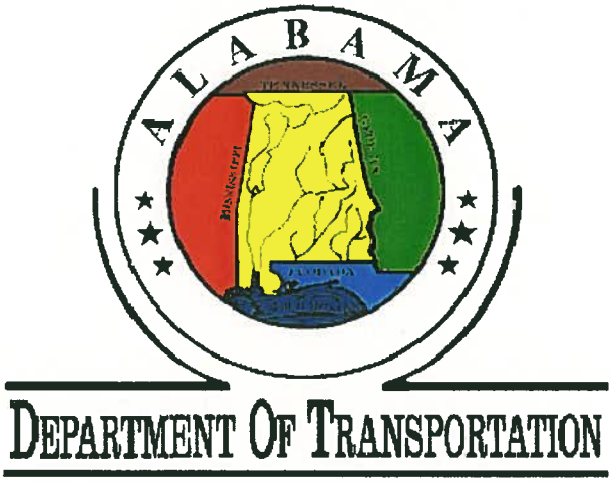
Addendum 10—Revision 1
Probehole 12 Area Monitoring Plan

Coliseum Boulevard Plume Investigation



August 7, 2002

Submitted to:
The Alabama Department of Environmental Management
Montgomery, Alabama

1.0 GENERAL

This Groundwater Monitoring and Aquifer Testing Work Plan has been prepared as Addendum 10 to the Work Plan for Rapid Response, Interim Corrective Measures and Comprehensive Site Assessment dated February 2001. This Work Plan Addendum focuses on the construction of a permanent groundwater monitoring well network, and aquifer testing, in the Probehole 12 Area. Figure 1 shows the location of Probehole 12. Data collected during the implementation of this plan will be used to evaluate remedial alternatives for the Probehole 12 Area. The additional monitoring points will establish a perimeter well network to monitor TCE concentrations in groundwater and evaluate the effectiveness of any corrective measure in the Probehole 12 Area.

Specific methods for installing Type 2 monitoring wells, Continuous Multi-channel Tubing (CMT) wells and pumping wells for aquifer testing are described herein. Additionally, this Work Plan outlines a method to screen for dense non-aqueous phase liquids (DNAPLs) during drilling activities. The procedures for sample collection and data interpretation are intended to be consistent with the ADEM-approved February 2001 Work Plan and subsequent Addenda. Appropriate health and safety protocols, as defined in the February 2001 Work Plan, will be followed while conducting all field activities.

Figure 2 shows the locations of monitoring wells, piezometers, and probeholes that were completed through May 2002 in the Probehole 12 Area. The results of this investigation are presented in the Investigation Report of Probehole PH-12 Area dated May 14, 2002.

2.0 MONITORING PROGRAM

2.1 INTRODUCTION

The proposed groundwater monitoring program will consist of the collection and analyses of samples obtained from a monitoring well network installed in the Probehole 12 Area. The criteria for the determination of proposed monitoring well locations is based on a compilation of groundwater analytical data results from previous investigations. These data are summarized on Figure 3, which shows isoconcentration contours of the maximum TCE concentrations detected in groundwater samples at each location. Figure 3 identifies a north-south trending area with elevated concentrations of TCE in groundwater. The locations for the proposed monitoring well network were selected by reviewing TCE concentrations in the groundwater samples along seven stratigraphic cross sections that transect the Probehole 12 Area. Figure 2 shows the locations of these cross sections (A-A' through G-G'), which are provided in Appendix A.

Figure 4 shows the proposed monitoring well network, which will include two new Continuous Multi-channel Tubing (CMT) wells and three new monitoring well clusters that will supplement the existing monitoring wells and CMT wells (CMT-1 and CMT-2) in the area. The proposed CMT wells are located within the area of elevated TCE concentrations. The monitoring well clusters will be installed as perimeter wells "stepped out" at locations adjacent to the focus area.

2.2 RATIONALE

The CMT wells will be installed to obtain groundwater analytical data at discrete vertical intervals where the highest TCE concentrations are present. CMTs provide the ability to collect groundwater samples and measure water levels from multiple vertical intervals at the same location. Each channel of the CMT is continuous and can be open to the aquifer at specific vertical positions with sampling ports. The filter packs surrounding these

ports are isolated above and below with bentonite seals, thus minimizing potential mixing between sampling intervals. This degree of vertical sampling refinement is not possible with conventional monitoring wells in areas of limited access to drilling locations (such as the Probehole 12 Area). CMT well construction is further described in Section 2.4.

As shown on cross-sections A-A', B-B' and E-E' in Appendix A, TCE concentrations vary more than four orders of magnitude with depth at individual locations, and the highest TCE concentrations are present in the lower glauconitic sandy silt layer. By sampling groundwater from the proposed CMT wells, the vertical distribution of TCE can be defined in the area of highest TCE concentrations. Groundwater analytical data and groundwater level measurements at these locations will be used to evaluate potential remedial alternatives in the Probehole 12 Area.

The two proposed CMT wells (CMT-3 and CMT-4) will be installed adjacent to Geoprobe® Locations 7 and 6R, respectively. These wells will screen discrete intervals within the saturated zone above the first retarding clay layer. The proposed sampling intervals, summarized on Table 1 and in cross-sections A-A', B-B' and E-E' in Appendix A, were selected based on the vertical distribution of existing TCE concentrations in this area. As shown on cross-section B-B' in Appendix A, a monitoring well cluster will be installed adjacent to proposed CMT-4 and consist of three separate conventionally constructed monitoring wells (see Section 2.4.2). These wells will be screened to coincide with three of the proposed sampling intervals in CMT-4.

Three monitoring well clusters will be installed to supplement the proposed and existing CMT installations and the existing well couplet MW-130/230 (Figure 4). As shown on cross-section E-E' and F-F' (Appendix A), two of the proposed clusters, MW-135A/235B/235C and 137A/237B/237C, will be installed at previously completed Geoprobe® Locations 28 and 41, respectively. As discussed in Section 3.0, the proposed monitoring well cluster MW-136A/236B/236C will also be used as an observation well cluster during one of the proposed aquifer tests. This monitoring well cluster will be located in the vicinity of previously completed Geoprobe® Location 38.

The proposed screened intervals of the wells in the monitoring well network are summarized in Table 1 and shown on the cross-sections in Appendix A. The well locations and screened intervals were selected to obtain hydraulic and groundwater analytical data for the sand and gravel, lower sandy silt (glauconitic), and lower glauconitic sand stratigraphic layers. These data, as well as the data from the CMTs, will be used to evaluate appropriate remedial alternatives in the Probehole 12 Area.

The CMT wells and monitoring wells proposed above will be screened at different vertical intervals above the first retarding clay layer. Soil samples collected during construction of these wells will be screened for DNAPL (see Section 2.3), with samples collected to the first restrictive clay layer. This work will better define the distribution of TCE in soil and groundwater above the first restrictive clay layer. Until this information is reviewed, it is premature to select locations for or drill deeper borings in the Probehole 12 Area.

Based on the work conducted under Addendum 08, (exploratory borings DZ-5 through DZ-8) the first restrictive clay layer in the Probehole 12 Area is estimated to be approximately 1 to 3 feet thick. Shelby tube samples from the first restrictive clay layer at borings DZ5, DZ6, and DZ7 had hydraulic conductivities of 5.8×10^{-7}, 7.4×10^{-7} and 5.9×10^{-8} cm/sec, respectively. Therefore, after this addendum has been implemented, results sent to and coordinated with ADEM, another addendum will be submitted dealing with the installation of deep wells in and around the vicinity of the Probehole 12 area.

Based on the Addendum 08 work, there is an approximately 10 to 20 foot-thick layer of micaceous, glauconitic silt and sand with variable amounts of clay underlying the first restrictive clay layer and overlying the clay confining unit of the Gordo Formation. To characterize groundwater quality in the layer below the first restrictive clay layer and above the Gordo Formation, a monitoring well or wells will be installed as part of this addendum. Any such wells will be in areas where TCE is present in groundwater above the first restrictive clay layer, but away from areas containing the highest concentrations of TCE or DNAPL, if present. This is specifically intended to minimize the potential for

cross contamination through the first restrictive clay layer. The rationale for the location of any wells will be provided to ADEM for review and approval in a subsequent addendum.

2.3 DRILLING AND SOIL SCREENING

The construction and installation of the proposed CMT wells and monitoring wells will be completed following the same specifications as other on-site wells of similar design. At each proposed well location, the boring will be drilled to a predetermined depth below the water table based on information presented on the cross sections. Each well will be installed within the saturated zone above the first retarding clay layer. Drilling and sampling methods previously referenced in the February 2001 Work Plan and subsequent addenda will be employed.

As described below, a DNAPL screening evaluation will be performed while drilling the boreholes for all proposed wells during the implementation of this Work Plan. In all borings, soils will be screened for DNAPL from the water table to the total depth of the boring. On the ALDOT property, soils above the water table will also be screened for residual DNAPL. The DNAPL screening techniques to be utilized will include:

- Visual Examination.
- FLUTe soil core sleeves.

FLUTe sleeves are plastic cores impregnated with a reactive dye that changes color when it comes in contact with DNAPL. The following procedures will be used in the DNAPL screening process:

- Cut approximately 12 to15 feet of the dye-striped FLUTe sleeve from the roll. Use the normal transparent plastic sleeve containing the core as a sleeve outside the FLUTe material.

- Fully extrude the sample core into the concentric FLUTe and plastic sleeves.
- Fold the open ends of the sleeved plastic coverings to contain the core and entrained in-situ fluids. If the core contains DNAPL, the DNAPL will be wicked into the hydrophobic FLUTe sleeve.
- Inspect the reactive dye in the FLUTe sleeve (through the clear plastic outer sleeve) for color changes. If the reactive dye comes in contact with DNAPL, the color change will be immediate.
- Document the presence and depth specific interval that dye staining is observed.
- If staining is present, cut a slit in the sleeve. Measure volatile organic vapors with a photoionization detector (PID) and collect one soil sample for VOC analysis.
- If staining is not apparent, roll the core back and forth to facilitate contact of the soil core with the FLUTe sleeve. Re-inspect the core for dye staining.

2.4 WELL INSTALLATION

2.4.1 CMT Wells

The CMT wells will be constructed of 1.7-inch diameter CMT tubing. These wells will contain up to seven discrete sampling intervals. As summarized in Table 1 and in the cross-sections in Appendix A, the proposed length of these sampling intervals will range between four to five feet based on stratigraphic and groundwater analytical data at each location. In each sampling interval, ports will be opened at one-foot spacing. For example, a four-foot long screened interval will consist of three ports (see Figures 5 and 6). Ports will be wrapped with stainless steel gauze and surrounded by filter pack material or natural filter pack from formation collapse. Bentonite pellets will be emplaced approximately one foot above and below each sampling interval to form a seal

and isolate the intervals. Proposed sampling intervals will be installed using a minimal volume of water. Table 1 summarizes the sampling intervals for the existing and proposed CMT wells.

2.4.2 Monitoring Well Clusters

The monitoring well clusters will be constructed of Schedule 40, two-inch diameter PVC with a 0.010-inch slotted well screen no more than five feet long. A filter pack consisting of #20-40 sand will be used to fill the borehole annulus to a maximum of two feet above the top of the screen. A minimum of two feet of bentonite pellets will be used to seal the well above the filter pack and cement bentonite grout will be tremied above the bentonite seal to a depth of approximately one-foot below grade. The well will be completed with a flush mounted roadbox anchored in a two-foot square concrete/asphalt pad. Sampling intervals for the existing and proposed perimeter monitoring wells are shown on Table 1.

2.4.3 Deep Monitoring Wells

The monitoring wells to be screened in the layer between the first restrictive clay layer and the top of the Gordo Formation will be constructed in accordance with the procedures described in Addendum 08. These deep-zone wells will be drilled with sonic methods and will be double-cased to reduce the potential for cross contamination across the first restrictive clay layer.

2.5 WELL DEVELOPMENT

Following installation, newly installed monitoring wells will be developed in accordance with established methods and the approved Work Plan dated February 2001. Each well will be left undisturbed for a minimum of 48 hours before development to allow the cement/bentonite grout mixture to cure. Prior to development, the static water level and well depth will be measured.

The monitoring wells will be developed using centrifugal (suction-lift pump), air-displacement pump, peristaltic pump or bottom discharging bailer. Well development protocols will be consistent with the February 2001 Work Plan, and will be considered complete when the pH, specific conductivity, temperature, and turbidity have stabilized after purging a minimum of three to five well volumes. Stability is defined as variation between measurements of 10 percent or less and no overall upward or downward trend in the measurements.

Development of the CMT wells may be accomplished using a modified air-lift pumping procedure to purge water introduced during the drilling process and entrained formation water. The purging and development procedure will require small diameter (1/4") polyethylene tubes inserted into one or more CMT channels to depths approximately five feet above the sample ports. Groundwater will be purged using a combination of compressed air blown downward through the plastic tubing and a vacuum applied to the opening of the CMT wells. Development will be considered complete when the volume of recovered purge water exceeds the approximate volume used during the drilling process.

2.6 GROUNDWATER SAMPLING

In conjunction with the on-going, site-wide groundwater monitoring, groundwater samples will be collected from the proposed monitoring well network on a quarterly basis to evaluate changes in TCE concentrations within, and at the perimeter of, the area containing elevated TCE concentrations.

Samples will be obtained and analyzed in accordance with this plan on a quarterly basis. Groundwater monitoring results will be reported to ALDOT/ADEM in the monthly status reports. Groundwater sampling will be performed using the established guidelines described in the February 2001 Work Plan. Groundwater samples will be collected from CMT-1 through CMT-4 and monitoring wells in the proposed well network and analyzed for volatile organic compounds.

Prior to sampling, the depth to groundwater will be measured in each CMT channel. The CMT wells will be purged using the procedures identified above in Section 2.5 (Well Development) or an alternative method using a modified low flow-sampling apparatus. Field parameters identified in Section 2.5 will be measured during purging. Sampling will be conducted using low-flow sampling methods.

2.7 SURVEY

The locations, ground surface elevations, and measuring point elevations of all wells will be surveyed using the same horizontal and vertical datum as specified in the February 2001 Work Plan.

3.0 AQUIFER TESTS

3.1 PUMPING TEST LOCATIONS

Aquifer tests will be conducted in two areas of the TCE plume to quantify hydrogeologic parameters and provide data with which to refine and calibrate a site-wide groundwater model. The site-wide groundwater model will be used to evaluate remedial alternatives for the Probehole 12 Area. The locations and construction procedures of the proposed pumping and observation wells are described in the following sections. The observation well networks will include new and existing monitoring well clusters and newly installed CMT wells. These CMT observation wells will be designed specifically for measuring hydraulic head changes in each hydrostratigraphic unit during the aquifer tests and are not intended to be used for long-term water quality sampling. Figure 4 shows the locations of the proposed pumping wells and observation wells. These locations were selected to evaluate the different hydrogeologic characteristics of the Probehole 12 Area.

