Silt
- Sandy Clay to Clayey Sand
- Fluvial Sand or Sand with Gravel
- Clayey Sand to Silty Clay
- Intermediated Sand
- Clay
- Groundwater Elevation Fluvial Aquifer 5/4/2007
- Groundwater Elevation Intermediate Aquifer 5/4/2007
- Well Screen Interval

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

HDR eM

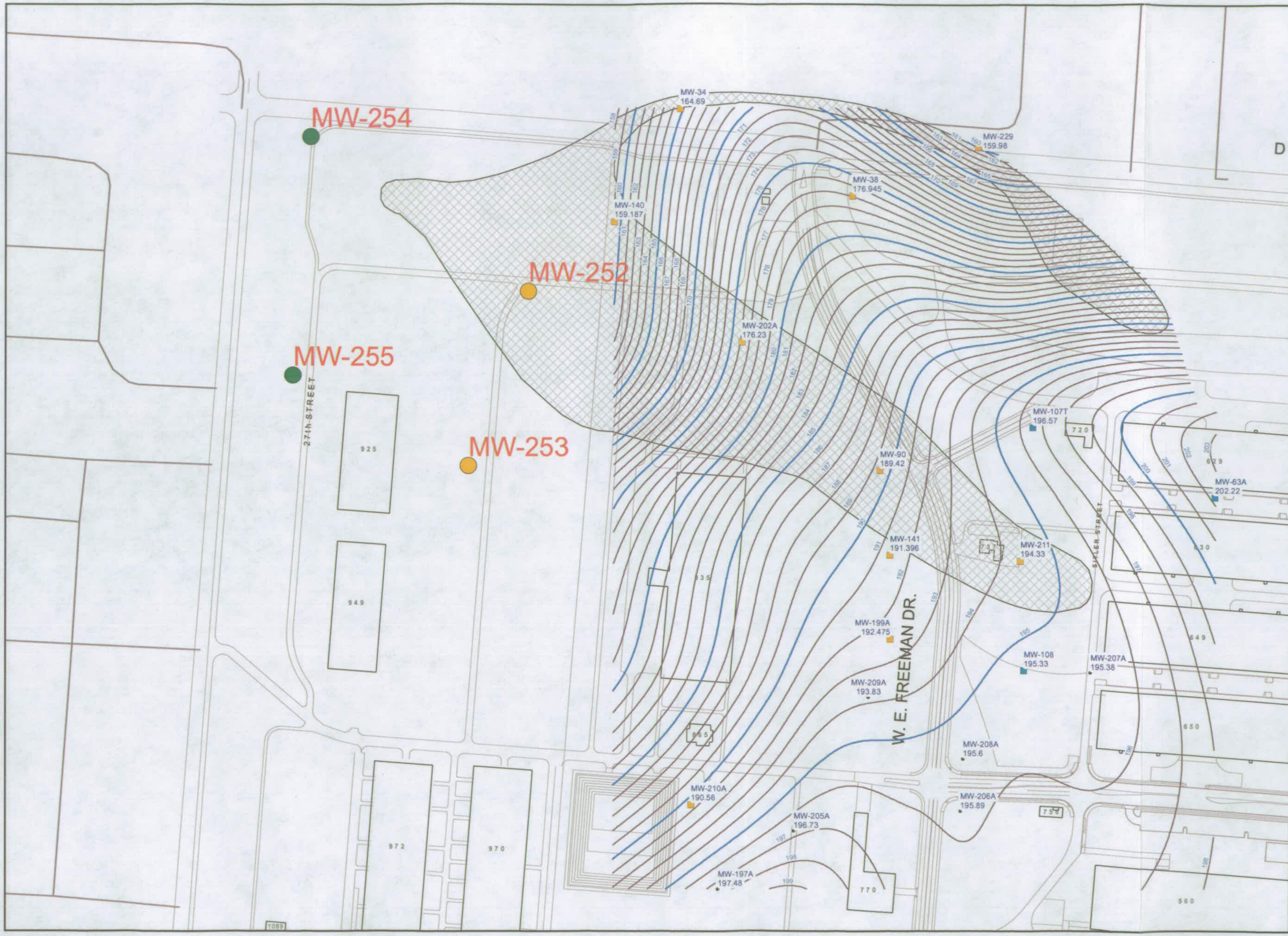


Figure 5

INTERMEDIATE AQUIFER GROUNDWATER ELEVATIONS, OCTOBER 2009

DEEP WELLS AND 2010 LTM WORK PLAN

MAIN INSTALLATION DEFENSE DEPOT MEMPHIS, TENNESSEE

Legend

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Intermediate Aquifer 5-ft. contour
- Clay Elevation Exceeds Groundwater Elevation
- MW-03 100.12 Groundwater Elevation (msl)
- Proposed Monitoring Well in the Memphis Aquifer
- Proposed Monitoring Well in the Intermediate Aquifer

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 100 200 400
Feet

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

HDR | eM

G:\121842\005\MI LTM_DEEP WELL WORK PLAN

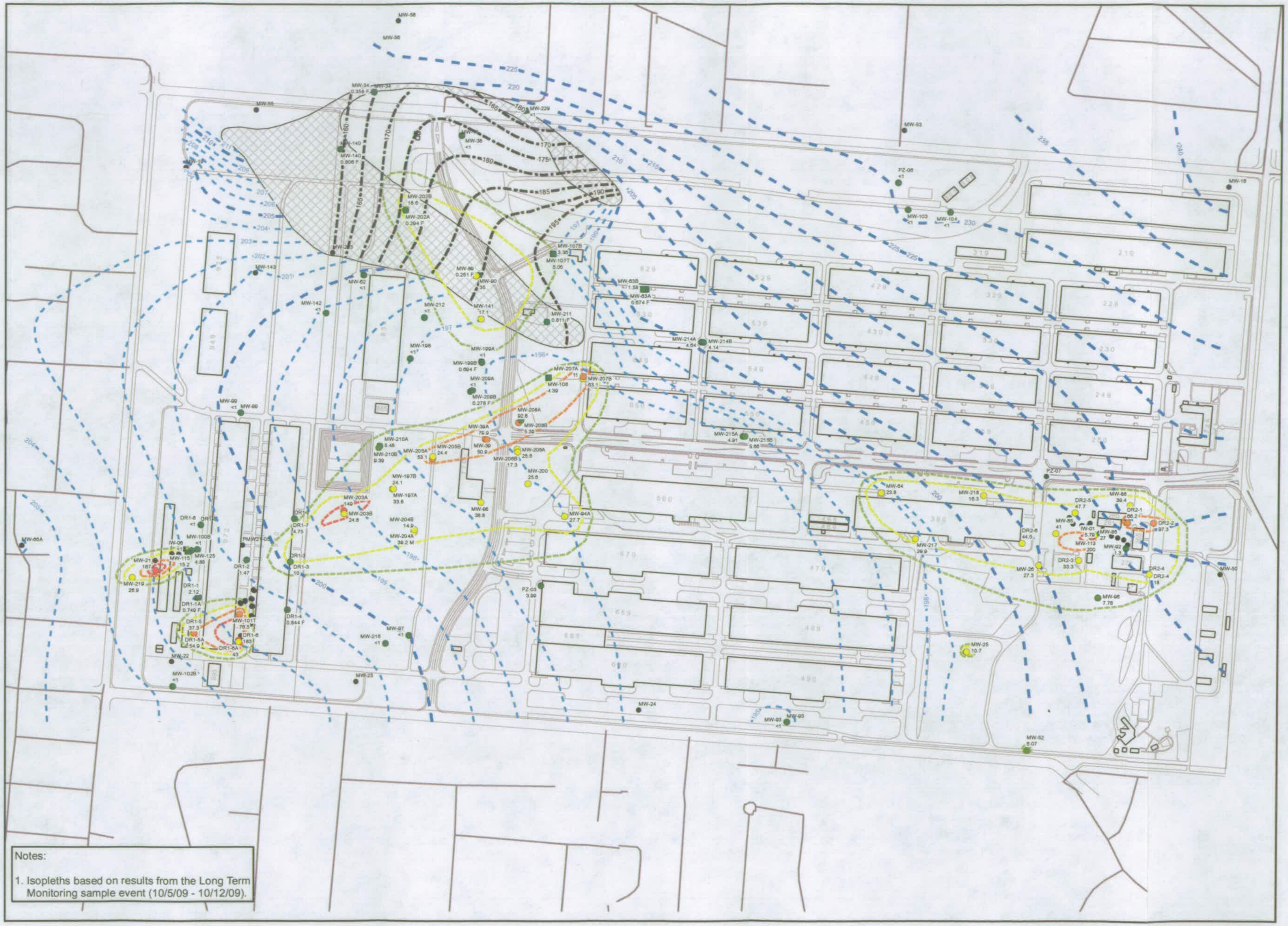


Figure 6

PCE ISOPLETH MAP, OCTOBER 2009

DEEP WELLS AND 2010
LTM WORK PLAN

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Legend

PCE Ranges
ug/L
- 0 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 300

PCE Isopleth
ug/L
- 5
- 10
- 50
- 100

- Monitoring Well Screened in the Fluvial Aquifer
- Monitoring Well Screened in the Intermediate Aquifer
- Monitoring Well Screened in the Transition Zone
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface of the Intermediate Aquifer 5-ft. contour
- Clay Elevation Exceeds Groundwater Elevation

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

0 200 400 800
Feet

Installation Location
Memphis, Tennessee

Date: March 2010
Edition: Rev 0

HDR | eM

Notes:

