AR1451

Remedial Investigation Field Sampling Plan Addendum II for Dunn Field (Operable Unit 1)

TO: U.S. Army Engineering and Support Center, Huntsville

COPIES: Memphis Depot Caretaker (MDC)
U.S. Environmental Protection Agency (USEPA), Region 4
Tennessee Department of Environment and Conservation (TDEC)

FROM: CH2M HILL

DATE: June 29, 2000

Purpose

This Field Sampling Plan (FSP) Addendum II is being prepared to describe the planned additional remedial investigation activities on the west-central portion of Dunn Field (OU-1) and area immediately west (off-site) of Dunn Field (Figures 1 and 2). This additional investigation will assess (1) the nature and extent of a previously undetected dissolved off-site groundwater plume suspected to result from dense non-aqueous phase liquid (DNAPL) and (2) to the extent practical, the source and extent of the subsurface DNAPL. The proposed technical approach for this additional investigation was initially presented at the Base Realignment and Closure (BRAC) Cleanup Team (BCT) Meeting dated April 19, 2000.

This FSP Addendum II, which was developed for the implementation of the additional remedial investigation activities, is to be considered an addendum to the following approved plans:

- Field Sampling Plan Addendum for OU-1 (CH2M HILL, March 1999)
- OU-1 Field Sampling Plan (CH2M HILL, September 1995)
- Screening Sites Field Sampling Plan (CH2M HILL, September 1995)
- Generic Quality Assurance Project Plan (CH2M HILL, August 1995)
- Generic Remedial Investigation/Feasibility Study Work Plan (CH2M HILL, August 1995)
- Hazardous and Toxic Waste Health and Safety Plan (CH2M HILL, August 1995)

Reasons for Additional Investigation

Monitoring wells MW-68, -69, -70, and -71 were installed west of Dunn Field in November 1999 (MW-69, -70 and -71) and February 2000 (MW-68) to provide water level control in the fluvial aquifer and to evaluate the capture zone of the Dunn Field groundwater extraction system (see Figures 1 and 2). Groundwater samples were collected by Sverdrup from wells MW-69, -70, and -71 in February 2000 during the quarterly groundwater monitoring program conducted as part of the second year of the operations and maintenance of the groundwater extraction system on Dunn Field. Groundwater analytical results from MW-70 indicated the presence of trichloroethene (TCE) and 1,1,2,2-tetrachloroethane (1,1,2,2-PCA) at concentrations of 11,700 micrograms per liter (µg/L) and 4,830 µg/L, respectively.

The aqueous solubility of TCE is 1,100,000 µg/L at 25°C (Fetter, 1993). When concentrations of DNAPL chemicals (e.g., TCE) in groundwater are greater than 1% of the aqueous solubility limit, then the presence of DNAPL is inferred (EPA, 1996). The detected concentrations of TCE in MW-70 are 1.06% of the aqueous solubility, which suggests the presence of DNAPL.

The detected concentrations of TCE and 1,1,2,2-PCA are an order of magnitude greater than what has been previously detected west of Dunn Field and represents a change to the nature and extent assessment, and the fate and transport conceptual model that has been developed. Previous sampling events, both on and off Dunn Field, have not indicated a presence of DNAPL in the saturated zone. The concentrations of chlorinated volatile organic compounds (CVOCs) detected in MW-70, coupled with TCE and 1,1,2,2-PCA concentrations in recovery well RW-5 rising over the past five quarters of monitoring (TCE from 433 µg/L in February 1999 to 1,170 µg/L in February 2000, and 1,1,2,2-PCA from 11.4 µg/L in February 1999 to 3,120 µg/L in February 2000), indicate a potential mobilization of groundwater CVOCs in the proposed area of investigation.

A groundwater sample was again collected from MW-70 in March 2000 as part of the monitored natural attenuation (MNA) sampling event conducted in the Main Installation and Dunn Field. The detected concentrations of TCE and 1,1,2,2-PCA from the March 2000 sampling event do not correlate to the analytical results from the February 2000 sampling event, as they are an order of magnitude lower. Two different laboratories conducted the analyses; however, the data from both labs have been deemed acceptable through validation (personal communication with Kevin Sanders, CH2M HILL chemist and Virgil Jansen, Sverdrup project manager). The data from the groundwater samples collected from MW-71 during both sampling events does appear to correlate. The volatile organic compound (VOC) concentrations from the February 2000 and March 2000 sampling events for MW-70 and MW-71 are presented in Table 1. One possible reason for the differing concentrations of VOCs may be due to different purging rates and sample collection intervals within the water column. Further evaluation of the initial concentrations in MW-70 is necessary.

Background Information

On March 9, 2000, the draft final Dunn Field Remedial Investigation (RI) Report was submitted by CH2M HILL for review by the BCT. On March 14, 2000, the elevated concentrations of TCE and 1,1,2,2-PCA were discovered during a review of the laboratory data. During the March 17, 2000 BCT Meeting in Memphis, Tennessee, the BCT members concluded that due to the potential DNAPL and the fact that the source areas within Dunn Field may need to be reevaluated, it is not appropriate to review the draft final RI Report at this time. The draft final RI Report was recalled. The draft Dunn Field RI report was issued in October 1999. The following soil and groundwater figures from the draft final Dunn Field RI Report have been provided in Appendix A of this FSP as background and reference material.

Soil

The results of the passive soil-gas survey for TCE for the Northwest Disposal Area of Dunn Field is included. An area of high TCE soil gas concentrations (>3.0 µg) is located approximately 200 feet east-southeast of MW-70 near northing 280900 and easting 802100 (see Figure 4-6 in Appendix A). The results of VOCs detected in the surface and subsurface soil in the Northwest Disposal Area of Dunn Field is also included. Soil borings SBLCF, SBLCA, SBLCD, SBLCB, SBLCC, and SBLCE were located in the area of high TCE soil gas referenced above (See Figure 4-7 in Appendix A). TCE was detected at concentrations ranging from 6 to 18,000 µg/kg, and 1,1,2,2-PCA was detected at concentrations ranging from 7 to 33,000 µg/kg in subsurface soil samples collected from these borings (See Figure 10-10 in Appendix A). This area on Dunn Field will be investigated as a possible source of DNAPL. As is the case for most of Dunn Field, the soil-gas plume containing these borings lies outside the boundaries of known disposal areas at Dunn Field. Therefore, no specific disposal area is known to be the source of the suspected DNAPL at this time.

Groundwater

TCE and 1,1,2,2-PCA concentration maps from the October 1998 groundwater sampling event at Dunn Field are included in Appendix A (Figures 14-3 and 14-8), as are the groundwater concentration trends from 1996 through 1998 for TCE and 1,1,2,2-PCA in the monitoring wells (Figure 14-10A in Appendix A). Soil and groundwater (October 1998 data) TCE and 1,1,2,2-PCA correlations are also presented (Figures 14-12 and 14-14 in Appendix A). Groundwater TCE and 1,1,2,2-PCA concentrations from the November 1999 groundwater extraction system performance monitoring are also included (Figures 14-27 and 14-36 in Appendix A).

Objectives

The objective of this FSP Addendum II is to present a detailed description of the proposed field activities that will be performed for the additional investigation at the west-central area of Dunn Field. Specifically, the sampling and analysis for the additional investigation will be required to:

- Establish the nature and extent of DNAPL and resulting dissolved plume associated with MW-70.
  - Horizontal extent within the fluvial aquifer;
  - Vertical extent within the unsaturated zone; and
  - Vertical extent within the saturated zone (if perching layers exist).
- Identify DNAPL sources within the soil/disposal areas on Dunn Field.
  - If DNAPL is found, assess specific areas where DNAPL may have been released; and
  - Evaluate vertical and horizontal distribution within the unsaturated zone.
- Evaluate DNAPL and dissolved phase transport in the vicinity of MW-70.

  - Establish orientation of the confining unit clay;
  - Establish orientation of perching units (saturated and unsaturated), if present;
  - Confirm groundwater gradient and flow direction in area of concern; and
  - Collect additional transport parameters (i.e., total organic carbon, grain size distribution, and hydraulic conductivity).

- Incorporate the findings from the additional field investigation into the revised Dunn Field draft final RI report.

Data Quality Objectives

The data quality objectives (DQOs) detailed below are established to achieve the objectives outlined above in the area of investigation (see Figure 2) and to define the site conceptual model for Dunn Field (as shown in Figure 4).

DQO No. 01—Confirm VOC Concentrations in Monitoring Well MW-70

Qualitative DQO

Confirm that TCE and 1,1,2,2-PCA concentrations are elevated per the February 2000 sampling. Results of the groundwater sampling from March 2000 were significantly lower.

During the drilling of MW-70, high organic vapor concentrations were detected at the surface of a clay lense near the water table interface. Confirm whether high groundwater concentrations are associated with the upper clay lense in MW-70.

Quantitative DQO

Analyze groundwater via SW-846 Method 8260B to evaluate concentrations relative to previous sampling.

Methods to Obtain DQO

Use low flow (<0.5 liter per minute [l/m]) sampling in the upper and lower portion of the screened interval to evaluate whether concentrations are associated with the upper saturated thickness (clay lense) or the lower saturated thickness (confining unit clay).

Sampling will be performed during the second quarter of the calendar year 2000 O&M sampling effort scheduled for May 2000. Results from sampling of the upper and lower portion of the screened interval will be available prior to mobilization for the DNAPL investigation effort.

In addition, a boring will be drilled adjacent (up-gradient) of MW-70 per the methods defined in DQOs No. 2 and 3 below. The boring will be located as close as practical to MW-70. Previous identification of the clay lense will allow precise sampling of the clay surface to assess whether DNAPL is perched on the upper clay surface.

DQO No. 02—Define Clay Lense and Confining Unit Clay Orientation on and West of Dunn Field

Qualitative DQO

Because DNAPL moves in the subsurface under the influence of both gravity and hydraulic gradient, a dip or slope along the top of a clay layer or other lower porosity subsurface strata will affect the direction and rate of DNAPL transport. There fore, this DQO will assess the presence or absence, elevation, and orientation of the confining unit clay and overlying clay lenses in three areas (see Figure 3):

- Area 1: in the vicinity of monitoring well MW-70;
- Area 2: up-gradient of MW-70 in the potential source area on Dunn Field; and
- Area 3: down-gradient (west, northwest, and southwest) of MW-70.

Quantitative DQO

Elevation of the land surface and underlying top of confining unit clay and clay lenses will be measured to the nearest 0.5 foot (ft) through the use of soil borings.

Methods to Obtain DQO

A series of soil borings will be drilled in the three areas identified above (see Figure 3). It is anticipated that an initial 10 to 15 borings will be advanced using continuous sampling techniques. Direct push techniques have been proven to be ineffective due to the depth of the confining unit clay (80- to 95-ft below ground surface [bgs]).

The ground surface elevation at the location of each proposed soil boring will be pre-surveyed so that the elevation of the clay layers encountered in the borings can be evaluated and mapped in the field. The elevations and orientation of the clay layers will dictate the location and number of subsequent borings. Installation of boreholes will begin in the suspected DNAPL source area approximately 50-ft northwest of former boring location SBLCA in Area 2. After investigating the area around SBLCA, a series of soil borings will be installed between recovery wells 04 and 05 to establish and confirm possible offsite subsurface pathways along the top of the confining clay. A soil boring will then be placed directly adjacent to MW-70 in Area 1 to confirm the lithology. The remaining soil borings will be installed in the vicinity and downgradient (Area 3) of MW-70. This sequence allows for the investigation to progress from the upgradient area (potential source area) to the down gradient area near MW-70 and west of MW-70.

Samples will be collected from the borings for lithology, field screening, and potential laboratory analyses (see DQO No. 03).

DQO No. 03—Evaluate Areal and Vertical Extent of DNAPL in the Subsurface Soils

Qualitative DQO

Assess the presence or absence of DNAPL in the three areas defined above, and identify the general source area of the DNAPL. Both the areal and vertical extent within subsurface soils will be assessed.

Quantitative DQO

Headspace field screening will be undertaken with a flame ionization detector (FID) and Sudan IV dye testing on samples collected from soil borings. Level 3 laboratory analyses will confirm field screening for VOCs via SW-846 Method 8260B.

Methods to Obtain DQO

Soil borings will be conducted as defined in DQO No. 02. Continuous sampling will be conducted at each boring location from the land surface to the termination depth of each boring. The lithology will be continuously logged throughout each borehole.

Headspace field screening will be conducted at 5-ft intervals within the continuously sampled portion of the borehole until the confining unit clay is encountered (i.e., termination depth of each boring). Additional headspace analysis will be obtained at any location where unusual coloration or texture of the soil or aquifer lithology is observed.

In addition, a "focused evaluation" will be conducted at the interface with each clay layer or low-permeability strata. The "focused evaluation" includes collecting samples at the interface for headspace field screening and a shake test using a hydrophobic dye (Sudan IV dye), which turns bright red in the presence of DNAPL. A standard operating procedure (SOP) for the shake dye test is included in Appendix B.

Discrete soil samples will be collected at the interface with each clay layer or low-permeability strata that indicate the presence of DNAPL or elevated headspace field screening readings for laboratory analyses for VOCs (SW-846 Method 8260B). A local laboratory will be used and the analytical turnaround time will be 12 to 24 hours so that the information can be used as a decision-making tool in the field for additional boring and/or monitoring well placement.

The placement of monitoring wells will confirm suspected DNAPL in the saturated zone, per the methods defined below in DQO No. 04.

DQO No. 04—Evaluate Areal Extent of Dissolved Plume

Qualitative DQO

Evaluate the nature and extent of the dissolved VOC plume west of Dunn Field (down-gradient of MW-70).

Quantitative DQO

Conduct laboratory analyses of groundwater samples via SW-846 Method 8260B from new and existing monitoring wells.

Methods to Obtain DQO

Soil borings will be converted to monitoring wells based on the results of the lithology logging, clay layer orientation, known groundwater gradient, field screening of soil samples, and laboratory analyses of the confirmation soil samples. Wells will be completed in or near borings of where high concentrations of VOCs/DNAPL are detected in soil, and in areas of groundwater convergence (as assessed by the slope of the clay layer and the field-measured water table surface). Well placement will also be such that the horizontal extent of elevated groundwater VOCs is established within the context of the existing groundwater monitoring system. It is anticipated that three to five additional monitoring wells will be installed to delineate the elevated dissolved VOC plume in the area of MW-70. Wells will be installed only after consultation with the USACE and members of the BCT concerning the field results from the soil investigation.

The placement of the bottom of the wells and the screened interval of the wells will be evaluated in the field based on the information gathered from DQOs No. 2 and 3. The construction details of the wells will be based on the presence of clay layers or other low-permeability units. Nested wells may be an option, depending on the clay layers and contamination detected in the field.

Following well installation, a round of groundwater samples will be collected from the new wells and from selected existing wells. Sampling of wells will be coordinated with the quarterly groundwater sampling associated with the groundwater extraction system performance monitoring. Quarterly sampling is scheduled for May 2000 (2nd quarter, year 2 of operation) and August 2000 (3rd quarter, year 2 of operation). Existing wells not in the current O&M monitoring network to be sampled include MW-06, -12, -13, -05, and -04. Wells included in the monitoring network that are important to this investigation include MW-70, -71, -69, -32, -33, -54, -59, and recovery wells RW-03, -04, -05, and -06. As stated above, these wells are scheduled for sampling in May 2000 and August 2000.