3.1.1 PW-1

Well PW-1 will be located on the ALDOT property in the vicinity of existing monitoring well cluster MW-106/206. This area represents the southern portion of the TCE plume where the saturated zone is approximately 30 feet thick (above the first retarding clay layer) and is comprised mostly of the lower sandy silt layer. Groundwater samples collected from wells screened in this layer have consistently contained the highest TCE concentrations, as shown in the cross sections in Appendix A. Quantifying the hydrogeologic characteristics of this layer will be crucial to the evaluation of potential remedial alternatives in similar portions of the CBP site. The overlying sand and gravel layer in this area is partially saturated (less than 20 percent of the total saturated thickness) and the lower glauconitic sand is less than 10 feet thick.

The observation well network for PW-1 will consist of existing wells MW-106 and MW-206 and two additional CMT wells at different radii from the pumping well (Figure 4). The CMT wells will be located approximately 10 feet and 20 feet from PW-1, which will be drilled approximately 30 feet from existing well cluster MW-106/206. The exact locations of the CMT wells and PW-1 will be determined in the field. The CMT wells will be constructed as discussed in Section 3.3.1. Channels in each of these CMT wells will be open in each of the two saturated layers: sand and gravel and lower glauconitic sand. The length of the channel openings will be based on geologic logs of the boreholes in which the CMT wells will be placed.

3.1.2 PW-2

The hydrogeologic characteristics in the northern portion of the plume will be assessed by conducting a pumping test at PW-2, the location of which is proposed to be on the undeveloped residential property on the eastern side of Fairground Road (Figure 4). This location was selected because the stratigraphy in this area differs from that in the vicinity of proposed pumping well PW-1. The sand and gravel layer is fully saturated in the proposed location of PW-2 and comprises approximately half of the saturated thickness. The upper sandy silt layer may also be partially saturated in this area. The saturated zone is approximately five feet thinner in this area than near proposed well PW-1. Because the characteristics of the sand and gravel layer contrast those of the underlying and overlying sandy silt layers, the results of the pumping test in this area will be used to evaluate the influence of the sand and gravel layer on any appropriate remedial alternatives.

The observation well network for PW-2 will consist of one additional CMT well with channels opened in the three saturated layers (upper sandy silt, sand and gravel, lower glauconitic sand). The proposed well cluster MW-136A/236B/236C will also be used as an observation well cluster during the pumping test (see Figure 4). The observation wells will be located at different radii from the pumping well. The CMT well and the MW-136A/236B/236C cluster will be drilled approximately 10 feet and 25

feet, respectively, from PW-2. The exact locations of these wells will be determined in the field.

3.1.3 Background Water-Level Monitoring Locations

Two existing groundwater monitoring wells outside the radii of influence of the pumping wells will be selected to measure antecedent groundwater elevations. Groundwater levels in these wells will also be measured during the aquifer tests to document background fluctuations and trends.

3.2 CONSTRUCTION OF PUMPING WELLS

3.2.1 Pilot Borings

Prior to drilling the boreholes for the pumping wells, one Geoprobe® boring will be advanced at the location of each pumping well to collect soil samples for grain-size analysis and determine the depth to the first retarding clay layer. The Geoprobe® will be equipped with a soil conductivity probe to locate the depth of the first retarding clay layer. Using the Macrocore® sampling device, up to two soil samples will be collected from each stratigraphic layer for sieve analyses. The grain-size curves from these analyses will be used to select the appropriate filter pack material and screens for the pumping wells.

3.2.2 Boreholes

Sonic drilling methods will be used to advance the boreholes in which pumping wells will be constructed. A nominal 10-inch diameter borehole will be advanced to the depth sufficient to intercept the first retarding clay layer. The depth of the pumping wells will be based on the soil conductivity log from the pilot Geoprobe® borings. All drill cuttings will be containerized and disposed of in accordance with the February 2001 Work Plan.

3.2.3 Casing and Screen

The screen and riser well materials shall consist of four-inch nominal diameter Schedule 40 flush-threaded PVC. The screen will extend the entire length of the saturated zone. Because the screened interval will intersect different stratigraphic units, the slot size of screen segments will be based on the appropriate filter pack selected for each unit. As discussed in Section 3.2.4 below, a single filter pack gradation may not be appropriate for all stratigraphic units in which the pumping wells will be screened. All screen intervals will consist of continuous slotted, wire-wrap PVC. The well riser will extend from the top of the screen to approximately three feet above ground surface.

3.2.4 Filter Pack

The filter pack material will consist of clean, well-rounded, quartz sand graded to the size range appropriate for each segment of the screened interval. As discussed in Section 3.2.1, the filter pack gradation will be determined based on the results of sieve analyses conducted on soil samples that will be collected prior to the drilling the pumping wells at both locations. The filter pack will be tremied in place from the base of the screen to two feet above the top of the screen. If flowing sands in the formation prevent filter pack installation, other standard procedures such as washing the filter pack into place will be used.

3.2.5 Bentonite Seal

The bentonite seal shall consist of high-grade sodium bentonite, and shall be supplied in a pellet form, with a minimum diameter of one-quarter inch and a maximum diameter of one-half inch. The bentonite seal will extend two feet above the top of the filter pack.

3.2.6 Grout

Subsequent to pellet hydration, the remainder of the annular space will be grouted to the surface using cement/bentonite grout.

3.2.7 Protective Casing

A temporary steel protective casing with a locking cover will be secured around each well stickup to prevent unauthorized tampering. The protective casing will be set approximately two feet below ground surface. Following the completion of the aquifer tests, each pumping well will be modified by removing the protective casing and three foot stickup and installing a flush mount shroud at ground surface. A two-foot square concrete protective pad will be placed around the flush mount shroud sloping away from the center to the outer edges. The well will be properly labeled for future identification.

3.2.8 Well Development

Pumping wells will be developed in accordance with the procedures outlined in the approved Addendum 1 of the February 2001 Work Plan.

3.3 CONSTRUCTION OF OBSERVATION WELLS

Existing and newly installed monitoring wells and CMT wells will comprise the observation well network for the aquifer tests. The wells will be located at varying radii from the pumping wells. Based on drawdowns measured during previous aquifer tests conducted at the CBP site, observation wells will be located between 10 and 30 feet from the pumping wells. Proposed locations are shown on Figure 4.

3.3.1 CMT Observation Wells

Two CMT wells will be installed in the vicinity of PW-1 and one will be installed near PW-2. In each CMT well, one channel will be assigned to each of the saturated

stratigraphic layers. For example, if three stratigraphic layers are saturated (or partially saturated), three channels will be open in that CMT observation well. In each channel, ports will be opened at one-foot spacing so that the water level measured in that channel will represent the average hydraulic head in the corresponding stratigraphic unit. Ports will be wrapped with stainless steel gauze and surrounded by filter pack material. Bentonite pellets will be emplaced approximately six inches above and below each layer interface to form a seal and isolate the channels. Construction diagrams for the proposed CMT observation wells are provided on Figures 7 through 9 and the monitoring intervals of these wells are summarized in Table 2. These wells will be developed following the procedures provided in Section 2.5.

3.3.2 Observation Well Clusters

Existing monitoring wells MW106 and MW206 will be used as observation wells during the PW-1 pumping test. One observation well cluster, consisting of three wells, will be installed in the vicinity of the PW-2 pumping well. The observation wells will be constructed of two-inch nominal diameter Schedule 40 flush-threaded PVC and will be completed in six-inch diameter boreholes. Screened intervals will be selected based on previous information and will coincide with the stratigraphic layers.

The appropriate gradation of filter pack shall be tremied into place using clean, potable water, from the bottom of the screen upward, to approximately two feet above the screen or by other industry approved techniques. The slot sizes of the screens will coincide with the appropriate filter pack. A two-foot thick bentonite pellet seal shall be placed immediately above the filter pack. After adequate pellet hydration, the annular space will be grouted to the surface using cement/bentonite grout.

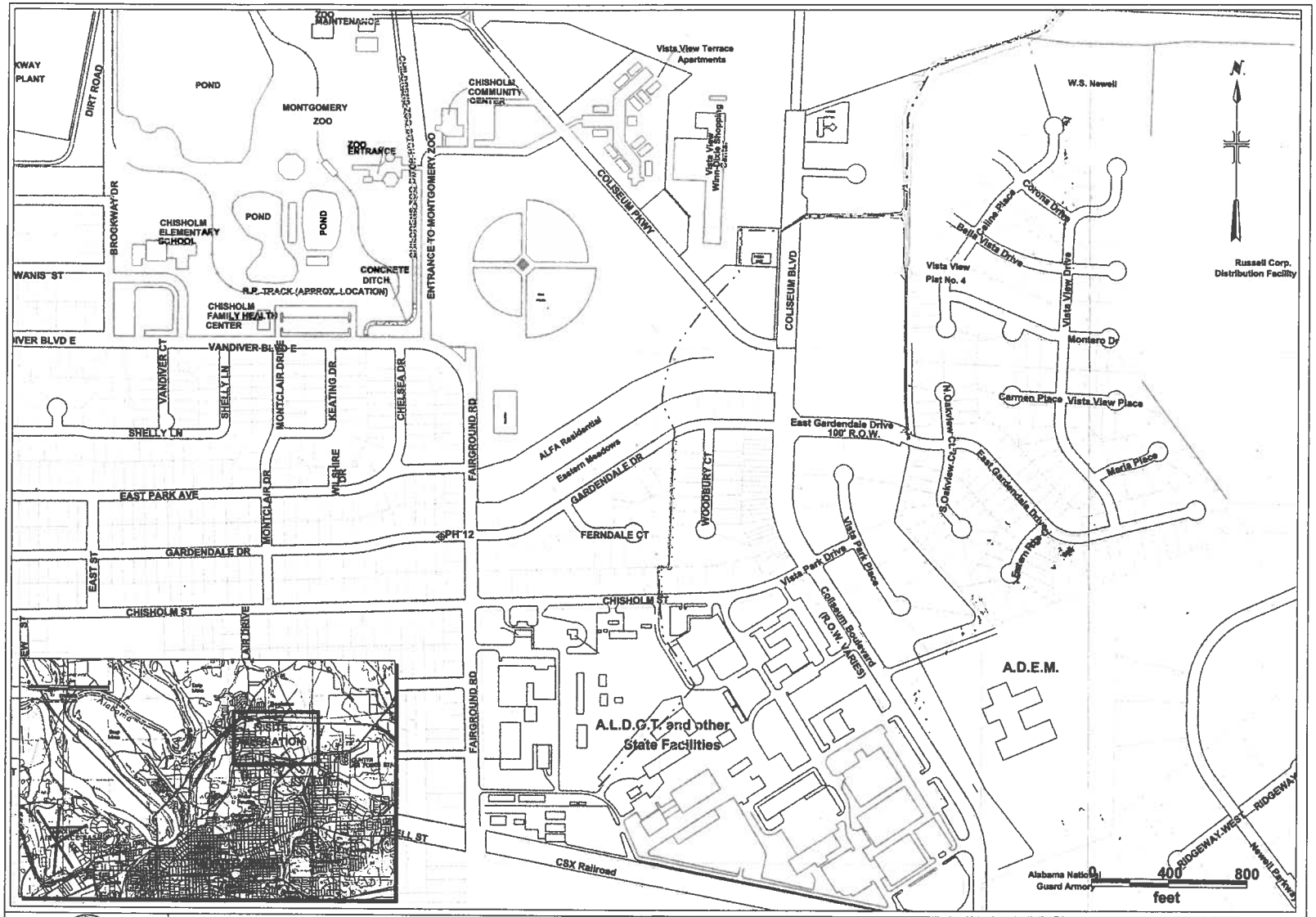
Each observation well shall be placed in the borehole such that the top of the casing is flush with ground surface. The top of the well will be set in a flush mount shroud at ground surface surrounded by a two-foot square concrete pad. All drill cuttings and fluids will be containerized and disposed of in accordance with the February 2001

Work Plan. The observation wells will be properly labeled for future identification. These wells will be developed using the procedures provided in the approved Addendum 1 of the February 2001 Work Plan.

3.4 PUMPING TEST PROCEDURES

Step-drawdown pumping tests will be conducted in each pumping well prior to the aquifer tests. Procedures provided in the approved Addendum 1 to the February 2001 Work Plan will be followed for the step-drawdown and constant-rate aquifer tests.

FIGURES



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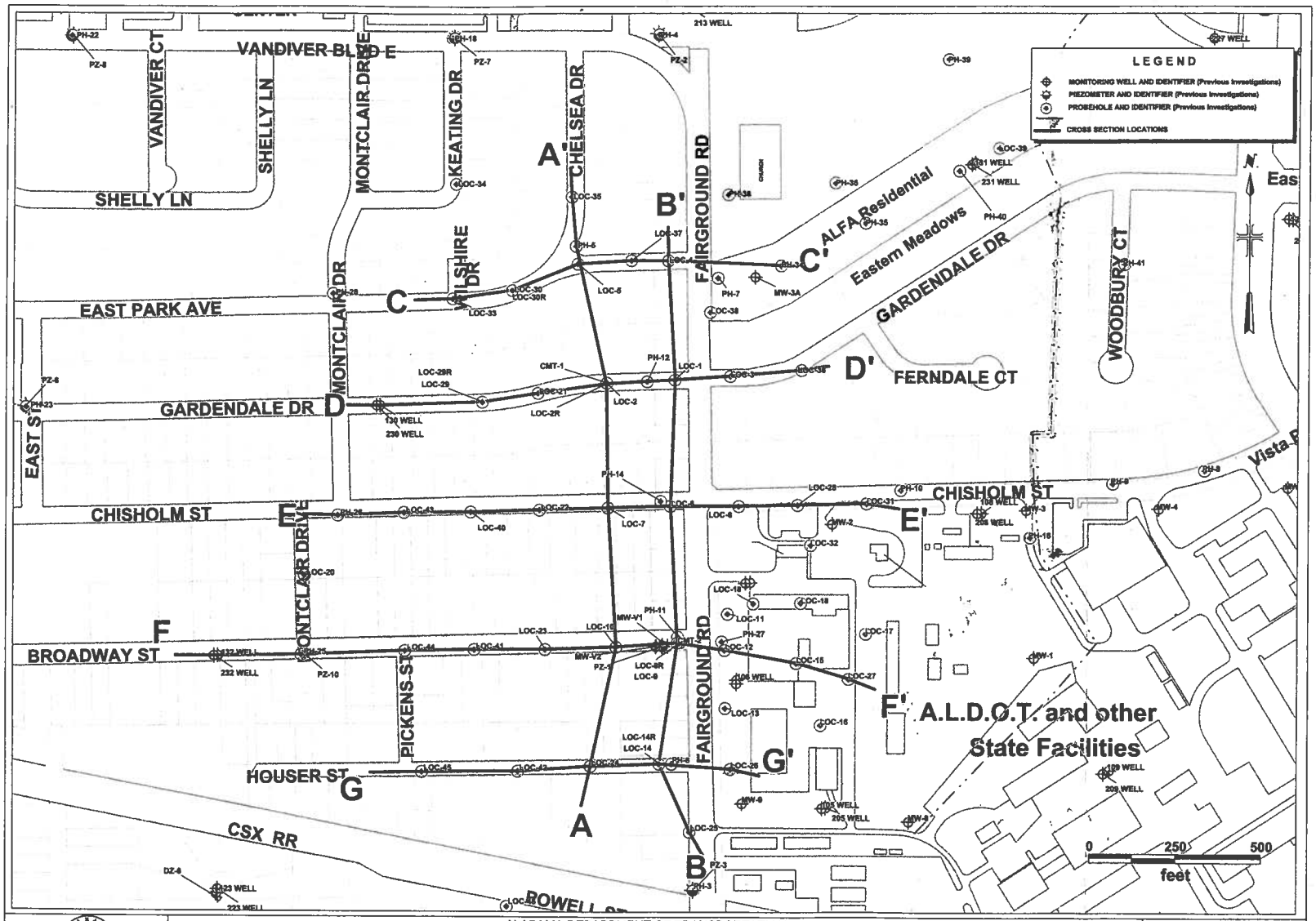
SITE LOCATION