1. Isopleths based on results from the Long Term Monitoring sample event (10/5/09 - 10/12/09).

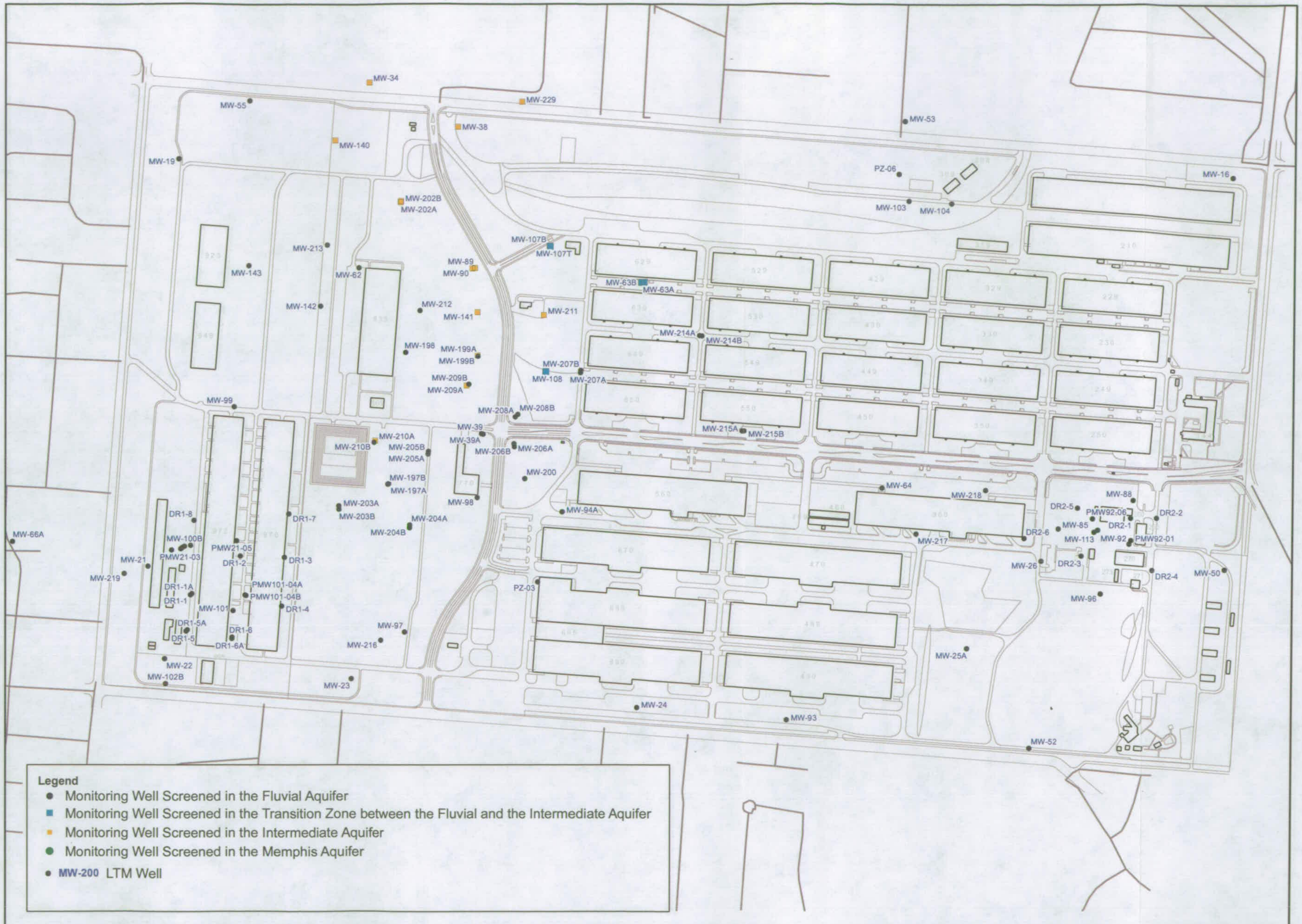


Figure 7

LTM WELL LOCATION MAP

DEEP WELLS AND 2010
LTM WORK PLAN

MAIN INSTALLATION
DEFENSE DEPOT
MEMPHIS, TENNESSEE

Projection: NAD 1927 StatePlane Tennessee
Units: Feet

Date: March 2010
Edition: Rev 0

G:\121842\005\MI LTM_DEEP WELL WORK PLAN

Appendix A

Selected Work and Test Procedures from RA SAP

WTP 1 General Procedures for Field Personnel
WTP 2 Drilling Operations
WTP 3 Well Installation, Development and Abandonment
WTP 4 Groundwater Sampling
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 13 Health and Safety Monitoring

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							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.

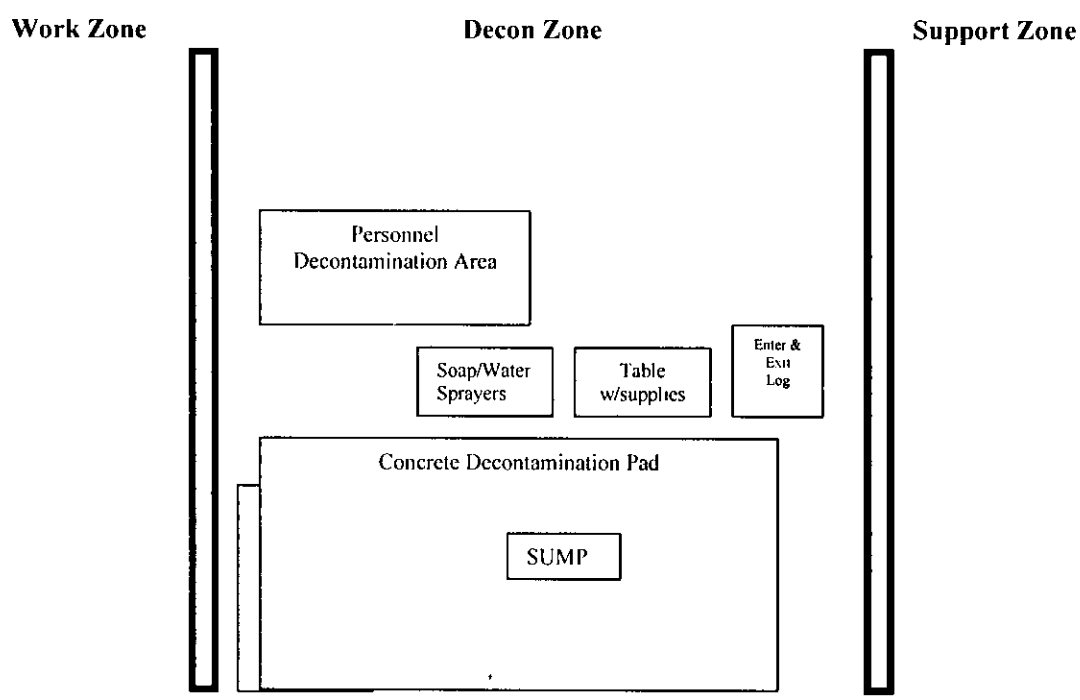
ATTACHMENT 2.2

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 3
WELL INSTALLATION, DEVELOPMENT, AND ABANDONMENT

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for the installation and development of monitoring wells suitable to generate data for determination of the extent of groundwater contamination and of site hydrogeological conditions. Procedures for well abandonment are also included.

2.0 DISCUSSION

This WTP specifies details and procedures for the design, construction, installation, and development of monitoring and injection wells at DDMT.

Monitoring wells allow for direct measurement of both groundwater contamination and flow parameters beneath the site. Monitoring wells will be designed and installation supervised by qualified environmental professionals according to project specifications, and in accordance with USEPA guidelines.

Well installation will be performed by the drilling subcontractor under the direction of a MACTEC 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 considered for review in conjunction with this WTP;

NUMBER	NAME
1	General Instructions for Field Personnel
2	Drilling Operations
12	Personnel Protective Equipment Decontamination
13	Health and Safety Monitoring

3.2 PREPARATION

Well installation will occur immediately after drilling. Therefore preparation for well installation should be made prior to beginning drilling operations, these preparations are given in WTP 1 and 2.

3.3 WELL CONSTRUCTION

Included in this section is the rationale for selection of well construction materials. A qualified geologist/engineer will oversee well installation activities.

3.3.1 Well Construction Materials

Well risers will consist of material durable enough to retain their long-term stability and structural integrity and be relatively inert to minimize alteration of groundwater samples. Selection of PVC or stainless steel for the monitoring wells is based on the primary purpose of the well, which is the detection of potential contaminants. PVC has demonstrated very good chemical resistance except to high concentrations of low molecular-weight ketones, aldehydes, and chlorinated solvents. Stainless steel has demonstrated very good chemical resistance, including resistance to high concentrations of low molecular-weight ketones, aldehydes, and chlorinated solvents. Low concentrations of these same chemicals with long term exposure to PVC have not had documented effects (Barcelona et al., 1983; NWWA, 1989).

Stainless steel resistance to corrosion, in most corrosive environments, particularly under oxidizing conditions, has been shown to be very effective. Stainless steel requires exposure to oxygen in order to attain its highest corrosion resistance. Oxygen combines with part of the stainless steel alloy to form an invisible protective film on the surface of the metal. As long as the film remains intact, the corrosion resistance of the stainless steel remains high. According to Barcelona et al. (1983), in cases where long-term exposures in very corrosive conditions are eminent, corrosion may occur with the subsequent release of chromium or nickel as contaminants in ground water samples.

Well materials will consist of new, threaded, flush joint polyvinyl chloride (PVC) or stainless steel pipe, with a minimum inside diameter of 2 inches. If PVC is used, the riser pipe will conform to ASTM D 1785, Standards for Schedule 40 Pipe. Materials will be new and unused and will be decontaminated prior to installation. Casing will only be joined with compatible welds or couplings that do not interfere with the primary purpose of the well. Use of solvent or glue will not be permitted.

Well screens will consist of new, commercially fabricated, threaded, flush joint, minimum 2-inch inside (ID) diameter, factory slotted or continuous wrap PVC, or, in the case where known or expected chlorinated solvents are present in the groundwater, stainless steel screen. Screen slot size will be based on previous available soil information, but will be generally sized to prevent 90 percent of the filter pack from entering the well. The screen slot size will be adjusted if site geologic conditions significantly differ from the expected conditions. Previous well installation at DDMT have generally used factory-slotted or wire-wrapped screens with 0.010-inch openings, no less than 10-feet in length, and no greater than 20-feet in length.

Silt traps will not be used in monitoring wells. Silt traps usage fosters a stagnant, turbid environment, which could influence analytical results for trace concentrations. A notch will be cut in the top of the casing to be used as a measuring point for water levels.

3.3.2 Well Design

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

This section describes well installation and construction procedures including the placement of the screen, installation of the filter pack, bentonite seal, and grout seal. The Field Team Leader and the Project/Task Manager will collectively make decisions on well depths, locations, screened intervals, etc. Boring at DDMT are generally drilled 10-feet into the clay unit at the base of aquifers to confirm the local presence of the lower confining unity. Well screens are generally set above the clay at the base of the aquifer; the deeper portion of the boring is filled with bentonite.

3.3.2.1 Screen Location

The screened intervals will be selected for each proposed well based on specific DQOS. There are several water bearing units of interest present at DDMT (fluvial, intermediate, and Memphis aquifer). Both the fluvial and intermediate aquifers can be found in unconfined conditions, with significant saturated thickness (>50 feet). In most areas, the saturated thickness of the fluvial aquifer is 20 feet or less. For most wells at DDMT the screen will start from the top of clay upward, for a maximum of 20 feet of screen per well. If the saturated thickness is substantially greater than 20 feet, a cluster well may be installed so that the entire saturated interval is screened.