Conceptual Model

The existing conceptual model for the Dunn Field and the area west of Dunn Field is shown on Figure 4 and is based on the following information that is known to date. Soil and groundwater concentrations of TCE and 1,1,2,2-PCA in the area of investigation are summarized on Figures 5 and 6, and support the conceptual model. The field activities proposed in this plan will better define the site conceptual model:

- The potential DNAPL corresponding to the area of investigation could have been released within disposal areas on Dunn Field in the area of soil borings SBLCA, SBLCB and SBLCD (see Figures 5 and 6). Boring SBLCA had maximum subsurface concentrations of TCE (18 milligrams per kilogram [mg/kg]) and 1,1,2,2-PCA (33 mg/kg) in the 28- to 30-ft bgs sample interval (Figures 5 and 6);
- Potential DNAPL transport would be vertical from the disposal area down through the loess and into the fluvial sands, and finally into the underlying fluvial aquifer (see Figure 4);
- Potential DNAPL could move horizontally when discontinuous clay lenses (several inches to 1.5-ft thick) impede the vertical movement in the vadose zone. Horizontal transport within the unsaturated zone could move the DNAPL off-site without elevated concentrations detected within the underlying aquifer;
- The horizontal movement of the potential DNAPL would be dictated by the slope and configuration of the impeding clay layers (unsaturated and/or saturated) and could be independent of the groundwater flow direction;

- The vertical component of movement for any DNAPL would ultimately be contained by the continuous clay confining unit present in the area of investigation; and
- Off-site DNAPL concentrations may result from the mobilization of on-site sources during groundwater pumping.

Methodology

Drilling, well installation and development, and sampling procedures will follow the guidelines set forth in: (1) Depot's Generic Quality Assurance Project Plan (QAPP) of 1995 (QAPP); (2) Draft Final Work Plan for the CWM at Dunn Field, dated November 1999; and (3) U.S. EPA Region IV Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), dated May 1996 (revised in 1997).

Preliminary Screening and Exploratory Borings

The area upgradient, downgradient, and near MW-70 will be investigated using a series of borings that will be advanced to the top of the confining unit clay located approximately 80 to 95-feet bgs. Ten to 15 soil borings are anticipated. The proposed locations of the borings are shown on Figure 7, though the locations may vary based on observed field conditions or safety limitations posed by the overhead powerline corridor that bisects the area of investigation. The proposed drilling techniques include using either: (1) hollow stem drilling techniques with a 5-ft continuous core sampler that is advanced along with the augers, that can be retrieved from of the inner-casing of the augers for sample collection; or (2) rotasonic drilling techniques with a continuous inner-casing sampling core.

Considerations in determining the drilling technique to be used to install soil borings and wells include availability of contractors, cost, and technical justification. Drilling experience at Dunn Field suggests that rotasonic drilling provides a more precise drilling technique that will be important for identifying the interbedded clay strata and that there is less investigation-derived waste (IDW) produced. However, considerable heat—that could affect VOC concentrations in the soil—is generated during the drilling process. In addition, the cost is greater than conventional drilling techniques and there are no local contractors that provide the service. Hollow-stem drillings were successfully used during the recent installation of off-site wells MW-68 through MW-71 with a local drilling contractor. Hollow-stem auger drilling problems associated with heaving fluvial sands have been reported with deeper (>100 ft) wells; however, the depths of <100 bgs are expected during this field effort. Based on the successful completion of wells MW-68 through MW-71, it is recommended that hollow-stem drilling techniques be used for the installation of the soil borings and monitoring wells.

The ground surface elevation at each potential location will be pre-surveyed, so the elevation of the underlying clay layers encountered can be determined in the field. The elevations of the clay layers will dictate the location and quantity of subsequent borings. Continuous sampling will be conducted at each boring location beginning at the surface for locations upgradient of MW-70 and at 50-feet bgs for borings near or downgradient of MW-70. Headspace field screening will be conducted at 5-ft intervals using an organic vapor analyzer (OVA) equipped with an FID until the confining unit clay is encountered (an OVA-FID headspace screening SOP is included in Appendix B). Soil samples that exhibit elevated headspace readings will be subjected to a shake test using a hydrophobic dye (Sudan IV dye) that turns bright red in the presence of DNAPL (a Sudan IV dye shake test SOP is included in Appendix B). Soil samples for laboratory analysis for VOCs (SW-846 Method 8260B) will be collected at the upper interface of each clay layer or low permeability strata that indicates the presence of DNAPL or elevated headspace field screening readings (an EnCore sampling SOP is included in Appendix B).

A local, certified laboratory will be used and the analytical turnaround time will be 12 to 24 hours; these laboratory results will be used to determine the placement of additional borings and/or monitoring wells. It is anticipated that based on 10 to 15 soil borings, that 10 to 37 soil samples will be collected for laboratory VOC analysis. Twenty percent of the samples collected will be split with the contract laboratory (Columbia Analytical Services in Redding, California) that has been selected and historically used for the RI at Dunn Field.

Monitoring Well Installation

Some of the soil borings will be converted to monitoring wells based on the results of the lithology logging, clay orientation, known groundwater gradient, field screening of soil samples, and laboratory analyses of the confirmation soil samples. The potential locations of the monitoring wells are shown on Figure 8; however, exact locations will be determined after consultation with the USACE and members of the BCT. Three to 5 additional monitoring wells are anticipated to be installed using 2-inch-diameter polyvinyl chloride (PVC) screen and riser, with 0.01-inch continuously slotted screen. Stainless steel well screens will be used in lieu of PVC in areas where DNAPL is confirmed. The placement of the bottom and screened interval of each well will be determined in the field based on the information gathered during preliminary screening of the soil borings.

Monitoring well construction will be based on the observed stratigraphy. It is anticipated that the complete saturated thickness interval will be screened, unless there is field evidence that an overlying clay strata is impeding the vertical migration of DNAPL or dissolved VOCs. If this is encountered within the fluvial aquifer, then the soil boring and bottom of the well screen will be completed on the top of the overlying clay strata. A double-cased monitoring well will then be nested adjacent to this shallow well within the underlying portion of the fluvial aquifer. The referenced overlying clay layer will be cased-off in this circumstance, and the soil boring and bottom of the well screen will be completed on the top of the confining clay unit (beneath the overlying clay layer). All soil borings not completed as monitoring wells will be plugged and abandoned with grout tremmied from the bottom up to the land surface.

Based on logged stratigraphy throughout Dunn Field, it is anticipated that a small number (one or two) clay lenses will be observed in the saturated and unsaturated portions of the fluvial aquifer and deposits. However, if numerous clay lenses are observed (>3) in the aquifer, use of diffusion sampling may be used as an option to multiple well installation or isolation of the clay layers as discussed above, in order to collect discrete water samples associated with each the clay layers. Diffusion samplers consist of polyethylene bags filled with deionized water, which are lowered into the well screen. The concentration gradient between the VOCs in the well and the water-filled bag result in an osmotic pressure on the polyethylene membrane and eventually the diffusion of contaminants into the sampler. The diffusion samplers would be installed in a continuous screen throughout the saturated thickness and would be placed adjacent to individual clay lenses as well as near the surface and at the base of the saturated thickness. Construction, installation, and sampling of the diffusion samplers will follow the technical approach presented by Vroblesky and Hyde (GWMR, 1997), and the methodology used at NSA Mid-South (EnSafe, 1998). The field data would be presented to the USACE and BCT and their concurrence would be required prior to any decision to use diffusion samplers.

In addition to the wells detailed above, two wells will be installed into the shallow fluvial aquifer on the southwestern portion of Dunn Field in the area of MW-34 and west of Dunn Field, in the area of former soil boring STB-14. Former boring STB-14 is located south of well MW-67 and equal distance between wells MW-34 and MW-43. The purpose of these wells is to confirm the presence of the shallow fluvial aquifer in this area, provide the potentiometric surface of the fluvial aquifer if present, and to provide groundwater quality information.

Following installation, all wells will be developed in accordance with the approved procedures previously established for the RI for OU-1 (Dunn Field). Hydraulic conductivity will also be measured at each well using the rising head pneumatic slug test technique applicable for high conductivity aquifers. A description of the slug testing methodology is provided in the final Groundwater Characterization Data Report (CH2M HILL, August 1997). A sample of aquifer materials will be obtained from the center of the saturated thickness for TOC analysis and grain size distribution.

Potentiometric Surface Mapping

Groundwater levels will be measured in the Dunn Field network of monitoring wells prior to the beginning of field activities and again, prior to groundwater sampling activities. Water levels will be recorded prior to field activities to document groundwater gradients and flow direction. A potentiometric surface map for the fluvial aquifer will be prepared identifying groundwater elevations and the inferred groundwater flow direction.

Sampling

Groundwater samples will be collected from wells in the western area of Dunn Field using sampling procedures developed in the Depot's Generic QAPP of 1995 (QAPP). Before sampling, each well will be purged using a low-flow technique in order to minimize agitation of the groundwater and turbidity, and the field parameters will be stable to within +/- 10% prior to sampling the groundwater. Field measurements will be collected during well purging activities after each well volume is removed and will include dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, pH, temperature, and specific conductance. Wells will be purged and sampled using QED bladder pump systems. The QED bladder pump will be equipped with a high-density polyethylene (HDPE) tubing that is lined on the inside with Teflon. The groundwater indicator parameters during purging will be recorded using a YSI probe equipped with an airtight flow-through cell. An HACH turbidity meter will be used on-site to measure the turbidity of each groundwater sample.

Samples will be collected and analyzed for VOCs via SW-846 Method 8260B. Samples will be collected as soon as enough water recharges into a well after purging. They will be preserved as required and will be delivered to a laboratory within the appropriate holding period. The wells to be sampled are identified in DQO No. 04.

In addition to the groundwater samples, quality assurance/quality control (QA/QC) samples will be collected during the field effort. The QA/QC samples that will be collected include field duplicates, matrix spike/matrix spike duplicate, ambient blanks, equipment blanks, and trip blanks. The quantity of QA/QC samples collected at the site will be determined by the guidelines in the OU1 FSP and Generic QAPP.

The groundwater samples will be analyzed and reported by the laboratory using EPA Level 3 protocols. The laboratory will report the data in both hard copy and electronic format. The laboratory analytical data will be validated by a project chemist according to the guidelines established in the Generic QAPP.

Investigation-Derived Waste

All soil cuttings, development and purge waters, and decontamination water will be drummed. All drums will be labeled and staged at Dunn Field. No drums will be staged off-site of Dunn Field, and all decontamination activities will be performed at the staging area on Dunn Field. Representative samples of the IDW will be collected for subsequent off-site disposal characterization. All IDW will be removed for offsite disposal within 60 days following the completion of the field sampling activities.

Logistics

CH2M HILL will mobilize equipment, supplies, and personnel required to complete the additional investigation at Dunn Field. CH2M HILL will also subcontract personnel and equipment needed to support the proposed fieldwork.

A site coordination meeting will be held before beginning the field effort. Participation will involve Depot, CH2M HILL, U.S. Army Corps of Engineers (USACE), and subcontractor personnel. The meeting will include a discussion of security badges, Depot regulations, field procedures, field schedules, and a site health and safety plan review. An addendum for the Site Health and Safety Plan will be prepared under separate cover prior to field activities.

Schedule

The following preliminary schedule is presented for the proposed field activities and preparation of the draft final RI report for Dunn Field, which will present the findings from this additional investigation.

Task	Date Started	Date Completed
Present Approach to BCT		April 19, 2000A
Submit Draft Amended Work Plan	April 20, 2000A	May 10, 2000A
Onboard Review of Work Plan at the BCT Meeting		May 17-18, 2000A
Submit Final Amended Work Plan		June 30,2000A
BCT Review of Final Amended Work Plan	June 30, 2000	July 12, 2000
BCT Amended Work Plan Approval		July 12, 2000
Negotiate Private Property Access Agreement	March 28, 2000A	May 28, 2000A
Receive Private Property Access Agreement		June 30, 2000
Obtain Right of Way Access with City of Memphis	June 14, 2000A	July 7, 2000
Mobilize and Pre-Survey Proposed Drilling Locations	July 12, 2000	July 14, 2000
Install Soil Borings, Conduct Field Screening, and Laboratory Screening Analyses	July 17, 2000	July 27, 2000
Weekly Field Status Report to USACE & BCT and Teleconference to Discuss Field Results		July 21, 2000
Well Installation and Development	July 28, 2000	August 11, 2000
Weekly Field Status Report to USACE & BCT and Teleconference to Discuss Field Results		July 28, 2000
Groundwater Sampling	August 14, 2000	August 17, 2000
Laboratory Analyses	July 20, 2000	September 7, 2000
Laboratory Data Evaluation	August 10, 2000	September 21, 2000
Draft Final RI Report Prep	August 21, 2000	November 2, 2000
Submit Draft Final Dunn Field RI		November 3, 2000
Agency Review	November 3, 2000	December 4, 2000
Agency Submit Comment of Draft Final RI		December 4, 2000
Submit Final Dunn Field RI		December 21, 2000

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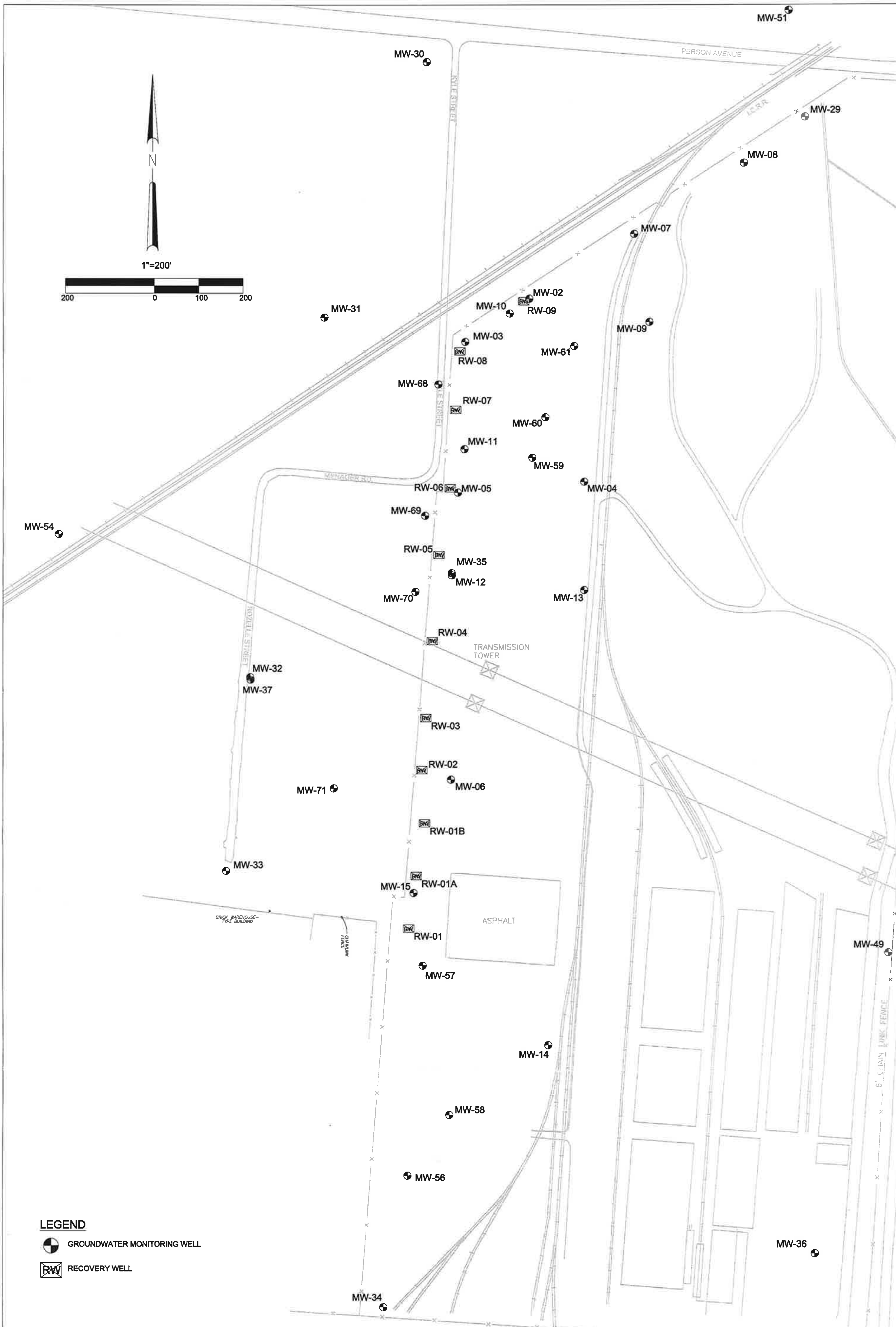
TABLE 1
SAMPLING AND ANALYTICAL SUMMARY