May 2002

FIGURE 1



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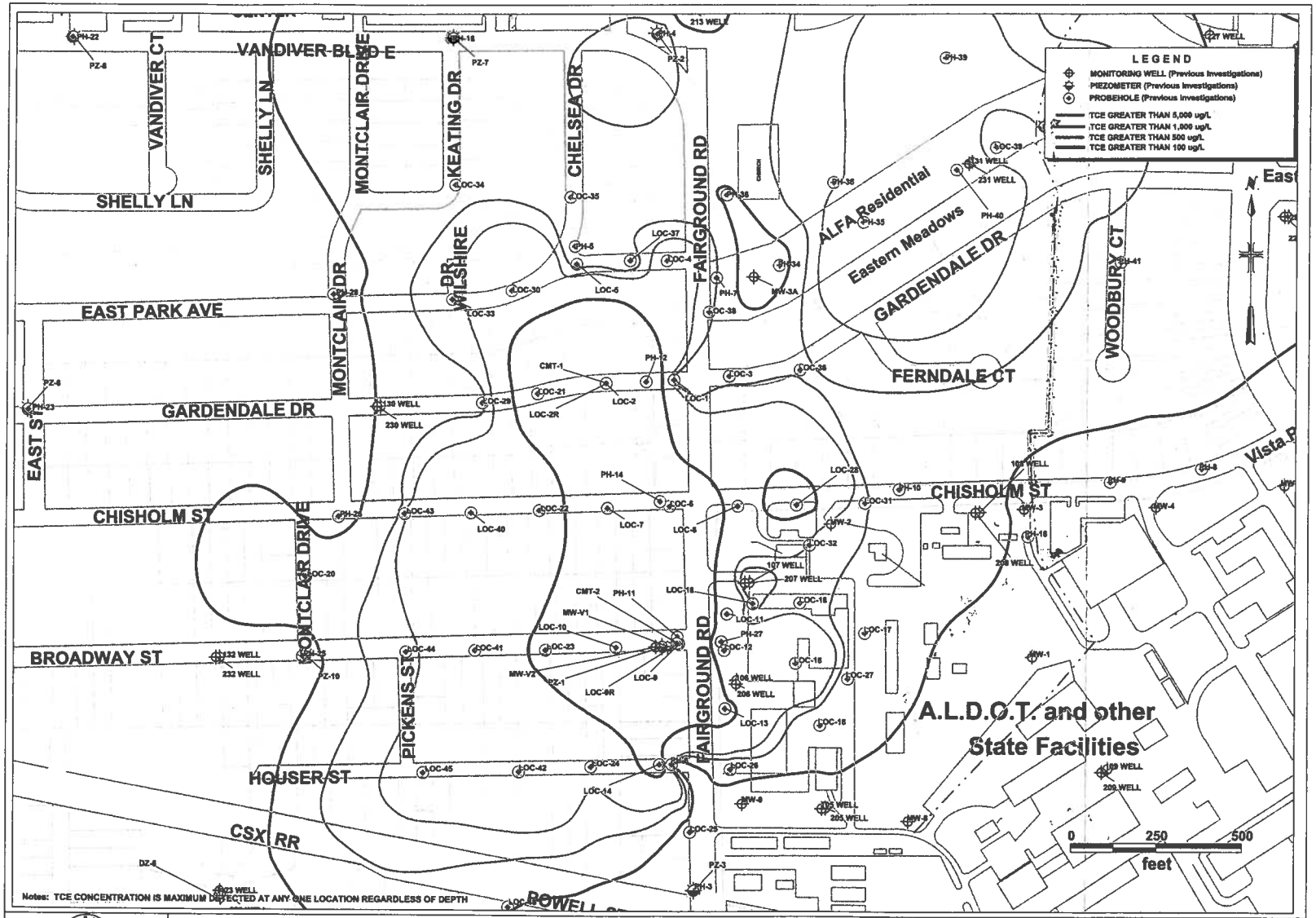
CROSS-SECTION LOCATIONS

May 2002

FIGURE 2



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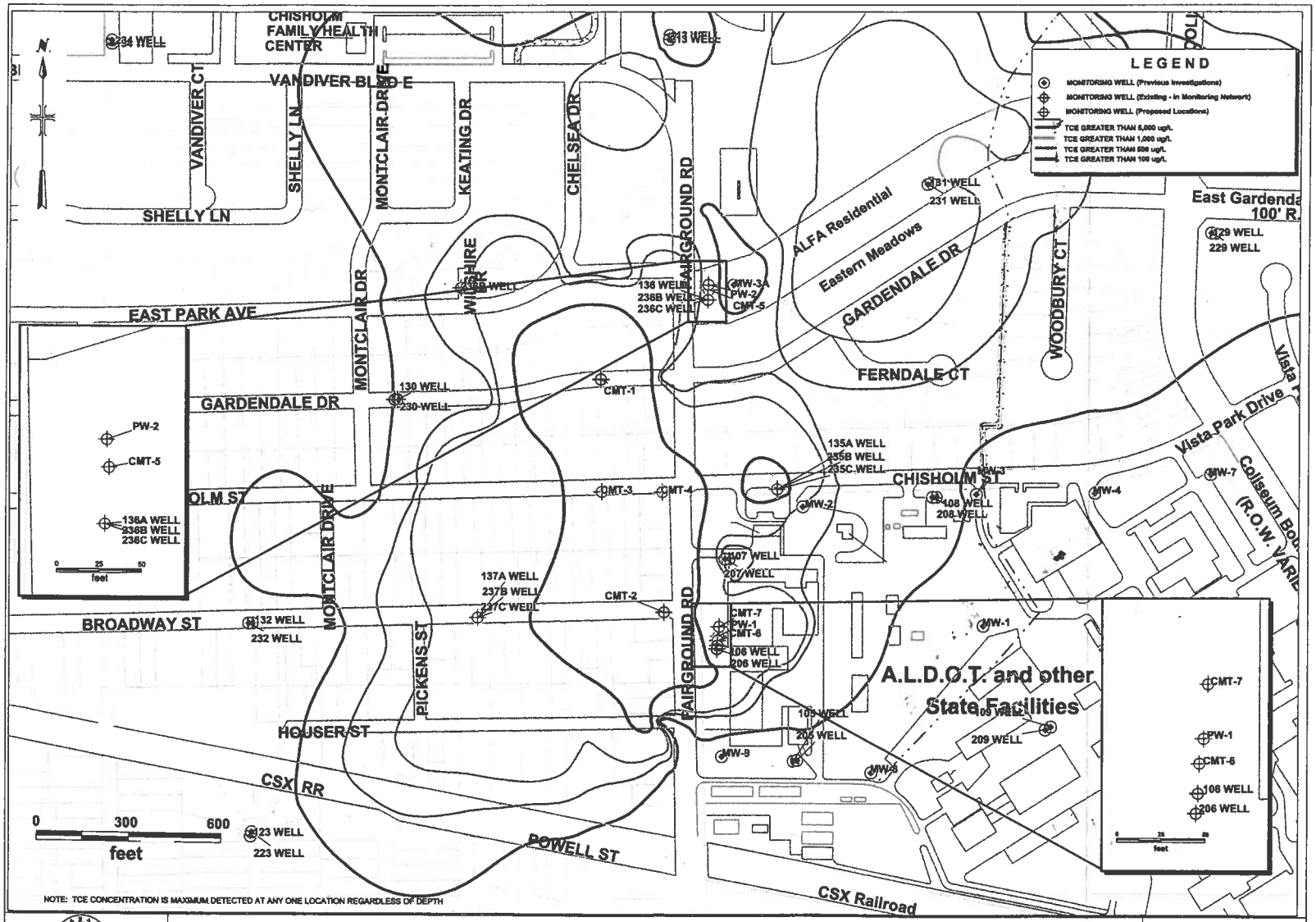
MAXIMUM TRICHLOROETHYLENE (TCE) CONCENTRATIONS IN GROUNDWATER

May 2002

FIGURE 3



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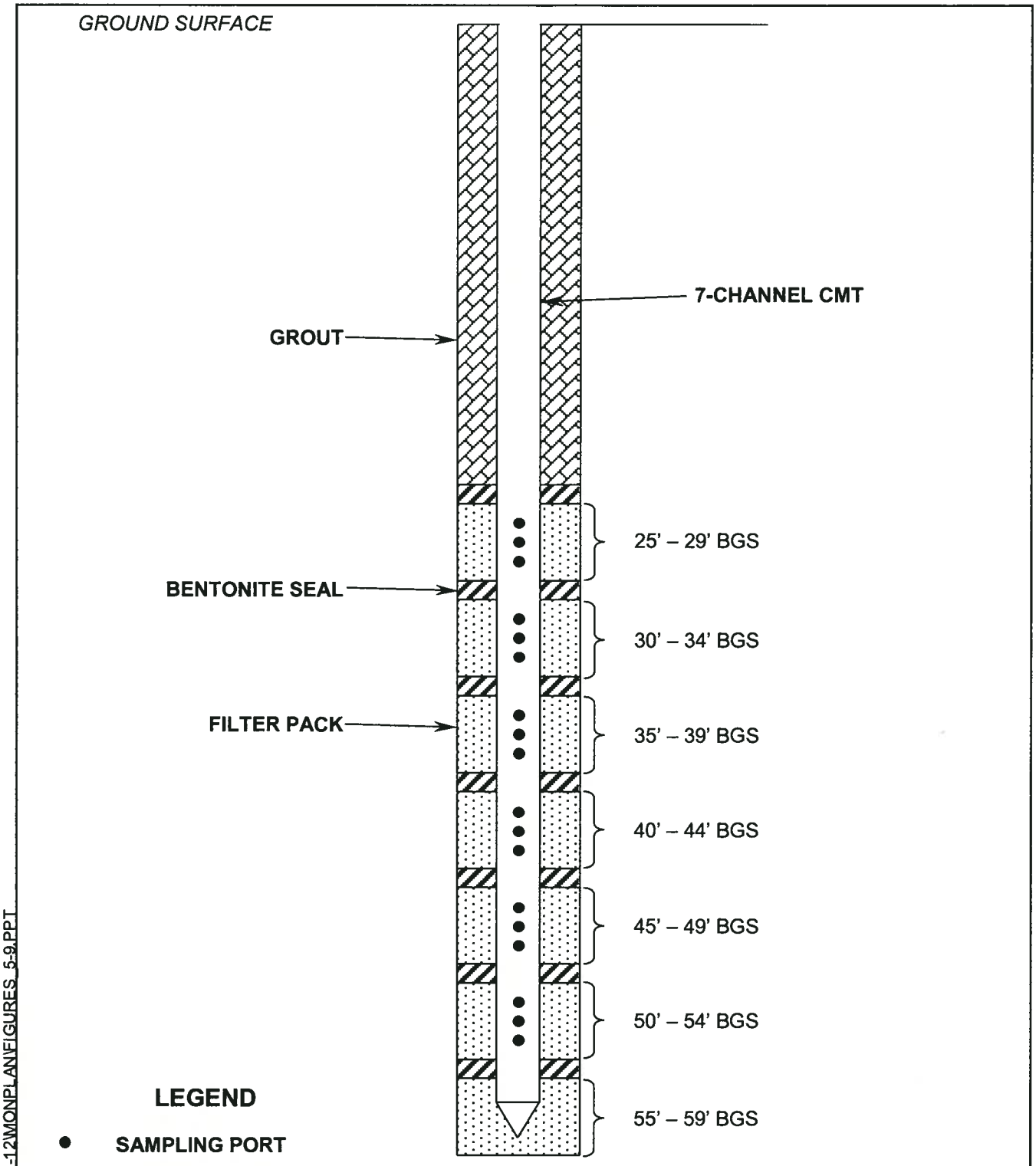
PROPOSED PRIMARY MONITORING WELL NETWORK

May 2002

FIGURE4



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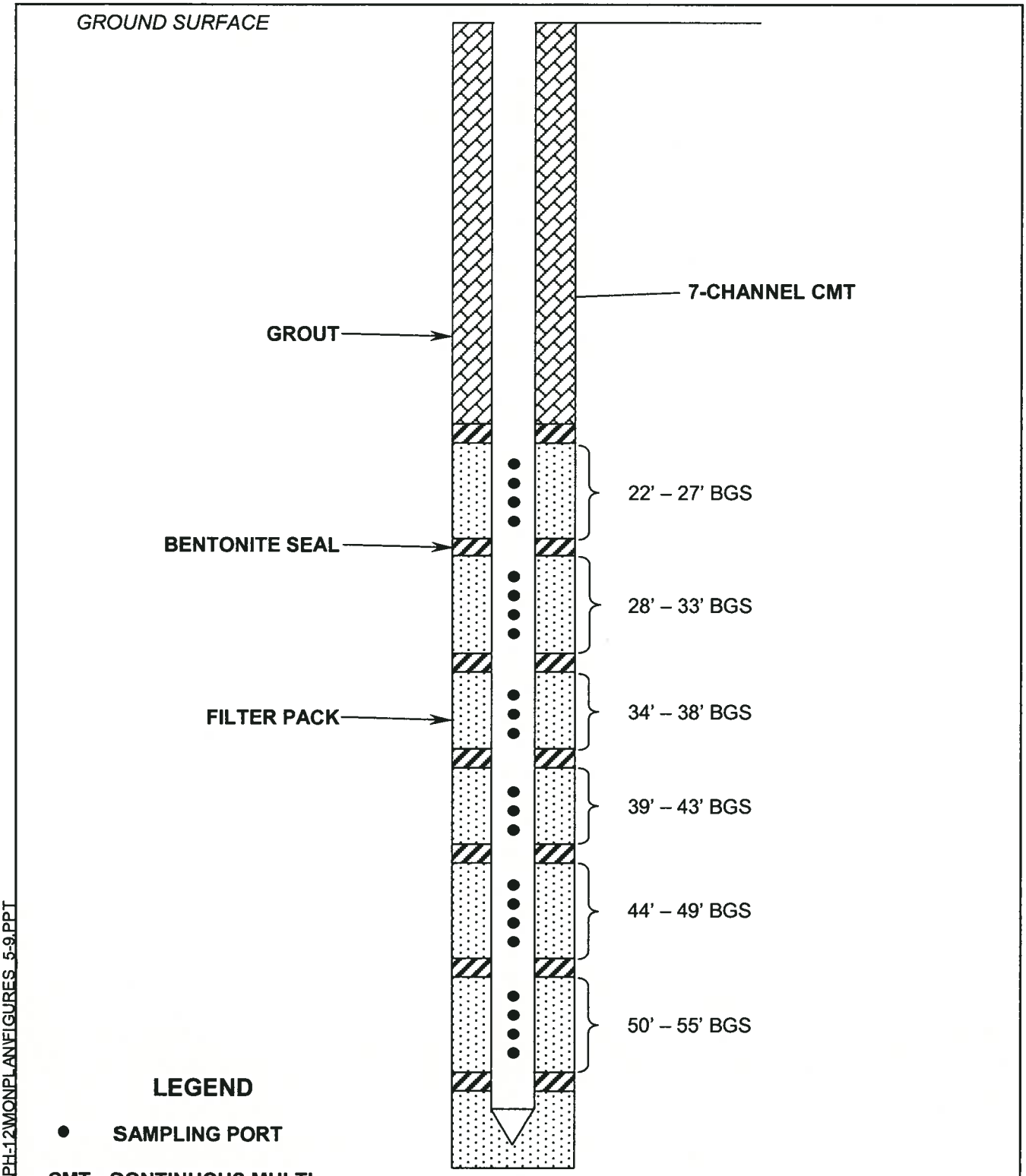
ALABAMA DEPARTMENT OF TRANSPORTATION		MAY 2002
COLISEUM BOULEVARD PROJECT		
CMT-3		**FIGURE 5**



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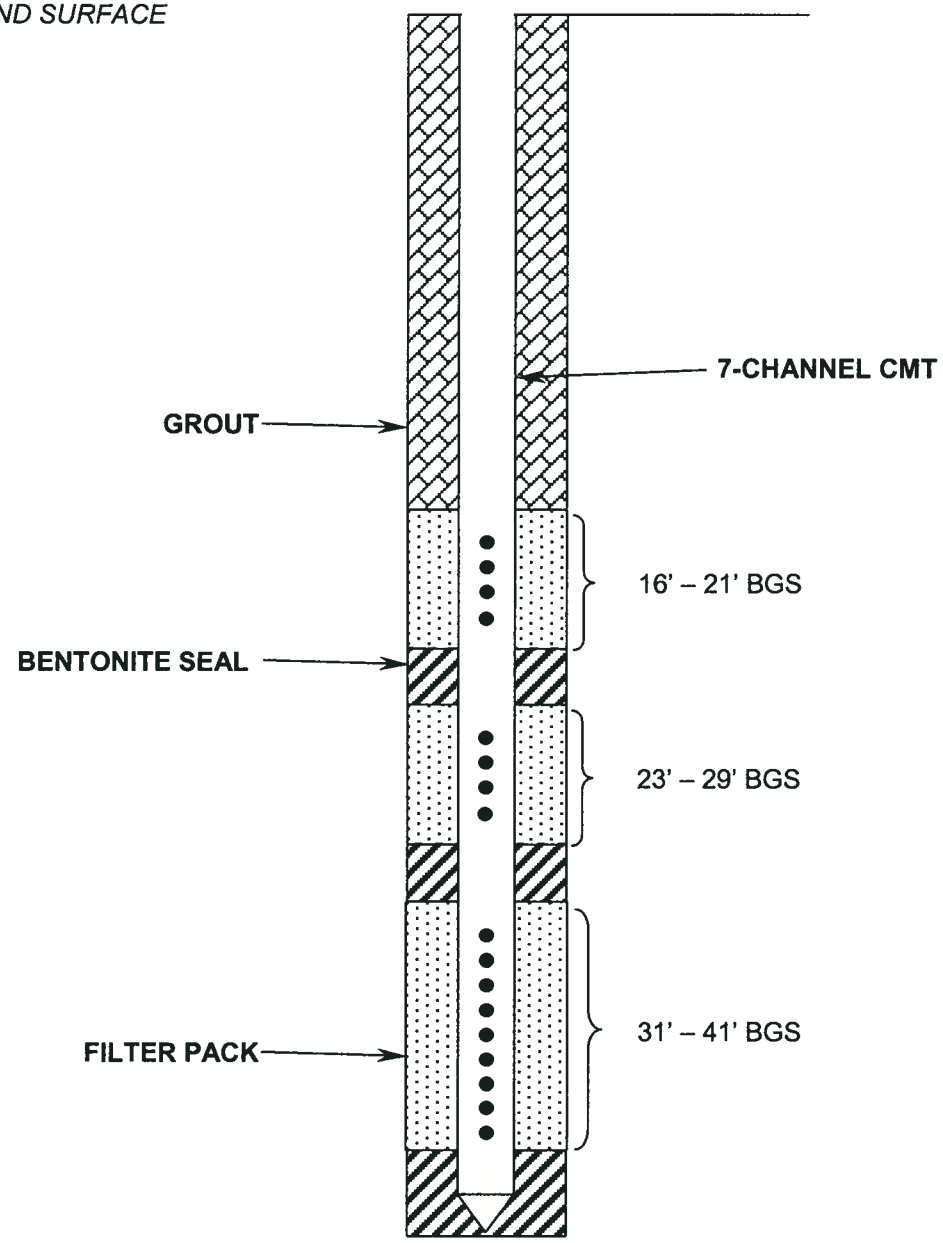
CMT-4

MAY 2002

FIGURE 6



LEGEND

- ● SAMPLING PORT

CMT - CONTINUOUS MULTI-CHANNEL TUBING

BGS - BELOW GROUND SURFACE

ALABAMA DEPARTMENT OF TRANSPORTATION	ALABAMA DEPARTMENT OF TRANSPORTATION COLISEUM BOULEVARD PROJECT	MAY 2002
	CMT-5	**FIGURE 7**

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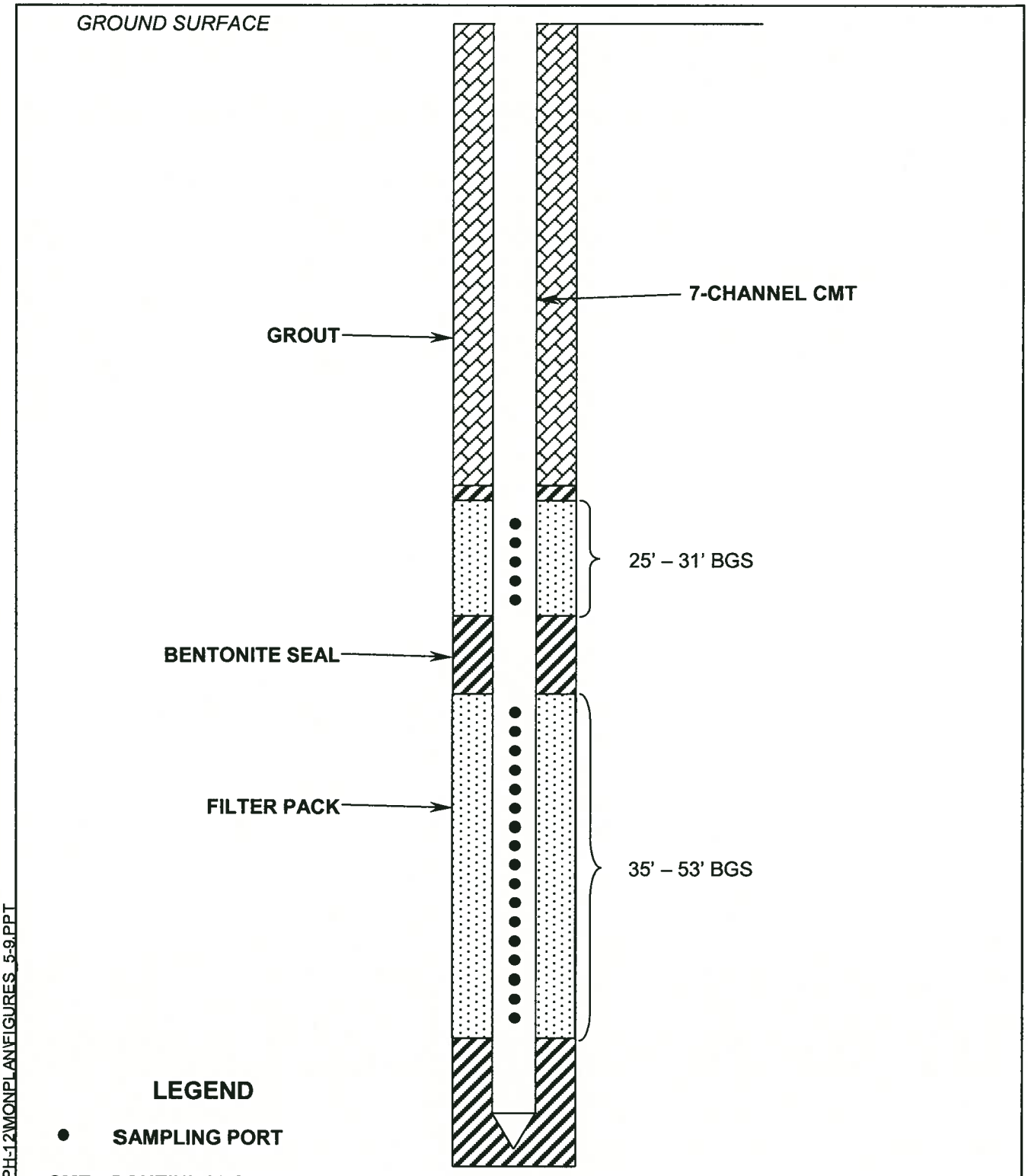

LEGEND

● **SAMPLING PORT**

CMT - CONTINUOUS MULTI-CHANNEL TUBING

BGS - BELOW GROUND SURFACE

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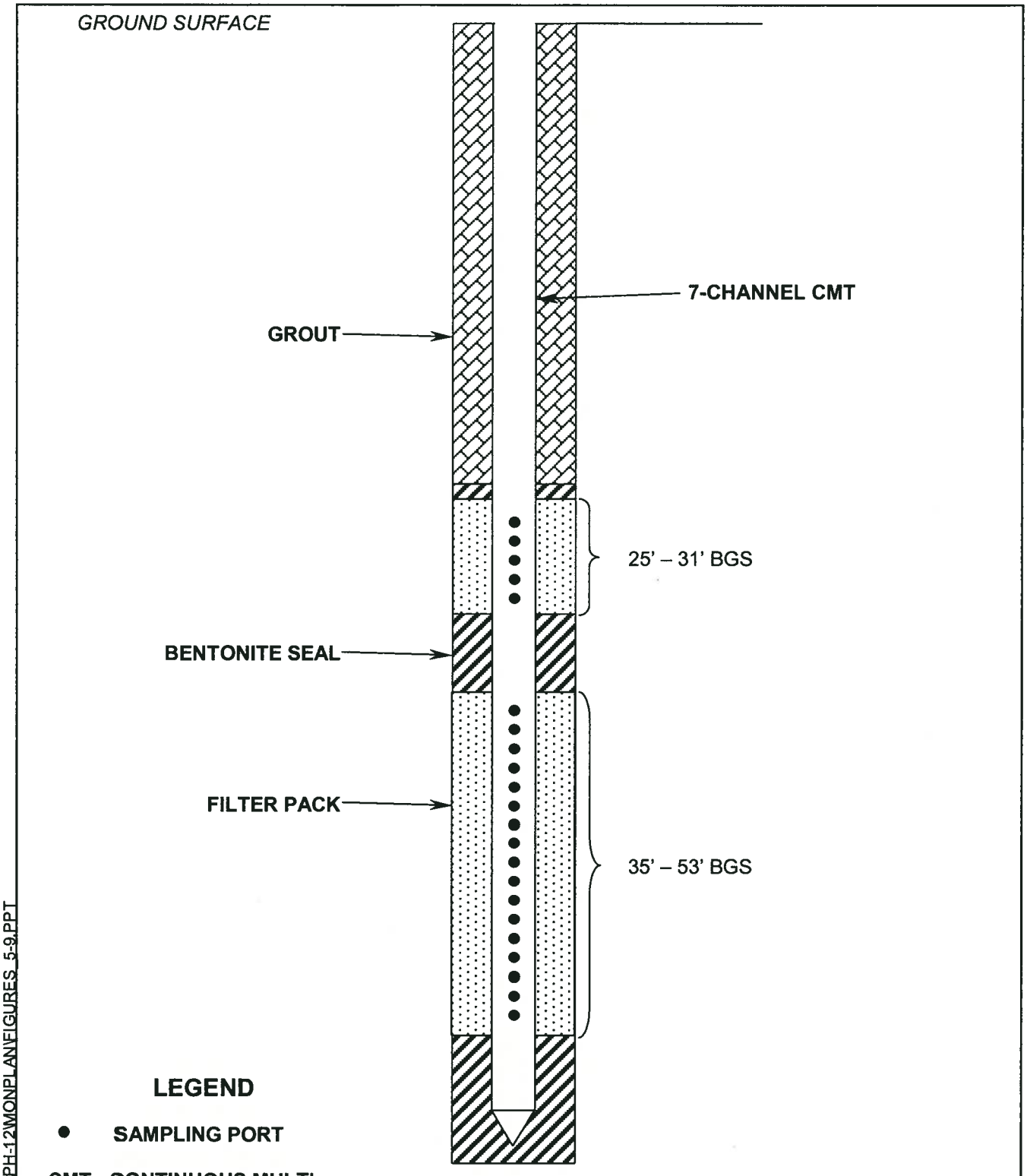
ALABAMA DEPARTMENT OF TRANSPORTATION	ALABAMA DEPARTMENT OF TRANSPORTATION COLISEUM BOULEVARD PROJECT	MAY 2002
	CMT-6	**FIGURE 8**



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	CMT-7	**FIGURE 9**

TABLES

TABLE 1

ALDOT FACILITY
COLISEUM BOULEVARD PROJECT

SUMMARY OF PROPOSED SAMPLING INTERVALS FOR CMT AND MONITORING WELLS

CMT Monitoring Intervals:

CMT-1 (existing)	CMT-2 (existing)	CMT-3 at Loc. 7	CMT-4 at Loc. 6
29-31'	30-34'	25-29'	22-27'
32-34' (1)	38-40'	30-34'	28-33'
35-37'	43-45'	35-39'	34-38'
39-41'	47-49'	40-44'	39-43'
42-45'	51-53'	45-49'	44-49'
46-49'	55-57'	50-54'	50-55'
51-53'	59-61'	55-59'	

Notes:

1. CMT sampling port #4 not available for sampling.

Monitoring Well Intervals:

MW-130/230 (existing)	MW-135A/235B/235C at Loc.28	MW-136A/236B/236C near Loc.38	MW-137A/237B/237C at Loc.41
A 18.5-27.5	A 31-36'	A 19-24'	A 32-37'
B 42-51'	B 40-45'	B 27-32'	B 41-46'
	C 52-62'	C 35-40'	C 48-53'

MW-138A/238B/238C at Proposed CMT-4			
A 34-38'			
B 44-49'			
C 50-55'			

Note:

All intervals in feet below ground surface

APPENDIX

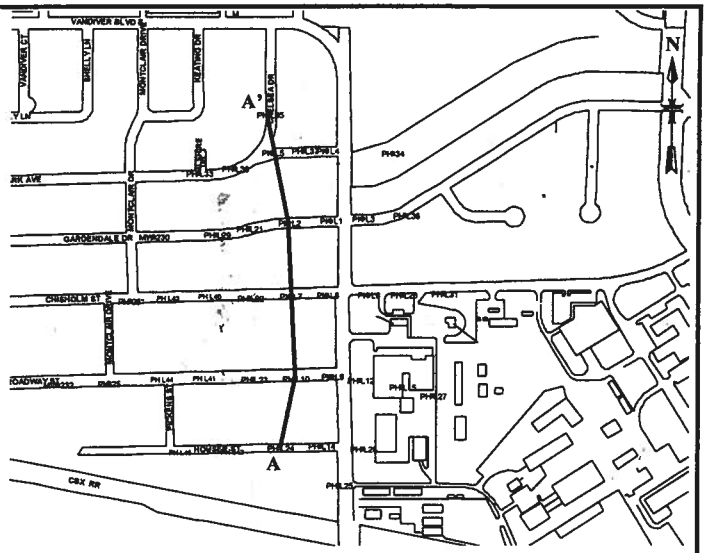
APPENDIX A

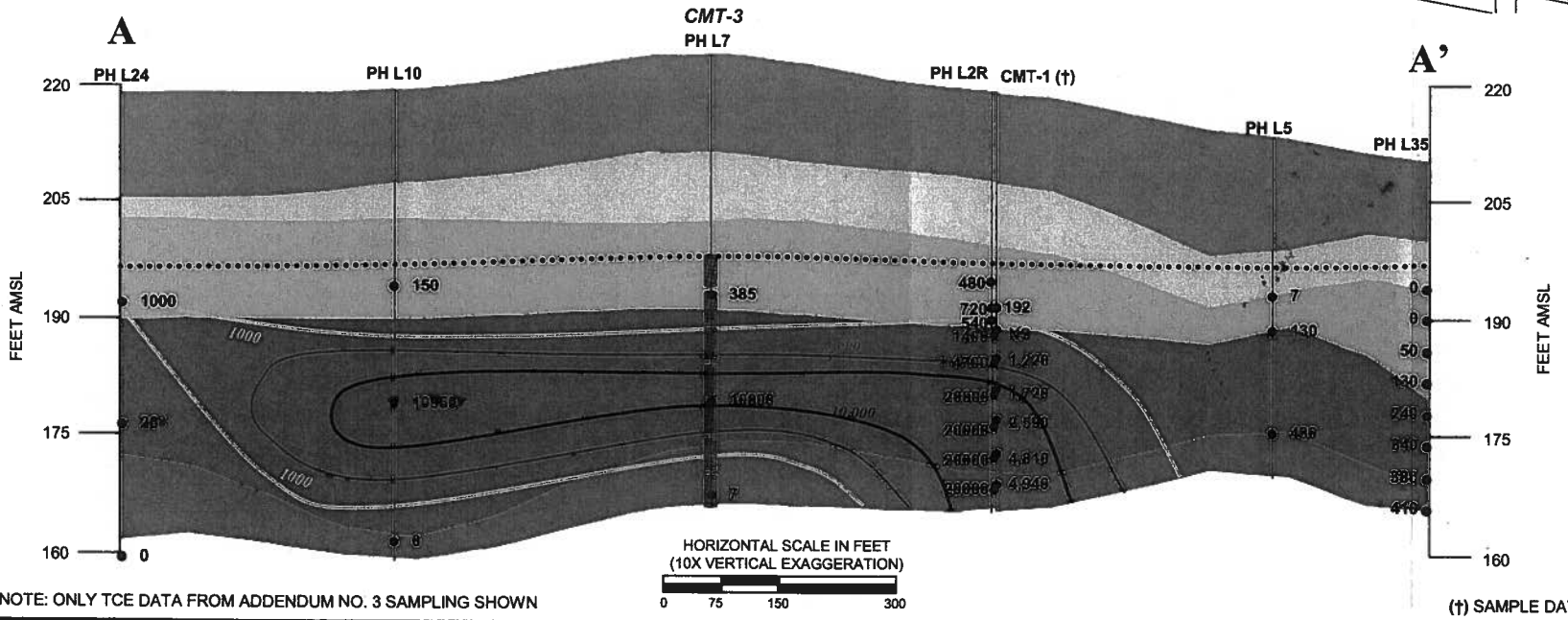
LEGEND

STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 385 — TCE CONCENTRATION (UG/L)
- ● — MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- * — TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.
- NS — NOT SAMPLED
- CMT-3 — PROPOSED CMT WELL
- PROPOSED FILTER PACK INTERVAL FOR CMT WELL





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

(†) SAMPLE DATE FOR CMT DATA IS MAY 2002

MALCOLM PIRNIE

ALABAMA DEPARTMENT OF TRANSPORTATION
COLISEUM BOULEVARD PROJECT

CROSS SECTION A-A'

ALABAMA DEPARTMENT OF TRANSPORTATION

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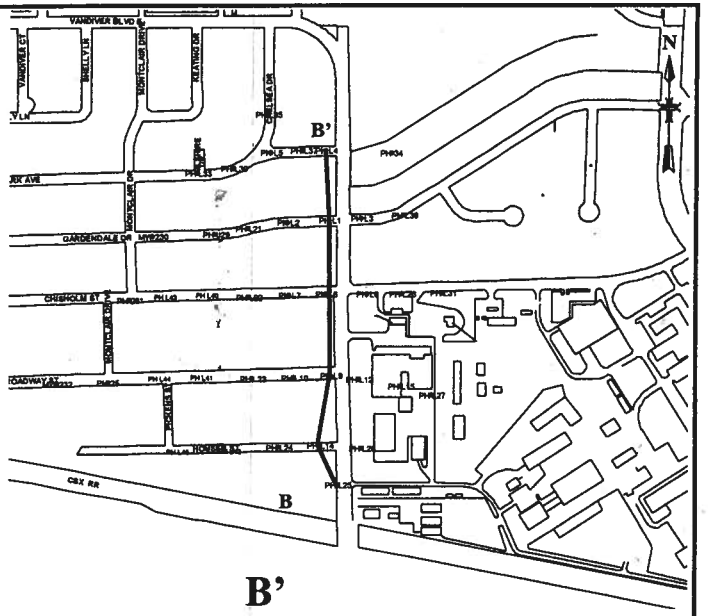
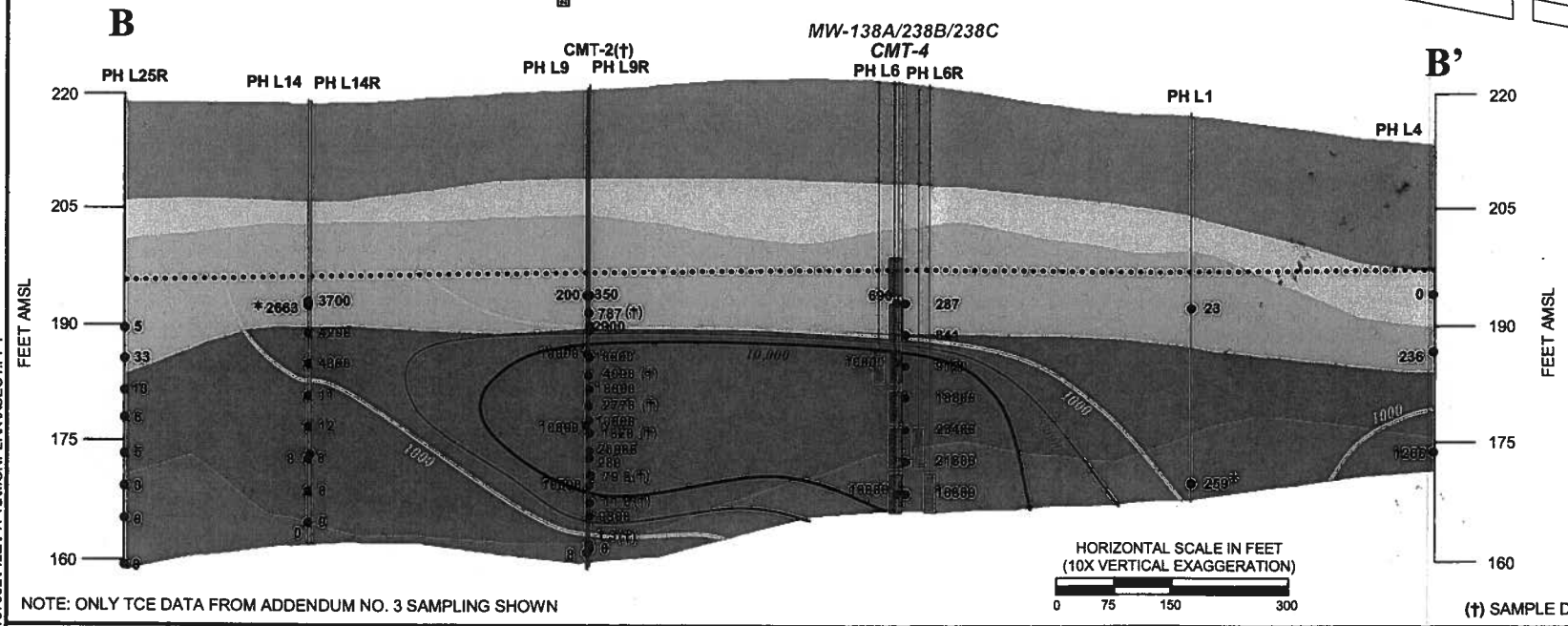
STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

LEGEND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 690 — TCE CONCENTRATION (UG/L)
- ● — MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- * — TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.
- *CMT-4* — PROPOSED CMT WELL
- PROPOSED SCEENED INTERVAL FOR CMT WELL
- *MW-138A/238B/238C* — PROPOSED CONVENTIONAL MONITORING WELL
- PROPOSED SCEENED INTERVAL FOR CONVENTIONAL WELL





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

(†) SAMPLE DATE FOR CMT DATA IS MAY 2002

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COLISEUM BOULEVARD PROJECT

CROSS SECTION B-B'

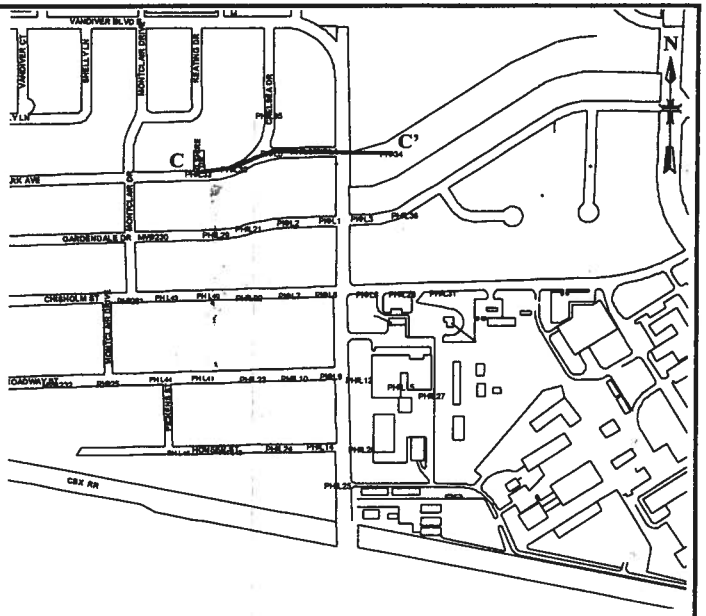
ALABAMA DEPARTMENT OF TRANSPORTATION

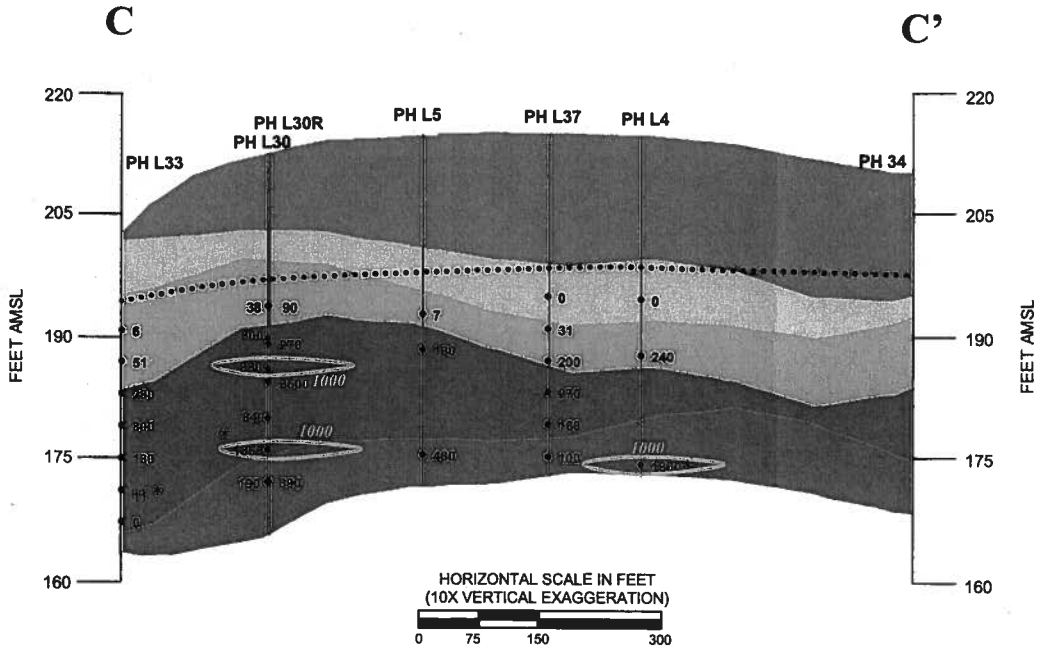
STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

LEGEND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 800 — TCE CONCENTRATION (UG/L)
- MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- * — TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

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COLISEUM BOULEVARD PROJECT

CROSS`SECTION C-C'

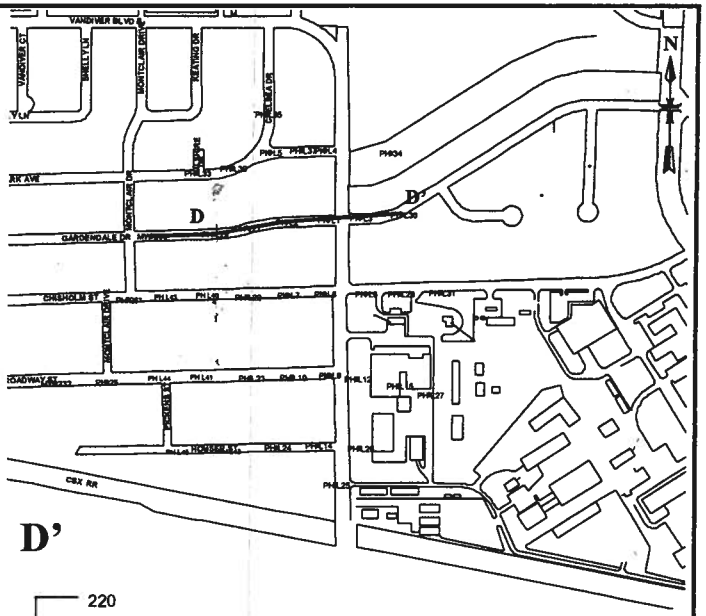
ALABAMA DEPARTMENT OF TRANSPORTATION

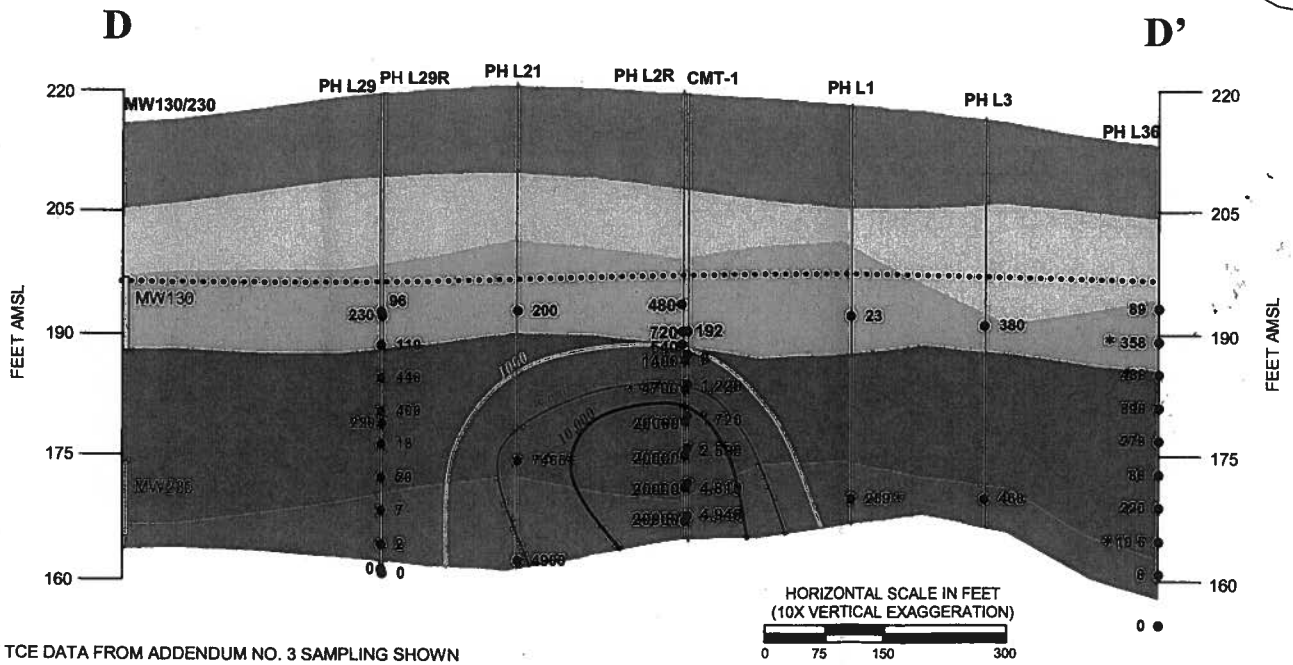
LEGEND

STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 480 — TCE CONCENTRATION (UG/L)
- MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- * — TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.
- MW130 — EXISTING MONITORING WELL SCREENED INTERVAL





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

NOTE: SAMPLE DATE FOR CMT DATA IS 5/6/2002

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COLISEUM BOULEVARD PROJECT

CROSS SECTION D-D'

ALABAMA DEPARTMENT OF TRANSPORTATION

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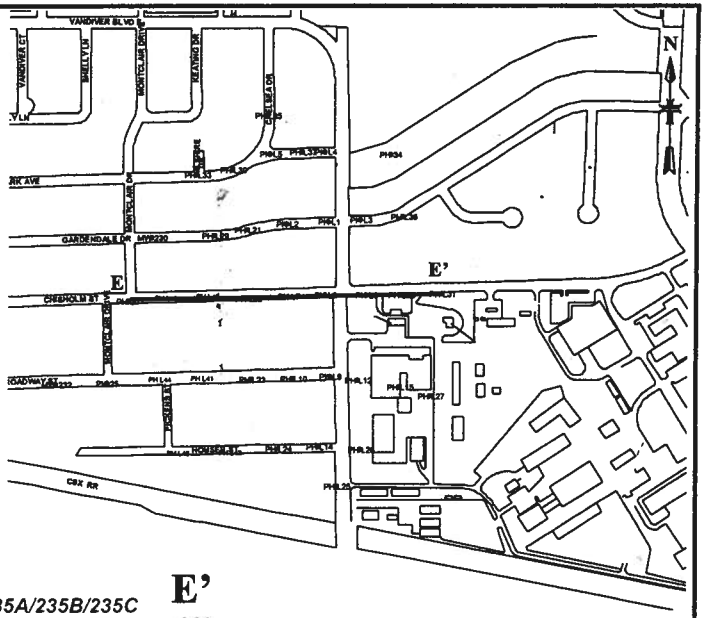
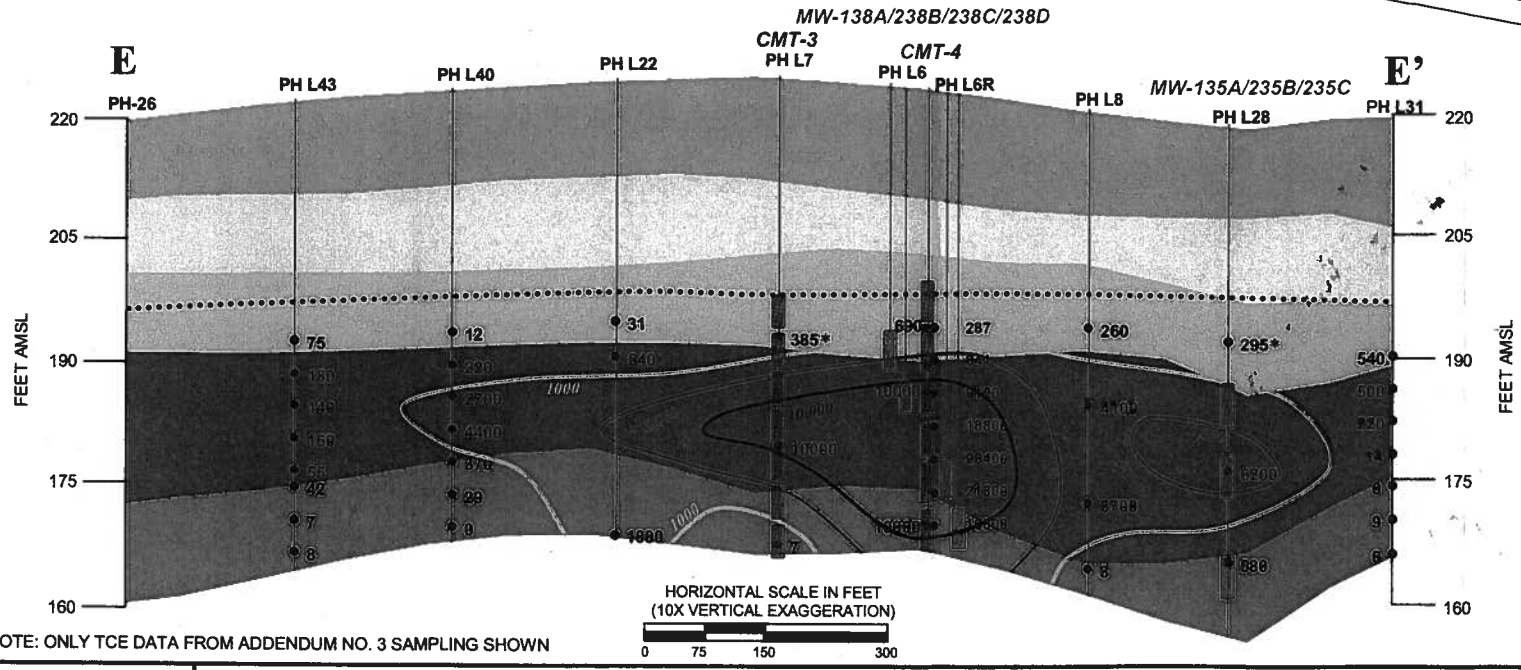
LEGEND

STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 690 — TCE CONCENTRATION (UG/L)
- MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.
- *CMT-4* — PROPOSED CMT WELL
- PROPOSED SCEENED INTERVAL FOR CMT WELL
- *MW-135A/235B/235C* — PROPOSED CONVENTIONAL MONITORING WELL
- PROPOSED SCEENED INTERVAL FOR CONVENTIONAL WELL





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

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COLISEUM BOULEVARD PROJECT

CROSS SECTION E-E'

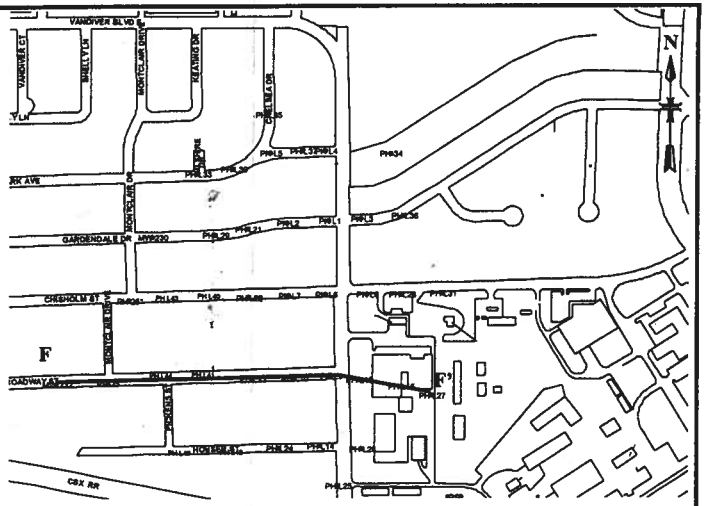
ALABAMA DEPARTMENT OF TRANSPORTATION

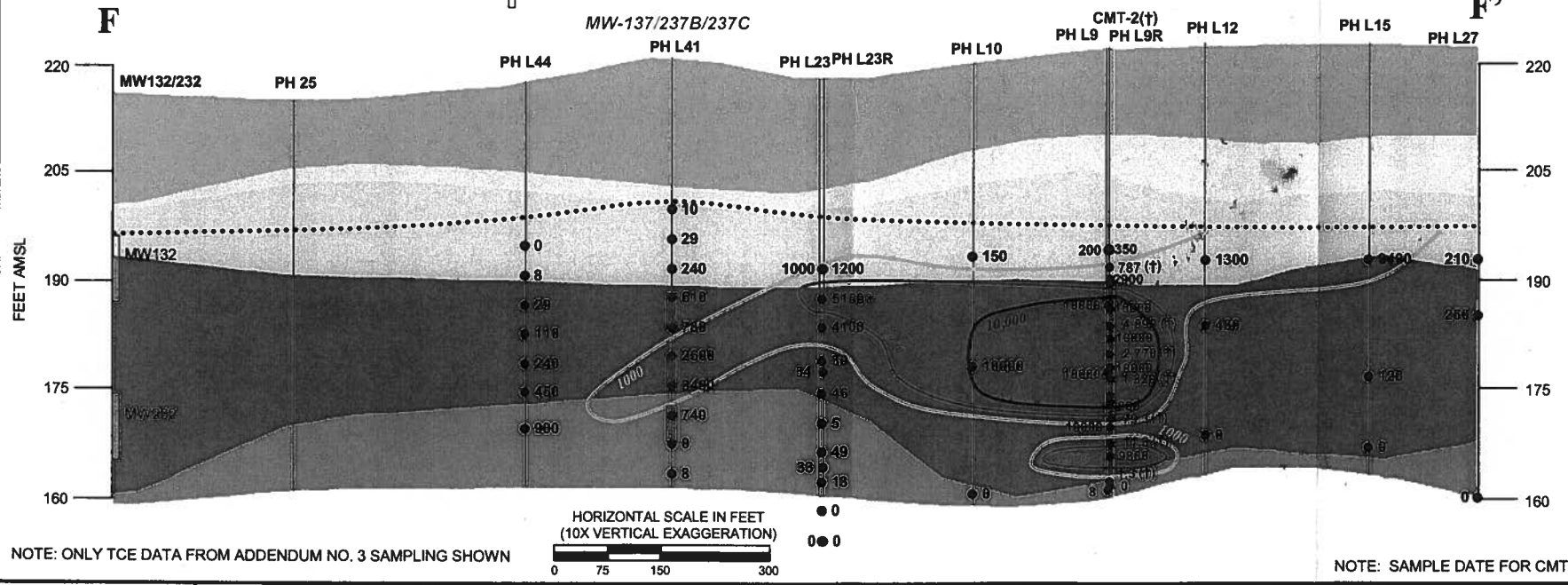
LEGEND

STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 900 — TCE CONCENTRATION (UG/L)
- ● — MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- * — TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.
- *MW-137/237B/237C* — PROPOSED CONVENTIONAL MONITORING WELL
- PROPOSED SCEENED INTERVAL FOR CONVENTIONAL WELL
- MW132 — EXISTING MONITORING WELL SCREENED INTERVAL





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

NOTE: SAMPLE DATE FOR CMT DATA IS 5/6/2002

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COLISEUM BOULEVARD PROJECT

CROSS SECTION F-F'

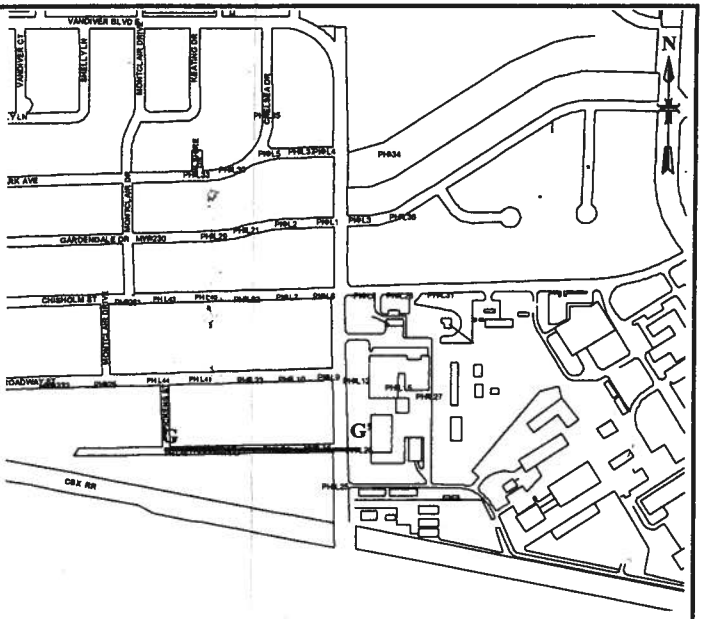
ALABAMA DEPARTMENT OF TRANSPORTATION

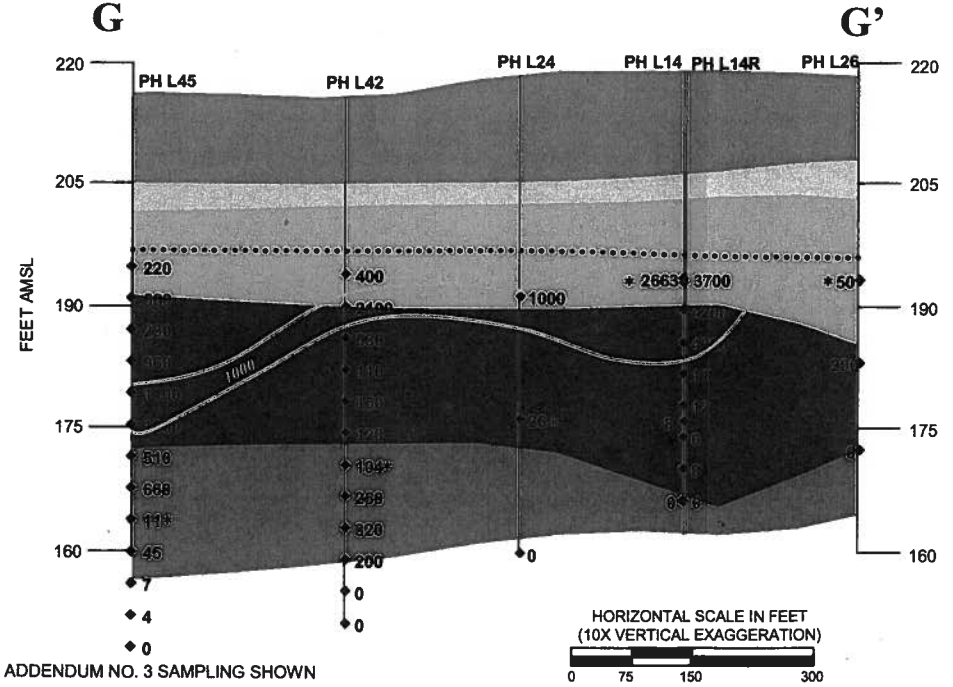
LEGEND

STRATIGRAPHIC LAYERS

- UPPER CLAY
- UPPER SANDY SILT
- SAND AND GRAVEL
- LOWER SANDY SILT (GLAUCONITIC)
- GLAUCONITIC SAND

- 1,000 UG/L ISOCONCENTRATION CONTOUR
- 5,000 UG/L ISOCONCENTRATION CONTOUR
- 10,000 UG/L ISOCONCENTRATION CONTOUR
- APPROXIMATE WATER TABLE
- 960 TCE CONCENTRATION (UG/L)
- MIDPOINT OF GROUNDWATER SAMPLING INTERVAL
- TCE CONCENTRATION BASED ON AVERAGE OF DUPLICATE SAMPLE AND/OR CONFIRMATION CONCENTRATION AND PRIMARY SAMPLE CONCENTRATION.





NOTE: ONLY TCE DATA FROM ADDENDUM NO. 3 SAMPLING SHOWN

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COLISEUM BOULEVARD PROJECT

CROSS-SECTION G-G'

ALABAMA DEPARTMENT OF TRANSPORTATION

ALABAMA DEPARTMENT OF TRANSPORTATION

1409 Coliseum Boulevard, Montgomery, Alabama 36130-3050

Bureau of Materials & Tests
3700 Fairground Rd., Montgomery, Alabama 36110
Geotechnical Section (334)206-2271 FAX (334)264-6263

Don Siegelman
Governor

Paul Bowlin
Transportation Director

August 7, 2002

Mr. Stephen A. Cobb
Alabama Department of Environmental Management
P.O. Box 301463
Montgomery, AL 36130-1463

Dear Mr. Cobb:

The Alabama Department of Transportation has reviewed the ADEM Review Comments letter dated July 19, 2002. Based upon the comments received from ADEM, the work plan has been revised and both a red line version (with changes highlighted) and "final" submittal are attached for your review. The ALDOT responses are:

ADEM Comment 1: *The work plan states on page 03 that two CMT wells and three proposed monitoring well clusters will be installed. However, all the proposed wells will be installed within the saturated zone above the first retarding clay layer. Previous investigation data indicates that the clay layer is thin and may not be competent; therefore, additional monitoring wells will be required in the deep zone. Please revise the work plan accordingly.*

Response: The work plan has been revised to include a discussion of information about the first retarding clay and the zone immediately beneath the first retarding clay in the Probehole 12 area. As discussed in the past, ALDOT plans to construct wells to monitor this deep zone. ALDOT has concluded that it will be environmentally prudent to select the locations and number of such monitoring wells after the screening for DNAPL. This screening was proposed in Addendum 10, which was submitted to ADEM on May 22, 2002. Such deep wells will be constructed in the PH12 area using Deep Well Construction Method 2, which was outlined in Addendum 08, Revision 1. ALDOT will provide a schedule and proposed locations for the deep wells after the field work in Addendum 10 is complete.

ADEM Comment 2: *The plan proposes the installation of only CMT wells in the areas of the highest detected concentrations of TCE. Ground water data indicates a poor correlation between ground water samples collected from CMT wells and ground water samples collected from geoprobe borings in previous investigations. Therefore, the Department requests that a monitoring well cluster be installed in the area of the highest detected TCE concentrations in addition to the installation of the CMT wells. Please revise the work plan accordingly.*

Response: The work plan has been revised to include a three-well cluster at CMT 4. The screened intervals for these three (3) wells are included in Table 1 and shown on cross section B-B'.

ALDOT proposed the CMT wells for monitoring, vertically, the effectiveness of remediation and not for comparison/correlation to monitoring well or Geoprobe data. Thus, CMT data would be compared only to CMT data.

ADEM Comment 3: *The vertical extent of the groundwater contamination in the probehole 12 area has not been defined. Additional vertical delineation of the ground water contamination in the probehole 12 area needs to be conducted. Please revise the work plan accordingly.*

Response: ALDOT has concluded that it will be environmentally prudent to investigate the vertical extent of TCE in the Probehole 12 area after the screening for DNAPL. This screening was proposed in Addendum 10, which was submitted to ADEM on May 22, 2002. Such deep wells will be constructed in the PH12 area using Deep Well Construction Method 2, which was outlined in Addendum 08, Revision 1. The work plan has been revised to include a discussion of information about the zone immediately beneath the first retarding clay in the Probehole 12 area. ALDOT will provide a schedule and proposed locations for the deep wells after the field work outlined in Addendum 10 is complete.

I trust that these revisions address your comments and look forward to your approval of the work plan so that ALDOT can continue the expedited investigations at the site.

Sincerely,

B.E. Cox, Jr.
Geotechnical Engineer

BEC/lbf

Attachments (2)

1.0 GENERAL

This Groundwater Monitoring and Aquifer Testing Work Plan has been prepared as Addendum 10 to the Work Plan for Rapid Response, Interim Corrective Measures and Comprehensive Site Assessment dated February 2001. This Work Plan Addendum focuses on the construction of a permanent groundwater monitoring well network, and aquifer testing, in the Probehole 12 Area. Figure 1 shows the location of Probehole 12. Data collected during the implementation of this plan will be used to evaluate remedial alternatives for the Probehole 12 Area. The additional monitoring points will establish a perimeter well network to monitor TCE concentrations in groundwater and evaluate the effectiveness of any corrective measure in the Probehole 12 Area.

Specific methods for installing Type 2 monitoring wells, Continuous Multi-channel Tubing (CMT) wells and pumping wells for aquifer testing are described herein. Additionally, this Work Plan outlines a method to screen for dense non-aqueous phase liquids (DNAPLs) during drilling activities. The procedures for sample collection and data interpretation are intended to be consistent with the ADEM-approved February 2001 Work Plan and subsequent Addenda. Appropriate health and safety protocols, as defined in the February 2001 Work Plan, will be followed while conducting all field activities.

Figure 2 shows the locations of monitoring wells, piezometers, and probeholes that were completed through May 2002 in the Probehole 12 Area. The results of this investigation are presented in the Investigation Report of Probehole PH-12 Area dated May 14, 2002.

2.0 MONITORING PROGRAM

2.1 INTRODUCTION

The proposed groundwater monitoring program will consist of the collection and analyses of samples obtained from a monitoring well network installed in the Probehole 12 Area. The criteria for the determination of proposed monitoring well locations is based on a compilation of groundwater analytical data results from previous investigations. These data are summarized on Figure 3, which shows isoconcentration contours of the maximum TCE concentrations detected in groundwater samples at each location. Figure 3 identifies a north-south trending area with elevated concentrations of TCE in groundwater. The locations for the proposed monitoring well network were selected by reviewing TCE concentrations in the groundwater samples along seven stratigraphic cross sections that transect the Probehole 12 Area. Figure 2 shows the locations of these cross sections (A-A' through G-G'), which are provided in Appendix A.

Figure 4 shows the proposed monitoring well network, which will include two new Continuous Multi-channel Tubing (CMT) wells and three new monitoring well clusters that will supplement the existing monitoring wells and CMT wells (CMT-1 and CMT-2) in the area. The proposed CMT wells are located within the area of elevated TCE concentrations. The monitoring well clusters will be installed as perimeter wells "stepped out" at locations adjacent to the focus area.

2.2 RATIONALE

The CMT wells will be installed to obtain groundwater analytical data at discrete vertical intervals where the highest TCE concentrations are present. CMTs provide the ability to collect groundwater samples and measure water levels from multiple vertical intervals at the same location. Each channel of the CMT is continuous and can be open to the aquifer at specific vertical positions with sampling ports. The filter packs surrounding these

ports are isolated above and below with bentonite seals, thus minimizing potential mixing between sampling intervals. This degree of vertical sampling refinement is not possible with conventional monitoring wells in areas of limited access to drilling locations (such as the Probehole 12 Area). CMT well construction is further described in Section 2.4.

As shown on cross-sections A-A', B-B' and E-E' in Appendix A, TCE concentrations vary more than four orders of magnitude with depth at individual locations, and the highest TCE concentrations are present in the lower glauconitic sandy silt layer. By sampling groundwater from the proposed CMT wells, the vertical distribution of TCE can be defined in the area of highest TCE concentrations. Groundwater analytical data and groundwater level measurements at these locations will be used to evaluate potential remedial alternatives in the Probehole 12 Area.

The two proposed CMT wells (CMT-3 and CMT-4) will be installed adjacent to Geoprobe® Locations 7 and 6R, respectively. These wells will screen discrete intervals within the saturated zone above the first retarding clay layer. The proposed sampling intervals, summarized on Table 1 and in cross-sections A-A', B-B' and E-E' in Appendix A, were selected based on the vertical distribution of existing TCE concentrations in this area. As shown on cross-section B-B' in Appendix A, a monitoring well cluster will be installed adjacent to proposed CMT-4 and consist of three separate conventionally constructed monitoring wells (see Section 2.4.2). These wells will be screened to coincide with three of the proposed sampling intervals in CMT-4.

Three monitoring well clusters will be installed to supplement the proposed and existing CMT installations and the existing well couplet MW-130/230 (Figure 4). As shown on cross-section E-E' and F-F' (Appendix A), two of the proposed clusters, MW-135A/235B/235C and 137A/237B/237C, will be installed at previously completed Geoprobe® Locations 28 and 41, respectively. As discussed in Section 3.0, the proposed monitoring well cluster MW-136A/236B/236C will also be used as an observation well cluster during one of the proposed aquifer tests. This monitoring well cluster will be located in the vicinity of previously completed Geoprobe® Location 38.

The proposed screened intervals of the wells in the monitoring well network are summarized in Table 1 and shown on the cross-sections in Appendix A. The well locations and screened intervals were selected to obtain hydraulic and groundwater analytical data for the sand and gravel, lower sandy silt (glauconitic), and lower glauconitic sand stratigraphic layers. These data, as well as the data from the CMTs, will be used to evaluate appropriate remedial alternatives in the Probehole 12 Area.

The CMT wells and monitoring wells proposed above will be screened at different vertical intervals above the first retarding clay layer. Soil samples collected during construction of these wells will be screened for DNAPL (see Section 2.3), with samples collected to the first restrictive clay layer. This work will better define the distribution of TCE in soil and groundwater above the first restrictive clay layer. Until this information is reviewed, it is premature to select locations for or drill deeper borings in the Probehole 12 Area.

Based on the work conducted under Addendum 08, (exploratory borings DZ-5 through DZ-8) the first restrictive clay layer in the Probehole 12 Area is estimated to be approximately 1 to 3 feet thick. Shelby tube samples from the first restrictive clay layer at borings DZ5, DZ6, and DZ7 had hydraulic conductivities of 5.8×10^{-7}, 7.4×10^{-7} and 5.9×10^{-8} cm/sec, respectively. Therefore, after this addendum has been implemented, results sent to and coordinated with ADEM, another addendum will be submitted dealing with the installation of deep wells in and around the vicinity of the Probehole 12 area.

Based on the Addendum 08 work, there is an approximately 10 to 20 foot-thick layer of micaceous, glauconitic silt and sand with variable amounts of clay underlying the first restrictive clay layer and overlying the clay confining unit of the Gordo Formation. To characterize groundwater quality in the layer below the first restrictive clay layer and above the Gordo Formation, a monitoring well or wells will be installed as part of this addendum. Any such wells will be in areas where TCE is present in groundwater above the first restrictive clay layer, but away from areas containing the highest concentrations of TCE or DNAPL, if present. This is specifically intended to minimize the potential for

cross contamination through the first restrictive clay layer. The rationale for the location of any wells will be provided to ADEM for review and approval in a subsequent addendum.

2.3 DRILLING AND SOIL SCREENING

The construction and installation of the proposed CMT wells and monitoring wells will be completed following the same specifications as other on-site wells of similar design. At each proposed well location, the boring will be drilled to a predetermined depth below the water table based on information presented on the cross sections. Each well will be installed within the saturated zone above the first retarding clay layer. Drilling and sampling methods previously referenced in the February 2001 Work Plan and subsequent addenda will be employed.

As described below, a DNAPL screening evaluation will be performed while drilling the boreholes for all proposed wells during the implementation of this Work Plan. In all borings, soils will be screened for DNAPL from the water table to the total depth of the boring. On the ALDOT property, soils above the water table will also be screened for residual DNAPL. The DNAPL screening techniques to be utilized will include:

- Visual Examination.
- FLUTe soil core sleeves.

FLUTe sleeves are plastic cores impregnated with a reactive dye that changes color when it comes in contact with DNAPL. The following procedures will be used in the DNAPL screening process:

- Cut approximately 12 to15 feet of the dye-striped FLUTe sleeve from the roll. Use the normal transparent plastic sleeve containing the core as a sleeve outside the FLUTe material.

- Fully extrude the sample core into the concentric FLUTe and plastic sleeves.

- Fold the open ends of the sleeved plastic coverings to contain the core and entrained in-situ fluids. If the core contains DNAPL, the DNAPL will be wicked into the hydrophobic FLUTe sleeve.

- Inspect the reactive dye in the FLUTe sleeve (through the clear plastic outer sleeve) for color changes. If the reactive dye comes in contact with DNAPL, the color change will be immediate.

- Document the presence and depth specific interval that dye staining is observed.

- If staining is present, cut a slit in the sleeve. Measure volatile organic vapors with a photoionization detector (PID) and collect one soil sample for VOC analysis.

- If staining is not apparent, roll the core back and forth to facilitate contact of the soil core with the FLUTe sleeve. Re-inspect the core for dye staining.

2.4 WELL INSTALLATION

2.4.1 CMT Wells

The CMT wells will be constructed of 1.7-inch diameter CMT tubing. These wells will contain up to seven discrete sampling intervals. As summarized in Table 1 and in the cross-sections in Appendix A, the proposed length of these sampling intervals will range between four to five feet based on stratigraphic and groundwater analytical data at each location. In each sampling interval, ports will be opened at one-foot spacing. For example, a four-foot long screened interval will consist of three ports (see Figures 5 and 6). Ports will be wrapped with stainless steel gauze and surrounded by filter pack material or natural filter pack from formation collapse. Bentonite pellets will be emplaced approximately one foot above and below each sampling interval to form a seal

and isolate the intervals. Proposed sampling intervals will be installed using a minimal volume of water. Table 1 summarizes the sampling intervals for the existing and proposed CMT wells.

2.4.2 Monitoring Well Clusters

The monitoring well clusters will be constructed of Schedule 40, two-inch diameter PVC with a 0.010-inch slotted well screen no more than five feet long. A filter pack consisting of #20-40 sand will be used to fill the borehole annulus to a maximum of two feet above the top of the screen. A minimum of two feet of bentonite pellets will be used to seal the well above the filter pack and cement bentonite grout will be tremied above the bentonite seal to a depth of approximately one-foot below grade. The well will be completed with a flush mounted roadbox anchored in a two-foot square concrete/asphalt pad. Sampling intervals for the existing and proposed perimeter monitoring wells are shown on Table 1.

2.4.3 Deep Monitoring Wells

The monitoring wells to be screened in the layer between the first restrictive clay layer and the top of the Gordo Formation will be constructed in accordance with the procedures described in Addendum 08. These deep-zone wells will be drilled with sonic methods and will be double-cased to reduce the potential for cross contamination across the first restrictive clay layer.

2.5 WELL DEVELOPMENT

Following installation, newly installed monitoring wells will be developed in accordance with established methods and the approved Work Plan dated February 2001. Each well will be left undisturbed for a minimum of 48 hours before development to allow the cement/bentonite grout mixture to cure. Prior to development, the static water level and well depth will be measured.

The monitoring wells will be developed using centrifugal (suction-lift pump), air-displacement pump, peristaltic pump or bottom discharging bailer. Well development protocols will be consistent with the February 2001 Work Plan, and will be considered complete when the pH, specific conductivity, temperature, and turbidity have stabilized after purging a minimum of three to five well volumes. Stability is defined as variation between measurements of 10 percent or less and no overall upward or downward trend in the measurements.

Development of the CMT wells may be accomplished using a modified air-lift pumping procedure to purge water introduced during the drilling process and entrained formation water. The purging and development procedure will require small diameter (1/4") polyethylene tubes inserted into one or more CMT channels to depths approximately five feet above the sample ports. Groundwater will be purged using a combination of compressed air blown downward through the plastic tubing and a vacuum applied to the opening of the CMT wells. Development will be considered complete when the volume of recovered purge water exceeds the approximate volume used during the drilling process.

2.6 GROUNDWATER SAMPLING

In conjunction with the on-going, site-wide groundwater monitoring, groundwater samples will be collected from the proposed monitoring well network on a quarterly basis to evaluate changes in TCE concentrations within, and at the perimeter of, the area containing elevated TCE concentrations.

Samples will be obtained and analyzed in accordance with this plan on a quarterly basis. Groundwater monitoring results will be reported to ALDOT/ADEM in the monthly status reports. Groundwater sampling will be performed using the established guidelines described in the February 2001 Work Plan. Groundwater samples will be collected from CMT-1 through CMT-4 and monitoring wells in the proposed well network and analyzed for volatile organic compounds.

Prior to sampling, the depth to groundwater will be measured in each CMT channel. The CMT wells will be purged using the procedures identified above in Section 2.5 (Well Development) or an alternative method using a modified low flow-sampling apparatus. Field parameters identified in Section 2.5 will be measured during purging. Sampling will be conducted using low-flow sampling methods.

2.7 SURVEY

The locations, ground surface elevations, and measuring point elevations of all wells will be surveyed using the same horizontal and vertical datum as specified in the February 2001 Work Plan.

3.0 AQUIFER TESTS

3.1 PUMPING TEST LOCATIONS

Aquifer tests will be conducted in two areas of the TCE plume to quantify hydrogeologic parameters and provide data with which to refine and calibrate a site-wide groundwater model. The site-wide groundwater model will be used to evaluate remedial alternatives for the Probehole 12 Area. The locations and construction procedures of the proposed pumping and observation wells are described in the following sections. The observation well networks will include new and existing monitoring well clusters and newly installed CMT wells. These CMT observation wells will be designed specifically for measuring hydraulic head changes in each hydrostratigraphic unit during the aquifer tests and are not intended to be used for long-term water quality sampling. Figure 4 shows the locations of the proposed pumping wells and observation wells. These locations were selected to evaluate the different hydrogeologic characteristics of the Probehole 12 Area.

3.1.1 PW-1

Well PW-1 will be located on the ALDOT property in the vicinity of existing monitoring well cluster MW-106/206. This area represents the southern portion of the TCE plume where the saturated zone is approximately 30 feet thick (above the first retarding clay layer) and is comprised mostly of the lower sandy silt layer. Groundwater samples collected from wells screened in this layer have consistently contained the highest TCE concentrations, as shown in the cross sections in Appendix A. Quantifying the hydrogeologic characteristics of this layer will be crucial to the evaluation of potential remedial alternatives in similar portions of the CBP site. The overlying sand and gravel layer in this area is partially saturated (less than 20 percent of the total saturated thickness) and the lower glauconitic sand is less than 10 feet thick.

The observation well network for PW-1 will consist of existing wells MW-106 and MW-206 and two additional CMT wells at different radii from the pumping well (Figure 4). The CMT wells will be located approximately 10 feet and 20 feet from PW-1, which will be drilled approximately 30 feet from existing well cluster MW-106/206. The exact locations of the CMT wells and PW-1 will be determined in the field. The CMT wells will be constructed as discussed in Section 3.3.1. Channels in each of these CMT wells will be open in each of the two saturated layers: sand and gravel and lower glauconitic sand. The length of the channel openings will be based on geologic logs of the boreholes in which the CMT wells will be placed.

3.1.2 PW-2

The hydrogeologic characteristics in the northern portion of the plume will be assessed by conducting a pumping test at PW-2, the location of which is proposed to be on the undeveloped residential property on the eastern side of Fairground Road (Figure 4). This location was selected because the stratigraphy in this area differs from that in the vicinity of proposed pumping well PW-1. The sand and gravel layer is fully saturated in the proposed location of PW-2 and comprises approximately half of the saturated thickness. The upper sandy silt layer may also be partially saturated in this area. The saturated zone is approximately five feet thinner in this area than near proposed well PW-1. Because the characteristics of the sand and gravel layer contrast those of the underlying and overlying sandy silt layers, the results of the pumping test in this area will be used to evaluate the influence of the sand and gravel layer on any appropriate remedial alternatives.

The observation well network for PW-2 will consist of one additional CMT well with channels opened in the three saturated layers (upper sandy silt, sand and gravel, lower glauconitic sand). The proposed well cluster MW-136A/236B/236C will also be used as an observation well cluster during the pumping test (see Figure 4). The observation wells will be located at different radii from the pumping well. The CMT well and the MW-136A/236B/236C cluster will be drilled approximately 10 feet and 25

feet, respectively, from PW-2. The exact locations of these wells will be determined in the field.

3.1.3 Background Water-Level Monitoring Locations

Two existing groundwater monitoring wells outside the radii of influence of the pumping wells will be selected to measure antecedent groundwater elevations. Groundwater levels in these wells will also be measured during the aquifer tests to document background fluctuations and trends.

3.2 CONSTRUCTION OF PUMPING WELLS

3.2.1 Pilot Borings

Prior to drilling the boreholes for the pumping wells, one Geoprobe® boring will be advanced at the location of each pumping well to collect soil samples for grain-size analysis and determine the depth to the first retarding clay layer. The Geoprobe® will be equipped with a soil conductivity probe to locate the depth of the first retarding clay layer. Using the Macrocore® sampling device, up to two soil samples will be collected from each stratigraphic layer for sieve analyses. The grain-size curves from these analyses will be used to select the appropriate filter pack material and screens for the pumping wells.

3.2.2 Boreholes

Sonic drilling methods will be used to advance the boreholes in which pumping wells will be constructed. A nominal 10-inch diameter borehole will be advanced to the depth sufficient to intercept the first retarding clay layer. The depth of the pumping wells will be based on the soil conductivity log from the pilot Geoprobe® borings. All drill cuttings will be containerized and disposed of in accordance with the February 2001 Work Plan.

3.2.3 Casing and Screen

The screen and riser well materials shall consist of four-inch nominal diameter Schedule 40 flush-threaded PVC. The screen will extend the entire length of the saturated zone. Because the screened interval will intersect different stratigraphic units, the slot size of screen segments will be based on the appropriate filter pack selected for each unit. As discussed in Section 3.2.4 below, a single filter pack gradation may not be appropriate for all stratigraphic units in which the pumping wells will be screened. All screen intervals will consist of continuous slotted, wire-wrap PVC. The well riser will extend from the top of the screen to approximately three feet above ground surface.

3.2.4 Filter Pack

The filter pack material will consist of clean, well-rounded, quartz sand graded to the size range appropriate for each segment of the screened interval. As discussed in Section 3.2.1, the filter pack gradation will be determined based on the results of sieve analyses conducted on soil samples that will be collected prior to the drilling the pumping wells at both locations. The filter pack will be tremied in place from the base of the screen to two feet above the top of the screen. If flowing sands in the formation prevent filter pack installation, other standard procedures such as washing the filter pack into place will be used.

3.2.5 Bentonite Seal

The bentonite seal shall consist of high-grade sodium bentonite, and shall be supplied in a pellet form, with a minimum diameter of one-quarter inch and a maximum diameter of one-half inch. The bentonite seal will extend two feet above the top of the filter pack.

3.2.6 Grout

Subsequent to pellet hydration, the remainder of the annular space will be grouted to the surface using cement/bentonite grout.

3.2.7 Protective Casing

A temporary steel protective casing with a locking cover will be secured around each well stickup to prevent unauthorized tampering. The protective casing will be set approximately two feet below ground surface. Following the completion of the aquifer tests, each pumping well will be modified by removing the protective casing and three foot stickup and installing a flush mount shroud at ground surface. A two-foot square concrete protective pad will be placed around the flush mount shroud sloping away from the center to the outer edges. The well will be properly labeled for future identification.

3.2.8 Well Development

Pumping wells will be developed in accordance with the procedures outlined in the approved Addendum 1 of the February 2001 Work Plan.

3.3 CONSTRUCTION OF OBSERVATION WELLS

Existing and newly installed monitoring wells and CMT wells will comprise the observation well network for the aquifer tests. The wells will be located at varying radii from the pumping wells. Based on drawdowns measured during previous aquifer tests conducted at the CBP site, observation wells will be located between 10 and 30 feet from the pumping wells. Proposed locations are shown on Figure 4.

3.3.1 CMT Observation Wells

Two CMT wells will be installed in the vicinity of PW-1 and one will be installed near PW-2. In each CMT well, one channel will be assigned to each of the saturated

stratigraphic layers. For example, if three stratigraphic layers are saturated (or partially saturated), three channels will be open in that CMT observation well. In each channel, ports will be opened at one-foot spacing so that the water level measured in that channel will represent the average hydraulic head in the corresponding stratigraphic unit. Ports will be wrapped with stainless steel gauze and surrounded by filter pack material. Bentonite pellets will be emplaced approximately six inches above and below each layer interface to form a seal and isolate the channels. Construction diagrams for the proposed CMT observation wells are provided on Figures 7 through 9 and the monitoring intervals of these wells are summarized in Table 2. These wells will be developed following the procedures provided in Section 2.5.

3.3.2 Observation Well Clusters

Existing monitoring wells MW106 and MW206 will be used as observation wells during the PW-1 pumping test. One observation well cluster, consisting of three wells, will be installed in the vicinity of the PW-2 pumping well. The observation wells will be constructed of two-inch nominal diameter Schedule 40 flush-threaded PVC and will be completed in six-inch diameter boreholes. Screened intervals will be selected based on previous information and will coincide with the stratigraphic layers.

The appropriate gradation of filter pack shall be tremied into place using clean, potable water, from the bottom of the screen upward, to approximately two feet above the screen or by other industry approved techniques. The slot sizes of the screens will coincide with the appropriate filter pack. A two-foot thick bentonite pellet seal shall be placed immediately above the filter pack. After adequate pellet hydration, the annular space will be grouted to the surface using cement/bentonite grout.

Each observation well shall be placed in the borehole such that the top of the casing is flush with ground surface. The top of the well will be set in a flush mount shroud at ground surface surrounded by a two-foot square concrete pad. All drill cuttings and fluids will be containerized and disposed of in accordance with the February 2001

Work Plan. The observation wells will be properly labeled for future identification. These wells will be developed using the procedures provided in the approved Addendum 1 of the February 2001 Work Plan.

3.4 PUMPING TEST PROCEDURES

Step-drawdown pumping tests will be conducted in each pumping well prior to the aquifer tests. Procedures provided in the approved Addendum 1 to the February 2001 Work Plan will be followed for the step-drawdown and constant-rate aquifer tests.