3.3.2.2 Filter Pack

A filter pack will be installed in the annular space between the boring and the well screen. The filter pack will consist of silica sand. The filter pack 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 (20-40) will be used based on wells previously installed at DDMT. This sand size was determined from grain-size analysis of the screened intervals by previous consultants at the site. If the site conditions show significant change (i.e. more gravelly, or much more clayey) from those previously encountered a grain-size analysis will be completed and filter pack design based on those results.

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. The filter pack will not extend across more than one water-bearing unit. 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.

3.3.2.3 Bentonite Seal

A minimum 5-foot thick bentonite seal will be installed above the filter pack in the annular space of the well. Only 100 percent sodium bentonite (pellets or chips) will be used and care will be taken to prevent bridging by frequently measuring the thickness of the bentonite as it is gravity placed. When the seal is installed above the water table, the bentonite will be hydrated with water from an approved water source as described in WTP 2 - Drilling Operations. 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 wells (USACE, 1998).

3.3.2.4 Annular Space

As described above, the annular space between the well riser and the borehole wall will be filled with a filter pack, a bentonite seal, and a grout seal. In the case of deeper, Type III wells, the upper section of the borehole will be cased with solid PVC or iron pipe and grouted in place.

3.3.2.5 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 50-foot intervals in wells greater than 20 feet in depth. The centralizers will not be attached in the length containing the well screen or bentonite seal. In addition the centralizers should not restrict the passage of the tremie pipe used for filter pack and grout placement (USACE, 1998).

3.3.2.6 Grout Seal

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

The cement-bentonite mixture will consist of 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. The tremie pipe will be located a maximum of 10 feet from the top of the bentonite seal in deep wells to ensure even placement of grout in the annular space. Pumping will continue until undiluted grout is visible at the surface.

3.3.2.7 Well Completion Details

Type II and Type III Monitoring Wells will be completed as shown in the project Well Installation Diagrams (Attachment 3.1 and 3.2 respectively).

Based on well location and future area use, the Project/Task Manager will determine surface completion (flush or projected above ground surface) requirements for all permanent monitoring well installations. Temporary monitoring well installations will be clearly marked by the use of wooden stakes placed around the well and cordoned off with silt fencing and/or barrier tape. For permanent monitoring well installations, if a well stick up is not appropriate, surface completions will be flush with the land surface. The casing will be cut approximately 3 inches below land surface and will be secured with a water tight casing cap to prevent surface water from entering the well. A water-proof valve box with locking cover will be placed over the well casing. The valve box lid will be centered in a 3-foot by 3-foot by 4-inch thick concrete pad that slopes away from the box.

If an aboveground surface completion is used, the well casing will be extended 2 or 3 feet above land surface. A casing cap will be provided for each well. A vent hole will be placed in the protecting casing and a ventilated well cap will be used. A steel sleeve will be placed over the casing to shield the extended casing and cap. The steel sleeve will be seated in a minimum 3-foot by 3-foot by 4-inch concrete surface pad. The diameter of the sleeve will be a minimum of 4 inches greater than the diameter of the casing. A weep hole will be drilled in the steel sleeve about 1 inch above the top of the well pad. The pad will be sloped away from the well sleeve and a lockable cap or lid will also be installed. Three 3-inch diameter concrete-filled steel guard posts will be installed around each well unless the well is located in an area receiving vehicular traffic. These guard posts will be 5 feet in total length and installed radially from the well head. The guard posts will be installed approximately 2 feet into the ground and set in concrete; these posts will not be installed in the concrete pad placed at the well base. The protective sleeve and guard posts will be painted orange using a brush (USACE, 1998). Installation of the well will be completed prior sampling the well.

Wells will be secured immediately after well completion. Corrosion-resistant locks will be provided for both flush and aboveground surface completions. A brass survey marker will be installed in the concrete pad. The information required by the TDEC (i.e., well identification number, registration number, etc.) should be inscribed, stamped or otherwise permanently marked on monitoring well identification tags.

3.3.3 Well Installation

Well installation will be supervised by a qualified geologist. When installing wells through more than one water bearing zone or aquifer, measures will be taken to prevent cross-connection or cross-contamination of the zones during the drilling and well installation.

3.3.3.1 Procedures

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

1. Remove the PVC or stainless steel screen and riser from packaging and steam clean to remove manufacturing residues.
2. Fill deepest part of boring that has intersected the clay layer with bentonite.
3. Install a 10 to 20-foot section of minimum 2-inch (I.D.), threaded, flush jointed, pre-manufactured PVC or stainless steel screen inside the steel drill casing.
4. Install solid riser to ground surface, plus 24-to 36-inch stick-up (if required).
5. 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.
6. 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.
7. 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. Deeper wells below the water table can utilize bentonite slurry for the bentonite seal if the potential exist for the bentonite to bridge during installation through water or drilling mud; bentonite slurry, if used, will be placed with a side-discharge tremie pipe.
8. Remove remaining drill casing and grout boring annulus to ground surface with grout/bentonite mixture.
9. Develop well (after waiting no less than 24 hours after installation).

3.3.3.2 Well Installation Diagrams

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 Monitoring Well Installation Diagrams (Attachment 3.1 and 3.2). Only Type II wells are currently planned for installation at DDMT. Additional information to be recorded on the monitoring well installation diagram will include:

- Well identification
- Drilling method
- Installation date(s)
- Elevations of ground surface and the measuring point notch
- Total boring depth
- Lengths and descriptions of the screen and rising
- Thickness and descriptions of filter pack, bentonite seal, casing grout, and any backfilled material
- Record quantities of all materials
- Summary of material penetrated by the boring

Each installation diagram will be completed in the field, reviewed in the office and submitted in an appendix of the Technical Report.

3.3.4 Well Development

The purpose of well development is to create good hydraulic contact between the well and the aquifer and to remove accumulated sediments from the well. Each newly installed monitoring well will be developed. Drilling fluids used during well construction will be removed during development. The following sections describe the procedures for well development.

3.3.4.1 Well Development Procedures

Each monitoring well will be developed no sooner than 24 hours after installation to allow for adequate grout curing time. Wells will be developed using pumps equipped with surge rings or bailers. Any other techniques must be approved by the Project/Task Manager. The monitoring well development protocol is as follows: .

1. Measure the static water level and the depth to the top of sediment in the well.
2. Record the total depth of the well (from the Well Installation Diagram).
3. Calculate the volume of water in the well and saturated annulus.
4. Begin developing the well using a combination of surging and pumping. Continue pumping and periodically surging until each the following criteria have been met:
   a. Fluids lost to the formation during well installation have been removed (this is a minimum requirement where conditions permit).
   b. The well water is clear to the unaided eye and the turbidity of the water removed.
   c. pH, temperature, turbidity, and specific conductance have stabilized. In general, field parameters are stable when nephelometric turbidity units (NTUs) are less than 10, pH is within 0.1 on consecutive readings, and temperature and specific conductance are within 10 percent of previous readings. It should be noted that natural turbidity levels in ground water may exceed 10 NTU.
   d. If feasible, monitor the static water level (SWL) during purging. Adjust the purge rate to keep the SWL from dropping more than 0.3 meter from the initial SWL.
   e. No sediment remains in the bottom of the well. However, it can be accepted if the sediment thickness remaining within the well is less than 1 percent of the screen length or less than 0.1 ft for screen equal or less than 10 feet long.
5. In the event that the above criteria have not been met after six hours of pumping, surging, and bailing (including recharge time for poorly recharging wells), development activities will be temporarily discontinued at that well. The MACTEC field staff will advise the MACTEC Project/Task Manager who will decide whether or not to continue development of the well.
6. In the event of slowly recharging wells that will not sustain pumping or bailing, the MACTEC field staff will advise the Project/Task Manager as soon as a determination of estimated recharge time has been made.
7. Physical characteristics of the water (suspended sediment, turbidity, temperature, pH, EC, purge rate, odor, etc.) will be recorded throughout the development operation. At a minimum, they will be recorded initially and after each well volume has been removed, or every 30 minutes, whichever comes first.
8. The total quantity of water removed and final depth to the top of sediment (total depth of well) will be recorded.
9. The static water level in the well (after at least 24 hours) will also be recorded once the water level in the well has completely recovered.

No detergents, soaps, acids, bleaches, or other additives will be used to develop a well. Well development equipment will be decontaminated as specified in WTP 11 -Sampling Equipment Decontamination.

3.3.4.2 Well Development Records

Well development data will be recorded on Well Development Data Sheets. An example of this sheet is shown as Attachment 3.3.

3.3.4.3 Well Development Water

Development water will be drummed or stored in bulk containers. The containers will be clearly labeled with site name, well name, date, and contents. The development water will be properly disposed in accordance with IDW procedures set forth in the FSP.

3.3.5 Well Abandonment

After it has been determined that a monitoring well is no longer needed it will be abandoned. According to the LTM Plan (CH2M Hill, 2004), wells are recommended for abandonment for the following reasons:

- The test objectives have been achieved and the well is no longer needed.
- The well is improperly constructed, i.e.:
  - Well installed with improper installation of the outer casing and position of the sand pack
  - Wells with elevated pH readings (due to improper construction)
- The wells that have improperly placed screens or long screens.
- The monitoring wells where dense non-aqueous phase liquid has been potentially indicated.
- The well has been vandalized or damaged.

To properly abandon a well, the surface completion (concrete pad and protective casing) should be removed and the well filled with a cement/bentonite grout from the bottom. An alternative method is to completely remove the well casing and screen from the borehole. This may be accomplished by over-drilling the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig.

The borehole can then be backfilled with the appropriate grout material. The grout should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). The top 2 feet of the borehole should be poured with concrete to insure a secure surface seal (plug). The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists.

3.3.6 Survey of Well Locations

Upon completion of the wells, a Tennessee licensed professional surveyor will locate each new monitoring well by standard surveying methods. A vertical survey will be conducted to establish the elevation of each monitoring well casing and brass disk. 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 (notch) 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/developed wells are secured.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Complete monitoring well development records and well installation diagram.
- Ensure that related equipment and associated supplies have been shipped back to the office.
- Ensure that all IDW containers are sealed and labeled clearly with the date, name, and contents.
- 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 and development 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.
- Inventory equipment and supplies shipped back to the office.
- Make provisions 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, 1991. Guidance on Oversight of Potentially Responsible Party Remedial Investigations and Feasibility Studies. Final, OSWER Directive 9835.1 Document 070191-1, July 1991.