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample No	Sampling Method	Sampling Equipment	TAT	DQO Level/ Data Package Reqmnt	Required Analysis	Analytical Method	Holding Time	Sample Preservtn	Containers
Dunn Field Soil Borings													
Soil Boring Sampling - Screening Samples	Upper Interface with Clay Layers or Areas of Low-Permeability	Soil	Approximately 1 to 2 per Soil Boring	10 to 30 Samples + 1 to 3 Dups (@ 10%) Total = 11 to 50	Discrete samples from Soil Core Barrel	Encore samplers	12-24 hour	DQO Level II	TCL Volatiles	SW-846 Method 8260B	14 days	Cool to 4°C	(3) 5g Encore Samplers
Soil Boring Sampling - Split Confirmation Samples	Upper Interface with Clay Layers or Areas of Low-Permeability	Soil	20% of the Screening Samples	2 to 6 Samples + 1 Dup (@ 10%) Total = 3 to 7	Split Discrete Samples from Soil Core Barrel	Encore samplers	14 days	DQO Level IIi	TCL Volatiles	SW-846 Method 8260B	14 days	Cool to 4°C	(3) 5g Encore Samplers
Soil Boring Sampling	Saturated Portion of the Fluvial Aquifer in Each Soil Boring	Soil	Samples from 5 select borings	10 to 15	1 Composite Sample from per Boring	SS spoon, SS bowl	14 days	DQO Level III	Total Organic Carbon	SW-846 Method 9060	14 days	Cool to 4°C	(1) 8 oz glass
									Sieve Analysis	ASTM C136-96a	NA	None	(1) 16 oz glass
	Pre-Equipment Rinsate Blank	Water	1 per set of pre-cleaned equipment	1	Prepared in Field	Analyte-free water, SS funnel	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial
	Post-Equipment Rinsate Blank	Water	1 per set of pre-cleaned equipment	1	Prepared in Field	Analyte-free water, SS funnel	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial
	Trip Blanks	Water	1 per shipment of VOCs	1 to 3	Prepared in Lab		14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial
Groundwater Samples													
Groundwater Sampling	Monitoring Wells	Groundwater	1 per well	12 Samples + 2 Dups (@ 10%) Total = 14	Pumping/ bailing	Bladder pumps/bailers	14 days	DQO Level III	TCL Volatiles	8260B	14 days	Cool to 4°C	(2) 40 ml vial
									Dissolved Oxygen	Field Screening	NA	NA	NA
									ORP	Field Screening	NA	NA	NA
									Turbidity	Field Screening	NA	NA	NA
									pH	Field Screening	NA	NA	NA
									Temperature	Field Screening	NA	NA	NA
									Specific Conductivity	Field Screening	NA	NA	NA
	Pre-Equipment Rinsate Blank	Water	1 per set of pre-cleaned equipment	1	Prepared in Field	Analyte-free water, SS funnel	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial
	Post-Equipment Rinsate Blank	Water	1 per set of pre-cleaned equipment	1	Prepared in Field	Analyte-free water, SS funnel	14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial
	Trip Blanks	Water	1 per shipment of VOCs	3	Prepared in Lab		14 days	DQO Level III	TCL Volatiles	8260B	14 days	HCl pH<2; Cool to 4°C	(2) 40 ml vial