Barcelona, et. al., 1983. A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling. Urbana, IL: Illinois State Water Survey, ISWS Contract Report 327.

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

NWWA, 1989. Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells. Dublin, OH: National Water Well Association.

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 3.1- Type II Monitoring Well Stickup Installation Diagram
Attachment 3.2- Type II Monitoring Well Flush Mount Installation Diagram
Attachment 3.3 - Well Development Record

ATTACHMENT 3.1

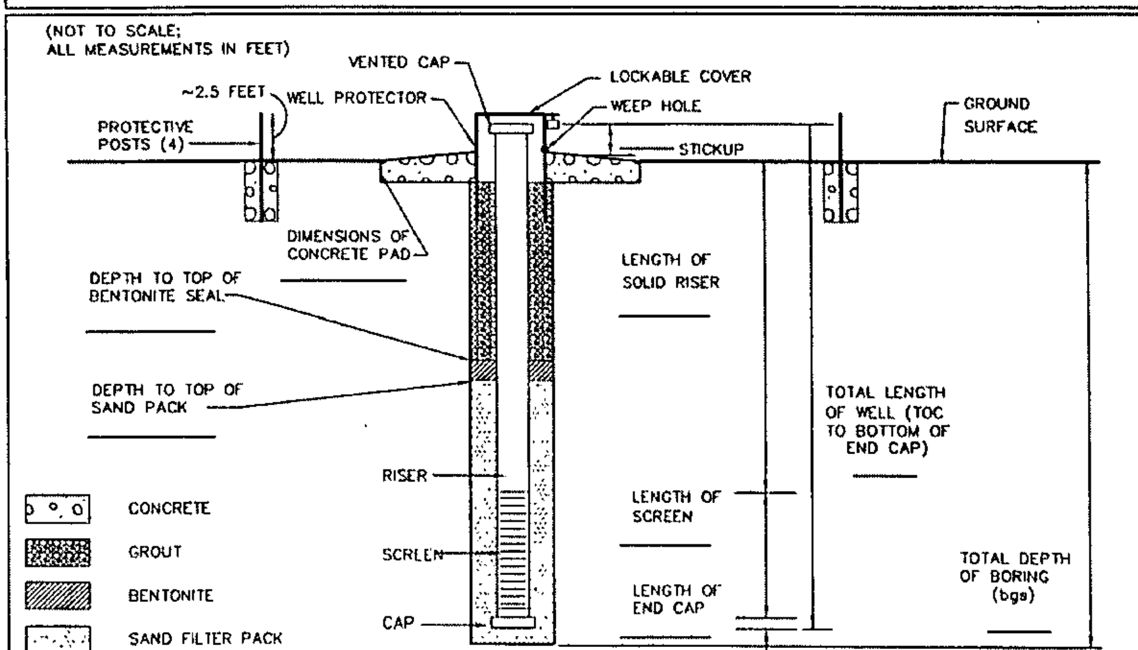
TYPE II MONITORING WELL INSTALLATION DIAGRAM (STICK-UP COMPLETION)

PROJECT NAME ____________ PROJECT NO. ____________
WELL NO. ____________ WELL LOCATION ____________
DATE ____________ TIME ____________

GROUND SURFACE ELEVATION ____________
TOP OF SCREEN ELEVATION ____________
REFERENCE POINT ELEVATION ____________
TYPE FILTER PACK ________ GRADATION ________
FILTER PACK MANUFACTURER ____________
SCREEN MATERIAL ____________
MANUFACTURER ____________
SCREEN DIAMETER ________ SLOT SIZE ________
RISER MATERIAL ____________
MANUFACTURER ____________
RISER DIAMETER ____________
DRILLING TECHNIQUE ____________
AUGER/BIT SIZE AND TYPE ____________

BENTONITE TYPE ____________
MANUFACTURER ____________
CEMENT TYPE ____________
MANUFACTURER ____________
BOREHOLE DIAMETER ____________
MACTEC FIELD REPRESENTATIVE ____________
DRILLING CONTRACTOR ____________
AMOUNT BENTONITE USED (SEAL) ____________
AMOUNT BENTONITE USED (GROUT) ____________
AMOUNT CEMENT USED (GROUT) ____________
AMOUNT SAND USED ____________
STATIC WATER LEVEL (>24 hrs after dev)
MEASURED ON (Date/Time) ____________

REMARKS ____________



QA / QC

DRILLER: ____________ INSPECTOR: ____________
DISCREPANCIES: ____________ CHECKED BY: ________ DATE: ____________

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PREPARED BY/DATE: JAH 12/23/02
CHECKED BY/DATE: DMW 12/23/02

ATTACHMENT 3.2

TYPE III MONITORING WELL INSTALLATION DIAGRAM (FLUSH MOUNT COMPLETION)

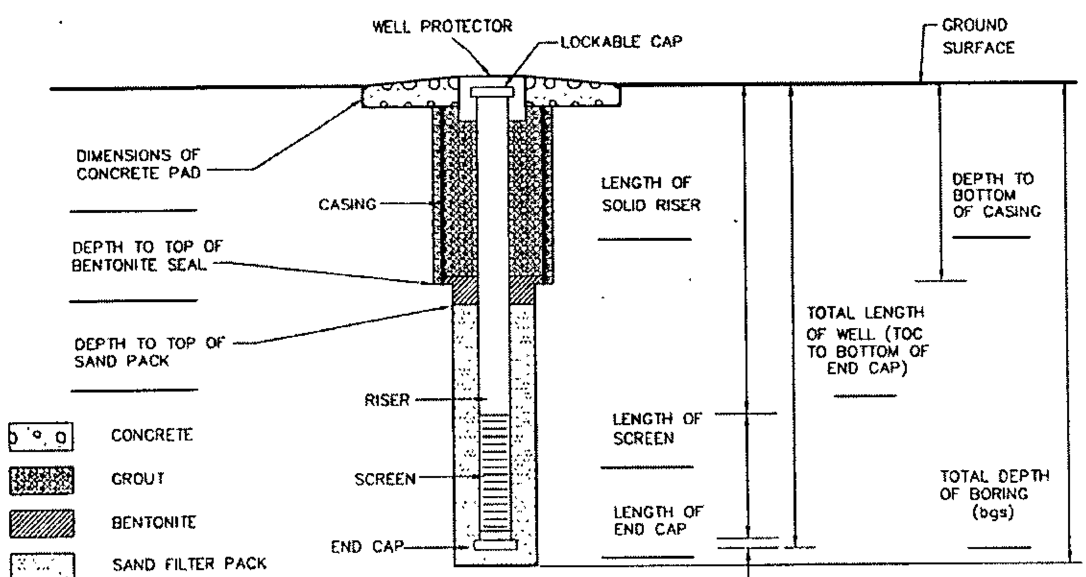
PROJECT NAME ______ PROJECT NO. ______
WELL NO. ______ WELL LOCATION ______
DATE ______ TIME ______

GROUND SURFACE ELEVATION ______
TOP OF SCREEN ELEVATION ______
REFERENCE POINT ELEVATION ______
TYPE FILTER PACK ______ GRADATION ______
FILTER PACK MANUFACTURER ______
SCREEN MATERIAL ______
MANUFACTURER ______
SCREEN DIAMETER ______ SLOT SIZE ______
RISER MATERIAL ______
MANUFACTURER ______
RISER DIAMETER ______
DRILLING TECHNIQUE ______
AUGER/BIT SIZE AND TYPE ______

BENTONITE TYPE ______
MANUFACTURER ______
CEMENT TYPE ______
MANUFACTURER ______
BOREHOLE DIAMETER ______
MACTEC FIELD REPRESENTATIVE ______
DRILLING CONTRACTOR ______
AMOUNT BENTONITE USED (SEAL) ______
AMOUNT BENTONITE USED (GROUT) ______
AMOUNT CEMENT USED (GROUT) ______
AMOUNT SAND USED ______
STATIC WATER LEVEL (>24 hrs after dev)
MEASURED ON (Date/Time) ______

REMARKS ______

(NOT TO SCALE;
ALL MEASUREMENTS IN FEET)



QA / QC
DRILLER: ______ INSPECTOR. ______
DISCREPANCIES: ______ CHECKED BY: ______ DATE: ______

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PREPARED BY/DATE: JAH 12/23/02
CHECKED BY/DATE: DMW 12/23/02

ATTACHMENT 3.3

WELL DEVELOPMENT DATA

PROJECT NAME ______________________ PROJECT No. ______________

DEVELOPED BY ______________ CHECKED BY ______________ SHEET 1 OF ______

1. Well No.: ______________ Site Location: ______________________
2. Date of Installation: ______________
3. Date of Development: ______________
4. Static Water Level: Before Development ________ ft.; 24 hrs. After ________ ft.; Date/Time ________
5. Organic Vapor: Before Development ____________ ppm; After Development ____________ ppm
6. Quantity of Water Loss During Drilling, If Used: ______________ gal.
7. Quantity of Standing Water in Well and Annulus Before Development: ______________ gal.
8. Depth From Top of Well Casing to Bottom of Well: ______________ ft. (from Well Installation Diagram)
9. Well Diameter: __________ in.
10. Screen Length: __________ ft.
11. Minimum Quantity of Water to be Removed: ______________ gal.
12. Depth to Top of Sediment: Before Development __________ ft.; After Development __________ ft.
13. Physical Character of Water (Before/After Development): ______________________

    ____
14. Type and Size of Well Development Equipment: ______________________

    ____
15. Description of Surge Technique, If Used: ______________________

    ____

    ____
16. Height of Well Casing Above Ground Surface: ______________ ft. (from Well Installation Diagram)
17. Quantity of Water Removed: ______________ gal. Time for Removal: ______________ hr. / min.
18. 1-Liter Water Sample Collected: ______________ (Time) Photographed? Y / N
19. Final Turbidity in Nephelometric Units: ______________ NTUs
20. Final Imhoff Cone Measurements < 0.75 mL/L, If Applicable: ______________

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ATTACHMENT 3.3
(continued)

WELL DEVELOPMENT DATA
(Continued)

PROJECT NAME ______________________ PROJECT No. ______________

DEVELOPED BY ____________ CHECKED BY ____________ SHEET ______ OF ______

Well No.: ______________ Site Location: ______________________

Date/ Time	Hrs. Dev./ Cum. Hrs. Dev.	Gals. Purged/ Cum. Gals. Purged	pH	Temp.	Cond.	NTUs	Remarks

HF — Rev. 4/94

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

WORK AND TEST PROCEDURE 4
GROUNDWATER SAMPLING

1.0 PURPOSE

The purpose of this Work and Test Procedure (WTP) is to provide guidance for collection of groundwater samples for field or laboratory analysis.

2.0 DISCUSSION

This WTP specifies details and procedures for collecting groundwater samples for chemical analysis. Groundwater samples will be collected from monitoring wells using either a disposable Teflon bailer or a stainless steel bladder pump. The groundwater samples will be analyzed to identify chemical constituents and their concentrations.

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
3	Well Installation and Development
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, as well as the following actions:

- Working with the project chemist to generate a sampling plan detail listing the wells 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 appropriate 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. A generalized list of sampling equipment and supplies is provided as Attachment 4.2
- Confirm the shipping receipts and schedule with lab and equipment suppliers

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.
- 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.
- Ensure that sufficient drums are on site to containerize any excess sample material collected.
- Assign task to field teams according to the project work plans

3.3 FIELD OPERATIONS

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. Field instruments will be calibrated, files containing sample information will be processed, and sample bottles will be sorted for each sample location according to analyses.

Environmental conditions will also be noted. Each sampling site will be characterized by the following factors:

- Location of work
- Weather conditions
- Rainfall amounts
- Temperature – minimum and maximum
- Wind direction
- Ongoing activities that may influence or disrupt sampling efforts
- Accessibility to the sampling locations (e.g., rough terrain, fallen trees, flooding, etc.)

These conditions will be recorded in the field sampling books and used to assess sampling procedures in relation to the sample data. A Site Manager – Daily Quick Reminder List for use in guiding field activities is included as Attachment 4.6.

3.3.1 Sampling Equipment Calibration

Field measurements of groundwater physical parameters are used for groundwater sampling and for independent measurements during remedial actions. Before, during, and after use, the water-quality measurement equipment will be properly calibrated per manufacturer's instructions and following EPA Guidance (EISOPQAM 2001). After sampling, before leaving the site, a calibration check will be made as described in the following sections.

Field measurements will be made with a YSI 6920 or similar multi-probe device with flow-through cell. The flow cell allows a water sample to be pumped from a source, such as a groundwater monitoring well, to a sonde. Flow cells add efficiency to low flow purging and field sampling applications, when it is impossible or undesirable to place a sonde down-hole in situ in a well. Calibration procedures for the YSI 6920 are given as Attachment 4.1.

3.3.2 Sample Collection Procedures

Groundwater samples may be collected from monitoring and injection wells, or piezometers. In most cases, non-dedicated bladder pumps or disposable bailers will be used to sample the wells. Passive Diffusion Bags may also be used for groundwater sampling. Decontamination of pumps at water level indicators are required prior to and after each sampling event. A general supply list for groundwater sampling is given as Attachment 4.2.

Sampling will be performed no less then 24 hours after well development is completed. Observations made during sample collection will be recorded in a field notebook and on a monitoring well purge and sampling form. The following intitial steps will be followed before collecting groundwater samples in the field.

1. Locate the well to be sampled and record the condition of the well including any damage or evidence of tampering.

2. Lay out plastic sheeting around the wellhead and place the monitoring, purging, and sampling equipment on the sheeting to prevent contamination of the surface soils and the equipment.

3. Determine concentration of organic vapors every time a casing cap is removed to measure a water level or to collect a sample.

4. Water levels will be measured before purging, during purging, and after sampling. For wells with dedicated pumps, water levels will be measured ONLY if the water is above the top of the pump. DO NOT pull the pump to measure the water level. The water level probe should be carefully lowered down the well to minimize disturbance.

   Caution shall be used when opening each well to avoid fumes which may have accumulated and to prevent foreign materials from entering the well. All ground-water levels shall be measured to the nearest 0.01 foot (from the well datum reference point) using an electronic water level indicator. Each well will be marked with an easily identifiable permanent reference point that will be located on the top of the well casing. The depth to ground water will be measured from this reference point to the ground-water surface in the well. The depth to ground water data will be recorded in either a project field notebook or on a ground-water level measurement sheet. The depth to the ground water is subtracted from the surveyed elevation of the reference point to determine the ground-water elevation.

   The water-level indicator and tape will be decontaminated prior to each use. The decontamination procedure for the water level indicator is:

   A. Hand wash the calibrated tape and probe with a solution of Alconox (or equivalent).

   B. Rinse with deionized (Reagent Grade II) water.

5. Measure the water level from the measuring point to the nearest 0.01 foot, as specified in ASTM D4750.

6. DO NOT measure the total depth of the well prior to sampling. Well depth should be obtained from well logs. Measuring to the bottom of the well casing may cause re-suspension of settled solids.

7. If the turbidity cannot be reduced to below 20 NTUs after purging for approximately two hours (and other field parameters are stable as indicated in the following sections), then the field team leader shall be contacted for approval to sample the well. If the turbidity is below 50 NTU, then the well may be sampled without using

filtration techniques. If the turbidity is 50 NTU or higher, then both dissolved and total metals and dissolved and total organic carbon samples should be collected (samples for organic compound analysis should not be filtered). The dissolved metals and organic carbon samples should be collected by filtration with a disposable 0.45 µm in-line filter. Approximately 500 mL of the groundwater should be pumped through the filter and disposed prior to sample collection.

3.3.2.1 Sampling using a Disposable Bailer

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

1. Well sampling equipment will be decontaminated as specified in WTP 11 – Sampling Equipment Decontamination, and protected from recontamination until use. Purging and sampling will be conducted in a manner that minimizes the agitation of sediments in the well and formation. Equipment will not be allowed to free fall into a well.

2. Measure the static water level prior to purging using a decontaminated electronic water level indicator. The probe of the water level indicator will be lowered into the well bore and the water level will be recorded.

3. Attach the Teflon coated stainless steel leader rope to the bailer and polypropylene (or nylon) rope to the Teflon coated rope. Lower the bailer into the well, until it contacts the water surface. Allow the bailer to sink and fill with a minimum of water surface disturbance. Slowly withdraw the bailer from the well, preventing the bailer and bailing line from touching the ground.

4. The well should be purged until a minimum of three well volumes is removed from the well, and the water quality indicators of pH, specific conductivity, and turbidity stabilize. Readings will be taken every 5 to 10 minutes and recorded on the well purge form (Attachment 4.4). Stabilization is achieved after three successive readings are within ± 0.1 for pH, ± 3% for specific conductance, and <20 NTU for turbidity. Temperature will also be measured and recorded, but will not be used as a stabilization parameter. Sampling may begin once the well has stabilized. If stabilization does not occur or turbidity cannot be reduced below 20 NTU, the field team leader should be contacted for further guidance. If the well is purged dry, a sample will be collected as soon as sufficient recharge has occurred within 24 hours. Temperature, specific conductance, turbidity and pH will also be measured and recorded; however, stabilization of these parameters is not required.

5. After purging the well and allowing for sufficient recharge, collect samples by pouring the water from the bailer into the appropriate sample containers. This process will be repeated as necessary to fill each container.

6. Collect the samples to be analyzed for volatile organics first, filling the bottle, leaving zero headspace. Proceed with the collection of samples for the remaining

analyses, collecting the more volatile parameters first. (Refer to sampling order presented in the low-flow section).

7. Wells should be sampled in order of increasing contamination (i.e. - samples that are expected to be least contaminated will be collected before those that are more highly contaminated) and as specified in the project specific work plan and WTP-8 - Sample Control and Documentation, and WTP-9 - Sample Containers and Preservation.

8. Add preservatives if necessary to samples as indicated in the QAPP and WTP-9 - Sample Containers and Preservation, label the sample containers as specified in the QAPP and WTP-8 - Sample Control and Documentation, and WTP-9-Sample Containers and Preservation. Required sample containers and holding times are presented in the project work plan, QAPP, and WTP-9 - Sample Containers and Preservation.

9. After samples have been collected, replace the well cap and lock the security casing.

10. Place samples into the cooler with ice and fill out required Chain-of-Custody documents in accordance with the procedures specified in the QAPP.

11. Record field conditions, any problems encountered during sampling, and sample appearance in the field logbook and transfer the information to the Field Sampling Report (Attachment 4.2). In addition to the information required in any field sampling investigation (WTP 1 - General Instructions for Field Personnel), the following information will also be recorded in the logbook each time a well is purged and sampled.

    - Depth to water before and after purging
    - Total depth of the well (measure after sample collected)
    - Condition of each well, including visual (mirror) survey
    - The thickness of any floating hydrocarbon layer
    - Field parameters such as pH, conductance, temperature, and turbidity

3.3.2.2 Sampling Using a Bladder Pump

The sampling protocol will be as follows for the collection of groundwater samples using a stainless steel/Teflon bladder pump:

1. Slowly and carefully lower the pump inlet to, or slightly above, the screened interval where representative groundwater flow is expected. In cases where the entire screen is not saturated, place the pump inlet at or slightly above the middle of the saturated zone, keeping in mind the limitations stated below.

2. DO NOT place pump inlet less than 2 feet above the bottom of the well, as this may cause the mobilization of bottom sediments. If saturated screen length is 2 feet or less, place pump inlet to, or slightly above, the middle of the screened interval.

3. Allow at least 1 foot of water above the inlet so there is little risk of entrainment or air in the sample.

4. After the water level in the well has equilibrated, begin purging at a rate of 200 to 500 mL/minute. All purge water will be containerized as IDW. The appropriate and final purge rate will be determined by monitoring groundwater drawdown. Drawdown should not exceed 4 inches.

5. The discharge during purging and sampling must flow with minimal turbulence or agitation.

6. The water level should stabilize and the pump rate should allow water to recharge the well so that little or no water level drawdown is observed.

7. Record groundwater level frequently until stabilization occurs. Adjust discharge rate appropriately to make sure that excessive drawdown does not occur. After stabilization, measure water levels at regular intervals.

8. If drawdown is greater than 4 inches, decrease the discharge rate of the pump and repeat discharge and water level measurements. Repeat until the water level stabilizes to closely match the recharge rate. Record pumping rate and any adjustments and depths to water on the purging and sampling log sheet.

9. An in-line multi-probe flow-through cell will be used to monitor the indicator parameters so as not to expose the sample to the atmosphere prior to measurement of the parameters. During purging, water quality indicator parameters [pH, redox potential (ORP), turbidity, specific conductivity, and dissolved oxygen (DO)] will be measured every 5-10 minutes until the parameters have stabilized. Measurement should be recorded on the well purge form (Attachment 4.4) A minimum of 5 sets of water quality indicator parameters should be recorded.