LEGEND

- GROUNDWATER MONITORING WELL
- RW RECOVERY WELL

DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

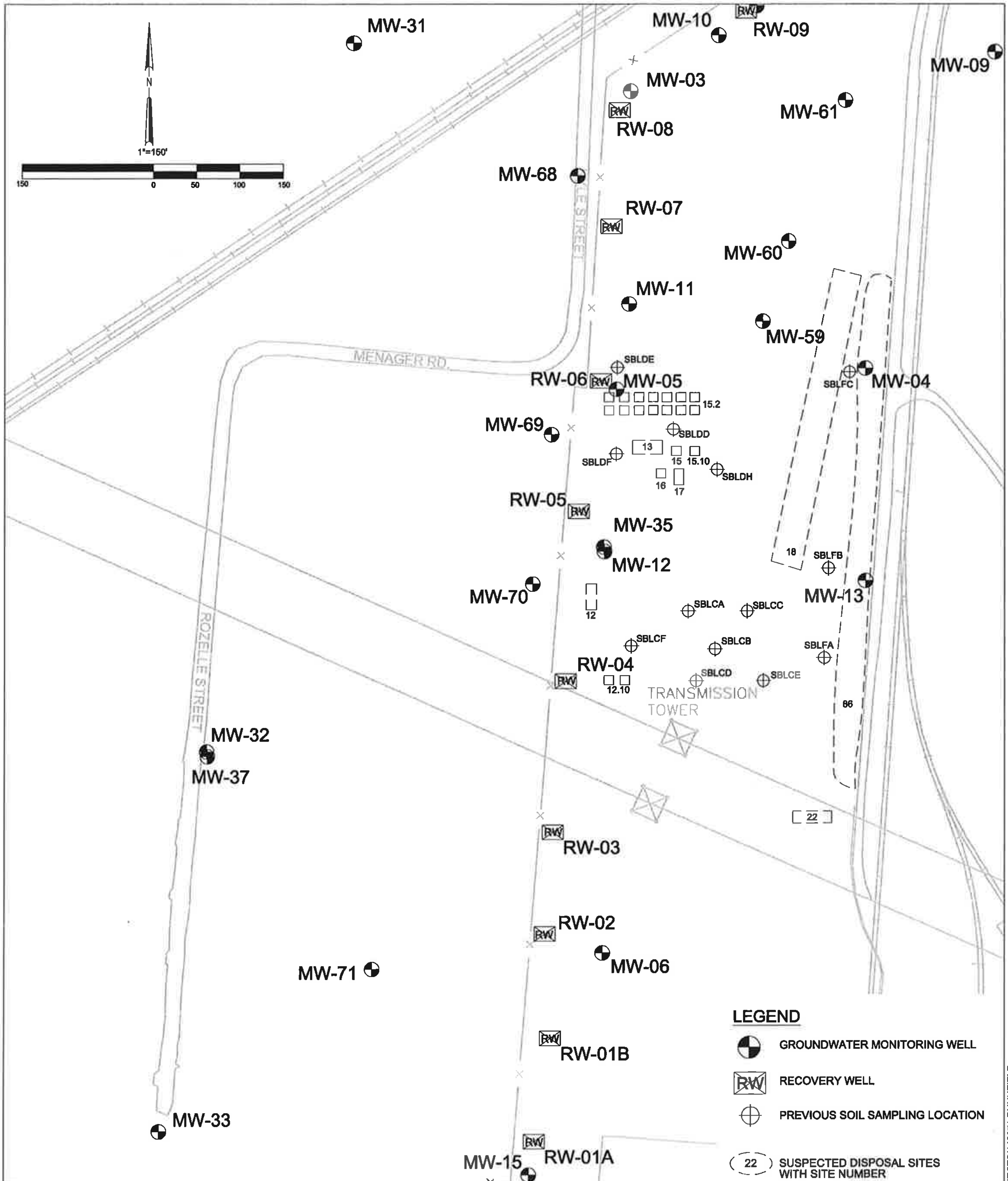
CH2MHILL

FIGURE 1

Western Portion of Dunn Field
Memphis Depot, Tennessee

5-9-2000 8071C001.dwg

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD



DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

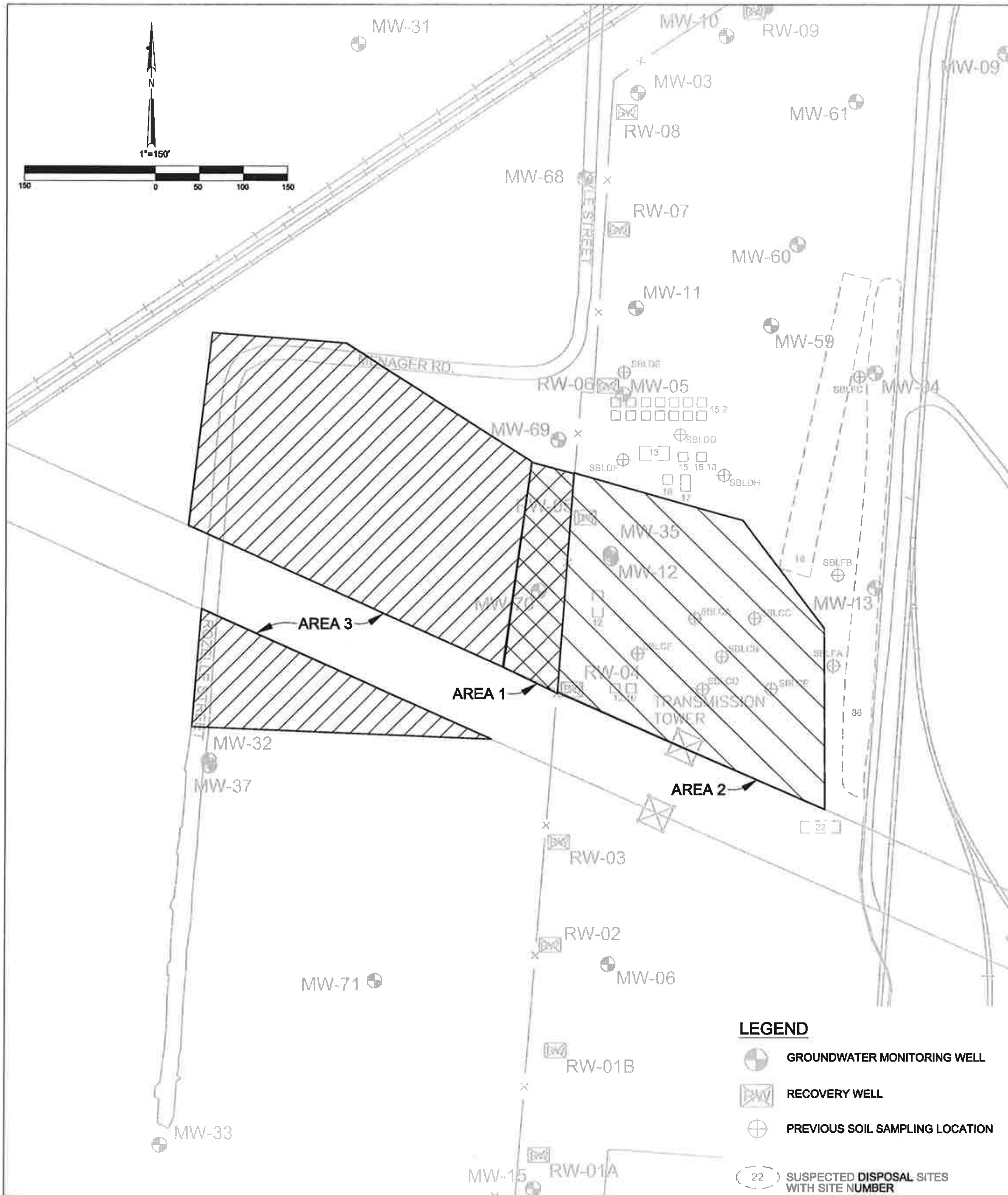
CH2MHILL

FIGURE 2
SITE LOCATION PLAN

Dunn Field
Memphis Depot, Tennessee

5-10-2000 8071C002.dwg

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD



DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

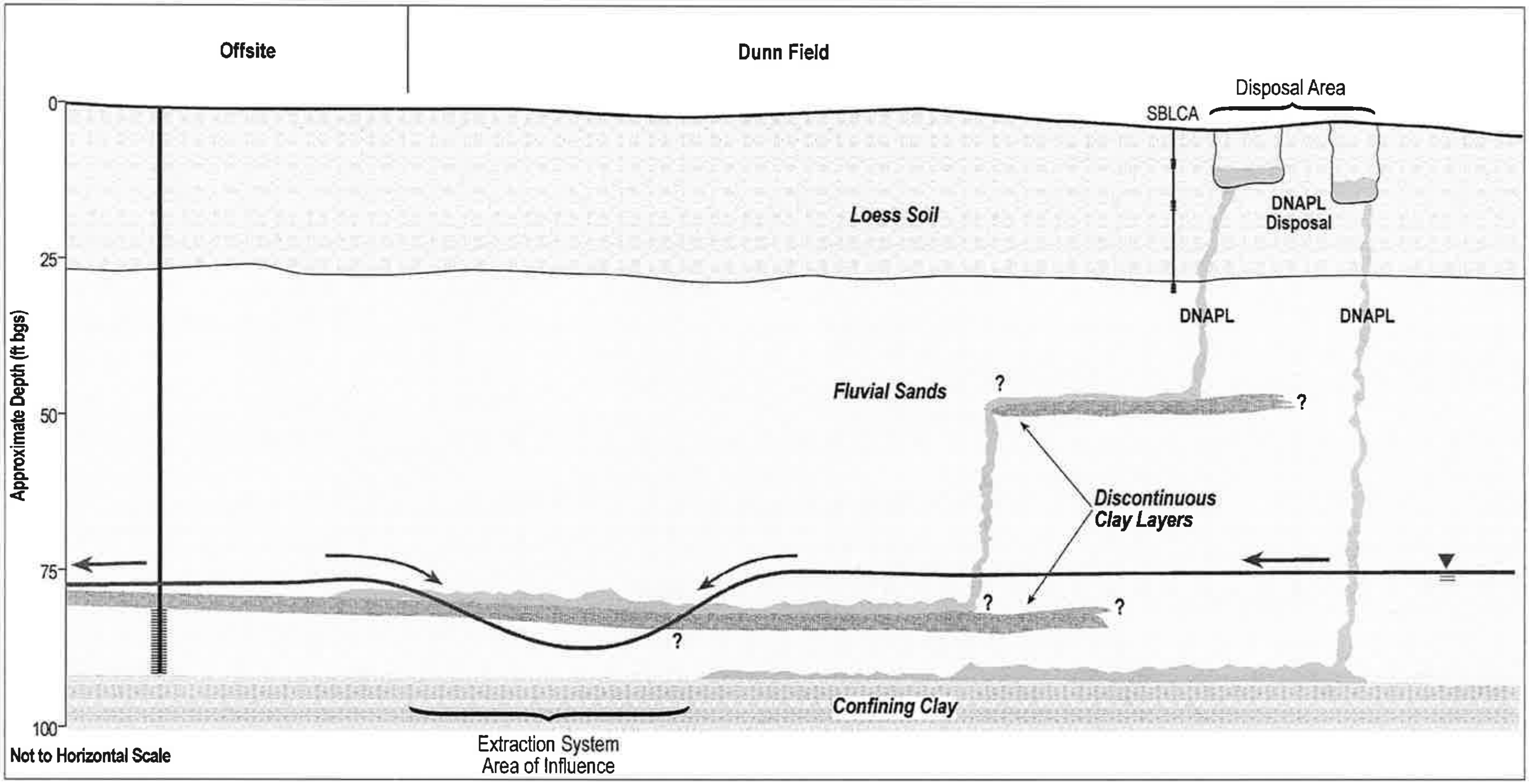
CH2MHILL

FIGURE 3
AREAS OF INVESTIGATION

Dunn Field
Memphis Depot, Tennessee

5-10-2000 8071C003.dwg

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD



DSGN	G. UNDERBERG
DR	L. KRISTICH
CHK	G. UNDERBERG
APVD	S. OFFNER

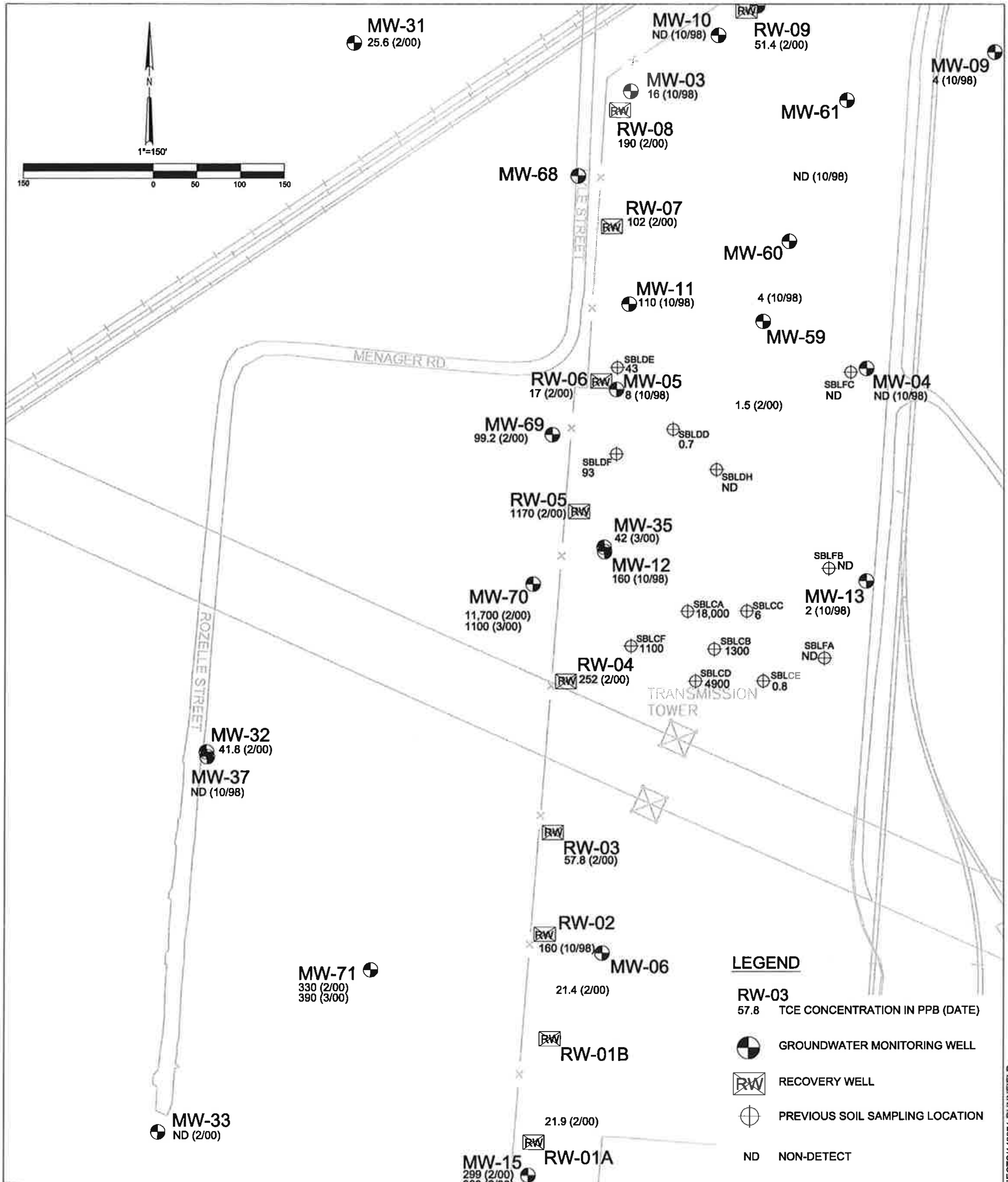
CH2MHILL

FIGURE 4
CONCEPTUAL MODEL

Dunn Field
Memphis Depot, Tennessee

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD

5-10-2000 8071C004.dwg



DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

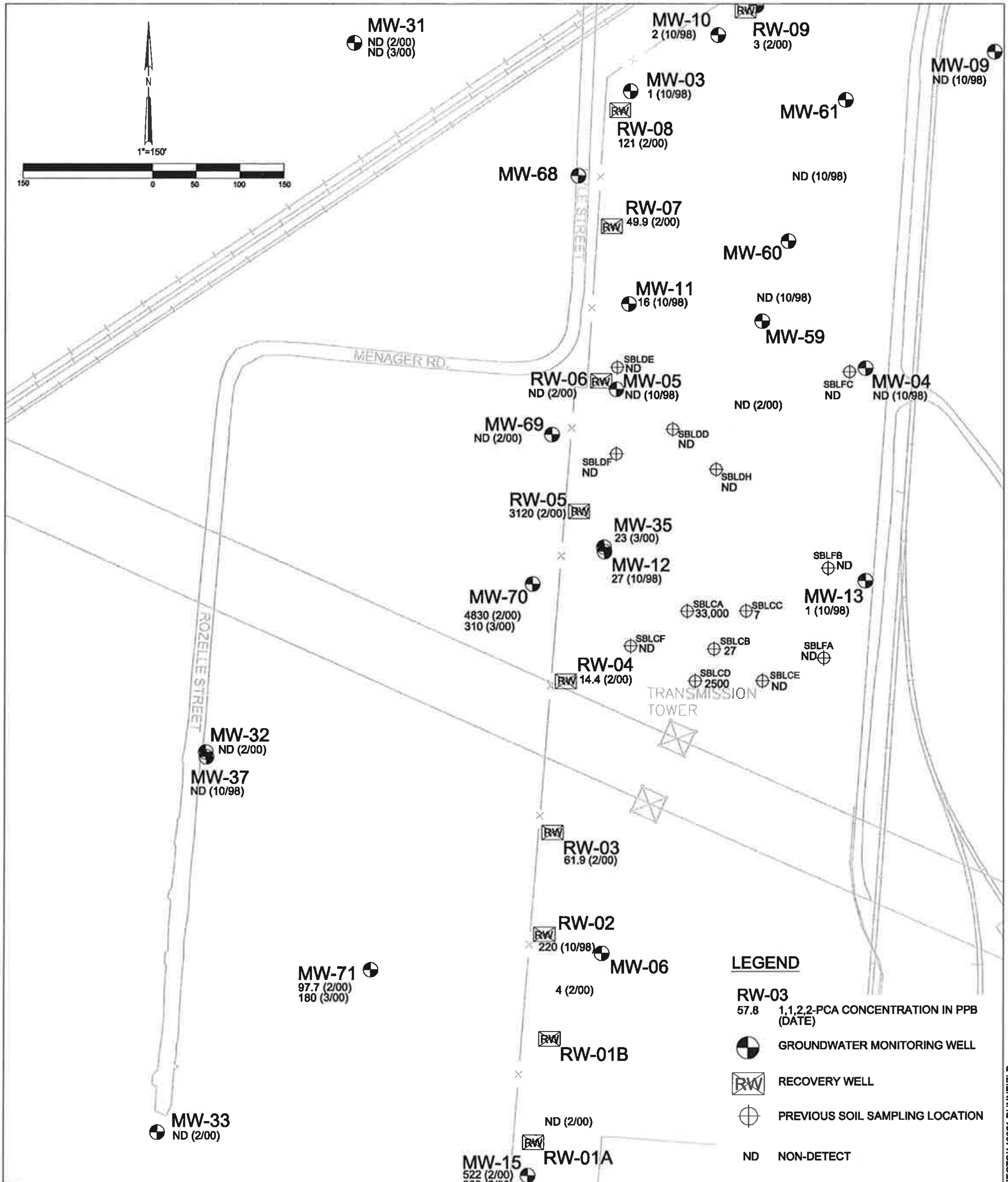
CH2MHILL

FIGURE 5
TCE CONCENTRATIONS

Dunn Field
Memphis Depot, Tennessee

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD

5-10-2000 8071C005.dwg



DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

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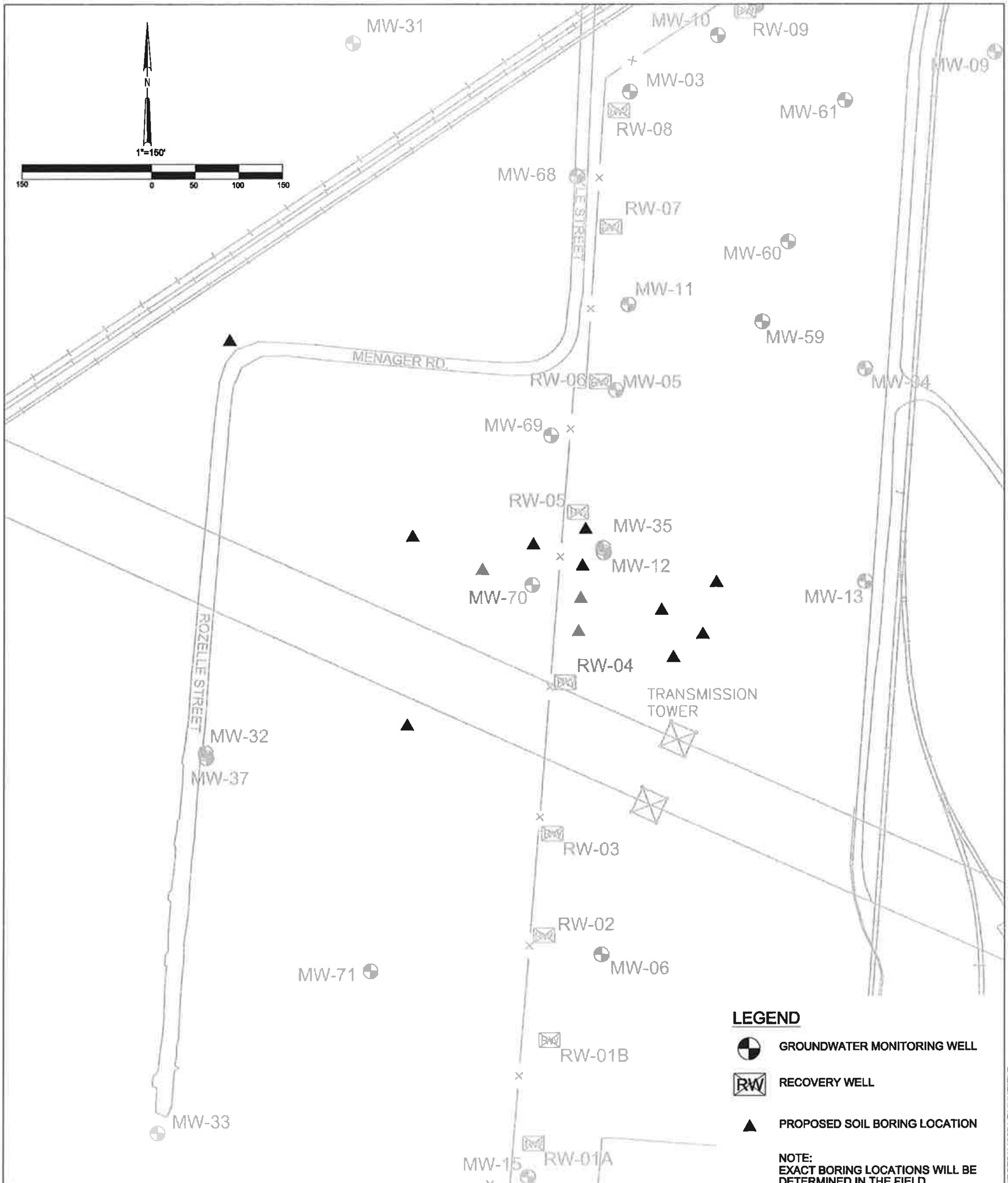
FIGURE 6
1,1,2,2-PCA CONCENTRATIONS

Dunn Field
Memphis Depot, Tennessee

5-10-2000 8071C006.dwg

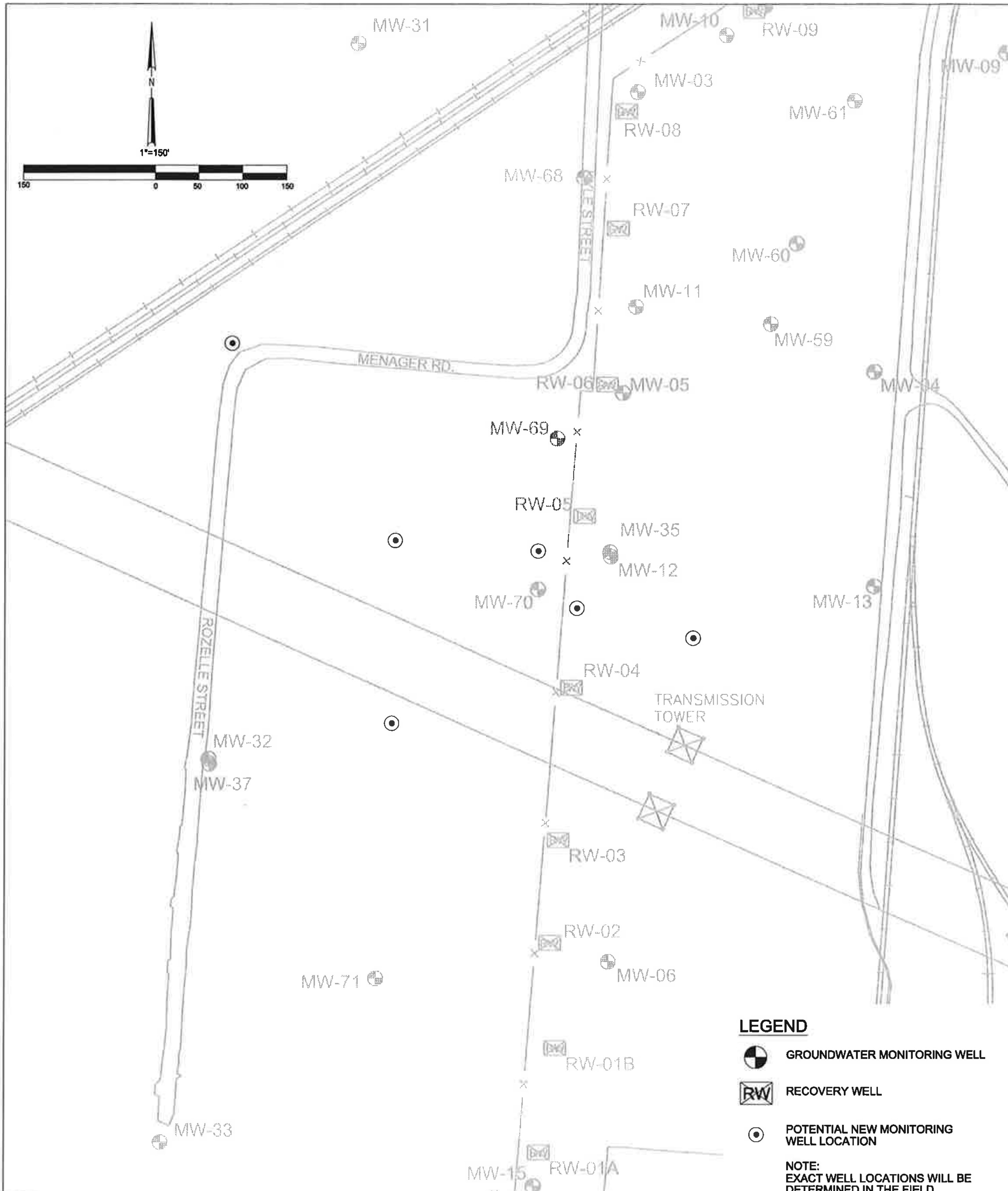
ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD



DSGN	B. BURKINGSTOCK	CH2MHILL	FIGURE 7 PROPOSED INITIAL SOIL BORING LOCATIONS Dunn Field Memphis Depot, Tennessee
DR	M. HALES		
CHK	S. OFFNER		
APVD	S. OFFNER		

6-28-2000 8071C007.dwg

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD



DSGN	B. BURKINGSTOCK
DR	M. HALES
CHK	S. OFFNER
APVD	S. OFFNER

CH2MHILL

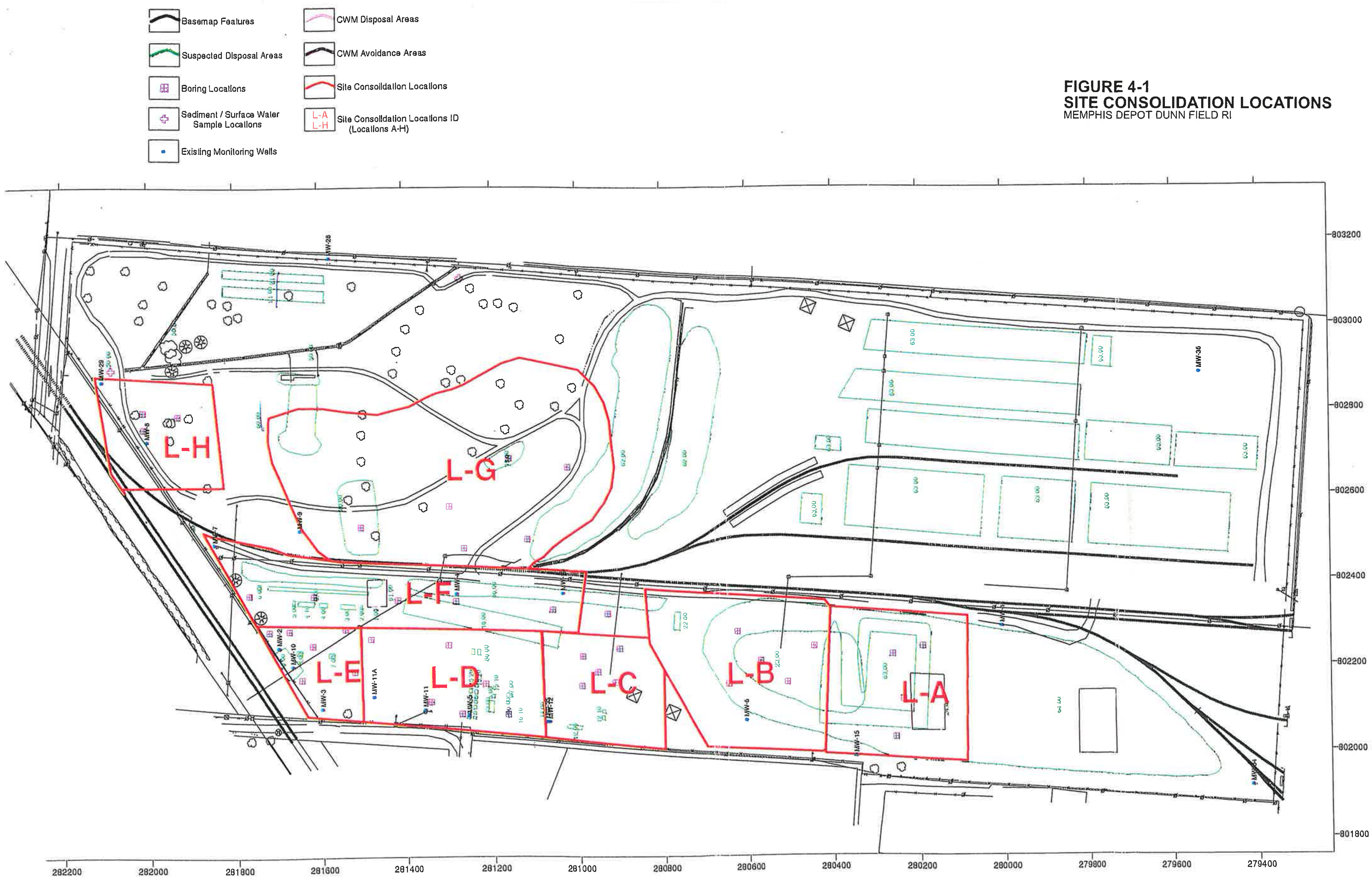
FIGURE 8
POTENTIAL LOCATIONS OF NEW MONITORING WELLS

Dunn Field
Memphis Depot, Tennessee

5-10-2000 8071C008.dwg

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD

FIGURE 4-1
SITE CONSOLIDATION LOCATIONS
MEMPHIS DEPOT DUNN FIELD RI



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

E081999003ATL \ Format-11x17.FH8

CH2MHILL

FIGURE 4-6
PASSIVE SOIL GAS SURVEY
TRICHLOROETHYLENE (TCE)
MEMPHIS DEPOT DUNN FIELD RI

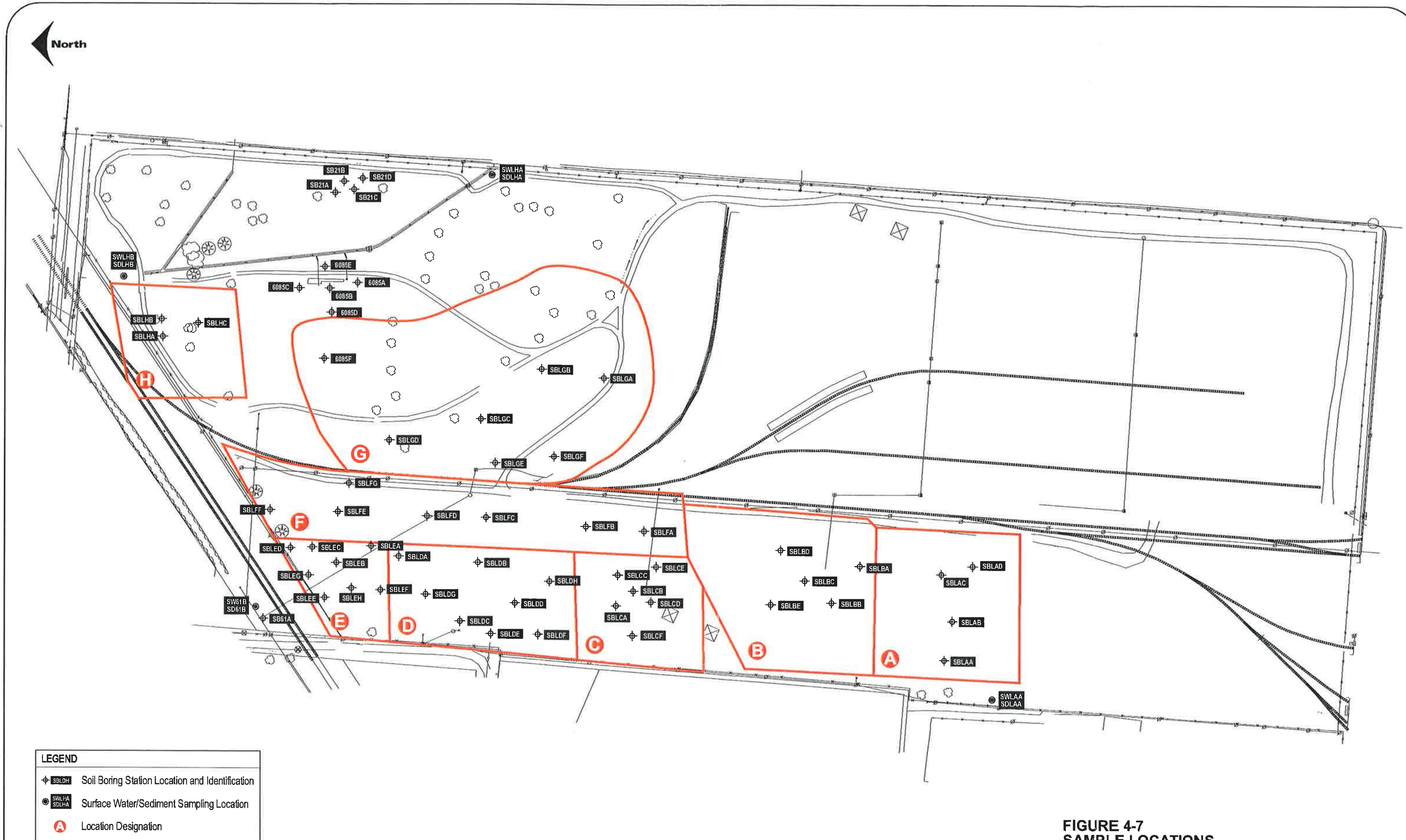


FIGURE 4-7
SAMPLE LOCATIONS
NORTHEAST OPEN AND DISPOSAL AREAS
MEMPHIS DEPOT DUNN FIELD RI

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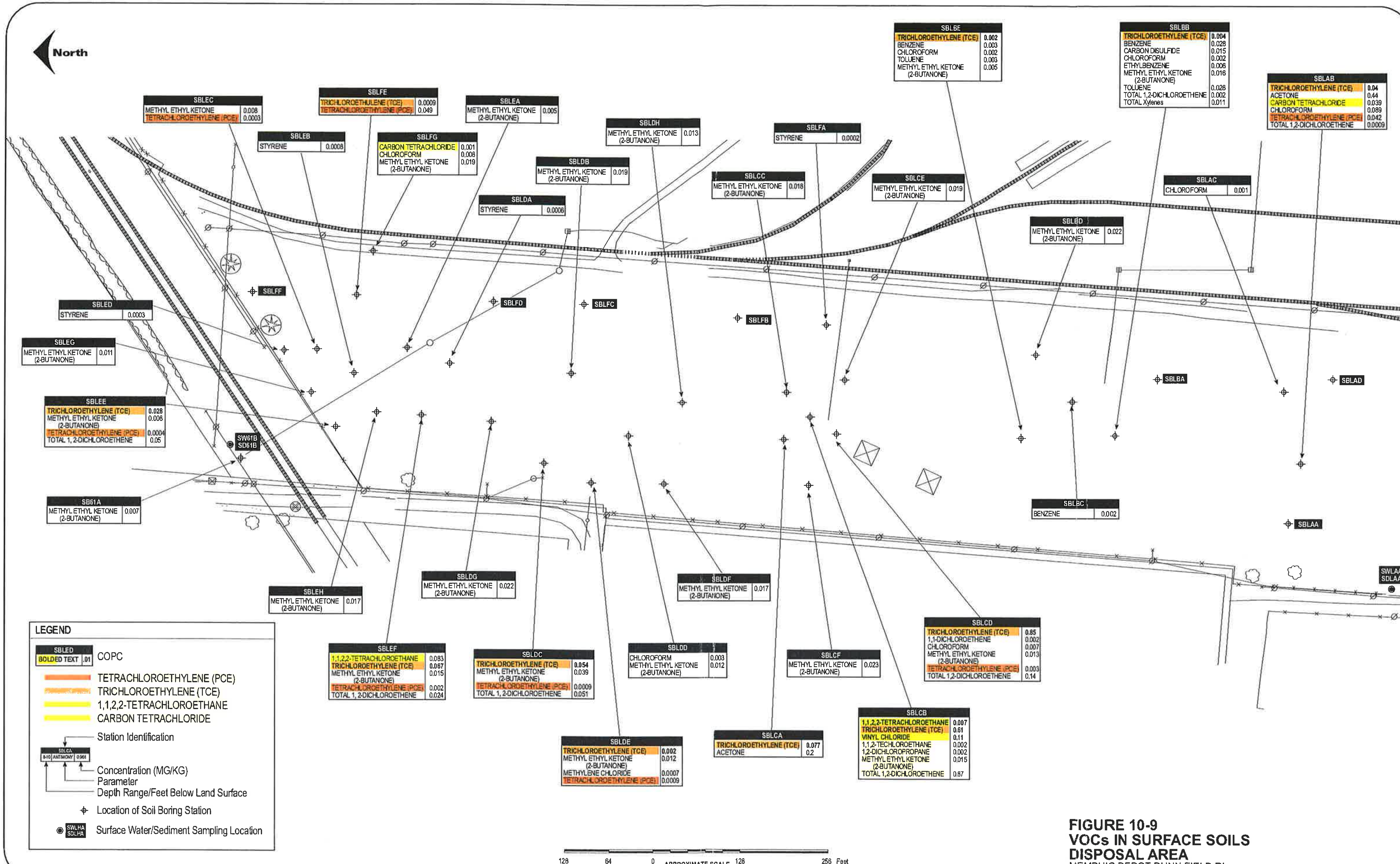


FIGURE 10-9
VOCs IN SURFACE SOILS
DISPOSAL AREA
MEMPHIS DEPOT DUNN FIELD RI

E081999003ATL \ Dunn113.FH8

CH2MHILL

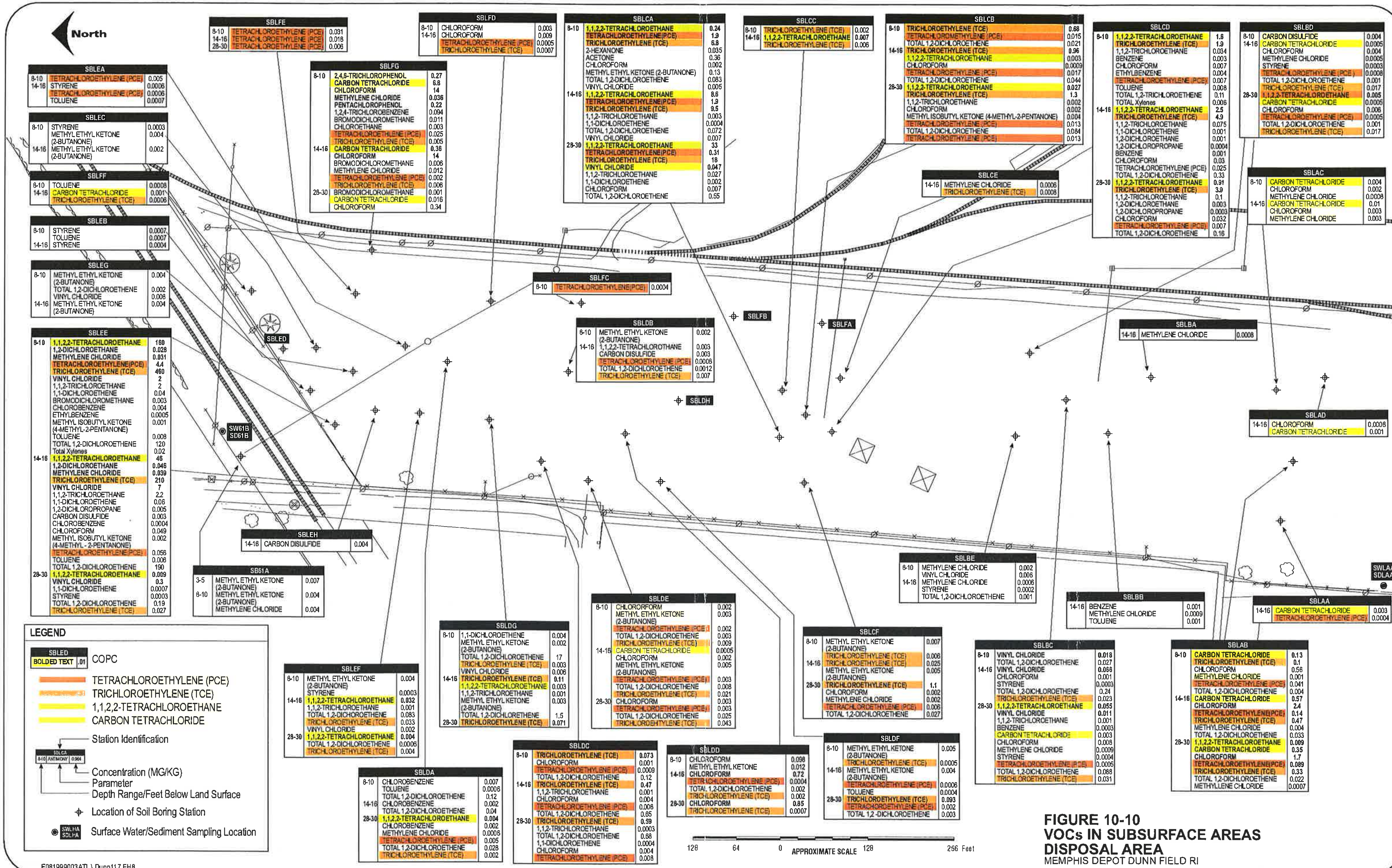
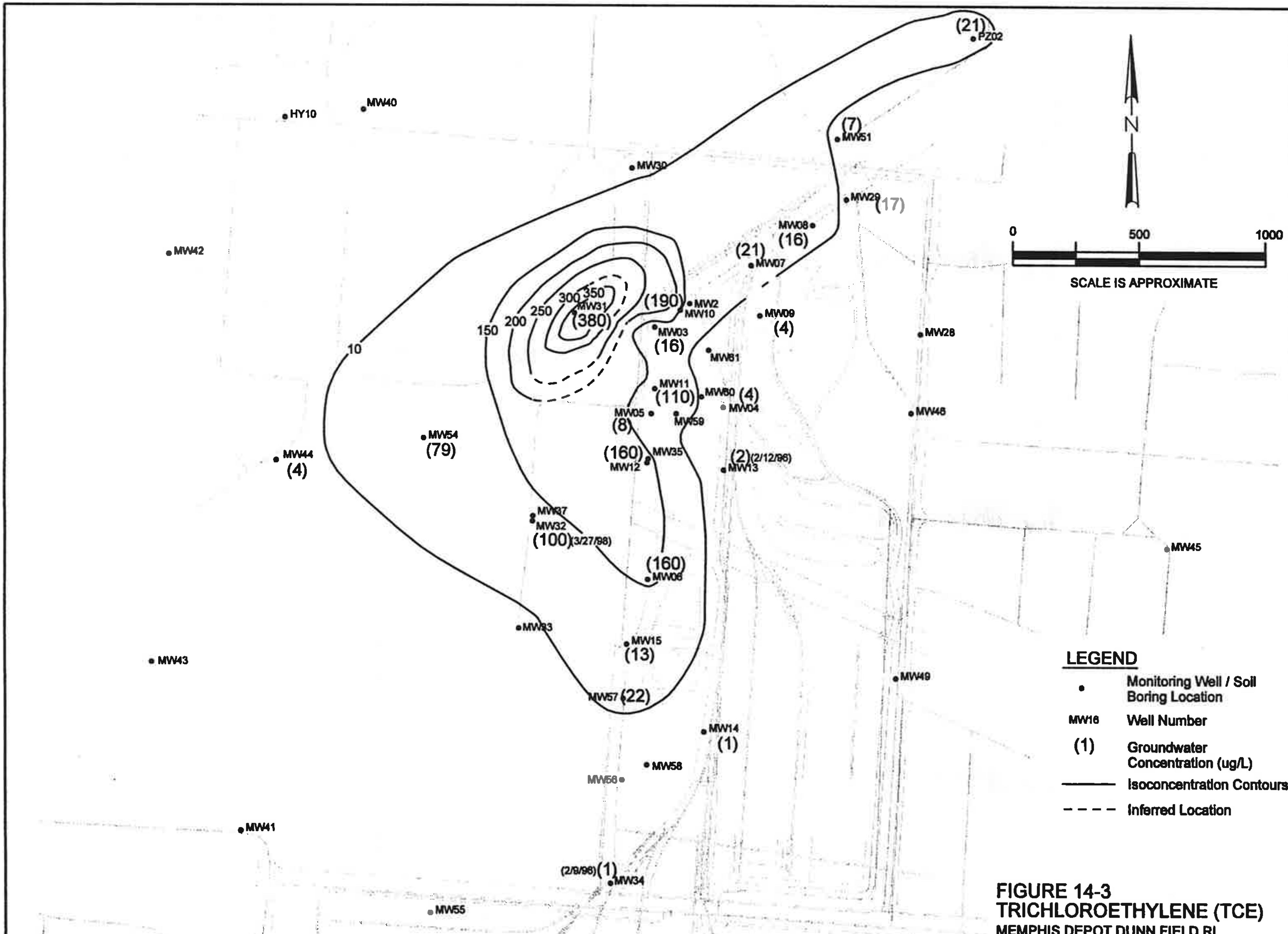


FIGURE 10-10
VOCs IN SUBSURFACE AREAS
DISPOSAL AREA
MEMPHIS DEPOT DUNN FIELD RI



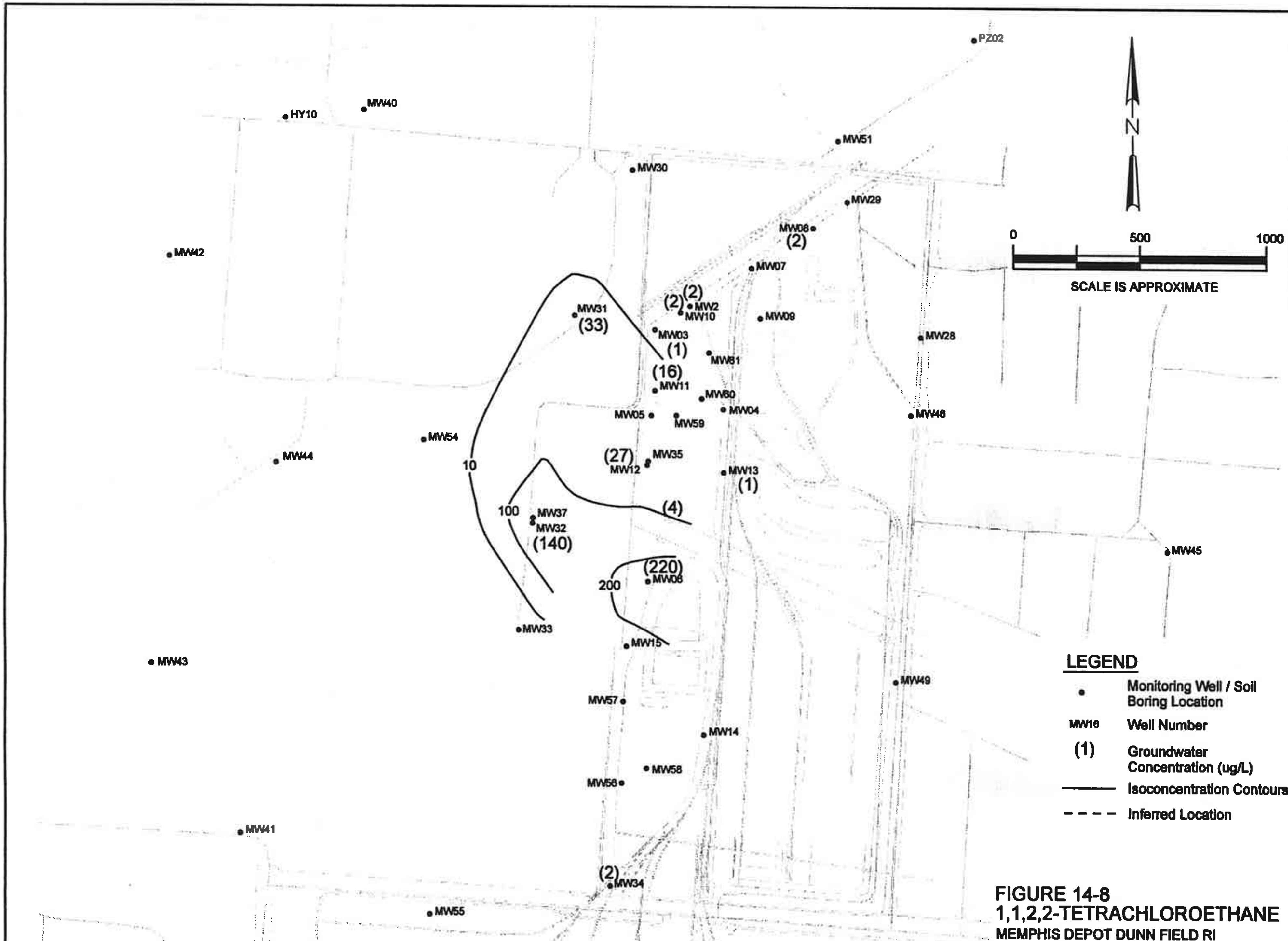
Note: All monitoring wells have been sampled for VOCs.
Those not listed with a detection are non-detects for VOCs.

FIGURE 14-3
TRICHLOROETHYLENE (TCE)
MEMPHIS DEPOT DUNN FIELD RI
(OCTOBER 1998)

CH2MHILL

ATLANTA/CAD1/PROJECTS/148071 DUNNFIELD

09-MAR-2000 8071fig8.dgn



Note: All monitoring wells have been sampled for VOCs.
Those not listed with a detection are non-detects for VOCs.

FIGURE 14-8
1,1,2,2-TETRACHLOROETHANE
MEMPHIS DEPOT DUNN FIELD RI
(OCTOBER 1998)

CH2MHILL

09-MAR-2000 8071fig9.dgn

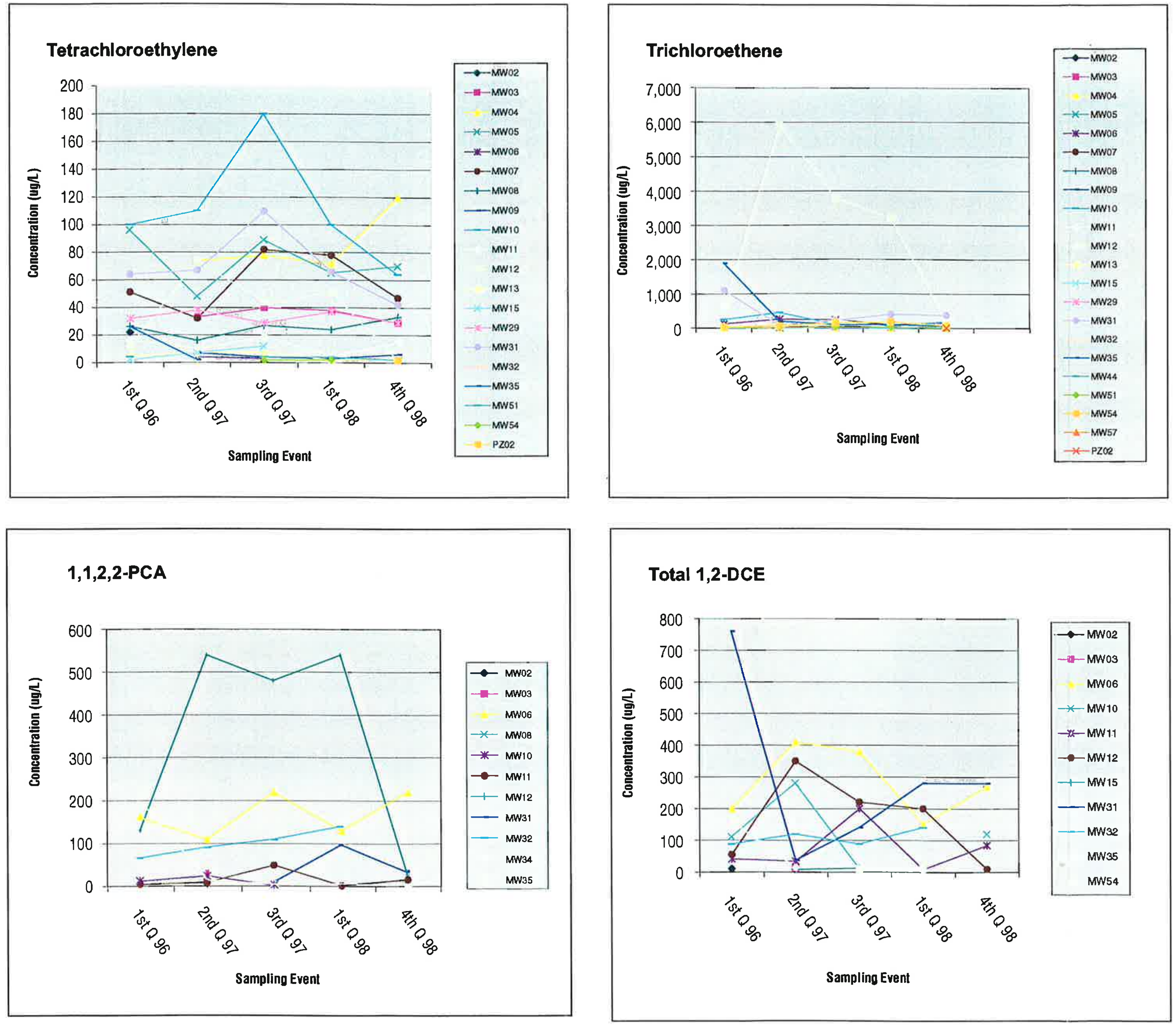


FIGURE 14-10 A
GROUNDWATER TRENDS
MEMPHIS DEPOT DUNN FIELD RI

E081999003ATL \ Dunn105.FH8

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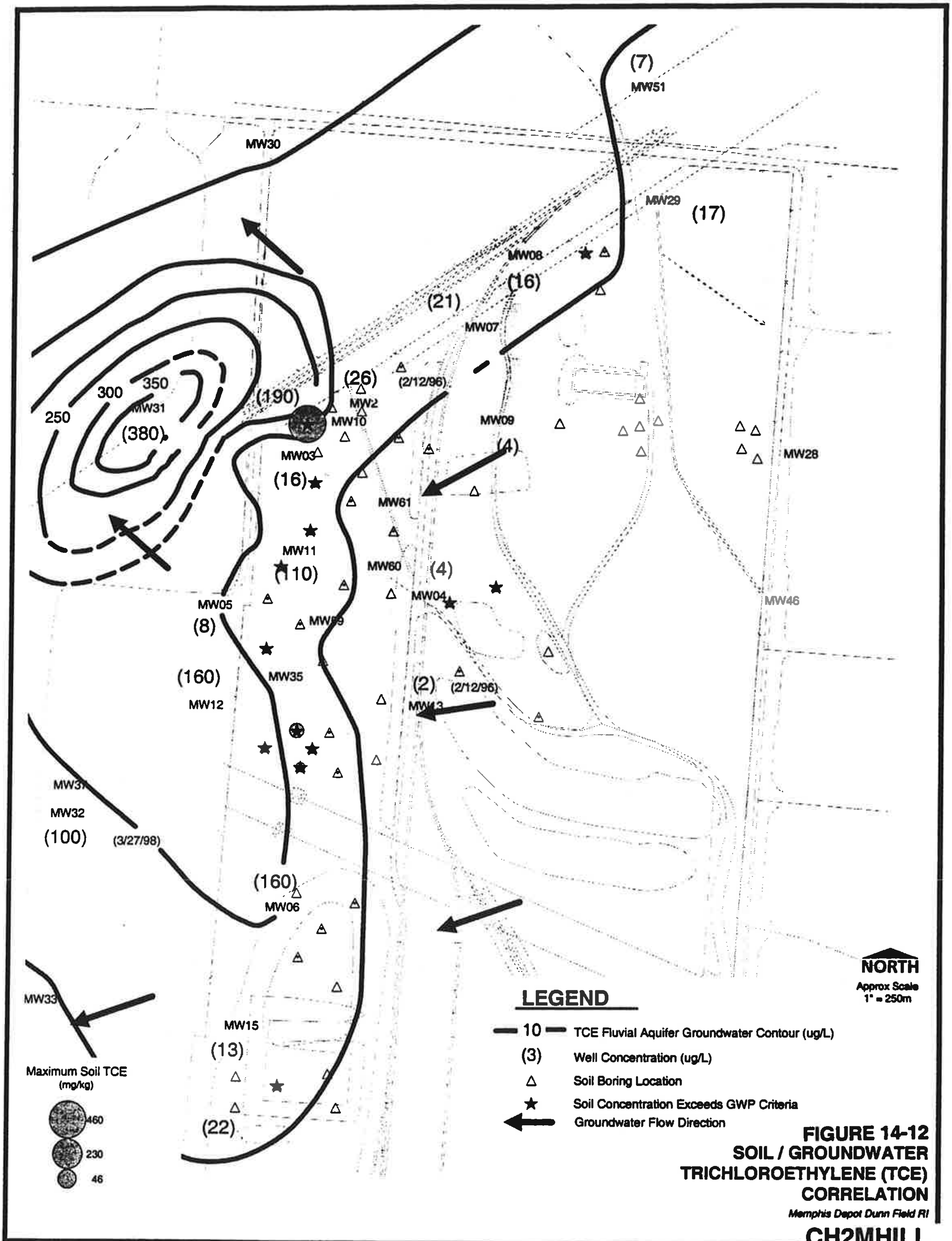

FIGURE 14-12
SOIL / GROUNDWATER TRICHLOROETHYLENE (TCE) CORRELATION
Memphis Depot Dunn Field RI

CH2MHILL

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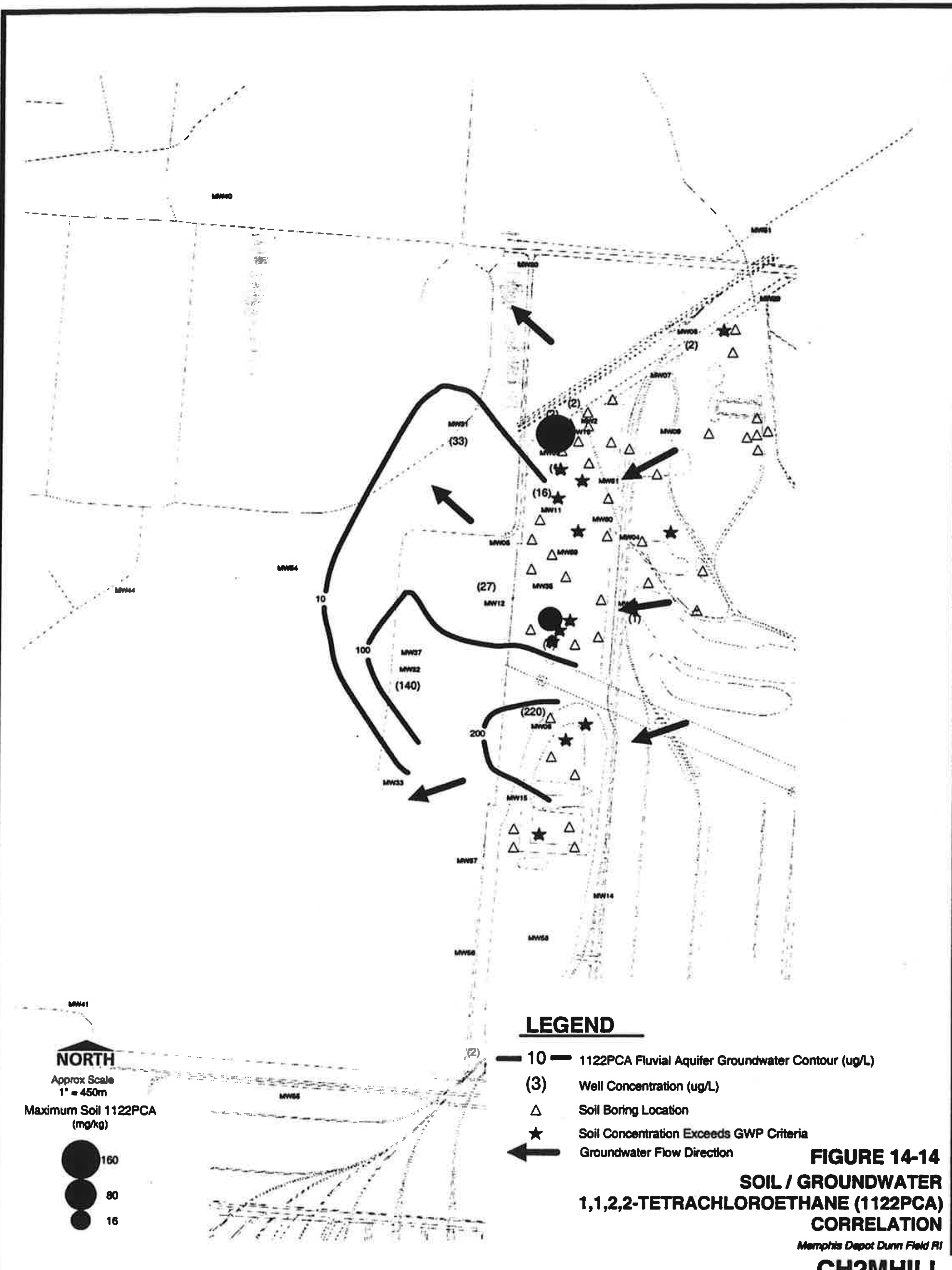

FIGURE 14-14
SOIL / GROUNDWATER
1,1,2,2-TETRACHLOROETHANE (1122PCA)
CORRELATION
Memphis Depot Dunn Field RI

CH2MHILL

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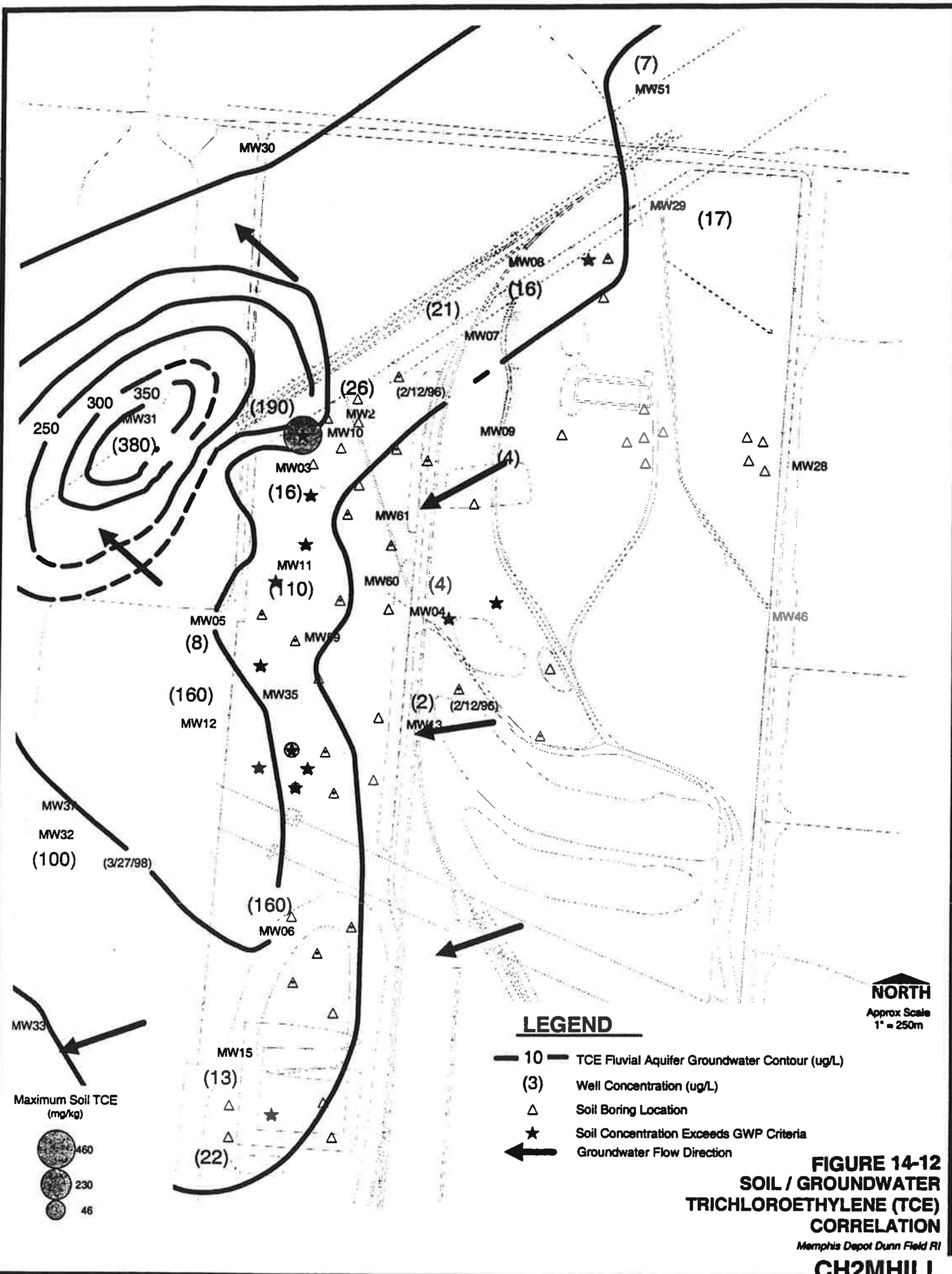

FIGURE 14-12
SOIL / GROUNDWATER TRICHLOROETHYLENE (TCE) CORRELATION

Memphis Depot Dunn Field RI

CH2MHILL

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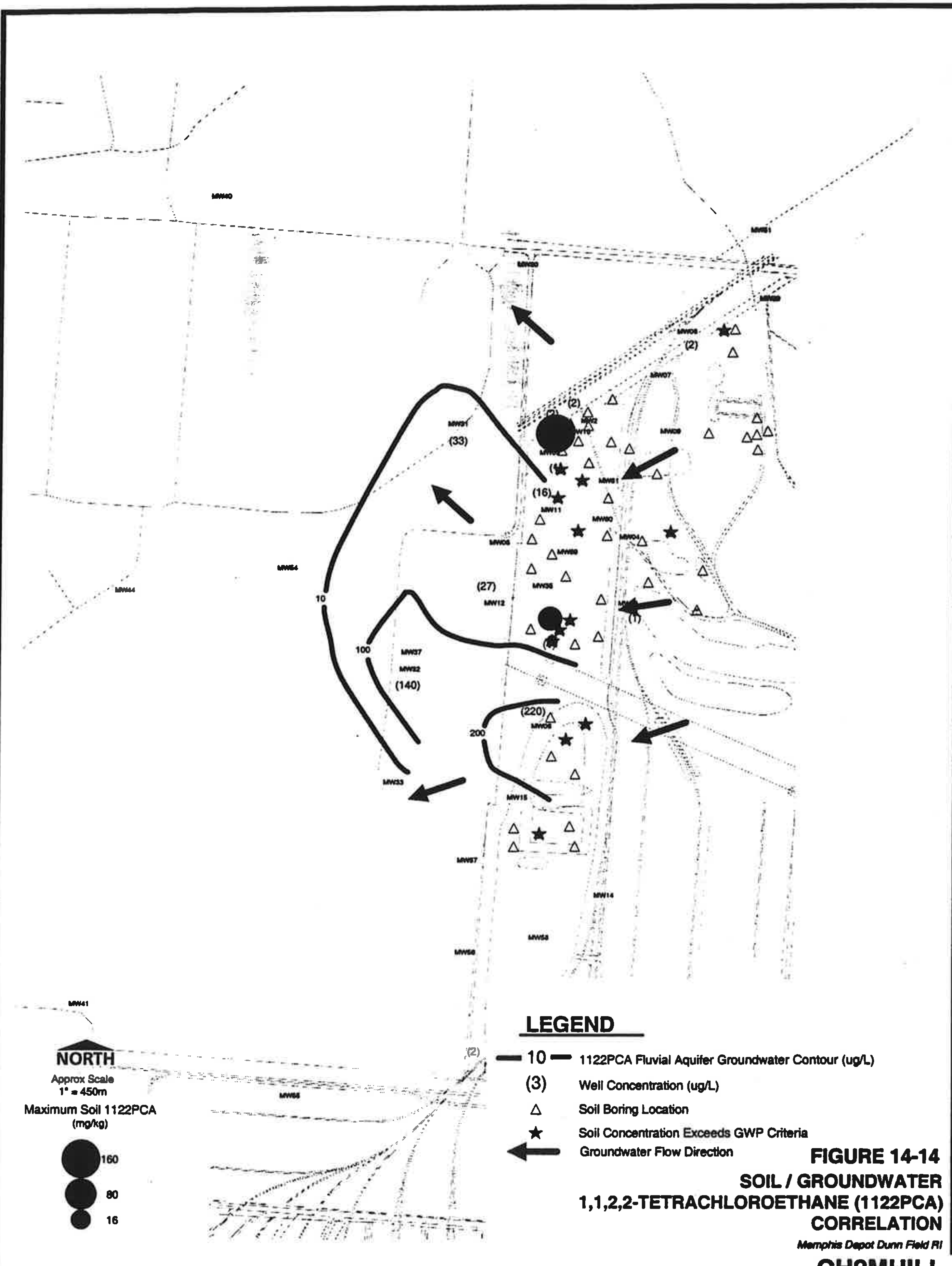

FIGURE 14-14
SOIL / GROUNDWATER
1,1,2,2-TETRACHLOROETHANE (1122PCA)
CORRELATION
Memphis Depot Dunn Field RI
CH2MHILL

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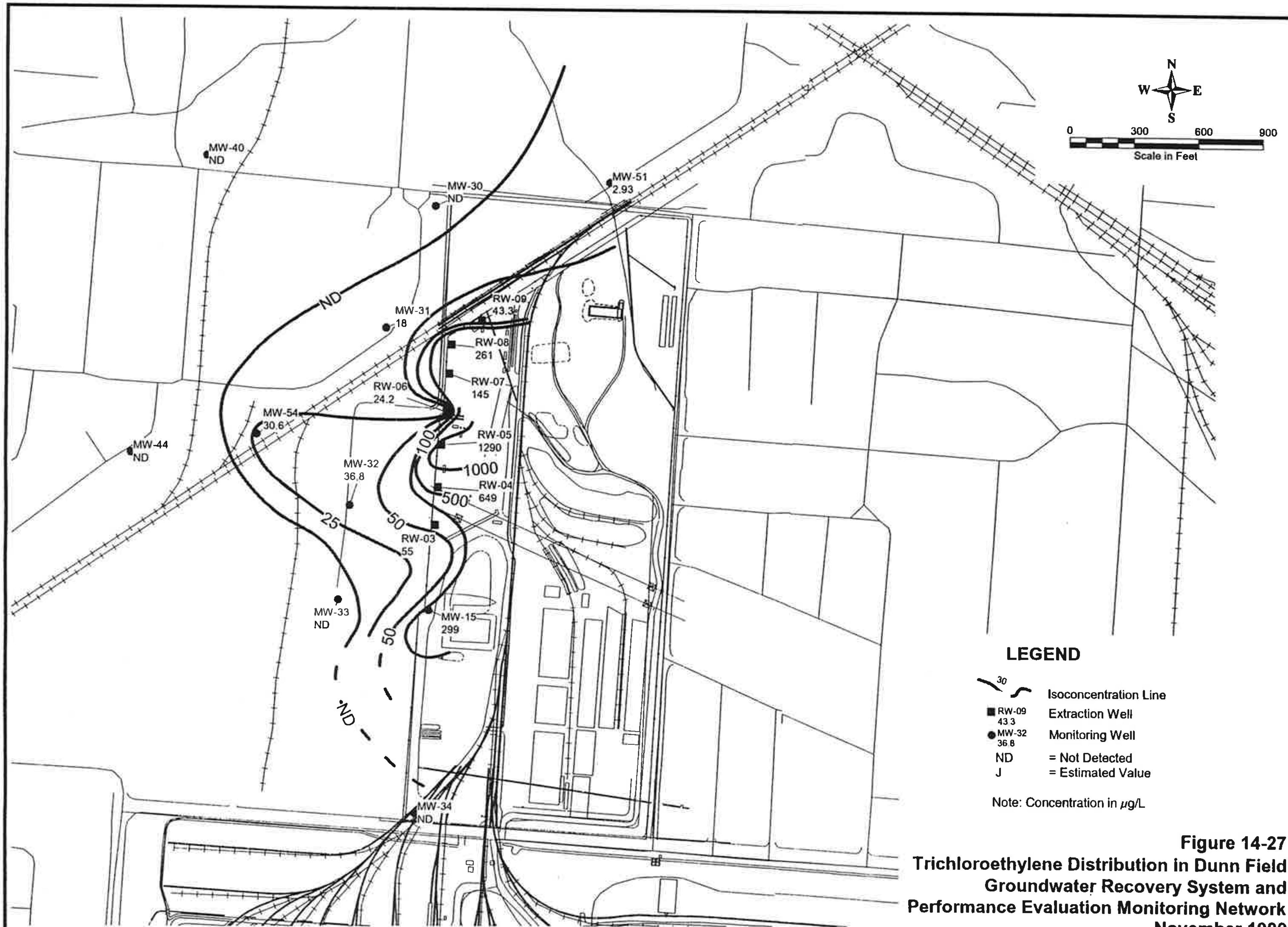

Figure 14-27
Trichloroethylene Distribution in Dunn Field Groundwater Recovery System and Performance Evaluation Monitoring Network November 1999

Defense Depot - Memphis, Tennessee

CH2MHILL

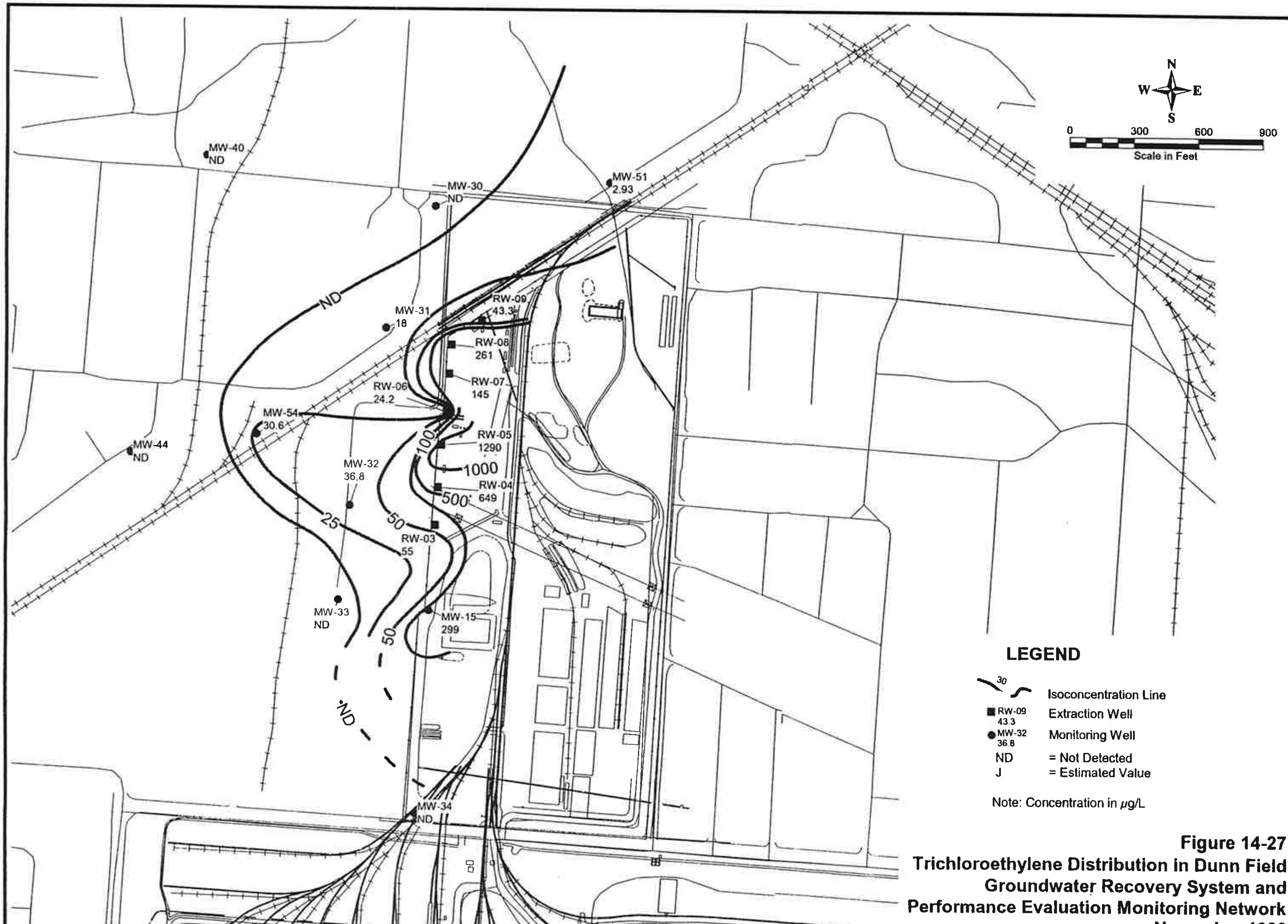

Figure 14-27
Trichloroethylene Distribution in Dunn Field Groundwater Recovery System and Performance Evaluation Monitoring Network November 1999

Defense Depot - Memphis, Tennessee

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Figure 14-36
1,1,2,2-Tetrachloroethane Distribution in Dunn Field Groundwater Recovery System and Performance Evaluation Monitoring Network
November 1999
Defense Depot - Memphis, Tennessee

CH2MHILL

Standard Operating Procedure for Soil Headspace Field Screening Using an OVA/FID

TO: U.S. Army Engineering and Support Center, Huntsville

COPIES: Memphis Depot Caretaker (MDC)
U.S. Environmental Protection Agency (USEPA), Region 4
Tennessee Department of Environment and Conservation (TDEC)

FROM: CH2M HILL

DATE: May 5, 2000

This memorandum describes the use of the Organic Volatile Analyzer (OVA)/ Flame Ionization Detector (FID) jar headspace method for performing field soil screening.

Collecting Soil Samples

1. Calibrate the FID per the manufacturer's procedures.
2. Place latex gloves on hands for protection and to prevent cross-contamination.
3. Using a stainless steel sampling spoon, fill two 16-ounce mason jars at least ½-full with the collected soil.
4. Immediately seal the mason jars by replacing the solid lid with a layer of thin aluminum foil.
5. Label the jars with the appropriate soil designation.
6. Allow the soil to reach room temperature or warmer [20°C (68°F) to 32°C (90°F)].
7. While the FID is running, insert the OVA/FID probe through the foil of the first jar after the temperature has equilibrated (typically after 5 minutes).
8. Record the highest reading on the gauge; this is the unfiltered concentration. If the unfiltered measurement is non-detect, do not proceed to line 9. Record the reading in the logbook as the total hydrocarbon measurement for that sample.
9. Attach an activated charcoal filter onto the OVA/FID .
10. While the FID is running, insert the OVA/FID probe with the attached charcoal filter through the foil of the second jar.
11. Record the highest reading on the gauge; this is the filtered concentration.
12. Subtract the filtered reading from the unfiltered reading for the total corrected hydrocarbon measurement.

Standard Operating Procedure for Sudan IV Dye Testing

TO: U.S. Army Engineering and Support Center, Huntsville

COPIES: Memphis Depot Caretaker (MDC)
U.S. Environmental Protection Agency (USEPA), Region 4
Tennessee Department of Environment and Conservation (TDEC)

FROM: CH2M HILL

DATE: May 5, 2000

Standard Operating Procedure

This memorandum describes the use of Sudan IV dye as a preliminary screening technique for detecting the presence of dense non-aqueous phase liquid (DNAPL) in groundwater and soil samples. Sudan IV is a hydrophobic dye which turns bright red in the presence of DNAPL.

Testing Soil Samples

1. Collect soil samples from the soil core extracted by the sampler.
2. Place an aliquot of soil from the area(s) exhibiting the highest flame ionization detector (FID) reading(s) into a 4-ounce glass, plastic jar, or other appropriate receptacle.
3. Fill approximately one-half of the container with the sampled soil.
4. Manually disperse the soil in the jar to minimize clumping.
5. Fill the remaining volume of the container with distilled water.
6. Add a very small amount (2 to 4 milligrams – an amount that would rest on the edge of a toothpick) of Sudan IV dye (in powder form) to the container using extra care not to expose the dye to any parts of the body. [*Sudan IV is an irritant and possible mutagen; skin or eye contact should be avoided. Gloves should always be worn when handling the Sudan IV dye*.]
7. After the dye has been added, seal the container and shake the soil/distilled water/dye mixture for approximately 30 seconds.
8. Note the presence or absence of bright red staining indicative of DNAPL in the logbook. Is there a presence of bright red staining? If yes, this indicates the presence of DNAPL in the sample.

Testing Groundwater Samples

1. DO NOT purge monitoring well prior to sample collection.
2. Collect groundwater samples from the bottom of each monitoring well using a bottom filling, 3-foot disposable Teflon bailer.

3. Pour an aliquot of the liquid from the bottom of the bailer into a 4-ounce glass jar or other appropriate receptacle.

4. Add a very small amount (2 to 4 milligrams – an amount that would rest on the edge of a toothpick) of Sudan IV dye (in powder form) to the container using extra care not to expose the dye to any parts of the body. [*Sudan IV is an irritant and possible mutagen; skin or eye contact should be avoided. Gloves should always be worn when handling the Sudan IV dye*.]

5. After the dye has been added, seal the container and shake the groundwater/dye mixture for approximately 30 seconds.

6. Note the presence or absence of bright red staining indicative of DNAPL in the logbook. Is there a presence of bright red staining? If yes, this indicates the presence of DNAPL in the sample.

Standard Operating Procedure for Collecting Soil Samples for Volatile Organic Compounds

TO:	U.S. Army Engineering and Support Center, Huntsville
COPIES:	Memphis Depot Caretaker (MDC) U.S. Environmental Protection Agency (USEPA), Region 4 Tennessee Department of Environment and Conservation (TDEC)
FROM:	CH2M HILL
DATE:	May 5, 2000

Standard Operating Procedure

This memorandum describes the use of an EnCore sampler to collect a discrete sample aliquot to be analyzed for volatile organic compounds (VOCs).

Collecting Soil Samples

1. Place latex gloves on hands for protection and to prevent cross-contamination.
2. Open the EnCore reusable package and remove the core device and cap.
3. Twist the piston on the EnCore sampler, so that the piston is unlocked and can move freely.
4. Place the core device into the T-handle.
5. Open the soil-core sampler (e.g., split spoon, core barrel) containing the soil core.
6. Using a stainless steel spoon, scrape off the initial soil touching the soil-core sampler.
7. Push the EnCore core device into the soil core.
8. Twist the T-handle, and pull the EnCore sampler free of the soil. The sampler should now be full of soil. If not, repeat this step until the EnCore is full of soil.
9. Remove excess soil from the sides of the sampler, and place the cap onto the sampler. (Make sure both sides of the cap lock into place.)
10. Twist the piston 90 degrees, so that it is locked.
11. Label and reseal in the original package.
12. Place into cooler with wet ice for shipment.