10. Stabilization is achieved after three successive readings are within ± 0.1 for pH, ± 10 mV for ORP, ± 3% for specific conductance, ± 10% for DO, and <20 NTU for turbidity. Temperature will also be measured and recorded, but will not be used as a stabilization parameter. Sampling may begin once the well has stabilized.

11. Specific conductance and DO usually take the longest to stabilize. Fifteen minutes to 1.5 hours of purging at the recommended purge rate may be required to reach stabilization. Stabilized purge indicator trends are generally obvious and follow either an exponential or asymptotic change to stable parameter values during purging. The above stabilization guidelines are provided as estimates and will not be appropriate for use in all circumstances.

12. The pump will not be turned off between the purging and sampling processes.

13. If stabilization does not occur or turbidity is >20 NTU after two hours of purging, the field team leader should be contacted for further guidance.

Wells installed in very low permeability formations (<0.1 L/minute recharge rate) will require alternative purging and sampling methods. Use of the usual low-flow techniques is impractical in this type of environment, because devices to pump at such low flow rates are not readily available. Under these conditions, the wells will be pumped at the lowest practical rate, and an attempt will be made to stabilize all parameters except drawdown. Sampling will commence early enough to ensure that the screened interval is not exposed to atmospheric conditions by the time the last sample is taken. In the event the added limitation of an insufficient volume of water in the well is encountered, the well will be sampled using a disposable Teflon bailer. The well will be bailed to dryness and sampled when it has recharged to the static water level.

Groundwater samples will be collected by gently filling the sample bottles with minimum turbulence once equilibrium is established. Lower the flow rate to 100 mL/minute and collect the parameters in the following order:

- VOCs (no headspace)
- Methane, Ethane, Ethene (no headspace)
- Carbon Dioxide (no headspace)
- TOC (no headspace)
- Sulfide (no headspace)
- Anions
- Alkalinity
- Metals (total and dissolved)
- Field Parameters (ferrous iron and carbon dioxide)

3.3.2.3 Sampling Using a Passive Diffusion Bag Sampler

Select groundwater samples will be collected for VOC analyses using passive diffusion bag (PDB) sampling. A typical PDB sampler consists of a low-density polyethylene tube closed at both ends and filled with deionized water. It is positioned in the well at the desired target depth by attaching it to weighted line, or a fixed object. The water within the bag is then allowed to equilibrate with the ambient groundwater (at least two weeks) before being retrieved. The sampler water is then decanted into 40 mL volatile organic analysis (VOA) vials and sent to the lab for analysis. Detailed procedures for using PDB samplers in wells can be found in "User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells" (USGS, 2001). The following is a generalized summary of PDB sampling:

1. The top and bottom of the PDB sampler will be attached to 3/16" polyester or similar non-buoyant rope strong enough to support the weight of the sampler and subject to minimal stretch. The PDB will be suspended within the well screen at various depths

based on the measured total depth and knowledge of the location of the screen in the well. Weights will be attached to the bottom of the sampler to keep it in place in the hole. The sampler can also be configured to rest on the bottom of the well. The sampler will be allowed to equilibrate before being carefully retrieved with the attached line and the contents analyzed.

2. For wells with dedicated in-well pumps, the PDB sampler will be tied to the pump just below the inlet using plastic cable ties or stainless rings. Total well depth will be measured after pump removal and compared to current records to ensure that the PDB will not rest in sediment settled in the bottom of the well. A stainless steel weight will be attached to the bottom of the PDB to counterbalance the buoyancy of the sampler and keep it in position. The pump/PDB apparatus will then be very carefully lowered back down the hole and secured in position.

3. After the equilibration period, the bags will carefully be withdrawn from the hole and the bag removed from the pump and inspected. Any evidence of algae or other coatings on the bag or tears in the membrane will be noted in the field book. If there are tears, the sample will be rejected.

4. The contents of the intact bag will then be transferred to pre-preserved VOA vials causing as little agitation of the sample as possible. The samples will then be shipped to the laboratory for analysis.

3.4 POST-OPERATION

3.4.1 Field

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

- Decontaminate equipment.
- Complete logbook, making notations as to site conditions, anomalous readings, etc.
- Ensure that equipment and associated supplies have been shipped back to the office.
- 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 drums containing any IDW are properly labeled with the date and drum contents. If IDW samples are to be taken, follow the procedures outlined in WTP 7 – Waste Sampling.

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.
- Make provisions for proper disposal of IDW upon receipt and review of the laboratory data concerning the contents.

4.0 REFERENCES

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

Barcelona, et. al., 1983. A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling. Urbana, IL: Illinois State Water Survey, ISWS Contract Report 327.

USACE, 2001. Requirements for the Preparation of Sampling and Analysis Plans, United States Army Corps of Engineers, EM 200-1-3, February, 2001.

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

USEPA, 1991. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, February 1, 1991.

USEPA, 1992. RCRA Groundwater Monitoring: Draft Technical Guidance, Office of Solid Waste, Washington, D.C., November 1992.

USEPA, 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, Office of Solid Waste, Washington, D.C., April 1996.

5.0 ATTACHMENTS

Attachment 4.1 – Sample Equipment Calibration
  Attachment 4.1a - YSI Calibration Sheet
Attachment 4.2 - General Field Supply Checklist-Sampling Activities
Attachment 4.3 - Field Sampling Report Form
Attachment 4.4 – Purge Form
Attachment 4.5 - Daily Quality Control Report Form
Attachment 4.6 – Site Manager - Daily Quick Reminder List

ATTACHMENT 4.1

YSI 6920 Calibration Procedures

The YSI 6920 will be calibrated for the following parameters; pH, temperature, specific conductivity meter, turbidimeter, dissolved oxygen, and redox potential. The following sections describe the procedures for calibrating each of these parameters. Date, time, and any problems encountered during calibration and check should be noted in the site field book, and complete records of each calibration recorded on YSI calibration sheet (Attachment 5.1a)

Conductivity

The following steps will be followed to calibrate the conductivity probe on the YSI 6290.

1. Prior to calibration, put the sonde into the **Run** mode and let the sensors make readings in air. The conductivity reading should be less than 3 uS/cm. If the readings are much higher (>10 uS/cm), follow the probe cleaning procedures before calibrating the sonde
2. Pour enough standard into the calibration/transport cup to fully immerse the conductivity cell and thermistor. The calibration standard used should be within the same range as the water to be sampled. However, standards with less than 1 mS/cm (1000 uS/cm) are NOT recommended.

   Recommended Calibration Standards:

Freshwater:	1 mS/cm standard
Brackish water:	10 mS/cm standard
Seawater:	50 mS/cm standard

3. Place the probe into the standard and make sure that the probe is completely immersed past the vent hole. Gently tap the side of the calibration cup to dislodge any air bubbles trapped inside the cell
4. Allow at least 1 minute for temperature equilibrium to occur before proceeding.
5. From the **Calibrate** menu, select Conductivity and then **SpCond** to calibrate for Specific Conductance (or temperature-compensated conductivity). Enter the value of the standard in mS/cm at 25°C and press Enter
   NOTE: The value entered MUST be in mS/cm. Multiply the value in uS/cm by 1000 to convert to mS/cm
6. Observe the conductivity readings until they stabilize and do not significantly change for approximately 30 seconds and then press Enter. The screen will indicate that calibration

has been accepted and will prompt you to press Enter again to return to the **Calibrate** menu.

7. Escape out of the **Calibrate** menu back to the **Main** menu. Select **Advanced** and then **Cal Constant**. Record the **Cond** cell constant which should range between 4.55 and 5.45
8. Rinse the sensors and calibration cup in DI water and then proceed to calibrate pH.

Conductivity Calibration Tips:

- Calibrate conductivity first to avoid carry-over from other standards. NOTE: pH buffers are highly conductive!
- Never calibrate with standards that are less than 1.0 mS/cm. These standards are easily interfered with by outside electrical noise (RF, etc.)
- Pre-rinse the sensor with a small amount of standard to eliminate contamination.
- Ensure that the conductivity probe is completely immersed in standard. The hole in the side of the probe MUST be under the surface of the solution and NOT have any trapped bubbles in the openings.
- If the meter reports **"Out Of Range,"** investigate the cause. **NEVER** override a calibration error without fully understanding the cause. The most typical cause is an incorrect entry of the standard value such as 1000 (uS/cm) rather than 1.0 (mS/cm). Other common errors are (1) not using enough standard to fill the cell and vent hole and (2) air bubbles trapped in the cell.
- When the calibration has been accepted, check the conductivity cell constant found in the **Advanced** menu under **Cal Constants**. The **Cond** cell constant should be 4.55 to 5.45. Values out of this range usually indicate a problem with the calibration process or calibration standard.

pH

The following procedure describes a 3 point to calibration of the pH probe on the YSI 6290.

1. Place enough pH 7 buffer into the calibration cup to immerse the pH probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading.
2. From the **Calibrate** menu, select **ISE1 pH** and then choose **2-Point** or **3-Point** depending on the calibration procedure required. For example, if the water to be monitored has a pH of 7.5, then there is no need to calibrate the probe with a pH 4 buffer – a 2 point calibration will be sufficient.
3. Enter **7.0** when prompted for the first pH value. ALWAYS begin with pH 7. Observe the pH reading and record the pH mV reading. The pH mV should range between -50 to +50.

When the values show no significant change for approximately 30 seconds, press Enter. The display will indicate that the calibration has been accepted and will prompt you to enter a second pH value:
NOTE: While calibrating pH, it is recommended that the pH mV readings are recorded. To enable pH mV, select **Report** from the **Main** menu. Highlight pH mV and press Enter to enable this value.

4. After the pH 7 calibration is accepted, press Enter again to continue. Rinse the sensors DI before rinsing them in the second buffer.

5. Place enough buffer (pH 4 or 10) into the calibration cup to immerse the pH probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading. Observe the pH reading and record the pH mV reading. The pH mV should range between 130 to 230 in pH 4 buffer and –130 to –230 in pH 10. Press enter when the pH reading shows no significant change for approximately 30 seconds. Press enter again to return to the **Calibrate** menu or to proceed to the third pH calibration buffer.
NOTE: Subtract the pH 7 mV from the pH 4 or 10 mV. This difference must be greater than 165 mV. While the pH probe may continue to calibrate with less than 165 mV, this indicates that the pH probe will soon need replacement.

6. If a 3-Point calibration is being performed, follow the directions above.

7. Rinse the sensors and calibration cup in DI water

Dissolved Oxygen

The following steps will be followed to calibrate the dissolved oxygen (DO) probe on the YSI 6290;

1. Place approximately 1/8 inch of water in the bottom of the calibration cup. Engage only 1 thread of the calibration cup onto the sonde to ensure that the DO probe is readily vented to the atmosphere. Ensure that the DO probe and the thermistor are NOT in contact with the water. Wait at least 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.

2. Observe the **DO charge** reading (DO ch) and ensure that the reading ranges between 25 and 75.

3. Observe the temperature and DO readings and when they show no significant change for approximately 30 seconds, the press Enter. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to return to the **Calibrate** menu.
NOTE: If you are using YSI model 600XLM, 6920, 6000, or 6600, you will need to make sure the auto-sleep functions are disabled. To disable the auto-sleep functions, go to the **Advanced** menu and select **Setup**. Choose **Auto-sleep RS232** and press Enter to disable. Then select **Auto-sleep SDI12** and press Enter.

4. Escape out of the **Calibrate** menu back to the **Main** menu. Select **Advanced** and then **Cal Constant**. Record the **DO Gain** which should range between -0.7 and 1.5.

5. Rinse the sensors and calibration cup in DI water

DO Calibration Tips:

- Inspect the DO probe anodes (silver rectangles), recondition using the 6035 reconditioning kit if they are darkened or gray in color.
- The KCl solution and membrane should be changed prior to each long-term deployment and at least once every 90 days. In addition, the KCl and membrane should be replaced if (1) bubbles are visible under the membrane; (2) deposits of dried KCl appear on the membrane or o-ring; (3) the readings are unstable; (4) the DO charge reading is out of range (<25 or >75).
- If needed install a new membrane, making sure that it is tightly stretched and wrinkle free. CAUTION: If you remove the DO probe from the sonde, be sure to inspect the probe port for moisture. Remove any moisture from the connector area. Also verify that the probe is clean and dry and apply a small amount of silicone grease to the o-ring before re-installing the probe. NOTE: DO membranes will be slightly unstable during the first 3 to 6 hours after they are installed. It is suggested that a calibration check be made after this time period.

DO Calibration Check:

1. From the **Report** menu, enable the **DO Charge**. Then go to the **Run** menu and start the sonde in the **Discrete Run** mode at a 4 second rate and allow the sonde to run (burn-in) for at least 10 minutes. Record the **DO Charge** (DO ch) after 5 minutes which should be 25 to 75.
2. After the burn-in is complete, go to the **Advanced** menu, then **Setup** and confirm that the **Auto-sleep RS232** and **Auto-sleep SDI12** functions are enabled. NOTE: Wait at least 60 seconds before proceeding to the next step.
3. Start the sonde in the **Discrete Run** mode at a 4 second rate and record the first 10 DO% numbers in your log book. These numbers must start high and gradually decrease. For example: 110, 105, 102, 101.5, 101.1, etc. It does not matter if the numbers do not reach 100%, it is only important that they have the same high to low trend. If you have a probe that starts with a low number and steadily climbs upward, then the sensor has a problem and the calibration must be rejected. NOTE: The initial power up can corrupt the first 2 DO% samples; disregard any low numbers that appear in this position.
4. The probe is now ready to be calibrated.

Oxidation Reduction Potential (ORP)

The following steps will be followed to calibrate the oxidation reduction potential (ORP) probe on the YSI 6290;

1. Place enough ORP (gold) calibration solution into the calibration cup to immerse the ORP probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading.
2. From the **Calibrate** menu, select **ISE2 ORP**
3. Enter 240.0 when prompted for it. When the values show no significant change for approximately 30 seconds, press Enter. The display will indicate that the calibration has been accepted.
4. Rinse the sensors and calibration cup in DI water

Turbidity

The following steps will be followed for a two point calibration of the turbidity probe on the YSI 6290;

1. Place enough 0 NTU solution into the calibration cup to immerse the turbidity probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading.
2. From the **Calibrate** menu, select **Optic T-Turbidity-6026** (or Turbidity 6136) and then choose **2-Point**.
3. Enter 0.0 at the prompt, and press Enter
4. When the values show no significant change for approximately 30 seconds, press Enter. The display will indicate that the calibration has been accepted and will prompt you to enter a second turbidity value. If needed activate the wiper 1-2 times by pressing 3-Clean Optics as shown on the screen, to remove any bubbles.
5. Rinse the sensors and calibration cup in DI water
6. Place enough 100 or 200 NTU solution into the calibration cup to immerse the turbidity probe, reference junction, and thermistor. Allow at least 1 minute for temperature equilibration before reading.
7. Enter 100.0 or 200.0 depending on the solution you are using. When the values show no significant change for approximately 30 seconds, press Enter. The display will indicate that the calibration has been accepted and will prompt you to enter.

Calibration Check

At the completion of sampling activities, and before leaving the site each night a calibration check of the YSI will be made including; DO, conductivity, pH, turbidity, and ORP. Calibration will be checked by placing the probe in the solution for each parameter, allowing at least one minute for temperature equilibration before reading the value and recording on the YSI calibration sheet (Attachment 5.1a). The sensors and calibration cup should be rinsed with DI water between each solution. If a significant difference (±5%) between the initial calibration and calibration check is observed, the Field Team Leader should be notified, the change should be noted in the field book, and on all purge forms, and field sampling reports used during that period.

References

Water Monitoring Solution, Inc. YSI Calibration Procedures Profiling and Logging, available online; http://www.water-monitor.com. July 2004.

YSI Incorporated. Environmental Monitoring Systems, Operations Manual. Available online; July 2004.

ATTACHMENT 4.1a
YSI CALIBRATION PRIOR TO SAMPLING

DATE ____/_____/___ TIME___.___:___
SONDE ID____________________ HANDSET ID____________________
BATTERY VOLTAGE____________________

DISSOLVED OXYGEN
CHANGED DO MEMBRANE? YES NO If yes, when? ____/_____/___ ___:___:___
Note: If membrane is changed, wait 6 to 8 hours before completing DO test and final calibration
DO % VALUE BEFORE CALIBRATION ___________%; AFTER CALIBRATION_________%

DO CHARGE ______________(range 25 to 75) DO GAIN ________________(range -0.7 to1.5)

CONDUCTIVITY
Note: Calibrate first to avoid carry-over from other standards (i.e. pH buffers are highly conductive)
CALIBRATION STANDARD USED_________________µS/cm, TEMP_________°C
READING BEFORE CALIBRATION__________µS/cm, AFTER CALIBRATION_________µS/cm

CONDUCTIVITY CELL CONSTANT______________________µS/cm (Range 5.0 ± 0.5)

pH
pH 7 VALUES BEFORE CALIBRATION: _________ (pH) AFTER CALIBRATION_________ (pH)

pH 7 MILLI-VOLT READINGS: __________mV Range -50 to +50 mV

ph 10 VALUES BEFORE CALIBRATION: ________ (pH) AFTER CALIBRATION_________ (pH)

pH 10 MILLI-VOLT READINGS: __________mVRange -130 to -230 mV

pH 4 VALUES BEFORE CALIBRATION: _________ (pH) AFTER CALIBRATION_________ (pH)

pH 4 MILLI-VOLT READINGS: __________mV Range 130 to 230 mV
Note: Span between pH 4 and 7, 7 and 10 mV numbers should be ~165-180 mV

REDOX POTENTIAL (ORP)
CALIBRATION STANDARD USED_________________mV, CAL TEMP_________°C

READING BEFORE CALIBRATION____________mV, AFTER CALIBRATION__________mV

TURBIDITY
Wiper Parked ~180° from optics? Y N Note: Change wiper if probe is not parked correctly
TURBIDITY STANDARD ___________________ (NTUs)

VALUES BEFORE CALIBRATION: _________ (NTUs) AFTER CALIBRATION________ (NTUs)

TURBIDITY STANDARD ___________________ (NTUs)

VALUES BEFORE CALIBRATION: _________ (NTUs) AFTER CALIBRATION________ (NTUs)

CALIBRATION SUCCESSFUL? YES NO INITIAL____________

DESCRIBE ANY PROBLEMS ENCOUNTERED ____
____
____

PREPARED BY/DATE: JP 07/13/04
CHECKED BY/DATE: AC 07/13/04

ATTACHMENT 4.1a-continued
YSI CALIBRATION CHECK AFTER SAMPLING

DATE ____/_____/___ TIME___:___:___
SONDE ID____________________ HANDSET ID_____________________
BATTERY VOLTAGE____________

NOTE: CALIBRATION IS SUCCESSFUL WHEN THERE IS NO SIGNIFICANT DIFFERENCES (± 5 %) BETWEEN INITIAL CALIBRATION AND CALIBRATION CHECK

DISSOLVED OXYGEN
CHANGED DO MEMBRANE? YES NO If yes, when? ____/_____/___ ___:___:___
Note: If membrane is changed, wait 6 to 8 hours before completing DO test and final calibration
DO % VALUE BEFORE CALIBRATION___________%, AFTER CALIBRATION________%
DO CHARGE ________________ DO GAIN _________________
CALIBRATION SUCCESSFUL? YES NO INITIAL____________

CONDUCTIVITY
Note :Calibrate first to avoid carry-over from other standards (i.e. pH buffers are highly conductive)
CALIBRATION STANDARD USED__________________μS/cm, CAL TEMP_________°C
VALUE____________μS/cm
CONDUCTIVITY CELL CONSTANT______________________μS/cm (Range 5.0 ± 0.5)
CALIBRATION SUCCESSFUL? YES NO INITIAL____________

pH
pH 7 VALUE _________ (pH)
pH 7 MILLI-VOLT READINGS: __________mV Range -50 to +50 mV
ph 10 VALUE _________ (pH)
pH 10 MILLI-VOLT READINGS: __________mV Range -130 to -230 mV
pH 4 VALUE _________ (pH)
pH 4 MILLI-VOLT READINGS: __________mV Range 130 to 230 mV
Note: Span between pH 4 and 7, 7 and 10 mV numbers should be ~165-180 mV
CALIBRATION SUCCESSFUL? YES NO INITIAL____________

REDOX POTENTIAL (ORP)
CALIBRATION STANDARD USED__________________mV, CAL TEMP_________°C
VALUE__________mV
CALIBRATION SUCCESSFUL? YES NO INITIAL____________

TURBIDITY
Wiper Parked ~180° from optics? Y N Note: Change wiper if probe is not parked correctly
TURBIDITY STANDARD 1 __________________ (NTUs)
VALUE__________ (NTUs)
TURBIDITY STANDARD 2 __________________ (NTUs)
VALUE __________ (NTUs)
CALIBRATION SUCCESSFUL? YES NO INITIAL____________

PREPARED BY/DATE: JP 07/13/04
CHECKED BY/DATE: AC 07/13/04

ATTACHMENT 4.2

General Field Supply Checklist-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 ________

Stainless Steel Bladder Pump (with extra bladders and grab plates) ________

Disposable Teflon Bailers ________

Air Compressor and Controller ________

Water Level Indicator ________

YSI (or similar meter with flow through cell) with calibration solution ________

Plastic Sheeting ________

Teflon Lined Plastic Tubing ________

Safety Line ________

DI Water, Methanol, and Liquinox for Decon ________

ATTACHMENT 4.3

FIELD SAMPLING REPORT

JOB No. 6301-04-0002
JOB NAME DDMT
DATE ________ TIME ______
SAMPLING POINT:
DEPTH ________

SAMPLE INFORMATION

SAMPLE I.D. NO.: EB-1

MATERIAL: ☐ WATER ☐ SOIL ☐ SLUDGE ☐ OTHER (LIST) ________
TYPE: ☐ GRAB ☐ COMPOSITE ☐ OTHER (LIST) ________
HAZARDOUS ☐ YES ☐ NO ☐ UNKNOWN

CONTAINER		NUMBER	PRESERVATIVE/ PREPARATION	COMMENTS
TYPE	VOLUME			

COMMENTS: (WELL PURGING VOLUME: SAMPLE APPEARANCE; ODOR; COLOR, ETC.)

____

____

GENERAL INFORMATION

WEATHER ________________ AIR TEMPERATURE ________

SAMPLES SHIPPED TO: ________________

SPECIAL HANDLING: ________________

MODE OF SHIPMENT: ☐ CAR/TRUCK ☐ BUS ☐ PLANE ☐ COMMERCIAL VEHICLE

QA/QC

SAMPLE COLLECTED BY: ________ SAMPLING OBSERVED BY: ________

DISCREPANCIES: ________________

Attachment 4.4

WELL PURGING - FIELD WATER QUALITY MEASUREMENTS FORM

Location. DDMT - ______________________ page ___ of ___
Site Name

Identify Measuring Point (MP) ______________
(e g Top of Casing)

Well ID ______________________
Field Sampling Personnel ______________________

Depth to Screen below MP: ________ of screen ________ of screen
Top Bottom

Pump Intake at (ft. below MP): ______________
Purging Device (Pump Type): ______________
(e g Dedicated pump, peristaltic pump, bailer, bladder pump, etc.)

Date	Time 24 hr	Depth to Water Below MP ft	Purge Rate mL/min	pH pH units	Spec Cond mS/cm	Turbidity NTUs	DO Flow cell mg/L	Temp. °C	Redox Potential mV	Cum. Volume Purged gallons	CHEMetrics DO mg/L (low)	Hach Ferrous Iron mg/L	Comments

Notes:
Note when "Stabilization" has occurred Stabilization Criteria (achieved after a minimum of three successive readings). ±0 1 for pH
±10 mV for redox
±3% for specific cond.
±10% for DO
<20 NTUs for turbidity
NA for temperature

If stabilization does not occur within 2 hours, contact Site Manager for action.
If well goes dry prior to stabilization, stop, allow well to recharge, and collect sample.

050006 01

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ATTACHMENT 4.5

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 4.6

SITE MANAGER – DAILY QUICK REMINDER LIST

Arrival at Site
- ☐ Pick up sampling supplies – compare inventory packing list with shipment
- ☐ Call lab daily to check status of samples. No sample bottle breakage, COC matches what is in cooler and samples received at correct temperature.

Instrument Calibration
- ☐ Supervise calibration of instruments and review calibration forms
- ☐ Call in for barometric pressure, used to calibrate DO for YSI meter
- ☐ Make sure each team conducts the mid-day calibration check on the YSI and fills out daily form

Health and Safety
- ☐ Make sure each team has appropriate PPE, first aid kit and fire extinguisher in each vehicle, map to nearest hospital, and knowledge of emergency phone nos.
- ☐ Make sure members are aware of any team member with medical emergency issues (i.e. allergic reactions to bees, etc.) and has necessary equipment to handle the incidence
- ☐ Make sure each team is aware of "Stop work" PID action levels

Vehicle Load Out
- ☐ Prepare coolers for samplers and assign locations to field teams. Emphasize QC locations.
- ☐ Make sure each team has field test kit supplies for ferrous iron and carbon dioxide.
- ☐ Distribute sample folders to team members each day

Purging and Sampling
- ☐ Remind team members to call in field measurements and verify reasonableness. Review field measurements for reasonableness (real time) and trouble shoot if required. Sign off on purge forms at end of day.
- ☐ Make team member aware of IDW disposal/storage procedures. Methanol must be containerized separately from wash water and rinse water.
- ☐ Oversee sample packing and shipping procedures. Verify that metals and sulfide pH has been checked and adjusted if necessary. Make sure coolers with VOCs have a trip blank. Verify that each cooler has a COC, RFAs, temperature blank, double bagged ice, trip blank (if required), and custody seals. Complete shipping checklist.
- ☐ Remind teams to leave no equipment or valuables in vehicles parked at the hotel (due to recent theft)

End of Day Activities
- ☐ Check field books, FSRs, and Purge forms for completeness daily
- ☐ Remind teams to leave no equipment or valuables in vehicles parked at the hotel (due to recent theft)
- ☐ Remind teams to charge equipment overnight
- ☐ Fax daily reports and purge forms to Paul Brafford/John Quinn daily – COCs to Judy Hartness
- ☐ Check schedule daily and update as needed

End of Shift Activities

- ☐ Call in work hours on Friday by 10:00AM EST for field team.
- ☐ Conduct supply inventory
- ☐ Pack and return all rental supplies to vendors
- ☐ Make sure all equipment has been decontaminated and wrapped in aluminum foil and stored neatly
- ☐ Make sure IDW has been sampled and labeled properly

Site Manager: ________________________________ Date: ____________________

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.

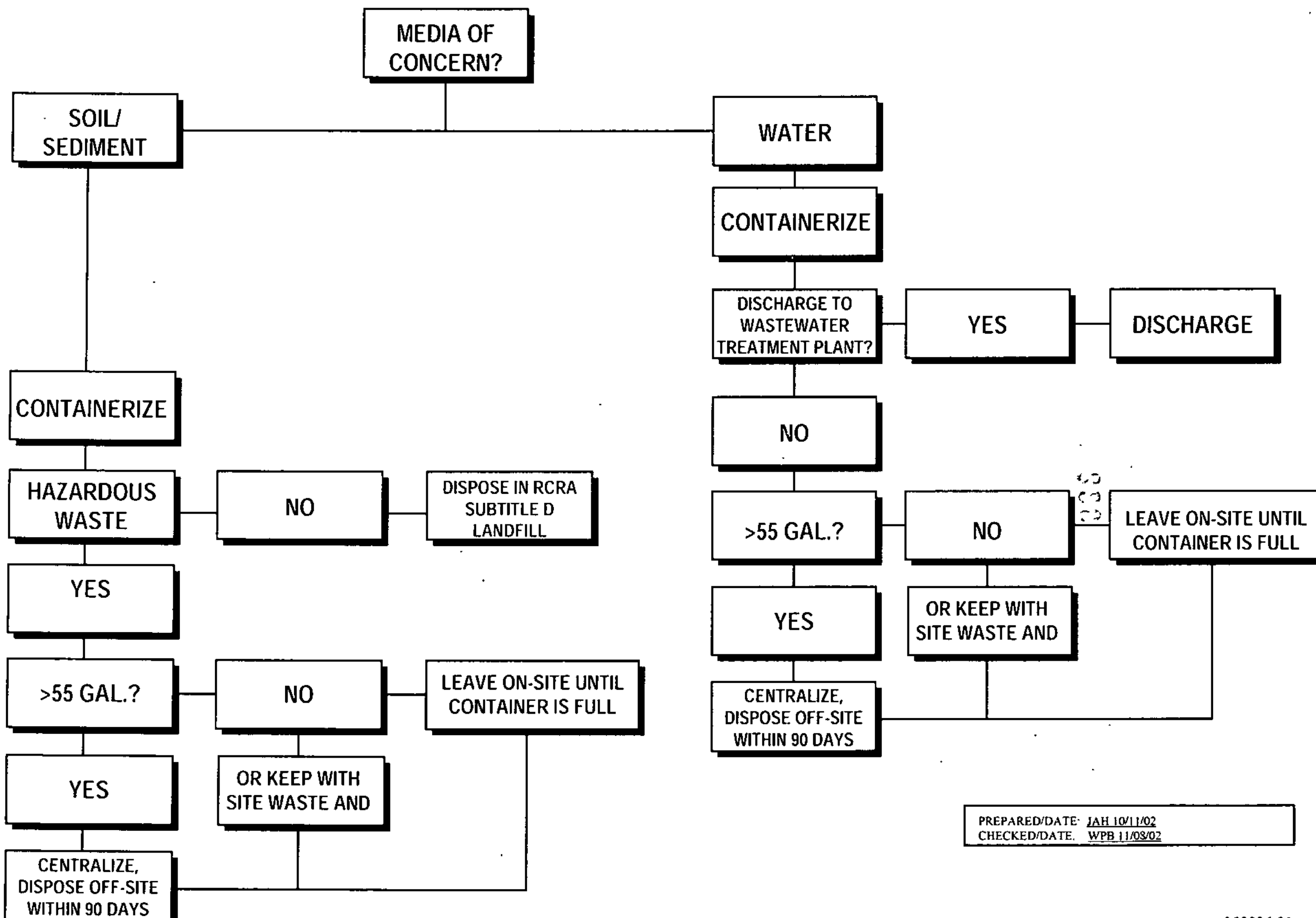
USEPA, 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Compliance Branch, Athens, Georgia, November, 2001.

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

1032 91

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).

<u>Custody Seals:</u> 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.

<u>Sample Handling:</u> 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

ATTACHMENT 7.4

Chain of Custody Record

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)	Special Instructions/ Conditions of Receipt
Project Name and Location (State)	Carrier/Waybill Number		
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

1032116

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

__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:	

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

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.

Sampling Equipment: 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. Label Sample Container - Label the sample container as outlined in WTP 7

b. Collect Sample - 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. Custody, Handling and Shipping - 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 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 <u>or</u> 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

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE