NELSON

FINAL
Phase I Remedial Investigation/ Feasibility Study Report Defense Personnel Support Center Philadelphia, Pennsylvania

Volume I

Reports, Figures, Tables, and Attachments 1 through 4

Submitted to:
U.S. Army Corps of Engineers

Submitted by:

KEMRON
ENVIRONMENTAL SERVICES

Versar INC.
ENVIRONMENTAL RISK MANAGEMENT

July 28, 1995

KEMRON
ENVIRONMENTAL SERVICES

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EXECUTIVE SUMMARY

The United States Army Corps of Engineers (ACOE), Baltimore District, tasked Kemron Environmental Services, Inc., and Versar, Inc., to conduct Phase I of the Remedial Investigation/Feasibility Study (RI/FS) at the Defense Personnel Support Center (DPSC) located in Philadelphia, Pennsylvania. This project was performed on behalf of the ACOE, Philadelphia District, under Contract No. DACW31-89-D-0060, Delivery Order No. 8.

The Defense Personnel Support Center (DPSC) is centrally located in the southern portion of Philadelphia, Pennsylvania, known as South Philadelphia. Comprising approximately 86.5 acres, the facility is situated at approximately 39°55' north latitude and 75°11' west longitude on the Philadelphia PA-NJ 7.5-minute quadrangle of the U.S. Geological Survey (USGS) topographic quadrangle map. Its street address is 2800 South 20th Street; the site is bounded by 20th Street to the east, Oregon Avenue to the north, the Schuylkill Expressway to the south, and the Conrail and CSX railroad properties to the west. Figure 1-1 indicates the location of the DPSC site and surrounding areas in South Philadelphia.

The DPSC is located in the vicinity of several bulk petroleum refining and storage facilities, retail gas stations, and a bus maintenance garage. Their locations are indicated in Figure 1-2. Adjacent refineries and bulk storage facilities include the Sun Refinery (north, south and west yards), the former Chevron Refinery, and the Philadelphia Gas Works.

A Southeast Pennsylvania Transit Authority (SEPTA) maintenance facility is located adjacent to the DPSC's eastern boundary along 20th Street. The George Young Rigging and Hauling Company is located near the northeast corner of DPSC at the intersection of Oregon Avenue and 20th Street. Formerly, there was also an Exxon gasoline station at this intersection. A Getty Oil gasoline station is located north of the DPSC at the intersection of 21st Street and Oregon Avenue, and a Gulf retail station is present at the southeast corner of DPSC, near the intersection of Moyamensing Avenue and the Schuylkill Expressway.

Previous subsurface investigations at DPSC indicated an extensive occurrence of petroleum hydrocarbon contamination in the soils and groundwater underlying the site. In addition, DDT and related pesticide contamination was identified around the former DDT mixing room and associated UST system. Some of the petroleum hydrocarbon contamination may be related to the presence of on-site aboveground and underground storage tanks (ASTs and USTs), but a significant amount was believed to be attributed to off-site sources, including the contiguous, upgradient refineries located just to the west of DPSC. The presence of one or more such plumes has had a far reaching effect on construction activities at the site. According to DPSC personnel, a ban presently exists on new construction activities due to the dangers and risks of explosion and toxic fume releases associated with earthwork.

The objectives of this investigation at DPSC have evolved from initial planning through execution and completion. During initial scoping, the DPSC facility was actively operating and had not been slated for closure under the BRAC program. Therefore, the primary objectives were to characterize and delineate petroleum hydrocarbon contamination, DDT contamination, and contamination from other areas of concern at the facility in order to identify and evaluate remedial alternatives for subsequent clean-up in accordance with the installation-wide master plan. The ultimate objective of the pre-BRAC investigation was to support the protection of human health and the environment and to allow for future development of the site. It was based on these objectives that the Draft Project Operations Work Plan for the DPSC RI/FS was prepared in October 1993.

Following completion of the Draft Project Operations Work Plan for the DPSC RI/FS in October 1993, the DPSC facility was approved for closure under the BRAC program. The known petroleum hydrocarbon contamination and DDT contamination at the site represented the primary obstacles to site transfer and future site use plans. Therefore, the primary objectives of the RI/FS were modified to characterizing and delineating petroleum hydrocarbon and DDT contamination for subsequent interim remedial measures, as necessary, and responsible party identification and cost apportionment. The secondary objectives of the post-BRAC RI/FS were to characterize and delineate contamination associated with other areas of concern and to develop subsequent remediation plans for these other areas of concern so that the site could be transferred in accordance with BRAC requirements. Based on these modified objectives, the Project Operations Work Plan for the DPSC RI/FS was revised in May 1994.

When this investigation commenced in September 1994, BRAC FY93 funding limitations necessitated a phased approach to the investigation. Consequently, DPSC and the BRAC Team assigned top priority to the characterization and delineation of the petroleum hydrocarbon contamination and the DDT contamination at DPSC, because these known problems represented the greatest obstacle to subsequent site transfer and future site use plans. A secondary objective of this investigation was to preliminarily identify potential responsible parties for the petroleum hydrocarbon plume. These priority objectives were extracted from the overall RI/FS Project Operations Work Plan as "Phase I," which is the subject of this report.

Phase I of a Remedial Investigation (RI) was performed at the 86.5-acre Defense Personnel Support Center in Philadelphia, Pennsylvania between September 1994 and April 1995. The Phase I RI work scope included performance of a ground penetrating radar survey, active and passive soil gas surveys, site characterization analysis penetrometer system survey, hydropunch sampling, and the advancement of sixteen borings that were subsequently converted to groundwater monitoring wells. Most of these field activities were conducted on

DPSC property, however, two monitoring wells were installed on the adjacent CSX railroad property along the western boundary of DPSC. The passive soil gas survey was to be conducted on both DPSC and the Sun Oil Company refinery sites, but subsequent discussions with Sun representatives failed to achieve rights of access to conduct that part or the survey that was to be performed within the refinery area. In addition to on-site field work, regulatory files were reviewed to obtain information on surrounding properties and potential contaminant migrations pathways (i.e., utilities, primarily sewers, surrounding DPSC). All work was performed in accordance with the RI Project Operations Plan dated May 23, 1994, the Technical Proposal dated August 10, 1994, and approved modifications made thereto.

The findings and key conclusions from the Phase I RI are summarized below:

- Several portions of DPSC showed low concentrations of petroleum hydrocarbons just below the soil surface (i.e., in the depth interval 0 to 8 feet). This contamination is most likely caused by past operations at DPSC.

- A massive free product plume consisting of gasoline and diesel fuel exists on the water table at the southern portion of DPSC. The volume of product contained in this plume (estimated at 1,000,000 gallons) is larger than can be attributed to the use of similar products at DPSC.

- Petroleum hydrocarbon contamination was conspicuously absent in the soil interval between the surficial soils (0-8 feet) and the water table, indicating that no direct pathway for contaminant migration exists between the surficial contamination and the free product plume.

- Based on regional and site specific groundwater flow patterns, the unique chemical signature of the massive free product plume, and the distribution patterns of soil and groundwater contaminants revealed through the preparation of various petroleum hydrocarbon species isoconcentration maps, the free product plume does not appear to have originated on-site or to have migrated onto DPSC from the presumed upgradient (i.e., northwest) direction.

- A review of regulatory files was conducted to investigate all documented on-site and off-site petroleum hydrocarbon releases. This review was performed in an attempt to determine the relationship of the releases, if any, to the free product plume. Most of these releases (i.e., those from SEPTA, Sears, and surrounding service stations) were found to be volumetrically insignificant and bore different chemical characteristics from the massive gasoline/diesel plume.

- From regulatory file reviews, the south yard of the neighboring Sun Oil Company refinery was found to have the greatest frequency of free product occurrences of any of the properties in the immediate vicinity of DPSC. Based on this information and a review of contaminant migration pathways, the Sun refinery south yard appears to be the most likely source of the existing free product plume.

- Interpretation of hydrogeologic and geochemical data suggests that the plume entered the installation from a southerly direction, possibly via a transport pathway associated with permeable bedding and backfill materials originally emplaced along the east-west trending Packer Avenue sewer line and a sewer lateral entering DPSC from the southeast. It is clear from available groundwater monitoring reports for the Sun Oil Company that utilities have played a key role in free product migration within certain portions of the refinery south yard. There is documented information concerning the existence of multiple free product plumes on the Sun south yard along the 26th Street sewer and the Pollock Street Sewer.

- Soils containing DDT at concentrations above Land Ban limits were detected in a small area adjacent to Building 9, in the southeast portion of the site immediately south of two former 10,000-gallon DDT underground storage tanks. Elevated levels of DDT above Land Ban limits were also identified in the soil samples collected from beneath the concrete floor of the mixing room in Building 9. In addition, low levels of DDT were found in the groundwater near the former USTs.

Three distinct areas of petroleum hydrocarbon contamination were documented at DPSC. Low-level diesel range organic contamination was identified in soils and groundwater in the northwest portion of the site. Weathered diesel fuel contamination was found in the soil associated with a release from former DPSC underground storage tanks located along Oregon Avenue in the north-central part of the site. A massive, free product plume was found covering most of the southern half of the facility. The first two areas of petroleum hydrocarbon contamination appear to be unrelated to the free product plume along the southern portion of DPSC based on the following factors: (1) the limited areal extent of diesel range organic and weathered diesel fuel contamination, (2) the geometry of the free product plume, and (3) the low levels of total petroleum hydrocarbons/ diesel range organic species associated with the former two areas.

The 54-acre free product plume consists of a gasoline/diesel fuel mixture ranging from 2:1 to 3:1 and was found to cover most of the southern half of the DPSC site. This plume, containing approximately one million gallons of free product, has caused extensive areas of soil and groundwater contamination. Free product has accumulated along the southern half of DPSC in response to the unique geologic conditions that exist in that area and also in association with a large, east-west trending sewer line that runs parallel to the southern property boundary.

Because the hydrogeologic data were not indicative of a direct contaminant migration pathway from an upgradient source, additional research of utility files was conducted to evaluate preferential contaminant migration pathways through a process of elimination of potential candidates. This additional research revealed that free product accumulations in the Sun Refinery's south yard commonly occur in association with sewer lines. At least one of these sewers with which free product is associated runs from the central part of the south yard in an easterly direction, skirting the southern property boundary of DPSC. Based on the data contained in this report, this sewer appears to represent the most logical pathway for migration of the petroleum hydrocarbon contamination onto the DPSC site. No other mechanisms for transport of such a volume of free product have been identified to date.

Versar has reason to conclude that the single most likely potential source of the 54-acre free product plume at the DPSC is the Sun Oil Company refinery south yard, in light of careful consideration of the following factors:

- The volume of free product in the aquifer along the southern portion of DPSC exceeds one million gallons, and additional product volume occurs in an irreducible form in subsurface soils due to historic water table fluctuations. Based on available information concerning various on-site and off-site releases in the vicinity of DPSC, none of these individual sources is likely to have generated a product volume this large, except for the refinery south yard. Interpretation of groundwater flowpaths and the chemical signatures associated with the various releases, excluding the Sun refinery south yard releases, indicate that they did not act in a cumulative sense to produce a one million gallon free product plume that is a gasoline/diesel fuel mixture.

- Free product does not appear to have migrated onto the DPSC site from a northwest direction following regional groundwater flow patterns. Although low levels of DRO contaminated media were detected in the northwest corner of DPSC, no discernible transport pathway for the free product plume was recognizable from the analyses of soil and groundwater samples collected in this area. If the gasoline/diesel plume entered the DPSC from the northwest, residual soil contaminants bearing this chemical signature should be evident in the silty, fine grained soils that comprise the aquifer. The absence of this chemical signature suggests an alternate transport pathway.

- As indicated by the pattern of isoconcentration contours for various hydrocarbon species, the extent of soil and groundwater contamination associated with the free product plume at DPSC suggests a source that lies somewhere to the south of the facility. The area south of DPSC is primarily residential; however, major city sewer lines south of the DPSC site continue into the refinery area and are known to be associated with various occurrences of free product in that area.

- There are no manifestations of the massive free product plume in soils in the depth interval from 0 to approximately 15 feet below grade, making it improbable that any major spills or surface releases at DPSC contributed significantly to the free product plume. The presence of a surficial low permeability silt and clay unit at DPSC tends to inhibit the potential infiltration of spills to water table depths.

Additional work is required to further evaluate contaminant migration pathways and to develop a chemical correlation between the source area (i.e., the responsible party) and the plume observed on the southern portion of the DPSC property. This additional work will determine whether the Packer Street sewers, or other sewers, have functioned as free product migration pathways. The additional work will include geotechnical characterization of the soils, bedding and backfill materials in contact with certain sewers; the evaluation of hydraulic gradients along these utilities; direct push soil and groundwater sampling and analysis; and detailed petroleum hydrocarbon fingerprinting at DPSC and all suspected source areas.

Three recommended tasks remain to be performed at DPSC to complete implementation of the RI/FS:

- Additional responsible party determination, including additional characterization required to identify free product and vapor phase transport mechanisms that may occur via subtle migration pathways.

- Assessment of the need for possible interim remedial measures to assure containment of the free product plume.

- Evaluation of the remaining areas of concern at DPSC, including delineation of the dissolved phase groundwater contaminant plume associated with the occurrence of more than one million gallons of free product, and subsequent completion of a Baseline Risk Assessment and Feasibility Study.

INTRODUCTION

The United States Army Corps of Engineers (ACOE), Baltimore District, tasked Kemron Environmental Services, Inc., and Versar, Inc., to conduct Phase I of the Remedial Investigation/Feasibility Study (RI/FS) at the Defense Personnel Support Center (DPSC) located in Philadelphia, Pennsylvania. This project was performed on behalf of the ACOE, Philadelphia District, under Contract No. DACW31-89-D-0060, Delivery Order No. 8.

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This report presents the results of the Phase I RI at DPSC. DPSC is centrally located in the southern portion of Philadelphia, Pennsylvania. The facility comprises approximately 86.5 acres and is found at approximately 39°55' north latitude and 75°11' west longitude. The facility street address is 2800 South 20th Street, and the site is bounded by 20th street to the east, Oregon Avenue to the north, the Schuylkill Expressway to the south, and the Conrail and CSX railroad properties to the west.

The DPSC facility is government-owned and is operated by the Defense Logistics Agency (DLA). The facility is responsible for the worldwide distribution of supplies for the DOD. This responsibility includes procuring and distributing food, clothing, and medical supplies to all branches of the armed forces and to other authorized federal agencies and foreign countries, as required. According to DPSC personnel, the property has always been owned or leased by the Department of Defense (DOD) ever since the facility was originally constructed in 1918. Additional construction and major renovations occurred at the site in the early 1940's. Prior to initial construction in 1918, the property was reportedly vacant, unimproved land.

Previous subsurface investigations at DPSC have indicated an extensive occurrence of petroleum hydrocarbon contamination in the soils and groundwater underlying the site. Some of this contamination may be related to the presence of on-site aboveground and underground storage tanks (ASTs and USTs), but a significant amount may be attributed to off-site sources. The primary operable units of this Phase I RI, therefore, consisted of petroleum hydrocarbon contaminated media including soil and groundwater.

The Phase I RI was performed between September 1994 and April 1995 in accordance with the Project Operations Work Plan, dated May 23, 1994, and in accordance with the Technical Proposal for the Phase I RI/FS, dated August 10, 1994. Phase I included characterization and delineation of the free product plume underlying DPSC, preliminary PRP determination for the free product plume, and delineation of residual DDT and pesticide contamination associated with the former DDT mixing room and associated UST systems. The report describes the field activities conducted at the DPSC facility and presents an in-depth evaluation of the findings from these investigations.

This report comprises 15 sections, including the following:

- Site description and history (Section 1.0);
- Previous investigations and assessments (Section 2.0);
- Remedial investigation objectives (Section 3.0);
- Summary of field activities (Section 4.0);

- Geology (Section 5.0);
- Hydrogeology (Section 6.0);
- Extent of contamination - petroleum hydrocarbons (Section 7.0);
- Extent of contamination - DDT USTs (Section 8.0);
- Data summary and comparison - non-petroleum related parameters (Section 9.0);
- Data validation (Section 10.0);
- Preliminary evaluation of contaminant migration pathways (Section 11.0);
- Contaminant source areas (Section 12.0);
- Conclusions (Section 13.0);
- Recommendations (Section 14.0); and
- Steps toward remediation of petroleum hydrocarbon contaminated media (Section 15.0).

1.0 SITE DESCRIPTION AND HISTORY

The objective of Phase I of the DPSC RI was to delineate the extent of petroleum hydrocarbon contaminated media. Therefore, the geographic framework for the Defense Personnel Support Center (DPSC) is presented to establish the facility's setting with respect to bulk petroleum storage facilities, a bus maintenance garage, and gasoline stations. These facilities all have associated underground and/or aboveground petroleum hydrocarbon storage tanks, many of which have experienced releases in the past. Moreover, a review of site history reveals significant modifications to this tract of land over time that may have altered subsurface conditions in certain areas. A more detailed discussion of the history of the DPSC site may be found in a report entitled, *Cultural Resources Survey, Defense Personnel Support Center, City of Philadelphia*, dated November 1994.

1.1 Site Description

The Defense Personnel Support Center (DPSC) is centrally located in the southern portion of Philadelphia, Pennsylvania, known as South Philadelphia. Comprising approximately 86.5 acres, the facility is situated at approximately 39°55' north latitude and 75°11' west longitude on the Philadelphia PA-NJ 7.5-minute quadrangle of the U.S. Geological Survey (USGS) topographic quadrangle map. Its street address is 2800 South 20th Street; the site is bounded by 20th Street to the east, Oregon Avenue to the north, the Schuylkill Expressway to the south, and the Conrail and CSX railroad properties to the west. Figure 1-1 indicates the location of the DPSC site and surrounding areas in South Philadelphia.

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A Southeast Pennsylvania Transit Authority (SEPTA) maintenance facility is located adjacent to the DPSC's eastern boundary along 20th Street. The George Young Rigging and Hauling Company is located near the northeast corner of DPSC at the intersection of Oregon Avenue and 20th Street. Formerly, there was also an Exxon gasoline station at this intersection. A Getty Oil gasoline station is located north of the DPSC at the intersection of 21st Street and Oregon Avenue, and a Gulf retail station is present at the southeast corner of DPSC, near the intersection of Moyamensing Avenue and the Schuylkill Expressway.

1.2 Site History

The DPSC facility, constructed in 1918, is government-owned and is operated by the Defense Logistics Agency (DLA). Before that time, this parcel of land was largely unimproved, and Penrose Avenue crossed what is now the southeast corner of the site. Figure 1-3 indicates the original site topography for the DPSC property. In the 1940s, additional construction and major renovations occurred at the site. According to a City of Philadelphia Planning Map (see Figure 1-4), a number of roads were proposed to criss-cross the site including 21st, 22nd, 23rd and 24th Streets (from north to south), as well as Johnston, Bigler and Pollack Streets (from east to west). Vare Avenue was also proposed to bisect the site in a northwest-southeast direction. However, it is not known which, if any, of these roads were actually constructed as planned. Figure 1-4 demonstrates the proposed development of the site by the mid-1900s.

Presently, 95% of the total property area is paved or developed with buildings. Figure 1-5 shows the current site configuration. Warehouses occupy much of the western portion of the site, whereas the active manufacturing operations and administrative functions are conducted mainly in buildings on the eastern half of the site. Utilities underlie all of the facility roadways and include water mains, gas lines, electrical lines, steam lines, telephone lines, a combined stormwater-sanitary sewer system, and an underground fuel tunnel.

The DPSC facility was responsible for the worldwide distribution of supplies for the Department of Defense (DOD). This responsibility included procuring and distributing food, clothing, and medical supplies to all branches of the armed forces and to other authorized federal agencies and foreign countries, as required. The majority of the supplies distributed by DPSC were manufactured and stored at other installations. However, DPSC previously manufactured some textile and clothing items on-site, and some of the supplies were stored in the DPSC facility's warehouses. The facility is scheduled for closure in 1999 under the Base Realignment and Closure (BRAC FY93) Program .

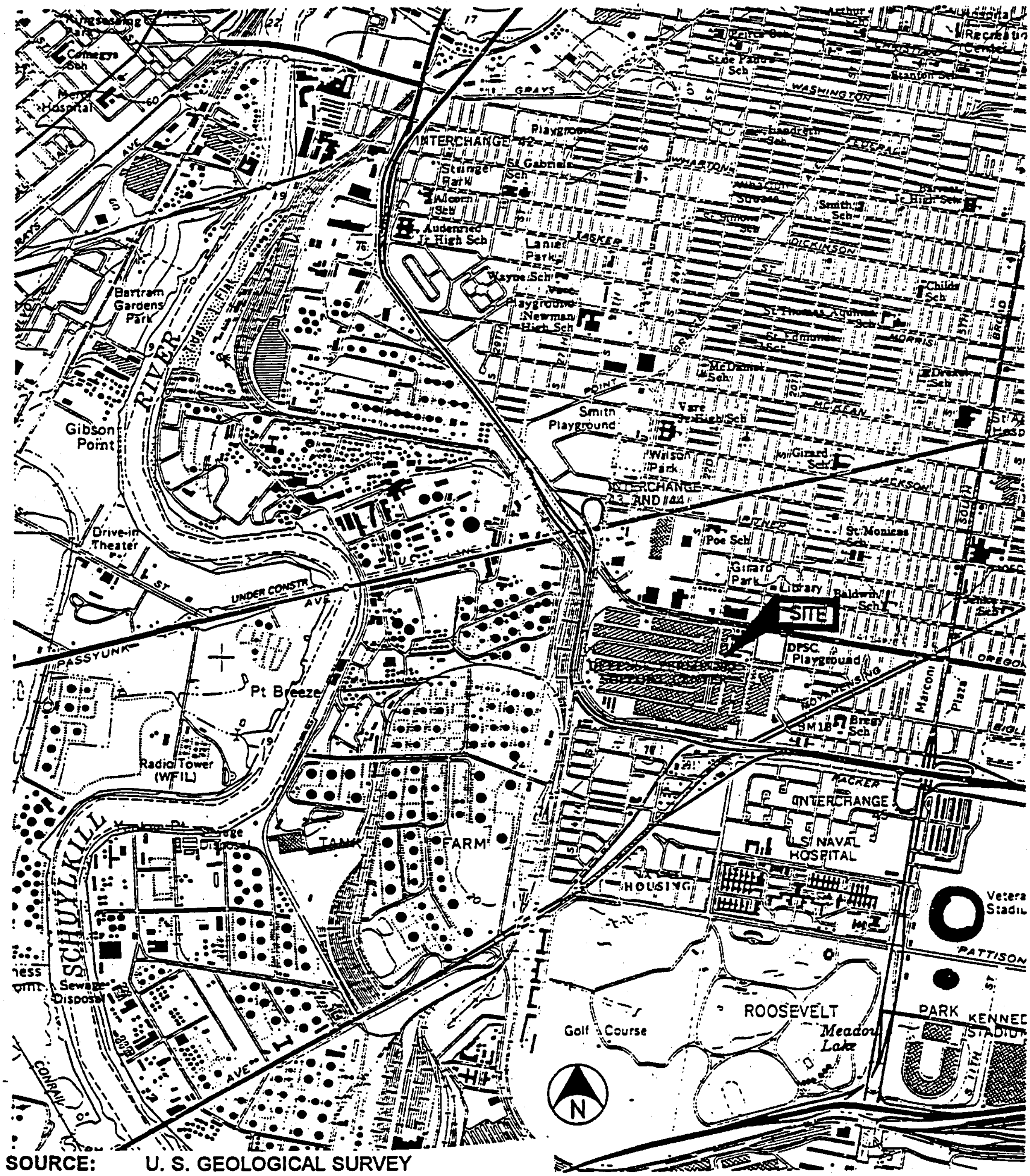
1.2.1 Evolution of Site and Site Topography

Site improvements made since the site was first developed in 1918 have had significant impacts on subsurface conditions that may have influenced the migration of petroleum hydrocarbons.

When the property was still owned by the Girard family, the original site topography was considerably different from its current appearance. A north-south trending ridge with an elevation of 18 to 20 feet above mean sea level (MSL) bisected the site with elevations dropping to approximately 15 to 16 feet above MSL to the east and west property lines. Two prominent low areas existed at the site: one in the northwest corner and another at the southeast corner. The low area to the northwest was reportedly a wetlands/marsh with elevations dropping to as low as 3 feet above MSL, close to the current depth of the water table at the site. At the southeast corner of the site, elevations dropped to about 11 feet above MSL, where a culvert channeled surface water in an easterly direction across Penrose Avenue. Figure 1-6, an early vintage map of the South Philadelphia area, indicates that a small creek formerly ran near the northeast corner of the site, flowing in an east-southeasterly direction into Chickhansink Creek. The latter drainage appears to have formerly run along what today is recognized as 20th Street.

Today, the average elevation at DPSC ranges between 18 and 21 feet above MSL. The former lowland areas at the northwest and southeast portions of the facility have been leveled with fill including ash, cinders, ceramic, and brick. Up to 22 feet of fill have been emplaced at the northwest corner of the site and approximately 10 feet at the southeast section. The physical properties of this fill, particularly hydraulic conductivity, vary markedly from the natural low permeability clay unit that is developed over much of the rest of the site.

The roads and streets built in the mid-1900's have probably had minimal impact on subsurface conditions at the site. However, the myriad of underground utilities presently underlying many of these streets may have functioned as migration pathways for vaporous phase hydrocarbons. Some of the deeper utilities, notably the combined stormwater-sanitary system, may have affected the migration of free product phase hydrocarbons to some extent. The presence of railroad tracks and the Schuylkill Expressway along the southern and western property boundaries may also influence the migration of petroleum hydrocarbon vapors.



SOURCE: U. S. GEOLOGICAL SURVEY
7.5-MINUTE SERIES TOPOGRAPHIC MAP
PHILADELPHIA, PA-NJ QUADRANGLE
1967, PHOTOREVISED 1985

SCALE: 1 INCH = 2,000 FEET

(215)

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 1-1

SITE LOCATION MAP

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE: 05/15/94
DESIGNED BY: D.M.
SCALE:
JOB NO.: 2727.001
DWG. NO.:

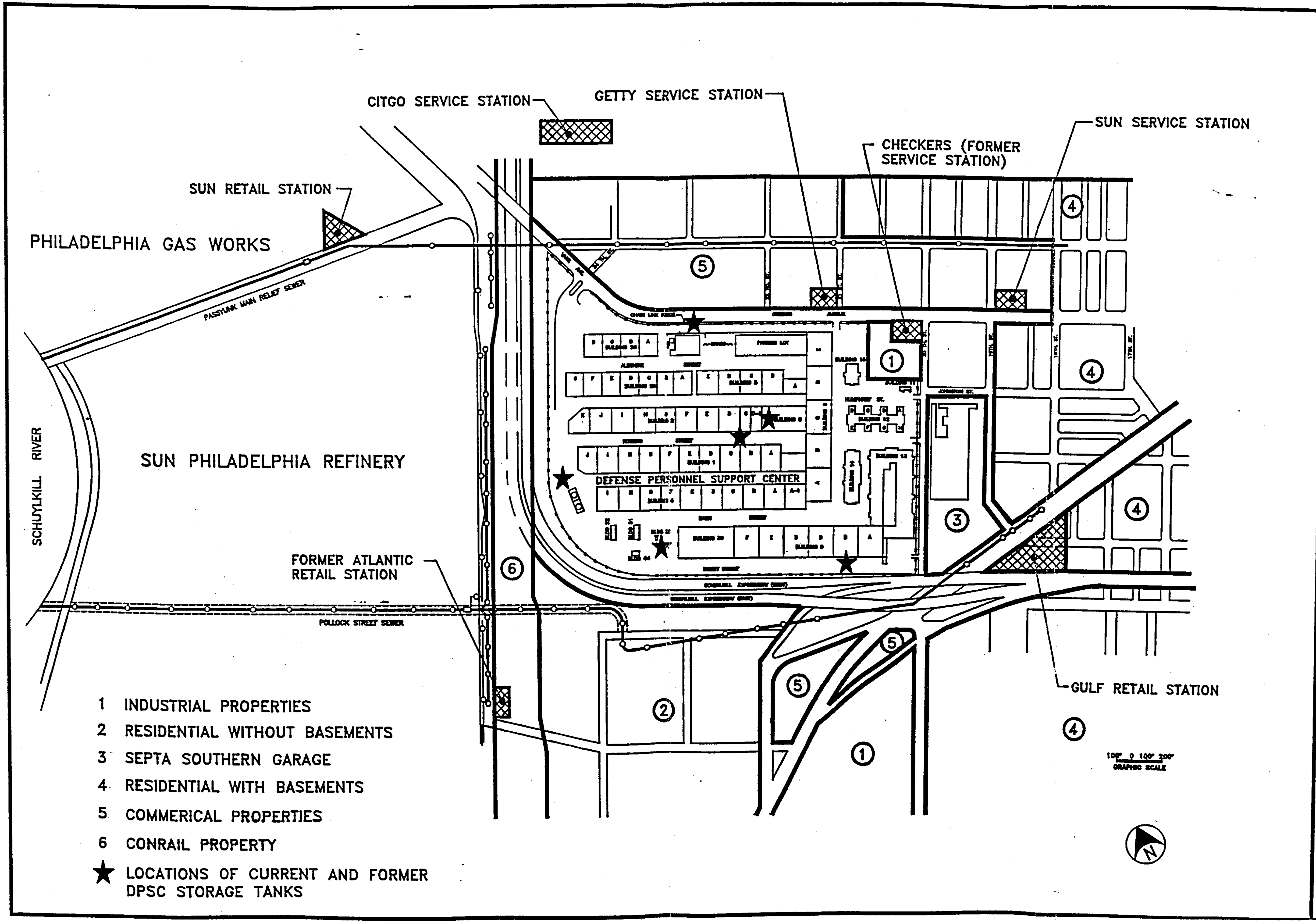


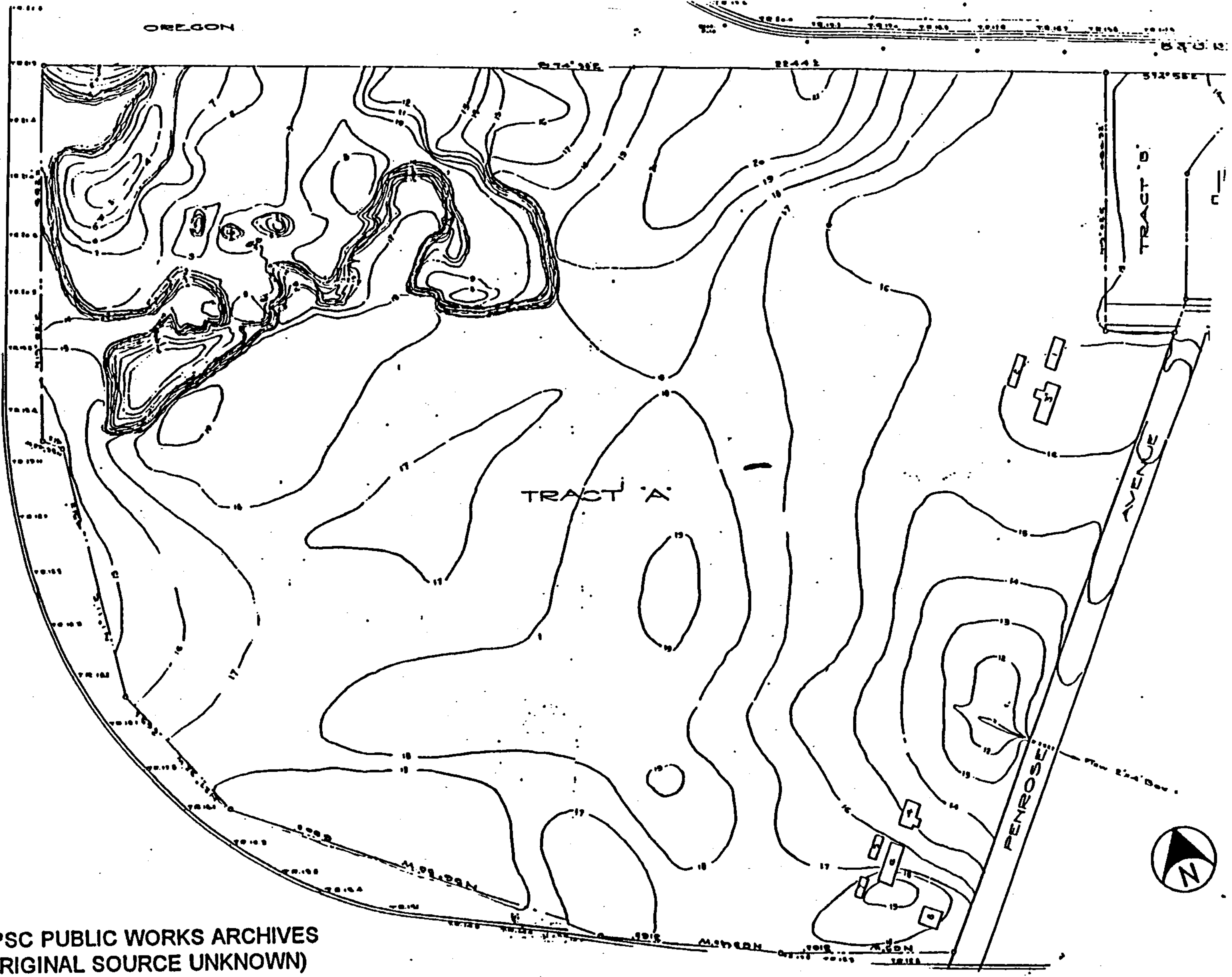
FIGURE 1-2

PROPERTIES CONTIGUOUS TO DPSC

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/02/95
SCALE: NOTED
DWG. BY: D.M.

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844



SOURCE: DPSC PUBLIC WORKS ARCHIVES
(ORIGINAL SOURCE UNKNOWN)

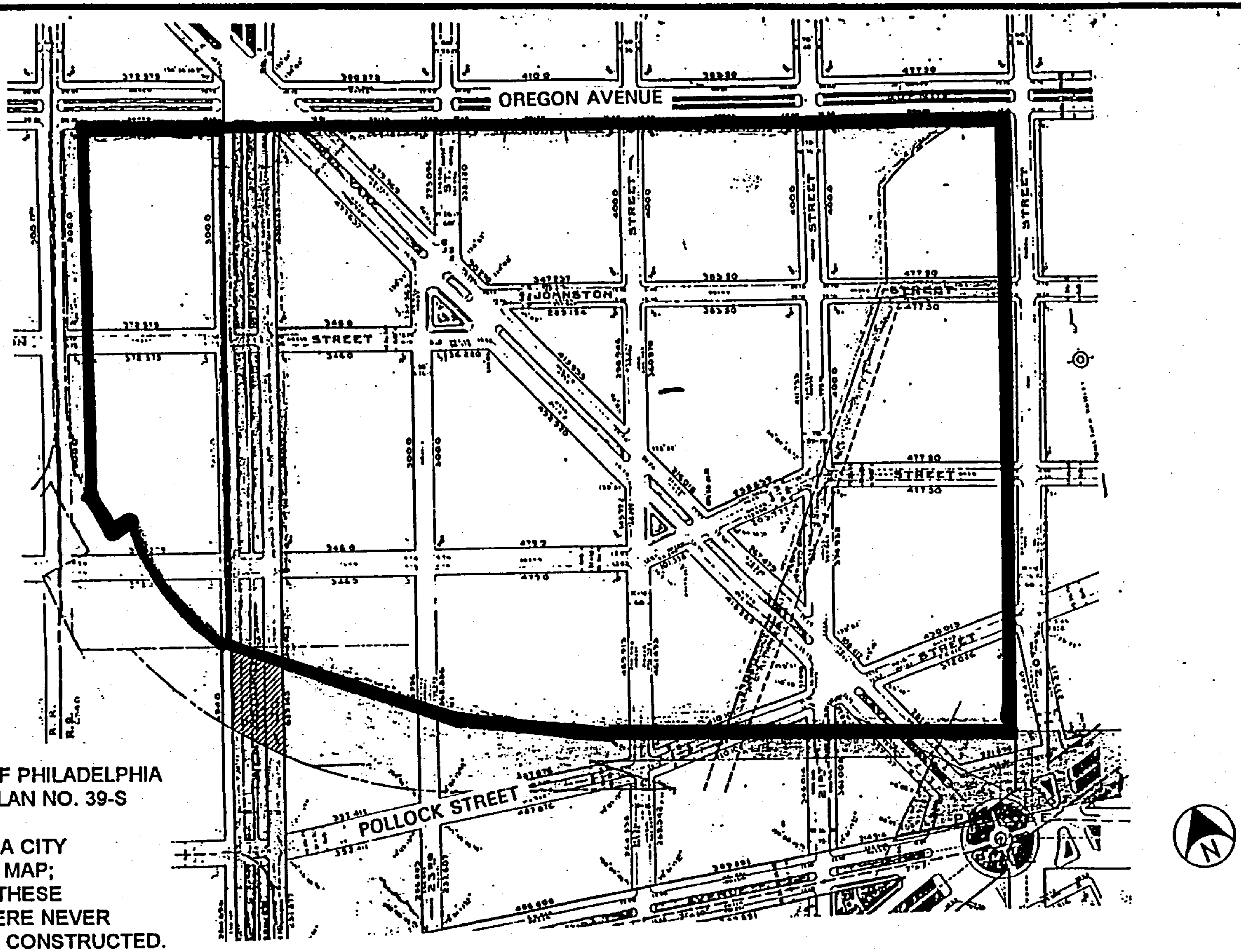
Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 1-3

ORIGINAL SITE TOPOGRAPHIC MAP (1918)

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE:	05/15/95
DESIGNED BY:	D.M.
SCALE:	NTS
JOB NO.:	2727.001
DWG. NO.:	



SOURCE: CITY OF PHILADELPHIA
CITY PLAN NO. 39-S

NOTE: THIS WAS A CITY
PLANNING MAP;
MANY OF THESE
ROADS WERE NEVER
ACTUALLY CONSTRUCTED.

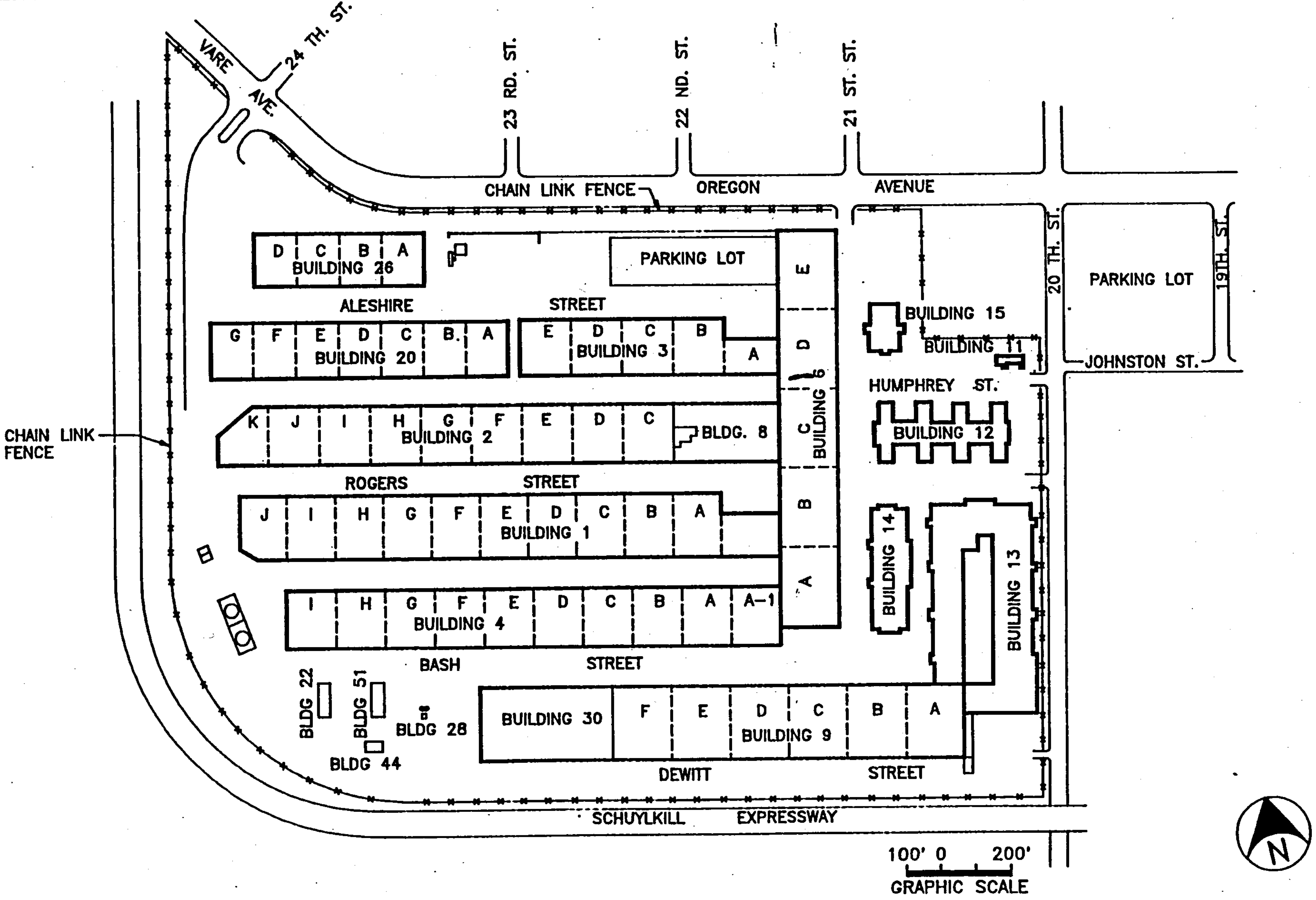
Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 1-4

EARLY HISTORY SITE FEATURES MAP (1914)

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE:	05/15/95
DESIGNED BY:	D.M.
SCALE:	NTS
JOB NO.:	2727.001
DWG NO.:	



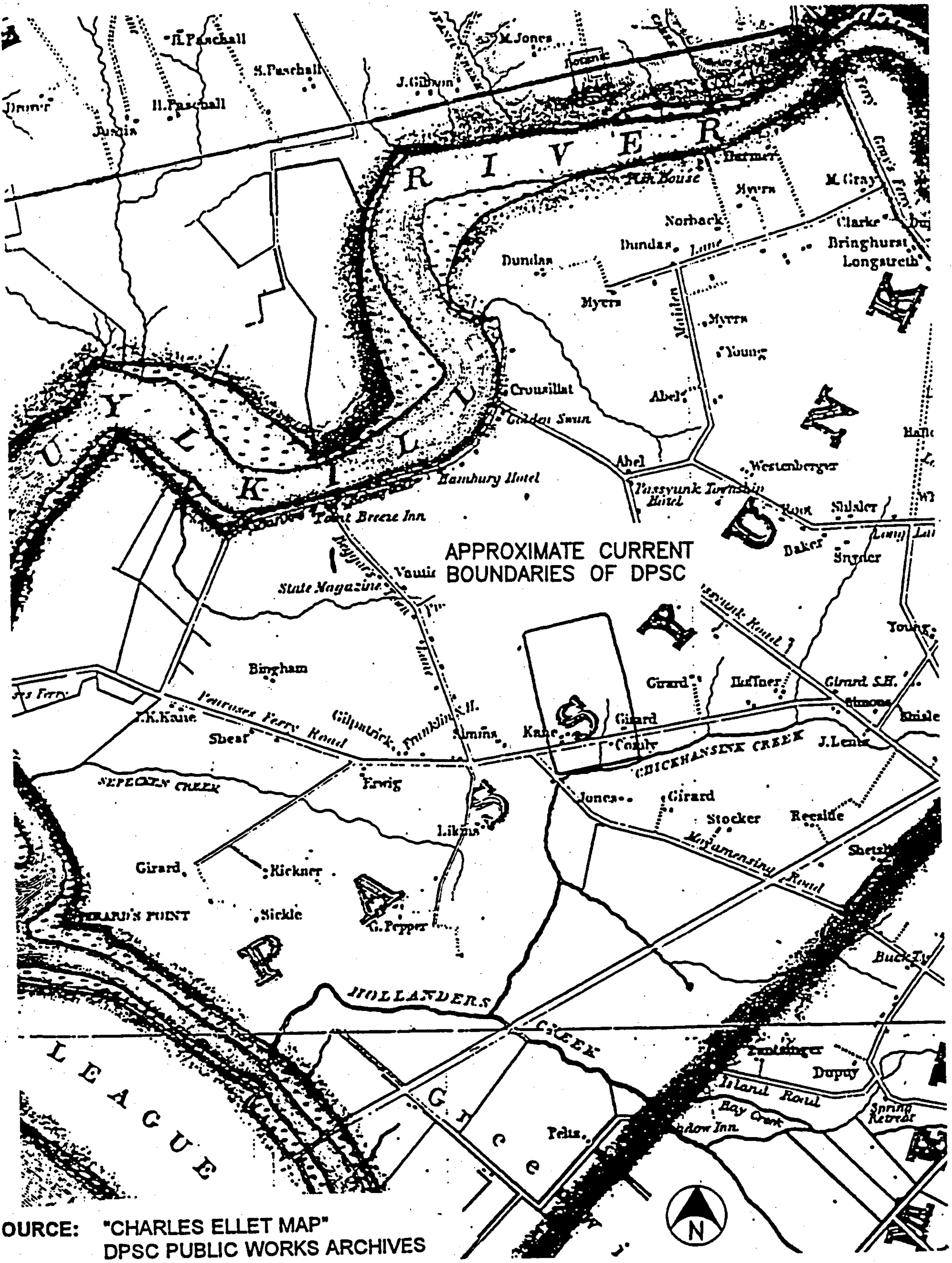
Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 1-5

PRESENT-DAY SITE FEATURE

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE:	05/15/94
DESIGNED BY:	D.M.
SCALE:	NTS
JOB NO.:	2727.001
DWG. NO.:	



SOURCE: "CHARLES ELLET MAP"
DPSC PUBLIC WORKS ARCHIVES

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 1-6
PRE-DPSC MAP OF SOUTHERN PHILADELPHIA AREA
(c. 1843 – DATE NOT CONFIRMED)

DATE:	05/15/94
DESIGNED BY:	D.M.
SCALE:	NTS
JOB NO.:	2727.001
DWG NO.:	

2.0 PREVIOUS INVESTIGATIONS AND ASSESSMENTS

Delineation of petroleum hydrocarbon contaminated media has been the objective of several site investigations at the DPSC preceding Phase I of the present remedial investigation. Prior studies included:

- *DPSC Fuel Contamination Study*: Performed in January 1988 by the Baltimore District of the ACOE, this investigation involved the advancement of soil borings near the southwestern corner of the facility to evaluate the extent of diesel contamination resulting from a leak in the piping between the underground storage tanks (USTs) and fuel dispenser in that area.
- *Final Engineering Report for the Defense Personnel Support Center*: Performed in November 1991 by Environmental Science and Engineering, Inc., this study differentiated between UST related contamination associated with the DPSC gasoline station and the presence of a deeper and areal extensive gasoline/diesel fuel free product plume.
- *Site Characterization Report for the New ADP/Admin Building, DPSC, Philadelphia, Pennsylvania*: Performed in October 1992 by the Baltimore District of the ACOE, this investigation examined the occurrence of petroleum hydrocarbon contamination in the vicinity of a proposed new building site in the east-central portion of the DPSC facility.
- *DPSC UST Closure Program* - Performed by Versar, American Construction Services, and Wu and Associates, Inc. between 1993 and 1995, this program involved the closure and/or replacement of facility USTs and included the sampling and analysis of soil samples for various species of petroleum hydrocarbons.

2.1 DPSC Fuel Contamination Study

The DPSC Fuel Contamination Study focused on delineating soil contamination in the vicinity of the gasoline station (Building 28) near the southwestern portion of the facility. In September 1987, during the excavation of a trench to install a computerized fuel distribution system, it was discovered that the feed and vent lines from the dispenser to the three USTs (diesel, unleaded gasoline, and leaded gasoline) were corroded. As excavation continued, it was found that diesel fuel was leaking from a corroded pipe at a depth of about 2 feet. In November 1987, the ACOE began the advancement of 20 borings to delineate the extent of contamination associated with this leaking fuel line. The boring program was generally restricted to the southwestern and western parts of DPSC.

The resulting report concluded that diesel fuel oil had leaked from a corroded pipe near the northeast corner of Building 28 and contaminated an area of approximately [illegible]000 square feet. The release centered around borings DH-1, DH-2, DH-3 and DH-4, and the trench from which the corroded pipe was removed. Soil contamination was observed at two discrete depths; 3 feet and 17 feet below grade. In each instance, the migration of these releases appeared to be controlled by the presence of two clayey, silty layers at these depths. The Baltimore ACOE indicated that the shallow contamination appeared to be associated with a release from the corroded diesel fuel line, while the deeper, more extensive gasoline contamination was interpreted to be attributable to a separate, and possibly older, release.

The corroded segments of the fuel lines that were responsible for the release of diesel fuel to the subsurface were replaced, and an unreported volume of petroleum hydrocarbon contaminated soils were excavated and disposed of at an off-site facility.

2.2 Final Engineering Report for the Defense Personnel Support Center, Philadelphia, Pennsylvania

Performed by Environmental Science and Engineering (ES&E) in November 1991, this investigation was undertaken to evaluate the probable extent and source of petroleum hydrocarbon contamination in the vicinity of three underground storage tanks located in the southwest portion of the DPSC. The scope of work involved the collection, sampling, and analysis of soil and groundwater samples from seven soil borings and seven groundwater monitoring wells.

Report findings indicated that petroleum hydrocarbon contaminated soils were identified in the depth interval from 0-10 feet below grade; were absent in the depth interval 14-16 feet; and were widespread in soils at a depth below 16 feet. Based on the widespread occurrence of free product and contaminated soils below a depth of 16 feet and an apparent absence of similar contamination in the depth range from 14 to 16 feet, ES&E concluded that the deeper, massive petroleum hydrocarbon contamination was not related to the DPSC fuel USTs near Building 28, but was more probably attributable to an upgradient, off-site source. Data from the ES&E report indicated that groundwater flow was in a southeasterly direction and that, therefore, the probable source of the extensive free product plume developed along the southern portion of the DPSC site was located somewhere to the northwest of the facility.

Recommendations made as a result of ES&E's site investigation included: remediating near surface contaminated soils associated with leakage from the former UST fuel lines, definition of the northern and eastern limits of the free product plume, further assessment of the western facility property boundary to locate the area where free product had entered the site, and improved definition of site groundwater flow and aquifer characteristics.

2.3 Site Characterization Report for the New ADP/Administration Building

This site characterization was performed in advance of the construction of a new facility administration building in the vicinity of the present location of the eastern portion of Buildings 1, 2 and 3. The investigation involved the installation of six soil borings and two groundwater monitoring wells to evaluate the presence of volatile organic compounds including BTEX, total petroleum hydrocarbons, and RCRA metals, particularly lead. The borings were advanced to a depth of approximately 21 feet below grade, and soil samples were screened at 5-foot intervals with a photoionization detector (PID). Samples showing PID readings above background levels were collected for laboratory analysis.

Monitoring well MW-1 exhibited the presence of free product and levels of approximately 1,500 ppm total petroleum hydrocarbons (TPH) in groundwater. TPH levels of up to 2,100 ppm were detected in soil boring SB-5 in the depth interval from 5-9 feet below grade. TPH concentrations observed in this boring were not believed to be associated with the free product and groundwater contamination in MW-1.

The proposed location of the new administrative building was just west of Building 8, which formerly housed a facility process water supply well that operated sometime between 1963 and 1973. Versar interviewed DPSC Public Works personnel in an attempt to obtain all available documentation for the former process water supply well, however, DPSC personnel were unable to provide any additional information on this well. The groundwater cone of depression that previously existed during the pumping of this supply well may have affected the migration of free product into this portion of the DPSC facility.

2.4 DPSC Underground Storage Tank Closures

During the period 1994 to 1995, a total of 10 underground storage tanks were removed and closed at the DPSC facility by Versar, Inc., American Construction Services, and Wu and Associates, Inc. The USTs included three 10,000-gallon diesel/gasoline USTs near Building 28, two 10,000-gallon DDT USTs near Building 9, one 30,000-gallon diesel UST on Rogers Street along the east end of Building 2, one 550-gallon waste oil UST in Building 8, and three fuel oil USTs (two 10,000-gallon and one 6,000-gallon) along Oregon Avenue.

Although UST closure reports were not available at the time the present remedial investigation report was in preparation, analytical data from soil samples collected during these UST removals was considered in modeling and mapping the extent of petroleum hydrocarbon contaminated media at the DPSC site. These analytical data are summarized in Tables 2-1, 2-2, and 2-3.

TABLE 2-1
DATA SUMMARY: UST SOIL SAMPLING ANALYTICAL RESULTS FOR DPSC GASOLINE STATION (BTEX, GRO, DRO, TPH, AND LEAD)

SAMPLE NO.	SAMPLE DATE	SAMPLED BY	DEPTH	SAMPLE PARAMETERS							
				BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)	LEAD (ppm)	GRO (ppm)	DRO (ppm)	TPH (ppm)
T-1-A	05/07/94	ACS	14'	<1.0	<1.0	<1.0	<3.0	NA	NA	NA	<0.05
T-1-B	05/07/94	ACS	14'	<1.0	1.0	<1.0	4.5	NA	NA	NA	0.17
T-1-C	05/07/94	ACS	14'	<500	2,500	7,700	17,000	NA	NA	NA	<0.05
T-2-A	05/07/94	ACS	14'	<1.0	<1.0	<1.0	<3.1	NA	NA	NA	<0.05
T-2-B	05/07/94	ACS	14'	<0.96	<0.96	<0.96	<2.9	NA	NA	NA	<0.05
T-2-C	05/07/94	ACS	14'	30	<16	25	54	NA	NA	NA	<0.05
T-3-A	05/07/94	ACS	14'	<1.1	<1.1	<1.1	<3.2	NA	NA	NA	300
T-3-B	05/07/94	ACS	14'	<1.0	<1.0	<1.0	<3.1	NA	NA	NA	<11
T-3-C	05/07/94	ACS	14'	<1.1	<1.1	43	470	NA	NA	NA	<10
BLANK	05/07/94	ACS	---	<1.0	<1.0	<1.0	<3.0	NA	NA	NA	<0.05
1001	05/07/94	VERSAR	14'	89	750	7,900	25,000	NA	8,100	84	NA
1002	05/07/94	VERSAR	14'	6.3	120	355	750	NA	210	46	NA
1003	05/07/94	VERSAR	14'	NA	NA	NA	NA	NA	<10	<10	NA
P1	06/02/94	ACS	3'	<15	<15	15	51	NA	NA	NA	56
P2	06/02/94	ACS	3'	<7.9	14	25	80	NA	NA	NA	<10
P3	06/02/94	ACS	3'	<12	<12	38	310	NA	NA	NA	5,000
P4	06/02/94	ACS	3'	<15	<15	76	120	NA	NA	NA	1,500

TABLE 2-1
DATA SUMMARY: UST SOIL SAMPLING ANALYTICAL RESULTS FOR DPSC GASOLINE STATION (BTEX, GRO, DRO, TPH, AND LEAD)
(continued)

SAMPLE NO.	SAMPLE DATE	SAMPLED BY	DEPTH	SAMPLE PARAMETERS							
				BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)	LEAD (ppm)	GRO (ppm)	DRO (ppm)	TPH (ppm)
P5	06/02/94	ACS	3'	<20	<20	28	100	NA	NA	NA	660
P6	06/02/94	ACS	3'	<4.0	<4.0	<4.0	<12	NA	NA	NA	620
P7	06/02/94	ACS	3'	<3.0	22	<3.0	<9.1	NA	NA	NA	160
BLANK	06/02/94	ACS	---	NA	NA	NA	NA	NA	NA	NA	<10
DISPENSER 1	06/06/94	ACS	3'	<26	35	37	150	NA	NA	NA	<2.6
DISPENSER 2	06/06/94	ACS	3'	370	960	940	33,000	NA	NA	NA	<3.8
DISPENSER 3	06/06/94	ACS	3'	<100	290	380	3,100	NA	NA	NA	1,500
STOCKPILE	06/06/94	ACS	---	<25	49	<25	130	NA	NA	NA	1,100
STOCKPILE	06/06/94	ACS	---	NA	NA	NA	NA	NA	NA	NA	<2.5
BLANK	06/06/94	ACS	---	NA	NA	NA	NA	NA	NA	NA	<10
GS001	07/06/94	VERSAR	26"	<2.0	<2.0	<2.0	<2.0	<47	<6.0	<5.0	NA
GS002	07/06/94	VERSAR	26"	<1.0	<1.0	<1.0	<2.0	<47	<6.0	<5.0	NA
GS003	07/06/94	VERSAR	26"	NA	NA	NA	NA	NA	NA	NA	160
GS004	07/06/94	VERSAR	26"	230	11,000	350	3,200	170	1,200	7,400	NA

NA NOT ANALYZED

TABLE 2-2
DATA SUMMARY: UST SOIL SAMPLING ANALYTICAL RESULTS FOR BUILDING 8 AND ROGERS STREET TANKS
(BTEX, TPH, AND PCBs)

DATA SUMMARY: 550-GALLON WASTE-OIL TANK AT BUILDING 8									
SAMPLE NO.	SAMPLE DATE	SAMPLED BY	DEPTH	SAMPLE PARAMETERS					
				BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)	TPH (ppm)	PCB's (ppm)
SP-1	01/03/94	VERSAR	1'	NA	NA	NA	NA	NA	0.29
SP-2	01/03/94	VERSAR	1'	NA	NA	NA	NA	NA	1.20
SP-3	01/03/94	VERSAR	1'	NA	NA	NA	NA	NA	0.20
SP-4	01/03/94	VERSAR	1'	NA	NA	NA	NA	NA	0.28
59005 (EAST END)	05/21/94	VERSAR	8'	<5	<2	<1	7.6	1,200	NA
DATA SUMMARY: 30,000-GALLON DIESEL FUEL TANK AT ROGERS STREET									
Sample 1	02/16/95	WU ASSC.	12'	<5	<5	<5	<5	<5	<0.5
Sample 2	02/16/95	WU ASSC.	12'	<5	<5	<5	<5	<5	<0.5
Sample 3	02/16/95	WU ASSC.	12'	<5	<5	<5	<5	<5	<0.5

NA NOT ANALYZED

TABLE 2-3
DATA SUMMARY: UST SOIL SAMPLING ANALYTICAL RESULTS FOR OREGON AVENUE TANKS (BTEX,GRO, DRO, AND TPH)

SAMPLE NO.	MATRIX	SAMPLE DATE	DEPTH	SAMPLE PARAMETERS							
				BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)	GRO (ppm)	DRO (ppm)	TPH (ppm)	CALIFORNIA LUFT METHOD (ppm)
TANK 1 CONTENTS	SOIL	03/22/94	4'	13	42	85	110	NA	NA	NA	ND
		04/07/95		NA	NA	NA	NA	NA	NA	11,000	NA
TANK 2 CONTENTS	AQUEOUS	03/22/94	4'	ND	ND	ND	2.1	NA	NA	NA	ND
		04/07/94		ND	ND	ND	ND	NA	NA	<1.0	NA
SS-1 SW CORNER OF EXCAVATION	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	3,400	NA
SS-2 NW CORNER OF EXCAVATION	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	5,900	NA
SS-3 N WALL BETWEEN TANKS 1 & 2	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	27,000	NA
SS-4 S WALL BETWEEN TANKS 1 & 2	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	8,100	NA
SS-5 NE CORNER OF EXCAVATION	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	57,000	NA
SS-6 SE CORNER OF EXCAVATION	SOIL	03/22/94	4'	NA	NA	NA	NA	NA	NA	NA	ND
		04/07/94		NA	NA	NA	NA	NA	NA	5,700	NA
STOCKPILE	SOIL	04/07/94	—	NA	NA	NA	NA	NA	NA	7,400	NA
ORE001	SOIL	07/14/94	14'	NA	NA	NA	NA	NA	NA	160	NA
ORE002	SOIL	07/15/94	14'	NA	NA	NA	NA	NA	NA	9,800	NA
STOCKPILE-0R001	SOIL	07/19/94	—	NA	NA	NA	NA	8.9	800	14,000	NA
STOCKPILE-OR002	SOIL	07/19/94	—	NA	NA	NA	NA	57	2,200	14,000	NA
STOCKPILE-OR003	SOIL	07/19/94	—	NA	NA	NA	NA	9.3	1,200	4,900	NA
STOCKPILE-OR004	SOIL	07/19/94	—	NA	NA	NA	NA	66	4,200	12,000	NA

NA - NOT ANALYZED
ND - NOT DETECTED

3.0 REMEDIAL INVESTIGATION OBJECTIVES

The final, complete RI/FS for DPSC will include all of the components outlined in the EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (1988). However, this Phase I RI, which focused only on the petroleum hydrocarbon free product plume and the DDT contamination, represents only a portion of the overall RI/FS. There are certain unique aspects to the DPSC site that have shaped the technical approach and remedial investigation objectives. In addition, these objectives have changed from initial pre-BRAC scoping through post-BRAC execution. These factors, described in the following sections, have resulted in an approach which varies slightly from the more conventional CERCLA investigations.

3.1 Original (Pre-BRAC) Objectives

Previous subsurface investigations at DPSC indicated an extensive occurrence of petroleum hydrocarbon contamination in the soils and groundwater underlying the site. In addition, DDT and related pesticide contamination was identified around the former DDT mixing room and associated UST system. Some of the petroleum hydrocarbon contamination may be related to the presence of on-site aboveground and underground storage tanks (ASTs and USTs), but a significant amount was believed to be attributed to off-site sources, including the contiguous, upgradient refineries located just to the west of DPSC. The presence of one or more such plumes has had a far reaching effect on construction activities at the site. According to DPSC personnel, a ban presently exists on new construction activities due to the dangers and risks of explosion and toxic fume releases associated with earthwork.

During initial scoping, the DPSC facility was actively operating and had not been slated for closure under the BRAC program. Therefore, the primary objectives of the RI/FS were to characterize and delineate petroleum hydrocarbon contamination, DDT contamination, and contamination from other areas of concern at the facility in order to identify and evaluate remedial alternatives for subsequent clean-up. The ultimate objective of the pre-BRAC RI/FS was to support the protection of human health and the environment and to allow for future development of the site. A secondary objective of the RI/FS was to earmark each of the sources of petroleum hydrocarbon contamination in various site media and determine their respective volumetric contributions. It was based on these objectives that the Draft Project Operations Work Plan for the DPSC RI/FS was prepared in October 1993.

3.2 Modified (Post-BRAC) Objectives

Following completion of the Draft Project Operations Work Plan for the DPSC RI/FS in October 1993, the DPSC facility was approved for closure in 1999 under the BRAC program. The BRAC Team believed that the petroleum hydrocarbon contamination and DDT contamination at the site represented the primary obstacles to site transfer and future site use plans. Therefore, the primary objectives of the RI/FS were modified to characterizing and delineating petroleum hydrocarbon and DDT contamination for subsequent interim remedial measures, as necessary, and responsible party identification and cost apportionment. The secondary objectives of the post-BRAC RI/FS were to characterize and delineate contamination associated with other areas of concern and to develop subsequent remediation plans for these other areas of concern so that the site could be transferred in accordance with BRAC requirements. Based on these modified objectives, the Project Operations Work Plan for the DPSC RI/FS was revised in May 1994.

The revised technical plan broke the investigation down into three separate components. The first component was delineation of the undifferentiated free product groundwater plume(s) and associated contaminated soils. This phase of the study was designed to define the full extent of petroleum hydrocarbon media at DPSC without regard to distinguishing between on-site and off-site sources. The second portion of the investigation was structured to differentiate between on-site and off-site sources contributing to the free product plume, using a number of strategies and tactics including identification of all pertinent on-site and off-site UST/AST locations and relevant data, soil gas surveys, free product chemical characteristics, and historic/current data concerning temporal and spatial petroleum hydrocarbon distribution trends; however, no off-site monitoring or sampling was planned during the RI. The third phase of the study was developed to evaluate and characterize the other areas of concern, including the DDT mixing room and associated USTs, using conventional sampling and analysis techniques.

3.3 Reasons for Phased Investigation Approach

Over the last 75 years, the overall appearance of DPSC has changed little. The facility has been exclusively used for producing military garments and uniforms and has not undergone significant modification. The consistent nature of these activities has had a limiting effect on the type, number, and distribution of areas of concern (AOCs), including on-site ASTs and USTs, PCB-containing transformers, asbestos-containing building materials, pesticide storage and application areas, potential radium contamination in Building 30, railroad spurs for unloading supplies and raw materials, small-scale RCRA storage areas, combined sewer drains, and the former incinerator location.

It is possible that each of these areas may have impacted site media to some extent, but none were believed to have resulted in contamination comparable to the magnitude of known petroleum hydrocarbon contamination, or to the significance of the known DDT contamination. Therefore, DPSC and the BRAC Team prioritized the characterization and delineation of the petroleum hydrocarbon contamination and the DDT contamination for the DPSC RI/FS, because these known problems represented the greatest obstacle to subsequent site transfer and future site use plans. Due to funding limitations, these priority objectives were extracted from the overall RI/FS Project Operations Work Plan as Phase I. After additional funding is made available, the other areas of concern will be evaluated under Phase II to complete the final RI/FS for the facility.

4.0 SUMMARY OF FIELD ACTIVITIES

Nine separate field tasks were performed at DPSC to delineate the extent of petroleum hydrocarbon contaminated media, to evaluate the presence of other types of contaminants in site soils and groundwater, and to provide a more complete geological and hydrogeological characterization (see Attachment 3 for a chronological summary of these activities). Delineation of the extent of contamination focused on the distribution of light non-aqueous phase liquids (also referred to as free product) and petroleum hydrocarbon contaminated soils. The extent of petroleum hydrocarbon related groundwater contamination was determined for the shallow portion of the upper aquifer; the vertical extent of groundwater contamination in the aquifer system at DPSC remains to be evaluated.

The logistics of evaluating subsurface conditions and contaminant distribution at DPSC in a safe and cost effective manner presented a challenge at the site. Most of the site is occupied by buildings. The intervening roadways have pavement thicknesses exceeding one foot and are underlain by a dense network of utilities. In addition, portions of the site are heavily trafficked, and there is a large working population. Finally, substantial personal protective equipment was required during several field tasks due to exceptionally high levels of vapors associated with a gasoline plume that occupies most of the southern portion of the site.

In light of the constraints and costs associated with drilling numerous soil borings and groundwater monitoring wells, a number of screening surveys were performed to provide as much information as possible on subsurface conditions and the probable distribution of volatile and semi-volatile contaminants. These surveys included a ground penetrating radar (GPR) survey, an active soil gas survey, a site characterization penetrometer analysis system (SCAPS) survey, a hydropunch survey, and a passive soil gas survey. At the conclusion of these surveys, it was clear that the most significant petroleum hydrocarbon contamination was restricted to the southern portion of DPSC. From these data, a total of sixteen permanent monitoring wells/borings were installed in key areas to complete delineation of the free product plume and associated contaminated soils.

4.1 GPR Survey

A GPR survey preceded all intrusive work at DPSC. The GPR survey was performed to clear 81 proposed active soil gas survey locations. These locations were distributed more or less uniformly about the entire 86.5 acre site. The 81 proposed locations were marked out using a full suite of facility utility layout maps, a measuring wheel, and fluorescent paint. Each proposed location was assigned an identification number, using the acronym SG to denote soil gas.

Environmental Services of America (ENSA), Inc. conducted field work at DPSC on September 24, 25, and October 1, 1994. The survey was performed using both a GPR unit and metal detector. A survey grid of 100 square feet (10' x

10') was established around the center of each proposed soil gas sampling location. Each location was then surveyed by ENSA personnel under the direct supervision of a Versar construction manager. The decision to accept, modify, or delete individual proposed soil gas sampling locations was a joint decision of ENSA technical staff and the Versar task manager. A description of the survey equipment and procedures and results of the GPR survey are presented in Appendix A.

Following the clearance of proposed soil gas survey sampling locations by ENSA and Versar staff, Pennsylvania One-Call utility clearance service and DPSC electrical and plumbing supervisors were contacted to review final plans for all proposed intrusive survey locations. No modifications to the siting of the 81 proposed soil gas sampling locations were requested by either of these groups or directly by the potentially effected utility services.

The degree of clearance established for intrusive surveys was, in most instances, 2 to 3 feet around the center point of the 10' x 10' grid. Utilities are so prevalent under the facility roadways that greater clearance is simply not possible. DPSC environmental staff declined to allow intrusive surveys to be performed inside of facility warehouses for health and safety reasons. Once utility clearance had been established, all parties involved in subsequent intrusive surveys were directed to omit sampling locations where survey tool refusal was encountered at depths between 0 and 10 feet below grade.

The active soil gas survey to be performed at DPSC involved direct push technology and could be conducted at approved sampling locations without prior drilling. SCAPS and hydropunch survey locations and soil boring/monitoring well drill sites required that a pre-drilled core bore first be advanced through the 1+ foot thickness of cement and asphalt pavement. For an additional margin of safety, the intrusive activities were limited to locations within a one-foot radius of the approved GPR soil gas sampling sites. No damage to utilities or accidents occurred during any of the intrusive surveys or drilling activities subsequently performed at DPSC.

4.2 Active Soil Gas Survey

An active soil gas survey was conducted at the DPSC site during the period September 26 to October 21, 1994. The objective of the survey was to identify volatile organic compounds associated with a known free product plume to aid in the siting of permanent groundwater monitoring wells. A survey grid of 81 sampling locations was established in a uniform pattern about the 86.5 acre DPSC site. All soil gas sampling locations were pre-cleared for utilities via a GPR survey and inspection of site utility maps.

Soil gas samples were acquired at depths of 10 to 12 feet below grade using a Geoprobe 5400 direct push rig. Extraction of soil gas from tubing coupled to the geoprobe screen was accomplished using a vacuum pump. Soil gas samples were subsequently transferred to an on-site gas chromatograph-flame ionization detector (GC/FID) for analysis using a syringe. GC/FID analyses included total volatile organic compounds, benzene, toluene, ethylbenzene and xylenes (BTEX). Data reported for each of these species, as well as total BTEX, is summarized in Table 4-1. Raw analytical data and direct push sampling protocols are presented in Appendix B.

The collection of soil gas samples at depths of 10 to 12 feet below grade was designed to achieve as accurate a reflection as possible of the distribution of free product and petroleum hydrocarbon contaminated groundwater at the site. Free product and water table elevations were known to occur in the depth range from 15 to 20 feet below grade.

The duration of the active soil gas survey spanned a period of approximately four weeks. Therefore, the data obtained was not time synchronous across weather cycles which occurred during that period. Low temperatures and high barometric pressure may both suppress soil gas levels. Nonetheless, inspection and interpretation of the soil gas data indicated a strong correlation between free product occurrence and maximum soil gas concentrations.

Three isoconcentration maps were prepared from the soil gas data obtained at DPSC: total VOCs, total BTEX, and total VOCs minus total BTEX (Figures 4-1, 4-2, and 4-3, respectively). The most significant trend observed in all three maps is the rather abrupt termination of high concentrations of soil gas which occurs just to the north of Rogers Street. During free product level measurements, this substantial decrease in soil gas concentration was found to be approximately coincident with the northern limit of the free product plume.

Total VOC isoconcentrations, shown in Figure 4-1, indicate the presence of two maxima; one along the western part of building 4 at the southwest portion of DPSC and another along the eastern segment of Bash Street near the central portion of building 9. Total VOC concentrations in these areas attain a maximum value of 29,975 ppm and 28,340 ppm, respectively. Between these two areas, total VOC concentrations decrease to a low of 280 ppm. The reason for the large decrease in total VOC concentrations is not clearly understood based on the available data, but it may be a result of preferential migration pathways along site utilities. Total VOCs decline precipitously north of Rogers Street, beyond the northern limit of the free product plume. In this area, maximum concentrations do not exceed 85 ppm.

Total BTEX and total VOCs minus total BTEX isoconcentration maps, presented as Figures 4-2 and 4-3, show the same general pattern as the total VOCs isoconcentration map. All three maps give a good approximation of the location of the underlying free product plume. However, the soil gas data do not differentiate between the various petroleum hydrocarbon components of the plume. The sampling of free product and groundwater conducted subsequent to the active soil gas survey indicated that the free product plume was not several distinct petroleum hydrocarbon plumes but rather a gasoline and diesel mixture.

The occurrence of high levels of soil gas, particularly BTEX which reached concentrations exceeding 12,000 ppm, necessitated the use of level B personal protective equipment at certain times during the advancement of soil borings and installation of monitoring wells. Depending on the degree of on- and off-site migration of these vapors, they may present a hazard to potential receptors. Basements are present in portions of buildings 9, 13, and 14, and are also present in certain residential areas to the southeast of DPSC. However, the currently available data do not indicate whether or not vapors have migrated to these off-site residential areas. The presence of a low permeability surficial clay unit, discussed in Section 5 of this report, and pavement thicknesses in excess of one foot appear to constrain vertical migration of a vapor phase plume to the surface. However, the network of underground utilities at DPSC, particularly the combined sanitary-stormwater sewer system, is likely to facilitate the migration of vaporous phase hydrocarbons (a detailed discussion of the effect of these utilities on vapor and free product phase hydrocarbons is presented in Section 11.2 of this report).

4.3 Site Characterization Analysis Penetrometer System Survey (SCAPS)

The Site Characterization Analysis Penetrometer System (SCAPS) survey incorporates existing cone penetrometer technology to evaluate in-situ geophysical soil properties while simultaneously using sensors to determine the presence of contaminants. Specifically, laser induced fluorescence is measured to evaluate the presence and location of petroleum hydrocarbons in the subsurface. A more detailed explanation of the technology is found in Appendix C.

The SCAPS survey was performed at DPSC to preliminarily identify the free product plume for subsequent siting of permanent groundwater monitoring wells, which were used for definition of the extent of the free product plume. The survey also provided information concerning the vertical distribution of petroleum hydrocarbons in subsurface soils. The development of the SCAPS scope of work was guided by the active soil gas survey results and existing information concerning the distribution of free product at DPSC. The original work scope for the SCAPS survey (Appendix C) called for utilizing this technology at 30 separate locations at DPSC in conjunction with hydropunch sampling. The final configuration of the SCAPS survey is shown in Figure 4-4. SCAPS locations are depicted relative to active soil gas and hydropunch sampling locations.

Work on this task began the week of October 24, 1994. The survey commenced in the southwestern corner of DPSC, an area of known free product occurrence. Here, it was intended that a calibration be developed for the SCAPS output by correlating cone penetrometer (CPT) and laser induced fluorescence (LIF) panel plots with soil boring logs and free product thickness measurements from existing monitoring wells MW-3 and MW-6. During the performance of the SCAPS survey at these first two locations, it became immediately obvious that the presence of cobbles at of near water table depth was going to be an obstacle to the successful insertion of the drive rods into the subsurface. In fact, due to continuing tool refusal, no relationship could be established between the CPT/LIF and soil boring/free product data. However, because the SCAPS survey was being conducted as a screening survey to evaluate potential locations for permanent groundwater monitoring wells, the lack of calibration data for the LIF panel plots did not adversely impact the functionality of the resulting data.

As the survey proceeded, the degree of refusal eventually dictated that the total survey depth needed to be restricted to at or slightly below water table depth (≈15 - 20 feet below grade), where the cobbles were so prevalent. This was determined to be the minimum effective survey depth to be able to identify free product occurrence at the site. At first, the survey was run using the combined CPT/LIF tools. However, significant downtime occurred as the CPT tool became damaged while attempting to insert it to this minimum depth. Consequently, a decision was made to use resistivity and LIF in lieu of the CPT/LIF combination. The resistivity tool was also unable to stand up to penetration of the cobble layer; hence, the survey was further limited to just running the LIF. After surveying 14 locations, the SCAPS survey was terminated by the ACOE due to extensive equipment damage. Of the 14 SCAPS survey locations, five incorporated the use of CPT/LIF, four were run using resistivity/LIF, and five were run with LIF only.

The SCAPS LIF data are summarized in Table 4-2. This table summarizes panel plot data in terms of the depth and amplitude of significant fluorescence intensity peaks. CPT and resistivity data from the SCAPS survey proved to be only marginally useful in the geologic characterization of the DPSC site. Panel plots and digital data for the CPT, resistivity, and LIF surveys are presented in Appendix C.

Four substantive observations were developed as a result of the SCAPS survey:

- LIF detectable petroleum hydrocarbon contamination was not found above water table depths, suggesting that free product occurrence at DPSC is not attributable to surface or near-surface releases.

- LIF detectable petroleum hydrocarbon contaminated media are limited to zones which are approximately 2 to 4 feet in overall thickness; this also suggests the introduction of this contamination via groundwater flow from an off-site source or sources.

- Petroleum hydrocarbons detected by LIF occur both as free product and as a dissolved phase; fluorescence intensity does not differentiate between these two modes of occurrence.

- SCAPS pinpoints the stratigraphic positions of petroleum hydrocarbon contamination with unique accuracy; LIF data indicated petroleum hydrocarbon contamination at depths below the water table in at least two instances. LIF data obtained at locations SG-6 and SG-42 both indicated the presence of petroleum hydrocarbons at a depth interval of 23 - 25 feet below grade, a full 5 feet lower than the water table at these two locations. In the case of SG-6, petroleum hydrocarbons occur beneath the base of a clay unit, while in SG-42 a gravel lenses appears to control their occurrence. In both instances, the occurrence of petroleum hydrocarbons at these specific depths was confirmed by subsequent hydropunch sampling. The significance of this mode of occurrence of petroleum hydrocarbons below water table depths is further discussed in Section 5.0.

The SCAPS survey performed at DPSC was a partial success. The LIF data was remarkably accurate in pinpointing the depth and thickness of petroleum hydrocarbons and served as a guide to determining screen depths in both hydropunch and monitoring well locations. It also identified some unusual modes of petroleum hydrocarbon occurrence which may reflect some unique transport pathways or accumulation mechanisms.

Due to the previously discussed logistical problems, the survey was terminated after 1.5 weeks and was not completed. Therefore, it did not, by itself, delineate the extent of the free product plume at this site. It did, however, identify several areas of petroleum hydrocarbon contamination that were not evident from the active soil gas survey and that warranted the siting of monitoring wells. These locations included SG-42 and SG-68, which were subsequently converted to monitoring wells MW-19 and MW-12, respectively. Under ideal subsurface conditions, this technology would be an extremely cost-effective approach to delineating petroleum hydrocarbon contamination.

4.4 Hydropunch Sampling

Hydropunch sampling was performed in conjunction with the SCAPS survey conducted from October 24 to November 3, 1994. Initially, the objective of the hydropunch survey was to delineate the extent of free product as identified from the active soil gas and SCAPS data. Hydropunch samples were collected via a screen inserted down the SCAPS drill rods. Due to continuous equipment breakdowns during the SCAPS activities and the limited time frame that the hydropunch sampler was on-site at DPSC, the original hydropunch sampling objectives were modified by Versar after consultation with the ACOE and PADER. Based on the new objectives, hydropunch sampling was focused along the western, presumed upgradient site boundary of the facility to ascertain whether free product existed in and was migrating through this area. Several hydropunch samples were also acquired at the southeastern corner of DPSC to determine free product plume limits in that area as well.

Eight hydropunch samples were collected at DPSC and analyzed for total petroleum hydrocarbons (TPH), gasoline range organics (GRO), diesel range organics (DRO), and BTEX by USEPA method 8015 (modified California LUFT). Each sample was collected at the water table depth. Two equipment blanks were also collected and analyzed for these parameters. The analytical results for hydropunch sampling are presented in Table 4-3. Hydropunch data was separated into two distinct geographic groups for purposes of discussion.

Group 1 consists of six hydropunch samples collected along the western site boundary. From south to north, this group includes HP-4, HP-5, HP-6, HP-3, HP-8 and HP-7. Inspection of Table 4-3 reveals that low levels of GRO and DRO, with concentrations ranging from 0.58 to 100 ppm, were encountered at all locations except HP-6. Free product was not encountered, nor was BTEX detected in any of the six hydropunch samples. DRO concentrations appeared to be highest at the southwestern corner of the site reaching a maximum of 100 ppm in HP-5; otherwise, no trend revealing either increasing or decreasing concentrations in a northerly or southerly direction existed for GRO and DRO species.

The laboratory case narrative which accompanied the analytical results for sample HP-3 characterized petroleum hydrocarbon contamination as follows: "Please note that the BTEX analysis appears anomalous when compared with the GRO analysis. Both BTEX and GRO chromatograms show multiple hydrocarbon peaks which do not confirm with benzene, ethylbenzene, toluene or xylene, although they elute within the gasoline range." The low concentrations of GRO and DRO, along with the absence of BTEX in hydropunch samples collected along the western site boundary are indicative of a petroleum hydrocarbon signature which is dissimilar to the strong gasoline/diesel mixture presently existing along the southern portion of the DPSC property. Groundwater samples in the latter area contain exceptionally high concentrations of GRO, DRO and BTEX. A more detailed discussion of groundwater sampling results is presented in Sections 4.9.2 and 7.2.3.

The relatively low levels of petroleum hydrocarbon contamination along the west site boundary had formerly been recognized in the DPSC Fuel Contamination Study performed in 1988. This study attributed the low level of petroleum hydrocarbon contamination along the western site boundary to a number of possible sources including, "the significant thickness of fill in the northwestern corner of the site, train refuse, contaminated railroad fill, and oily run-off from numerous parking lots." Two other observations suggest possible sources for the low level petroleum hydrocarbon contamination at the west site boundary:

- The alignment of the six hydropunch sampling locations is near and runs parallel to a north-south trending sewer line that exits DPSC at its northwest corner.

- According to interviews recorded in ES&E's 1991 engineering report, a sump in the DPSC fuel tunnel formerly flowed into a lift station in Building 18, where it was subsequently discharged to a drain field just to the west of Building 18.

To summarize, the chemical signature of petroleum hydrocarbon contamination as detected in hydropunch samples acquired along the western DPSC boundary does not correlate well with the distinctive gasoline/diesel fuel fingerprint that is associated with the free product plume known to exist at the southern portion of the site. Fuel contamination in groundwater at the western portion of the site does not occur as a well defined plume. Petroleum hydrocarbon contamination in this area is probably attributable to a number of various minor sources, as discussed in the previous paragraph.

Group 2 hydropunch samples were collected at two locations in the southeastern corner of DPSC. Sample HP-1 was collected in the far southeastern corner of DPSC. Benzene was the only petroleum hydrocarbon detected at this location with a concentration of only 6 ppb. This hydropunch location, along with analytical data available from four groundwater monitoring wells installed by SEPTA just to the east, indicate the southeasterly limit of the free product plume at DPSC.

Hydropunch sample HP-2 was acquired from a location approximately 250 feet to the west of HP-1. Free product was recognized in this hydropunch sample collected at a depth a 23 to 25 feet below grade. Analytical results indicated a GRO level of 340,000 ppm and total BTEX exceeding 10,000 ppm; these data are consistent with the occurrence of the massive gasoline/diesel free product plume developed at the southern part of DPSC.

The occurrence of free product at this depth, 4 feet below the present water table elevation for this part of the facility, demonstrates that free product migration and accumulation at DPSC is significantly influenced by site geology. In HP-2, free product appears to have been trapped beneath a low permeability clay unit, possibly at a time when the water table elevation fluctuated to lower levels.

This mode of free product occurrence is only evident through the combined SCAPS/hydropunch survey. Upon penetration of the surficial clay unit with a well screen, the previously trapped free product migrates into the well, where it appears as a sheen and can be measured with an interface probe. If the surficial clay unit was not penetrated, the presence of free product would go undetected because it would remain below the clay. It is also notable that the thickness of free product as identified by the SCAPS/hydropunch survey in HP-2, which was measured at approximately 2 feet from laser induced fluorescence, is greater than the 0.04 feet thickness measured with an interface probe following the installation of monitoring well MW-9 at this location (Table 4-4 cross-references soil gas, SCAPS, hydropunch, and monitoring well identification numbers). However, as described previously, the SCAPS LIF panel plots do not differentiate between free product and contaminated soil, which may explain this apparent discrepancy.

The effects of site geology on the migration and accumulation of petroleum hydrocarbons at DPSC are discussed further in Section 5.3. Analytical data for hydropunch sampling may be found in Appendix D.

4.5 Soil Boring and Monitoring Well Installation

Field work for soil borings and groundwater monitoring well installation was initiated on November 28, 1994. Huntingdon Empire Soils, Inc. (Empire) was retained by Versar, Inc. to drill the soil borings. All work was performed in accordance with the Project Operations Work Plan and subsequent approved modifications. These modifications included continuous split-spoon sampling, replacement of two deep wells with the shallow CSX wells, and changes to well locations. The modifications to the Project Operations Work Plan are contained in Appendix I. Soil boring and monitoring well locations are shown in Figure 4-5.

4.5.1 Soil Borings

Sixteen soil borings were drilled during this phase and converted into groundwater monitoring wells. Fourteen of the borings were located on the DPSC site, within a 1 to 2-foot radius of the soil gas (SG) locations previously cleared for underground utilities by GPR. The other two borings (MW-CSX1 and MW-CSX2) are located on an adjacent property owned by CSX Railroad. An entry agreement between CSX Railroad and Versar was executed allowing Empire Soils access to the off-site drilling locations. Locations of these wells were cleared for underground utilities prior to intrusive activities. The mud rotary drilling method was used on the two deep soil borings (MW-6D & MW-20D). All other soil borings were drilled with 8.25-inch outer diameter hollow-stem augers. All down-hole equipment was steam cleaned between soil borings. Soil boring logs are contained in Appendix G.

A copy of the Versar Health and Safety Plan (HASP) was provided to all subcontractors and field personnel. Breathing zone air was continuously monitored with an HNu photoionization detector to measure VOCs. When the levels of VOCs continuously exceeded 1 or 5 ppm above background levels in the breathing zone, Personal Protective Equipment (PPE) was upgraded to either level C or level B, respectively. On several of the soil borings, part of the drilling near and below the water table was performed in level B PPE, due to presence of either soil gas or free product. All personnel working on site had undertaken 40-hour OSHA health and safety training for hazardous waste site investigation. Appropriate health and safety measures were adopted as and when required.

4.5.2 Monitoring Well Installation

Huntingdon Empire Soils, Inc., performed drilling, well installation, and well development operations. Sixteen groundwater monitoring wells were installed, 14 on DPSC property and 2 on CSX Railroad property along the western boundary of DPSC. Of the 14 wells installed on the DPSC property, 12 were of shallow depth (<34 feet in depth) and 2 were deep wells (>60 feet). The two deep wells, MW-6D and MW-20D, complete couplets with the previously installed well MW-6 and a recently installed well MW-20, respectively. The two wells on CSX Railroad property are of intermediate depth (50-60 feet).

All groundwater monitoring wells were installed between November 28, 1994 and February 28, 1995. The work extended beyond the originally proposed schedule due primarily to the need to conduct drilling and well installation activities in Level C and/or Level B PPE. Whenever possible, attempts were made to install wells at locations with lower levels of expected contamination first, moving onto areas of suspected higher contamination. In order to execute the field operations efficiently, it was not always possible to adhere strictly to the above schedule.

4.5.2.1 Well Construction

Table 4-5 contains detailed information for each well installed, including north and east coordinates, ground and top of casing (TOC) elevations, total depth and diameter of the actual borehole, and lengths and intervals of the screen, grout, bentonite and gravel zones. These and other details are shown on well construction diagrams in Appendix I.

All wells were installed in keeping with the Project Operations Work Plan dated May 23, 1994, and ACOE protocols. Deviations from these guidelines were noted and communicated to the ACOE project manager and are discussed in Section 4.5.3.

Except for the two deep wells, MW-20D and MW-6D, all other wells were installed with the hollow-stem auger technique. Deep wells MW-6D and MW-20D were drilled using the mud rotary technique. For the rest of the wells, 8.25-inch outer diameter hollow stem augers were used to advance the boreholes 10 feet into the water table and 3 feet beyond that. Boreholes were backfilled 3 feet from the bottom up with clean morie #1 gravel before the casing and screens were installed. For most of the wells, a 15-foot section of screen was used. Schedule 40, PVC casings, and slot 10 screens were used on all the wells. The gravel zone was extended to 5 feet above the top of the screen. A 5-foot bentonite pellet seal was placed on top of the gravel, and a cement/bentonite grout was placed on top of the bentonite. All wells, except for MW-15, MW-17, MW-19, and MW-20D, have 8-inch flush mounts installed at grade. MW-20D has a 12-inch flush mount and MW-15, MW-17, and MW-19 are stick-ups and are equipped with steel protective casings with protective pickets around them. The deep well MW-20D contains an

8-inch diameter outer surface steel casing grouted into clay at 63 feet bgs. Any deviations from the proposed work plan are noted below. Work plan modifications with respect to deep well construction are contained in Appendix I.

4.5.3 Variances from the Proposed Work Plan

Several changes to the approved Project Operations Work Plan were necessitated by varying site conditions. These changes are summarized in this section.

The location of one well, MW-12, was changed slightly. MW-12, originally sited to be at SG-68, was moved from the middle of the road to approximately 12 feet east on the grass to avoid a suspected underground utility.

Except for wells MW-6D, MW-9, MW-18, MW-20D and MW-CSX1, the screens on all other wells were installed so that 10 feet of screen extends under the existing water table and 5 feet extends above the water table to account for seasonal water table fluctuations and to identify/capture the Light Non-Aqueous Phase Liquid (LNAPL) floating on top of the water table. Well screens for MW-9, MW-18, were extended approximately 15 and 13 feet below the water table. Deep wells MW-6D and MW-20D are screened in the lower portion of the aquifer, and thus are fully submerged and equipped with 10 and 15 feet of screen, respectively. MW-CSX1 is equipped with 10 feet of screen.

- MW-9: During split spoon sampling, the depth to water level was anticipated to be approximately 24 feet bgs. Historically, the water table on the DPSC site had been known to occur between 18 and 21 feet bgs. SCAPS fluorescent intensity suggested the presence of free product at approximately 24 to 26 feet bgs. Therefore, it was advisable to screen the 24 to 26 feet bgs as indicated by SCAPS. A clay layer extended from approximately 14 to 26 feet bgs. Consequently, a 20-foot screen (13 to 33 feet bgs) was installed in order to capture seasonal groundwater fluctuations, if the true water table should prove to be 19 feet bgs, and also to tap the sandy/gravelly strata below the clay layer. The static water level in MW-9 was subsequently found to be approximately 19.0 feet bgs.

- MW-18: During split-spoon sampling, the first water was encountered at 14 feet bgs, approximately 4 to 5 feet above the groundwater table known to occur at the DPSC site. It was suspected to be perched water. An 18-foot section of screen was installed from 28.7 feet to 10.7 feet bgs. If the water table actually occurs at 14 feet bgs, this increased screen length ensures that any contamination on top of the water table can be monitored during seasonal water table fluctuations. At the same time, this screened interval also taps the sandy/gravelly zone from 20 to 28 feet bgs. The static water level in MW-18 was subsequently found to be approximately 15.5 feet bgs.

- MW-6D was originally scheduled to be a deep well to monitor the water quality in the deeper aquifer, with a surface casing extending into the confining unit. No confining unit or identifiable clay was observed while drilling to a total depth of 88 feet bgs. Upon retrieval of the drill bit, the borehole caved in to approximately 77 feet below grade. It was resolved, with ACOE concurrence, to install the screen approximately at same elevation as the screen in MW-20D. A 10-foot section of screen was installed from 64 to 74 feet. No surface casing was installed at this well location.

- During the installation of well MW-CSX1, located on CSX Railroad property, an anomaly was noted. The ground surface elevation is approximately 20 to 23 feet higher than the wells located on DPSC property. The borehole was advanced with 8.25-inch outer diameter hollow-stem augers. Split-spoon samples were collected every 5 feet down to 20 feet and every 2 feet thereafter. A layer of clayey silt/silty clay was encountered in the interval from approximately 32 to 44 feet bgs. At approximately 46 feet, moistness/dampness was noted in the samples. Subsequently, two samples were noted to be moist to slightly wet and contained a slight petroleum odor. When drilling reached approximately 54 feet bgs, the water level inside the augers rose to a depth of 16.5 feet below grade. At the end of the day, augers were left in the ground at 54 feet bgs. The water level inside the augers remained at a level of 16.5 feet below grade until the next morning. Technical representatives from the ACOE geotechnical group oversaw the installation of this well and discussed the site observations with the Versar geologist. After an evaluation of site conditions, Versar and the ACOE geotechnical group mutually agreed that a confined aquifer, possibly the Old Bridge Sand, had been penetrated and the latter portion of the borehold should be backfilled to seal off this zone. The borehole was backfilled with bentonite from 52 to 54 feet bgs, and a 10-foot section of screen was installed from 40 to 50 feet bgs. Subsequently, the static groundwater in this well was equilibrated at 45.7 feet bgs (5.6 feet above MSL), a level consistent with water table elevations in the unconfined upper aquifer.

On most wells, the gravel zone extends 5 feet above the top of screen followed by a 5-foot interval of bentonite and cement/bentonite grout to the top thereafter. As indicated in Table 4-5, these measurements differ slightly in MW-6D, MW-18, MW-CSX1, MW-CSX2 and MW-20D.

During mud rotary drilling of MW-20D, various problems were encountered. From 10- feet the borehole continually caved in due to the presence of fill, resulting in a larger diameter hole and extremely slow drill bit advancement. It was decided to sink a larger steel diameter (14 inch) casing down to a depth of 28 feet bgs to prevent collapse. This casing was subsequently to be pulled out upon sinking the 8-inch diameter surface casing. However, various attempts failed to retrieve the larger casing, and it was left in place at a depth of approximately 28 feet bgs. After installing the casing, the well was drilled to approximately 90 feet bgs.

4.5.4 Well Development

Following installation, the groundwater monitoring wells were developed to remove fines/silts and residual drilling fluids (i.e., drilling mud or water) added during well construction. Proper development of wells is required to establish a good hydraulic connection between the existing formation and the well screen and ensures recovery of representative formation water during groundwater sampling events.

Prior to development, the bottom of each well was sounded with a weighted tape; depth to water and LNAPLs, if present, were recorded. Where possible, wells were evacuated of at least 3 to 5 times the volume of standing water in the well, in addition to any water added during well installation. Wells with poor yields were bailed dry more than once. MW-9, MW-16, MW-17, and MW-CSX1 exhibited extremely low yields/recharges and were bailed with decontaminated PVC bailers on more than one day. MW-20 was developed prior to installation of MW-20D and had to be redeveloped after MW-20D was installed. Detailed information regarding well development is contained in Table 4-6. The well development field data forms are contained in Appendix J.

Development was accomplished by using submersible pumps and/or PVC bailers. On wells developed with submersible pumps, frequent surging with the pump was done to clear out fines in and around the gravel pack. Huntingdon Empire Soils conducted development activities for the new wells in conjunction with installation. Versar monitored each development process and tested the groundwater with a pH meter, a conductivity meter, thermometer, and a turbidity meter. Development was considered complete when pH, conductivity, and temperature readings were relatively consistent.

4.5.5 Equipment Decontamination

In accordance with ACOE's/DPSC's requirements and the Project Operations Work Plan, no solvents were used on site during soil sampling and monitoring well installation and development. All down-hole equipment was steam cleaned between soil borings. Split-spoons were steam cleaned between soil borings, scrubbed with Alconox^{TM} detergent, and rinsed with clean water between sampling events.

After each well development, PVC bailers and submersible pumps were decontaminated in accordance with the Project Operations Work Plan and ACOE protocols. Submersible pumps used for development were steam cleaned, scrubbed with Alconox^{TM}, purged with clean water, and rinsed with DI water. Dedicated PVC bailers were used for well purging. Well development and decontamination fluids/water thus generated were properly contained along with the rest of the investigation derived waste (IDW) for laboratory analysis and disposal.

4.5.6 Investigation Derived Waste (IDW) Disposal

All soil cuttings, groundwater, and waste generated during field activities were contained in 55-gallon drums for sampling and disposal. Versar sampled the IDW, contained the IDW in 55-gallon drums, labeled the drums to identify the source, packed them appropriately, and staged them on wooden pallets for pick-up and storage on-site by DPSC. DPSC personnel managed and disposed of the IDW. According to the sampling protocol of DPSC's contractor, Laidlaw, Inc., 10% of the drums were subsequently sampled and analyzed for full toxicity characteristic leaching procedure (TCLP) parameters, and laboratory results were furnished to DPSC within three weeks of sampling.

4.6 Soil Sampling

Except for one deep soil boring (MW-20D) and two intermediate depth soil borings (MW-CSX1 & MW-CSX2) located on CSX Railroad property along the western boundary of DPSC, continuous split-spoon sampling was performed on all other soil borings. Split spoon soil samples were collected and field screened by an HNu/PID. On MW-20D, MW-CSX1, and MW-CSX2, soil sampling was performed every 5 feet from 0 to 20 feet and continuously thereafter because in the case of MW-20D, continuous sampling had already been performed on the shallow well (MW-20) located adjacent to this well and lithologic information from 0 to 20 feet was already available. For the two CSX wells, the first 20 feet were suspected to be "fill." The difference in ground surface elevations between the CSX wells and DPSC site is approximately 22 feet. All samples were collected in laboratory supplied jars. HNu readings are presented in Table 4-7.

At the end of each boring, two soil samples, one with the highest HNu reading and another at the soil/free product or soil/groundwater interface, were selected for laboratory analysis. The two sets of samples were poured into separate decontaminated stainless steel bowls. The volatile organic compound samples were then collected with stainless steel spatulas and transferred to appropriate labeled laboratory containers. Following collection of the volatile organic samples, the remaining soil was quickly homogenized with steel spatulas, and transferred to labeled laboratory containers and preserved on ice. No soil samples were collected on MW-20D for chemical analysis because soil samples had already been collected from the adjacent MW-20. Because elevated HNu readings were not detected, only one soil sample (at the soil/water interface) was collected on MW-18. On MW-15, a 16 to 18 foot split-spoon sample was taken by PADER. In spite of a high HNu reading, split-spoon sampling at 18 to 20 feet did not yield enough soil volume; hence, a 14 to 16 foot split-spoon sample was collected as S-17. All laboratory soil samples were analyzed for the following parameters:

TCL VOCs	SW846	Method 8240
TCL SVOCs	SW846	Method 8270
TCL Pesticides/PCBs	SW846	Method 8080
Total Metals	SW846	Method 7000/6010
Total Petroleum Hydrocarbons	SW846	Method 418.1
Diesel Range Organics	SW846	Method 8015A
Gasoline Range Organics	SW846	Method 8015A
Cyanide	SW846	Method 335.2

In order to be able to compare the analytical data with Sun Oil's analytical data, the analytical methods used were in accordance with the requirements of the Pennsylvania Department of Environmental Resources (PADER). Soil analytical data summary tables showing analytical parameters are included as follows:

Data Summary:	Table 4-8: Soil Sampling Analytical Results (TPH, GRO, DRO, and BTEX)
Data Summary:	Table 4-9: Soil Sampling Analytical results (TCL Organic Compounds)
Data Summary:	Table 4-10: Soil Sampling Analytical Results (TAL inorganic Compounds)

Actual laboratory analytical data for the soil samples are contained in Appendix O. Because of their sheer volume, raw data are not included in this report.

Prior to beginning each soil boring, field/equipment blanks (FB/EB) were collected, alternating between steel bowls and split spoons. In accordance with the laboratory protocols, no matrix spike/matrix spike duplicate (MS/MSD) was collected during soil sampling.

One sample from each boring was selected for geotechnical analyses to confirm soil classification done in the field. Overall, four Shelby tube samples were collected for estimation of various geotechnical parameters. One turned out to be sand; hence, only three tube samples were sent for geotechnical analysis. Upon retrieval, Shelby tubes were immediately sealed with hot wax, stored, and transported in accordance with applicable American Society of Testing Materials (ASTM) protocol. Geotechnical data is presented and discussed in Section 5.2. The rest of the soil samples were archived with the ACOE.

4.7 Surveying

James M. Stewart, Inc., a Pennsylvania licensed land surveyor, was retained by Versar to perform all surveying. Eighty-two soil gas (SG) and sixteen recently installed groundwater monitoring wells were surveyed. In addition, previously existing wells MW-1, MW-3, MW-6, MW-1A, MW-2A and four wells located on SEPTA property were surveyed. Monitoring wells were surveyed for elevations and coordinates of the inner PVC casing, outer protective casing/flush mount, and ground surface. Two monuments, S-1 and S-6, located on Sun Oil's property, were also surveyed. Building corners at the DPSC were also surveyed to establish an accurate AutoCad base map for all subsequent mapping and modeling.

All locations were surveyed for horizontal (X & Y) coordinates and vertical (Z) coordinates. Horizontal locations were surveyed for latitude/longitude and northing/easting coordinates. Elevations of all locations were surveyed with reference to National Geodetic Vertical Datum (NGVD).

The following Data and Bench Marks were used:

Horizontal Datum:	Pennsylvania State Plane Coordinates NAD 27 South Zone
Vertical Datum:	NGVD 1929
Bench Mark Used:	NGS N 276
Horizontal Monument:	USACE Fort 2, 1987

A number of inconsistencies were observed with respect to survey data for previously installed wells on site and the Sun Oil Company refinery south yard monuments S-1 and S-6.

- The elevations of 3 previously installed wells on DPSC were checked for accuracy and previously documented values were found to be 0.30 feet more than the currently surveyed values. Horizontal coordinates of these same wells were found to be -45 feet (north) and +5783 feet (east) when compared to the currently surveyed values.
- The coordinates of the Sun monument S-1 were found to be +11.45 feet (north) and -8.80 feet (east) compared to the currently surveyed values.
- The elevations of Sun monuments S-1 and S-6 are found to be +1.13 and +1.05 feet, respectively, compared to the currently surveyed values.
- It was also noted that elevations of the soil borings surveyed by the Corps of Engineers, Baltimore District, during the Fuel Contamination Study completed in 1987-88, were referenced to the City of Philadelphia plan elevation which is found to be 5.96 feet higher than NGVD. All survey data collected along with explanation of the observations made are presented in Appendix E.

4.8 Synoptic Groundwater and Free Product Level Measurements

The purpose of taking synoptic (i.e., simultaneous) groundwater level measurements is to generate a composite water table contour map of both the Sun Oil Company and DPSC sites to infer the groundwater flow direction. Three rounds of synoptic groundwater level measurements were taken during this phase of the project. All these synoptic levels were taken simultaneously with Sun Oil's synoptic groundwater and free product level measurements. Sun Oil's measurements were taken by its consultants, Groundwater and Environmental Services, Inc. (GES). These data were exchanged.

October 21, 1994, Groundwater and Free Product Level Measurement: Water and free product levels in 9 wells on DPSC and 14 wells on the Sun Oil Company site were measured. DPSC measurements are presented on Table 4-11. Sun Oil Company measurements are presented in Appendix K. Water table elevations are referenced to Sun monuments S-1 and S-6.

December 14, 1994, Groundwater and Free Product Level Measurement: Groundwater and free product levels in 9 wells on DPSC, 36 wells on the Sun Oil Company site, and 3 wells on the SEPTA site were measured. DPSC measurements are presented in Table 4-12. Sun Oil Company measurements are presented in Appendix K. Water table elevations are referenced to Sun monuments S-1 and S-6.

March 1 and 2, 1995, Groundwater and Free Product Level Measurement: Groundwater and free product levels in 25 wells (23 on DPSC property and 2 on CSX Railroad property) were measured along with 36 wells on the Sun Oil Company south yard and 4 wells at the SEPTA south garage. DPSC measurements are presented on Table 4-13. Sun Oil Company measurements are presented in Appendix K. Groundwater and free product levels in four wells located at SEPTA's south garage were also measured by Sun Oil Company's consultant (GES).

The March 1-2, 1995, measurements were used to generate the Composite Groundwater Table Elevation Map.

Wells were allowed to vent, and the water level was allowed to equilibrate for a few minutes prior to measuring depth to water level (DTW) and/or depth to product (DTP). An oil/water interface meter and an electronic water level indicator (M-Scope^{TM}) were used. All depths were measured from the top of the PVC casing (TOC). Equipment was decontaminated between each well as follows:

Potable water rinse
Hexane spray
Deionized water rinse

In wells with free product, DTW and DTP were taken three times to remove any inaccuracies resulting from equipment malfunction or from free product coating the probe.

As discussed in Section 4.7, all measurements on DPSC wells are referenced to NGVD. Measurements on Sun Oil Co. wells are referenced to monuments S-1 and S-6 on the Sun site. The elevations of these monuments were found to be +1.13 and +1.05, when compared to previously surveyed values, above NGVD. Measurements contained in Appendix K, *March 1-2, 1995, Water Table Elevation Data*, reflect corrected readings with respect to NGVD. In wells with free product, adjusted water table elevations were calculated according to the following formula:

AWL = TOC - (DTW-0.75*PT)

Where:

AWL = Adjusted Water Level Elevation in feet, above NGVD
TOC = Top of Casing Elevation in feet, above NGVD
DTW = Depth to Water in feet, below TOC
PT = Free Product Thickness in feet.
0.75 = Average Free Product Specific Gravity

4.9 Free Product and Groundwater Sampling

Sixteen monitoring wells (MW-9 through MW-20, MW-6D, MW-20D) including the two off site wells (CSX-1 and CSX-2) were installed at DPSC to determine the presence or absence of groundwater contaminants and to define the local hydrogeologic conditions. In addition, the nine on-site monitoring wells installed in 1991 (MW-1 through MW-7, and MW-1A and MW-2A) were sampled as part of the Phase I RI.

4.9.1 Free Product Sampling

Prior to groundwater sampling, free product samples were collected from all applicable existing and new monitoring wells. Free product samples were collected using a laboratory-cleaned 40-ml VOA vial on a dedicated length of nylon rope. Free product samples were collected on March 1 and 2, 1995, from the following monitoring wells: MW-1A, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-9, MW-11, MW-14, and MW-15.

Free product samples were submitted for quantitative analysis of BTEX parameters (benzene, toluene, ethyl-benzene, and total xylenes), diesel range organics, and gasoline range organics, following strict chain-of-custody procedures as defined in the DPSC Project Operations Work Plan. Collection, documentation, preservation and shipping of samples also followed the protocols outlined in the DPSC Project Operations Work Plan. Chemical analysis was completed by ACOE

MRD-certified Kemron laboratory in Marietta, Ohio. Table 4-14 presents analytical results of the free product sampling.

4.9.2 Groundwater Sampling

A minimum of 14 days after development, the wells were purged and sampled. Wells included in the sampling process included the 16 recently installed monitoring wells and nine pre-existing wells installed in 1991. Prior to sampling, all wells were purged a minimum of five times the well casing volume, using the following purging apparatus: a field decontaminated, 3-inch diameter bailer was used for all shallow and intermediate 4-inch diameter wells; dedicated disposable bailers were used for the existing 2-inch diameter wells; and a field decontaminated 4-inch diameter submersible pump was used for the two deep wells (MW-6D and MW-20D).

Field decontamination procedures for the 3-inch diameter bailers consisted of the following:

- soap and water wash
- tap-water rinse
- hexane rinse
- DI-water rinse
- air dry

The submersible pump was decontaminated using the same procedures on the exterior of the pump, and by flushing 55-gallons of soap/water solution, followed by 55-gallons of tap water, through the pump.

In the event of wells having slow recharge rates, the well was purged dry, allowed to recharge to within 10 percent of it's pre-purge volume, then purged dry again. This occurred at monitoring wells; MW-1A, MW-2A, MW-7, MW-9, MW-10, MW-13, MW-16, MW-17, and MW-CSX1. Before purging, Versar measured the depth to water below the top of the well casing using a electronic water level meter. This measurement, along with the known depth and diameter of the well, was used to determine the volume of water that needed to be purged. The water level meter was decontaminated between each well by washing with hexane and DI water.

Groundwater samples were collected from March 6 to March 15, 1995, and were submitted for quantitative analysis of volatile organic compounds, semi-volatile organic compounds, total and dissolved metals, cyanide, TPH, DRO, and GRO, following strict chain-of-custody procedures. Collection, documentation, preservation and shipping of samples followed the protocol outlined in the DPSC Project Operations Work Plan. Chemical analysis was completed by ACOE MRD-certified Kemron laboratory in Marietta, Ohio. Analytical results for the groundwater samples for TPH, GRO, DRO, and BETX; TCL organics; and TAL inorganics are provided in Tables 4-15, 4-16, and 4-17, respectively.

Following well purging, groundwater samples were obtained from the 2-inch and 4-inch diameter wells using laboratory-cleaned, dedicated, 2-inch diameter PVC bottom-filling bailers on a dedicated length of rope. Groundwater samples were collected directly from the dedicated bailers, using a bottom emptying device. For free-floating product wells, the outside of the bailers were wiped clean to prevent product from flowing into the sample containers. The volatile organic fraction was collected first, followed by the remaining sample parameters. Samples for dissolved metals were poured into a separate plastic water jug for laboratory filtration. Filtration of the sample consisted of drawing the sample volume through a 0.45 micron filter, using air pressure.

Preservation of the samples included HCl for volatile organics; HNO_3 for total metals; NaOH for cyanide; and H_2SO_4 for total petroleum hydrocarbons. After collection, all samples were placed on ice in coolers.

Two equipment rinsate blanks were obtained during groundwater sampling. The first (EB-1) was collected from the 3-inch diameter purging bailer prior to purging MW-5, and the second (EB-2) was collected from the 4-inch diameter submersible pump prior to purging MW-20D. The equipment blanks were prepared by pouring DI-water over the field-decontaminated bailer and pump, and collecting the rinsate in sample bottles for analysis.

4.10 Slug Testing

In accordance with the Project Operations Work Plan, rising head slug tests were performed on the monitoring wells to estimate the hydraulic conductivity of the formation in the immediate vicinity of the wells. Since the screen in all monitoring wells except MW-20D and MW-6D extends approximately 5 feet above the water table, rising head slug tests were performed on all the wells. All monitoring wells are screened in the unconfined aquifer and are partially penetrating. These tests were performed between March 22 and April 7, 1995.

4.10.1 Theory

The slug test developed by Bouwer and Rice (1989) permits measurement of saturated hydraulic conductivity (K) of an aquifer with a single well. The method consists of quickly lowering or raising the water level in a well or borehole from equilibrium and measuring its subsequent rise or fall, respectively. The method was designed to measure the K of the aquifer in the vicinity of the well screen or open borehole.

The following terms are defined:

DTP:	Depth to free product (if applicable)
DTW:	Depth to Water (Initial)
AWL:	Depth to Adjusted Water Level.

IG:	Infiltration Goal
RG:	Recharge Goal
PT:	Product Thickness
TOC:	Top of Casing

Infiltration Goal - (Assuming the AWL or DTW is 20 feet) Upon submerging the slug, if the initial rise in the water column in 4 feet, then IG will be 5% of 4 feet, or 0.2 feet. This means that the slug can be pulled out and the rising head test started when the AWL or DTW is 20.0-0.2 = 19.8 feet.

Recharge Goal - (Assuming the AWL or DTW is 20 feet) Upon instantaneous removal of the slug, if the immediate fall in the water column (drawdown) is 3 feet, then RG will be 5% of 3 feet, or 0.15 feet. This means that the rising head test is deemed to be complete when the AWL or DTW is 20.0 + 0.15 = 20.15 feet.

An In-Situ, Inc., Hermit 1000-C^{TM} data logger was used in combination with a 20 psi pressure transducer to monitor and record the water level. Eleven of the monitoring wells tested contained LNAPL. Since the pressure transducer reads the pressure of the fluid column above it, depth to adjusted water levels were calculated for wells with LNAPL, using the following formula:

AWL = DTW - 0.75*(DTW-DTP)
or
AWL = DTW - 0.75*(PT)

Average Specific Gravity of LNAPL = 0.75

For wells with LNAPL, AWL was used as the reference level for the data logger. For wells with no LNAPL, initial DTW was used.

IG and RG were utilized in cases of very poorly infiltrating or recharging wells only. Otherwise, it was considered preferable for the water level to equilibrate to its original level prior to starting and ending the tests.

4.10.2 Test Procedure

Prior to starting the test, DTW and DTP (if applicable) were recorded, and AWL was calculated. Then, the pressure transducer was lowered sufficiently below the water level to avoid contact with a fully submerged slug. The transducer cable was taped to the well casing to secure it to one position. AWL or DTW was input into the data logger as the reference level and set to ready mode. A 3.5-inch (1.75-inch for 2-inch wells) diameter solid PVC slug was quickly submerged in the water, and the data logger was set almost instantaneously (Step 0). Upon attainment of the IG, the slug was rapidly pulled out of the water, and the data logger was reset (Step 1). The data logger was allowed to monitor the water level until the RG was achieved. Upon termination of the test, data were downloaded from the data logger to an IBM-compatible personal computer. Raw data from the data logger is contained in Appendix L.

4.10.3 Data Analysis

Slug test data were analyzed using the Bouwer and Rice method for partially penetrating wells. Widely accepted and utilized software, AQuifer TEst SOLVer (AQTESOLV) was used to analyze the data and print the plots.

The raw data show only two columns, time versus change in reference level. Reference level, DTW or AWL (if applicable) for a particular well was an input in the data logger. Data logger data were transformed for input into AQTESOLV by subtracting the initial DTW or AWL (same as reference level) from the second column of the data logger data, or change in reference level. The result of this transformation is two columns of data, time versus change in fluid level. These data were entered into AQTESOLV.

The following assumptions were made:

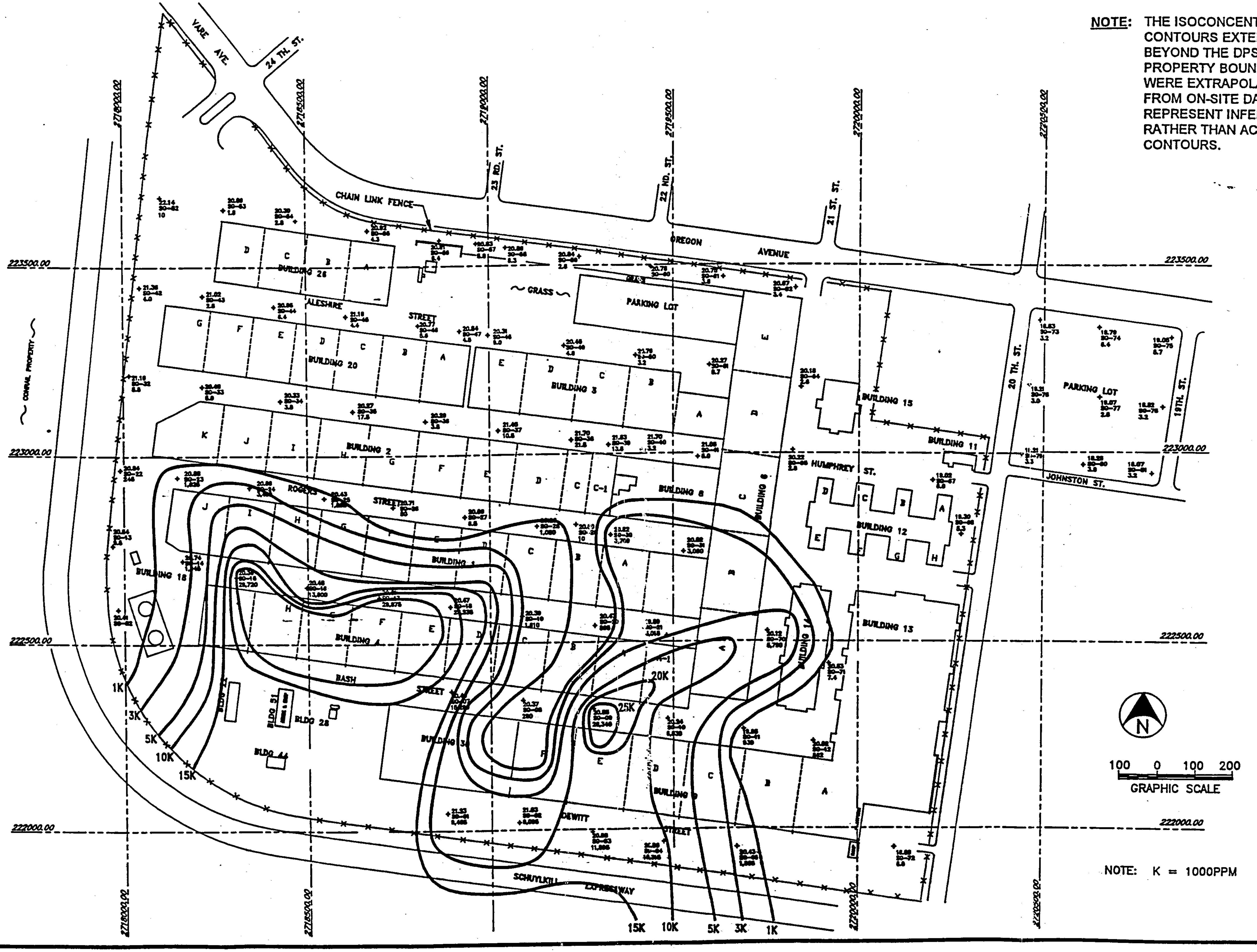
- In all shallow wells, the thickness of the saturated zone is 25 feet, and in MW-20D and MW-6D, it is equivalent to the height of the standing water column in the well.
- The water table in wells is under unconfined condition.
- All wells are partially penetrating.

Under ideal conditions, a typical slug test plot should exhibit two different slopes. The initial steep slope is probably indicative of the gravel pack drainage around the screen. The second, less steep slope is indicative of the K of the undisturbed aquifer around the screen. This portion of the data should be used for analysis.

In some formations, a third, still less steep slope, is seen that is probably indicative of the residual drawdown. This may or may not be exhibited depending upon the geologic formation.

Raw data from the data logger was transformed into acceptable AQTESOLV format and imported in AQTESOLV. Individually applicable values of initial drawdown (Ho), radius of the screen (rc), radius of the gravel pack or effective well radius (rw), length of the screen (L), thickness of the saturated zone (b) and initial water column (H) were entered in AQTESOLV. A straight line fit was visually matched with the data point interval indicative of estimated K of formation. Different input parameters and estimated K values are presented on individual plots contained in Appendix L. Table 4-18 shows estimated K values.

Monitoring well numbers correspond to identification numbers on the data logger raw data (i.e., MW-01 corresponds to identification 01 on data logger raw data). MW-CSX1, MW-2, MW-7, and MW-9 are not included, either due to erroneous data logged or extremely slow recharge rates.



NOTE: THE ISOCONCENTRATION CONTOURS EXTENDING BEYOND THE DPSC PROPERTY BOUNDARY WERE EXTRAPOLATED FROM ON-SITE DATA AND REPRESENT INFERRED, RATHER THAN ACTUAL CONTOURS.

NOTE: K = 1000PPM

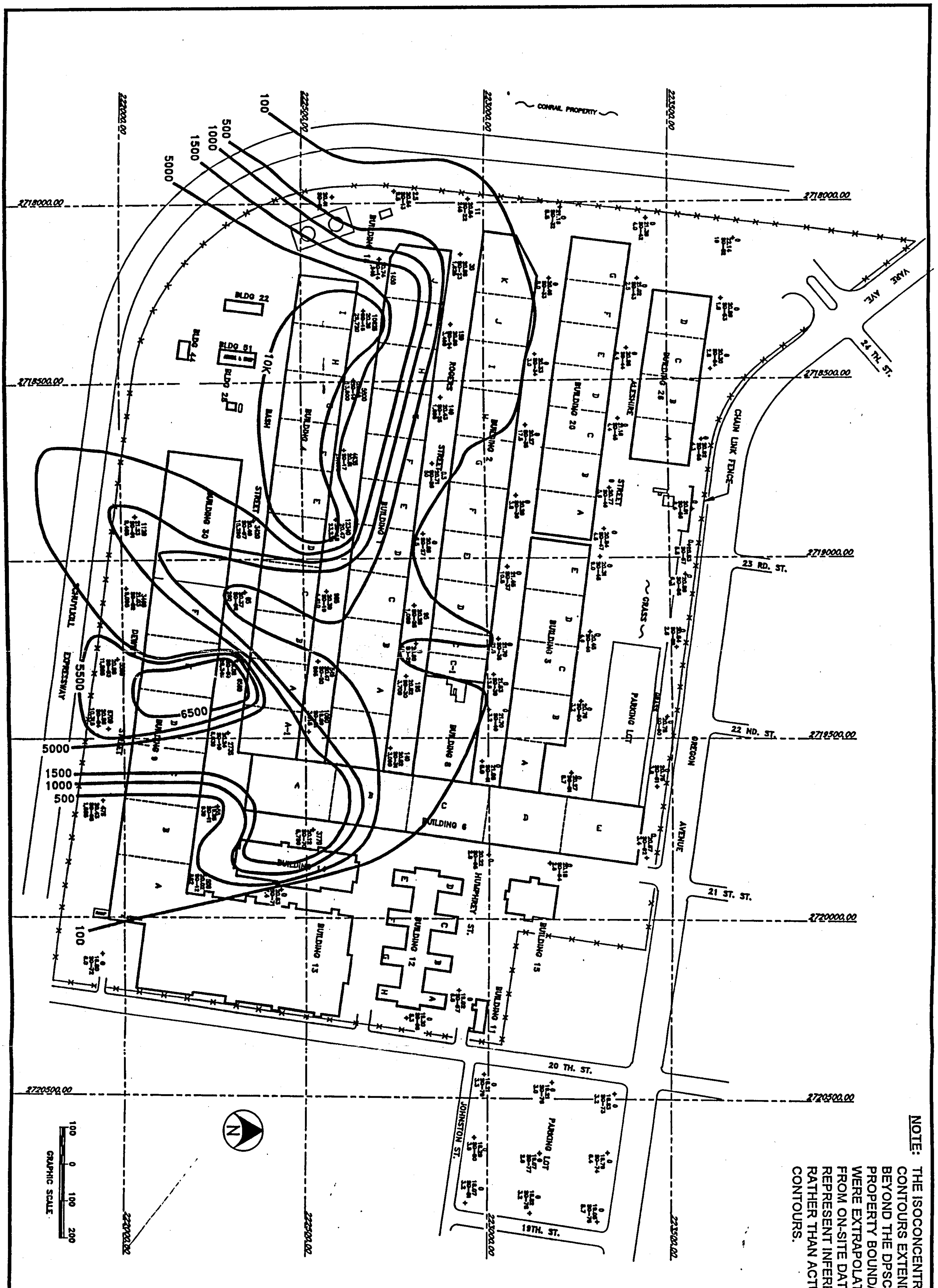
FIGURE 4-1

SOIL GAS ISOCONCENTRATION MAP (TOTAL VOCS >1000PPM)

DEFENSE PERSONNEL SUPPORT CENTER

DATE:	04/05/95
SCALE:	NTS
DWG. BY:	G.B.

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844



NOTE: THE ISOCONCENTRATION CONTOURS EXTENDING BEYOND THE DPSC PROPERTY BOUNDARY WERE EXTRAPOLATED FROM ON-SITE DATA AND REPRESENT INFERRED, RATHER THAN ACTUAL CONTOURS.

Versar INC.
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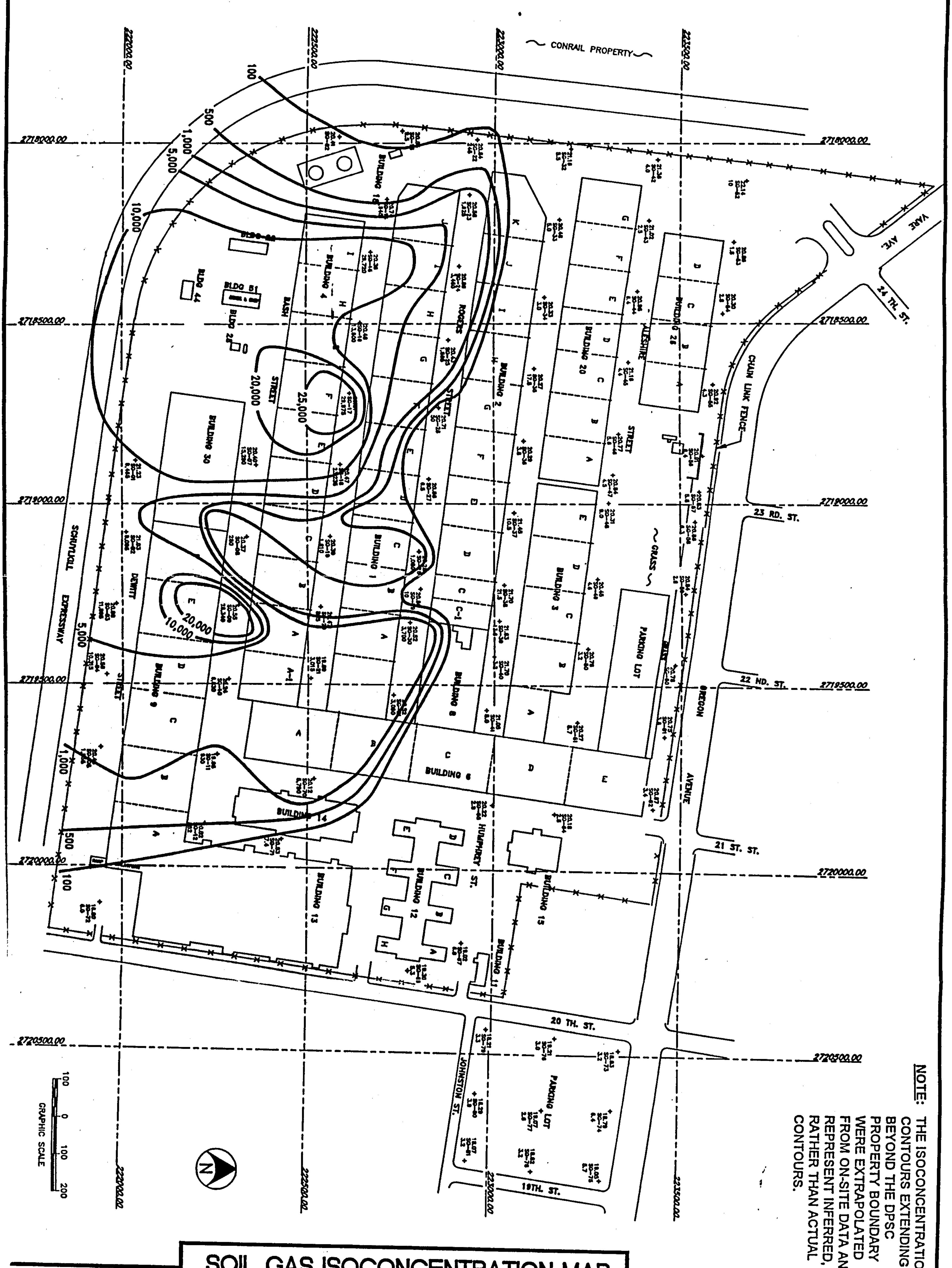
BRISTOL, PA 19007
(215) 788-7844

SOIL GAS ISOCONCENTRATION MAP (TOTAL BTEX >100)

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/12/95
SCALE: NTS
DWG. BY: G.B.

FIGURE 4-2



NOTE: THE ISOCONCENTRATION CONTOURS EXTENDING BEYOND THE DPSC PROPERTY BOUNDARY WERE EXTRAPOLATED FROM ON-SITE DATA AND REPRESENT INFERRED, RATHER THAN ACTUAL CONTOURS.

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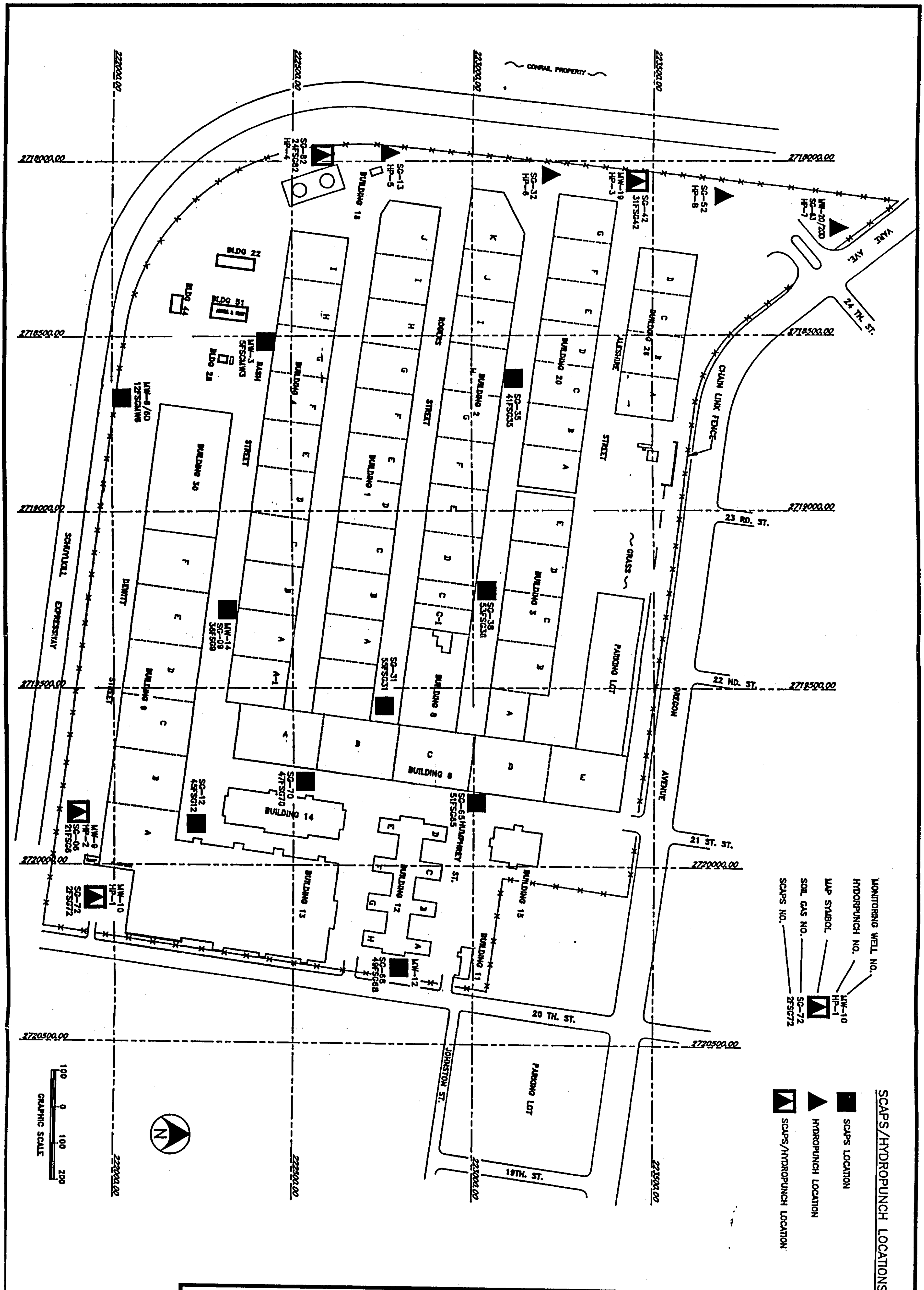
SOIL GAS ISOCONCENTRATION MAP
(TOTAL VOCS - TOTAL BTEX >100 PPM)

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: NOTED
DWG. BY: G.B.

FIGURE 4-3



Versar INC.
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BRISTOL, PA 19007
(215) 788-7844

SCAPS AND HYDROPUNCH SURVEY LOCATION MAP

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: NOTED
DWG. BY: V.S.

FIGURE 4-4

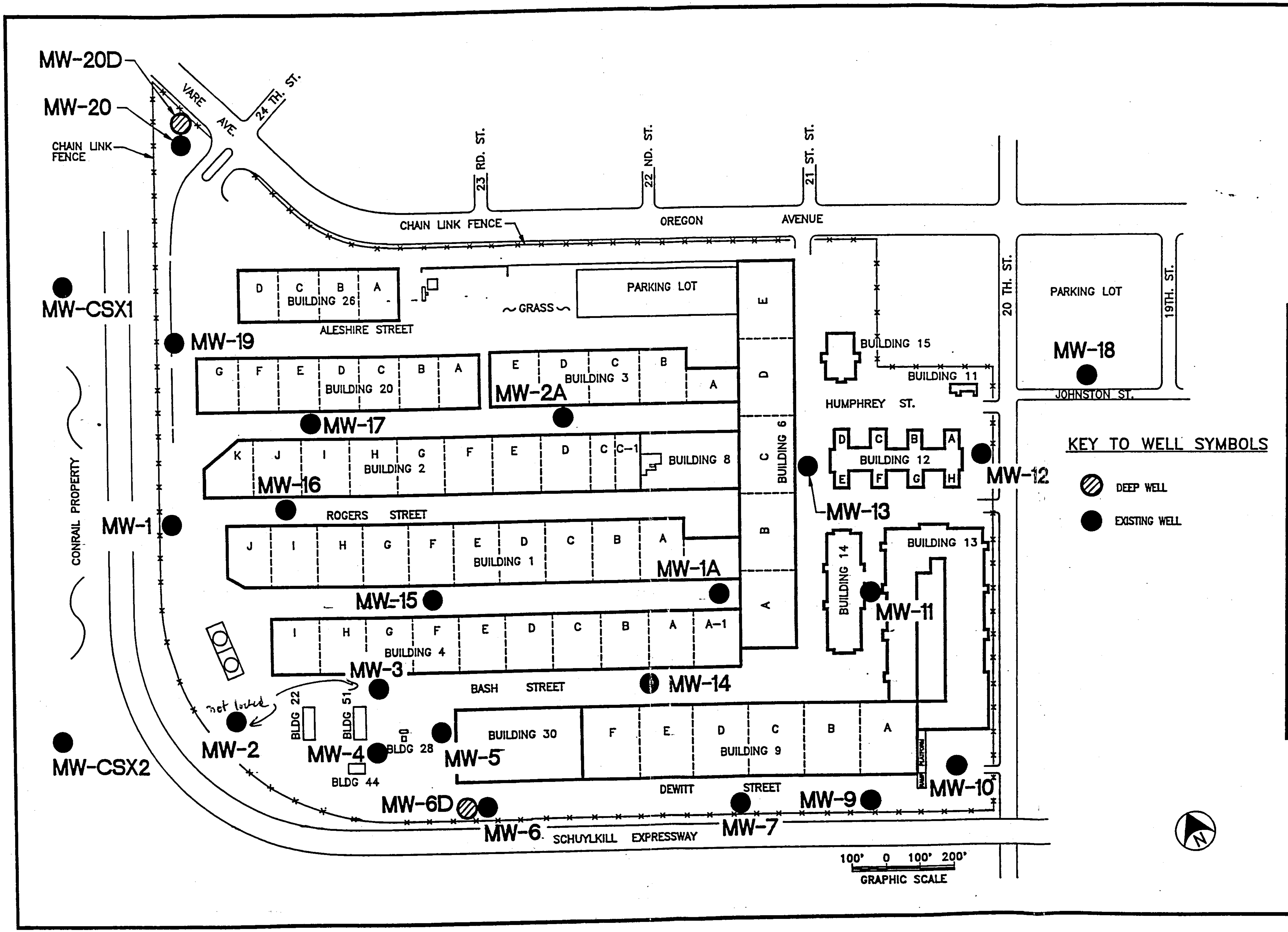

FIGURE 4-5

SOIL BORING AND MONITORING WELL LOCATION MAP

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/04/95
SCALE: AS SHOWN
DWG. BY: D.M.

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BRISTOL, PA 19007
(215) 788-7844

TABLE 4-1
ACTIVE SOIL GAS SURVEY ANALYTICAL DATA
(BTEX AND TOTAL VOCs)
(Survey Date: September 26 through October 21, 1994)

SAMPLE I.D.	BENZENE (ppm)	TOLUENE (ppm)	ETHYL-BENZENE (ppm)	TOTAL XYLENES (ppm)	TOT-BTEX (ppm)	TOT-VOC's (ppm)
SG-01	1,035	<0.1	<0.1	90	1,125	9,465
SG-02	2,700	245	195	300	3,440	9,095
SG-03	4,330	580	220	360	5,490	11,865
SG-04	4,160	605	245	690	5,700	10,315
SG-05	305	40	65	60	470	1,555
SG-06	<0.1	0.2	0.2	0.9	1.3	6.0
SG-07	2,860	315	140	105	3,420	15,290
SG-08	60	2.0	1.0	1.0	64	280
SG-09	4,600	1,700	NR	260	6,560	28,340
SG-10	2,165	380	<0.1	195	2,740	6,030
SG-11	55	<0.1	<0.1	<0.2	55	930
SG-12	100	<0.1	<0.1	1.0	101	882
SG-13	<0.1	<0.1	<0.1	<0.2	ND	9.5
SG-14	1,020	300	30	100	1,450	1,945
SG-15	8,080	1,190	625	730	10,625	29,720
SG-16	2,000	1,110	NR	780	3,890	13,600
SG-17	2,230	1,790	55	560	4,635	29,975
SG-18	8,595	2,730	NR	1,015	12,340	23,325
SG-19	435	320	170	65	990	1,610
SG-20	225	275	30	10	540	865
SG-21	170	500	265	155	1,090	3,015
SG-22	8.0	2.0	1.0	<0.2	11	245
SG-23	20	6.0	4.0	1.0	31	625

TABLE 4-1
ACTIVE SOIL GAS SURVEY ANALYTICAL DATA
(BTEX AND TOTAL VOCs)
(Survey Date: September 26 through October 21, 1994)
(continued)

SAMPLE I.D.	BENZENE (ppm)	TOLUENE (ppm)	ETHYL-BENZENE (ppm)	TOTAL XYLENES (ppm)	TOT-BTEX (ppm)	TOT-VOC's (ppm)
SG-24	100	30	20	<0.1	150	3,460
SG-25	90	40	10	<0.2	140	1,865
SG-26	5.0	<0.1	<0.1	<0.2	5.0	50
SG-27	<0.1	<0.1	<0.1	<0.2	ND	6.5
SG-28	30	30	35	<0.2	95	1,080
SG-29	<0.1	<0.1	<0.1	<0.2	ND	10
SG-30	130	35	30	<0.2	195	3,700
SG-31	80	40	20	<0.2	140	3,060
SG-32	<0.1	<0.1	<0.1	<0.2	ND	5.5
SG-33	<0.1	<0.1	<0.1	<0.2	ND	5.0
SG-34	<0.1	<0.1	<0.1	<0.2	ND	3.0
SG-35	<0.1	<0.1	<0.1	<0.2	ND	17.5
SG-36	<0.1	<0.1	<0.1	<0.2	ND	3.8
SG-37	<0.1	<0.1	<0.1	<0.2	ND	10.5
SG-38	<0.1	<0.1	<0.1	<0.2	ND	21.5
SG-39	<0.1	<0.1	<0.1	<0.2	ND	13.6
SG-40	<0.1	<0.1	<0.1	<0.2	ND	3.2
SG-41	<0.1	<0.1	<0.1	<0.2	ND	5.0
SG-42	<0.1	<0.1	<0.1	<0.2	ND	4.0
SG-43	<0.1	<0.1	<0.1	<0.2	ND	2.5
SG-44	<0.1	<0.1	<0.1	<0.2	ND	6.4
SG-45	<0.1	<0.1	<0.1	<0.2	ND	4.4
SG-46	<0.1	<0.1	<0.1	<0.2	ND	5.6

TABLE 4-1
ACTIVE SOIL GAS SURVEY ANALYTICAL DATA
(BTEX AND TOTAL VOCs)
(Survey Date: September 26 through October 21, 1994)
(continued)

SAMPLE I.D.	BENZENE (ppm)	TOLUENE (ppm)	ETHYL-BENZENE (ppm)	TOTAL XYLENE (ppm)	TOT-BTEX (ppm)	TOT-VOC's (ppm)
SG-47	<0.1	<0.1	<0.1	<0.2	ND	4.5
SG-48	<0.1	<0.1	<0.1	<0.2	ND	9.0
SG-49	<0.1	<0.1	<0.1	<0.2	ND	4.6
SG-50	<0.1	<0.1	<0.1	<0.2	ND	3.2
SG-51	<0.1	<0.1	<0.1	<0.2	ND	8.7
SG-52	<0.1	<0.1	<0.1	<0.2	ND	10.0
SG-53	<0.1	<0.1	<0.1	<0.2	ND	1.6
SG-54	<0.1	<0.1	<0.1	<0.2	ND	2.8
SG-55	<0.1	<0.1	<0.1	<0.2	ND	4.3
SG-56	<0.1	<0.1	<0.1	<0.2	ND	6.4
SG-57	<0.1	<0.1	<0.1	<0.2	ND	5.8
SG-58	<0.1	<0.1	<0.1	<0.2	ND	6.3
SG-59	<0.1	<0.1	<0.1	<0.2	ND	2.6
SG-60	<0.1	<0.1	<0.1	<0.2	ND	5.7
SG-61	<0.1	<0.1	<0.1	<0.2	ND	3.8
SG-62	<0.1	<0.1	<0.1	<0.2	ND	3.4
SG-63	<0.1	<0.1	<0.1	<0.2	ND	85
SG-64	<0.1	<0.1	<0.1	<0.2	ND	2.6
SG-65	<0.1	<0.1	<0.1	<0.2	ND	2.9
SG-66	DELETED					
SG-67	<0.1	<0.1	<0.1	<0.2	ND	6.0
SG-68	<0.1	<0.1	<0.1	<0.2	ND	5.3
SG-69	DELETED					

TABLE 4-1
ACTIVE SOIL GAS SURVEY ANALYTICAL DATA
(BTEX AND TOTAL VOCs)
(Survey Date: September 26 through October 21, 1994)
(continued)

SAMPLE I.D.	BENZENE (ppm)	TOLUENE (ppm)	ETHYL-BENZENE (ppm)	TOTAL XYLENES (ppm)	TOT-BTEX (ppm)	TOT-VOC's (ppm)
SG-70	2,325	843	230	370	3,768	5,790
SG-71	<0.1	<0.1	<0.1	<0.2	ND	7.4
SG-72	<0.1	<0.1	<0.1	<0.2	ND	ND
SG-73	<0.1	<0.1	<0.1	<0.2	ND	3.2
SG-74	<0.1	<0.1	<0.1	<0.2	ND	6.4
SG-75	<0.1	<0.1	<0.1	<0.2	ND	5.7
SG-76	<0.1	<0.1	<0.1	<0.2	ND	3.0
SG-77	<0.1	<0.1	<0.1	<0.2	ND	2.6
SG-78	<0.1	<0.1	<0.1	<0.2	ND	3.2
SG-79	<0.1	<0.1	<0.1	<0.2	ND	3.3
SG-80	<0.1	<0.1	<0.1	<0.2	ND	3.9
SG-81	<0.1	<0.1	<0.1	<0.2	ND	3.2

Note: Soil gas sampling interval ranged from 10' to 12'.
ND - Not Detected

TABLE 4-2
SCAPS SURVEY DATA SUMMARY
FLUORESCENCE INTENSITY

SAMPLE I.D. NUMBER	SAMPLE LOCATION	MAXIMUM LIF AMPLITUDE (COUNTS)	WAVELENGTH AT PEAK (NM)	DEPTH INTERVAL (FEET)	TOTAL DEPTH SAMPLED (FEET)
2FSG72	SG72	None	None	NA	27.68
5FSGMW3	MW3	None	None	NA	6.56
12FSGMW6	MW6	None	None	NA	11.10
15FSGMW6	MW6	None	None	NA	10.47
17FSGMW6	MW6	None	None	NA	10.00
9FSGMW3	MW3	None	None	NA	17.85
7FSGMW3	MW3	None	None	NA	10.25
21FSG6	SG6	1878.8	410.4	23-25	27.96
24FSG82	SG82	None	None	NA	16.20
25FSG82	SG82	None	None	NA	16.12
36FSG9	SG9	2887.5	403.0	17-19	20.17
31FSG42	SG42	2220.9	395.5	23-25	26.08
41FSG35	SG35	None	None	NA	24.79
47FSG70	SG70	14580.9	407.3	17-22	23.43
49FSG68	SG68	8217.5	426.4	17-21	22.34
45FSG12	SG12	8824.6	404.1	19-22	23.37
51FSG65	SG65	None	None	NA	16.96
55FSG31	SG31	None	None	NA	21.97
53FSG38	SG38	938.6	401.9	2-3	23.38

Key:
LIF stands for laser induced fluorescence
None indicates no measureable readings
NA indicates not applicable
MW indicates monitoring well sampling location
SG indicates soil gas sampling location

TABLE 4-3
DATA SUMMARY: SAMPLE DEPTHS AND ANALYTICAL RESULTS FOR HYDROPUNCH SAMPLES (GRO, DRO, AND BTEX)

SAMPLE NO.	SOIL GAS REFERENCE NO.	SAMPLE DEPTH (bgs)	SAMPLE PARAMETERS					
			GRO (ppb)	DRO (ppb)	BENZENE (ppb)	ETHYL BENZENE (ppb)	TOLUENE (ppb)	TOTAL XYLENES (ppb)
HP-1	SG-72	16'- 19'	<100	<500	6	<5	<5	<5
HP-2	SG-6	23'- 26'	340,000,000	NA	2,900,000	230,000 J	1,400,000	6,000,000
HP-3	SG-42	22'- 25'	1,600	4,500	<5	<5	<5	<5
HP-4	SG-82	18'- 21'	1,100	3,600	<5	<5	<5	<5
HP-5	SG-13	18'- 21'	3,700	100,000	<5	<5	<5	<5
HP-6	SG-32	18'- 21'	<100	NA	<5	<5	<5	<5
HP-7	SG-63	20'- 23'	<100	2,400	<5	<5	<5	<5
HP-8	SG-52	20'- 23'	<100	580	<5	<5	<5	<5
EB-1	-----	-----	<100	<500	<5	<5	<5	<5
EB-2	-----	-----	<100	<515	<5	<5	<5	<5

NA Not Analyzed

TABLE 4-4
SOIL GAS, SCAPS, HYDROPUNCH, AND MONITORING WELL LOCATION CROSS REFERENCE

SOIL GAS NO.	SCAPS			HYDROPUNCH NO.	MONITORING WELL NO.
	NO.	CPT/RESIS.	LIF		
SG-6	21FSG6	CPT (0-28')	LIF (0-26')	HP-2	MW-9
SG-9	36FSG9	RESIS (0-17')	LIF (0-19')	—	MW-14
SG-12	45FSG12	RESIS (0-19')	LIF (0-22')	—	—
SG-13	—	—	—	HP-5	—
SG-17	—	—	—	—	MW-15
SG-21	—	—	—	—	MW-1A
SG-24	—	—	—	—	MW-16
SG-31	55FSG31	—	LIF (0-18')	—	—
SG-32	—	—	—	HP-6	—
SG-34	—	—	—	—	MW-17
SG-35	41FSG35	RESIS (0-22')	LIF (0-24')	—	—
SG-38	53FSG38	—	LIF (0-24')	—	—
SG-42	31FSG42	RESIS (0-25')	LIF (0-25')	HP-3	MW-19
SG-52	—	—	—	HP-8	—
SG-63	—	—	—	HP-7	MW-20/20D
SG-65	51FSG65	—	LIF (0-16')	—	—
SG-68	49FSG68	—	LIF (0-22')	—	MW-12
SG-70	47FSG70	—	—	—	—
SG-71	—	—	—	—	MW-11
SG-72	2FSG72	CPT (0-28')	LIF (0-25')	HP-1	MW-10
SG-80	—	—	—	—	MW-18
SG-82	24FSG82 25FSG82	CPT (0-16')	LIF (0-14')	HP-4	—
—	5FSGMW3 7FSGMW3 9FSGMW3	CPT (5'-6') CPT (14'-18')	LIF (0-4') — LIF (0-16')	—	MW-3
—	12FSGMW6 15FSGMW6 17FSGMW6	CPT (5'-11')	LIF (0-9')	—	MW-6

CPT : CONE PENETROMETER SURVEY
RESIS : RESISTIVITY SURVEY
LIF : LASER INDUCED FLUORESCENCE SURVEY
— : SURVEY NOT PERFORMED

TABLE 4-5
MONITORING WELL CONSTRUCTION DATA SUMMARY

WELL IDENTIFICATION	GRADE ELEVATION (FT.)	TOC ELEVATION (FT.)	DIAMETER OF BORE (INCH)	DEPTH OF THE BORE (FT.)	DEPTH OF THE WELL (FT.)	SCREEN LENGTH (FT.)	SCREEN INTERVAL (FT.)	GROUT INTERVAL (FT.)	BENTONITE INTERVAL (FT.)	GRAVEL INTERVAL (FT.)
MW-6D	21.64	21.45	10	77	74	10	64 - 74	0 - 48	48 - 58	58 - 77
MW-09	20.39	20.08	8.25	37	33	20	13 - 33	0 - 3	3 - 8	8 - 37
MW-10	16.92	16.56	8.25	31.5	28.5	15	13.5 - 28.5	0 - 3.5	3.5 - 8.5	8.5 - 31.5
MW-11	20.55	20.21	8.25	35	32	15	17 - 32	0 - 7	7 - 12	12 - 35
MW-12	19.72	19.54	8.25	32	29	15	14 - 29	0 - 4	4 - 9	9 - 32
MW-13	20.62	20.38	8.25	33	30	15	15 - 30	0 - 5	5 - 10	10 - 33
MW-14	20.67	20.27	8.25	35	32	15	17 - 32	0 - 7	7 - 12	12 - 35
MW-15	20.58	22.58	8.25	34	31	15	16 - 31	0 - 6	6 - 11	11 - 34
MW-16	20.69	20.36	8.25	34	31	15	16 - 31	0 - 6	6 - 11	11 - 34
MW-17	20.49	22.25	8.25	32	29	15	14 - 29	0 - 4	4 - 9	9 - 32
MW-18	18.31	17.93	8.25	32	28.7	18	10.7-28.7	0 - 2.5	2.5 - 6.5	6.5 - 32
MW-19	21.21	23.12	8.25	31	28	15	13 - 28	0 - 3	3 - 8	8 - 31
MW-20	26.08	25.66	8.25	34	31	15	16 - 31	0 - 6	6 - 11	11 - 34
MW-20D	26.10	25.08	12	92	81	15	66 - 81	0 - 50	50 - 61	61 - 92
MW-CSX1	51.17	51.32	8.25	52	50	10	40 - 50	0 - 32	32 - 36	36 - 52
MW-CSX2	46.96	46.70	8.25	60	57	15	42.5 - 57.5	0 - 34	34 - 38	38 - 60

- MW-20D has a 8.25 inch diameter steel surface casing grouted down to 63 feet and into the existing clay member. Also, there is an outside 14 inch diameter casing down to 28 feet. MW-20D and MW-6D are drilled by mud rotary method.
- All depth measurements are taken from ground surface. It should be noted that measurements may differ minutely on successive tables which are taken from top of casing (TOC). All elevations are referenced to National Geodetic Vertical Datum (NGVD).
- MW-15, MW-17 and MW-19 are stick-up wells with protective casings.

TABLE 4-6
MONITORING WELL DEVELOPMENT DATA SUMMARY

WELL IDENTIFICATION	WELL DEPTH (FT.)	WELL/BORE DIAMETER (INCH)	DEPTH TO FLUID (FT.)	FLUID COLUMN (FT.)	CASING FLUID VOLUME (GAL.)	SCREEN LENGTH (FT.)	VOLUME OF FLUID ADDED (GAL.)	TOTAL VOLUME PURGED (GAL.)	APPROXIMATE RECHARGE RATE (GPM)	METHOD OF DEVELOP-MENT
MW-6D	74	4/10.00	20.60	53.40	34.70	10	200	440	8 - 10	Pumped
MW-9	33	4/8.25	18.60	13.86	9.00	20	0	55	< 0.10	Bailed
MW-10	28.5	4/8.25	13.56	14.94	9.50	15	75	165	0.40	Pumped
MW-11	32	4/8.25	18.96	13.04	8.50	15	50	165	8-10	Pumped
MW-12	29	4/8.25	17.94	11.06	7.20	15	50	330	8-10	Pumped
MW-13	30	4/8.25	18.69	11.31	7.50	15	50	110	0.10	Pumped
MW-14	32	4/8.25	19.15	12.85	8.50	15	50	100	0.10	Pumped
MW-15	31	4/8.25	21.62	9.38	6.00	15	50	165	1 - 2	Bailed
MW-16	31	4/8.25	18.90	12.10	7.85	15	25	65	< 0.05	Bailed
MW-17	29	4/8.25	20.00	9.00	5.85	15	0	55	< 0.10	Bailed
MW-18	28.7	4/8.25	15.60	13.10	8.50	18	50	245	0.75	Pumped
MW-19	28	4/8.25	18.72	9.28	6.00	15	50	330	2 - 3	Pumped
MW-20	31	4/8.25	20.47	10.53	7.00	15	50	85	1 - 2	Bailed
MW-20D	81	4/10.00	20.75	60.25	39.50	15	200	660	6 - 8	Pumped
MW-CSX1	50	4/8.25	37.70	12.30	8.00	10	50	35	< 0.05	Bailed
MW-CSX2	57	4/8.25	46.40	11.10	7.20	15	0	85	< 0.50	Bailed

TABLE 4-7
MONITORING WELL PID READINGS (PPM ABOVE BACKGROUND)
(continued)

HOLE DEPTH (BGS)	MW-17 (32')	MW-18 (32')	MW-19 (31')	MW-20 (34')	MW-6D (0'-60')	MW-6D (60'-88')	MW-20D (92')	CSX-1 (54')	CSX-2 (60')
0' - 2'	0	0	0	0	0	10	NS	0	0
2' - 4'	0	0	0	1	0	25	NS	0	0
4' - 6'	0	0	NS	0.2	0	5	NS	0	0
6' - 8'	0	NS	3	0.2	0	12	NS	0	0
8' - 10'	0	1	4	0.1	0	5	NS	0	0
10' - 12'	0	0	4	0.9	15	5	NS	0	0
12' - 14'	0	0	2	1.4	50	3	NS	0	0
14' - 16'	0	1	3.5	0.8	30	NS	NS	0	0
16' - 18'	0	1	5	0.2	25	50	NS	0	0
18' - 20'	0	1.5	2.5	5	90	50	NS	0	0
20' - 22'	0	1.2	1.8	2	250	50	NS	0	0
22' - 24'	0	1.6	50	1.2	300	50	NS	0	0
24' - 26'	0	1.4	80	2.6	175	50	NS	0	0
26' - 28'	0	1.6	150	1	400	35	NS	0	0
28' - 30'	0	1.8	NS	40	150	NS	NS	0	10
30' - 32'	NS	NS	NS	25	NS	NS	0.6	NS	1
32' - 34'	NS	NS	NS	NS	NS	NS	0.4	0	0.5
34' - 36	NS	NS	NS	NS	3	NS	1	0	0
36' - 38	NS	NS	NS	NS	18	NS	1.2	0	1
38' - 40'	NS	NS	NS	NS	35	NS	0	0	4
40' - 42'	NS	NS	NS	NS	25	NS	0	0	25
42' - 44'	NS	NS	NS	NS	NS	NS	0	0	250
44' - 46'	NS	NS	NS	NS	20	NS	0	25	350
46' - 48'	NS	NS	NS	NS	70	NS	0	50	400
48' - 50'	NS	NS	NS	NS	30	NS	0	30	80
50' - 52'	NS	NS	NS	NS	50	NS	0	60	100
52' - 54'	NS	NS	NS	NS	20	NS	0	30	150
54' - 56'	NS	NS	NS	NS	7	NS	0	30	200
56' - 58'	NS	NS	NS	NS	17	NS	0	NS	NS
58' - 60'	NS	NS	NS	NS	20	NS	0 *	NS	NS

NOTE: Concentrations reported are total volatile organic vapors in soil as measured using an HNu photoionization detector upon opening the split-spoon sampler.

* Remaining PID vapor readings for monitoring well MW-20D were 0 ppm above background for intervals from 60' to 92' below ground surface.

NS - Not Sampled

TABLE 4-7
MONITORING WELL PID READINGS (PPM ABOVE BACKGROUND)

HOLE DEPTH (BGS)	MW-9 (37')	MW-10 (31.5')	MW-11 (35')	MW-12 (32')	MW-13 (33')	MW-14 (35')	MW-15 (34')	MW-16 (34')
0' - 2'	0	0	0	0	2	0	1	0
2' - 4'	0	0.6	0	0	2	2.5	0	0
4' - 6'	0	0.6	1.8	0.8	0.4	2.0	0	NS
6' - 8'	0	0.4	0	0.8	0	0.4	7	0
8' - 10'	0	0.4	NS	2	0	9	90	0
10' - 12'	0	0.4	0	2.4	0	NS	65	0
12' - 14'	0	NS	0.6	5	0	100	NS	2.8
14' - 16'	0	NS	0	10	0	15	45	20
16' - 18'	0	NS	300	190	0	50	250	20
18' - 20'	0	0.2	200	150	0	300	300	4
20' - 22'	0	0.2	300	325	15	300	250	0
22' - 24'	1.4	NS	200	200	150	400	350	0
24' - 26'	7,200	0.2	200	200	150	150	300	0.5
26' - 28'	7,200	1	300	300	150	400	250	0.5
28' - 30'	160	10	300	300	200	400	200	0
30' - 32'	150	NS	300	NS	200	300	200	NS
32' - 34'	170	NS	NS	NS	NS	NS	NS	NS
34' - 36	NS	NS	NS	NS	NS	NS	NS	NS
36' - 38	NS	NS	NS	NS	NS	NS	NS	NS
38' - 40'	NS	NS	NS	NS	NS	NS	NS	NS
40' - 42'	NS	NS	NS	NS	NS	NS	NS	NS
42' - 44'	NS	NS	NS	NS	NS	NS	NS	NS
44' - 46'	NS	NS	NS	NS	NS	NS	NS	NS
46' - 48'	NS	NS	NS	NS	NS	NS	NS	NS
48' - 50'	NS	NS	NS	NS	NS	NS	NS	NS
50' - 52'	NS	NS	NS	NS	NS	NS	NS	NS
52' - 54'	NS	NS	NS	NS	NS	NS	NS	NS
54' - 56'	NS	NS	NS	NS	NS	NS	NS	NS
56' - 58'	NS	NS	NS	NS	NS	NS	NS	NS
58' - 60'	NS	NS	NS	NS	NS	NS	NS	NS
60' - 62'	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 4-8
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TPH, GRO, DRO, AND BTEX)

WELL NO.	SAMPLE DEPTH (bgs)	SAMPLE PARAMETERS						
		TPH (ppm)	GRO (ppb)	DRO (ppb)	BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)
MW-9	20'- 22'	88	310	28,000	60	<7.7	<7.7	<7.7
MW-9	22'- 24'	110	1,500	16,000	100	27	68	490
MW-10	6'- 8'	<30	<120	23,000	<6.0	<6.0	<6.0	<6.0
MW-10	10'- 12'	<33	<130	1,300,000	<6.6	<6.6	<6.6	<6.6
MW-11	18'- 20'	13,000	5,400,000	7,600,000	<6,800	<6,800	58,000	210,000
MW-11	20'- 22'	16,000	6,100,000	7,300,000	<6,600	<6,600	62,000	190,000
MW-12	16'- 18'	1,900	100,000	1,500,000 B	<680	<680	<680	<680
MW-12	18'- 20'	3,600	370,000	2,800,000 B	<670	<670	<670	<670
MW-13	16'- 18'	<28	<110	<11,000	<5.6	<5.6	<5.6	<5.6
MW-13	18'- 20'	<28	<110	<11,000	<5.6	<5.6	<5.6	<5.6
MW-14	18'- 20'	1,500	2,400,000	1,300,000	<5.5	<5.5	6,300	29,000
MW-14	20'- 22'	19,000	16,000,000	9,700,000	26,000	17,000	120,000	690,000
MW-15	14'- 16'	NA	<120	<12,000	<6.1	<6.1	<6.1	<6.1
MW-15	20'- 22'	7,300	6,000,000	10,000,000	<7,200	<7,200	76,000	220,000
MW-16	14'- 16'	<27	<110	<11,000	<5.4	<5.4	<5.4	<5.4
MW-16	20'- 22'	<28	<110	<11,000	<5.6	<5.6	<5.6	<5.6
MW-17	16'- 18'	<30	<120	<12,000	<6.0	<6.0	<6.0	<6.0
MW-17	18'- 20'	<25	<120	10,000	<5.1	<5.1	<5.1	<5.1
MW-18	14'- 16'	<30	<120	<12,000	<6.1	<6.1	<6.1	<6.1
MW-19	8'- 10'	<30	<120	<12,000	<6.1	<6.1	<6.1	<6.1
MW-19	18'- 20'	300	<120	<12,000	<6.0	<6.0	<6.0	<6.0
MW-20	4'- 6'	130	180	12,000	9.4	<5.9	<5.9	<5.9
MW-20	20'- 22'	850	<110	24,000	<5.7	<5.7	<5.7	<5.7
MW-6D	18'- 20'	110	13,000	71,000 B	<6.0	<6.0	<6.0	30
MW-6D	20'- 22'	2,700	3,400,000	2,400,000 B	<29	12,000	24,000	150,000
CSX-1	46'- 48'	<28	<110	<11,000	<5.6	<5.6	<5.6	<5.6
CSX-1	48'- 50'	<28	<110	<11,000	<5.6	<5.6	<5.6	<5.6
CSX-2	44'- 46'	620	230,000	210,000	<27	<27	<27	<27
CSX-2	46'- 48'	460	180,000	150,000	<28	<28	<28	37

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL - SAMPLES (TCL ORGANIC COMPOUNDS)

PARAMETER	MW-9 (S-7) 20'- 22'	MW-9 (S-8) 22'- 24'	MW-10 (S-5) 6'- 8'	MW-10 (S-6) 10'- 12'	MW-11 (S-11) 18'- 20'	MW-11 (S-12) 20'- 22'
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Methylene chloride	290	480	920	200	<6,800	<6,600
Acetone	<15	520	130	130	<14,000	<13,000
Chloroform	<7.7	<6.7	<6.0	<6.6	<6,800	<6,600
2-Butanone	<15	<13	<12	<13	<14,000	<13,000
Benzene	60	100	<6.0	<6.6	<6,800	<6,600
Toluene	<7.7	27	<6.0	<6.6	<6,800	<6,600
Ethyl benzene	<7.7	68	<6.0	<6.6	58,000	62,000
Xylenes (Total)	<7.7	490	<6.0	<6.6	210,000	190,000
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Naphthalene	<250	<210	<190	840	14,000	24,000
2-Methylnaphthalene	<250	<210	<190	540	20,000	29,000
Acenaphthylene	<250	<210	<190	250	<360	<350
Acenaphthene	<250	<210	<190	2,200	<360	<350
Dibenzofuran	<250	<210	<190	1,600	<360	<350
Fluorene	<250	<210	<190	2,100	<360	<350
Phenanthrene	<250	<210	490	28,000	2,100	3,200
Anthracene	<250	<210	<190	4,900	<360	<350
Di-n-butylphthalate	<250	<210	<190	1,100	<360	<350
Fluoranthene	<250	<210	710	37,000	<360	<350
Pyrene	<250	<210	730	<210	580	860
Benzo(a)anthracene	<250	<210	330	13,000	<360	<350
Chrysene	<250	<210	390	12,000	<360	<350
bis(2-Ethylhexyl)phthalate	<250	<210	<190	<210	<360	790
Di-n-octylphthalate	<250	<210	<190	<210	<360	610
Benzo(b)fluoranthene	<250	<210	310	13,000	<360	<350
Benzo(k)fluoranthene	<250	<210	310	8,800	<360	<350

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-9 (S-7) 20'- 22'	MW-9 (S-8) 22'- 24'	MW-10 (S-5) 6'- 8'	MW-10 (S-6) 10'- 12'	MW-11 (S-11) 18'- 20'	MW-11 (S-12) 20'- 22'
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Benzo(a)pyrene	<250	350	290	11,000	<360	<350
Indeno(1,2,3-cd)pyrene	<250	<210	<190	7,000	<360	<350
Dibenzo(a,h)anthracene	<250	<210	<190	1,100	<360	<350
Benzo(g,h,i)perylene	<250	<210	<190	7,000	<360	<350
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
4,4'-DDT	<5.1	7.9	<3.9	<4.3	<7.3	<7.0
delta-BHC	<2.5	<2.1	<1.9	<2.1	<3.6	<3.5
Endrin	<5.1	<4.4	<3.9	<4.3	<7.3	<7.0

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-12 (S-19) 16'- 18'	MW-12 (S-20) 18'- 20'	MW-13 (S-13) 16'- 18'	MW-13 (S-14) 18'- 20'	MW-14 (S-9) 18'- 20'	MW-14 (S-10) 20'- 22'
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Methylene chloride	<680	<670	39	17	<5.5	<700
Acetone	10,000	7,400	14	90	<11	<1,400
Chloroform	<680	<670	<5.6	<5.6	<5.5	<700
2-Butanone	<1,400	<1,400	<11	<11	<11	<1,400
Benzene	<680	<670	<5.6	<5.6	<5.5	26,000
Toluene	<680	<670	<5.6	<5.6	<5.5	17,000
Ethyl benzene	<680	<670	<5.6	<5.6	6,300	120,000
Xylenes (Total)	<680	<670	<5.6	<5.6	29,000	690,000
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Naphthalene	5,900	12,000	<180	<180	3,600	4,400
2-Methylnaphthalene	15,000	22,000	<180	<180	4,400	51,000
Acenaphthylene	<180	<170	<180	<180	<180	<1,800
Acenaphthene	<180	<170	<180	<180	<180	<1,800
Dibenzofuran	<180	<170	<180	<180	<180	<1,800
Fluorene	590	790	<180	<180	<180	<1,800
Phenanthrene	470	740	<180	<180	440	2,900
Anthracene	<180	<170	<180	<180	<180	<1,800
Di-n-butylphthalate	<180	<170	<180	<180	230	6,600
Fluoranthene	290	380	<180	<180	<180	<1,800
Pyrene	<180	300	<180	<180	<180	<1,800
Benzo(a)anthracene	<180	<170	<180	<180	<180	<1,800
bis(2-Ethylhexyl)phthalate	<180	<170	<180	430	<180	<1,800
Di-n-octylphthalate	<180	<170	<180	<180	<180	<1,800
Benzo(b)fluoranthene	<180	<170	<180	<180	<180	<1,800
Benzo(k)fluoranthene	<180	<170	<180	<180	<180	<1,800

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-12 (S-19) 16'- 18'	MW-12 (S-20) 18'- 20'	MW-13 (S-13) 16'- 18'	MW-13 (S-14) 18'- 20'	MW-14 (S-9) 18'- 20'	MW-14 (S-10) 20'- 22'
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Benzo(a)pyrene	<180	<170	<180	<180	<180	<1,800
Indeno(1,2,3-cd)pyrene	<180	<170	<180	<180	<180	<1,800
Dibenzo(a,h)anthracene	<180	<170	<180	<180	<180	<1,800
Benzo(g,h,i)perylene	<180	<170	<180	<180	<180	<1,800
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
4,4'-DDT	<3.6	<3.6	<3.7	<3.7	<3.6	<3.7
delta-BHC	<1.8	<1.7	<1.8	<1.8	<1.8	<1.8
Endrin	<3.6	<3.6	<3.7	<3.7	<3.6	<3.7

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-15 (S-17) 14'- 16'	MW-15 (S-18) 20'- 22'	MW-16 (S-15) 14'- 16'	MW-16 (S-16) 20'- 22'	MW-17 (S-21) 16'- 18'	MW-17 (S-22) 18'- 20'
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Methylene chloride	7.3	<7,200	89	130	<6.0	<5.1
Acetone	110	<15,000	55	170	<12	33
Chloroform	<6.1	<7,200	<5.4	<5.6	<6.0	<5.1
2-Butanone	<12	<15,000	<11	<11	<12	<10
Benzene	<6.1	<7,200	<5.4	<5.6	<6.0	<5.1
Toluene	<6.1	<7,200	<5.4	<5.6	<6.0	<5.1
Ethyl benzene	<6.1	76,000	<5.4	<5.6	<6.0	<5.1
Xylenes (Total)	<6.1	220,000	<5.4	<5.6	<6.0	<5.1
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Naphthalene	<200	51,000	<170	<180	<190	<160
2-Methylnaphthalene	<200	48,000	<170	<180	<190	<160
Acenaphthylene	<200	<400	<170	<180	<190	<160
Acenaphthene	<200	<400	<170	<180	<190	<160
Dibenzofuran	<200	570	<170	<180	<190	<160
Fluorene	<200	840	<170	<180	<190	<160
Phenanthrene	<200	1,300	<170	<180	<190	<160
Anthracene	<200	<400	<170	<180	<190	<160
Di-n-butylphthalate	<200	<400	<170	<180	<190	<160
Fluoranthene	<200	<400	<170	<180	<190	<160
Pyrene	<200	<400	<170	<180	<190	<160
Benzo(a)anthracene	<200	<400	<170	<180	<190	<160
Chrysene	<200	<400	<170	<180	<190	<160
bis(2-Ethylhexyl)phthalate	<200	790	<170	<180	490	<160
Di-n-octylphthalate	<200	<400	<170	<180	<190	<160
Benzo(b)fluoranthene	<200	<400	<170	<180	<190	<160

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-15 (S-17) 14'- 16'	MW-15 (S-18) 20'- 22'	MW-16 (S-15) 14'- 16'	MW-16 (S-16) 20'- 22'	MW-17 (S-21) 16'- 18'	MW-17 (S-22) 18'- 20'
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Benzo(k)fluoranthene	<200	<400	<170	<180	<190	<160
Benzo(a)pyrene	<200	<400	<170	<180	<190	<160
Indeno(1,2,3-cd)pyrene	<200	<400	<170	<180	<190	<160
Dibenzo(a,h)anthracene	<200	<400	<170	<180	<190	<160
Benzo(g,h,i)perylene	<200	<400	<170	<180	<190	<160
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
4,4'-DDT	<4.0	<3.8	<3.6	<3.7	<3.9	<3.3
delta-BHC	<2.0	8.1	<1.7	<1.8	<1.9	<1.6
Endrin	<4.0	8.1	<3.6	<3.7	<3.9	<3.3

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-18 (S-23) 14'- 16'	MW-19 (S-1) 8'- 10'	MW-19 (S-2) 18'- 20'	MW-20 (S-3) 4'- 6'	MW-20 (S-4) 20'- 22'	MW-6D (S-25) 18'- 20'
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Methylene chloride	<6.1	7.3	<6.0	550	13	<6.0
Acetone	30	<12	<12	220	<11	110
Chloroform	<6.1	<6.1	<6.0	<5.9	<5.7	<6.0
2-Butanone	<12	<12	<12	<12	<11	21
Benzene	<6.1	<6.1	<6.0	9.4	<5.7	<6.0
Toluene	<6.1	<6.1	<6.0	<5.9	<5.7	<6.0
Ethyl benzene	<6.1	<6.1	<6.0	<5.9	<5.7	<6.0
Xylenes (Total)	<6.1	<6.1	<6.0	<5.9	<5.7	30
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Naphthalene	<200	<200	<190	<190	<180	<190
2-Methylnaphthalene	<200	<200	<190	<190	<180	<190
Acenaphthylene	<200	<200	<190	<190	<180	<190
Acenaphthene	<200	<200	<190	<190	<180	<190
Dibenzofuran	<200	<200	<190	<190	<180	<190
Fluorene	<200	<200	<190	<190	<180	<190
Phenanthrene	<200	<200	<190	<190	<180	<190
Anthracene	<200	<200	<190	<190	<180	<190
Di-n-butylphthalate	<200	<200	<190	<190	<180	<190
Fluoranthene	<200	<200	<190	270	<180	<190
Pyrene	<200	<200	<190	240	<180	<190
Benzo(a)anthracene	<200	<200	<190	<190	<180	<190
Chrysene	<200	<200	<190	<190	<180	<190
bis(2-Ethylhexyl)phthalate	<200	<200	<190	<190	360	600
Di-n-octylphthalate	<200	<200	<190	<190	<180	<190
Benzo(b)fluoranthene	<200	<200	<190	<190	<180	<190

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-18 (S-23) 14'- 16'	MW-19 (S-1) 8'- 10'	MW-19 (S-2) 18'- 20'	MW-20 (S-3) 4'- 6'	MW-20 (S-4) 20'- 22'	MW-6D (S-25) 18'- 20'
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Benzo(k)fluoranthene	<200	<200	<190	<190	<180	<190
Benzo(a)pyrene	<200	<200	<190	<190	<180	<190
Indeno(1,2,3-cd)pyrene	<200	<200	<190	<190	<180	<190
Dibenzo(a,h)anthracene	<200	<200	<190	<190	<180	<190
Benzo(g,h,i)perylene	<200	<200	<190	<190	<180	<190
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
4,4'-DDT	<4.0	<4.0	<3.9	<3.9	<3.8	<3.9
delta-BHC	<2.0	<2.0	<1.9	<1.9	<1.8	<1.9
Endrin	<4.0	<4.0	<3.9	<3.9	<3.8	<3.9

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-6D (S-26) 20'- 22'	CSX-1 (S-29) 46'- 48'	CSX-1 (S-30) 48'- 50'	CSX-2 (S-27) 44'- 46'	CSX-2 (S-28) 46'- 48'
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)					
Methylene chloride	<29	<5.6	<5.6	<27	<28
Acetone	51	220	200	130	160
Chloroform	<29	<5.6	<5.6	<27	<28
2-Butanone	<59	20	<11	<55	<56
Benzene	<29	<5.6	<5.6	<27	<28
Toluene	12,000	<5.6	<5.6	<27	<28
Ethyl benzene	24,000	<5.6	<5.6	<27	<28
Xylenes (Total)	150,000	<5.6	<5.6	<27	37
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)					
Naphthalene	9,500	<180	<180	660	790
2-Methylnaphthalene	2,800	<180	<180	420	360
Acenaphthylene	<190	<180	<180	<180	<180
Acenaphthene	<190	<180	<180	<180	<180
Dibenzofuran	<190	<180	<180	<180	<180
Fluorene	<190	<180	<180	<180	<180
Phenanthrene	220	<180	<180	<180	<180
Anthracene	<190	<180	<180	<180	<180
Di-n-butylphthalate	<190	<180	<180	<180	330
Fluoranthene	<190	<180	<180	<180	<180
Pyrene	<190	<180	<180	<180	<180
Benzo(a)anthracene	<190	<180	<180	<180	<180
Chrysene	<190	<180	<180	<180	<180
bis(2-Ethylhexyl)phthalate	240	<180	<180	<180	<180
Di-n-octylphthalate	<190	<180	<180	<180	<180
Benzo(b)fluoranthene	<190	<180	<180	<180	<180

TABLE 4-9
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-6D (S-26) 20'- 22'	CSX-1 (S-29) 46'- 48'	CSX-1 (S-30) 48'- 50'	CSX-2 (S-27) 44'- 46'	CSX-2 (S-28) 46'- 48'
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)					
Benzo(k)fluoranthene	<190	<180	<180	<180	<180
Benzo(a)pyrene	<190	<180	<180	<180	<180
Indeno(1,2,3-cd)pyrene	<190	<180	<180	<180	<180
Dibenzo(a,h)anthracene	<190	<180	<180	<180	<180
Benzo(g,h,i)perylene	<190	<180	<180	<180	<180
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)					
4,4'-DDT	<3.9	<3.7	<3.7	<3.6	<3.7
delta-BHC	<1.9	<1.8	<1.8	<1.8	<1.8
Endrin	<3.9	<3.7	<3.7	<3.6	<3.7

TABLE 4-10
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TAL INORGANIC COMPOUNDS)

INORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppm)						
PARAMETER (TOTAL)	MW-9 (S-7) 20'- 22'	MW-9 (S-8) 22'- 24'	MW-10 (S-5) 6'- 8'	MW-10 (S-6) 10'- 12'	MW-11 (S-11) 18'- 20'	MW-11 (S-12) 20'- 22'
Cyanide	<0.77	<0.67	<0.60	<0.66	<0.55	0.64
Aluminum	20,000	15,000	2,700	7,600	4,700	4,600
Antimony	1,500	910	700	1,100	<11	<11
Arsenic	2.2	1.6	14	11	1.5	1.7
Barium	150	130	200	430	13	15
Beryllium	<3.8	<3.3	<3.0	<3.3	<0.55	<0.53
Cadmium	<3.8	<3.3	<3.0	<3.3	<0.55	<0.53
Calcium	2,200	1,300	35,000	14,000	250	240
Chromium	38	28	15	13	14	12
Cobalt	11	6.7	21	7.9	3.3	3.2
Copper	12	8.0	610	100	8.8	8.5
Iron	22,000	16,000	29,000	11,000	5,400	5,500
Lead	71	12	600	1,200	5.7	5.0
Magnesium	4,300	3,500	3,500	4,200	1,300	1,200
Manganese	290	190	250	240	29	41
Mercury	<0.38	<0.33	1.3	1.1	<0.27	<0.27
Nickel	<15.0	20	150	9.2	11	9.6
Potassium	1,300	910	500	1,100	250	290
Selenium	<0.31	<0.27	0.36	0.39	<0.22	<0.21
Sodium	290	240	430	500	52	63
Thallium	<0.38	<0.33	<0.30	0.39	<0.27	<0.27
Vanadium	42	33	13	25	7.4	8.7
Zinc	58	45	210	220	26	24

TABLE 4-10
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

INORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppm)						
PARAMETER (TOTAL)	MW-12 (S-19) 16'- 18'	MW-12 (S-20) 18'- 20'	MW-13 (S-13) 16'- 18'	MW-13 (S-14) 18'- 20'	MW-14 (S-9) 18'- 20'	MW-14 (S-10) 20'- 22'
Cyanide	<0.55	<0.54	<0.56	<0.56	<0.55	<0.56
Aluminum	6,900	3,500	3,000	6,400	7,000	7,500
Antimony	<11	<11	<11	<11	1,400	1,200
Arsenic	0.77	0.98	2.1	2.2	1.1	1.8
Barium	30	15	19	22	25	38
Beryllium	0.55	<0.54	7.0	5.8	<2.7	<2.8
Cadmium	<0.55	<0.54	<0.56	<0.56	<2.7	<2.8
Calcium	750	220	630	790	510	390
Chromium	18	8.7	14	17	15	15
Cobalt	8.8	4.3	5.8	8.1	8.8	12
Copper	NA	NA	4.4	13	11	13
Iron	15,000	6,800	32,000	25,000	22,000	13,000
Lead	4.0	3.8	2.6	1.9	4.9	4.5
Magnesium	1,300	650	630	2,100	2,200	1,700
Manganese	190	41	470	610	300	300
Mercury	<0.27	<0.27	<0.28	<0.28	<0.27	<0.28
Nickel	11	5.4	7.8	13	<11	12
Potassium	570	200	160	440	730	790
Selenium	<0.22	<0.22	<0.22	<0.22	<0.22	<0.22
Sodium	56	59	120	120	130	120
Thallium	<0.27	<0.27	<0.28	<0.28	<0.27	<0.28
Vanadium	25	11	6.6	17	21	17
Zinc	30	15	20	36	31	35

TABLE 4-10
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

	INORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppm)					
PARAMETER (TOTAL)	MW-15 (S-17) 14'- 16'	MW-15 (S-18) 20'- 22'	MW-16 (S-15) 14'- 16'	MW-16 (S-16) 20'- 22'	MW-17 (S-21) 16'- 18'	MW-17 (S-22) 18'- 20'
Cyanide	<0.61	<0.58	<0.54	<0.56	<0.60	<0.51
Aluminum	15,000	5,100	6,600	5,200	7,900	3,700
Antimony	<12	<12	<11	<11	<12	<10
Arsenic	2.9	9.1	2.1	1.1	0.95	1.1
Barium	50	21	17	15	26	16
Beryllium	0.98	<0.58	<0.54	<0.56	<0.60	<0.51
Cadmium	<0.61	<0.58	<0.54	<0.56	<0.60	<0.51
Calcium	820	270	230	270	580	230
Chromium	17	24	22	12	24	17
Cobalt	8.5	8.1	11	6.7	11	8.1
Copper	20	8.1	9.8	6.7	13	8.1
Iron	32,000	50,000	30,000	17,000	14,000	14,000
Lead	12	5.5	5.1	3.4	6.0	3.8
Magnesium	2,800	880	800	600	1,700	640
Manganese	510	120	84	220	180	170
Mercury	0.37	<0.29	<0.27	<0.28	<0.30	<0.25
Nickel	20	15	9.8	4.5	12	8.1
Potassium	910	400	290	380	390	200
Selenium	<0.24	<0.23	<0.22	<0.22	<0.24	<0.20
Sodium	57	72	99	64	58	52
Thallium	<0.30	<0.29	<0.27	<0.28	<0.30	<0.25
Vanadium	22	12	18	12	35	15
Zinc	55	30	22	16	30	16

TABLE 4-10
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

INORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppm)						
PARAMETER (TOTAL)	MW-18 (S-23) 14'- 16'	MW-19 (S-1) 8'- 10'	MW-19 (S-2) 18'- 20'	MW-20 (S-3) 4'- 6'	MW-20 (S-4) 20'- 22'	MW-6D (S-25) 18'- 20'
Cyanide	4.3	<0.61	<0.60	<0.59	<0.57	0.83
Aluminum	12,000	11,000	5,000	11,000	5,000	9,500
Antimony	<12	1,300	1,300	2,100	850	<12
Arsenic	2.8	4.5	2.1	2.6	4.1	2.3
Barium	37	44	54	190	33	44
Beryllium	<0.61	<3.0	<3.0	<2.9	<2.8	0.71
Cadmium	<0.61	<3.0	<3.0	<2.9	<2.8	0.71
Calcium	870	1,300	1,300	21,000	2,000	1,100
Chromium	20	18	14	19	16	29
Cobalt	4.9	6.1	11	18	5.7	7.1
Copper	9.8	8.5	<6.0	52	13	23
Iron	18,000	21,000	37,000	25,000	27,000	35,000
Lead	8.0	7.4	4.0	74	22	20
Magnesium	2,400	1,800	860	6,800	1,700	1,800
Manganese	84	98	2,100	490	69	110
Mercury	<0.30	<0.30	<0.30	0.59	<0.28	<0.30
Nickel	8.5	15	19	22	14	20
Potassium	730	730	480	1,200	450	650
Selenium	<0.24	<0.24	<0.24	0.35	<0.23	<0.95
Sodium	320	<150	<150	220	<140	90
Thallium	<0.30	<0.30	<0.30	<0.29	<0.28	<0.60
Vanadium	23	26	13	26	26	30
Zinc	30	38	37	210	36	62

TABLE 4-10
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC SOIL SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

INORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppm)					
PARAMETER (TOTAL)	MW-6D (S-26) 20'- 22'	CSX-1 (S-29) 46'- 48'	CSX-1 (S-30) 48"- 50"	CSX-2 (S-27) 44'- 46"	CSX-2 (S-28) 46'- 48'
Cyanide	0.71	<0.56	<0.56	<0.55	<0.56
Aluminum	8,600	2,500	6,900	7,100	6,500
Antimony	<12	<22	<22	<22	<22
Arsenic	1.6	<0.45	<0.90	2.0	1.3
Barium	36	13	46	23	18
Beryllium	0.59	NA	NA	<1.1	<1.1
Cadmium	<0.59	<1.1	<1.1	<1.1	<1.1
Calcium	850	220	1,100	590	600
Chromium	24	7.9	22	33	29
Cobalt	9.4	3.4	6.7	9.9	9.0
Copper	16	5.6	11	16	13
Iron	27,000	4,400	13,000	22,000	19,000
Lead	13	7.3	6.0	5.8	5.3
Magnesium	1,900	570	1,500	1,100	920
Manganese	140	96	180	110	93
Mercury	<0.29	<0.28	<0.28	<0.27	<0.28
Nickel	16	<4.5	13	14	13
Potassium	740	220	450	370	330
Selenium	<0.94	<1.1	<0.90	<1.1	<0.90
Sodium	67	35	79	68	55
Thallium	<0.59	<0.56	<0.56	<0.55	<0.56
Vanadium	32	9.0	20	34	27
Zinc	48	13	35	34	29

TAL - Target Analyze List

TABLE 4-11
SYNOPTIC GROUNDWATER AND FREE PRODUCT ELEVATION DATA
DPSC, PHILADELPHIA, PENNSYLVANIA
OCTOBER 21, 1994

WELL ID. NO.	ELEVATION AT TOC (MEASURING POINT) ABOVE M.S.L.(FT.)	DEPTH TO PRODUCT (FT.)	DEPTH TO WATER (FT.)	PRODUCT LAYER THICKNESS (FT.)	ADJUSTED WATER TABLE ELEVATION* (FT.)
MW-1	20.78	NA	18.65	NA	2.13
MW-2	21.87	20.40	21.15	0.75	1.28
MW-3	20.34	18.65	20.60	1.95	1.20
MW-4	20.61	18.98	20.54	1.56	1.24
MW-5	20.33	18.87	20.14	1.27	1.14
MW-6	21.18	19.63	20.78	1.15	1.26
MW-7	19.31	17.42	19.28	1.86	1.43
MW-1A	21.33	19.35	19.78	0.43	1.87
MW-2A	21.13	NA	18.80	NA	2.33

* Based on the free product specific gravity of 0.75

NA - Not Applicable

TABLE 4-12
SYNOPTIC GROUNDWATER AND FREE PRODUCT ELEVATION DATA
DPSC, PHILADELPHIA, PENNSYLVANIA
DECEMBER 14, 1994

WELL ID. NO.	ELEVATION AT TOC (MEASURING POINT) ABOVE M.S.L. (FT.)	DEPTH TO PRODUCT (FT.)	DEPTH TO WATER (FT.)	PRODUCT LAYER THICKNESS (FT.)	ADJUSTED WATER TABLE ELEVATION* (FT.)
MW-1	20.78	NA	19.30	NA	1.48
MW-2	21.87	20.03	21.95	1.92	1.36
MW-3	20.34	19.30	21.20	1.90	0.57
MW-4	20.61	19.66	21.29	1.63	0.54
MW-5	20.33	19.37	20.78	1.41	0.61
MW-6	21.18	20.40	21.45	1.05	0.52
MW-7	19.31	18.08	20.24	2.16	0.69
MW-1A	21.33	20.06	20.55	0.49	1.15
MW-2A	21.13	NA	19.05	NA	2.08

*** Based on free product specific gravity of 0.75**

NA - Not Applicable

TABLE 4-13
SYNOPTIC GROUNDWATER AND FREE PRODUCT ELEVATION DATA
DPSC, PHILADELPHIA, PENNSYLVANIA
MARCH 1 AND 2, 1995

WELL ID. NO.	ELEVATION AT TOC (MEASURING POINT) ABOVE M.S.L. (FT.)	DEPTH TO PRODUCT (FT.)	DEPTH TO WATER (FT.)	PRODUCT LAYER THICKNESS (FT.)	ADJUSTED WATER TABLE ELEVATION* (FT.)
MW-1	20.78	NA	19.29	0	1.49
MW-2	21.81	20.89	21.84	0.95	0.68
MW-3	20.34	19.06	21.02	1.96	0.79
MW-4	20.61	19.34	21.00	1.66	0.86
MW-5	20.33	18.77	20.76	1.99	1.06
MW-6	21.18	20.00	21.71	1.71	0.75
MW-6D	21.45	NA	20.76	0	0.69
MW-7	19.31	18.04	19.97	1.93	0.79
MW-1A	21.33	20.06	20.34	0.28	1.20
MW-2A	21.13	NA	19.12	0	2.01
MW-9	20.08	19.12	19.16	0.04	0.95
MW-10	16.56	NA	15.01	0	1.55
MW-11	20.21	18.92	20.59	1.67	0.87
MW-12	19.54	NA	17.85	0	1.69
MW-13	20.38	NA	18.69	0	1.69
MW-14	20.27	18.83	20.40	1.57	1.05
MW-15	22.58	21.28	22.43	1.15	1.01
MW-16	20.36	NA	18.78	0	1.58
MW-17	22.25	NA1	19.91	0	2.34
MW-18	17.93	NA	15.92	0	2.01
MW-19	23.12	NA	18.00	0	5.12
MW-20	25.66	NA	20.50	0	5.16
MW-20D	25.80	NA	24.56	0	1.24
MW-CSX-1	51.32	NA	45.73	0	5.59
MW-CSX-2	46.70	NA	46.31	0	0.39

* Based on product specific gravity of 0.75

NA - Not Applicable

TABLE 4-14
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC FREE PRODUCT SAMPLES (GRO, DRO, AND BTEX)

SAMPLE NO.	SAMPLE DATE	SAMPLE PARAMETERS					
		GRO (ppb)	DRO (ppb)	BENZENE (ppb)	ETHYL BENZENE (ppb)	TOLUENE (ppb)	TOTAL XYLENES (ppb)
MW-15 (FP)	03/01/94	330,000,000	130,000,000	1,700	4,800	860	11,000
MW-2 (FP)	03/01/94	360,000,000	160,000,000	2,700	4,900	2,200	12,000
MW-3 (FP)	03/01/94	30,000,000	140,000,000	3,000	4,100	1,500	9,500
MW-14 (FP)	03/01/94	370,000,000	150,000,000	3,700	4,200	610	8,200
MW-11 (FP)	03/01/94	360,000,000	120,000,000	2,800	2,600	<500	5,000
MW-4 (FP)	03/01/94	500,000,000	150,000,000	1,400	6,500	3,100	18,000
MW-6 (FP)	03/01/94	390,000,000	150,000,000	6,100	5,700	6,100	17,000
MW-7 (FP)	03/01/94	340,000,000	130,000,000	1,600	5,100	<1,000	3,700
MW-1A (FP)	03/01/94	270,000,000	190,000,000	<1,000	4,800	<1,000	8,500
MW-5 (FP)	03/02/94	380,000,000	150,000,000	<1,000	4,700	<1,000	10,000
MW-9 (FP)	03/02/94	280,000,000	150,000,000	<1,000	3,000	<1,000	4,400

NOTE: Laboratory could not perform TPH analyses on free product samples.

TABLE 4-15
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TPH, GRO, DRO, AND BTEX)

WELL NO.	SAMPLE DATE	SAMPLE PARAMETERS						
		TPH (ppm)	GRO (ppm)	DRO (ppm)	BENZENE (ppb)	TOLUENE (ppb)	ETHYL BENZENE (ppb)	TOTAL XYLENES (ppb)
MW-1A	3/7/95	360*	90,000	78,000	6,500	520	1,000	3,300
MW-2A	3/8/95	<1.0*	<100	<500	<5.0	<5.0	<5.0	<5.0
MW-1	3/8/95	6.0*	9,200	2,000	<5.0	16	77	280
MW-2	3/8/95	85*	28,000	50,000	1,100	960	1,200	2,200
MW-3	3/9/95	30	55,000	48,000	32,000	3,200	1,400	6,300
MW-4	3/9/95	280	26,000	110,000	9,100	1,300	540	3,500
MW-5	3/10/95	160	25,000	20,000	500	340	550	1,800
MW-6	3/9/95	69	69,000	68,000	37,000	12,000	1,400	7,100
MW-7	3/10/95	65	23,000	29,000	4,200	140	590	670
MW-9	3/15/95	39	22,000	11,000	9,600	220	490	1,600
MW-10	3/15/95	<1.0	290	<500	13	<5.0	<5.0	<5.0
MW-11	3/14/95	230	41,000	95,000	9,900	200	830	2,500
MW-12	3/8/95	99*	27,000	44,000	260	140	740	600
MW-13	3/8/95	8.0*	13,000	4,800	160	260	1,200	2,300
MW-14	3/10/95	340	160,000	170,000	14,000	660	1,200	3,700
MW-15	3/14/95	180	170,000	96,000	4,600	2,800	2,500	6,300
MW-16	3/6/95	<1.0*	230	<500	<5.0	<5.0	<5.0	<5.0
MW-17	3/7/95	<1.0*	<100	<500	<5.0	<5.0	<5.0	<5.0
MW-18	3/7/95	<1.0*	<100	<500	<5.0	<5.0	<5.0	<5.0
MW-19	3/7/95	2.0*	940	<500	<5.0	<5.0	<5.0	<5.0
MW-20	3/6/95	<1.0*	120	<500	<5.0	<5.0	<5.0	<5.0
MW-6D	3/15/95	<1.0	820	<500	590	<5.0	<5.0	<5.0
MW-20D	3/15/95	<1.0	<100	<500	<5.0	<5.0	<5.0	<5.0
CSX-1	3/14/95	<1.0	<100	<500	<5.0	<5.0	<5.0	<5.0
CSX-2	3/15/95	4.0	6,400	2,700	87	7.0	43	230
EB-1	3/10/95	<1.0	<100	<500	<5.0	<5.0	<5.0	<5.0
EB-2	3/15/95	<1.0	<100	<500	<5.0	<5.0	<5.0	<5.0

* Biased low (12% LCS recovery)

TABLE 4-16
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TCL ORGANIC COMPOUNDS)

VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
PARAMETER	MW-1A	MW-2A	MW-1	MW-2	MW-3	MW-4
Methylene chloride	<25	<5	<5	<50	<50	<50
Acetone	<50	<10	<10	<100	<100	<100
Benzene	6,500	<5	<5	1,100	32,000	9,100
Tetrachloroethene	<25	6	<5	<50	<50	<50
Toluene	520	<5	16	960	3,200	1,300
Chlorobenzene	<25	<5	<5	<50	<50	<50
Ethyl benzene	1,000	<5	77	1,200	1,400	540
Styrene	<25	<5	<5	<50	<50	<50
Xylenes (Total)	3,300	<5	280	2,200	6,300	3,500
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Phenol	<100	<10	<10	58	68	<10
2-Methylphenol	<100	<10	<10	<10	<10	<10
4-Methylphenol	<100	<10	<10	<10	<10	17
2,4-Dimethylphenol	<100	<10	<10	14	<10	<10
Benzoic acid	<500	<50	<50	<50	49	<50
Naphthalene	890	<10	<10	400	390	300
2-Methylnaphthalene	370	<10	<10	79	96	97
Phenanthrene	<100	<10	<10	<10	10	13
Di-n-butylphthalate	<100	11 B	12 B	<10	<10	<10
Pyrene	<100	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)phthalate	<100	<10	<10	27	27	17
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
alpha-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDE	<0.10	<0.10	<0.10	<0.10	<0.10	0.69

TABLE 4-16
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
PARAMETER	MW-5	MW-6	MW-50[1]	MW-7	MW-9	MW-10
Methylene chloride	31	<50	<50	<50	<5	<5
Acetone	110	<100	<100	<100	<10	<10
Benzene	500	37,000	38,000	4,200	9,600	13
Tetrachloroethene	<25	<50	<50	<50	<5	<5
Toluene	340	12,000	12,000	140	220	<5
Chlorobenzene	<25	<50	<50	<50	<5	<5
Ethyl benzene	550	1,400	1,600	590	490	<5
Styrene	<25	63	<50	<50	<5	<5
Xylenes (Total)	1,800	7,100	7,400	670	1,600	<5
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Phenol	<10	<10	69	110	<10	<10
2-Methylphenol	<10	<10	13	<10	<10	<10
4-Methylphenol	<10	<10	17	<10	<10	<10
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10
Benzoic acid	<50	<50	<50	<50	<50	<50
Naphthalene	300	560	250	170	140	<10
2-Methylnaphthalene	58	110	42	26	19	<10
Phenanthrene	<10	11	<10	<10	<10	<10
Di-n-butylphthalate	<10	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
alpha-BHC	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05
beta-BHC	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05
delta-BHC	0.50	<0.05	<0.05	<0.10	<0.05	<0.05
Endosulfan sulfate	<0.10	<0.10	<0.01	<0.02	<0.10	<0.10
4,4'-DDE	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10

TABLE 4-16
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
PARAMETER	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16
Methylene chloride	<25	62	<25	<250	<25	<5
Acetone	<50	<100	<50	<500	<50	51
Benzene	9,900	260	160	14,000	4,600	<5
Tetrachloroethene	<25	<50	<25	<250	<25	<5
Toluene	200	140	260	660	2,800	<5
Chlorobenzene	<25	<50	49	<250	<25	<5
Ethyl benzene	830	740	1,200	1,200	2,500	<5
Styrene	<25	<50	<25	<250	<25	<5
Xylenes (Total)	2,500	600	2,300	3,700	6,300	<5
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Phenol	<10	<10	<10	<100	<10	<10
2-Methylphenol	<10	<10	<10	<100	<10	<10
4-Methylphenol	<10	<10	<10	<100	<10	<10
2,4-Dimethylphenol	<10	<10	<10	<100	<10	<10
Benzoic acid	<50	<50	<50	<500	<50	<50
Naphthalene	690	370	160	1,400	1,500	<10
2-Methylnaphthalene	170	65	<10	420	320	<10
Phenanthrene	44	15	<10	100	21	<10
Di-n-butylphthalate	<10	<10	11 B	<100	<10	<10
Pyrene	12	<10	<10	<100	<10	<10
bis(2-Ethylhexyl)phthalate	<10	<10	<10	<100	20	<10
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
alpha-BHC	0.13	<0.05	<0.05	<0.10	<0.05	<0.05
beta-BHC	<0.05	0.07	<0.05	<0.10	<0.05	<0.05
delta-BHC	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05
Endosulfan sulfate	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10
4,4'-DDE	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10

TABLE 4-16
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-17	MW-18	MW-19	MW-20	MW-6D	MW-20D
VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Methylene chloride	<5	<5	<5	<5	<5	<5
Acetone	<10	<10	<10	<10	15	<10
Benzene	<5	<5	<5	<5	590	<5
Tetrachloroethene	<5	<5	<5	<5	<5	<5
Toluene	<5	<5	<5	<5	<5	<5
Chlorobenzene	<5	<5	<5	<5	<5	<5
Ethyl benzene	<5	<5	<5	<5	<5	<5
Styrene	<5	<5	<5	<5	<5	<5
Xylenes (Total)	<5	<5	<5	<5	<5	<5
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)						
Phenol	<10	<10	<10	<10	16	<10
2-Methylphenol	<10	<10	<10	<10	<10	<10
4-Methylphenol	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10
Benzoic acid	<50	<50	<50	<50	<50	<50
Naphthalene	<10	<10	<10	<10	<10	<10
2-Methylnaphthalene	<10	<10	<10	<10	<10	<10
Phenanthrene	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	<10	<10	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10	<10	<10
bis(2-Ethylhexyl)phthalate	<10	46	<10	<10	<10	<10
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)						
alpha-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	<0.10	<0.10	<0.10	<0.10	0.19	0.14
4,4'-DDE	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

TABLE 4-16
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TCL ORGANIC COMPOUNDS)
(continued)

VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)				
PARAMETER	CSX-1	CSX-2	EB-1	EB-2
Methylene chloride	<5	<5	<5	<5
Acetone	<10	<10	<10	<10
Benzene	<5	87	<5	<5
Tetrachloroethene	<5	<5	<5	<5
Toluene	<5	7.0	<5	<5
Chlorobenzene	<5	<5	<5	<5
Ethyl benzene	<5	43	<5	<5
Styrene	<5	<5	<5	<5
Xylenes (Total)	<5	230	<5	<5
SEMI-VOLATILE ORGANIC COMPOUNDS-ANALYTICAL RESULTS (ppb)				
Phenol	<10	<10	<10	<10
2-Methylphenol	<10	<10	<10	<10
4-Methylphenol	<10	<10	<10	<10
2,4-Dimethylphenol	<10	<10	<10	<10
Benzoic acid	<50	<50	<50	<50
Naphthalene	<10	70	<10	<10
2-Methylnaphthalene	<10	14	<10	<10
Phenanthrene	<10	<10	<10	<10
Di-n-butylphthalate	<10	<10	<10	<10
Pyrene	<10	<10	<10	<10
bis(2-Ethylhexyl)phthalate	<10	<10	<10	31
PESTICIDE/PCB-ANALYTICAL RESULTS (ppb)				
alpha-BHC	<0.05	<0.05	<0.05	<0.05
beta-BHC	<0.05	<0.05	<0.05	<0.05
delta-BHC	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	<0.10	<0.10	<0.10	0.13
4,4'-DDE	<0.10	<0.10	<0.10	<0.10

[1] (Duplicate OF MW-6)

TCL Target Compound List

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)

PARAMETER	MW-1A	MW-2A	MW-1	MW-2	MW-3	MW-4
INORGANIC COMPOUNDS (TOTAL) - ANALYTICAL RESULTS (ppm)						
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Aluminum	3.9	5.4	8.6	1.9	0.60	9.0
Arsenic	0.033	0.008	0.010	0.006	0.010	0.009
Barium	3.9	0.13	0.23	0.04	0.29	0.48
Cadmium	<0.01	0.05	<0.01	<0.01	<0.01	0.01
Calcium	29	95	68	54	47	150
Chromium	<0.02	0.03	<0.02	<0.02	<0.02	0.10
Cobalt	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	0.04	<0.02	<0.02	<0.02	0.15
Iron	26	28	54	68	61	92
Lead	0.010	0.031	0.015	<0.005	<0.005	0.22
Magnesium	48	82	30	17	84	46
Manganese	0.59	5.4	3.1	4.0	0.78	3.8
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Potassium	<1.0	5.0	6.0	3.0	1.0	9.0
Sodium	51	110	67	10	99	270
Vanadium	0.02	0.02	0.02	<0.01	<0.01	0.05
Zinc	0.14	0.41	0.04	0.03	0.03	0.60
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Aluminum	<0.10	<0.10	<0.10	<0.10	0.20	0.60
Arsenic	0.011	<0.004	<0.004	<0.004	0.005	<0.004
Barium	0.05	0.08	0.12	0.02	0.28	0.46
Calcium	30	100	65	53	47	160
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-1A	MW-2A	MW-1	MW-2	MW-3	MW-4
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Iron	0.81	<0.04	6.1	15	27	39
Lead	<0.005	<0.005	0.007	<0.005	<0.005	0.094
Magnesium	48	89	32	17	88	43
Manganese	0.55	4.9	3.0	4.0	0.83	3.7
Potassium	<1.0	5.0	6.0	4.0	1.0	9.0
Sodium	52	120	71	10	100	280
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.07	0.04	0.02	0.01	0.01	0.28

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-5	MW-6	*MW-50	MW-7	MW-9	MW-10
INORGANIC COMPOUNDS (TOTAL) - ANALYTICAL RESULTS (ppm)						
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aluminum	1.9	0.3	0.02	1.3	13	2.0
Arsenic	0.006	0.010	0.012	0.082	0.011	<0.004
Barium	0.03	0.24	0.25	0.10	0.19	0.76
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium	29	120	120	89	62	120
Chromium	<0.02	<0.02	<0.02	<0.02	0.02	<0.02
Cobalt	0.02	<0.02	<0.02	<0.02	0.05	<0.02
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	8.9	67	68	59	70	10
Lead	<0.005	<0.005	<0.005	<0.005	0.01	0.014
Magnesium	14	16	16	13	33	52
Manganese	2.5	4.8	4.9	0.16	11	0.44
Nickel	<0.04	<0.04	<0.004	<0.04	<0.04	<0.04
Potassium	1.0	4.0	5.0	11	6.0	12
Sodium	50	74	75	55	40	65
Vanadium	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Zinc	0.02	0.02	0.02	0.02	0.06	0.05
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Aluminum	<0.10	0.20	0.30	<0.10	<0.10	<0.10
Arsenic	<0.004	0.004	0.007	0.044	<0.004	<0.004
Barium	0.03	0.24	0.23	0.05	0.09	0.66
Calcium	30	120	120	93	64	130
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	0.03	<0.02	<0.02	<0.02	0.03	<0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-5	MW-6	*MW-50	MW-7	MW-9	MW-10
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.61	50	48	17	8.1	<0.04
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Magnesium	15	16	16	14	34	56
Manganese	2.6	4.7	4.8	0.15	12	0.45
Potassium	1.0	4.0	3.0	11	6.0	12
Sodium	54	77	73	58	42	69
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.01	0.02	0.03	<0.01	0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16
INORGANIC COMPOUNDS (TOTAL) - ANALYTICAL RESULTS (ppm)						
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aluminum	28	12	1.8	18	11	0.70
Arsenic	0.009	0.007	0.007	0.013	<0.004	<0.04
Barium	0.45	0.31	0.24	0.18	0.30	0.11
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium	72	62	59	35	61	68
Chromium	0.06	<0.02	<0.02	0.06	0.02	<0.02
Cobalt	0.03	<0.02	<0.02	0.02	<0.02	<0.02
Copper	0.03	0.03	<0.02	0.03	<0.02	<0.02
Iron	140	90	11	59	59	2.1
Lead	0.035	0.014	<0.005	0.020	0.025	<0.005
Magnesium	55	25	57	63	67	54
Manganese	0.86	1.2	0.19	0.65	1.9	1.3
Nickel	0.05	<0.04	<0.04	<0.04	<0.04	<0.04
Potassium	14	8.0	11	3.5	7.0	13
Sodium	190	220	190	64	83	56
Vanadium	0.05	0.03	<0.01	0.05	0.02	0.01
Zinc	0.13	0.08	0.02	0.11	0.06	0.05
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Aluminum	<0.10	<0.10	<0.10	0.10	<0.10	0.70
Arsenic	0.007	0.004	<0.004	0.005	0.005	<0.004
Barium	0.23	0.18	0.21	0.06	0.17	0.11
Calcium	73	60	60	36	65	68
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Copper	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.64	14	0.12	0.17	0.27	1.9
Lead	<0.005	<0.005	<0.005	<0.005	0.007	<0.005
Magnesium	55	23	62	66	69	53
Manganese	0.28	0.99	0.16	0.41	1.2	1.2
Potassium	13	7.0	11	1.0	7.0	12
Sodium	200	220	190	71	86	55
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.01	0.01	<0.01	0.01	<0.01	0.01

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-17	MW-18	MW-19	MW-20	MW-6D	MW-20D
INORGANIC COMPOUNDS (TOTAL) - ANALYTICAL RESULTS (ppm)						
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aluminum	6.0	2.8	19	13	<0.10	0.60
Arsenic	<0.04	<0.004	<0.004	<0.004	<0.004	<0.004
Barium	6.0	2.8	19	0.18	0.07	0.06
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium	77	47	65	69	41	55
Chromium	0.03	<0.02	0.1	0.07	<0.02	<0.02
Cobalt	<0.02	<0.02	0.06	0.02	<0.02	<0.02
Copper	<0.02	<0.02	0.06	0.03	<0.02	<0.02
Iron	23	5.5	110	50	0.87	39
Lead	0.005	0.007	0.03	0.017	<0.005	<0.005
Magnesium	49	36	53	60	15	45
Manganese	4.3	0.98	5.6	1.8	0.75	5.3
Nickel	<0.04	<0.04	0.07	<0.04	<0.04	<0.04
Potassium	8.6	5.3	4.3	14	5.0	5.0
Sodium	49	210	49	59	37	39
Vanadium	0.02	<0.01	0.09	0.06	<0.01	<0.01
Zinc	0.07	0.04	0.24	0.21	0.06	0.04
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Aluminum	<0.10	<0.10	<0.10	5.5	<0.10	<0.10
Arsenic	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Barium	0.11	0.06	0.28	0.14	0.06	0.05
Calcium	85	48	63	69	41	61
Chromium	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Cobalt	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	MW-17	MW-18	MW-19	MW-20	MW-6D	MW-20D
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)						
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.03	0.05	0.21	24	0.04	18
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Magnesium	54	37	49	61	15	50
Manganese	4.7	0.87	3.2	1.5	0.73	6.6
Potassium	8.6	6.4	3.2	14	2.0	6.0
Sodium	55	230	50	58	35	42
Vanadium	<0.01	<0.01	<0.01	0.03	<0.01	<0.01
Zinc	0.06	0.07	0.18	0.04	0.06	0.04

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	CSX-1	CSX-2	EB-1	EB-2
INORGANIC COMPOUNDS (TOTAL) - ANALYTICAL RESULTS (ppm)				
Cyanide	0.01	0.02	<0.01	<0.01
Aluminum	21	6.2	<0.10	<0.10
Arsenic	<0.004	0.006	<0.004	<0.004
Barium	0.25	0.07	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01
Calcium	72	180	0.20	1.0
Chromium	0.10	<0.02	<0.02	<0.02
Cobalt	0.03	<0.02	<0.02	<0.02
Copper	0.05	<0.02	<0.02	<0.02
Iron	57	26	<0.04	0.13
Lead	0.021	<0.005	<0.005	<0.005
Magnesium	66	160	<0.50	<0.50
Manganese	1.2	0.69	<0.01	<0.01
Nickel	0.06	<0.04	<0.04	<0.04
Potassium	23	5.0	<1.0	2.0
Sodium	32	43	0.90	1.5
Vanadium	0.07	<0.01	<0.01	<0.01
Zinc	0.12	0.02	<0.01	0.01
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)				
Aluminum	0.10	0.6	<0.10	<0.10
Arsenic	<0.004	0.006	<0.004	<0.004
Barium	0.13	0.07	<0.01	<0.01
Calcium	71	200	0.60	1.2
Chromium	<0.02	<0.02	<0.02	<0.02
Cobalt	<0.02	<0.02	<0.02	<0.02

TABLE 4-17
DATA SUMMARY: ANALYTICAL RESULTS FOR DPSC GROUNDWATER SAMPLES (TAL INORGANIC COMPOUNDS)
(continued)

PARAMETER	CSX-1	CSX-2	EB-1	EB-2
INORGANIC COMPOUNDS (DISSOLVED) - ANALYTICAL RESULTS (ppm)				
Copper	<0.02	<0.02	<0.02	<0.02
Iron	0.13	7.4	<0.04	0.08
Lead	<0.005	<0.005	<0.005	<0.005
Magnesium	67	180	<0.50	<0.50
Manganese	0.72	0.70	<0.01	<0.01
Potassium	23	5.0	<1.0	<1.0
Sodium	34	41	0.90	1.5
Vanadium	<0.01	0.01	<0.01	<0.01
Zinc	0.02	0.05	<0.01	0.03

* (Duplicate of MW-6)

TAL - Target Analyte List

TABLE 4-18
AQUIFER HYDRAULIC CONDUCTIVITIES (SLUG TEST DATA)
DPSC, PHILADELPHIA, PENNSYLVANIA

WELL IDENTIFICATION	HYDRAULIC CONDUCTIVITY K (FT/MIN)	HYDRAULIC CONDUCTIVITY K (FT/DAY)	HYDRAULIC CONDUCTIVITY K (GPD/FT^2)
MW-1	3.2060×10^{-3}	4.6166	34.5
MW-1A	0.4553×10^{-3}	0.6566	4.91
MW-2A	0.0479×10^{-3}	0.0690	0.516
MW-3	5.609×10^{-3}	8.079	60.414
MW-4	0.4549×10^{-3}	0.6550	4.8996
MW-5	1.7260×10^{-3}	2.485	18.623
MW-6	0.5776×10^{-3}	0.8317	6.221
MW-10	0.7599×10^{-3}	1.0942	8.185
MW-11	10.960×10^{-3}	15.7824	118.05
MW-12	7.4660×10^{-3}	10.7510	80.417
MW-13	0.3666×10^{-3}	0.5279	3.941
MW-14	4.2440×10^{-3}	6.111	45.713
MW-15	3.3460×10^{-3}	4.8182	36.040
MW-16	0.1396×10^{-3}	0.2010	1.503
MW-17	0.1927×10^{-3}	0.2774	2.075
MW-18	0.2846×10^{-3}	0.4069	3.043
MW-19	4.8400×10^{-3}	6.9696	52.123
MW-20	2.9600×10^{-3}	4.2620	31.882
MW-CSX2	0.7740×10^{-3}	1.1145	8.337
MW-20D	2.4010×10^{-3}	3.4570	25.858
MW-6D	17.130×10^{-3}	24.667	184.510

Average $=2.640 \times 10^{-3}$ Ft/min 3.81 Ft/day 28.50 gpd/ft^2

Monitoring Wells MW-2 & MW-9 not included due to erroneous data.

Monitoring Wells MW-CSX1 and MW-7 not included due to extremely slow recharge.

Data are analyzed for deep monitoring wells MW-6D & MW-20D, but are not included in average K evaluation because these are not screened in the shallow zone in which the rest of the wells are screened.

Data for monitoring well MW-CSX2 not included in the average K evaluation because of its location outside of the main DPSC facility.

5.0 GEOLOGY

Establishment of the geological framework in the area of DPSC is a prerequisite to defining both the facility's site specific aquifer system and contaminant transport pathways within that system. Extensive drilling within the Philadelphia area and on the DPSC site itself has provided a substantial data base from which geologic profiles may be constructed to help develop a better understanding of subsurface conditions. Historical land use data discussed in Section 1.0 of this report provides an indication of how various site activities and structures may have influenced subsurface conditions at DPSC. Section 11.3 gives some insights into how underground utilities and associated bedding materials and backfill may affect contaminant transport pathways in the subsurface.

The primary reference for regional geologic data in the vicinity of DPSC is entitled *Groundwater in the Coastal Plain of Pennsylvania*, published in 1961 by the Pennsylvania Geological Survey. DPSC's site specific geotechnical database originated from four separate site investigations conducted during the past fifty years. The first was conducted in the early 1940s to determine the stability of soils prior to building construction. In January 1988, a *Fuel Contamination Study* was conducted involving the advancement of soil borings and the installation of monitoring wells. Additional soil borings and monitoring wells were emplaced in January and May 1991 at the request of the ACOE in Huntsville, Alabama. The ACOE in Baltimore advanced soil borings and installed two additional monitoring wells in June 1992. Logs of each of these borings and wells were compiled and integrated with regional geologic logs available from the 1961 Pennsylvania Geologic Survey report and the soil boring logs prepared by Versar during the DPSC Phase I RI investigation. This geotechnical database has been reproduced and included along with a boring location map in Appendices F and G.

5.1 Regional Geology

The DPSC is located in the Coastal Plain Physiographic Province just east of the Fall Line, a northeast-southwest trending line that divides the rolling hills of the Piedmont from the flat lowlands of the Coastal Plain. The Piedmont is underlain by dense hard rocks that support its hilly surface, while the Coastal Plain overlies soft unconsolidated deposits that erode easily to form low, nearly flat plains. These soils dip gently (40-80 feet per mile) to the southeast, forming a wedge-shaped mass that thickens toward the Atlantic Ocean. In the Philadelphia area, the various soil layers are laterally discontinuous and locally thicken and thin or are completely absent. The availability of extensive drilling data in the South Philadelphia area has enabled the Pennsylania Geological Survey to generate reliable estimates of the thickness and areal extent of these formations.

5.1.1 Stratigraphy

Approximately 100 to 120 feet of overburden materials overlie bedrock at the DPSC location. This overburden consists of sediments of Cretaceous, Pleistocene, and Recent age. Macrostratigraphy (i.e., the areal extent of individual formations and formation members) is controlled largely by the location of paleochannels incised into the Pre-Camrian bedrock surface. One such paleochannel, referred to as the League Island Trough, is developed along the western side of the DPSC site. According to well construction data available from a water supply well that formerly existed in Building 8 (Figure 5-1A), sediments within this trough are limited to a thickness of about 80 feet on the eastern side on DPSC.

Regional mapping and DPSC soil boring data indicate that the sediments in the League Island paleochannel thickens along the western portion of the site. Based on this information, it is anticipated that a number of Cretaceous, Pleistocene, and Recent Formations should thin or be absent on the eastern part of the installation. Table 5-1 presents the subsurface stratigraphy projected from regional geologic data. The formation elevations and thicknesses derived from the installation of the supply well in Building 8 indicated bedrock to be shallower than was originally mapped in the 1961 Pennsylvania Geological Survey report. Geologic cross-sections were developed to show the stratigraphy of the DPSC site along several section lines as shown in Figure 5-1B. Figure 5-2 is a revised regional cross-section of the stratigraphic section at DPSC based on geologic data from the supply well and on soil boring logs prepared during the installation of two deep monitoring wells MW-6D and MW-20D, both of which drilled to a depth of approximately 85 feet below land surface during Phase I. This revised regional cross-section provides the geologic framework for differentiation of individual aquifers in the aquifer system underlying DPSC. The DPSC aquifer system is described in Section 6.2 of this report.

5.2 Phase I Geological Characterization

Sixteen soil borings were advanced during Phase I of the DPSC RI. The boring data were incorporated into the existing DPSC geotechnical database to characterize site specific geology. Geologic site characterization then served as the basis for evaluating migration and accumulation mechanisms and pathways for petroleum hydrocarbons and any other potential groundwater contaminants detected during the RI.

During the installation of the Phase I RI monitoring wells, continuous split-spoon sampling was conducted in order to accurately define the soil characteristics and site stratigraphy. All split-spoon samples were identified in accordance with Unified Soil Classification System (USCS) criteria. In order to confirm the accuracy of field identification, undisturbed soil samples were procured from each boring. In addition, to determine the confining nature of the clays at the site, Shelby Tube samples were procured. All geotechnical samples were sent to Schnabel Engineering Associates for analysis.

Table 5-2 summarizes the laboratory analyses and includes the field identifications for comparison. Table 5-3 presents the results from the Shelby tube permeability testing. Geotechnical analyses, including soil gradation curves, are presented in Appendix H. Some variation is expected in the field descriptions of sands and gravels; however, of primary importance to this site is the confirmation of the descriptions of the clay, silt, and other low permeability units.

5.2.1 Discussion of Geologic Cross-sections

Data acquired during Phase I of the RI indicate that the geology of the DPSC site varies to some extent from regional mapping due to the site's orientation relative to the axis of the League Island paleochannel. DPSC was found to be located on the eastern flank of this paleochannel, rather than along its axis. Sediments on the flank of the paleochannels tend to have steeper initial dips and thin, pinch-out, or are truncated by younger deposits. As can be seen in Figure 5-2, sedimentary units in the vicinity of MW-20D appear at the depths predicted by the 1961 USGS report. However, since the middle and lower clays were not encountered during the installation of MW-6D, it may be concluded that an unconformity exists which places Recent and Pleistocene deposits in contact with Cretaceous sediments. This stratigraphic relationship suggests that a single aquifer, consisting of undifferentiated Recent, Pleistocene and Cretacous deposits, exists in the central and eastern portions of DPSC.

Shallow well logs and boring logs from the site were utilized in the preparation of geologic cross sections. This was done to provide a framework for the analysis of groundwater flow and contaminant transport pathways. These cross sections were also used to evaluate the mechanism through which substantial volumes of petroleum hydrocarbons accumulated as free product within the uppermost aquifer at DPSC.

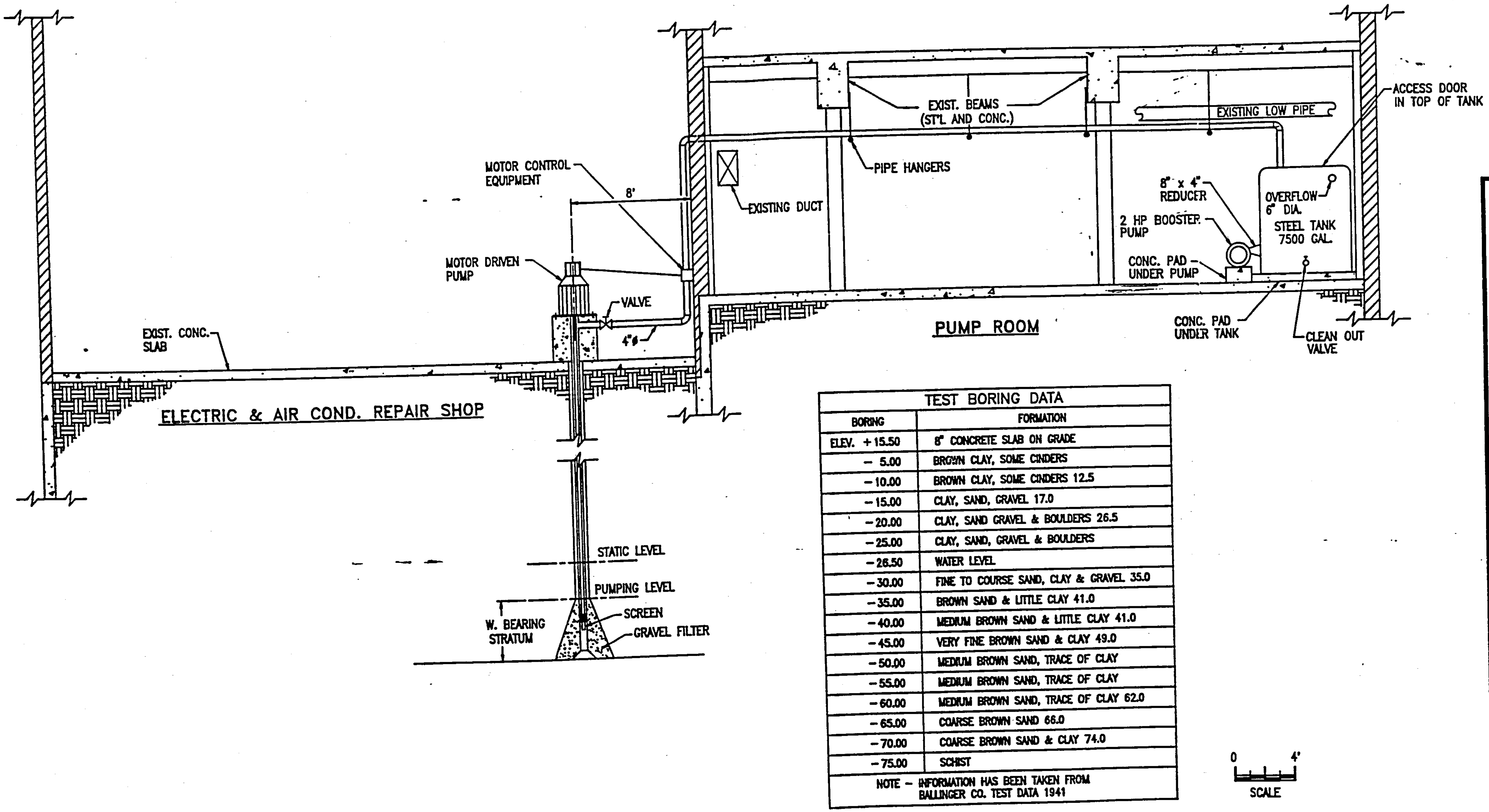
Cross section A-A', Figure 5-3, was completed in the presumed direction of regional groundwater flow. The line of section originates in the northeastern part of the Sun Oil Company refinery south yard and continues in a southeasterly direction across the DPSC site. This cross-section shows, in the vicinity of S-76, a sand pinching out beneath a clay; these stratigraphic units being interpreted as the Old Bridge and the Upper Clay, respectively. The Upper Clay unit, in turn, appears to pinch out between MW-17 and MW-16, and reappears in MW-7.

It was not possible to distinguish between the undifferentiated Recent/Pleistocene deposits and the underlying Farrington sand during the logging of soil borings MW-6D and MW-20D, the two deep wells drilled during Phase I of the RI. MW-20D was drilled to 66' below MSL. Nine feet of clay was encountered from 31' to 39' below MSL. This depth interval corresponds to regional depths of the middle and lower clays. Therefore, it is concluded that MW-20D was completed in the Farrington Member. MW-6D was drilled to 65' below MSL. No similar clay unit was encountered during the installation of MW-6D. The absence of clay would indicate the presence of an erosional unconformity. In the absence of this clay layer, dissolved contaminants may potentially migrate to the Farrington Sand aquifer.

The presence of a near surface clay unit at DPSC has a significant bearing on the migration and accumulation of vaporous and free product phase hydrocarbons at the site. Figures 5-4 and 5-5 illustrate the structural attitude of the lower surface of the clay and the unit's overall thickness, respectively. Note that the surficial clay is absent in the northwestern portion of the site, an area where fill materials exceed a total thickness of twenty feet. It is also significant that this clay thins along the southern portion of the site. Shelby tube samples of this clay unit were acquired at various locations for permeameter analysis. The results of this testing, shown in Table 5-3, indicate that the clay's permeability is sufficiently low to retard both fluid and gas migration.

The cross-sections and maps presented in Figure 5-3, 5-4, 5-5, and 5-6 indicate that the surfical clay unit has the geometry of a dome-like feature. The base of this clay appears to intersect the site water table in the vicinity of the southern property boundary, and at the southwest and southeast corners of the site. The clay, acting in conjunction with a large, east-west trending City of Philadelphia sewer located just south of the Schuylkill Expressway, inhibits the southerly (regional) flow of groundwater and any associated free product. The limits of the "clay dome" are consistent with the areal extent of free product at the DPSC site, discussed in detail in Section 7.2. Areas of non-deposition of the surficial clay (northwestern portion of the site where substantial volumes of [illegible] are present), and breaches in the clay unit caused by building footers, foundations, and underground utilities facilitate the movement of volatile soil gases that emanate from the free product plume along the southern portion of the site.

The base of the surficial clay unit also has some impact on the movement of free product, as evidenced by SCAPS sampling performed at location SG-6 (MW-9). SCAPS fluoresence intensity panel plots at this location indicated the presence of hydrocarbons at a depth of 23-25 feet below grade, 4 feet below water table elevations in this portion of DPSC. Free product was confirmed to exist at this depth by hydropunch sampling. The occurrence of free product beneath the clay and below the water table may be attributable to historical fluctuations in the water table. Figure 5-5 illustrates the mode of occurrence of free product at sampling location SG-6. Once this former SCAPS location was converted into a groundwater monitoring well, groundwater and free product trapped beneath the surficial clay unit was free to migrate into the wellbore, where it was detectable with an interface probe. The true depth of free product at this location, however, is within the vadose zone and not at water table elevations as measured by interface probe readings subsequent to well installation.



TEST BORING DATA	
BORING	FORMATION
ELEV. +15.50	8" CONCRETE SLAB ON GRADE
− 5.00	BROWN CLAY, SOME CINDERS
−10.00	BROWN CLAY, SOME CINDERS 12.5
−15.00	CLAY, SAND, GRAVEL 17.0
−20.00	CLAY, SAND GRAVEL & BOULDERS 26.5
−25.00	CLAY, SAND, GRAVEL & BOULDERS
−26.50	WATER LEVEL
−30.00	FINE TO COURSE SAND, CLAY & GRAVEL 35.0
−35.00	BROWN SAND & LITTLE CLAY 41.0
−40.00	MEDIUM BROWN SAND & LITTLE CLAY 41.0
−45.00	VERY FINE BROWN SAND & CLAY 49.0
−50.00	MEDIUM BROWN SAND, TRACE OF CLAY
−55.00	MEDIUM BROWN SAND, TRACE OF CLAY
−60.00	MEDIUM BROWN SAND, TRACE OF CLAY 62.0
−65.00	COARSE BROWN SAND 66.0
−70.00	COARSE BROWN SAND & CLAY 74.0
−75.00	SCHIST

NOTE – INFORMATION HAS BEEN TAKEN FROM BALLINGER CO. TEST DATA 1941

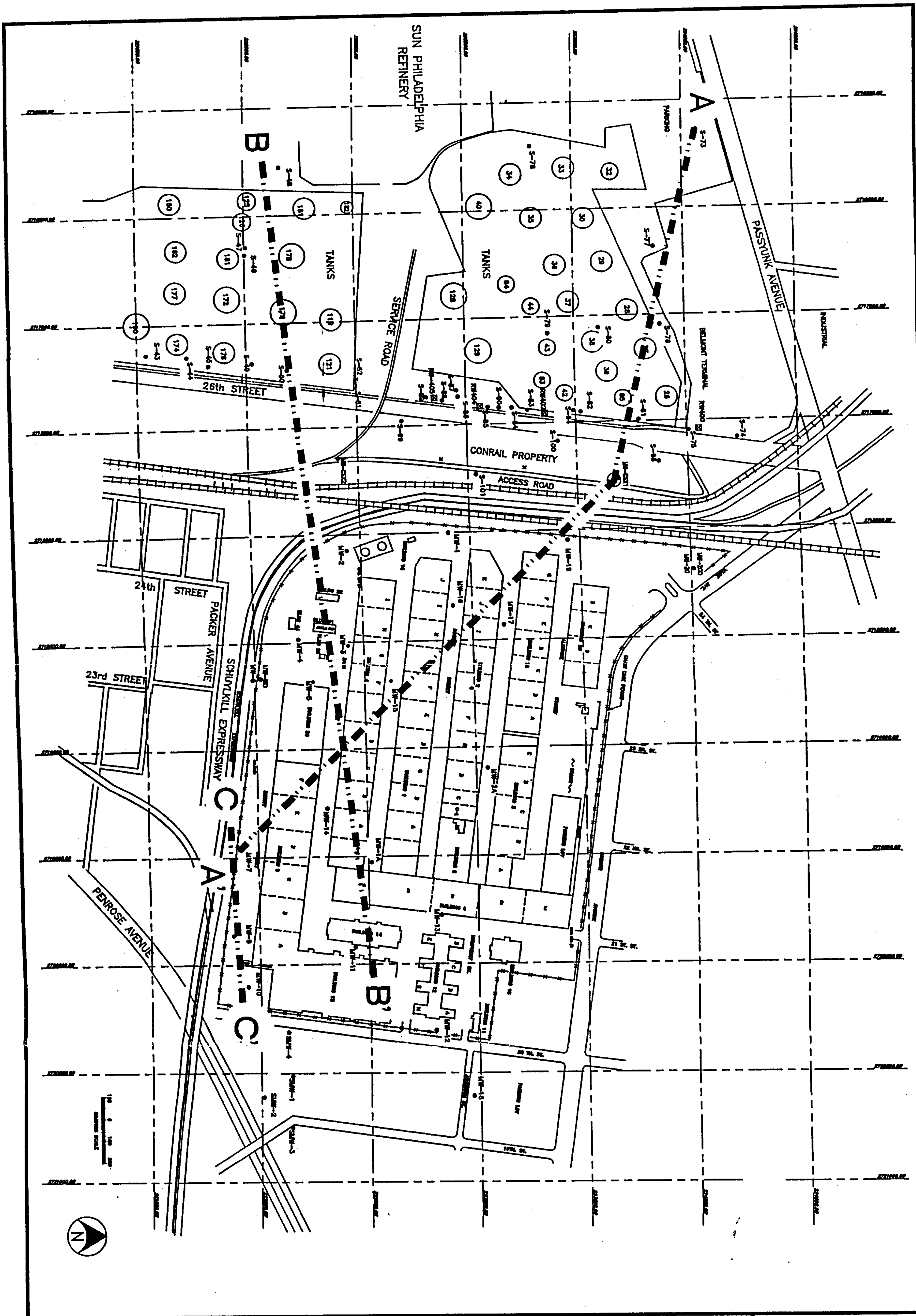
SCHEMATIC OF FORMER DPSC PROCESS WATER SUPPLY WELL

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/11/95
SCALE: AS NOTED
DWG. BY: V.S.

FIGURE 5-1A

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844



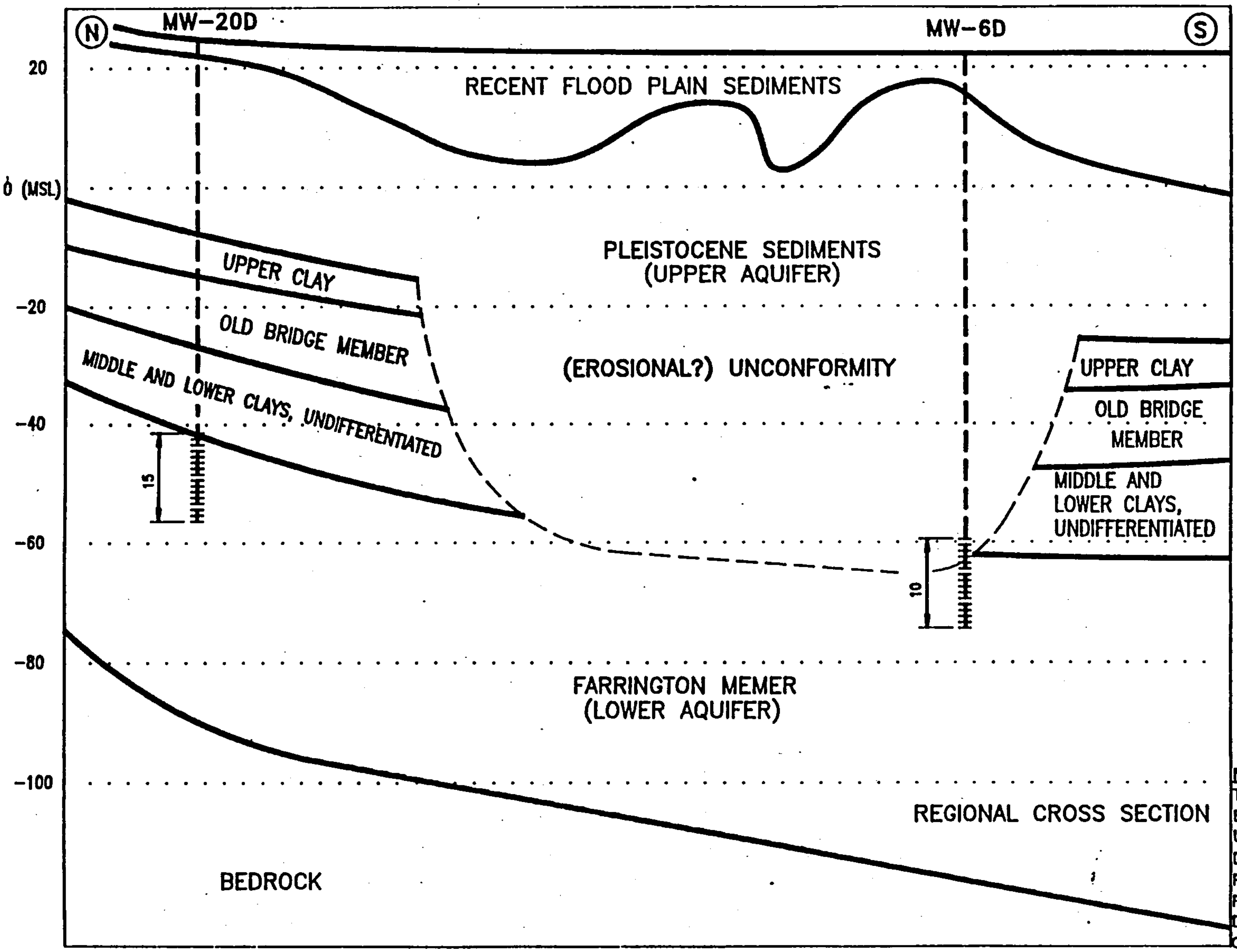
Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

DPSC LINES OF SECTION

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: NOTED
DWG. BY: G.B.

FIGURE 5-1B



NOTE:
THE SUSPECTED EROSIONAL UNCONFORMITY DEPICTED ON THIS FIGURE IS INFERRED FROM LIMITED SAMPLING DATA AND REGIONAL GEOLOGIC INFORMATION.

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 5-2

NORTH-SOUTH REGIONAL GEOLOGIC CROSS SECTION

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE:	04/24/95
DESIGNED BY:	G.B.
SCALE:	NTS
JOB NO.:	2727.011
DWG. NO.:	

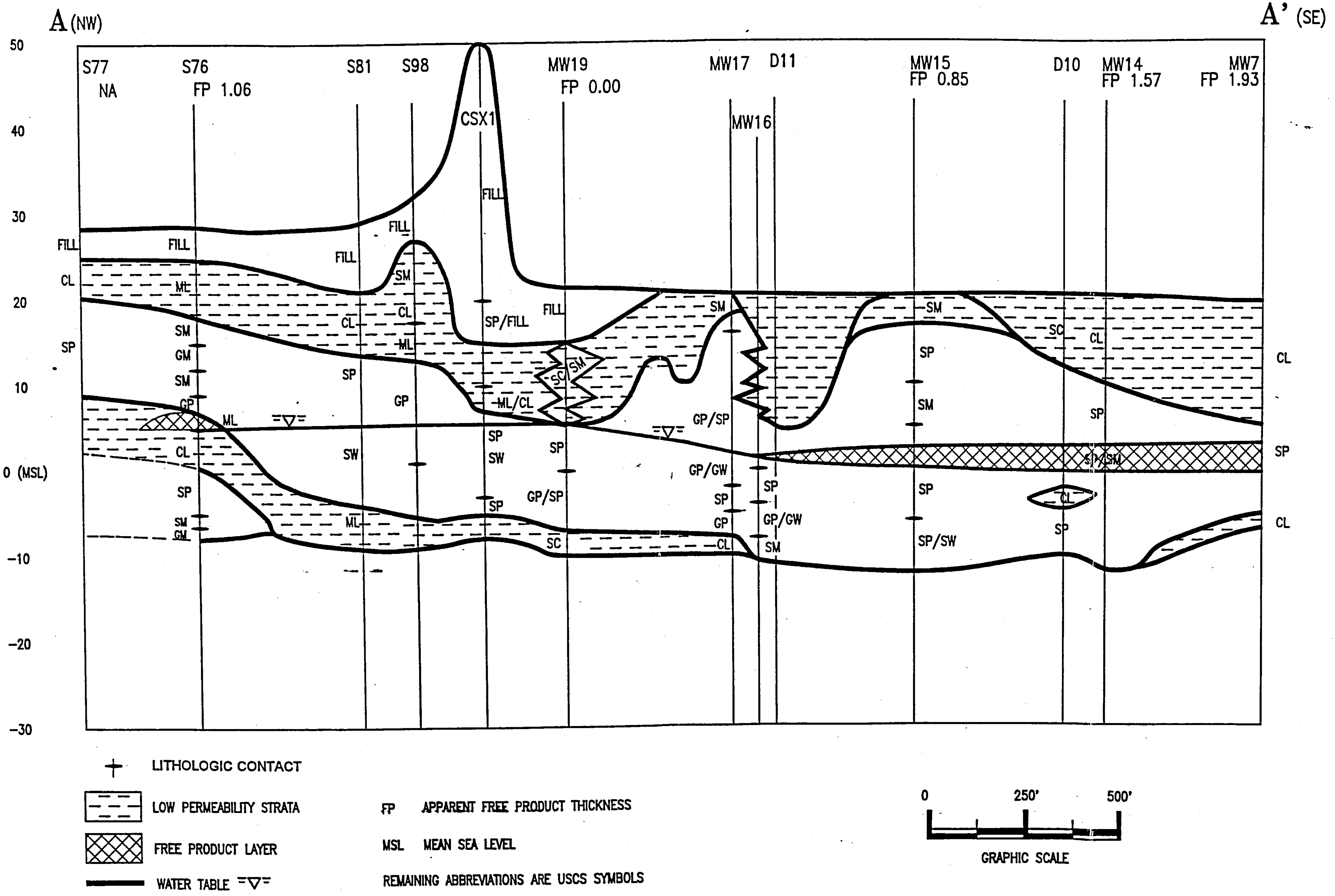


FIGURE 5-3

DATE: 05/01/95

SCALE:

DWG. BY:

NORTHWEST-SOUTHEAST GEOLOGIC CROSS SECTION

DEFENSE PERSONNEL SUPPORT CENTER

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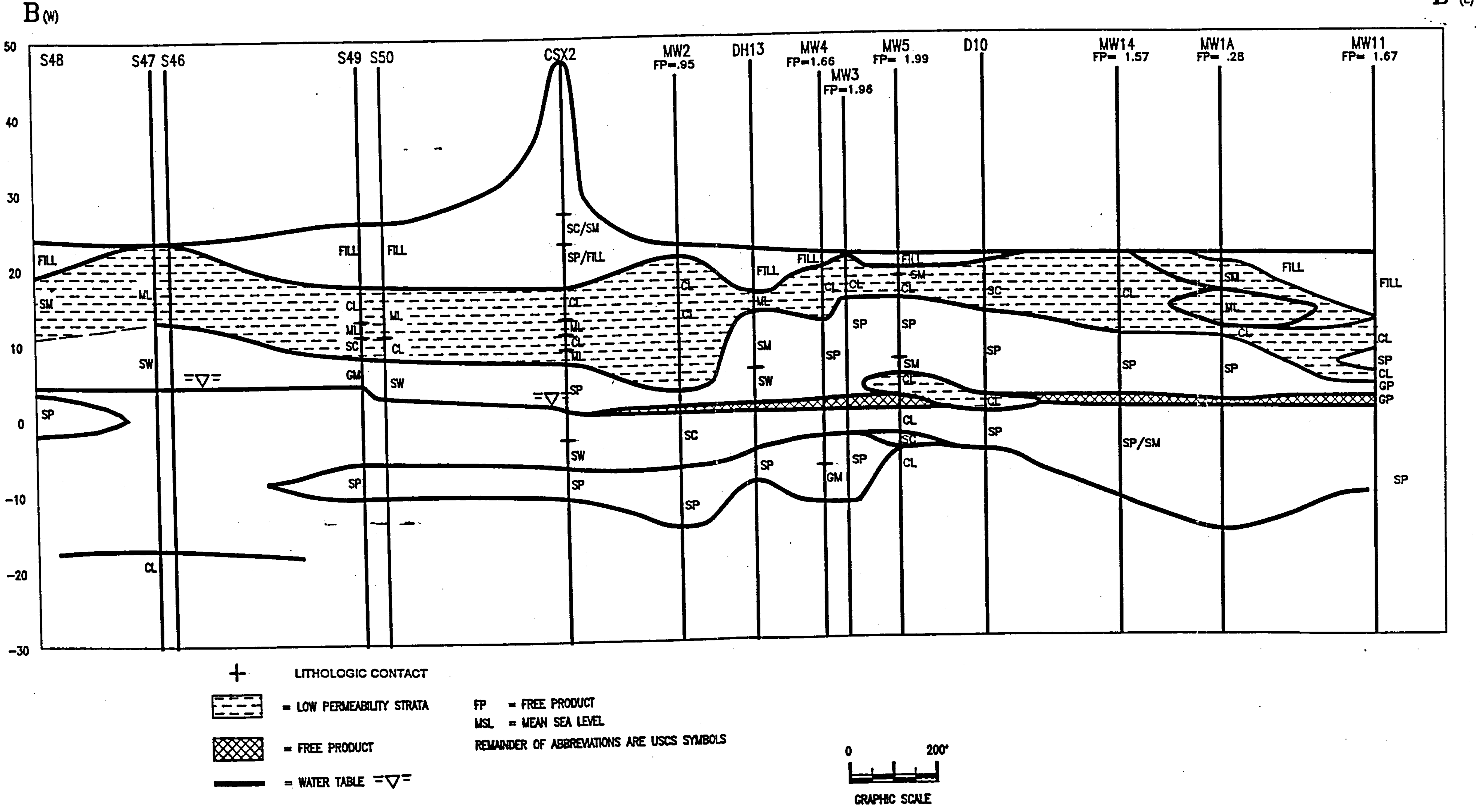

FIGURE 5-4

DATE: 05/10/95
SCALE: NOTED
DWG. BY: G.B.

WEST-EAST GEOLOGIC CROSS SECTION

DEFENSE PERSONNEL SUPPORT CENTER

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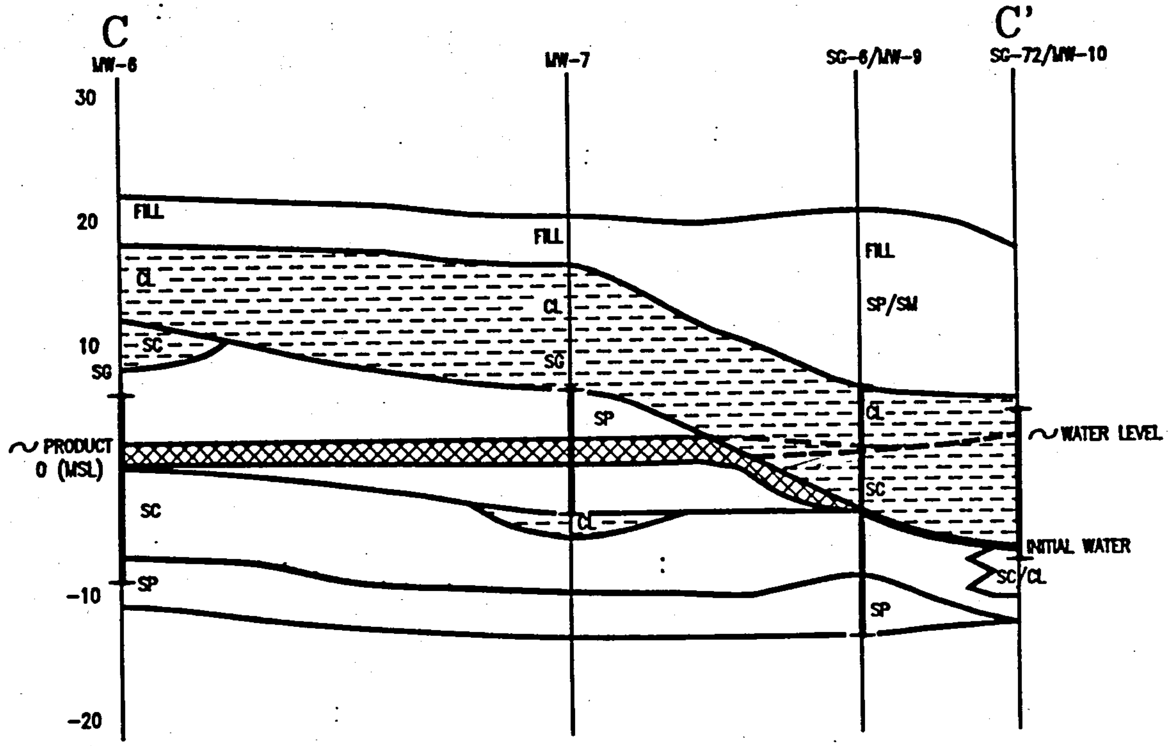


MW-6

DTP 20.00
DTW 21.71
SG-01 { BTEX 1120 mg/L
VOC 9465 mg/L
DIFF 8345 mg/L
15' SCREEN ZONE

MW-7

DTP 20.00
DTW 21.71
SG-04 { BTEX 3420 mg/L
VOC 15240 mg/L
DIFF 11870 mg/L
10' SCREEN ZONE

SG-6/MW-9

FIRST WATER ENCOUNTERED
AT 24.5' BGS, ROSE TO 16 BGS.
MW9 { DTW 19.12
DTP 19.16
HYDRO PUNCH SCREEN 23' - 26'
20' SCREEN ZONE

SG-06 { BTEX 1.5mg/L
VOC 6.0 mg/L
DIFF 4.5 mg/L

SG-72/MW-10

MW10 { DTW 15.01
DTP N/A
HYDRO PUNCH SCREEN N/A
15' SCREEN ZONE

BTEX N/D
VOC N/D

CONTAMINANT CONCENTRATION
PROPORTIONAL TO CLAY
THICKNESS AND DEPTH

I = SCREENED INTERVAL
▨ = APPARENT FREE PRODUCT THICKNESS
▤ = LOW PERMEABILITY STRATA

——— WATER TABLE
——— APPARENT PRODUCT LEVEL
– – – – – APPARENT WATER LEVEL
REMAINING ABBREVIATIONS ARE USCS SYMBOLS

0 200'
GRAPHIC SCALE

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

FIGURE 5-5

MW-7 - MW-10 GEOLOGIC CROSS SECTION

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA

DATE:	05/05/95
DESIGNED BY:	G.B.
SCALE:	NOTED
JOB NO.:	2727.001
DWG. NO.:	

TABLE 5-1
GENERAL SUBSURFACE STRATIGRAPHY
SOUTHEASTERN PHILADELPHIA, PENNSYLVANIA

FORMATION	DESCRIPTION	THICK-NESS	DEPTH BELOW LAND SURFACE (BSL)
Fill & Concrete	Fill & Concrete	0-22 feet	Varies
Recent Alluvium	Dark gray mud, silt and fine sand	5-10 feet	2-5 feet
Pleistocene Deposits	Brown to gray sand and gravel composed of medium to coarse grained, angular to rounded quartz sand grains, with sandstone, siltstone, chert, quartzite, and mica schist size boulders (Becomes thicker towards the north of DPSC).	10-50 feet	10-15 feet
Cretaceous Deposits			
Upper Clay Member	Gray sandy clay; with red, white, and yellow clays interbedded (Exists on the southeast portion of DPSC).	2-5 feet	15-20 feet
Old Bridge Sand Member	Light gray to yellowish brown, medium to coarse grained sand, with silt, clay, and gravel beds common at the base of the aquifer (Thins out and becomes non-existent towards the north; Pleistocene Sand becomes dominant formation).	20-50 feet	20-30 feet
Middle & Lower Clay Members	Red and white clay with some sand beds present in the Lower clay formation.	10-30 feet	60-80 feet
Farrington Sand Member	Yellow, gray, and brown coarse sand with gravel which grades into a fine to medium grained sand composed of a small percentage of white clay beds.	10-50 feet	50-100 feet

TABLE 5-2
USCS CLASSIFICATION OF GEOTECHNICAL SAMPLES

BORING NUMBER	SAMPLE DEPTH (FT.)	LAB ID	FIELD ID
MW-9	18-20	CL, brown	CL, light gray
MW-10	18-20	CL, gray	CL, gray
MW-11	8-10 28-30	CL/ML, brown, green, gray SP, brown	CL, gray GP, brown
MW-12	14-16	SM, gray	SP, grayish brown
MW-13	20-22	GM, gray	GP, brown
MW-14	12-14	SP/SM, brown	SP, brown
MW-15	26-28	SP/SM, brown	SP, brown
MW-16	4-6 16-18	ML, brown, green, gray SC, brown	CL, brown SP/GP, brownish orange
MW-17	24-26	SC, brown	SP, brown
MW-18	18-20	CL, brown	SM
MW-19	4-6 10-12	CL, brown, green, gray CL, brown	N/A SC, brown
MW-20	16-18	SC, gray	SP, light brown
MW-6D	72-74	SW-SM, brown	GP, gray
MW-20D	70-72	GC, grayish brown	GC, gray
MW-CSX1	40-42	CL, brown	ML/CL, light brown
MW-CSX2	36-38	CL, brown	CL, yellowish brown

TABLE 5-3
DATA SUMMARY: GEOTECHNICAL SAMPLES, SHELBY TUBES PERMEABILITY TESTING

BORING NUMBER	SAMPLE DEPTH (FT.)	HORIZONTAL PERMEABILITY (CM/SEC)	VERTICAL PERMEABILITY (CM/SEC)
MW-11	8-10	1.3×10^{-6}	2.0×10^{-6}
MW-16	4-6	2.4×10^{-6}	2.0×10^{-6}
MW-19	4-6	6.6×10^{-7}	1.3×10^{-6}

6.0 HYDROGEOLOGY

An evaluation of the movement and accumulation of free product and the migration of dissolved phase contaminants in the aquifer system at DPSC must be preceded by an understanding of site geology and groundwater flow patterns. The interpretation of geological data from soil borings advanced at DPSC indicates that the aquifer is heterogeneous. In addition, there are numerous underground utilities in the vicinity of the installation which may exert significant influences on local flow patterns and free product/contaminant migration.

A relatively large regional and site specific database exists to support the mapping of aquifers and groundwater flow patterns at DPSC. Regional data is available from a text entitled *Groundwater Resources of the Coastal Plain Area of Southeastern Pennsylvania*, published in 1961 by the Pennsylvania Geological Survey. Also included in the hydrogeological database are data from 25 groundwater monitoring wells that have been installed at DPSC, 4 wells at the SEPTA maintenance garage east of DPSC, and approximately 36 wells at the Sun Oil Company refinery south yard, located west of DPSC.

6.1 Regional Hydrogeologic Framework

Regional hydrogeologic data for the Southeastern Pennsylvania Coastal Plain indicates the presence of two distinct aquifers underlying the DPSC site. The upper aquifer is unconfined and composed of undifferentiated Recent and Pleistocene sands, silts and clays. This aquifer ranges from 40 to 60 feet in thickness, and regional groundwater flow within this unit is to the southeast. Two Cretaceous age clay units, referred to as the Middle and Lower Clay units, separate the upper aquifer from the Farrington Sand. At DPSC, the Middle Clay directly overlies the Lower Clay and cannot be distinguished from the latter. The combined thickness of these two clays reaches 60 feet; thus this stratigraphic interval functions as a confining unit for the underlying Farrington Sand. The Farrington Sand is characterized as an artesian aquifer and overlies the Wissahickon Schist. This aquifer locally attains a thickness of up to 20 feet. Regional groundwater flow patterns in the Farrington are updip to the northwest. Substantial groundwater withdrawals from this aquifer in the mid to late 1900s has eliminated artesian conditions in many parts of Philadelphia and has likely resulted in modifications to regional flow patterns.

6.2 Aquifer System at DPSC

Regional mapping indicated that distinct upper and lower aquifers were present at DPSC. However, hydrogeological data acquired during the Phase I RI revealed that this is not the case. Monitoring well MW-20D, drilled in the northwestern corner of DPSC, penetrated what appeared to be the upper and Farrington Sand aquifers. A well couplet was installed at this location with MW-20 screened in the upper aquifer and MW-20D screened in a stratigraphic unit interpreted as the Farrington Sand. The confining unit between the upper and lower aquifers in this area was only nine feet in total thickness.

At the southwestern part of DPSC, a second deep well, MW-6D, was installed adjacent to the existing shallow well screen in MW-6. These two wells also form a couplet. MW-6D was drilled to a depth of 88 feet below grade and did not encounter any confining units within the footage penetrated. This well was drilled well below the anticipated depths of the Middle and Lower Clay units.

Regional geologic data and the lack of any confining clays in MW-6D and the thin nature of this unit in MW-20D suggest that the Middle and Lower Clay units have been truncated by a nonconformity along the western and central portion of DPSC. The location of these deep wells within the League Island Trough suggests that the clay units which normally confine the Farrington Sand aquifer may have been eroded by a northwest-southeast trending paleochannel. Based on the limited deep stratigraphic data from MW-6D, MW-20D, and the former process supply well in Building 8, it is believed that a single unconfined aquifer underlies the DPSC site. This aquifer probably attains a maximum thickness of about 80 feet.

6.3 Aquifer Characteristics

Modeling of the extent of contamination for volumetric calculations and pathline analyses required the quantification of a number of key geological and hydrogeological parameters including hydraulic gradient, hydraulic conductivities, aquifer thickness, and porosity. Capillary pressure relationships at air-oil and oil-water interfaces were generated from the SPILLCAD model, using gradation curves derived from sieve analyses of aquifer soil samples. The latter soil parameters are important in calculating *in situ* free product volumes.

6.3.1 Hydraulic Gradient

Hydraulic gradients at DPSC and the adjacent Sun Oil Company refinery were determined from the mapping of synoptic free product and water table measurements taken on March 1 and 2, 1995. The preparation of adjusted water table elevation maps served as the basis for hydraulic gradient interpretation and measurement.

An adjusted water table elevation map for the combined DPSC, Sun Oil Company refinery south yard, and SEPTA garage is presented in Figure 6-1; the DPSC water table elevation map is presented in Figure 6-2. The preparation of these maps involved several important assumptions:

- Measuring point elevations all needed to be normalized to National Geodetic Vertical Datum (NGVD); this process involved the resurveying of Arco benchmarks used to establish wellhead elevations at the refinery, and the application of conversion factors to both the Sun wells and monitoring wells MW-1 through MW-7, which were installed by Environmental Science and Engineering prior to Phase I of the RI. Specifically, elevation adjustments of +0.3 feet were made to monitoring wells MW-1 through MW-7 at DPSC, and elevation adjustments of 1.13 and 1.05 feet were made to refinery south yard wells surveyed with reference to Arco benchmarks S-1 and S-6, respectively.

- Piezometric data for one well in the Sun Oil Company refinery's south yard and one of SEPTA's wells, S-77 and SMW-4, respectively, were omitted from the water table elevation map. The water table elevation in S-77, indicated to be 22.3 feet above MSL, is considered to be an outlier, since the range in water table elevations for the entire south yard was observed to be -2.29 to 8.65 feet above MSL. SWM-4, the westernmost of the SEPTA wells, was also considered a data outlier; this well had an elevation of 3.41 feet above MSL in contrast to a range of 0.19 to 1.69 in the southeastern portion of DPSC. The anomalous elevation data associated with these two wells may be attributable to either perched water conditions or insufficient well development.

Where apparent regional hydraulic gradients exist on the DPSC and Sun Oil Company refinery south yard sites, respective gradients of 0.004 and 0.008 were measured. However, there are two anomalies which exist that affect steeper or flatter gradients at both sites. One such anomaly, shown in Figure 6-1, is in the vicinity of 26th Street, east of the refinery south yard and west of the Conrail property. The anomaly occurs as a north-south trending swale and a steepening of the hydraulic gradient to 0.01. A sewer line that runs in a northerly direction along 26th Street at depths below the water table is apparently functioning as a subsurface drain in this area. This underground utility is causing a local steepening of the hydraulic gradient and is also affecting groundwater flow to deviate from regional patterns.

Another anomalous hydraulic gradient, occurring along the southern portion of the DPSC site, is shown in Figure 6-2. At this location, the hydraulic gradient has flattened out substantially, decreasing to less than 0.001. This anomaly is interpreted to be associated with a hydraulic conductivity change in the upper aquifer. Geologic mapping of a low permeability surficial clay unit indicates that the clay intersects the water table along the southern, southwestern, and southeastern portions of DPSC. This clay, along with the presence of a large (8' x 10'), reinforced concrete sewer at water table depth, appears to inhibit the southerly flow of groundwater, creating a large groundwater mound. The location of this groundwater mound is consistent with the occurrence of free product in the upper aquifer; hence, the clay unit and sewer may also be causing free product to preferentially accumulate in this area.

Vertical hydraulic gradients were measured in two shallow and deep well couplets during Phase I of the RI. These couplets include MW-6/6D, and MW-

20/20D, located at the southwestern and northwestern parts of the site, respectively. In both instances, the measured vertical hydraulic gradients were positive, indicating a net downward component of groundwater flow in the aquifer. The vertical hydraulic gradient in MW-20/20D was measured at .07, while a gradient of only .001 was observed in the MW-6/6D well couplet. The larger head loss in MW-20/20D is probably due to the presence of a 9-foot thick clay unit between the two well screens in that couplet. The positive vertical hydraulic gradients suggest that it may be possible for dissolved phase contaminants to migrate into the basal portion of the aquifer, particularly at locations where the Middle and Lower Clay units are absent.

6.3.2 Hydraulic Conductivities

Hydraulic conductivities in the aquifer at DPSC are moderate to low, largely due to the significant amount of silt and clay matrix within the Recent, Pleistocene and Cretaceous deposits. Hydraulic conductivities at DPSC were measured by performing 22 separate slug tests. Data from these aquifer tests are presented in Table 4-18. Hydraulic conductivities ranged from a low of 0.069 feet per day to a high of 15.8 feet per day, with an average value of 3.81 feet per day. Although only two monitoring wells, MW-6D and MW-20D, were screened in the lower portion of the aquifer, a slight increase in hydraulic conductivity appears to occur; MW-6D had a measured hydraulic conductivity of 24.6 feet per day.

The most significant hydraulic conductivity variation in the aquifer underlying the DPSC site is the transition from a silty or well graded sand to a clay which occurs along the southern, southwestern, and southeastern portions of the site. Here, the aquifer hydraulic conductivity decreases abruptly from an average of 3.81 feet per day to a range of 0.00283 - 0.283 feet per day. From this data it appears that the water table aquifer is semi-confined in the southeastern corner of the site. Hydraulic conductivity values for this surficial clay unit were determined from permeameter analyses of Shelby tube samples taken as soil borings were advanced during Phase I of the RI. The gradation from sand to clay at the southern portion of the site, along with the presence of the east-west trending Packer Avenue sewer immediately south of DPSC, effectively creates an east-west trending cut-off to southerly (regional) groundwater flow. This phenomenon is probably the cause of a large groundwater mound that is observed along the southern portion of the site in Figure 6-2, the March 1, 1995 water table elevation map. It is also believed to have affected the accumulation of free product which occurs within the same geographical area as the groundwater mound itself.

6.3.3 Aquifer Thickness

The stratigraphic relationships discussed in section 6.2 seem to indicate the presence of what is essentially a single aquifer at DPSC. However, where the Middle and Lower Clay units are developed (e.g., in the northwestern corner of the site), these units probably exert a significant influence on groundwater flow paths.

Vadose zone thickness at DPSC varies from approximately 40 feet where remnants of this confining unit exist, up to 80 feet in places where these clays have been eroded away.

6.3.4 Porosity

Due to the unconsolidated aquifer materials underlying DPSC, it is not possible to obtain a truly undisturbed sample for porosimeter analysis. The porosity of overburden materials, which are predominantly sand, silt and clay, and, to a lesser extent, fill composed of ash, cinders, brick and ceramic materials is estimated to be in the range of 35 to 40%. The siltier, matrix-rich portions of the aquifer are probably in the low end of this range, whereas the poorly graded sands and gravels may attain the upper limits of this range.

6.4 Groundwater Flow

The direction and velocity of groundwater flowpaths at DPSC were evaluated using the measured and/or calculated values of hydraulic gradient, hydraulic conductivity, and porosity discussed in Section 6.3. It is notable that while interpretations concerning the direction and magnitude of groundwater flowpaths are significant in analyzing the migration of dissolved phase contaminants, the transport of free product and vaporous phase hydrocarbons may also be controlled by the presence of numerous underground utilities and associated bedding/backfill materials.

6.4.1 Direction of Groundwater Flow

Regional hydrogeological mapping for the southern Philadelphia area indicates that groundwater flow in the vicinity of DPSC occurs primarily in a southeasterly direction towards the Delaware River. However, as can be seen from Figure 6-1, a number of local features which exist in the vicinity of the site cause anomalous groundwater flowpaths:

- Groundwater in the western portion of the Sun Oil Company refinery south yard flows in a westerly direction in response to a hydraulic gradient sloping towards the Schuylkill River in that area.
- Along 26th Street, groundwater flows both east and west due to the presence of a deep sewer pipe at this location which appears to be functioning as a subsurface drain. Groundwater elevation contours in the vicinity of this sewer line behave similarly to those contiguous with a gaining stream. The presence of this particular anomaly decreases the potential for groundwater in the upper aquifer to migrate directly from the refinery south yard into the DPSC site.

- An apparent groundwater mound exists in the southern portion of DPSC. This feature, believed to be associated with a significant hydraulic conductivity change and the presence of a large reinforced concrete sewer in that area, causes a deviation from regional flow patterns. Groundwater at this part of the site flows east and west in response to these subsurface barriers.

A process water supply well, formerly located in Building 8 in the east-central portion of DPSC, has reportedly been abandoned. A sketch of this well is presented in Figure 5-1A. Based on interviews with personnel from the facility's Public Works Department, the well had not been operational since the early 1970s. No data are available concerning well construction details, production rates, or aquifer test data. It is possible that during the period when this well was active, its cone of depression may have affected different groundwater flowpaths than are presently observed at this part of the facility.

The direction of groundwater flow in the aquifer at DPSC and contiguous areas is generally well understood. However, the extent to which other underground utilities modify groundwater flow and a clear understanding of how underground utilities function in the transport of free product phase petroleum hydrocarbons has yet to be achieved.

6.4.2 Groundwater Velocity

Based on an average site hydraulic conductivity of 3.14 feet per day, a range in hydraulic gradients of 0.004 to 0.001, and an estimated porosity range of 35 to 40%, groundwater velocity in the aquifer underlying DPSC is less than a tenth of a foot per day. Being composed of fluvial deltaic deposits, the aquifer is extremely heterogeneous; therefore, it is probable that areas of both higher and lower groundwater velocities exist. Areas of higher velocity may be present where coarse channel fill is associated with fluvial deposits, while lower aquifer velocities may be associated with overbank type facies. In any case, the velocity of groundwater estimated using hydraulic conductivities derived from slug test data is subject to a margin of error of approximately one order of magnitude and should be modeled with that constraint in mind. Consequently, pump testing may be required to refine the hydraulic conductivity values prior to subsequent remedial design.

7.0 EXTENT OF CONTAMINATION - PETROLEUM HYDROCARBONS

Data acquired during Phase I of the RI was combined with existing data from previous site investigations conducted at DPSC to determine the distribution of free product and delineate the extent of soil and groundwater contamination. Since most soil sampling conducted to date at DPSC focused on the massive gasoline/diesel free product plume and underground storage tank subsurface assessment, a substantial volume of analytical data exist from which to evaluate the extent of subsurface soil contamination. Since most surface soil sampling has been scheduled for Phase II of the RI, only a limited amount of surface soil analytical data have been generated thus far. Some inferences may be drawn from the Phase I PID screening of shallow soil horizons relative to the levels of petroleum hydrocarbon contaminants that are likely to be detected during future surface soil sampling. However, these interpretations must be considered strictly qualitative until they are confirmed during Phase II sampling and analysis.

The distribution of free product in the aquifer at DPSC has been accurately established in north, west and easterly directions; the southern plume boundary, off-site to the south of DPSC, has yet to be established, but as suggested in report sections 5 and 6, it is probably limited by hydraulic conductivity changes in the aquifer and the presence of a large sewer line in that direction.

The areal extent of petroleum hydrocarbon related groundwater contamination has been clearly established at DPSC, again with the exception of the southern plume boundaries. The vertical extent of groundwater contamination has yet to be defined; only two data points presently exist to define groundwater quality in the lower portion of the aquifer. Therefore, no calculation of dissolved species contaminant masses was attempted at this time. Recommendations for the completion of delineation of the dissolved phase groundwater contaminant plume are made in Section 14.2.

Certain key isoconcentration maps were developed for assessing the distribution of free product and extent of dissolved phase groundwater contaminants. These maps included free product thickness, and TPH, BTEX, GRO, DRO and benzene isoconcentrations. Their preparation is discussed in Section 7.2.

Selecting the appropriate maps to indicate the extent of petroleum hydrocarbons in subsurface soils involved a review of the mapping objectives. The primary Phase I objective is to differentiate between multiple releases which have impacted site soils in an effort to associate these releases with their respective sources. To accomplish this, isoconcentration maps were prepared to indicate TPH concentrations in the depth intervals 0 - 8', 8 - 15' and 15 - 30' below grade. The rationale for selecting these intervals was to dissect TPH impacts which were related to surface spills/releases, UST related releases and contamination associated with the massive gasoline/diesel plume respectively. Depending on which final remedial action objectives are established for the DPSC site, it is likely additional mapping w[illegible] warranted. It is suggested that the DPSC geochemical database be retained [illegible]sk format for use in the preparation of additional isoconcentration overlays.

7.1 DPSC Geochemical Database

As a result of the numerous site investigations that have been performed to date at DPSC, a substantial volume of analytical data exist to support the mapping of petroleum hydrocarbon contaminated media. Although collected over a period of nearly seven years, much, but not all, of the soil analytical data is considered comparable considering the primary mapping objective. Because different hydrocarbons species were evaluated for various site characterization objectives, the volume of data for certain parameters, such as DRO, is limited. Groundwater analytical data have been developed from two separate investigations conducted over four years. Because these data are not time synchronous and since groundwater concentrations are subject to significant variation with time, these data are not considered comparable.

The DPSC geochemical database consists of soil and groundwater analyses from four separate site investigations. To date, 31[illegible] soil samples have been collected at DPSC for various petroleum hydrocarbon analyses, along with 43 groundwater samples, and eleven free product samples. A summary of the complete petroleum hydrocarbon sampling database is presented in Table 7-1. This database supported the delineation of soil and groundwater contamination through the application of a modeling software package.

7.2 SpillCAD™ Data Assessment

In order to develop a conceptual site model of petroleum hydrocarbon contamination, available soil and groundwater data were evaluated using the SpillCAD computer program. The objectives of the computer program were to develop a graphic representation of the distribution of free product contaminated groundwater, petroleum contaminated soil, and groundwater contaminated with dissolved phase hydrocarbons, and to estimate the volume of petroleum hydrocarbons on the groundwater table and contained in the soil.

The SpillCAD computer program utilizes a user-specified database to provide a graphical representation of monitoring well and soil boring data contoured or posted on a site map. The program is able to handle free product contamination as well as dissolved phase contamination; however, it does not distinguish between multiple phases of free product contamination (e.g., oil and gasoline). The program contains a number of analytical modules that enable quantitative assessment of spill volume, contaminated soil volume, volume of free product, and dissolved and free product contaminant migration. The following sections provide a brief summary of the site-wide program parameters, including input data, program assumptions, and uncertainties and limitations, and a discussion of the program results on a media-specific basis.

7.2.1 Conceptual Model

7.2.1.1 Input Data

The conceptual model was developed using a CAD-generated site map and the soil and groundwater data from the DPSC geochemical database described in Section 7.1 (A copy of the database is included in Appendix M). It contains the following modules: locations, monitoring wells, soil borings, fluid level data, well concentrations, and soil concentrations. The soil database had to be modified from the format specified in the program to account for site conditions. SpillCAD evaluates soil in the vertical direction based on the depth of the sample with respect to the ground surface. In order to account for large differences in site elevations and provide for a more accurate depiction of soil contamination in the vertical direction, the value of sample depth input to the program was normalized with respect to mean sea level. In addition, because several sampling points were located below mean sea level, a factor of 8.57 was added to the depth of each sample with respect to mean sea level to eliminate negative values from the program.

The model domain encompasses the entire DPSC site and a portion of the contiguous properties and was set to the following coordinates:

Lower left corner	2717400 east	221700 north
Upper right corner	2720900 east	224200 north

The following soil properties required to generate contours and calculate soil volume were entered into the SpillCAD program:

Parameter	Assigned Value	Method of Determination
K_{sw}	3.6 ft/day	Slug test data
ϕ	0.4	Representative soil properties
S_m	0.215	Calculated from grain size data
α	2.846 /ft	Calculated from K_{sw}
η	1.446	Calculated from grain size data
S_{or}	0.235	Calculated from S_m
S_{og}	0.051	Calculated from S_m

The following fluid properties required to generate contours and calculate free product volume were input into the SpillCAD program:

Parameter	Value Assigned	Method of Determination
P_{ro}	0.75	Measured
μ_{ro}	1.14	Weighted average (3 parts gasoline/1 part oil)
β_{ao}	3.2	Weighted average (3 parts gasoline/1 part oil)
β_{ow}	1.4	Weighted average (3 parts gasoline/1 part oil)

7.2.1.2 Uncertainties/Limitations

The SpillCAD computer program is a valuable estimating tool for free product contamination, but the program has a number of limitations that must be considered when evaluating contaminant trends. Some of the program limitations encountered and their impact on the data evaluation are presented below.

The SpillCAD computer program assumes constant conditions (e.g., hydraulic conductivity) across the model domain in the horizontal and vertical direction. This representation of site conditions does not provide the optimal depiction of groundwater flow conditions and migration pathways. Due to this limitation the pathline analysis and dissolved phase transport modules of the program were not utilized.

For the soil volume estimation modules the program, utilizes an averaging algorithm to estimate contaminant concentrations in the vertical direction. If only one data point is available for a given soil column, the concentration is assumed to be constant throughout the column. This method of estimation provides a relatively accurate representation of site conditions. Elevated results may be obtained for depth intervals with only one data point. This is not considered a drawback for the DPSC site, because there are multiple data points in the vertical direction and the depth intervals evaluated were relatively narrow.

The model is capable of conducting user-specified queries of the database (e.g., all concentrations of TPH detected in groundwater). The queries can be used to evaluate data trends or to generate data contours. When querying the data for soil concentrations within a specified sample depth interval, the query will report multiple concentrations in the vertical direction for each sample point, but when contours are generated, only the first value encountered is recognized. For example, if samples were collected every 2 feet to a depth of 10 feet, the contours generated from a query of all soil data from 0 to 10 feet would use the data from the 0 to 2 foot interval and ignore the remaining data points. In order to minimize the impacts of this program limitation, three sample intervals were established.

The maximum grid size allowed by SpillCAD is 26 by 26 (NOTE: this grid size is unitless and indicates that maximum number of nodes that may be used in the model domain). Using this maximum grid size resulted in a distance between nodes of 140 feet in the x direction and 100 feet in the y direction. The relatively large distance between nodes may result in a small overestimation of contaminant volumes.

7.2.2 Soil Contamination

Available soil data for the site extends from a depth of 0 to 30 feet below grade. As discussed above, in the query mode SpillCAD has certain limitations regarding the evaluation of data in the vertical direction. In order to minimize these impacts 3 soil depth intervals were established: 0 to 8 feet below grade, 8 to 15 feet below grade, and 15 to 30 feet below grade. The 0 to 8 foot interval represents surface soil impacts; the 8 to 15 foot interval UST related impacts; and the 15 to 30 foot interval is indicative of water table and vadose zone contamination. The following graphic models of the distribution of soil contamination were developed using the SpillCAD computer program:

- TPH in soils from a depth of 0 to 8 feet below grade
- TPH in soils from a depth of 8 to 15 feet below grade
- TPH in soils from a depth of 15 to 30 feet below grade

Queries attempted for BTEX, GRO and DRO soil contamination in the depth intervals 0 -8' and 8 - 15' below grade yielded little information because the databases were limited, and at locations where these analyses had been performed, these parameters were seldom detected. Copies of each of the data queries performed are included in Appendix M.

Overlays generated for BTEX, GRO and DRO soil contamination in the depth interval 15 - 30' below grade were used exclusively for volumetric calculations. The areal extent of BTEX, GRO and DRO soil contamination in the depth interval 15'-30' below grade very closely approximates the groundwater isoconcentration maps developed for each of these petroleum hydrocarbon species. This outcome is not surprising considering that this soil contamination is directly associated with the massive gasoline/diesel present at the southern portion of DPSC. Therefore, separate maps were not prepared from these particular Spillcad overlays.

7.2.3 Volumetric Estimates of Petroleum Hydrocarbon Contaminated Media

The following quantitative analyses of soil contamination were conducted using the SoilVol module of the SpillCAD program:

- The volume of TPH contaminated soil (i.e., >500 ppm) from a depth of 0 to [illegible] feet below grade was estimated to be 19,678,027 cubic feet (i.e., 72[illegible],816 cubic yards).

- The mass of BTEX contained in soils from a depth of 15 to 30 feet below grade was estimated to be 78,172 kg.

- The mass of BTEX contained in soils from depth ranges of 8 to 15 feet and 0 to 8 feet was determined to be insignificant.

- The volume of TPH contained in soil from a depth of 15 to 30 feet was estimated to be 354,957 gallons.

- The mass of GRO contained in soils from a depth of 15 to 30 feet below grade was estimated to be 433,728 kg.

- The mass of DRO contained in soils from a depth of 15 to 30 feet below grade was estimated to be 242,709 kg.

- The volume of TPH contained in soil from a depth of 0 to 8 feet was estimated to be 81,825 gallons.

No attempt was made to generate volumetric estimates of contaminated groundwater due to the very limited data available to delineate its vertical extent (only two deep well screen intervals were sampled during the Phase I RI).

7.2.4 Free Product Distribution

Using the SpillCAD program, a free product distribution map was developed based on the fluid level data collected by Versar in March 1995. The free product distribution does not distinguish between multiple phases of free product (e.g., gasoline and oil); it is merely a representation of total product thickness. In order to obtain a quantitative estimate of the volume of free product on the groundwater table, the WellVol module of the SpillCAD program was run. The results of this analysis indicated that the volume of free product is 1,176,691 gallons. This value may be slightly high, because the model domain extends beyond the southern property boundary, resulting in the extrapolation of data in this region.

7.2.5 Groundwater Contamination

The following dissolved phase groundwater contamination maps were developed using the SpillCAD program:

- TPH in groundwater
- BTEX in groundwater
- Benzene in groundwater

- GRO in groundwater
- DRO in groundwater

Contaminant distribution trends in groundwater were used to provide a framework for the evaluation of potential transport pathways. Actual pathline analysis was not performed as part of the Spillcad Modeling effort. Spillcad's particle tracking module assumes homogeneous, isotropic aquifer conditions; however, during Phase I of the RI, it was determined that this assumption was inconsistent with subsurface conditions observed at DPSC. Copies of the data queries used to generate the groundwater maps listed above are included in Appendix M.

7.2.6 Evaluation of Spillcad™ Maps

Overlays generated by Spillcad supported model-derived calculations of the volumes of contaminated media presented in sections 7.2.2 and 7.2.3. In addition, the maps developed from each of the Spillcad queries were used in the attempt to differentiate between multiple releases, by comparing their spatial relationships and chemical characteristics. Whenever possible, inferences with respect to the probable location of source areas were drawn from these maps. The limitations associated with Spillcad-generated soil isoconcentration maps are discussed in section 7.2.1 under Uncertainties/Limitations. It is believed that the selection of three discrete intervals for the preparation of these maps leads to an accurate representation of the distribution of TPH-contaminated soils at DPSC. The definition of narrower intervals for mapping would overly constrain the geochemical database by eliminating areal coverage (e.g., mapping an interval of TPH soil contamination as limited as the increment 10-12 feet below grade would create too small a database query to generate interpretable contour patterns).

7.2.6.1 Free Product

Approximately 54 acres of the DPSC site are underlain by free product. According to chemical analysis, the free product consists of a 2:1 to 3:1 mixture of gasoline to diesel fuel with a specific gravity of 0.75. The Wellvol module of SPILLCAD calculated an *in situ* volume of approximately 1.2 million gallons of free product. Since the southern model domain boundary extends slightly beyond the DPSC property line, it is estimated that *in situ* free product volume for DPSC proper is at least one million gallons. This volume represents extractable petroleum hydrocarbons only and does not include irreducible hydrocarbons.

Actual free product thicknesses range from 0 to 1.84 feet. (TPH free product thickness contours are presented in Figure 7-1.) Three separate maximas are evident; one (1.84') between monitoring wells MW-3 and MW-5 near building 28 in the southwestern portion of the site, a second (1.84') located just to the west of MW-7 and just to the south of building 9, and a third (1.44') in the vicinity of MW-11 immediately to the east of building 14. The latter two free product maxima form the apparent axis of a southwest-northeast trending free product plume, while the first may represent a separate, secondary axis and possibly a different migration pathway. Based on the overall trend of free product occurrence at DPSC, these hydrocarbons appear to be entering the site from somewhere to the south and probably near the southeast corner near MW-7. Based on this data, it is believed that the most logical pathway is flow of the free product from the west along the Pollock Street/Packer Avenue sewer with a lateral entering the site from the southeast representing the primary transport mechanism onto DPSC.

7.2.6.2 TPH in Soils > 500 ppm (Depth Interval 0 - 8')

Mapping of TPH isoconcentrations in the depth interval 0-8' below grade was performed to evaluate the location and nature of possible near surface releases. TPH soil isoconcentrations for this depth interval are presented in Figure 7-2. The occurrence of petroleum hydrocarbons in the surficial soils at DPSC appears to be sporadic and limited in area. However, several factors must be considered in the evaluation of this Spillcad overlay:

- The geochemical database for shallow soil samples is limited in comparison to the deeper soil horizons, particularly to those collected at or near the soil/water interface. The lack of significant PID readings in split-spoon samples screened in the upper 8 feet of soil during the ES&E and Phase I RI (Table 4-7) investigations tend to support a sporadic occurrence of TPH in this soil horizon.

- A cut-off concentration of 500 ppm was chosen for use in the development of this Spillcad overlay for two reasons: 1) this concentration represents the PADER clean-up standard for an older release and 2) a significantly lower cut-off concentration would result in the identification of trace amounts of TPH which are likely to be ubiquitous at DPSC because the siting of sampling locations was constrained to the numerous roads and parking areas at this facility.

TPH isoconcentrations >500 ppm occur in two distinct areas at DPSC; one in the north central portion of the site and a second in the vicinity of MW-3 near the southwestern part of the facility. The TPH occurrence in the north central portion of the site is associated with a release from DPSC's 6,000-gallon UST located along Oregon Avenue. This release is identifiable only by EPA Method 418.1; analysis of soil gas chromatograms from soil samples collected at this location did not confirm with gasoline, diesel, kerosene or lube oil patterns. Hydrocarbons detected here represent a weathered fuel, probably diesel in nature.

Possibly the two TPH maxima located along Aleshire Street, just north of the eastern portion of Building 3 and at Building 8, are related to the Oregon Avenue release. The location of fuel lines associated with the 6,000-gallon UST are unknown. From north to south, the three isoconcentration maxima in this area have areal extents of approximately 1, 0.75, and 0.5-acres, respectively. However, the actual extent of TPH contamination associated with the Oregon Avenue UST location has not yet been delineated.

The source of TPH concentrations >500 ppm in the vicinity of the central portion of Building 8 is unknown. TPH levels >500 ppm in the vicinity of MW-3, located south of the western portion of Building 4, may be related to a documented release from corroded diesel fuel lines that formerly existed in the general area.

7.2.6.3 TPH in Soils >200 ppm (Depth Interval 8'-15')

Mapping of TPH isoconcentrations in the depth interval 8'-15' was performed to assess the nature and level of petroleum hydrocarbon contamination associated with the depth interval in which all of the DPSC USTs are or were formerly located. Due to the low levels of TPH in this depth interval, the cut-off concentration for mapping was adjusted downward to >200 ppm. TPH soil isoconcentrations for this depth interval are presented in Figure 7-3.

Three TPH isoconcentration maxima were revealed in the Spillcad overlay; one in the northwest corner of DPSC, a second in the southeast section, south of Building 9, in the immediate vicinity of MW-7, and a third in the north-central part of the site near Oregon Avenue. The northwest corner of DPSC, where TPH concentrations reach a maximum of 225 ppm, is approximately four acres in area and characterized as having extensive fill deposits reaching a maximum thickness of 22'. The physical characteristics of these fill deposits are not well known and possibly the TPH contamination is directly associated with these fill materials. At this location, TPH contamination is in the diesel organics range and, as indicated in the DRO groundwater isoconcentration overlay, is consistent with the presence of low level DRO concentrations in groundwater that also occur at this location. This low level DRO soil contamination was characterized during the DPSC Fuel Contamination Study as an "older" release, unrelated to the massive TPH contamination associated with the free product plume along the southern portion of DPSC.

The second TPH concentration maxima occurs at the location of MW-7, where TPH was detected at a level of 236 ppm, and is approximately 3 acres in size. MW-7 is in close proximity to the former 10,000-gallon DDT USTs located at the southeast portion of the DPSC. This soil contamination is related to petroleum hydrocarbons which were previously used as a carrying agent for the DDT and that may have been released during overfill of these tanks.

A third area of TPH concentration occurs in the north-central part of DPSC along Oregon Avenue. A TPH level of 9,800 ppm was detected in a soil sample collected at a depth of 14 feet near the easternmost 10,000-gallon diesel UST. The extent of this contamination has not yet been fully delineated. Its areal extent as indicated by the SPILLCAD overlay may be slightly exaggerated.

7.2.6.4 TPH in Soils >500 ppm (Depth Interval 15 - 30')

The mapping of TPH isoconcentrations in soils in the depth interval 15'-30' provides a good indication of the distribution of petroleum hydrocarbon contamination at and below the soil/water interface. A cut-off concentration of 500 ppm was selected to identify TPH concentrations exceeding PADER clean-up standards and to focus on maximum TPH concentration trends and their likely sources. The total area within the 500 ppm cut-off isoconcentration at the southern portion of DPSC is approximately 31 acres. TPH soil isoconcentrations for this depth interval are presented in Figure 7-4.

Three TPH isoconcentration maxima are evident on this Spillcad overlay. Two occur along the southern portion of DPSC, both showing axes which have a southwest-northeast trend. The highest observed TPH soil concentrations exceed levels of over 12,500 ppm near the eastern part of Building 9 and continuing into the vicinity of Building 14. A secondary concentration maxima occurs to the west of Building 30, where maximum concentrations reach 4500 ppm. These high TPH levels are correlated with high GRO, DRO and BTEX levels, all of which are directly associated with the massive gasoline/diesel free product plume that occurs in the area. The orientation of these maximum contaminant isoconcentration axes together with the abrupt decrease to levels below 500 ppm in a northerly direction suggest the presence of a source located somewhere south of the facility. There is a significant correlation between isoconcentration trends in this overlay with the product thickness trends presented in Figure 7-1.

The isolated TPH occurrence in the northwestern corner of DPSC attains a maximum concentration of only 850 ppm and is limited to the diesel organic range. The low levels of TPH contamination in this area and its discontinuity with the high levels of TPH along the southern portion of the site suggest that it is related to a different source, possibly to the fill materials known to be present in the northwestern corner of the facility.

7.2.6.5 Groundwater Isoconcentration Maps

Versar developed five separate groundwater isoconcentration maps from Spillcad overlays for correlation with the free product thickness map and to further evaluate probable contaminant transport pathways and source areas:

1. TPH concentrations >0.02 ppm (Figure 7-5)
2. BTEX concentrations >0.005 ppm (Figure 7-6)
3. Benzene concentrations >0.005 ppm (Figure 7-7)
4. GRO concentrations >0.5 ppm (Figure 7-8)
5. DRO concentrations >0.5 ppm (Figure 7-9)

The occurrence of TPH, BTEX and benzene concentrations exceeding method detection limits was limited to the southern portion of DPSC and appears to represent a single continous plume. The occurrence of GRO and DRO groundwater contamination showed a slightly broader areal extent about DPSC. Therefore, a higher cut-off concentration was chosen for mapping in an attempt to isolate separate source areas.

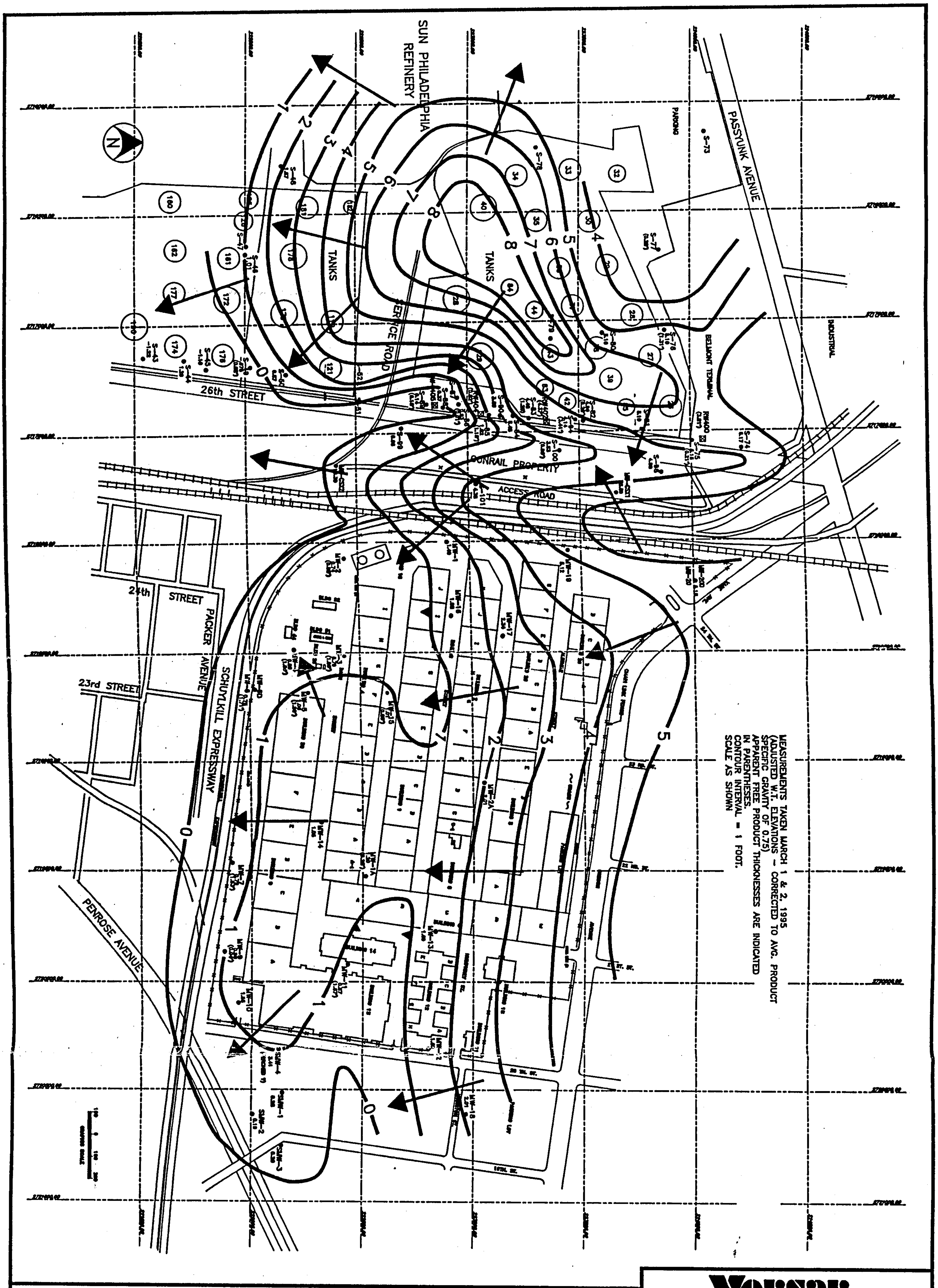
The following maximum concentrations and areal extents were observed for each of these petroleum hydrocarbon species:

Species	Maximum Concentration (Well)	Areal Extent
TPH	0.4 ppm (MW-1A)	54 acres
BTEX	57.5 ppm (MW-6)	54 acres
Benzene	37 ppm (MW-6)	57 acres
GRO	170 ppm (MW-15)	62 acres
DRO	170 ppm (MW-14)	71 acres

The isoconcentration maps for TPH, BTEX and benzene all correlate very closely with the distribution of free product and TPH contaminated soil >500 ppm (interval 15'-30') as shown in Figures 7-1 and 7-4, respectively. The geometry of groundwater contaminant plumes for these hydrocarbon species is very similar and shows no evidence of an upgradient source area (i.e., there is no continuity of these groundwater contaminants into the northern portion of DPSC). The areal extent of TPH, BTEX and benzene groundwater contaminants appears to be consistent with a dissolution of free product plume whose location is restricted to the southern portion of the installation. Based on these observations, the source for the free product plume and associated dissolved phase groundwater contaminant plumes appears to lie somewhere to the south of DPSC.

The areal extent of GRO and DRO groundwater contamination is also consistent with the spatial distribution of the free product but covers a slightly larger area than the free product, TPH, BTEX and benzene plumes. This is due to the occurrence of low levels of GRO and DRO detected in hydropunch and monitoring well locations in the northwest portion of DPSC. The occurrence of low levels of GRO and DRO groundwater contaminants to the northwest may be attributed to the presence of similar contaminants detected in the extensive fill deposits in that area. The isolated character of the DRO groundwater contaminant plume indicated in Figure 7-9 indeed suggests that it is unrelated to the massive free product plume to the south.

In summary, there appear to be two distinct areas of groundwater contamination that are discernible in the aquifer underlying DPSC: one associated with the massive free product plume developed along the southern portion of the facility, and a second, unrelated occurrence of DRO that may be attributable to contaminated fill materials present at the northwestern corner of the site.



MEASUREMENTS TAKEN MARCH 1 & 2, 1995
(ADJUSTED W.T. ELEVATIONS – CORRECTED TO AVG. PRODUCT
SPECIFIC GRAVITY OF 0.75)
APPARENT FREE PRODUCT THICKNESSES ARE INDICATED
IN PARENTHESES.
CONTOUR INTERVAL = 1 FOOT.
SCALE AS SHOWN

WATER TABLE ELEVATION MAP AND FREE PRODUCT THICKNESSES IN DPSC, SUN OIL REFINERY AND SEPTA MONITORING WELLS (MARCH 1995)

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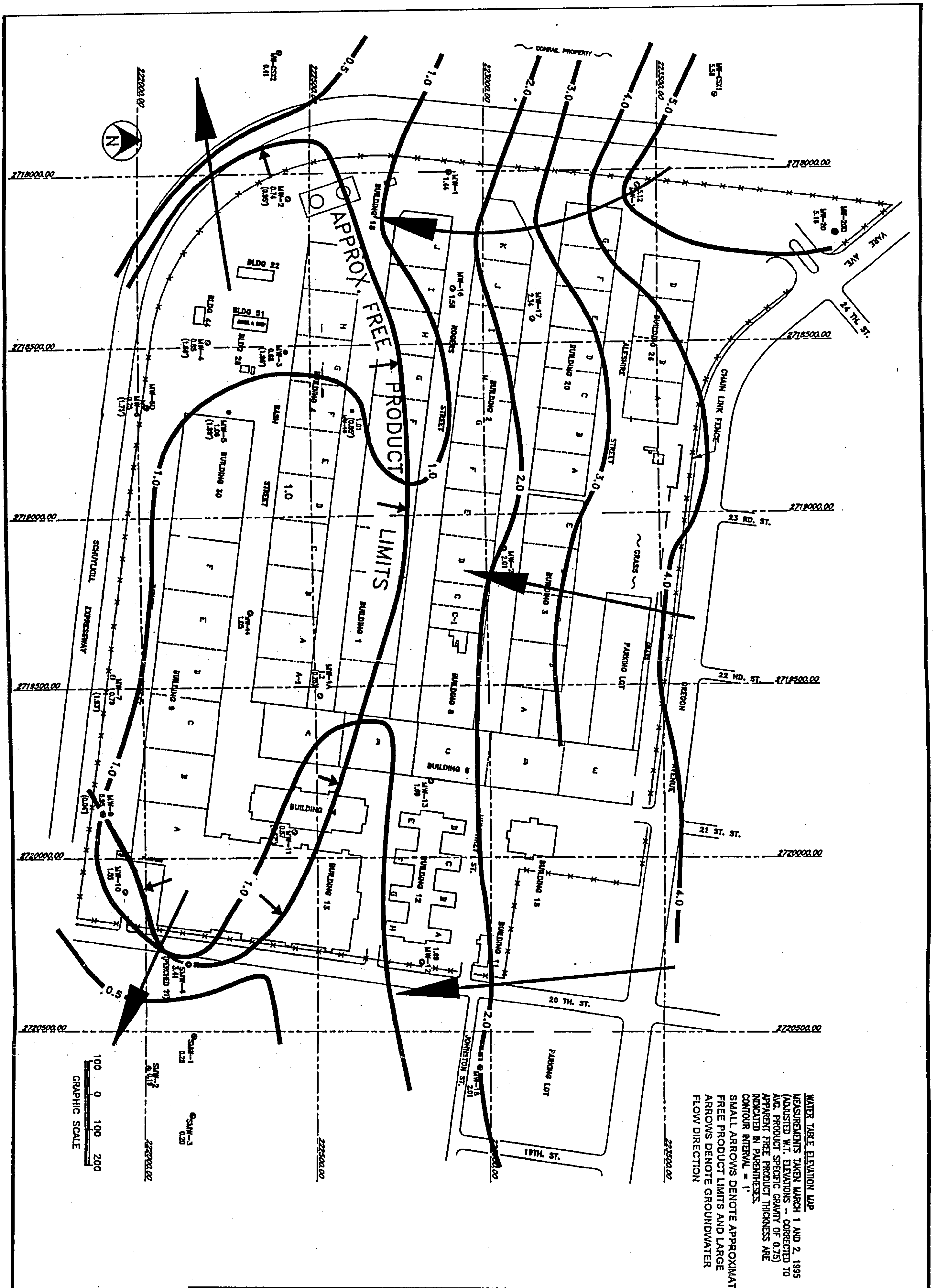
BRISTOL, PA 19007
(215) 788-7844

DATE: 04/15/95
SCALE: AS SHOWN
DWG. BY: V.S.

FIGURE 6-1



WATER TABLE ELEVATION MAP

MEASUREMENTS TAKEN MARCH 1 AND 2, 1995
(ADJUSTED W.T. ELEVATIONS – CORRECTED TO
AVG. PRODUCT SPECIFIC GRAVITY OF 0.75)
APPARENT FREE PRODUCT THICKNESS ARE
INDICATED IN PARENTHESES.
CONTOUR INTERVAL = 1'
SMALL ARROWS DENOTE APPROXIMATE
FREE PRODUCT LIMITS AND LARGE
ARROWS DENOTE GROUNDWATER
FLOW DIRECTION

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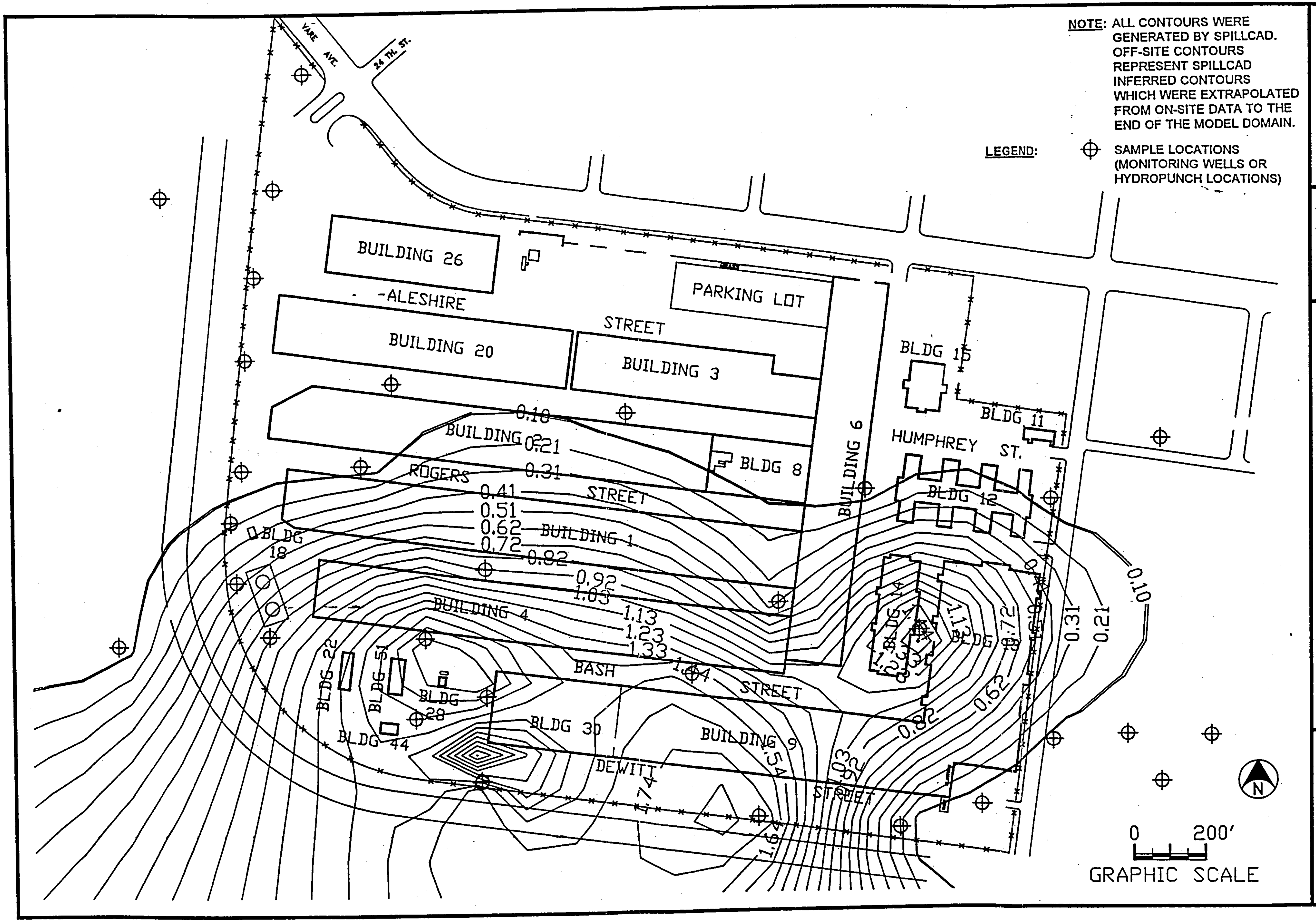
WATER TABLE ELEVATION MAP AND FREE PRODUCT THICKNESS IN DPSC MONITORING WELLS (MARCH 1995)

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: AS SHOWN
DWG. BY: D.M.

FIGURE 6-2



NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND:

⊕ SAMPLE LOCATIONS (MONITORING WELLS OR HYDROPUNCH LOCATIONS)

FIGURE 7-1

FREE PRODUCT THICKNESS MAP

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SCALE: NOTED
DWG. BY: D.M.

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LEGEND: ● SOIL SAMPLE LOCATIONS (SOIL BORINGS AND UST CONFIRMATORY SAMPLES)

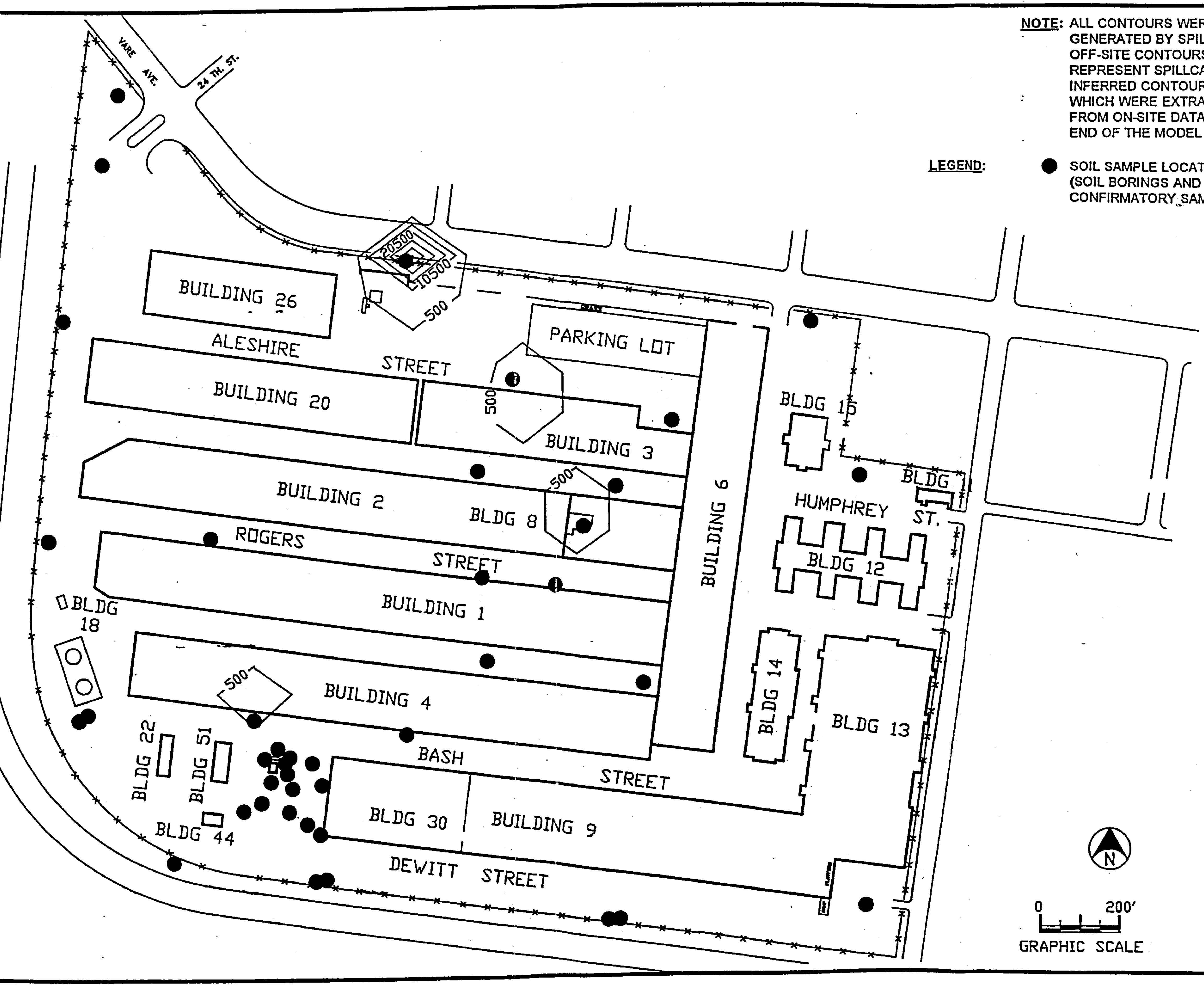

FIGURE 7-2

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

TPH SOIL CONCENTRATIONS (0 - 8') >500 PPM

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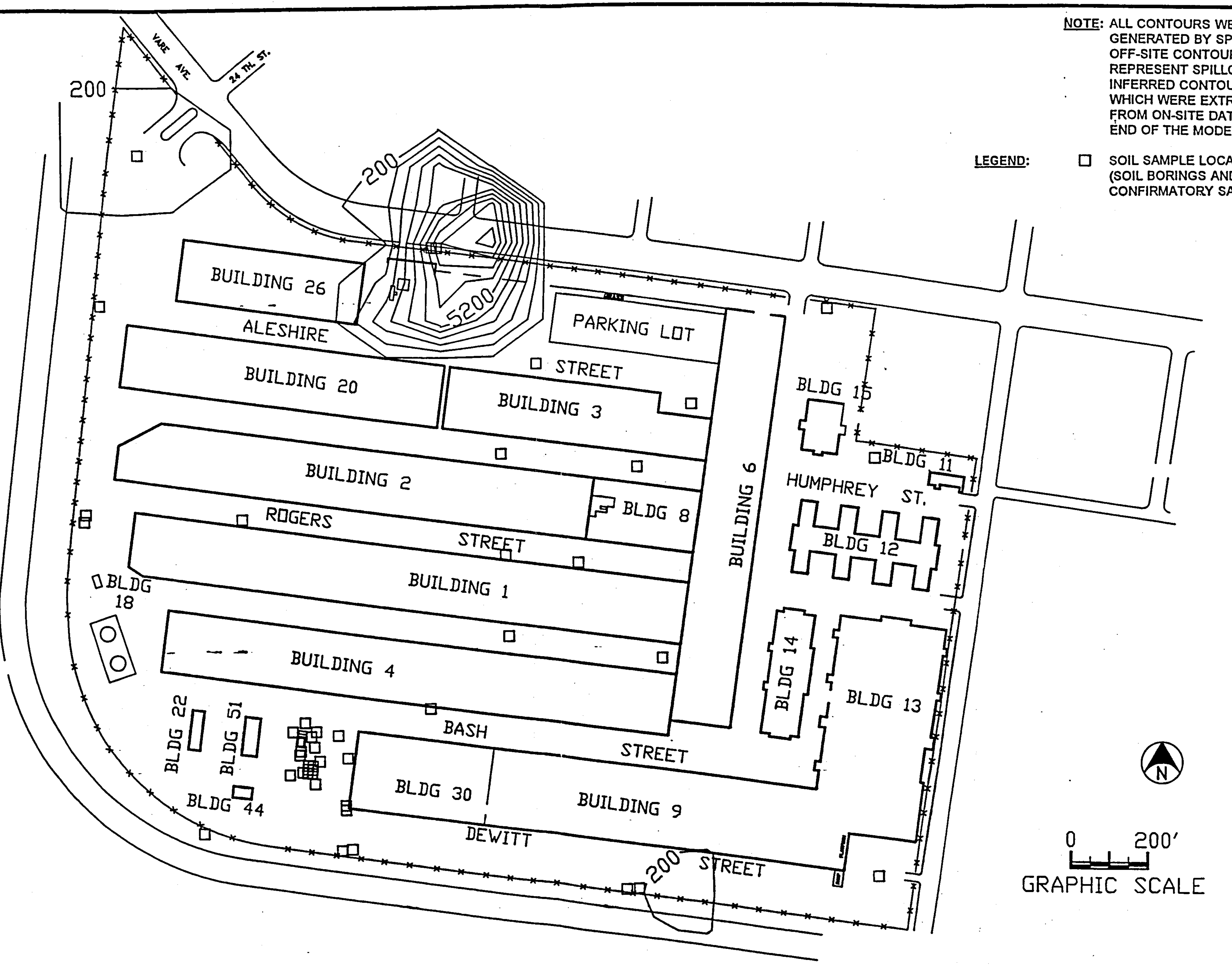

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ☐ SOIL SAMPLE LOCATIONS (SOIL BORINGS AND UST CONFIRMATORY SAMPLES)

FIGURE 7-3

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

TPH SOIL CONCENTRATIONS (8-15')
>200 PPM

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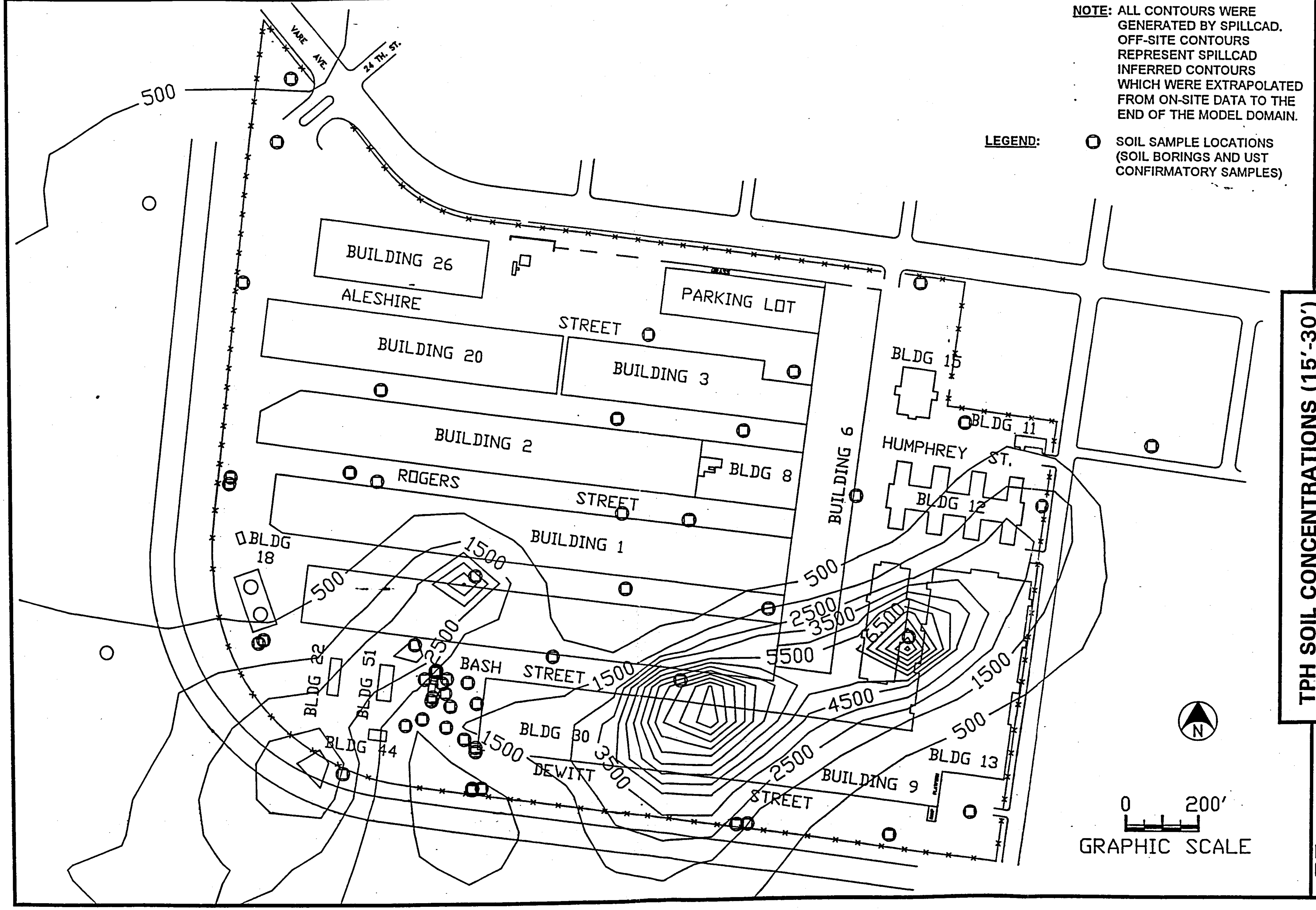

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ○ SOIL SAMPLE LOCATIONS (SOIL BORINGS AND UST CONFIRMATORY SAMPLES)

FIGURE 7-4

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

TPH SOIL CONCENTRATIONS (15'-30') > 500 PPM

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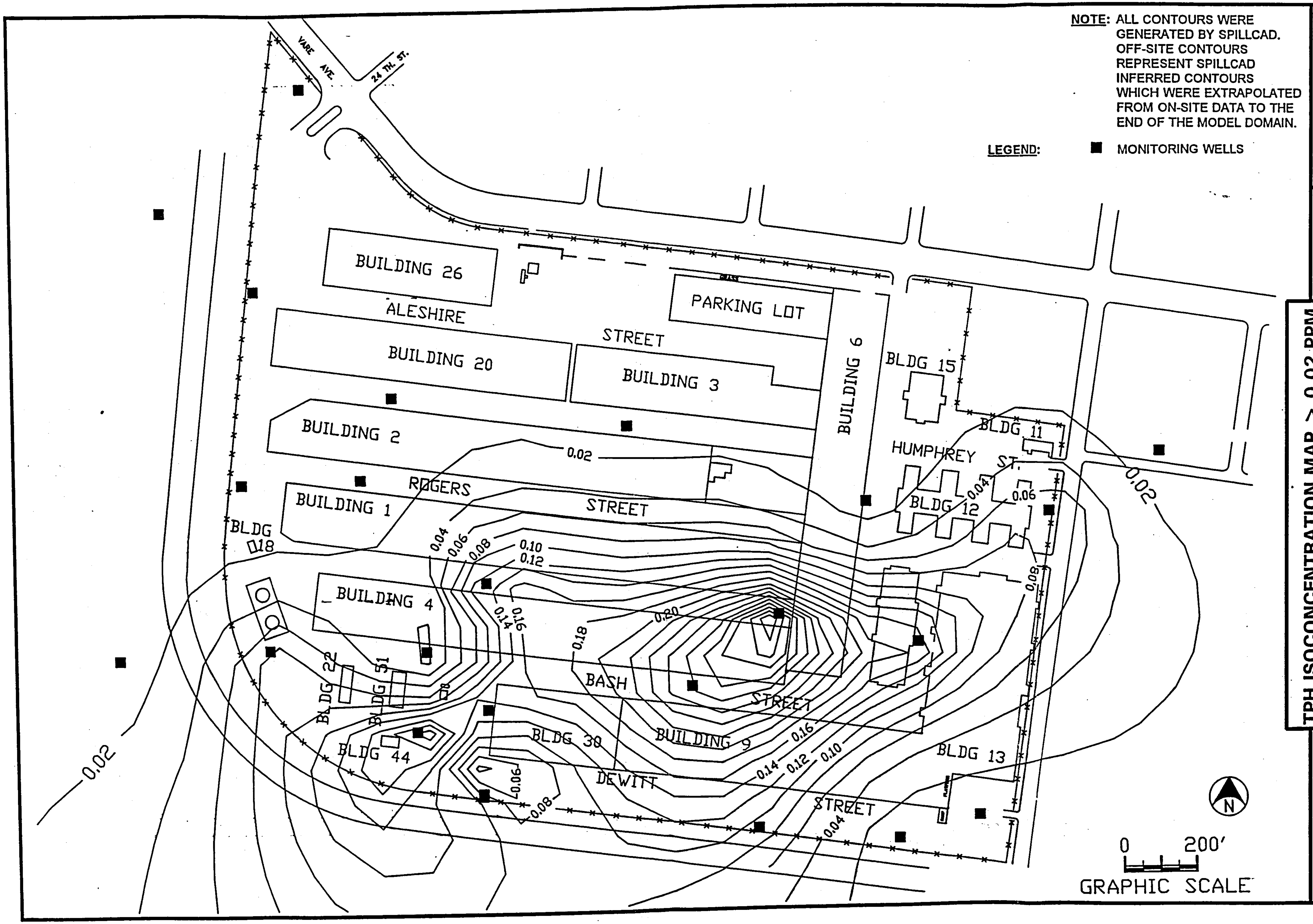

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ■ MONITORING WELLS

FIGURE 7-5

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

TPH ISOCONCENTRATION MAP > 0.02 PPM
(GROUNDWATER)

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FIGURE 7-6

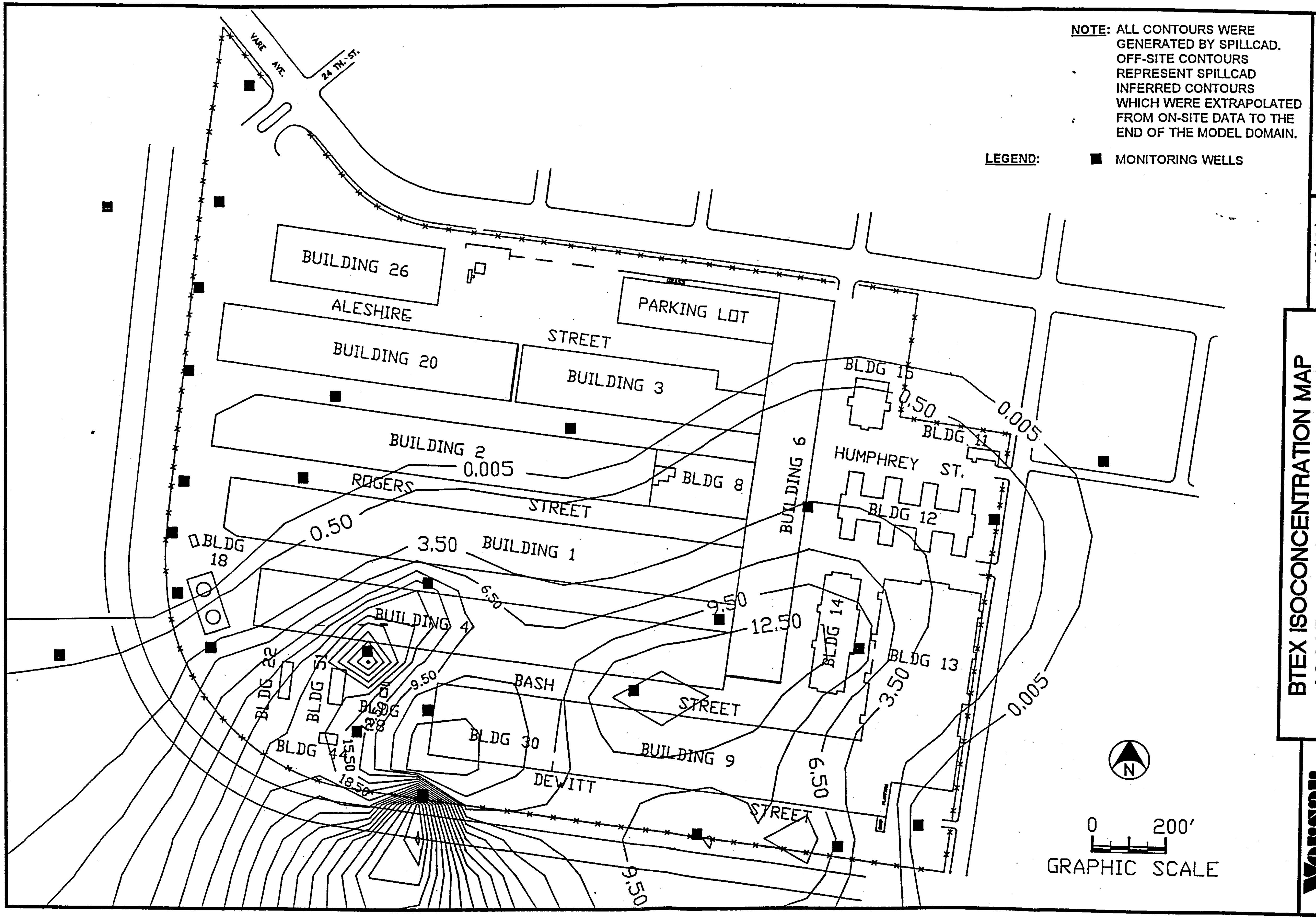
BTEX ISOCONCENTRATION MAP >0.005 PPM (GROUNDWATER)

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ■ MONITORING WELLS



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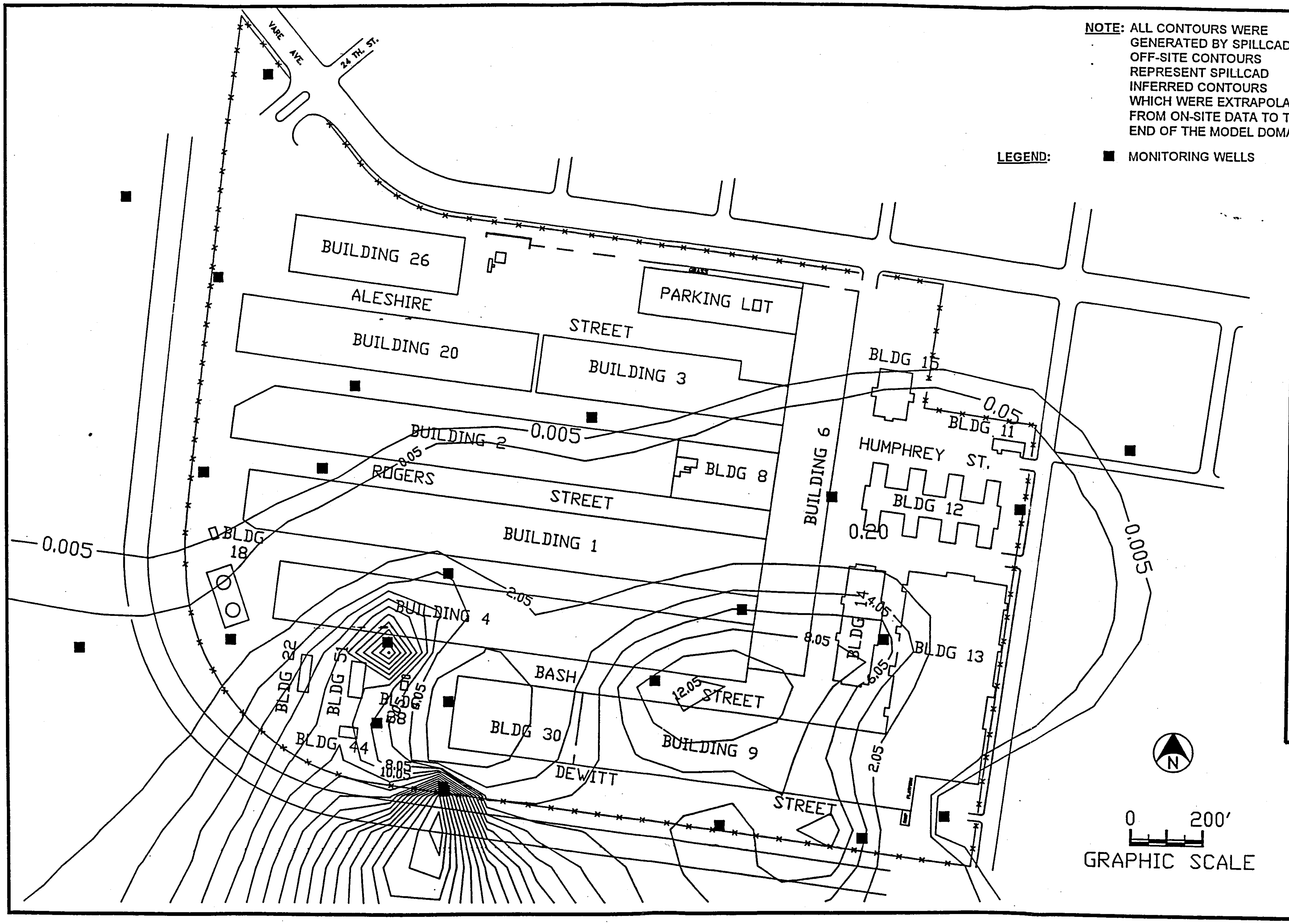

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ■ MONITORING WELLS

BENZENE ISOCONCENTRATION MAP >0.005 PPM (GROUNDWATER)

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DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

FIGURE 7-7

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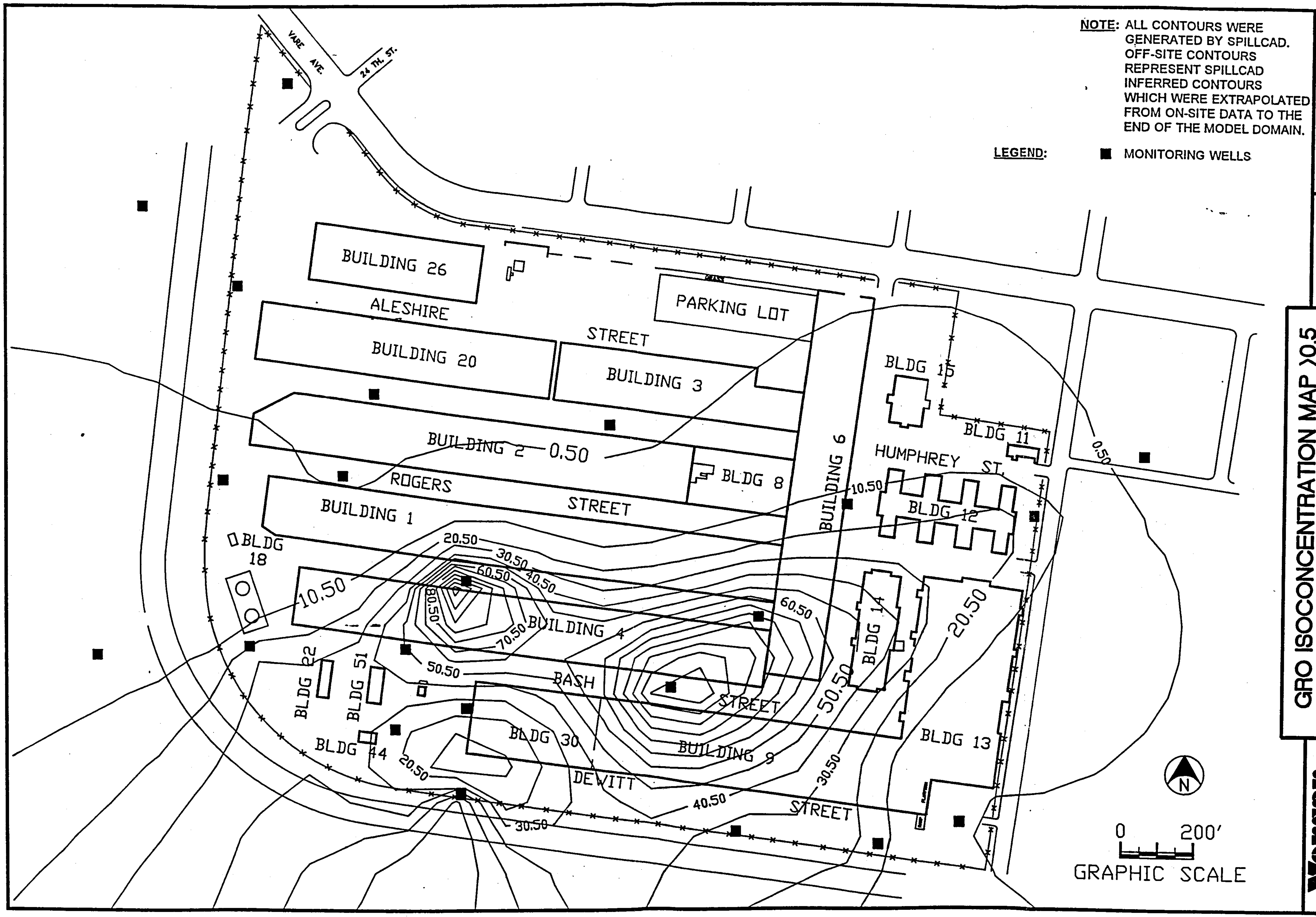

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LEGEND: ■ MONITORING WELLS

FIGURE 7-8

GRO ISOCONCENTRATION MAP >0.5 (PPM GROUNDWATER)

DEFENSE PERSONNEL SUPPORT CENTER

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

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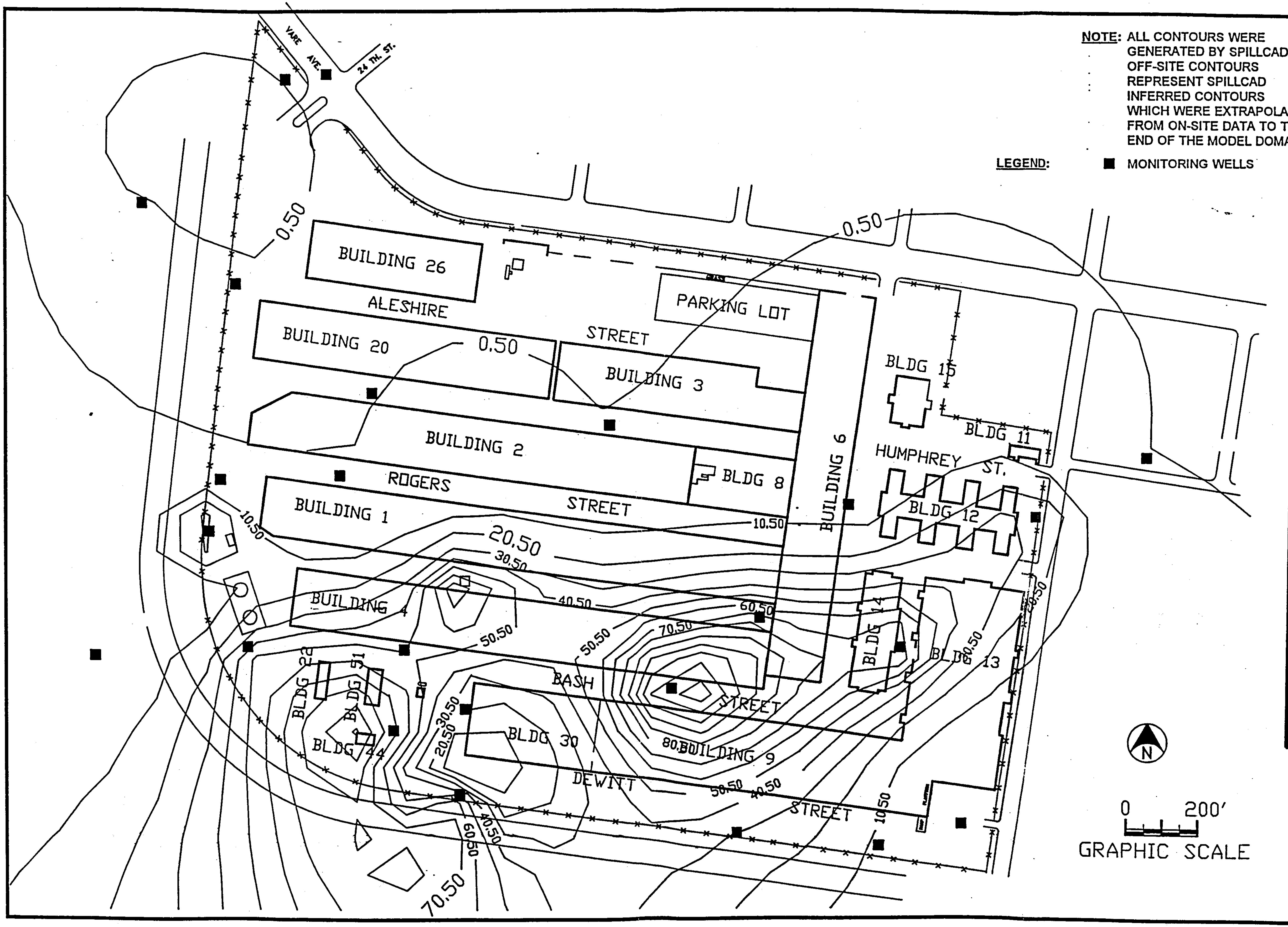

NOTE: ALL CONTOURS WERE GENERATED BY SPILLCAD. OFF-SITE CONTOURS REPRESENT SPILLCAD INFERRED CONTOURS WHICH WERE EXTRAPOLATED FROM ON-SITE DATA TO THE END OF THE MODEL DOMAIN.

LEGEND: ■ MONITORING WELLS

FIGURE 7-9

DATE: 05/15/95
SCALE: NOTED
DWG. BY: D.M.

DRO ISOCONCENTRATION MAP >0.5 (PPM GROUNDWATER)

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TABLE 7-1
DPSC GEOCHEMICAL DATABASE SUMMARY

SITE ASSESSMENT	DATE	SOIL SAMPLES	GROUNDWATER SAMPLES	PARAMETERS ANALYZED
DPSC Fuel Contamination Study	1988	78	None	TPH
Environmental Science and Engineering Report	1991	65	7	TPH - California Method, BTEX
Site Characterization for the New Admin/ADP Bldg.	1992	37	4	TPH, BTEX
Phase I RI Report*	1995	29	25	TPH, GRO, DRO, BTEX
DPSC Gasoline Station UST Closures	1994	28	None	TPH, GRO, DRO, BTEX, Lead
Oregon Avenue UST Closures	1994	13	None	TPH, GRO, DRO
Rogers Street and Bldg. 8 UST Closures	1995& 1994	8	None	TPH, BTEX, DRO, PCBS
DDT UST Closures	1994	55	7	TPH, Pesticides

* Eleven free product samples were also collected and analyzed for TPH, GRO, DRO and BTEX.

8.0 EXTENT OF CONTAMINATION FROM DDT UNDERGROUND STORAGE TANKS

KEMRON Environmental Services, Inc. (KEMRON) conducted a limited DDT investigation at the Defense Personnel Support Center, Philadelphia, Pennsylvania. The investigation was conducted in response to the discovery of DDT contamination in the vicinity of former underground tanks used to store DDT and in consideration of contamination potentially present beneath the former DDT mixing room floor and in floor drains in and around Building 9 of the complex. KEMRON's characterized and delineated the extent of DDT contamination to identify areas that might require further investigation and/or remediation as part of the BRAC closure process.

The investigation identified elevated levels of DDT above Land Ban requirements in soils collected from three borings south of the DDT UST excavation pit and beneath the concrete slab floor of the mixing room. Based on the DDT concentrations detected in these samples, the affected soils would require incineration. Groundwater also was found to contain low levels of DDT. The highest concentration of DDT found in the water samples was 1 microgram per liter, suggesting minimal migration of the DDT from the impacted soils.

Future work should include an investigation to determine if the contamination found beneath the floor in Building 9 extends beyond the building. Such an investigation would focus on the potential subsurface routes of contamination, notably the floor drain, which runs a long distance before interfacing with a sewer. The investigation should be designed to determine if contamination resulted from exfiltration from the drainage piping.

A separate report documenting the findings of the DDT investigation was prepared and submitted to the ACOE. The complete text of the DDT Investigation Report is appended as Attachment 1.

9.0 DATA SUMMARY AND COMPARISON - NON-PETROLEUM RELATED PARAMETERS

9.1 Subsurface Soils

A total of 29 subsurface soil samples were collected during Phase I RI monitoring well installation. With the exception of MW-18 and MW-20D, two samples were collected at each monitoring well location. Because investigation of groundwater and the free product plume were of primary interest, samples were generally collected at and just above the soil/water or soil/free product interface. Near surface soil samples were not collected during the Phase I RI. Therefore, a detailed discussion of potential contaminant migration from overlying soils can not be presented. In general, concentrations of organic constituents were greater in the deeper samples. No obvious pattern existed for inorganic constituents with respect to sample depth.

9.1.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) detected in subsurface soil samples are primarily considered petroleum related (i.e., BETX). Certain samples exhibited extremely high concentrations of petroleum-related contaminants. In these samples, sample dilution and the associated high detection limits resulted in data reported in less than values exceeding potential ARAR standards for the non-petroleum related compounds. The presence or absence of non-petroleum related compounds cannot be evaluated in these samples.

Non-petroleum related VOCs detected in subsurface soil samples consisted of methylene chloride (7.3 to 920 ppb), acetone (14 to 10,000 ppb), and 2-butanone (20 and 21 ppb). The 2-butanone was detected in only two samples. Methylene chloride and acetone detection was more common, in 12 and 19 samples, respectively. Both methylene chloride and acetone are common laboratory chemicals and can be an indication of laboratory contamination, although the levels of these two compounds appear too high to be attributed to solely to laboratory or field sampling contamination. Trip blanks routinely contained acetone, but not methylene chloride; field equipment blanks did not contain either acetone or methylene chloride.

9.1.2 Semi-Volatile Organic Compounds

A total of 21 semi-volatile organic compounds (SVOCs) were detected in subsurface soil samples. Ten of the 21 SVOCs were detected only in the samples collected from monitoring well location MW-10. A review of boring logs for MW-10 revealed that both samples from MW-10 were collected from fill material. Based on this information, contaminated fill is suspected to be the source of the SVOCs at location MW-10. The SVOCs detected only at MW-10 are summarized below:

Acenaphthylene
Benzo(a)anthracene
Benzo(k)fluoranthene
Dibenzo(a,h)anthracene
Acenaphthene
Chrysene
Indeno(1,2,3-cd)pyrene
Benzo(g,h,i)perylene
Anthracene
Benzo(b)fluoranthene

Two other SVOCs were detected at MW-10 and one additional monitoring well location. Dibenzofuran was identified in sample MW-15 (S-18) and benzo(a)pyrene was detected in sample MW-9 (S-7).

Several SVOCs were detected primarily at locations identified in boring logs as exhibiting petroleum odors and found to contain petroleum-related VOCs. These SVOCs are constituents of diesel and fuel oil range petroleum products and are considered to be related to the underlying petroleum contamination of groundwater. Naphthalene, 2-methylnaphthalene, and phenanthrene were the most commonly detected of these SVOCs. Fluorene, fluoranthene, and pyrene were detected less often.

The three other SVOCs detected were di-n-butylphthalate, bis(2-ethylhexyl)phthalate, and di-n-octylphthalate. No definitive pattern could be determined for the occurrence of these compounds. However, phthalates are known to be common laboratory and equipment related contaminants, and may not be representative of site conditions. These compounds were also found in field equipment blanks at concentrations approximately equal to those found in the field samples.

9.1.3 Inorganic Compounds

In general, inorganic constituent concentrations in subsurface soils occurred within ranges expected for a site with various soil types. However, one pattern was apparent. Samples collected from monitoring well locations MW-9, and particularly MW-10, exhibited the highest concentrations for 16 of the 23 inorganic parameters monitored. Lead was observed to be 1 to 2 orders of magnitude greater at MW-10. Other differences were less discrete. The elevated metals concentrations in the southeast corner of the site appear to correlate directly to the presence of extensive fill material observed at location MW-10. The ranges of inorganic parameter concentrations across the site are presented in Table 9-1.

9.1.4 Pesticides/PCBs

The detection of pesticides/PCBs in subsurface soils was limited to low concentrations of three compounds, 4,4-DDT, delta-BHC, and endrin. Sample MW-9 (S-8) exhibited 7.9 ppb of 4,4-DDT. Sample MW-15 (S-18) exhibited 8.1 ppb of delta-BHC and 8.1 ppb of endrin. No other sample was found to contain pesticides or PCBs.

9.2 Groundwater

Although groundwater samples were collected from 25 monitoring wells during the Phase I RI primarily to document petroleum plume related contamination, the samples were analyzed for full TCL and TAL parameters to gain additional information on overall groundwater quality beneath the site. The findings of the groundwater sampling are discussed in the following subsections.

9.2.1 Volatile Organic Compounds

VOCs detected in groundwater samples are primarily considered petroleum related (i.e., BETX). Certain samples exhibited extremely high concentrations of petroleum-related contaminants. In these samples, dilution was required in order to conduct the analysis within the calibrated range of the laboratory instrumentation. Following analysis of the diluted samples, the corresponding dilution factor is applied to both the measured concentrations and to the detection limits for non-detected parameters. This results in high detection limits for non-detected parameters, which are reported as "less than" the detection limit value. In many cases, this high detection limit exceeds potential ARAR standards for the non-petroleum related compounds. Consequently, the presence or absence of the non-petroleum related compounds in these diluted samples cannot be evaluated because of the "masking effect" of the petroleum hydrocarbon related compounds.

Non-petroleum related VOCs detected in groundwater consisted of methylene chloride (31 and 62 ppb), acetone (15 to 110 ppb), tetrachloroethene (6 ppb), chlorobenzene (49 ppb), and styrene (63 ppb). Methylene chloride and acetone, considered potential laboratory contaminants, were identified in 2 and 3 samples, respectively, and were also found in the associated trip blanks. Tetrachloroethene, chlorobenzene, and styrene were each identified at one sample location, at levels slightly exceeding detection limits.

9.2.2 Semi-volatile Organic Compounds

A total of 11 SVOCs were detected in groundwater samples collected during the Phase I RI. The most commonly detected SVOCs (naphthalene, 2-methylnaphthalene, and phenanthrene) are constituents of diesel and fuel oil range petroleum products. Petroleum-related VOCs were detected at all locations exhibiting concentrations of these three SVOCs. Four randomly detected phenol compounds may also be petroleum-related contaminants. The phenols were detected at low concentrations in groundwater wells located in the southern portion of the site, an area impacted by free petroleum product.

Pyrene and benzoic acid were each detected at single locations, at concentrations slightly exceeding detection limits. Di-n-butylphthalate and bis(2-ethylhexyl)phthalate were detected in various samples without a discernible pattern. Di-n-butylphthalate was detected in a laboratory blank and bis(2-ethylhexyl)phthalate was identified in an equipment blank. Thus, the presence of these compounds in the site environment is questionable.

9.2.3 Inorganic Compounds

The detection of potentially elevated levels of inorganic constituents in groundwater was limited. No inorganic constituent was detected at extremely elevated concentrations in total or dissolved samples. Since background has not been established for the site, a generic discussion of inorganic concentrations is provided. This discussion focuses on the dissolved concentrations, as they are believed to better represent the characteristics of the aquifers.

Few parameters exceeded maximum contaminant levels (MCLs) or secondary MCLs (SMCLs) in filtered samples collected across the site. However, concentrations of iron and manganese exceeded SMCLs at most monitoring well locations. This finding corroborates literature information that suggests shallow groundwater in the Philadelphia area has been impacted by discharges from sewers and other sources of surface runoff and wastewater. These discharges have resulted in an overall degradation of groundwater, with iron, manganese, magnesium, chloride, and sodium the primary contaminants. The site-specific analytical data do not provide evidence of site related contamination for any of these constituents.

Aluminum concentrations exceeded the SMCL at 5 locations. Aluminum was detected at 5.5 ppm in MW-20, an order of magnitude greater than the next highest concentration. Lead exceeded the MCL at one location, MW-4 (0.094 ppm). This concentration was one order of magnitude greater than the closest concentration detected. No other constituent was detected in excess of MCLs or SMCLs in filtered groundwater samples collected during the Phase I RI.

9.2.4 Pesticides/PCBs

Five pesticide compounds were detected in groundwater at levels slightly exceeding detection limits. No PCBs were detected in the analysis of groundwater samples.

Endosulfan sulfate was detected in samples MW-6D, MW-20D, and an equipment blank (EB-2). Concentrations ranged from 0.13 ppb to 0.19 ppb. Alpha-BHC was detected in sample MW-11 at 0.13 ppb. Beta-BHC was detected at 0.07 ppb in sample MW-12. Delta-BHC was detected at 0.5 ppb in sample MW-5. Sample MW-4 was found to contain 0.69 ppb of 4,4-DDE.

TABLE 9-1
RANGES OF INORGANIC CONSTITUENTS IN SUBSURFACE SOILS

CONSTITUENT	RANGES OF CONCENTRATION (PPM)
Aluminum	2,700 to 20,000
Antimony	10 U to 2,100
Arsenic	0.45 U to 14
Barium	13 to 430
Beryllium	0.51 U to 7.0
Cadmium	0.51 U to 3.8 U
Calcium	220 to 35,000
Chromium	7.9 to 38
Cobalt	3.2 to 21
Copper	6 U to 610
Cyanide	0.54 U to 4.3
Iron	4,400 to 50,000
Lead	1.9 to 1,200
Magnesium	570 to 6,800
Manganese	29 to 2,100
Mercury	0.25 U to 1.3
Nickel	4.5 U to 150
Potassium	160 to 1,300
Selenium	0.2 U to 0.39
Sodium	52 to 500
Thallium	0.25 U to 0.39
Vanadium	6.6 to 42
Zinc	13 to 220

U - Not Detected; the number preceding the U indicates the detection limit.

10.0 DATA VALIDATION

The analytical data for the DPSC Phase I RI were generated by Kemron Environmental Services, Inc., a ACOE Missouri River District (MRD) certified laboratory, in accordance with the U.S. EPA's Contract Laboratory Program (CLP) protocols. The CLP protocols specify rigorous (i.e., EPA Level IV) quality assurance (QA) and quality control (QC) requirements and define limits that ensure a high probability of detecting invalid data for either all or the majority of the measurement systems.

Laboratory data quality objectives (DQOs) for this project were developed in the Project Operations Work Plan to ensure the validity and certainty of analytical results. In addition, the CLP requirements for laboratory analyses provide a high level of confidence that the data are reliable. The data generated from this Phase I RI will ultimately be used for site characterization, source identification (i.e., the determination of potentially responsible parties), environmental monitoring, risk characterization, engineering support studies, and the analysis of potential remediation strategies. Therefore, indicators of data quality, including accuracy and precision, were reviewed and monitored closely by the analytical laboratory in accordance with the CLP protocols.

The following indicators were used to define quality levels for analytical activities:

Accuracy:	A measurement of the bias in a system. Accuracy was assessed through the evaluation of the percent recoveries associated with reference samples (i.e., matrix spikes, surrogates, continuing calibration checks).
Precision:	A measurement of the reproducibility of data under a specified set of conditions. Precision is a quantitative measure which assesses the variability of a data set in reference to the calculated average value. Precision was assessed by the evaluation of the day-to-day variances in matrix spikes and was monitored using control charts.
Representativeness:	A qualitative measure used to determine the degree to which obtained data correlated to the population sampled. The evaluation of this parameter was assessed through field auditing and QA review of SOPs and Work Plans.
Completeness:	The percentage of measurements evaluated and judged to be valid measurements. For this project, the criteria was set in the range between 90-100%.

Comparability:	A qualitative measure assessing the confidence with which data sets obtained for similar samples and sample conditions can be correlated. This parameter is dependent upon the accuracy and precision of the analytical measurement.

Quality control samples were analyzed throughout the Phase I RI/FS to assess these data quality indicators and to ensure that the sampling and analytical systems used in support of project activities were in control. Quality control samples for this project consisted of field QC samples (e.g., trip blanks, equipment rinsate blanks, and drilling water), as well as laboratory QC samples (e.g., method blanks, matrix spikes/matrix spike duplicates, surrogate spikes, and continuing calibration standards).

Trip blanks were prepared by the laboratory and were collected to indicate any potential field contamination associated with volatile organic sampling. Trip blanks were included at a frequency of one per cooler during the course of volatile organic sampling.

Equipment rinsate (field) blanks were used to provide information on the extent of potential cross-contamination at the site. Equipment rinsate blanks were collected at a frequency of one per sampling equipment type per day by rinsing the sampling equipment with deionized water and collecting the rinsate directly into the appropriate sample container.

The water source used during drilling activities must be free of any contamination that would compromise sample integrity. Therefore, one sample of the drilling water was also collected and analyzed for EPA TCL parameters and TPH.

The reliability of all data generated during the Phase I RI/FS, including the field QC sample results, was evaluated as part of the data validation process. Data validation is a set of computerized and manual checks applied to analytical data at various appropriate levels of the measurement process to ensure that the data are complete, precise, accurate, and legally defensible. Validated data result from the consistent application of a rigorous QA/QC program. The data validation process for the Phase I RI at the DPSC included, but was not limited to, a review of sample preservation and holding time requirements, analytical system operational parameters, calibration data, QC sample data (e.g., method blanks, continuing calibration standards, field blanks, etc.), statistical tests, and manual checks of hand calculations.

Data validation commenced with each analyst and continued until the data were reported. Every analyst was responsible for internal QC checks for each sample and for implementing corrective action when outliers were identified. Thus, most data validation occurred at the moment the data were generated. At the conclusion of each analysis, the data were independently reviewed by the laboratory manager and/or data quality manager prior to approval and release. Data assessment techniques used by the laboratory staff included routine quality control checks and system audits. The independent review of data packages was performed to ensure compliance with specified analytical QA criteria; data reduction procedures; data reporting requirements; and required accuracy, precision, and completeness measures. The following items were reviewed:

- Sample holding times;
- Documentation that the analytical results are in control and within the calibrated ranges;
- Documentation that data and calculations, including mass spectra and chromatograms, were checked by a reviewer who was not involved in the performance of sampling, analysis, or data reduction;
- Calibration documentation for methods and instruments, including the results of calibration and continuing calibration standards, chromatographic acceptance criteria, and mass spectrometer tuning criteria;
- Routine instrument checks (calibration, control samples, etc.);
- Documentation on traceability of instrument standards, samples, and data;
- Documentation on analytical methodology and QC methodology;
- The potential presence of interferences in analytical methods (check of method blanks and surrogate spike recoveries);
- Documentation of routine maintenance activity to ensure analytical reliability; and
- Documentation of sample preservation and transport.

As a result of the data validation process, data were approved and released, rejected, or qualified. Data qualifiers are "red flags" that may indicate potential problems with the data, so qualified data were evaluated carefully prior to use. Data qualifiers are used to denote several potential laboratory problems including, but not limited to, the following: sample matrix interferences, contamination of method blanks (i.e., laboratory introduced contamination), unacceptable duplicate precision, unacceptable spike recovery, estimated concentrations (i.e., for tentatively identified compounds or for analytical parameters that are detected at a concentration below the quantitation limit), and samples that required dilution to bring the sample concentration within the linear calibration range. Unqualified data that are released by the analytical laboratory meet all of the prerequisite data quality objectives for this project and are assumed to be accurate, precise, and technically defensible.

Upon receipt of the laboratory-validated data package, the Versar project manager spot-checked sample holding times, laboratory and field QC sample results, and data qualifiers to ensure that the data met the DQOs established for the project. This internal review represented an additional, secondary data validation step to ensure that all data used in this report was valid and reliable.

Auxiliary data produced for internal records and not reported as part of the analytical data package included the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, and associated quality control records. These sources document data reduction and are available for inspection during audits to determine the validity of data.

The New England District (NED) of the ACOE is also conducting independent data validation. However, their report was not available for inclusion in this report.

11.0 PRELIMINARY EVALUATION OF FREE PRODUCT AND ASSOCIATED DISSOLVED PHASE CONTAMINANT PATHWAYS

The preliminary evaluation of contaminant pathways at DPSC is limited to petroleum hydrocarbons in Phase I of the RI. Pathways for other contaminants of concern will be assessed during Phase II of the investigation. Our primary concern is the origin of the massive gasoline/diesel free product plume that underlies most of the southern portion of the DPSC site. The physical conditions that caused free product to accumulate in the aquifer have been discussed in report Sections 5.0 and 6.0. The focus of this chapter is the flowpaths along which the hydrocarbons migrated to reach their present point of accumulation.

Several steps were involved in determining possible and then probable petroleum hydrocarbon migration pathways in the vicinity of DPSC, including:

- A review of the nature and relative volumes of known hydrocarbon releases at the DPSC site and at contiguous off-site locations.
- Preparation of a semi-regional water table elevation map to use as a basis for visualization of groundwater flowpaths (see Figure 6-1).
- Evaluation of free product and associated petroleum hydrocarbon species distribution maps generated by SPILLCAD™ to define plume boundaries.
- Comparison of soil gas "signatures" which may be associated with free product occurrence at DPSC and contiguous sites.
- Inspection of utilities drawings, specifically sewer lines, whose dimensions and depths are such that they are likely to be in contact with free product as defined from Phase I mapping of free product at DPSC or previous mapping of off-site plumes.

To determine the origin of the massive gasoline/diesel free product plume present underlying much of the southern half of the facility, Versar is employing reverse particle tracking. Once groundwater flowpaths in the vicinity of DPSC are understood, it is possible to extrapolate particle tracks from known areas of petroleum hydrocarbon groundwater contamination in an upgradient direction back towards their original source. The "corridor" through which free product and contaminated groundwater migrated in the aquifer should bear some residual petroleum hydrocarbon contamination, particularly within the silty and clayey formations that comprise the aquifer at DPSC. At the same time, utility corridors must also be considered as potential migration pathways. It is clear from available groundwater monitoring reports that utilities have played a role in free product migration within certain portions of the Sun Oil Company refinery south yard. The migration of vapor phase hydrocarbons can also be influenced by the presence of underground utilities. As possible pathways are identified and ruled out by process of elimination, potential source areas where specific types of releases have originated are indicated and can be confirmed through file searches.

11.1 Soil Gas Fingerprinting

Soil gas surveys often closely reflect the areal distribution and physical characteristics of a groundwater contaminant plume or, as in the case of DPSC, a free product plume. The key to obtaining a good correlation between soil gas and free product distribution is collecting soil gas samples as near to the soil/product interface as possible. The extensive development of a surficial clay unit in the vicinity of DPSC causes an "attenuation" or filtering of the soil gas signal. Therefore, the comparability of soil gas data to actual free product characteristics decreases in proportion to the distance between the soil gas sampling depth and the depth of the free product. At DPSC, soil gas samples were generally collected below the surficial clay unit within 5 to 10 feet of the free product plume. As a result of these sampling depths, the active soil gas survey performed at the beginning of Phase I field activities provided a very good approximation of the location of the underlying free product plume.

To the extent that a good correlation is achieved between soil gas concentrations or flux, the soil gas characteristics or "signature" can be a useful tool in tracking the boundaries of a plume. This process is commonly referred to as "fingerprinting." Ideally, the chemical fingerprinting of separate hydrocarbon releases for correlation purposes is accomplished through direct sampling and analysis of free product and/or dissolved phase contaminants from the plume. Such fingerprinting analyses were not planned and implemented in Phase I of the RI. Soil gas data comparisons, while less accurate than direct product analyses, still provide a good initial perspective on common constituents of spatially separated free product plumes.

11.1.1 Active Soil Gas Surveys and Data Comparisons

11.1.1.1 Description of the Active Soil Gas Survey Performed at DPSC

An active soil gas survey was performed on-site from September 26 through October 21, 1994. A van-mounted 1/2" stainless steel probe connected to hollow stainless steel sections was hydraulically pushed down to a depth of 10 to 14 feet below ground surface (bgs). When the probe extension reached the desired depth, it was disconnected from the hydraulic hammer, and the probe and the extension rods were purged with a vacuum pump. Soil gas extracted with the vacuum pump was sampled prior to the pump, using a syringe. Soil gas was analyzed in the field by gas chromatography (GC) for benzene, toluene, ethylbenzene, total xylenes (BTEX), and total VOCs. Field analytical results are shown on Table 4-1.

Soil gas sampling was performed throughout the DPSC site at 82 locations as shown on Figures 4-1 through 4-3. As evident from the these figures, a plume of soil gas seems to be concentrated towards the southern half of the site. This correlates very well with the free product plume, Figure 7-1. The soil gas survey revealed comparatively low levels (2 to 10 ppm) of total VOCs in the northern half of the site and along its western boundary, except at SG-63 (85 ppm). Comparatively higher levels of BTEX in soil gas samples at SG-01 through SG-04, SG-07, SG-09, SG-10, SG-14 through SG-18, and SG-70 are interpreted to represent a gasoline signature associated with the free product plume identified in that area. Table 4-1 shows a summary of soil gas sampling results.

11.1.1.2 Description of the Active Soil Gas Survey Performed at the Sun Site

Target Environmental Services, Inc., of Columbia, Maryland, performed a soil gas survey at the Sun site in July 1988. To collect the samples, a 1/2 inch diameter hole was advanced to a depth of 2 feet using a slide hammer. The hole was then purged of the ambient air, a stainless steel tube was inserted to the bottom of the hole and sealed from atmosphere. After purging again, a soil gas sample was withdrawn, collected, and sent for laboratory analysis.

Soil gas samples were collected at more than 250 locations on the south yard. Total VOCs and BTEX were detected ranging from not detected (ND) to 305 ppm and ND to 1.5 ppm, respectively. Concentration of methyl tertiary butyl ether MTBE/pentane ranged between ND and 44 ppm. Most of these locations indicated high MTBE concentration, which is a gasoline additive and pentane which is a gasoline component. This may be indicative of presence of either gasoline or gasoline components is soils.

The soil gas survey revealed that the highest concentrations of total VOCs were detected around the site perimeter, along the west side of 26th street, and in another localized area on the north side of Philadelphia gas works. These soil gas concentrations are consistent with the occurrence of free product in the vicinity of 26th street sewer.

11.1.1.3 Data Comparison

In the September 1994 soil gas survey conducted at DPSC, total VOCs and total BTEX were detected at concentrations up to 29,975 ppm and 10,625 ppm, respectively. MTBE and pentane were not specifically analyzed for at DPSC. At the Sun site, total VOCs and BTEX ranged from ND to 305 ppm and ND to 1.5 ppm, respectively. Concentrations of MTBE/pentane ranged between ND and 44 ppm.

The highest soil gas concentrations were detected on the southern part of the DPSC site, which is consistent with the occurrence of the mapped free product plume in that area. At the Sun refinery south yard, the highest soil gas concentrations were detected at the eastern perimeter along 26th Street, which is also consistent with a free product plume known to be present at that location.

At DPSC, BTEX concentrations detected in the soil gas samples are consistent with the hydrocarbon species detected in the free product samples, which bear a mixed gasoline/diesel signature. No chemical analyses for characterization of the free product existing at the Sun site have been performed. However, the detection of BTEX in the groundwater samples from two monitoring wells located along the 26th Street sewer suggests that the soil gas composition exhibits some similarity to free product and dissolved contaminant plume chemical signatures. The comparatively low levels of BTEX in soil gas at the Sun site could be due to the fairly shallow soil gas sampling depth for that survey. At DPSC, soil gas data were collected at 10 to 14 bgs, approximately 5 feet above the mapped free product plume. At the Sun site, soil gas data were collected at 2 feet bgs, at least 16 to 18 feet above the groundwater or free product plume.

Soil gas sampled at DPSC was not analyzed for MTBE and pentane. However, various soil gas samples at the Sun refinery south yard exhibited high concentrations of these parameters (up to 44 ppm), which are characteristic of gasoline additives. A partial list of former products in the south yard made available by Sun Company representatives (Atlantic Richfield Company, partial inventory list along 26th street, dated January 5, 1981) shows that various gasoline components and gasoline have been stored in the past in storage tanks 27, 28, 37, 38, 39,128, 129, 178, 179, 190. Other tanks in the south yard stored kerosene, naphtha, furnace oil, etc.

11.1.1.4 Conclusions

Based on the limited soil gas data available, it is only possible to make some broad comparisons between survey results for the DPSC and Sun sites. There appear to be possible compositional similarities between the free product at DPSC and that at the Sun site; the occurrence of BTEX concentrations in soil gas analyses at both sites indicate the presence of gasoline or gasoline components in the free product released in these areas. Also, the detection of MTBE, which is an additive in gasoline, appears to confirm the presence of gasoline or gasoline components in soils on the Sun refinery south yard site.

11.1.1.5 Limitations to Data Comparison

Various constraints must be placed on the comparison and interpretation of active soil gas survey data from DPSC and the Sun Company refinery south yard:

- The two soil gas surveys occurred 6 years apart.

- The depth of soil gas sample collection at DPSC was 10 to 14 feet bgs, whereas at the Sun site was 2 feet. In the latter case, soil gas chemistry may not correlate as closely to subjacent free product characteristics.

- Soil gas sampling locations at the Sun Company site were limited to the perimeter of the facility, whereas on the DPSC site, the soil gas sampling grid was uniformly distributed across the entire site.

11.1.2 Petrex™ (Passive) Soil Gas Survey

A passive soil gas survey was also planned and implemented during Phase I of the RI. The objective of this supplemental soil gas survey was to perform a principle component analysis of free product head space samples from each on-site well and correlate their respective mass spectra signatures to soil gas data collected from a specified sampling grid. Unlike an active soil gas survey, the passive survey measures soil gas flux as opposed to actual soil gas concentrations. The active survey measures instantaneous soil gas concentrations, while the passive survey measures flux across a period of several weeks. The latter type of survey, therefore, provides more of a time weighted average of soil gas species trends and is less susceptible to varying atmospheric conditions.

The output from Petrex's principle component analysis is referred to as "similarity mapping." A detailed explanation of the procedures involved during the generation of these maps may be found in the Petrex report entitled *Findings of the Petrex Soil Gas Survey Performed at the Defense Personnel Support Center in Philadelphia, Pennsylvania*. This report is presented in Appendix Q. In principle component analysis, mass spectra data from free product head space samples are correlated to a computer library of petroleum hydrocarbon signatures. Once a "fingerprint" for a given petroleum hydrocarbon mixture has been identified, this fingerprint serves as a framework for comparison of soil gas data collected from a pre-planned sampling grid. The preparation of similarity maps then indicates portions of the study area where the best correlations have been achieved between individual petroleum hydrocarbon species or the complete hydrocarbon mixture. These maps often reveal the source or pathway from which free product or a dissolved phase contaminant plume originated or migrated.

The Petrex sampling grid was modified from the DPSC RI work plan specifications on two separate occasions. Initially, the survey was structured to compare soil gas data along the western, southern, and central portions of the facility. At that stage of planning, the reasoning was that free product was already known to exist along the southern and central portions of the site and that one of the most likely migration pathways was from the northwest. This assumption was based on hydraulic gradient data indicating groundwater flowed in a northwest to southeast direction across the DPSC site.

The review of SCAPS data and hydropunch sampling results, both completed before the Petrex survey was performed, indicated an apparent lack of free product along DPSC's western property boundary. Based on these findings, the proposed Petrex sampling grid was reconfigured. The revised grid included the southwestern portion of the DPSC site and the northeastern portion of the Sun Oil Company refinery south yard, both known areas of free product occurrence. Subsequent discussions with Sun Oil Company representatives failed to achieve rights of access to conduct that part of the Petrex survey which was to be performed within the refinery area.

The Petrex grid was finally re-established to cover the DPSC site proper in a regular grid pattern. It was reasoned that free product or individual hydrocarbon species migration patterns might become apparent through similarity mapping. Work plan modifications to the originally proposed Petrex sampling grid are presented in Appendix Q.

The maps generated from the Petrex survey are presented in Appendix Q and include benzene, toluene, ethylbenzene/xylene flux maps, and similarity maps for gasoline character, fuel oil character, and free product character. The following trends were observed with respect to each individual map:

- **Benzene Flux Map:** This map shows a northwest-southeast trending pattern of high soil gas flux values.

- **Toluene and Ethylbenzene/Xylene Flux Maps:** These maps both show a broad area of soil gas flux maxima along the southern portion of DPSC and a linear trend to soil gas on the northern half of the site.

- **Gasoline and Fuel Oil Character Similarity Maps:** Both maps show broad areas of similar contamination at the northwest and north-central portions of the site with minor indications of this signature in the southeastern and south-central parts of DPSC.

- **Free Product Character Similarity Map:** This map reveals two separate areas with signatures analogous to those associated with head space analyses performed on actual free product samples from DPSC monitoring wells. These areas occur at the northwest and southeast portions of the installation.

The interpretation of Petrex soil gas flux and similarity maps was preceded by a review of DPSC site characteristics that may have influenced survey results, as follows:

- A surficial clay unit exists at DPSC that may have an attenuating effect on soil gas transmissivity, thus decreasing flux values measured in

Petrex collector tubes emplaced at a sampling depth of approximately 1.5 to 2 feet below grade.

- The clay unit is thickest along the southern portion of the site and is entirely absent in the northwest part of the site, an area occupied by as much as 22 feet of fill materials.
- Shallow petroleum hydrocarbon contamination is known to exist in the north-central portion of DPSC, where a release has been documented from one of three underground storage tanks closed at the Oregon Avenue location. This contamination is likely to influence passive soil gas flux measurements.
- Innumerable underground utilities exist beneath the streets at DPSC, most running in an west-east direction. Some of these utilities may influence the migration of vaporous phase contaminants.

The following conclusions have been drawn from the Petrex survey results:

- The northwest-southeast trends to benzene flux and free product similarity maps could be indicative of a free product and dissolved phase contaminants that are migrating from northwest to southeast along regional groundwater flowpaths. However, this interpretation is not consistent with soil and groundwater sampling results that show neither free product, nor gasoline related dissolved contaminants, at the northwest portion of the site. The northwest-southeast trends to benzene flux and free product similarity maps are more likely related to the migration of a vapor phase plume from southeast to northwest. These volatiles apparently originate from the free product plume along the southern part of the site and migrate along the base of the surficial clay unit into an area of extensive fill at the northwestern corner of DPSC.
- The broad fuel oil character signature in the north-central portion of the site is probably caused by a combination of factors, including the migration of diesel fuel constituents along the previously described vapor migration pathway; soil gas migration related to the Oregon Avenue UST release; and low level diesel-related petroleum hydrocarbon contamination in the fill area at the northwestern corner of the site.
- Linear trends to toluene and ethylbenzene/xylene flux maxima may relate to the preferential migration of soil gas along underground utilities in the north portion of the site.

Because of the geological characteristics of DPSC, the Petrex survey has limitations with respect to the direct tracking of free product phase hydrocarbons. Specifically, the surficial clay layer and the paving throughout the site may be retarding the vertical migration of the vapor phase. However, the technology appears to be a good tool for evaluating and tracking vaporous phase contaminants. This type of survey may prove beneficial in future phases of work, when vapor phase pathways must be delineated for risk assessment objectives using a low profile sampling technique. It may also be possible to utilize the Petrex method to track free product migration along major sewer lines through a deeper emplacement of soil gas collector tubes.

11.2 Free Product Migration through Direct Flowpaths through the Unconfined Aquifer

The water table elevation map, TPH soil concentration map for the interval 15'-30' below grade, and free product distribution map presented as Figures 6-1, 7-4 and 7-1, respectively, together with the groundwater isoconcentration maps for each petroleum hydrocarbon species (Figures 7-5 through 7-9) served as the basis for evaluation of migration pathways of these contaminants.

Groundwater flow along the western DPSC boundary line appears to be influenced significantly by the water table elevation anomaly that runs parallel to 26th Street. This anomaly may be attributable to a deep sewer line in this area that is functioning similarly to a subsurface drain or interceptor trench. Groundwater flowpaths in the area of this swale-like pattern of elevation contours track towards 26th Street, indicating that free product releases originating within the northeastern portion of the Sun Oil Company refinery south yard would be likely to move in a southerly direction, semi-parallel to 26th Street. Groundwater and fluid particles at water table depth are less likely to track in a strict northwest to southeast (regional flow) direction from the northeast portion of the refinery south yard across the western DPSC site boundary. Free product releases and dissolved phase contaminants in the shallow portion of the unconfined aquifer originating in the northeastern part of the refinery south yard would be expected to migrate in a southerly direction, towards the Pollock Street/Packer Avenue sewer lines. Areas of known free product presence in the refinery south yard are described in Section 12.2.

East of DPSC, near the SEPTA maintenance garage, groundwater flowpaths approach regional patterns. Flowpaths along the northern half of the SEPTA garage are to the south and shift to easterly near the southern portion of the SEPTA property. At present, there do not appear to be any flowpaths in the vicinity of the SEPTA facility that track towards the DPSC. However, it is possible that past operation of the former process water supply well located in Building 8 may have caused a cone of depression with a subsequent temporary reversal of hydraulic gradient, causing groundwater near the northern portion of the SEPTA facility to flow towards the DPSC. If this cone of depression and hyraulic gradient reversal were not present, groundwater flowpaths would be expected to emulate current conditions. According to DPSC Public Works personnel, this well has not been active since the early 1970s. Releases documented with respect to the SEPTA facility are discussed in Section 12.3.

Groundwater particles originating north of Oregon Avenue, DPSC's northern property boundary, generally track to the south onto the DPSC site. In the northwestern corner of the DPSC site, there is a slight southeasterly component to flow; otherwise, flow patterns along the remainder of Oregon Avenue are southerly. Any releases to groundwater that have occurred along Oregon Avenue or just off-site to the north would be expected to migrate onto the DPSC property. A discussion of known releases that have occurred along Oregon Avenue is presented in Sections 12.1 and 12.3.

Figures 7-3 through 7-9 all reveal similar maximum contaminant thickness and/or isoconcentration trends. In each instance, the axis of the maximum soil contaminant concentrations and free product/groundwater contaminant plumes generally trends west-east. In Figures 7-3, 7-6, 7-7, 7-8, and 7-9, there is a slight inclination to the axis of the maximum isoconcentration values, giving these areas of contamination and plumes a more southwest-northeast orientation. None of these isoconcentration maps indicates a continuity of soil or groundwater contamination into the northern half of the site.

Low levels of TPH and DRO contamination in soil and groundwater are present at the northwestern portion of DPSC. The northwest limits of this contamination are presently unknown. The areal extent of soil contamination, geometry of the groundwater contaminant plume, and low level concentration of the TPH/DRO species all suggest that this contamination is unrelated to the massive gasoline/diesel plume covering the southern half of DPSC.

Since groundwater flow at DPSC is primarily north to south, for the massive free product plume to have originated from the south, other transport mechanisms needed to be evaluated. At this point, attention was directed towards a major sewer line located just to the south of DPSC. This sewer, referred to as the Packer Avenue and Pollock Street sewer system, runs east to west and continues through the Sun Oil Company refinery south yard to the Schuylkill River. A preliminary evaluation of the ability of sewer lines and other underground utilities in the vicinity of the DPSC to convey free product and vapor phase petroleum hydrocarbon contaminants is presented in Section 11.3.

If the massive gasoline/diesel plume on the southern half of DPSC originated from the north, a more obvious corridor of residual soil and groundwater contamination should be present in that area. The lack of high levels of residual contamination on the north half of the site, together with the patterns of maximum soil and groundwater contaminant isoconcentrations for each of the petroleum hydrocarbon species, appears to indicate that the contaminants migrated onto the DPSC site from somewhere to the south.

11.3 Free Product and Vapor Phase Migration via Underground Utilities

A large volume of free product (petroleum hydrocarbons) is known to exist underneath the DPSC site, a larger volume than can be attributed to use of similar products at DPSC. Since no other mechanisms for transport of such a volume of free product have been identified to date, the objective of this section is to examine the role of underground utilities as potential migration pathways for the free product plume at DPSC.

DPSC is underlain and surrounded by various utilities, including water, sewer, electricity, telephone, and gas lines. Such underground utilities are capable of influencing the migration of groundwater or free product with which they come in contact. Normally these utilities, including sewers, are installed surrounded by stone and/or gravel (bedding material). Any fluids in contact with such bedding materials find a preferential pathway along these lines. Underground electric cables are laid out inside another conduit. Any leakage of contamination inside the conduits, due to corrosion, etc., may also provide preferential pathways for contaminant migration. Various case histories, as documented in *Assessment and Remediation of Petroleum Contaminated Sites* (Cole, 1994), have shown that high permeability underground utility beddings provide preferential pathways for contaminant migration irrespective of groundwater flow direction. Since very limited information is available regarding bedding materials and depths of excavation at this time, a detailed evaluation of how one or more of these underground utility beddings may be acting, or may have acted, as contaminant migration pathways is beyond the scope of this discussion.

DPSC is surrounded by several commercial gasoline and diesel outlet facilities. Considering the substantial volume of free product currently existing on DPSC, only large utility lines are considered in this discussion. Since no other large underground utility lines have been identified entering DPSC and because of the locations and size of the sewers on and around DPSC, only these utilities have been identified as potential contaminant migration pathways.

Sun Oil Company, a petroleum refinery, is located along the western boundary of the DPSC, extending from northwest of DPSC to southwest of the site. The Sun Oil Company's south yard is located along the western boundary of DPSC. There is documented information concerning the existence of multiple free product plumes on the Sun Company site along the 26th street sewer (north-northwest of DPSC) and Pollock Street sewer, as shown on Figure 11-1. The free product plume located at the Pollock street sewer is approximately 17 acres in area.

All material referenced herein was acquired from the City of Philadelphia Water Department, DPSC archives, and Sun Company Reports. *City of Philadelphia Plat 15* and the *DPSC Sanitary Sewer & Storm Drainage Map* (drawing #1357, dated 01-31-92) are contained in Appendix R.

The evaluation of sewers in the vicinity of DPSC as free product migration pathways begins with the establishment of proper reference elevations. On the *City of Philadelphia Plat*, manhole invert bottom (IB) elevations are referenced to the city plan elevation. The DPSC sanitary sewer and storm drainage map does not indicate whether manhole elevations are referenced to City of Philadelphia plan elevations or to NGVD. DPSC Public Works personnel indicated that manhole elevations on the DPSC map are probably referenced to the City plan elevation. Also, the elevation (-1.54') of manhole #186 shown on the DPSC map near the southern boundary of the site correlates closely with the elevation (-1.62') shown for the same manhole on the City of Philadelphia Plat 15, suggesting that the DPSC map references the City Plan elevation. Throughout this discussion, an assumption is made that the elevations on both maps (Appendix R) are referenced to the City Plan elevation. Since the City Plan elevation is 5.96 feet lower than NGVD, all elevations have been normalized with respect to NGVD (i.e., 5.96 feet has been added to all city plan elevations).

11.3.1 Off-Site Sewer Lines

The following major sewers lie along DPSC's western, southern, eastern and northern boundaries:

- 26th street stormwater (shallow)
- 26th street sanitary sewer/Lower Schuylkill East Interceptor (deep)
- Pollock Street Sewer
- Packer Avenue Sewer
- 20th Street Sewer
- Oregon Avenue Sewer

The 26th street sewers are proximal to and run parallel with the western boundary of the DPSC. Although Packer Avenue presently stops at 20th street, the Packer Avenue sewer continues south of the DPSC boundary, meeting the 26th street sewers beyond the southwest corner of the DPSC. From this point on, it becomes the Pollock Street sewer, running east-west and continuing to an outfall at the Schuylkill River. An interception chamber is located close to the intersection of the 26th Street and Packer Avenue/Pollock Street sewers. The Oregon Avenue and 20th Street sewers run parallel to, and lie beneath, Oregon Avenue and 20th Street, respectively.

A Sears Roebuck auto center was formerly located on Oregon Avenue, north of the DPSC, and the SEPTA maintenance garage is located along 20th street, east of DPSC. There have been documented releases of petroleum products from USTs at these two facilities. However, considering the volume of free product estimated to be present on the DPSC site, it is unlikely that releases from USTs at either of these commercial facilities could cause free product to attain the areal extent and volume observed at DPSC.

11.3.1.1 26th Street Stormwater Sewer (Shallow)

North of Pollock Street: The 26th Street stormwater sewer flows north to south and intercepts the Pollock Street sewer. Manhole invert elevations on this sewer change from +17.86 feet to +7.64 feet; hence, this sewer is unlikely to affect groundwater or free product migration because the groundwater table elevation in the monitoring wells along 26th Street is estimated to be between -0.1 and +5.15 feet with reference to NGVD, indicating that the water table/free product level is below the bottom of the sewer. However, the Sun Company reports confirm a possible breach in the 26th Street sewer. Hence, there is a possibility that vapor phase contaminant migration may be occurring, or may have occurred in the past, along this sewer.

South of Pollock Street: This stormwater sewer flows south to north and intercepts the Pollock Street sewer. Manhole invert elevations change from +15.07 feet to +11.89 feet. Lack of groundwater table elevation data in this region prevents a precise prediction of where this sewer could be in contact with groundwater/free product table and affect contaminant migration. Considering the available groundwater elevation data in the vicinity (Sun Company Reports), the water table in this area is not expected to be as high as the lowest sewer invert elevation of +11.89' and hence is unlikely to effect contaminant migration.

11.3.1.2 26th Street Sanitary Sewer/Lower Schuylkill East Interceptor (Deep)

North of Pollock Street: This 48" diameter Reinforced Concrete Pipe (RCP) combined sanitary and stormwater sewer flows south to north. The sewer has a grade of 0.07% and 0.08% between the Packer Avenue sewer and Oregon Avenue. Manhole invert elevations on this sewer change from -8.83 to -10.29 feet, indicating the sewer is below the water table. As indicated by the shape and closely spaced water table elevation contours on Figure 6-1, this sewer seems to be acting as a subsurface drain and is capable of influencing the groundwater flow in the vicinity of the sewer by providing a preferential pathway along highly permeable bedding material surrounding the sewer. The Sun Company Reports indicate the existence of a free product plume along the 26th Street sewer. Free product migration may be occurring along groundwater flowpaths associated with this sewer line.

South of Pollock Street: This 36" RCP combined sanitary and stormwater sewer flows south to north, with a grade of 0.02%. Elevations of manhole inverts change from -4.50 to -8.28 feet. It is possible that this sewer is capable of affecting contaminant migration, as discussed above. Groundwater table elevations can not be accurately extrapolated in this area; therefore, it is difficult to determine precisely where this sewer is in contact with water table and what its effect on free phase and dissolved phase migration may be.

11.3.1.3 Pollock Street Sewer

The Packer Avenue sewer at the intersection of 26th Street becomes the Pollock Street sewer, ultimately discharging into the Schuylkill River. An interception chamber is located at this point. The Pollock Street combined stormwater and sanitary sewer is an 8' x 12', rectangular, concrete sewer, approximately 3,000 feet long, with a constant grade of 0.05%; it flows east to west. According to the Philadelphia City Water Department, during regular times, only stormwater from the 26th street shallow sewer flows into it. During high intensity rain storms, the hydraulic gate shuts off the flow into the lower Schuylkill east interceptor and a combined flow is directed into the Pollock Street sewer outfalling in the Schuylkill River.

City Drainage Plat 15 shows 11 manholes on this sewer. Manhole elevations could not be located either on Plat 15 or on the city return plan No. 9334. All manhole elevations have been extrapolated from an inlet elevation shown on City Plat 15. Elevations of manhole inverts on this sewer change from approximately -0.6 feet to -2.04 feet between 26th Street and the Schuylkill river. Elevation of the bottom of the sewer outfall is approximately -2.04 feet. The lower two feet of almost the entire length of this sewer are presently estimated to be under the water table.

Even though there is a limited amount of data available, considering the enormous size of this sewer, the existence of free product plume around this sewer on the Sun Company site, the fact that the lower portion of this sewer may be submerged underwater, together with various findings of the Sun Company reports, there is a strong suggestion that this sewer and the sewer bedding is affecting contaminant migration and providing preferential pathways for dissolved phase and/or free product.

The Sun Company Reports indicate the following with respect to the Pollock street sewer:

- The existence of a free product plume extending between S-62 to S-48 (locations shown on Figure 6-1) and estimated to be approximately 17 acres in area. A thickness of free product ranging from 0.24 to 3.32 feet has been noted in the monitoring wells along the sewer. There is a possibility of free product migration eastward along the sewer bedding. The existence of free product was also noted near the outfall of the sewer at the Schuylkill River.

- An elevated water table, which may be an indication of groundwater flow being influenced, was noted in the area around manholes MH-7 and MH-8.

- The lower portion of this sewer intercepts the groundwater table, suggesting preferential flow along the sewer bedding.

- The lithologic cross section shows the existence of high permeability backfill (gravel and sand) around and below this sewer .

- The tidal influence on the Pollock Street sewer, noted by flow reversal eastward towards 26th street as far as manhole MH-7, may also cause an eastward groundwater flow along the sewer bedding.

11.3.1.4 Packer Avenue Sewer

The Packer Avenue Sewer, a combined sanitary and stormwater sewer located south of DPSC's southern boundary, flows east to west. A rectangular, 7' x 10', concrete sewer, it increases to 8' x 12' as it nears 26th Street. It has a grade of 0.05% between Penrose Ferry Road and 26th Street and joins the Lower East Schuylkill sanitary sewer at the 26th Street interception chamber. A 42" diameter RCP lateral from DPSC hooks into the Packer Avenue sewer at DPSC's southern boundary (near MW-7). Manhole invert elevation on this lateral of the DPSC property is +4.34 feet and the elevation of the point of hook up into the Packer Avenue sewer is +2.06 feet. Figure 6-1 was used to extrapolate groundwater contours beyond DPSC's southern boundary. This information was used to project a groundwater profile along the Pollock Street and Packer Avenue sewers and to conceptualize any possible potential pathway via high permeability backfill along the sewer. Figure 11-2 shows an elevated groundwater table in the area between manholes MH-7 and MH-2 on Pollock Street. This apparent decrease in hydraulic gradients suggests that an easterly component of groundwater flow may exist along the Pollock Street sewer in the vicinity of 26th Street.

Although current data is limited, considering the large capacity of this sewer, its proximity to DPSC, and its intersection with the estimated water table in the vicinity of 26th Street (Figure 6-2), there is a strong suggestion that the sewer bedding may be acting, or in the past may have acted, as a conduit for migration of the free product plume to the DPSC site.

11.3.1.5 20th Street Sewer

The 20th Street Sewer runs along 20th Street, on the eastern boundary of DPSC. South of Johnston Street, it is a 42" x 28" elliptical brick sewer flowing north to south and hooking into the Packer Avenue sewer at the intersection of Packer and Moyamensing Avenues. Manhole invert elevations on this section of sewer change from +7.0 to +3.5 feet. Based on Figure 6-1, water table elevation in this area is between 0 to +1.0 foot. Hence, it is unlikely that this sewer is in contact with the groundwater table and influencing the flow of groundwater in this area.

North of Johnston Street, this sewer is a 15" diameter sewer for a short distance and then joins a 39" x 26" elliptical brick sewer that hooks into the Shunk Avenue sewer. The manhole elevation on this sewer near DPSC is approximately +12.36 feet. Based on Figure 6-1, the water table elevation in this area is between +3 to +5 feet, making it unlikely that this sewer is in contact with the groundwater table and influencing the flow of groundwater in this area.

The *DPSC Sanitary Sewer & Storm Drainage Map* (Appendix R) shows several laterals hooked up into the City of Philadelphia 20th Street sewer along the DPSC eastern boundary. They are discussed in Section 11.3.2.4.

11.3.1.6 Oregon Avenue Sewers

The Oregon Avenue sewer consists of separate sanitary and stormwater sewers, with several sections flowing east to west and west to east, finally connecting with the Shunk Avenue Sewer via 20th, 21st and 22nd Streets. As shown on the *DPSC Sanitary-Sewer & Storm Drainage Map and City Plat 15* (Appendix R), there are no hook-ups into the Oregon Avenue sewer section along the DPSC northern boundary. Elevations of the manhole inverts located on Oregon Avenue, as shown on *City of Philadelphia Plat 15*, vary between +12 and +15 feet. Figure 6-1 indicates that the groundwater table elevation in this area occurs between +4 to +6 feet. Hence, it is unlikely this sewer is in contact with the water table and is affecting groundwater flow. Any effects that these sewer sections may have on free product migration with respect to alleged off-site spills at a former Sears automotive center, discussed in Section 12.0, are not likely to be consistent with the amount of free product known to be present at DPSC.

11.3.2 On-site Sewer Lines

DPSC is underlain by various sewer lines. Most of these utility lines are located between 5'-10' above average groundwater table elevation on-site and are not likely to effect either free product or dissolved phase migration. A detailed assessment of on-site sewer lines as potential pathways for contaminant migration is reserved for the Phase II scope of work. This section discusses the sewers along the western, southern, northern, and eastern boundaries of DPSC and preliminarily evaluates them, along with two other prominent utilities, as potential pathways for contaminant migration.

11.3.2.1 Western Boundary

The *DPSC Sanitary Sewer and Storm Drainage Map* (Appendix R), shows laterals at Cheatham Street, Rogers Street, and Aleshire Street connecting to a 36" diameter city sewer running parallel to DPSC's western boundary and flowing south to north. According to the City of Philadelphia Water Department, there are no city sewers at this location at what might previously have been 25th Street. Versar has not found any further information about this sewer either in DPSC archives or at the City Drainage Department. A DPSC Utility Map dated 1918 also shows this sewer in the same location. Manhole elevations have been extrapolated from this map. It is assumed that the elevations on the 1918 DPSC utility map are referenced to City of Philadelphia plan elevation. Manhole elevations change from +10.53 foot to +8.53 foot along the DPSC western boundary; hence, this sewer is unlikely to affect any free product or dissolved phase migration, considering the current water table elevation in that area (+1 to +6 feet) as depicted on Figure 6-1.

11.3.2.2 Southern Boundary

A 42" diameter RCP lateral from the DPSC connects to the Packer Avenue Sewer at DPSC's southern boundary (near MW-7). The manhole invert elevation on this lateral on the DPSC property is +4.34 feet and the elevation of the point of hook-up into the Packer Avenue sewer is +2.06 feet. Monitoring well MW-7 has historically exhibited more than a foot of free product. As shown on Tables 4-11 through 4-13, the adjusted water table elevation in MW-7 is approximately +0.8 feet. Based on currently available information, this lateral is not in contact with the groundwater table in this area at this time. However, it is likely that this lateral has been exposed to free product and/or the water table during seasonally or historically high water table fluctuations. Because this lateral is the most direct possible pathway between the free product plume at DPSC and the Packer Avenue sewer, this area should be investigated extensively.

11.3.2.3 Northern Boundary

This sewer runs along DPSC's northern boundary and joins the city sewer located parallel to DPSC's western boundary, as described in Section 11.3.2.1. As shown on the *DPSC Sanitary-Sewer & Storm Drainage Map and City Plat 15* (Appendix R), there are no hook-ups into the Oregon Avenue sewer sections along DPSC's northern boundary. Since this sewer flows into the city sewer located at the western boundary of the DPSC, the elevation of this sewer should be higher than the elevation of the western boundary sewer and, in turn, the sewer flowing along the northern DPSC boundary is above groundwater table in this area. Hence, this sewer line is not likely to influence groundwater flow in this area.

11.3.2.4 Eastern Boundary

This sewer runs along the eastern boundary of DPSC. The *DPSC Sanitary Sewer & Storm Drainage Map* (Appendix R) shows several laterals connected to the City of Philadelphia 20th Street sewer, along the DPSC eastern boundary. The 20th Street sewer joins the Packer Avenue sewer outside the southeastern boundary of DPSC. The invert elevation of the Packer Avenue sewer at this point is expected to be above the groundwater table, indicating that the 20th Street sewer flowing into the Packer Avenue sewer is also above groundwater table (0 to -1 foot). Therefore, this sewer is not likely to influence groundwater flow in this area.

As is the case with most of the smaller sewers discussed above, it is unlikely that these boundary sewers have caused the vast plume of free product to accumulate at the DPSC.

11.3.2.5 Fuel Tunnel on Rogers Street

A rectangular, concrete, underground tunnel, approximately 5.5' x 6.5,' running from Building 18 to Building 8 along Rogers Street, houses steam pipes and No. 6 fuel oil transport pipes approximately 6 inches in diameter. No. 6 fuel oil is very viscous and must be heated in order to transport it to the boiler. Since the concrete tunnel is no more than 3 to 9 feet bgs, it is not likely to be interfering with groundwater flow on-site. A minor spill in the tunnel is discussed in Section 12.1.1.

11.3.3 Vapor Phase Migration

Several of the utilities underlying the DPSC site are located above the groundwater table and as such are unlikely candidates for dissolved phase and free product migration pathways. However, various case histories have shown that these shallow, high permeability utility beddings make excellent pathways for soil-gas vapor migration. An active soil-gas survey at DPSC has shown that higher concentrations of soil-gas were detected in the southern half of the site, a finding which is consistent with the location of the free product plume on DPSC. Soil gas migration pathways most likely originate in this area. The passive (Petrex) soil gas survey results appear to indicate that soil vapors are presently migrating along certain on-site utilities and into areas of fill.

11.3.4 Conclusions

Based upon the limited information available about various underground utilities, we cannot conclude that any of the identified utilities are acting, or have acted, as pathways for contaminant migration. Considering the network of various utilities that surround the DPSC and their sizes, there is a strong likelihood that the bedding of one or more utilities may be providing, or may have provided, preferential contaminant migration pathways. The Packer Avenue sewer, Pollock Street sewer, and 26th Street deep sewer, because of their large size, their location relative to the free product plume, and the possibility of high permeability beddings, are likely to be interfering with groundwater and/or free product flow.

11.3.5 Ranking of Utilities as Potential Hydrocarbon Migration Pathways

Based on information provided throughout this section, the following utilities (i.e., sewer lines) appear to represent the most likely petroleum hydrocarbon migation pathways, in decreasing order of importance:

- Packer Avenue sewer and any other utilities located along the southern boundary of DPSC,
- Pollock Street sewer including the interception chamber,
- 26th Street sewer appears to be acting as a subsurface drain, and
- 20th Street sewer

11.3.6 Intrusive Work Recommended for Further Evaluation of Utilities As Hydrocarbon Migration Pathways

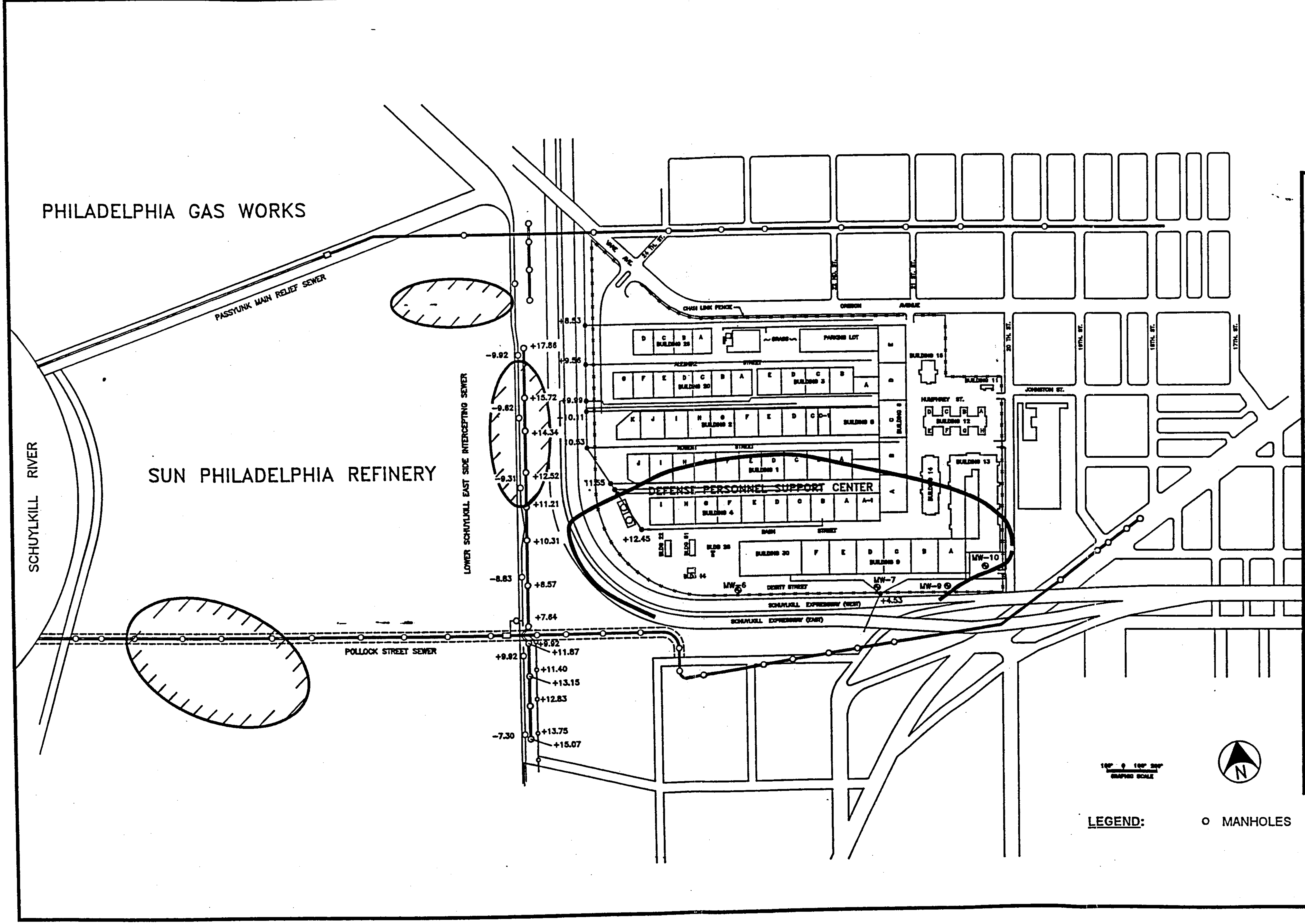
The area south of DPSC, along the Packer Avenue sewer, needs to be thoroughly investigated. The need for further intrusive work should be evaluated based upon findings of the Packer Avenue sewer investigation, notably with respect to the following:

- The approximately 17-acre free product plume on the Sun Company refinery south yard in the area along the Pollock Street sewer should be further investigated.
- The Sun Company property along the 26th Street sewer, south of the DPSC, should be further investigated because a free product plume, though not along the sewer, has been reported. It is possible that the Lower East Schuylkill interceptor, flowing south-north, may be interfering with groundwater and/or free product flow.

- The groundwater contour patterns around the 26th Street deep sewer, north of Pollock Street, exhibit an anomaly. Therefore this area merits further investigation as this sewer is below the groundwater table and may be acting as a subsurface drain.

On-site utilities should be investigated and eliminated as preferential pathways for contaminant migration during Phase II of the RI. Most on-site sewers are estimated to be above the groundwater table and therefore unlikely to affect groundwater flow. However, they may provide pathways for vapor phase migration. No information is available regarding the exact location of the city sewer running along the western DPSC boundary. This area will require some exploratory work to locate this sewer line.

Detailed information is required about the depths of excavations and bedding materials along the sewers and points where sewers are possibly in contact with groundwater or free product.



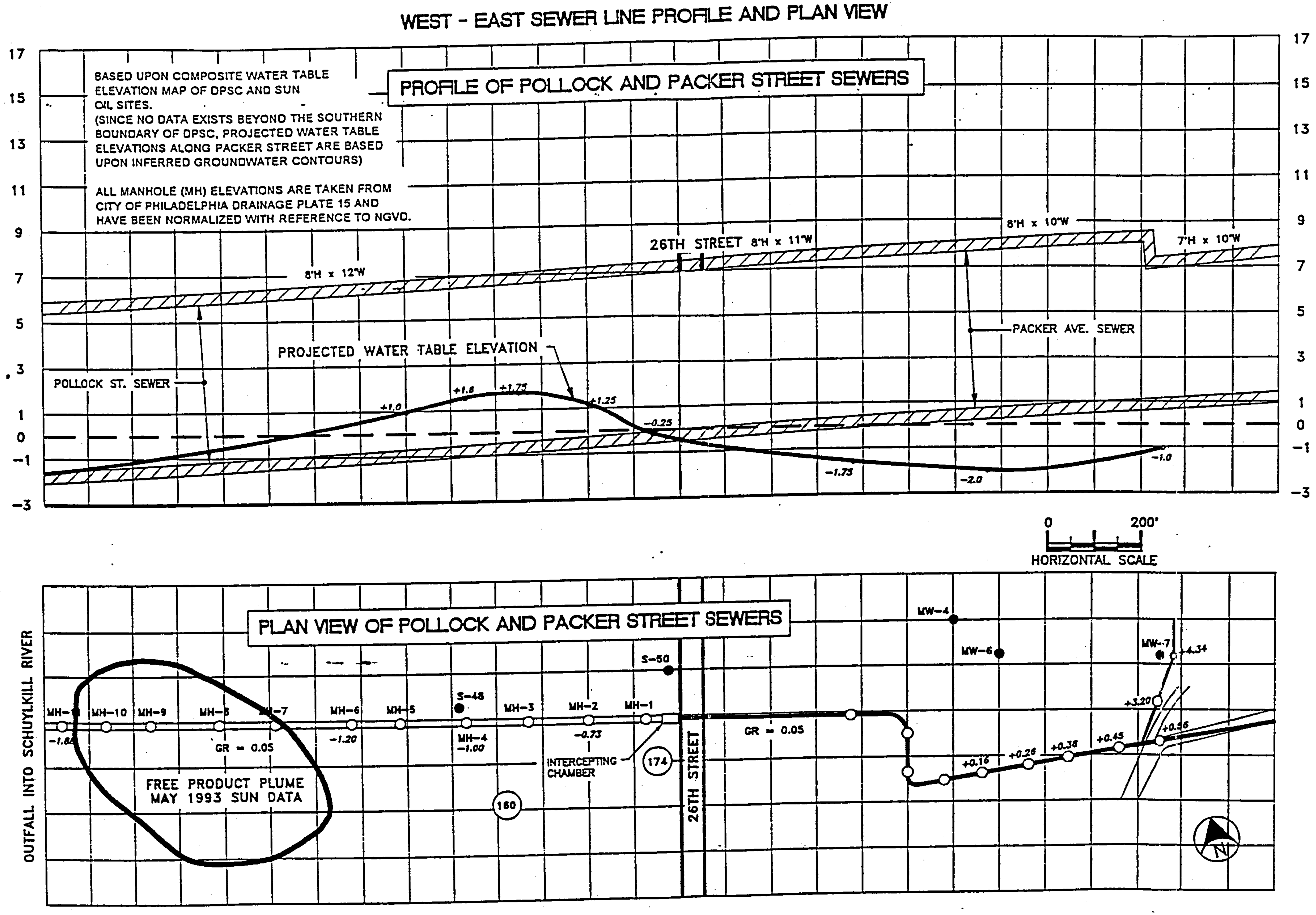
LEGEND: o MANHOLES

SEWER LINE LOCATIONS AND FREE PRODUCT OCCURRENCE AT DPSC AND CONTIGUOUS AREAS

DEFENSE PERSONNEL SUPPORT CENTER

FIGURE 11-1

DATE: 05/15/95
SCALE: AS SHOWN
DWG. BY: V.S.



BASED UPON COMPOSITE WATER TABLE ELEVATION MAP OF DPSC AND SUN OIL SITES. (SINCE NO DATA EXISTS BEYOND THE SOUTHERN BOUNDARY OF DPSC, PROJECTED WATER TABLE ELEVATIONS ALONG PACKER STREET ARE BASED UPON INFERRED GROUNDWATER CONTOURS)

ALL MANHOLE (MH) ELEVATIONS ARE TAKEN FROM CITY OF PHILADELPHIA DRAINAGE PLATE 15 AND HAVE BEEN NORMALIZED WITH REFERENCE TO NGVD.

FIGURE 11-2

DATE: 05/15/95
SCALE: NOTED
DWG. BY: V.S.

PROFILE OF PACKER AVENUE-POLLOCK STREET SEWERS

DEFENSE PERSONNEL SUPPORT CENTER

Versar INC.
1900 FROST ROAD, SUITE 110
BRISTOL, PA 19007
(215) 788-7844

12.0 CONTAMINANT SOURCE AREAS

As part of the effort to identify the primary source or sources associated with the massive free product plume that covers much of the southern portion of DPSC, Versar researched areas where there have been documented releases of petroleum hydrocarbons at DPSC and contiguous properties. These releases were categorized according to whether they occurred on or off-site and in terms of their relative size (i.e., major versus minor, the former being defined as a release demonstrated to affect an area greater than 1 acre in size). On-site releases were further subdivided into those associated with surface spills and those related to underground storage tanks (USTs). Releases are described with respect to type, location, and approximate size. The reference materials used to establish a record of releases in the vicinity of the DPSC include VISTA database searches, regulatory file reviews, preliminary UST closure data, and various site characterization and groundwater monitoring reports for DPSC and contiguous sites. These resource materials are identified in the list of references provided at the end of this Phase I RI report.

The identification of non-petroleum hydrocarbon contaminant source areas will be made at the conclusion of Phase II of the DPSC RI.

12.1 On-site Releases

12.1.1 Spills

Several documented and undocumented spill incidents have been reported at DPSC. No discharge from DPSC to the environment prior to 1982 was documented.

During October 1982, the fuel line to the boiler leaked approximately 600 gallons of No. 6 fuel oil, which discharged to the fuel tunnel sump system. The fuel was pumped to the storm sewer system, where it was transported off-site and discharged to the Schuylkill River. During recovery efforts, suction trucks recovered approximately 2,500 gallons of oil/water mixture. The actual quantity of oil recovered is unknown; therefore, the possibility exists that fuel from the tunnel and unlined manholes was discharged on-site.

An undocumented release reportedly occurred at the DPSC facility in 1981. The two USTs along the northern property boundary, extending beneath Oregon Avenue, were not properly abandoned when taken out of service. Reportedly, the top openings of the tanks were not sealed, allowing stormwater to flow into the tanks. During a 1981 storm, the water levels in the tanks rose and displaced the remaining petroleum hydrocarbons out of the tank. The displaced petroleum hydrocarbons reportedly flowed onto the street and into the storm sewer system. Subsequently, the oil/water mixture was removed from the tanks and storm drain with a vacuum truck and the ground surface was cleaned up. After the tanks were pumped, they were filled with a sand slurry and sealed to abandon in place.

An undocumented PCB spill occurred during the demolition of Building 5 in 1992. According to ACOE and DPSC representatives, the PCB transformer, contaminated floor slab, contaminated fill (to a depth of approximately 3 feet), and contaminated floor drain and 4-inch lateral to the 24-inch storm/sanitary sewer were removed. The PCB fluid contaminated the surrounding soils and reached the combined sewer system. Following excavation, soil sampling results indicated residual PCB contamination. Reportedly, the extent of the PCB contamination was never fully delineated, and no remedial actions were taken with respect to the combined sewer.

An October 1985 site visit by PADER personnel identified surficial soil staining around the rail car fuel unloading station adjacent to the 200,000-gallon ASTs. Following receipt of a PADER citation for the potential contamination, DPSC remediated the area by removing the contaminated soils for off-site disposal and backfilling the area with clean soil.

In September 1987, diesel contaminated soils were detected near the fuel facility (Building 28) during excavation to install a computerized fuel management system. Subsequently, a leak from the diesel tank piping was detected. The incident was reported to PADER, which conducted a site visit in October 1987. PADER notified DPSC that this soil contamination was a violation of state regulatory criteria. Subsequently, DPSC requested that the ACOE, Baltimore District, perform a contamination assessment. After this request for assistance was made, DPSC retrofitted the diesel tank fuel line and integrity tested all of the fuel facility USTs and associated piping. The testing indicated that all of the UST systems were tight, and no additional leaks were identified. In addition, a review of records indicated that no significant diesel fuel inventory discrepancies had been documented. The contaminated soil from the leaking diesel fuel lines was reported to be removed and placed in 55-gallon drums for disposal off-site.

The Baltimore District of ACOE performed a contamination assessment in the area between November 1987 and January 1988 to define the extent of soil contamination and to determine if groundwater had been impacted. The conclusions of the assessment indicated that the fuel line leak contaminated an area of approximately 1,000 square feet. The contamination spread laterally along the clayey layers, approximately 3 and 17 feet below ground surface (bgs). The contaminated soil detected at 17 feet bgs may represent an older release not associated with the fuel line leak; and the free-floating plume detected on the groundwater may be from off-site sources. Therefore, based on the review of tank inventory files and the contamination assessment of the fuel line leak, this release has a low potential to contribute to the on-site plume.

Two releases of petroleum product occurred at the DPSC facility in November 1991. The first release occurred when the fill valve was left open during an operation to heat and circulate fuel oil on the No. 6 fuel oil service tank at Building 18. It is estimated that approximately 1,975 gallons of fuel oil were discharged into the pipe tunnel from this spill. The second release was caused by thermal expansion of the No. 6 fuel oil service tank located at Building 18. It is estimated that 30 gallons of fuel oil were discharged to the ground during this second release. A total estimate of 1,361 gallons of product was released to the environment. Both of these spill incidents were reported to PADER, and their subsequent clean-up was coordinated with PADER. According to DPSC representatives, the Building 18 oil spill cleanup was completed in accordance with direction from PADER on March 24, 1992. However, there was no documentation in the files to verify that the remedial actions were completed.

In conclusion, based on the documents and files reviewed, the majority of spills that have occurred at the DPSC facility have either been cleaned up, or due to the quantity and characteristics of the materials spilled, they could not have been a major contributor to the on-site gasoline/diesel contamination plume found beneath the site.

12.1.2 Petroleum Storage Tanks

Historically, there have been 14 underground and 2 aboveground storage tanks located at the DPSC site. The underground storage tanks are in various states of use or closure. Gasoline, diesel fuel, DDT concentrate, motor oil, and No. 6 fuel oil were or are stored in the USTs. The aboveground tanks (ASTs) both contain No. 6 fuel oil. For the most part, final closure of the USTs at the DPSC site is complete, with the exception of the five No. 6 fuel oil USTs. However, closure reports for the removed USTs are not available at this time. This section was written by obtaining a correlation of sampling activities conducted by Versar and/or the tank removal contractor, review of previous site investigation reports, and conversation with knowledgeable site personnel. Current plans are for the five 25,000-gallon No. 6 fuel oil USTs and two 200,000-gallon No. 6 fuel oil ASTs to remain in service.

In February 1994, American Construction Services (ACS) began removing two 6,000-gallon USTs containing diesel fuel or No. 2 fuel oil along Oregon Avenue. The tanks were reported to have been installed in January 1922, and have been out of service since the 1940's. During tank removal activities, another 6,000-gallon UST was uncovered, which also contained diesel fuel or No. 2 fuel oil. Visible soil contamination was encountered around this tank. Wu and Associates completed removal of the original two USTs in July 1994. The third was cleaned and closed-in-place because of its proximity to Oregon Avenue. Soil samples collected at the bottom of the excavation (14 feet bgs), beneath one of the two removed tanks, indicated a TPH concentration of 9,800 ppm. No additional soil removal occurred at the location and the hole was backfilled. The soil contamination associated with these USTs has not yet been delineated. However, SPILLCAD™ overlays generated from soil samples collected during the RI/FS, tank removals, and previous sampling activities conducted at the DPSC site indicate that the contamination plume from these tanks is contained within the 0 to 8 foot bgs interval, except for directly beneath the tanks, where a TPH concentration of 9,800 ppm was detected at 14 feet bgs. Soil samples collected between the tanks and northern edge of the contamination plume, below the 8 feet bgs interval, indicate no TPH contamination present. Therefore, it is not anticipated that the release of fuel oil from these tanks has contributed to the groundwater contamination plume beneath the southern portion of DPSC.

In April 1994, ACS removed a 550-gallon waste oil tank located in the courtyard of Building 8. The tank was reportedly installed in January 1973 and was constructed of steel. Versar was not provided with a closure report on this tank. However, samples collected beneath the tank indicated a minor release of waste-oil into the environment. Sampling for TPH analysis indicated a concentration of 1,200 ppm beneath the UST. The extent of contamination from this release has not been fully delineated. However, it is not anticipated that this release has impacted groundwater or contributed to the on-site contamination plume.

On May 7, 1994, ACS removed two 10,000-gallon gasoline tanks and one 10,000-gallon diesel tank, located south of Building 28. The USTs were installed in January 1971 and supplied fuel for on-site automotive consumption. The tanks were recently replaced with two 1,000-gallon ASTs. In 1988, these USTs and associated piping were tightness tested, and the results of this testing revealed no leaks. According to a Draft Closure Report dated June 20, 1994, no visible signs of contamination were evident beneath the excavated tanks. Soil sampling conducted beneath the tanks indicated that minor soil contamination was present. However, significant levels of soil contamination were evident in the piping trench near the associated pumping island, located north of Building 28. The piping trench was excavated to approximately 26 inches bgs, and approximately 50 cubic yards of contaminated soil were removed from the trench. The extent of contamination has not yet been delineated. However, it is not anticipated that the contamination extends vertically to groundwater, due to a reported clayey layer located at 3 feet bgs.

Two 10,000-gallon DDT USTs, located south of Building 9, were removed from service by Wu and Associates during the winter of 1994/1995. The tanks held a concentrated DDT solution that was pumped into the basement of Building 9, where it was blended and subsequently applied to blankets. The tanks were originally filled with sand in 1983. On March 7, 1994, Versar collected soil samples from within the DDT USTs, the concrete manway, and surrounding soil for VOCs, TPH, and pesticide analyses. Results indicated that high levels of DDT were encountered in the tanks and surrounding soil. TPH and VOCs were relatively low. The highest measured TPH concentration was 242 ppm in the concrete manway, and the highest VOC concentration was 10 ppb xylenes from inside UST No. 1. Versar was not provided with a tank closure report on these tanks; however, the USTs have been removed, the soil excavated, and the excavation backfilled in March 1995. Therefore, these USTs are no longer a concern to the DPSC facility, and are not believed to have contributed to the on-site contamination plume beneath the site.

In February 1995, Wu and Associates removed the 30,000-gallon diesel fuel UST located on Rogers Street, between Buildings 1 and 8. It was reportedly installed in January 1971, was constructed of steel, and supplied diesel fuel to generators located in Building 8. The tank has been out of service for approximately 10 years. Versar was not provided with a closure report on this tank. However, analytic results of soil sampling beneath the UST indicated there was no VOC or TPH contamination beneath the tank. The excavation pit has subsequently been backfilled and asphalted. This UST is not believed to have contributed to the on-site contamination plume.

Currently, there are five active 25,000-gallon No. 6 fuel oil USTs located on the southwest corner of the facility between Building 18 and the two ASTs. All five USTs were installed in 1942, are constructed of steel, and reportedly encased in concrete. A piping network connects these tanks with the two ASTs and the pump house (Building 18). No. 6 fuel oil is supplied to the Boiler House by means of a concrete underground piping tunnel that runs from Building 18 to Building 8. According to facility management, in the Fall of 1994, all five tanks were cleaned and precision tested. Precision test results indicated that the tanks tested tight. Therefore, it is not likely these tanks have contributed to the groundwater contamination plume beneath the DPSC.

12.2 Major Potential Off-Site Sources

Regulatory files, various reports, and legal documents exist documenting significant petroleum hydrocarbon releases that have occurred at the properties adjoining DPSC on the west and northwest. Although it is possible that distant sources may have contributed to the massive free product plume which exists at DPSC, for reasons discussed in Section 11.0, the identification of areas where major releases have been documented focused on those which are closest to the DPSC site.

The closest tract of land where major free product releases are known to exist is the Sun Oil Company refinery south yard, located northwest and west of DPSC. Free product occurrence in the south yard has been documented at six separate locations within that geographic area, according to maps included in the Sun Company, Philadelphia Refinery 1993 Comprehensive Remedial Plan. These locations may be summarized as follows:

- **Area 1:** An east-west trending free product plume, approximately 2 acres in size, located in the northeastern part of the south yard, near the Belmont terminal and adjacent to the 26th Street sewer. Apparent free product thicknesses range from 0.25 to 1.25'.

- **Area 2:** A north-south trending free product plume approximately 1 acre in size and also located near the 28th Street sewer in the northeastern part of the south yard. Apparent free product thicknesses range from 0.39 to 1.04'.

- **Area 3:** An east-west trending free product plume, approximately 17 acres in size and located in the west-central (process area) portion of the south yard, directly along the Pollock Street sewer. Apparent free product thicknesses range from 0.03 to 2.27'.

- **Area 4:** An oval shaped free product plume, approximately 12 acres in size, located in the southwestern part of the south yard underlying the parking lot and tankage in that area. Apparent free product thicknesses range from 0.15 to 3.32'.

- **Areas 5 and 6:** Two comparatively smaller free product plumes, each approximately one acre in size and located near the southernmost portion of the south yard. Apparent free product thicknesses range from trace amounts to 7.73'.

Areas 1, 2 and 3 are all located along sewer lines, segments of which pass directly to the south of the DPSC site. A more detailed discussion of the relationship of these utilities may be found in Section 11.3. It is possible that one or more of these major free product sources is related to the free product plume encountered in the southern portion of DPSC.

12.3 Minor Potential Off-Site Contributors

Versar, and its database consultant Vista, contacted appropriate federal, state, and local regulatory agencies/offices for information to determine if any past or present uses of the surrounding properties are of environmental concern to the DPSC site. The federal and state environmental databases are presented in Appendix S. Based on review of the database, there are several off-site properties that may have contributed to the groundwater contamination at the DPSC site. In addition, there are several off-site properties with the potential to affect the subject property adversely. The results of these inquiries and associated records research are discussed in this section.

12.3.1 Federal Database Review

Versar reviewed the EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) and National Priorities List (NPL) to determine whether any properties nearby the DPSC are listed for inclusion. EPA's CERCLA (or Superfund program) identifies hazardous waste disposal sites that may require remedial action to mitigate potential negative impacts to human health and the environment. Sites with potential contamination or abandoned hazardous waste disposal sites are included in the EPA inventory, designated the CERCLIS. Sites that have undergone evaluation and are subsequently determined to be above a specified level of threat to human health and the environment are included on the NPL list.

Versar's review indicated that there are no NPL sites located within a 1-mile radius or CERCLIS sites located within 1/2-mile radius of the subject property.

Versar also reviewed the EPA's Resource Conservation and Recovery Act (RCRA) database to determine if any nearby properties are included. The RCRA program identifies and tracks hazardous waste from the point of generation to the point of disposal. The RCRA notifiers are those sites which have filed notification forms with the EPA in accordance with RCRA requirements. These sites include treatment, storage, and disposal facilities (TSDFs); underground injection facilities; transporters; and generators of hazardous waste. While RCRA facilities represent some form of hazardous waste activity, these sites are most significant if they are determined to be out of compliance with RCRA regulations. Sites determined to be out of compliance are listed in the Resource Conservation and Recovery Act Administrative Actions Tracking System (RAATS) database or the RCRA Violators (VIOLS) or Corrective Actions (CORRACTS) databases.

Versar's search of the RCRA databases indicated that there are five RCRA generators located within 3/8-mile radius of the DPSC site. There are no RCRA TSD facilities or CORRACTS sites within a 1-mile radius, no VIOLS sites within a 1/2-mile radius, and no RAATS sites located near the subject property. Moreover, the five RCRA generators are all in compliance with the rules governing RCRA and are not believed to be a current environmental concern to the subject property.

Versar reviewed the Emergency Response Notification System (ERNS) to determine whether there are any adjacent properties listed. The ERNS is a national database used to collect information on reported releases of oil and hazardous substances. The database contains information from spill reports made to federal authorities including the EPA, the U.S. Coast Guard, the National Response Center, and the Department of Transportation. There are three ERNS sites located within 3/8-mile of the DPSC facility. However, all ERNS sites are located more than 0.15-mile east of the subject property. Based on known groundwater flow direction to the southeast, these sites would be hydrogeologically down-gradient of the DPSC site.

12.3.2 State and Local Regulatory Review

Versar reviewed the VISTA database search of the PADER Hazardous Sites Cleanup Program List (SPL); List of Confirmed Releases-Leaking Underground Storage Tank Sites (LUST); Inactive Solid Waste Facilities, Solid

Waste Transfer Stations, and Solid Waste Inventory Database (SWLF); and Storage Tank Database System-Underground Tanks (UST).

Versar's review of the database search revealed that no SPL sites were identified within 1 mile and no SWLF sites were identified within a 1/2-mile radius of the subject property.

There are 9 UST sites within 3/8 mile and 5 LUST sites within 3/4 mile of the subject property. The 9 UST sites are not listed on the LUST list. Therefore, they do not currently pose a known significant environmental threat to the subject property. Four of the five LUST sites are located more than 3/8-mile from the DPSC facility, are hydrogeologically crossgradient (northeast) or downgradient (southeast) of DPSC, and are not expected to have an environmental impact on the property. These sites include the 20th Street Associates, 3200 South 20th Street (0.39-mile south); Sunoco Gas Station, 18th Passyunk Avenue (0.59-mile, northeast); Ryder Truck Rental, 3400 South 26th Street (0.64-mile southwest); and JFK Stadium, Broad and Patterson Streets (0.71-mile southeast). The remaining LUST is the Sears Roebuck Co (a.k.a., Kahn Joint Venture site), located north of the subject property at 2201 Oregon Ave. The database did not provide much information regarding the LUST. Therefore, Versar conducted a file review at PADER's Division of Underground Storage Tanks. According to the file review, in 1990, during the closure of a 550-gallon waste oil tank utilized by the Sears Automotive Department, soil contamination was detected. The release of waste oil was caused by Sears personnel dumping waste oil into the access manhole instead of a remote drain installed to receive waste oil. It is reported that this practice has been going on for 20 years. Currently, Sears and Kahn Joint Ventures are in litigation over the waste oil contamination, and the extent of contamination has not yet been delineated. Therefore, it is unknown whether waste oil contamination has affected the DPSC property.

The SEPTA South Garage, adjacent to the DPSC on the east, is another another potential environmental threat. Versar obtained a Phase II Limited Site Characterization Report conducted on the SEPTA South Garage dated March 10, 1992. During removal of four USTs, petroleum hydrocarbon contamination was found in the subsoil. In April 1991, a Subsurface Site Investigation was conducted in which 3 monitoring wells (MW-1, MW-2, and MW-3) were installed and sampled. Petroleum hydrocarbons and BTEX constituents benzene and xylenes were detected in all three wells. An additional well, MW-4, was installed up-gradient of the former tank area and all wells were re-sampled in February 1992. Results of the sampling indicated the highest TPH concentration of 270 ppm was found in the up-gradient well MW-4. However, no BTEX constituents were detected. Conclusions from the Phase II Site Characterization Report indicated that the TPH contamination found in MW-4 may be due to off-site sources (i.e., DPSC). However, the BTEX contamination was due to on-site sources.

Current groundwater flow direction in the vicinity of the SEPTA garage was measured to be in an easterly direction, away from the DPSC facility. However, in the 1960s, DPSC utilized a groundwater production well located in Building 8 for on-site water uses. It is possible that groundwater flow directions were altered due to this production well, causing an environmental impact to the DPSC facility from the SEPTA South Garage BTEX contamination. However, the BTEX contamination has not been delineated at the SEPTA site, and it is not known when the contamination occurred.

13.0 CONCLUSIONS

13.1 Extent of Contamination

The determination of the extent of contaminated media at the 86.5-acre DPSC site is based on data generated from Phase I of the Remedial Investigation work plan dated May 23, 1994, as well as on earlier site investigations performed at this facility (listed in the reference section of this report).

Phase I of the RI focused primarily on delineation of the extent of petroleum hydrocarbon contaminated media at the DPSC and secondarily on the extent of DDT contamination associated with the DDT storage tanks and mixing room located in and around Building 9. Phase I of the RI investigation did not include delineation of the vertical component of the dissolved petroleum hydrocarbon groundwater contaminant plume or evaluation of other areas of concern at DPSC. The latter investigatory tasks are planned as part of Phase II of the RI.

13.1.1 Petroleum Hydrocarbons

Petroleum hydrocarbons are ubiquitous contaminants of concern at the DPSC site. During Phase I of the RI, three separate areas of contamination were identified:

- A massive free product plume developed over much of the southern half of the site
- An area of DRO contaminated soil and groundwater in the northwestern portion of the site and
- A release of a weathered fuel oil along Oregon Avenue in the north central part of the DPSC

The massive free product plume is composed of a 2:1-3:1 mixture of gasoline and diesel fuels and occupies an area of approximately 54 acres, covering most of the southern half of the facility. It is estimated that there are over one million gallons of extractable free product in place with additional hydrocarbons present in irreducible form. Soil and groundwater contamination maps for various species of petroleum hydrocarbons all show similar trends to the distribution of free product.

The free product plume occurs within a clay dome developed on the southern side of DPSC and may also be accumulating at that location as a result of migration along the Packer Avenue sewer south of the facility. Within the footprint of the free product plume, petroleum hydrocarbon contaminated soils reach thicknesses of up to 13 feet, probably in response to a combination of water table fluctuations and dissolution/transport of the more soluble constituents of the fuel products comprising the plume. The vertical extent of groundwater contamination in the aquifer is unknown, but is likely to be significant; a benzene concentration of 590 ppb was measured in MW-6D, which is screened approximately 45 feet below water table depth.

An isolated area of DRO contaminated soils and groundwater was identified at the northwestern corner of the DPSC. The comparatively low levels of diesel range organics in both soil and groundwater, the absence of other petroleum hydrocarbon species, and the discontinuity with soil and groundwater contamination encountered along the southern portion of the site, all suggest that this contamination is associated with a different release. The DRO contaminants detected in soils at the northwestern part of DPSC were found at several sampling depths within the fill materials at that location and also in groundwater samples collected from monitoring well and hydropunch samples.

A third area of petroleum hydrocarbon contamination was identified near the north-central portion of DPSC along Oregon Avenue. TPH contaminated soils were detected at this location during sampling for the in-place closure of a 6,000-gallon diesel UST. No historical data was available concerning this UST, one of three tanks in the area; however, it is believed that the 6,000-gallon UST was used to store diesel fuel. TPH contaminated soils could not be differentiated by the California LUFT sampling method; the release was simply characterized as a weathered fuel oil product. The extent of TPH contaminated media at this location has not yet been completely defined. It occurs in the depth range 0 to 8 feet below grade and could be associated with similar soil contamination that occurs directly to the south along Aleshire Street, and possibly as far south as Building 8.

13.1.2 Other Contaminants of Concern

Phase I of the RI focused primarily upon delineation of the extent of petroleum hydrocarbon contaminated media. However, the analyses of soil and groundwater samples collected for this objective were extended to include TCL organic and TAL inorganic compounds to determine if any other site-wide contaminant trends were evident. Sampling locations were limited by the primary RI objective, and hence were not sited to evaluate other areas of concern and involved no surface soil sampling.

The two significant contaminants identified as a result of the extended analyses were polynuclear aromatic hydrocarbons (PAHs) and DDT. Certain of the PAHs were found to be directly related to the presence of the massive gasoline/diesel free product plume in the south part of the site, while others appeared to be related to the occurrence of fill materials at the northwestern and southeastern corners of the facility. DDT contamination was detected in soils directly contiguous to the former DDT UST sites south of Building 9 in the southeast part of the site. This contamination was observed to have a very limited areal extent. Analysis of samples acquired via direct push technology indicated the contamination had not significantly impacted groundwater in the vicinity of these USTs. The DDT USTs and associated contaminated soils were removed by Henry

Wu and Associates, Inc. in the first quarter of 1995. However, DDT contamination was also identified beneath the concrete floor in the basement of Building 9, and this contamination has not yet been completely delineated.

13.1.3 Potentially Uncontaminated Tracts at DPSC

The identification of any "clean" land tracts at the DPSC is of considerable interest relative to BRAC reuse plans for the facility. From Phase I of the RI and from earlier site investigations, it is evident that petroleum hydrocarbon contamination has impacted most of the 86.5-acre property. Based on limited data from the performance of an active soil gas survey, the installation of MW-18, and a single soil boring/monitoring well, no soil or groundwater contaminants have been detected to date at the visitor's parking lot located at the southeast corner of the intersection of 20th Street and Oregon Avenue. However, the following factors must be weighed before this location may be designated as "clean":

- As a parking lot area, this area is subject to the gradual and non-sudden release of minor amounts of fuel oil and gasoline from the vehicles that are parked in this area during working hours.
- The parking lot is situated immediately to the north of the SEPTA maintenance garage; USTs at this facility have reportedly failed precision testing.
- The visitor's parking lot is situated east of the George Young Rigging and Hauling Company, formerly the location of an Exxon gasoline station.

13.2 Probable Sources of Petroleum Hydrocarbon Contamination

The occurrence of DRO contaminated soil at the northwest corner of DPSC was first documented in the DPSC Fuel Contamination Study conducted by the Baltimore ACOE in 1988. This soil contamination and associated groundwater contamination was confirmed by Versar during Phase I of the RI. The low level DRO soil and groundwater contamination may be related to emplacement of a substantial thickness of fill materials of unknown composition in this area. These fill materials attain thicknesses of up to 22 feet. Alternatively, it is possible that this DRO contamination has originated from an off-site source located somewhere northwest of DPSC. TPH levels in the form of DRO are below the PADER clean-up standard of 500 ppm established for releases exceeding one year in age. The clean-up standards for DRO in groundwater are dependent on DPSC's background water quality conditions, which will be further evaluated in Phase II of the RI.

TPH contamination in soils contiguous to the 6,000-gallon Oregon Avenue UST occurs at depth of 0 to 4 feet below grade and was observed to be associated with overfill at the UST fill port. This TPH contamination was characterized as a weathered diesel fuel. The extent of soil and groundwater contamination associated with this release has not yet been fully delineated.

Evaluation of the source of the massive free product plume at the southern portion of DPSC was accomplished through a process of elimination of potential candidates.

13.2.1 Evaluation of Potential On-Site Source Areas

- The DRO release in the northwestern portion of the site is spatially distinct from the massive free product plume and has a different chemical signature.

- The weathered diesel fuel release in the north-central portion of the DPSC is also spatially distinct from the massive free product plume. No free product was detected in MW-2A, downgradient of the Oregon Avenue UST release and upgradient of the massive free product plume. Moreover, the Oregon Avenue release has a different chemical signature from the free product plume.

- Near the northeast corner of Building 28, soil contamination was delineated during the *1988 DPSC Fuel Contamination Study* and found to be limited to an area of approximately 1000 square feet. It appears to have been associated with a diesel fuel release attributed to corroded tank piping. The report indicated that the diesel contamination had spread laterally along two clay layers at 3 feet and 17 feet below grade, but suggested that the deeper contamination might have represented an older release. Contaminated soil at the 3 foot level in the pipe trenches was removed on two separate occasions: during retrofitting of the corroded sections of piping and then again when these pipes were replaced in 1994.

- There is no evidence of significant releases from either of the former 10,000-gallon gasoline USTs or from the 10,000-gallon diesel UST near Building 28. All three tanks passed inspection following tightness testing performed between December 1990 and July 1991.

- No releases were evident during the closure of the 30,000-gallon diesel UST on Rogers Street or during closure of the 550-gallon waste oil (used motor oil) tank in Building 8.

- There are no documented releases of No. 6 fuel oil from the either the two 200,000-gallon ASTs, five 25,000-gallon USTs, or the DPSC fuel tunnel that runs along Rogers Street. Any releases that may have occurred with respect to any of these "Bunker C" fuel oil tanks would be easily distinguishable from the gasoline/diesel oil character of the 54-acre free product plume by their chemical signature.

13.2.2 Evaluation of Potential Off-Site Source Areas

- Of the eight USTs installed at the SEPTA garage in 1979, at least one 10,000-gallon diesel UST is now permanently out of service. As of 1991, the facility also had two 10,000-gallon diesel USTs, one 6,000-gallon gasoline UST, and five waste oil USTs (one 1,000-gallon, three 550-gallon, and one 285-gallon tanks). Based on current hydraulic gradients, any releases that might have occurred from these tanks would be expected to migrate in a south or southeasterly direction away from the DPSC. The former DPSC process water supply well located in Building 8 may have caused an earlier reversal in hydraulic gradient (i.e., westerly direction of groundwater flow) in the vicinity of the SEPTA garage, but production from this well pre-dated the installation of the eight previously described USTs. The underground stormwater sewer lines between the SEPTA garage and the free product plume at DPSC do not appear to represent a significant transport pathway due to the shallow depth of this sewer line. It is not known whether the occurrence of BTEX in one of the SEPTA groundwater monitoring wells at the southern portion of the facility represents an easterly transport of dissolved phase hydrocarbons from the DPSC free product plume, or if it is related to a release associated with the SEPTA gasoline UST.

- The Kahn Joint Venture property, at the northwest corner of the intersection of 22nd Street and Oregon Avenue, is located near the north central portion of the DPSC. This site was formerly the location of a Sear's automotive repair shop with three 2,000-gallon virgin motor oil USTs and one 550-gallon waste oil (spent motor oil) UST. The three 2,000-gallon USTs were closed in-place and the 550-gallon waste oil UST was removed. TPH soil contamination was detected upon removal of the waste oil tank at levels of up to 7,500 ppm. The extent of this release has not been completely delineated. However, soil and groundwater impacts associated with this release would be expected to have a lube oil type chemical signature and should be easily distinguishable from the massive gasoline/diesel plume located on the southern half of the DPSC.

- West of DPSC, numerous areas of free product occurrence have been documented in the Sun Oil Company refinery south yard. Based on 1993 mapping, at least six separate areas of free product occurrence are known to exist in this area; it is estimated that more than 30 acres of this contiguous property are underlain by free product, which in some areas attains apparent thicknesses up to 7.3 feet. No characterization data is available concerning the nature of the product released in this area. However, limited product inventory records indicate that both gasoline and diesel products were stored at this location at some past time. The inspection of free product maps in Sun Oil Company annual groundwater monitoring reports indicates that several of the free product plumes occur in the vicinity of underground sewer lines, notably the 26th Street and Pollock Street sewers. It is possible that free product migration occurs along the bedding materials and/or backfill associated with these sewers and that a continuous utility pathway exists between the refinery south yard property and the southern portion of the DPSC.

13.3 Preliminary Findings Regarding Responsible Parties

Versar has reason to conclude that the single most likely potential source of the 54-acre free product plume at the DPSC is the Sun Oil Company refinery south yard, in light of careful consideration of the following factors:

- The volume of free product along the southern portion of DPSC exceeds one million gallons, and additional product volume occurs in an irreducible form in vadose zone soils. Based on available information concerning various on-site and off-site releases in the vicinity of DPSC, none of these individual sources is likely to have generated a product volume this large, except for the refinery south yard. Interpretation of groundwater flowpaths and the chemical signatures associated with the various releases, excluding the Sun refinery south yard releases, indicate that they did not act in a cumulative sense to produce a one million gallon free product plume that is a gasoline/diesel fuel mixture.

- Free product does not appear to have migrated onto the DPSC site from a northwest direction following regional groundwater flow patterns. Although low levels of DRO contaminated media were detected in the northwest corner of DPSC, no discernible transport pathway for the free product plume was recognizable from the analyses of soil and groundwater samples collected in this area. If the gasoline/diesel plume entered the DPSC from the northwest, residual soil contaminants bearing this chemical signature should be evident in the silty, fine grained soils that comprise the aquifer. The absence of this chemical signature suggests an alternate transport pathway.

- As indicated by the pattern of isoconcentration contours for various hydrocarbon species, the extent of soil and groundwater contamination associated with the free product plume at DPSC suggests a source that lies somewhere to the south of the facility. The area south of DPSC is primarily residential; however, major city sewer lines south of the DPSC site continue into the refinery area and are known to be associated with various occurrences of free product in that area.

- There are no manifestations of the massive free product plume in soils in the depth interval from 0 to approximately 15 feet below grade, making it improbable that any major spills or surface releases at DPSC contributed significantly to the free product plume. The presence of a surficial low permeability silt and clay unit at DPSC tends to inhibit the potential infiltration of spills to water table depths.

14.0 RECOMMENDATIONS

Three recommended tasks remain to be performed at DPSC to complete implementation of the RI/FS:

- Additional responsible party determination, including additional characterization required to identify free product and vapor phase transport mechanisms that may occur via subtle migration pathways.
- Assessment of the need for possible interim remedial measures to assure containment of the free product plume.
- Evaluation of the remaining areas of concern at DPSC, including delineation of the dissolved phase groundwater contaminant plume associated with the occurrence of more than one million gallons of free product, and subsequent completion of a Baseline Risk Assessment and Feasibility Study.

14.1 Completion of Phase II of the Remedial Investigation

Phase I of the remedial investigation deals exclusively with the delineation of petroleum hydrocarbon and DDT contaminated media at DPSC. Identification of DPSC AOCs and the sampling and analysis plan requirements are specified in the RI/FS Project Operations Plan dated May 23, 1994. It is recommended that characterization of the following additional areas of concern (AOCs) be performed.

- Sediment and surface water in site stormwater catch basins;
- Subsurface soils along the combined sanitary/stormwater sewers and along the underground fuel oil tunnel;
- Subsurface soils and groundwater adjacent to the NIKE missile assembly area (Building 26);
- The former incinerator area and associated fill materials;
- Surface soils along site railroad tracks and background surface soils;
- Sand filter trap sediment and subsurface soils near the waste oil UST in the Building 30 motor pool area; and
- Subsurface soils beneath Building 9 and along the product lines from the former DDT USTs to the DDT mixing room.

14.2 Follow-on Tasks to Improve PRP Determinations

The interpretation of data collected in Phase I of the RI concerning the nature and extent of petroleum hydrocarbon contamination at DPSC significantly narrowed the number of possible sources likely to have contributed to the massive free product plume on the southern half of the site. These data, while suggesting the most probable product transport directions and contributory sources, are not conclusive. Additional characterization should be conducted to establish a clear understanding of the mechanisms controlling product migration along underground utilities (specifically sewers) and to delineate the southern boundary of the free product plume. To ensure a technically defensible PRP determination, the following tasks must be completed, in order, with the objectives of each task and a detailed scope of work clearly defined in a work plan prior to implementation:

- Performance of a soil gas survey along the Packer Avenue and Pollock Street sewers for identification of volatiles associated with free product. The survey will support the siting of soil and/or groundwater sampling locations along both sewers.

- Geologic logging, sampling, and analysis of soil and groundwater samples along the Packer Avenue and Pollock Street sewers via direct-push technology and on-site analytical capabilities. These sampling locations should be extended as far south as necessary to delineate the southern limits of the free product plume.

- Excavation of test pits in the vicinity of the Packer Avenue and Pollock Street sewers to characterize the thickness and physical characteristics of bedding materials and backfill and their propensity to transmit free phase petroleum hydrocarbons.

- Fingerprinting analyses of free product on the southern portion of the DPSC site, along the Packer Avenue and Pollock Street sewers, and in Areas 1, 2, and 3 of the Sun Oil Company refinery south yard as defined in Section 12.2. To maximize the correlation of free product chemical characteristics across substantial distances, these analyses should include the following:

    1. All the gaseous hydrocarbons in the C_1-C_5 range
    2. Eighty volatiles in the gasoline (C_3-C_{10}) range
    3. Total lead and organic lead
    4. Lead alkyl additives in gasoline, including identification of the individual compounds and amounts
    5. Lead isotope ratios - $^{206}Pb/^{204}Pb$ of total lead in gasoline
    6. N-alkanes through carbon numbers C_{33} or greater, along with certain other paraffinic species for diesel fuels

7. Polycylic saturated hydrocarbon classes of steranes and triterpanes called "biomarkers" that are chemical fossils that contain the hydrocarbon skeletons of components in the biological materials from which the petroleum was originally formed.
8. Polynuclear aromatic compounds
9. Side chain substitution on polynuclear aromatic hydrocarbons
10. Stable isotope ratios for carbon, hydrogen, and sulphur
11. Trace metals, especially vanadium and nickel

- The extent of the dissolved phase of the petroleum hydrocarbon groundwater contaminant plume should be delineated. The geometry and geochemical characteristics of this plume may provide additional information concerning migration pathways of the free product plume. Delineation of the dissolved phase plume may also be necessary, depending on the establishment of remedial action objectives and groundwater clean-up standards, to support remedial design criteria for aquifer restoration.

14.3 Interim Remedial Measures

The Phase I RI findings show that there are nearly one million gallons of free product located in the southern portion of the DPSC site. In addition to groundwater contaminated by free product, there is a significant quantity of soil containing TPHs and dissolved phase groundwater contamination. Potential migration pathways for the free product include on-site and off-site migration via groundwater and vapor phase migration through the soil and along utility lines to on-site and off-site receptors (e.g., basements). In order to minimize the potential for further migration of the free product contamination and to protect the health and safety of potential on-site and off-site receptors, the implementation of an interim remedial measure (IRM) designed to minimize the migration of free product is recommended. Protection of human health and the environment and containment/removal of the free product plume are the primary objectives of the IRM. However, it should be noted that until free product contamination is addressed, TPH contaminated soil and dissolved phase groundwater contamination cannot be cost effectively treated.

The installation of a free product extraction system is the most effective method for containing/removing the free product from the groundwater. The extraction system will not control vapor migration, but the removal of the free product will reduce the amount of material available to be released via the vaporous phase. In addition to the free product extraction system, a vapor phase monitoring program should be developed to ensure the continued protection of the health and safety of on-site workers. The vapor phase monitoring program should include, at a minimum, a combination of soil vapor monitoring and ambient air monitoring in all basements.

The extraction system will typically consist of a series of extraction wells whose configuration will be dependent upon the hydrogeologic characteristics of the site and the site-specific remedial objectives. In order to effectively design the system, existing groundwater flow conditions should be modeled using a three-dimensional flow model such as MODFLOW. Once existing conditions have been determined, various groundwater pumping scenarios should be modeled in order to determine the optimal design for the free product extraction system. The extraction system will modify regional flow patterns, effectively containing the plume, and will result in the removal of free product.

A cost-benefit analysis should be conducted to identify the most cost effective method(s) of handling the extracted product and groundwater. For the free product, reuse or recycling is recommended. Limited analytical testing may be required to effectively evaluate reuse and recycling options. The extracted groundwater can be reinjected, treated on-site, treated off-site, or recycled. Some treatability testing will likely be required to determine the best method for ultimate disposition of extracted groundwater.

15.0 STEPS TOWARDS REMEDIATION OF PETROLEUM CONTAMINATED MEDIA

To reach the goal of remediating the petroleum hydrocarbon contaminated media at the DPSC site and to ensure the protection of human health and the environment, several steps must be conducted concurrently with the recommended Phase II Investigation in order to expedite remediation and minimize future health concerns. The scope and objective of each step are summarized in the following sections.

15.1 Remedial Action Objectives

A key step in the selection of the most appropriate remedial alternative is the development of Remedial Action Objectives (RAOs), which define specific goals for the protection of human health and the environment on a media-specific or operable unit specific basis. RAOs ensure that potential remedial actions adequately protect human health and the environment. RAOs typically specify (1) the contaminants of concern, (2) exposure pathways and receptors, (3) acceptable contaminant levels, and (4) areas of attainment. Key factors influencing the development of RAOs are (1) regulatory requirements, (2) risk-based health criteria, and (3) future land use scenarios. For example, acceptable contaminant levels for a site that is to be used for industrial purposes may be greater than acceptable contaminant levels for a site that may be used for residential purposes. Examples of potential RAOs for the DPSC site include:

- Prevent ingestion of groundwater found to exceed ARARs or estimated to have an excess cancer risk of greater than 10^{-6} or a hazard index of greater than 1.0 by a hypothetical future on-site resident.
- Prevent the migration of free product contaminated groundwater to off-site receptors.
- Prevent direct contact with surface soils found to exceed ARARs or estimated to have an excess cancer risk of greater than 10^{-6} or a hazard index of greater than 1.0 by an on-site worker.
- Prevent the migration of contaminants from soil to groundwater.
- Prevent the migration of vapor phase contaminants from site soils to the basements of on-site buildings.

15.2 Applicable or Relevant and Appropriate Requirements

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that remedial cleanup actions comply with Federal (i.e., EPA and DOD) and State environmental laws. Although the DPSC site is not a CERCLA regulated site, the CERCLA requirements should be utilized as a guideline for investigating the site and selecting an appropriate remedial alternative. In accordance with CERCLA provisions, remedial cleanup actions must satisfy requirements that are applicable, or relevant and appropriate to the hazardous substances or to the circumstances of the release. The requirements that must be met are those which are applicable, or relevant and appropriate (ARARs). ARARs are defined as follows:

- Applicable requirements are those requirements promulgated under Federal (i.e., EPA and DOD) or State law that specifically address a hazardous substance, remedial action, or other circumstance at a hazardous waste site.

- Relevant and appropriate requirements are those requirements promulgated under Federal (i.e., EPA and DOD) or State law that are not applicable to a hazardous substance, remedial action, or other circumstance at a hazardous waste site, but that address situations similar to those encountered and their use is well suited to the hazardous waste site.

- "To be considered requirements" are those requirements (e.g., health advisories, guidances, proposed regulations) that have not been promulgated, but should be considered in developing remedial action alternatives at the hazardous waste site.

There are three types of ARARs that remedial actions may have to comply with (1) Chemical-specific ARARs, (2) Location-specific ARARs, and (3) Action-specific ARARs. These types of ARARs are defined below:

- **Chemical-specific ARARs** set concentration limits or ranges in various environmental media for specific hazardous substances (e.g., Maximum Contaminant Levels).

- **Action-specific ARARs** set restrictions on specific types of activities related to the management of hazardous substances (e.g., National Ambient Air Quality Standards).

- **Location-specific ARARs** set restrictions on activities based on site-specific characteristics (e.g., wetlands restrictions).

15.3 Baseline Risk Assessment

The objective of a baseline Risk Assessment (RA) is to provide an evaluation of potential threats to human health and the environment in the absence of any remedial action. The primary components of an RA are:

contaminant identification, exposure assessment, toxicity assessment, and risk characterization. Contaminant identification involves the evaluation of available data to determine the concentrations and toxicity of hazardous substances present in the relevant media (e.g., soil, groundwater). The objectives of the exposure assessment are to identify current and/or future exposure pathways, evaluate potential receptors, and estimate expected exposure concentrations. Adverse effects of exposure are evaluated during the toxicity assessment. Finally, an estimate of the potential for adverse health or environmental effects is developed during the risk characterization.

Depending on the complexity of the site (e.g., number and types of contaminants present) and the RAOs, the RA may be a quantitative or qualitative evaluation of risks. A quantitative RA will result in the development of numerical risk estimates based on carcinogenic risks and noncarcinogenic risks. A qualitative RA may involve the comparison of contaminants of concern to ARARs. Quantitative toxicity data are available for individual components of petroleum hydrocarbon contamination, such as benzene, but are generally unavailable for petroleum hydrocarbons as a whole. Based on this fact, the evaluation of risks related to petroleum hydrocarbons at the DPSC site will most likely require qualitative or semi-quantitative risk assessment methods.

15.4 Focused Feasibility Study

Based on the data gathered above, a focused Feasibility Study (FS) should be conducted to identify optimal remedial alternative(s) for dissolved phase groundwater contamination and soil contamination. The primary objective of the FS is to gather sufficient data to decide the most appropriate remedy for a given site. The FS typically consists of two major steps (1) development and screening of technologies, and (2) detailed analysis of alternatives. Although the areal extent of petroleum hydrocarbon contamination is large, the number of contaminants of concern is limited. Based on the limited number of contaminants of concern, a focused FS should be considered for the DPSC site in the interest of saving time and money.

In a focused FS, the detailed analysis of alternatives will be conducted, but the development and screening of technologies will be streamlined. The development and screening of technologies typically involves the identification and screening of the universe of remedial technologies. Because there are only a limited number of potentially viable remedial technologies applicable to petroleum hydrocarbon contamination, the screening process should be limited to those technologies that have proven successful in the remediation of petroleum hydrocarbon contamination.

The identification and screening of potentially viable remedial technologies should be completed as early as possible so data gaps (e.g., treatability testing requirements) can be identified and resolved prior to conducting the detailed analysis of alternatives.

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ACRONYM LIST

ACOE	U.S. Army Corps of Engineers
ACS	American Construction Services, Inc.
AOCs	Areas of Concern
AQTESOLV	Aquifer Test Solver
ARAR	Applicable or Relevant and Appropriate Requirement
AST(s)	Aboveground Storage Tank(s)
ASTM	American Society of Testing Materials
AWL	Adjusted Water Level
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CLP	Contract Laboratory Program
CORRACTS	RCRA Corrective Actions Database
CPT	Cone Penetrometer
DI	Deionized
DLA	Defense Logistics Agency
DOD	Department of Defense
DPSC	Defense Personnel Support Center
DQOs	Data Quality Objectives
DRO	Diesel Range Organics
DTP	Depth to Product
DTW	Depth to Water
EB	Equipment Blank
ENSA	Environmental Services of America, Inc.
EPA	U.S. Environmental Protection Agency
ERNS	Emergency Response Notification System
ES&E	Environmental Science & Engineering
FB	Field Blank
FID	Flame Ionization Detector
FS	Feasibility Study
GC	Gas Chromatography
GES	Groundwater and Environmental Services, Inc.
GPR	Ground Penetrating Radar
GRO	Gasoline Range Organics
HASP	Health and Safety Plan
HCl	Hydrochloric Acid
HNO_3	Nitric Acid
H_2SO_4	Sulfuric Acid
HP	Hydropunch

ACRONYM LIST
(Continued)

IB	Invert Bottom
IDW	Investigation Derived Waste
IG	Infiltration Goal
IRM	Interim Remedial Measure
LIF	Laser Induced Fluorescence
LNAPL	Light Non-Aqueous Phase Liquid
LUST	Leaking Underground Storage Tank
MCLs	Maximum Contaminant Levels
MH	Manhole
MRD	Missouri River District, U.S. Army Corps of Engineers
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level
MTBE	Methyl Tertiary Butyl Ether
MW	Monitoring Well
NaOH	Sodium Hydroxide
ND	Not Detected
NED	New England District, U.S. Army Corps of Engineers
NGVD	National Geodetic Vertical Datum
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PADER	Pennsylvania Department of Environmental Resources
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PID	Photoionization Detector
PPE	Personal Protective Equipment
PRP	Potentially Responsible Party
PT	Product Thickness
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
RA	Risk Assessment
RAATS	RCRA Administrative Actions Tracking System
RAO	Remedial Action Objective
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
RG	Recharge Goal
RI	Remedial Investigation
SARA	Superfund Amendments Reauthorization Act
SCAPS	Site Characterization Analysis Penetrometer System
SEPTA	Southeastern Pennsylvania Transit Authority
SG	Soil Gas
SMCLs	Secondary Maximum Contaminant Levels

ACRONYM LIST
(Continued)

SOPs	Standard Operating Procedures
SPL	State Priority List
SVOCs	Semi-volatile Organic Compounds
SWLF	Solid Waste Landfill
SW846	Test Methods for Evaluating Solid Wastes
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbons
TSDFs	Treatment, Storage and Disposal Facilities
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
UST(s)	Underground Storage Tank(s)
VIOLS	RCRA Violators Database
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds

Attachment 1

PHASE I REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR DDT UST/MIXING ROOM

Project 8057

PHASE I REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR DDT UST/MIXING ROOM FOR THE DEFENSE PERSONNEL SUPPORT CENTER PHILADELPHIA, PENNSYLVANIA

Submitted to:

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July 27, 1995

KEMRON
ENVIRONMENTAL SERVICES

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EXECUTIVE SUMMARY

KEMRON Environmental Services, Inc (KEMRON) and Versar, Inc. as part of the larger Phase I Remedial Investigation/Feasibility Study as outlined in Section 2.2.3.5 of the revised Project Operations Work Plan conducted a limited DDT investigation.

The task was to characterize and delineate the extent of DDT (dichlorodiphenyltrichloroethane) contamination determined to be present surrounding the former UST locations and the potential contamination which might be present beneath the former DDT mixing room flooring and floor drains in and adjacent to Building No. 9, and to identify those areas which might require further investigation and/or remediation as part of the BRAC closure process.

Studies of DDT indicate that there are several target organs in humans and DDT has been found to cause tumors in laboratory animals. However, results from this limited investigation indicate that such impact for either human or animal receptors is minimal due to the following site conditions and observations: (1) the target contaminant, DDT, appears to be confined within site soils, generally above the observance of local groundwater, (2) that contamination is segregated from direct human or animal contact by the site's thick concrete and asphalt pad overlying the contaminated areas, and (3) the potential for volatilization of the contaminant is low. Therefore, the potential exposure from ingestion, inhalation or dermal contact is low.

The results of this investigation determined that contamination existed south of the DDT UST pit excavation to the south in three borings and beneath the concrete slab floor in the mixing room at levels which would require incineration as a result of the Land Ban. The contamination level must be less than 87 ppb. The highest soil contamination found during the investigation surrounding the UST's was 20 ppm. Soil contamination beneath the floor of Building No. 9 was found as high as 220 ppm. This indicates that there may be extensive contamination beneath the sub-basement flooring. KEMRON recommends that future work should include an investigation to determine if the contamination found beneath the flooring in Building No. 9 extends beyond the limits of the building. This investigation should focus on the potential subsurface routes of contamination which is primarily the floor drain which has a long run to the storm sewer. The purpose of this study would be to determine if there was contamination as a result of possible exfiltration from the drainage piping. Furthermore, groundwater samples were found to contain DDT contamination. The level measured ranged from .19 to 1 micrograms per liter. Currently, there is no DDT MCL for drinking water. However, a proposed RCRA remediation level of .0001 milligrams per liter was found for groundwater. Therefore a risk assessment may be necessary to determine if the level present in the groundwater poses a significant risk. Kemron also recommends that as part of the risk assessment an appropriate remedial response be based on the potential future use of the facility and possible future construction projects.

1.0 INTRODUCTION

This report summarizes activities of a limited field investigation conducted by KEMRON between September 15 and December 14, 1994. This investigation was the result of the discovery of DDT contaminated soil from an earlier sub-surface soil and groundwater investigation. Site data from that previous investigation where pesticides were detected in soils reported in an earlier report titled *Sampling of Unknown Contents in DDT USTs* by VERSAR dated April 8, 1994. The area of concern is adjacent to two former underground storage tanks (USTs) used for the storage of DDT located south of Building 9 (*Figure 1*). The tanks held a concentrated DDT solution that was pumped to a mixing room in the basement of Building 9, where it was blended and subsequently applied to blankets. Wipe sampling inside the mixing room indicated moderate to high levels of DDT contamination. As part of this investigation boreholes were placed in the sub-floor to evaluate potential DDT impact to the sub-floor soils.

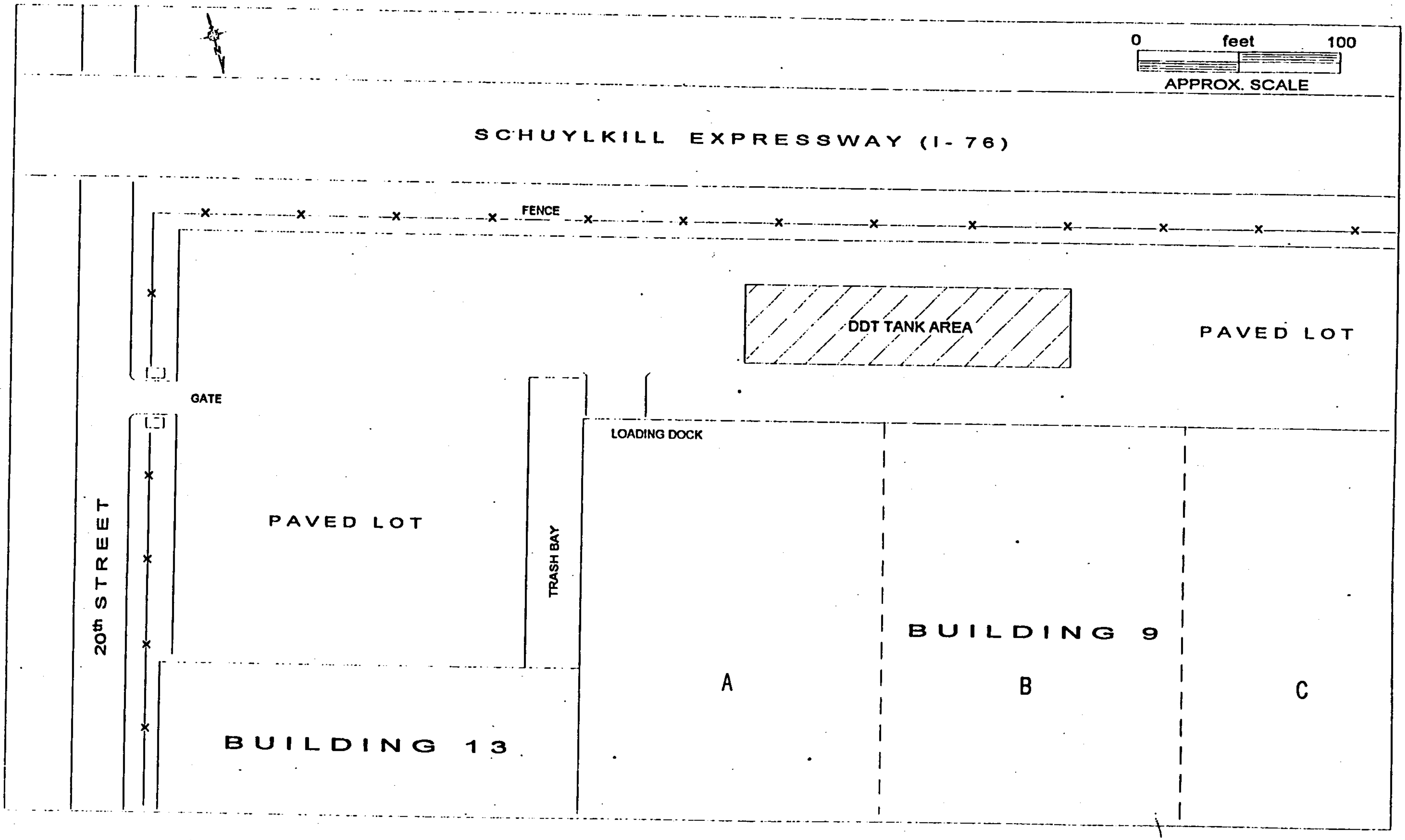

FIGURE 1. LOCATION OF DDT TANKS AT DPSC SITE.

2.0 SITE DESCRIPTION

2.1 Site Location

As previously noted the DPSC is located at 2800 South 20th Street in Philadelphia and is bounded by 20th Street to the east, Oregon Avenue to the north, the Schuylkill Expressway to the south, and the CSXT/Conrail line to the west. The site consists of several warehouse/loading dock buildings, and office structures located on a 0.5 square mile parcel. The facility comprises approximately 86.5 acres and is found at approximately 39°55' north latitude and 75°11' west longitude on the Philadelphia, PA-NJ 7.5 minute U.S. Geological Survey (USGS) topographic quadrangle map.

2.2 Facility Description and Operation

The DPSC facility is government-owned and is operated by the Defense Logistics Agency (DLA). According to DPSC personnel, the property has always been owned or leased by the Department of Defense (DOD). The facility was constructed in 1918, and additional construction and major renovations occurred at the site in the early 1940's. Prior to initial construction in 1918, the property was reportedly vacant, unimproved land. Presently, approximately 95% of the total property area is developed with buildings or pavement.

The DPSC facility is responsible for the worldwide distribution of supplies for the DOD. This responsibility includes procuring and distributing food, clothing, and medical supplies to all branches of the armed forces and other authorized federal agencies and foreign countries, as required. The majority of the supplies distributed by DPSC are manufactured and stored at other installations. Historically however, DPSC did manufacture some textile and clothing items on-site, and some of the supplies were stored in the DPSC facility's warehouses.

2.3 Site Geology/Hydrogeology

Sediments are of a locally undifferentiated lithology consisting of pebbly, poorly sorted quartzo-feldspathic sands interbedded with sandy clay and silt. Also found locally are sediments of a fine to coarse-grained sand and clay with traces of diatomaceous earth and shell fragments. Younger, Pliocene stream outwash sediments are mixed with surface exposures.

Groundwater at the site was encountered at a depth of approximately 16 to 18 feet in a light gray coarse-grained Cretaceous sand. A silty clay, a potential aquitard, was present at a depth of about 4 feet, overlain by the undifferentiated Pliocene sediments. A denser, less silty clay layer was encountered between 10 and 12 feet in site boreholes. The hydraulic gradient is locally low, and the general groundwater flow direction is to the southwest toward the Schuylkill River.

3.0 HEALTH AND SAFETY

A site-specific Health and Safety Plan was adhered to during the on-site work. Protective clothing, steel-toed boots, and hardhats were worn by the field staff while on site. In accordance with the current OSHA regulations, all personnel working on site were required to:

- Have completed an OSHA approved 40-hour health and safety course (29 CFR 1910.120, 1991) for hazardous material workers, with annual updates;
- Have participated in a medical surveillance program;
- Wear highly visible clothing while on site, where necessary;
- Use safety cones in the work area, where necessary;

Before the onset of drilling at the DPSC site, "Miss Utility" was timely notified for appropriate demarcation of all underground utility lines on the property, including electric, gas/oil, communications, water, and sewer lines. As an additional precaution, a "Miss Utility" agent was asked to visit the project area at the start of work to verify the absence of utility lines in the vicinity of the proposed borehole locations.

3.1 Risk Assessment

DDT is also known as dichloro-diphenyl-trichoroethane. Studies in mice have shown that DDT exposures results in an increase incidence of liver tumors; therefore, exposure to residual DDT compounds were major health and safety concerns for the field staff (Appendix A). Potentially impacted receptors would locally include human exposure, limited wildlife contact, and exposure of constituents to nearby waterways. However, results from this limited investigation indicate that such impact for any of those receptors here is minimal due to the following observations: (1) the target contaminant, DDT, appears to be confined within site soils, above the observance of local groundwater, (2) that same contamination is protected from direct human or animal surface contact by the site's concrete and asphalt pad overlying the contaminated areas, and (3) the potential for volatilization of constituents is not present at the site. Therefore, the potential exposure risk to locally released substances by the most common receptor pathways - ingestion, dermal contact, or inhalation, is low.

4.0 SAMPLING PROGRAM

Field sampling methods were performed in accordance with KEMRON's Field Operations SOP manual and strict chain-of-custody procedures were followed for all sample identification and shipping activities.

Soils at all of the sampling locations with the exception of the mixing room areas were gathered using a Geoprobe rig. The Geoprobe is a vehicle-mounted, hydraulically-powered direct push, soil sample acquisition machine that uses hydraulic pressure and percussion to advance small diameter sampling tools into the subsurface for collection of soil or groundwater samples.

4.1 DDT Tank Area Soil Sampling

Soil samples were taken at the DPSC project site in accordance with the original scope of work and the additional work described in the *Technical Proposal - Remedial Investigation for the Former DDT Tank Location, Defence Personnel Support Center Philadelphia, Pennsylvania*, dated October 6, 1994. Exact sample locations were chosen for proximity to the spread of DDT contamination (*Figure 2*). All borehole soil samples were collected at or near the proposed locations shown in Figure 2 of this report. A total of fifty-five soil and seven groundwater samples were collected and analyzed from around the DDT tank pit area beginning on November 15, 1994.

4.2 Groundwater Sampling

Following completion of soil sampling activities, five of the seventeen soil-sampling boreholes which had been drilled down to between 18 and 26 feet were then fitted with 1-inch inside diameter rod with a bottom-end slotted screen to gain access to groundwater, which had been encountered at an average depth of 17 feet. The 20-foot length of stainless steel pipe was driven into the ground using the Geoprobe hydraulic driver to a depth of approximately 4 inches below the groundwater surface level. A length of 0.25 inch outer diameter polyethylene tubing was inserted inside the stainless steel pipe to retrieve the water samples. Water was then extracted using a manual oscillating ball-valve pump. All water samples were contained in sterilized bottles and shipped in temperature-controlled containers to KEMRON's Ohio Valley Laboratory for analysis as were control samples (OVL).

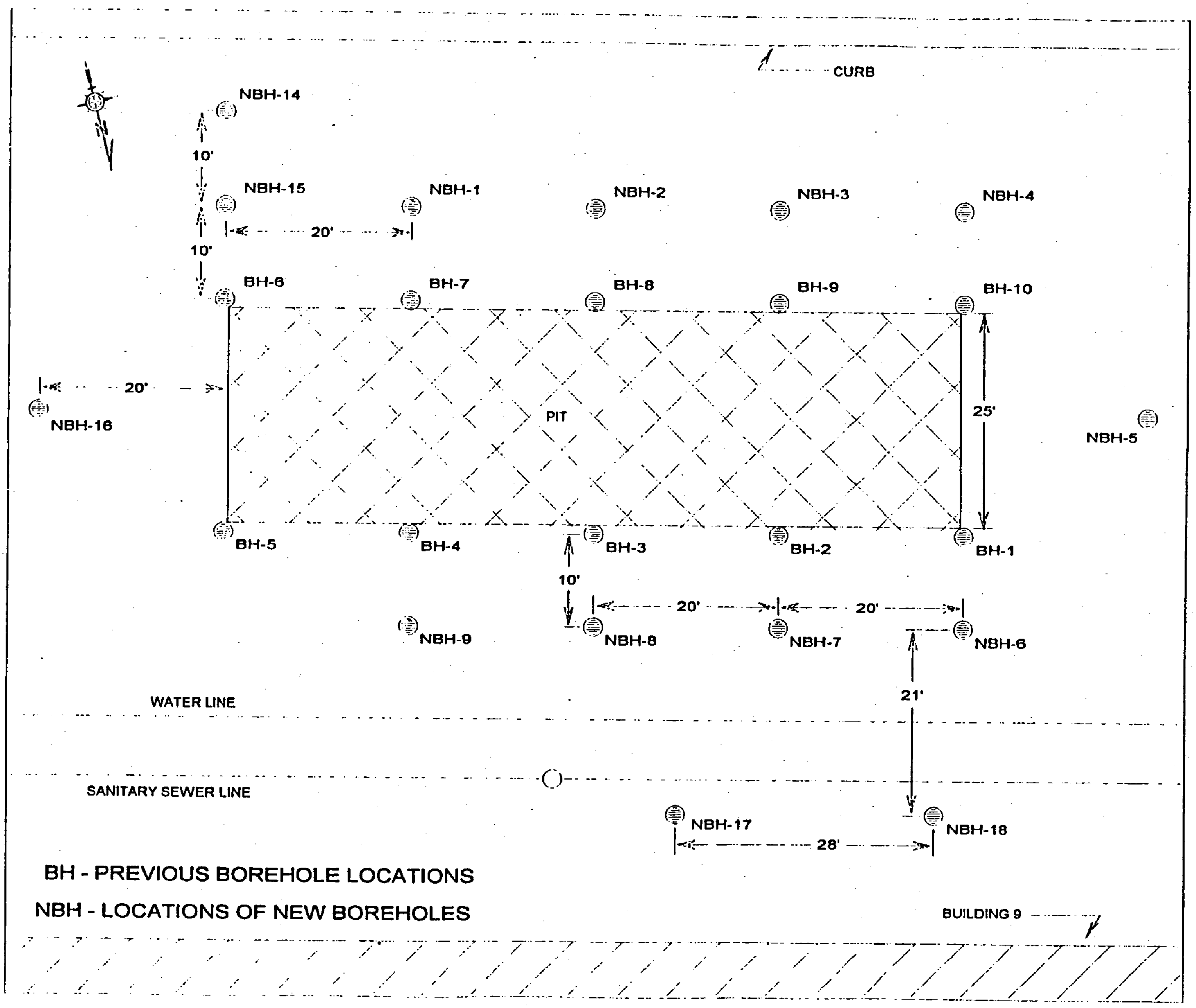

FIGURE 2. BOREHOLE LOCATION MAP.

4.3 Mixing Rooms Soil Sampling

These rooms were used to mix and regulate the concentration of DDT and other constituents utilized in the spray mix for military blankets.

On December 13 and 14, 1994, six coreholes were drilled through the concrete floor of the two basement DDT mixing rooms of Section B of Building 9. Upon completion of the eight-inch deep cores by Gem Cut Construction Co., soils beneath the floor were sampled for the presence of any residual DDT which might have found its way into the subsurface. Two of the six holes were cut adjacent to drainage sumps (*Figure 3*), one sump was located in each of the two rooms. These sumps would have collected any spilled liquid or wash water deposited on the floor surface during the time that the mixing rooms were active.

5.0 Field Screening Procedures and Analysis

Soil sample extraction methods and field analyses were performed in accordance with Millipore EnviroGard™ test kit instructions (*Appendix B*), which are a modification of laboratory protocols stated in "Test Methods for Evaluating Solid Wastes", (EPA/SW-846, 3rd edition,1987).

The procedure is an immunoassay based on the use of polyclonal antibodies that bind DDT and its' metabolites (DDD or DDE) when present in a sample. (NOTE: The Millipore test kit is a qualitative or semi-qualitative field screening and WILL NOT differentiate between DDT and its' metabolites.

All soil samples collected from each borehore from the area surrounding the DDT tank pit were either analyzed using the field screen test kit (*Appendix B*). Borehole samples with DDT concentrations greater than 2ppm were forwarded to KEMRON's Ohio Valley Laboratory for confirmation and total petroleum hydrocarbon (TPH) analysis (*Table 1*). Only three boreholes (BH-7, BH-8, and BH-9) indicated the presence of DDT concentrations above the action level of 2ppm (*Figure 4*). Groundwater sample collected were also shipped to KEMRON's Laboratory following strict chain-of-custody. The highest value found in any of the water samples was 1 microgram/liter.

All of the mixing room sub-floor samples were field screened and forwarded to KEMRON's OVL for confirmation because field analyses determined that DDT concentrations were extremely high, much higher than the upper calibration detection limit provided for in the field test kit (*Table 2*). The highest value found for these soil samples was 64 parts per million, with the lowest at 18 part per billion (*Table 2*).

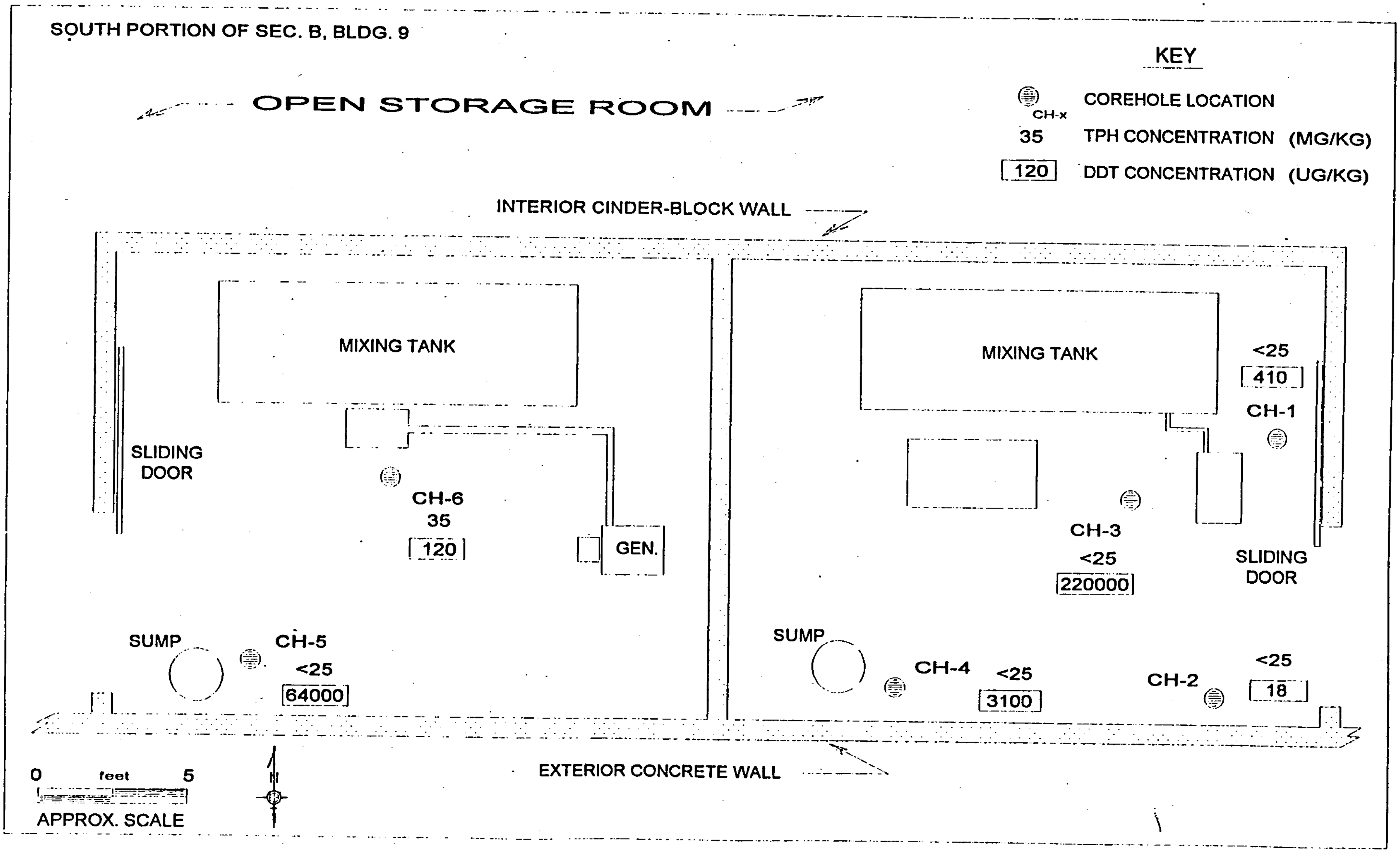

FIGURE 3. LOCATION OF MIXING ROOM COREHOLE SAMPLES.

Table 1 - Borehole Field Screen Analytical Results*

Date Sample Taken	Sample I.D. Number	Depth Sample Taken (ft.)	Results (ppm)
11/16/94	BH-7	6-8	< 2
11/16/94	BH-7	10-12	< 2
11/16/94	BH-7	14-16	> 2 < 10
11/16/94	BH-7	16-18	< 2
11/16/94	BH-7	18-20	< 2
11/16/94	BH-7D	18-20	< 2
11/18/94	BH-6	6-8	< 2
11/18/94	BH-6	10-12	< 2
11/18/94	BH-6	14-16	< 2
11/18/94	BH-6	18-20	< 2
11/21/94	BH-9	8-10	< 2
11/21/94	BH-9	12-14	< 2
11/21/94	BH-9	14-16	< 2
11/21/94	BH-9	20-22	> 2 < 10
11/22/94	BH-8	6-8	< 2
11/22/94	BH-8	10-12	< 2
11/22/94	BH-8	14-16	> 1 < 10
11/22/94	BH-8	18-20	> 1 < 10
11/22/94	BH-8	20	> 10

11/23/94	BH-8	22-24	≥ 10
11/23/94	BH-8	25	> 1 < 10
11/29/94	BH-16	10-12	< 2
11/29/94	BH-16	14-16	< 2
11/29/94	BH-16	18-20	< 2
11/30/94	BH-15	4-6	< 2
11/30/94	BH-15	10-12	< 2
11/30/94	BH-15	14-16	< 2
11/30/94	BH-15	18-20	< 2
11/30/94	BH-15	20-22	< 2
11/30/94	BH-1	6-8	< 2
11/30/94	BH-1	10-12	< 2
11/30/94	BH-1	14-16	< 2
11/30/94	BH-1	18-20	< 2
12/01/94	NBH-2	6-8	< 2
12/01/94	NBH-2	10-12	< 2
12/01/94	NBH-2	14-16	< 2
12/01/94	NBH-2	20-22	< 2
12/01/94	NBH-3	6-8	< 2
12/01/94	NBH-3	10-12	< 2
12/01/94	NBH-3	14-16	< 2
12/01/94	NBH-3	20-22	< 2
12/02/94	NBH-4	18-20	< 2
12/02/94	NBH-4	20-22	< 2
12/06/94	BH-14	22-24	< 2
12/06/94	BH-14	18-20	< 2
12/07/94	BH-14	8-10	< 2
12/07/94	BH-14	10-12	< 2

12/07/94	BH-14	14-16	< 2
12/07/94	BH-17	8-10	< 2
12/07/94	BH-17	10-12	< 2
12/07/94	BH-17	14-16	< 2
12/07/94	BH-17	18-20	< 2
12/08/94	BH-18	8-10	< 2
12/08/94	BH-18	14-16	< 2
12/08/94	BH-18	18-20	< 2

* The following table represents all the locations and the depth of each borehole soil sample analyzed by the DDT field test kit. All results are reported in parts per million (ppm). Note that these results are from a field screening methodology, and do not necessarily reflect laboratory methology.

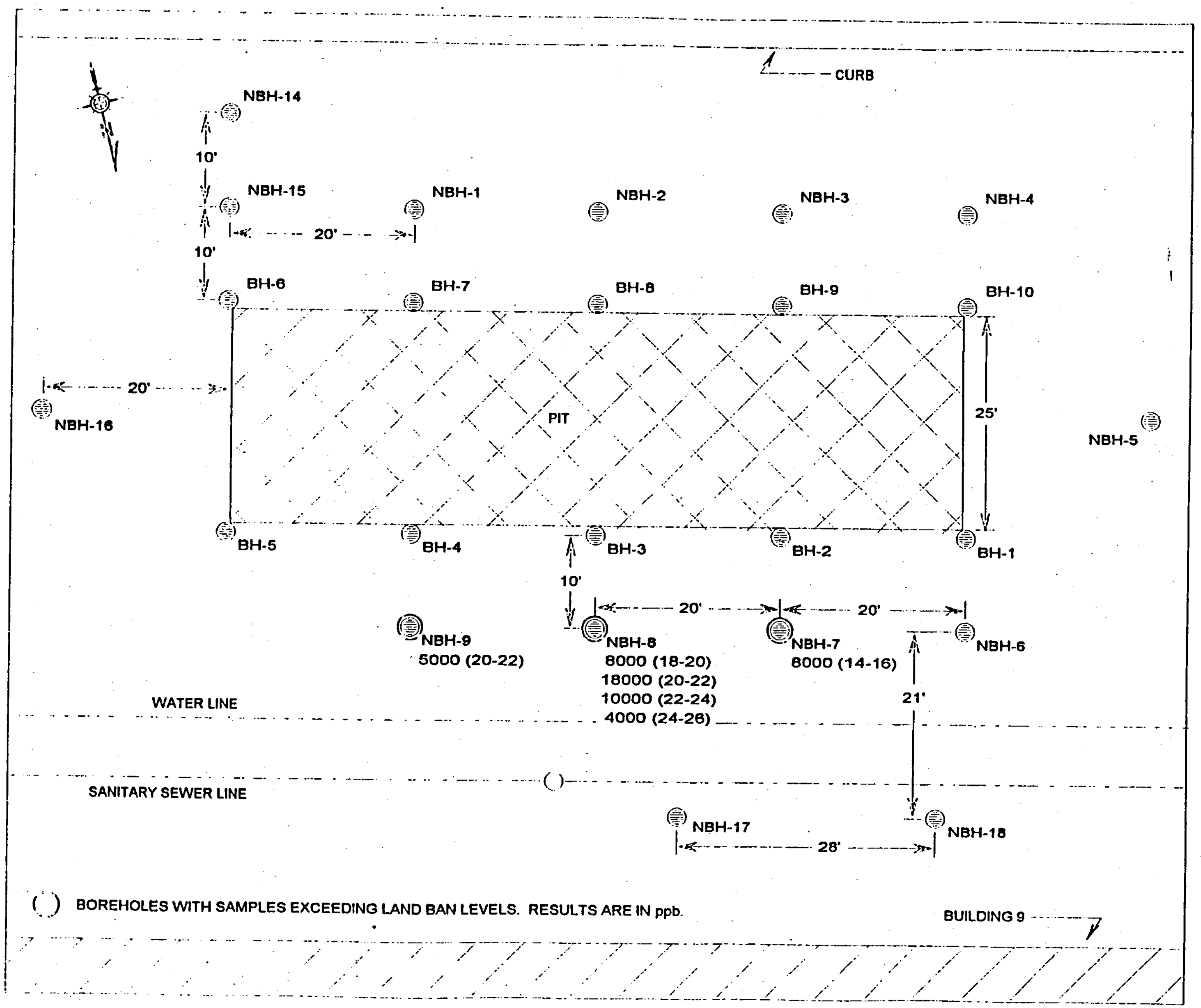

FIGURE 4. SAMPLES EXCEEDING LAND BAN LIMITS.

Table 2 - Mixing Rooms Field Screening Analytical Results*

Date Sample Taken	Sample I.D. Number	Depth of Soil Sample (in.)	Laboratory Results (ppb)	Field Results (ppm)
12/20/94	CH-1	18	410	Not analyzed
12/20/94	CH-2	18	18	> 10
12/20/94	CH-3	18	220,000	> 10
12/20/94	CH-4	18	3,100	> 10
12/20/94	CH-5	18	64,000	> 10
12/20/94	CH-6	18	120	> 10

* This table represents the locations and the depth of each mixing room sample analyzed by the DDT field test kit. All results are reported in ppm. Note that these results are from a field screening methodology, and do not necessarily reflect laboratory methology.

6.0 DATA INTERPRETATION

Following KEMRON's standard QA/QC proceedures a percentage of the soil samples which had indicated positive for the presence of DDT based on field analytical methods were sent for analysis to KEMRON's fixed base laboratory for confirmation. It was noted that in several instances field analytical results indicated the presence of DDT while those same samples analyzed by the laboratory indicated that DDT was not present (Appendix C). An investigation into the apparent discrepancies was conducted by the laboratory and a determination was made that there was a high matrix interference which prevented the positive identification of DDT in the samples of concern. As a result although DDT was determined to be present in the samples it could not be quantified by laboratory procedures.

The samples in question were also analyzed for TPH since petroleum byproducts were commonly used as a DDT solvent and common carrier fluid. A petrolific odor was noticed in samples which showed elevated field analysis concentrations for DDT. Laboratory data do confirm the presence of TPH in samples from borehole eight (BH-8), which had a DDT field screen of greater than 2 but less than 10 ppm. In addition, the lab analysis for the water sample from borehole nine (BH-9W), also indicated the presence of TPH and DDT at low levels, but again due to matrix interference no level could be quantified (Appendix C).

Laboratory data did confirm field analyses for presence of DDT contamination in two of the mixing rooms samples (Table 2). Laboratory data confirmed that three of the mixing room samples results were higher than the 10ppm calibration level as indicated by the field test methods (Appendix C).

7.0 CONCLUSIONS AND RECOMMENDATIONS

The contaminants of concern are listed below with their respective land ban concentrations for soils and RCRA actions levels.

Parameter	Land Ban Concentration (ppb)	RCRA Action Level (ppb)
4,4' -DDT	87	2,000
4,4' -DDD	87	3,000
4,4' -DDE	87	2,000

The results of this investigation determined that contamination existed south of the DDT UST pit excavation to the south in three borings and beneath the concrete slab floor in the mixing room at levels which would require incineration as a result of the Land Ban. The contamination level must be less than 87 ppb. The highest soil contamination found during the investigation surrounding the UST's was 20 ppm (Table 1). Soil contamination beneath the floor of Building No. 9 was found as high as 220 ppm (Table 2). This indicates that there may be extensive contamination beneath the sub-basement flooring. KEMRON recommends that future work should include an investigation to determine if the contamination found beneath the flooring in Building No. 9 extends beyond the limits of the building. This investigation should focus on the potential subsurface routes of contamination which is primarily the floor drain which has a long run to the storm sewer. The purpose of this study would be to determine if there was contamination as a result of possible exfiltration from the drainage piping. Furthermore, geoprobe groundwater samples were found to contain DDT contamination. The level measured ranged from .19 to 1 micrograms per liter. There is currently no DDT MCL for drinking water. However, a proposed RCRA remediation level of .0001 milligrams per liter was found for groundwater. Therefore a risk assessment may be necessary to determine if the level present in the groundwater poses a significant risk. Kemron also recommends that as part of the risk assessment an appropriate remedial response be based on the potential future use of the facility and possible future construction projects.

APPENDIX A
PHYSICAL AND CHEMICAL PROPERTIES OF DDT

Physical and Chemical Properties of DDT

DDT is also known as dichlorodiphenyltrichloroethane; 2,2-*bis*(p-chl orophenyl)-1,1,1-trichloroethane; and some of the tradenames are as follows: Pentech; Santobane; Chlorophenothane; Gesarol and Neoid. The chemical formula is $C_{14}H_9Cl_5$.

DDT is a colorless to slight white color to white powder with a slight aromatic odor. This odor will vary depending on purity and manufacturing process. It has a molecular weight of 354.50 grams/mole, a melting point of 108 - 109°C and is non-combustible. At 20°C its vapor pressure equals 1.5×10^{-7} mm Hg. DDT is insoluble in water, however it is soluble in acetone, benzene, toluene, and other common organic solvents. It is *incompatible* with alkaline materials.

Toxicological Effects

The TLV and STEL (Theshold Limit Value and Short Term Exposure Limit) are 1 mg/m^3 and 3 mg/m^3, repectively. DDT is employed as a contact insecticide. The oral LD_{50} value for rats is 113 mg/kg and the dermal LD_{50} value for rats is 2500 mg/kg.(1)

The U. S. Public Health Service(2) reported that human volunteers breathed 423 mg/m^3 of DDT for periods of one hour/day for six days. The only ill effect was eye irritation. Barns(3) found no illness reported among workers using DDT throughout the world. The known accumulation of DDT and its detoxication product DDE in animals and man(4,5) and the possibility that delayed ill effects may occur after years of exposure to low levels makes it advisable to set a low limit. DDT is half as toxic as lindane in single oral doses.

In contrast to earlier studies, formulating plant workers, Lehman(6) found that a dietary level of 5.0 ppm for two years (which is equivalent to 17.5 mg/man/day) produced tissue changes in rats. This was confirmed for male rats, but not for female rats Ortega.(7) Lehman(6) found a dietary level of 1 ppm produced no effects in rats. A level of 1 ppm for rats corresponds to human intake of 3.5 mg/man/day. The tissue change caused by low exposure levels of DDT is peculiar to rodents and occurs predominantly in the male rat although the female stores more DDT and is more suspectible to its (DDT) toxic effects. The very different histological effects of high level of DDT exposures occurs in all species and is not necessarily rodent specific, and in general these effects parallel the overall toxic effects inparted by DDT. The signifiance of these findings that are peculiar to rodents is open to question even in connection with the health of the rodents themselves.(6)

It has been shown that men tolerate 35 mg/man/day without any ill effect detectable by themselves or by careful examination.(5,8) However, at this dosage of technical DDT, men stored DDT in their fat at an average of 281 ppm, one reaching as high as 619 ppm.(8) One formulating worker stored DDT at a level of 648 ppm without detected effect on his health.

Many formulating plant workers excrete DDA in their urine at rates as high or higher than those encountered in volunteers fed DDT at a rate of 35 mg/man/day.(9) Laws(10) reported no ill effects in workers exposed 11-to 19 years to up 18 mg/day of DDT.

So far as acute toxicity is concerned, it is known that a single dose of 286 mg produced mild toxic poisioning in a sick man weighing 47.5 kg.(11) A single ingestion at the rate of about 10 mg/kg produces moderate illness is some poeple, but not all, even though no vomiting occurs; a single dose of 16 mg/kg frequently leads to convulsions.(12)

Studies in mice have shown that DDT exposure results in an increased incidence of liver tumors and in shortening of their latency period.(13) Hepatocaringenisis is dose related and DDT induced hepatomas contiue to grow after cessation of exposure. The incidence of hepatomas in male CF-1 mice fed technical grade DDT at levels of 2, 10, 50, and 250 ppm was increased 50 to 55 per cent at the 2, 10, 50, dosage levels and 86 per cent at the 250 ppm level. A significant increase in malignant liver tumors occurred at 250 ppm.(14) The TLV Committee(15) makes recommendations a TLV of 1 mg/m^3 and a STEL of 3 mg/m^3 by analogy with lindane, and is view by the TLV Committee that such limits are sufficiently low to prevent acute DDT poisioning by a large margin of safety and prevent significant accumulation in body storage tissues. In general, DDT like other Organochlorine insecticides (i.e. chlorodecone and mirex) are hepatotoxic inducing liver enlargement and centrolobular necrosis.(16)

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APPENDIX B
MILLIPORE FIELD ANALYTICAL PROCEDURE

MILLIPORE

EnviroGard™ DDT in Soil Test Kit

ENVR 000 31

Intended Use

The EnviroGard DDT in Soil Test Kit is a qualitative or semi-quantitative field test for the detection of DDT and its metabolites DDD and DDE in soil. The EnviroGard DDT in Soil Test Kit allows rapid semi-quantitative screening for DDT at 0.2, 1.0, and 10.0 parts per million (ppm) in soils.

Test Principles

The EnviroGard DDT in Soil Test Kit is based on the use of polyclonal antibodies that bind either DDT or DDT-Enzyme Conjugate. These antibodies are immobilized to the walls of the test tubes. When DDT is present in the sample, it competes with the DDT-Enzyme Conjugate for a limited number of antibody binding sites.

- A sample containing DDT is added to a test tube containing Assay Diluent. DDT-Enzyme Conjugate is then added to the test tube. The DDT-Enzyme Conjugate competes with the DDT for the antibody binding sites.
- After the incubation, the unbound molecules are washed away.
- A clear solution of chromogenic Substrate is then added to the test tube. In the presence of bound DDT-Enzyme Conjugate, the clear Substrate is converted to a blue color. One enzyme molecule can convert many Substrate molecules.

Since there are the same number of antibody binding sites on every test tube and each test tube receives the same number of DDT-Enzyme Conjugate molecules, a sample that contains a low concentration of DDT allows the antibody to bind many DDT-Enzyme Conjugate molecules.

Therefore, a low concentration of DDT produces a dark blue solution. Conversely, a high concentration of DDT allows fewer DDT-Enzyme Conjugate molecules to be bound by the antibodies, resulting in a lighter blue solution.

✱ **NOTE:** Color is inversely proportional to DDT concentration.

Darker color = Lower concentration
Lighter color = Higher concentration

Performance Characteristics

The EnviroGard DDT in Soil Test Kit will not differentiate between DDT, its metabolites, and other structurally similar compounds, but will detec their presence to differing degrees. The following table shows a number of compounds and th approximate concentration of each required to yiel a positive result (Lower Limit of Detection or LLD), and the concentration required to inhibit one-half o the color developed by the Negative Control (IC50). Concentration is in parts per million (ppm) in soil.

Compound	LLD	IC50
p,p'-DDT (kit calibrator)	0.04	1.25
p,p'-DDD	0.01	0.3
p,p'-DDE	0.18	3.6
o,p'-DDT	4	93
o,p'-DDD	0.4	11
o,p'-DDE	3	93
DDA	0.002	0.04
Chloropropylate	0.007	0.08
Chlorobenzilate	0.03	0.35
Dicofol	0.14	2
Tetradifon	1.2	14
Thiobencarb	5	52
Tebuconazole	7	95
Neburon	17	284
Chloroxuron	24	216
Monolinuron	25	714
Diclofop	70	>1000

The following compounds have lower limits o detection > 100 ppm:

2,4-D
Chlorbromuron
Chlortoluron
Diflubenzuron
Lindane
MCPA acid
Mecoprop

4-chlorophenoxyacetic acid
Chlordane
Dicamba
Diuron
Linuron
MCPB

Precautions

- Treat DDT, solutions that contain DDT and potentially contaminated soil samples as hazardous materials.
- Where appropriate, use gloves, proper protective clothing, and methods to contain and handle hazardous material.
- Store all test kit components at 4°C to 8°C (39°F to 46°F) when not in use.
- Do not freeze test kit components or expose them to temperatures greater than 37°C (99°F).
- Allow all reagents to reach ambient temperature (18°C to 27°C or 64°F to 81°F) before beginning the test.
- Do not use test kit components after the expiration date.
- Do not use reagents or test tubes from one test kit with reagents or test tubes from a different test kit.
- Use approved methodologies to confirm any positive results.
- Do not dilute or adulterate test reagents or use samples not called for in the test procedure; this may give inaccurate results.
- Tightly recap the DDT calibrator vials to prevent evaporative loss.
- Distribution of DDT in soils may be highly variable. The use of a composite sampling technique may be appropriate. Development of a sampling plan that assures adequate sample number and distribution is the responsibility of the analyst.
- DDT is light sensitive. Store soil extracts at 2°C to 7°C, shielded from direct light.

Materials Provided

EnviroGard DDT in Soil Test Kit

This test kit contains the following items:

20	Antibody-Coated Test Tubes
1	vial of Assay Diluent
1	vial of Negative Control (methanol)
1	vial of 0.2 ppm DDT Calibrator in methanol
1	vial of 1.0 ppm DDT Calibrator in methanol
1	vial of 10.0 ppm DDT Calibrator in methanol
1	vial of DDT-Enzyme Conjugate
1	vial of Substrate
1	vial of Stop Solution
1	20-place Test Tube Rack
22	Pipette Tips, yellow (for the Gilson M-25 Microman® Positive Displacement Pipettor)

Materials Required and Ordered Separately

See "Ordering Information" for the appropriate catalogue numbers.

EnviroGard Soil Extraction Bottle Kit

Use this kit for the extraction of DDT in soil samples. This kit contains enough devices to process 14 samples:

- 14 30 milliliter (mL) Polypropylene Bottles with screw caps (each bottle contains stainless steel mixing beads)
- 14 filtration caps
- 14 Millex® HV13 filters
- 18 Wooden Spatulas
- 1 Syringe with coupler
- 1 Syringe coupler
- 14 Screw Top Glass Vials, 4.0 mL
- 14 Stoppers
- 18 Weigh Boats

Methanol

ACS reagent grade Methanol is required for soil extraction, but is not included in the EnviroGard Soil Extraction Kit. You must order it separately. (See "Ordering Information.")

Materials Required but Not Provided

You will also need several other items, some of which are included in the EnviroGard Soil Field Lab. (See "Ordering Information" for the appropriate catalogue number).

- Gilson M-25 Microman Positive Displacement Pipettor
- Eppendorf™ Repeater® Pipettor and five Combitips® (3 x 12.5 mL, 1 x 5.0 mL, and 1 x 50 mL)
- Balance capable of accurately weighing 5 grams
- Millipore Differential Photometer or Enviro-Quant Photometer
- Indelible marker for labeling test tubes
- Watch or timer
- Clean running water or a wash bottle containing tap or deionized water (500 mL)
- Calculator (optional)

Suggestions for Pipettor Use

- Practice using both pipettors (positive displacement and Repeater pipettor) with water and extra tips before you analyze your samples.

- Use a new tip each time you use the Repeater pipettor to avoid reagent cross-contamination. Label three 12.5 mL tips "Diluent", "Substrate" and "Stop," and one 5.0 mL tip "Conjugate".

- Draw the desired reagent volume into the Repeater pipettor and dispense one portion of the reagent back into the container to properly engage the ratchet mechanism. If you do not do this, the first volume delivered may be inaccurate.

- To add reagents using the Repeater pipettor, pipette down the side of the test tube just below the rim.

- To add samples and calibrators using the positive displacement pipettor, pipette down the side of the test tube just above the liquid level.

- The carryover volume of the positive displacement tips is minimal, but may affect results if you are going from a high to low DDT concentration. Use a new pipettor tip each time you pipette a new unknown.

Assay Procedure

Collect/Store the Sample

1. Collect soil in appropriately-sized and labeled containers.

2. Take care to remove excess twigs, organic matter and rocks or pebbles from the sample. For best results, wet soils should be air-dried overnight and thoroughly mixed before testing.

3. Store soil samples at 4°C (39°F).

Prepare the Sample/Extract the Soil

1. Please follow the instructions from the EnviroGard Soil Extraction Bottle Kit to prepare the soil extract before the assay.

2. **5 ml of Methanol** will be used to extract DDT residue from a 5 gram soil sample. As per instructions, attach a **50 mL** Combitip to the Repeater pipettor and set the dial to **5**. Deliver once to add **5 mL of methanol** to the extraction vial, and cap tightly.

Perform the Test

NOTE: Allow all reagents and sample extracts to reach room temperature before you begin the test. Do not analyze more than 20 test tubes at a time.

1. The choice of calibrators to use in the test will depend on the the selection of the analysis. The use of two calibrators may be appropriate if screening for a single level of DDT.

Remove the test tubes from the plastic bag and label them as follows*:

Tube Label	Tube Contents
NC	Negative Control
C1	0.2 ppm Calibrator
C2	1.0 ppm Calibrator
C3	10.0 ppm Calibrator
S1	sample 1
S2	sample 2
etc.	

action & range lvls

* You are not required to perform the assay in duplicate; however, doing so will increase the precision.

Place the test tubes in the test tube rack. Push down on each tube so that it is held firmly and does not fall out of the rack when shaken.

CAUTION: Do not "snap" the test tubes into th rack as this may result in a cracke tube.

2. Attach the **12.5 mL** Combitip labeled "Diluen to the Repeater pipettor and adjust the dial to 2 Add 500 microliters (µL) of Assay Diluent t each test tube.

3. Attach a clean pipette tip to the Mic pipettor and adjust the dial to "250". A of each calibrator (including Negative Control) the corresponding test tube by placing the er

of the pipette tip against the side of the tube (just above the level of the Assay Diluent) and dispensing the volume. Use a clean pipette tip each time.

CAUTION: Replace the caps on the calibrator vials immediately after use to minimize evaporation.

4. Using a clean tip for each sample, add 25 µL of each sample extract to the appropriately-labeled test tube.
5. Attach the 5.0 mL Combitip labeled "Conjugate" to the Repeater pipettor and adjust the dial to 1. Add 100 µL of DDT-Enzyme Conjugate to each test tube.
6. Shake the test tube rack to mix for 10 to 15 seconds. Leave the test tubes undisturbed for 15 minutes.
7. Vigorously shake out the test tube contents into a sink or suitable container. Fill the test tubes to **overflowing** with cool tap or distilled water, then decant and vigorously shake out the remaining water.

   Repeat this wash step three more times, being certain to shake out as much water as possible on each wash. After the final wash, remove as much water as possible by tapping the inverted tubes on absorbant paper.
8. Attach the 12.5 mL Combitip labeled "Substrate" to the Repeater pipettor and set the dial to 2. Add 500 µL of Substrate to each test tube. Leave the test tubes undisturbed for 10 minutes.

NOTE: If a blue color does not develop in the Negative Control test tube within 10 minutes after adding the Substrate, the test is invalid and you must repeat it.

Interpret the Results

You can either interpret the results visually within 10 minutes after adding the Substrate to each test tube, or you can perform a more precise analysis with a photometer after you add the Stop Solution.

Visual Interpretation

After you add the Substrate, wait 10 minutes then mix the test tubes by shaking them for a few seconds until they are a uniform blue color. Compare the sample test tube to the calibrator test tubes against a white background. The test tube rack in the kit is well-suited for this purpose.

NOTE: The word DDT in the interpretation instructions below refers to "total DDT", i.e. the sum of *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE.

- If a sample test tube contains *more* color than the calibrator test tube, the sample contains DDT at a concentration *lower* than the calibrator.
- If a sample test tube contains *less* color than the calibrator test tube, the sample may contain DDT at a concentration *greater* than the calibrator.
- If the sample test tube contains color that is between the calibrator test tubes, the sample contains DDT at a concentration between the calibrator concentrations.
- If a sample test tube contains *approximately the same* amount of color as the calibrator test tube, the sample contains DDT at a concentration *approximately equal* to the calibrator.
- If the sample test tube contains less color than the 10 ppm Calibrator test tube, you may dilute a fraction of the soil extract in methanol (for example, 1:100) and perform the assay again. To determine the concentration of the diluted extract multiply the result by the dilution factor. (Go to "Semi-Quantitative Interpretation" for further details.)

Photometric Interpretation

After you add the Substrate, wait 10 minutes then add the Stop Solution to each test tube.

WARNING: Stop solution is 1N Hydrochloric acid. Handle carefully.

Attach the 12.5 mL Combitip labeled "Stop" to the Repeater pipettor and set the dial to 2. Add 500 µL of Stop Solution to each test tube. This converts the blue color in the test tubes to yellow.

NOTE: After you add Stop Solution to the test tubes, results should be read within 30 minutes.

Millipore Differential Photometer

1. Place a water blank test tube containing 1.5 mL of Milli-RO® or Milli-Q® water, or equivalent in the left (reference) well.
2. Place the Negative Control test tube into the right (sample) well. Record the optical density (OD) of the Negative Control.
3. Remove the Negative Control test tube and replace it with the 0.2 ppm Calibrator test tube

to reactivate the photometer. Record the result. Repeat this step to determine the OD for each of the remaining calibrators and for each sample.

Semi-quantitative Interpretation

Compare the OD of each sample to the OD of each calibrator:

NOTE: The word DDT in the interpretation instructions below refers to "total DDT", i.e. the sum of *p,p'*-DDT, *p,p'*-DDD, and *p,p'*-DDE.

- If a sample OD is ***equal*** to the OD of a calibrator, the sample contains DDT at a concentration ***approximately equal*** to the calibrator.
- If a sample OD is *greater* than a calibrator OD, the sample contains *less* DDT than the calibrator.
- If a sample OD is *lower* than a calibrator OD, the sample may contain *more* DDT than that calibrator.
- If an assay result indicates that a soil sample contains greater than 10 ppm total DDT, but you need more specific information, the soil extract may be diluted 1:100 in neat methanol, and assayed again. You must then multiply the results of the re-assay by 100 to determine the approximate sample concentration.

NOTE: If you know in advance that the "action level" of interest is greater than 10 ppm total DDT in soil, the assay may be modified to pinpoint that particular concentration. For example:

If you wish to categorize samples as less than or greater than 250 ppm, you should dilute all sample extracts 1:250 in neat methanol (e.g. 20 µL extract plus 4.98 mL methanol) and compare the diluted extracts to the 1 ppm DDT kit calibrator. Due to the 250-fold dilution, the 1 ppm calibrator represents 250 ppm in the assay.

NOTE: If you are interested in action levels [illegible]ter than 1000 ppm, please contact Mil[illegible] Technical Services for assistance.

Example

Actual OD values will vary. This data is for demonstration purposes only.

Tube	OD	Interpretation
NC	0.90	
C1 (0.2 ppm)	0.75	
C2 (1.0 ppm)	0.49	
C3 (10.0 ppm)	0.35	
S1	0.68	>0.2 ppm < 1.0 ppm
S2	0.16	> 10.0 ppm

NOTE: The EnviroQuant Photometer is [illegible]o available from Millipore. This dual wavelength instrument measures the OD at 450 nanometers (nm) minus 600 nm of all samples and calibrators, and provides a printout of results. See "Ordering Information" for the appropriate catalogue number.

Limitations of the Procedure

The EnviroGard DDT in Soil Test Kit [illegible] qualitative/semi-quantitative screening test o[illegible]. Actual quantitation of DDT by EnviroGard immunoassay is not possible due to the Test kit's cross-reactivity with DDT breakdown products and other similar compounds and to the variations in extraction efficiency inherent in the fast extraction protocol described in this product insert.

Soil sampling error may significantly affect testing reliability. The distribution of pesticides in different soils can be extremely heterogeneous. Soils should be dried and homogenized before analysis by any method. Split samples (i.e. for GC and immunoassay) should always derive from the same homogenate.

Ordering Information

The following table lists descriptions and catalogue numbers for the EnviroGard DDT in Soil Test Kit, Soil Extraction Bottle Kit and related products.

Description	Catalogue Number
EnviroGard DDT in Soil Test Kit	ENVR 000 31
EnviroGard Soil Extraction Bottle Kit	ENSP 000 30
Methanol for soil extraction, 100 mL bottle	ELCR 000 07
Millipore Differential Photometer: • 115 volt (V), or • 230 V	 ENVR 000 00 ENVR 002 30
EnviroQuant Photometer, 110V, or EnviroQuant Photometer, 220V	ENVR T11 00 ENVR T22 00
EnviroQuant Replacement Paper, 12 rolls	ENVR T11 02
nviroGard Replacement Pipettor Tips (available separately): Positive displacement pipettor tips, 1-25 µL range 200/pk (not preassembled) • Repeater pipettor tips, 5.0 mL, 100/pk • Repeater pipettor tips, 12.5 mL, 100/pk • Repeater pipettor tips, 50 mL, 10/pk	 ENVR L04 09 ENVR L01 09 ENVR L02 09 ENVR L03 09
EnviroGard Soil Field Lab includes: • 1 Positive displacement precision pipettor • 1 Eppendorf Repeater pipettor • 1 Electronic timer • 13 Polystyrene test tubes, 12 mm X 75 mm (for blanking the spectrophotometer and sample dilutions) • 1 Portable balance with 100 gram calibrator weight • 1 Wash bottle, 500 mL • 4 Test tube racks, six-position • 8, 5.0 mL Pipette tips for the Repeater pipettor, for 0.1 mL through 0.5 mL dispensing volumes • 4, 12.5 mL Pipette tips for the Repeater pipettor, for 0.25 mL through 1.250 mL dispensing volumes • 1, 50 mL Pipette tip for the Repeater pipettor, for 1.0 mL through 5.0 mL dispensing volumes • 100 pipette tips, 2.0-25 µL (not preassembled) • 100 pipette tips, 50-250 µL (not preassembled) Contact Millipore Technical Service for kit component replacement reordering information. (See the "Technical Assistance" section for the number of the Millipore office nearest you.)	ENVR L00 09

Technical Assistance

For additional information about Millipore products, call the nearest Millipore office listed below.

Call toll-free 800-MILLIPORE (800-645-5476) FAX Orders 508-624-8873

Millipore Worldwide:

Australia
A•C•N: (001) 239-818
Toll Free (008) 222-111
In Sydney Area (02) 428-7333

Austria, Central Europe, C.I.S., Africa, Middle-East, and Gulf
In Austria: (43) 1-877-8926

Baltic Republics
In Finland: (90) 801 90 77

Belgium and Luxembourg
(02) 242-17-40

Brazil
Tel. (011) 548-7011

Canada
Toll Free 1-800-268-4881
In Toronto Area:
416-678-2161

China, People's Republic of
Beijing: (86) 1-5135114
Guangzhou: (86) 20-686217
Shanghai: (86) 21-3203856

Czech Republic
Tel. (42) 2-35-02-27
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(48) 2-663-70-31

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Sevilla: 95-425-68-77

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Sundbyberg:
08-628-69-60

Switzerland
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United States of America
Tel. Toll Free
800-MILLIPORE
(800-645-5476)

In Puerto Rico:
(809) 747-8444

In All Other Countries:

Millipore Intertech, U.S.A.
397 Williams Street
Marlborough, MA
01752-9162 U.S.A.
Tel. (508) 624-8622
Fax (508) 624-8630

General Limited Warranty

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Safety

To receive complete safety information on this product, contact the nearest Millipore office and request Material Safety Data Sheet documents P70002, P34782, P34207 and P34210.

Acknowledgment

This kit was developed in collaboration with the Commonwealth Scientific and Industrial Research Organization (Australia) using reagents produced and supplied under exclusive license to Millipore and ImmunoSystems Incorporated.

P35409, Rev - 2/24/94

T5006

MILLIPORE

EnviroGard™ Soil Extraction Bottle Kit

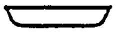
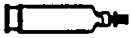
ENSP 000 30

Intended Use

The EnviroGard™ Soil Extraction Bottle Kit enables you to extract pesticides and industrial contaminants from soil. This kit contains enough material for 14 soil samples.

Parts of the Kit

This kit includes the following items:

Part Name	Example
18 Weigh boats	
18 Wooden spatulas	
Soil extraction bottles (each containing three mixing beads) with caps	
1 Syringe, 20 cubic centimeters (cc) with coupler	
1 Syringe coupler	
14 Millex®-HV_{13} filter units	
14 Filter caps	
14 Glass storage vials with caps, 4 milliliters (mL)	
14 Stoppers	

NOTE: The syringe coupler, Millex®-HV_{13} filter units, storage vial caps, and stoppers are packaged under the weigh boat compartment.

Materials You Supply

You need to supply:

- Methanol
- Portable balance
- Pen or marker
- Timer
- Eppendorf™ Repeater® pipettor with 50 mL Combitip® (included with the EnviroGard Soil Field Lab)
- Soil extraction bottle rack (included with the EnviroGard Soil Field Lab)

NOTE: The bottle rack is optional. Use it to extrac up to six soil samples simultaneously.

Soil Preparation and Extraction Procedures

The following sections describe how to:

- Prepare the soil sample
- Extract the soil
- Filter the sample by squeezing the bottle or by using a syringe to pressurize the bottle.

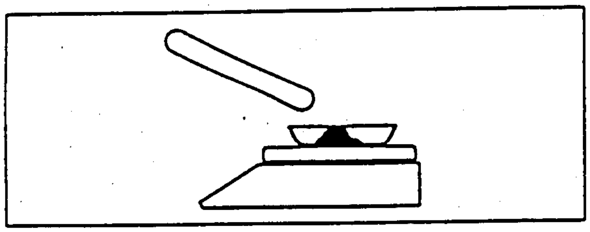
Prepare the Soil Sample

1. Collect a soil sample. Then locate these items:
    - Weigh boat
    - Wooden spatula
    - Portable balance
    - Soil extraction bottle with cap
    - Pen or marker

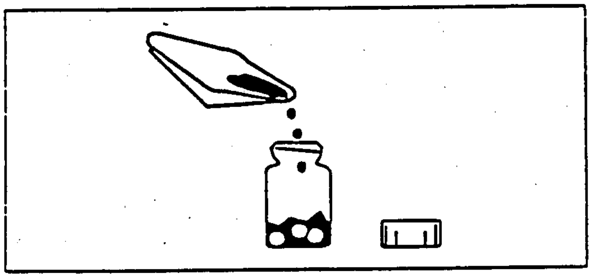
Prepare the Soil Sample, Continued

2. Place the weigh boat on the balance and press ON/MEMORY. Then weigh out 5.0 grams (g) of soil into the weigh boat using the wooden spatula.

   NOTE: The grams of soil may vary, depending on the assay you use. Refer to your EnviroGard test kit instructions.



3. Uncap the soil extraction bottle and label it appropriately. Then fold the weigh boat into the mouth of the bottle and pour in your sample. Discard the boat and spatula appropriately. Repeat steps 1–3 for each sample you want to t.



Extract the Sample

Locate these items before you extract the sample:

- Eppendorf Repeater pipettor with a 50 mL Combitip
- Methanol
- Timer

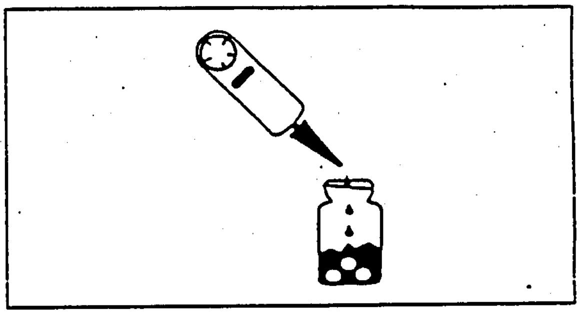
NOTE: The amount of methanol you add depends on the EnviroGard test kit you use. Refer to your EnviroGard test kit instructions.

tract the sample:

1. Insert the Combitip into the Eppendorf Repeater pipettor and position the volume dial to 5. (This is equivalent to 5 mL.) Then add the methanol to each sample in the soil extraction bottle. (Refer to the Eppendorf Repeater instruction manual for details on pipettor use.)

   CAUTION: If you have clay samples, add an additional 5.0 mL of methanol to each sample. Otherwise, the samples soak up all of the methanol, leaving little or no excess liquid to decant. When interpreting results, factor the dilution into the calculations. For example, you will need to multiply each of the calibrator concentrations by the ratio of methanol (in mL) to soil (in g). See your test kit instructions for details.

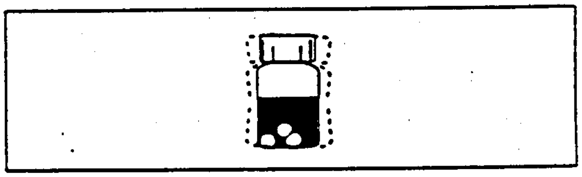
   $\times \frac{\text{ml methanol}}{\text{g soil}}$



2. Screw the cap back onto the extraction bottle.

   CAUTION: Be sure that the extraction bottle cap is tight to prevent leaks.

3. Set the timer for two minutes and agitate the bottle for that length of time.



Filter the Sample

This section describes how to filter the sample in two ways. For example, you can:

- Squeeze the bottle

OR

- Use a syringe to pressurize the bottle

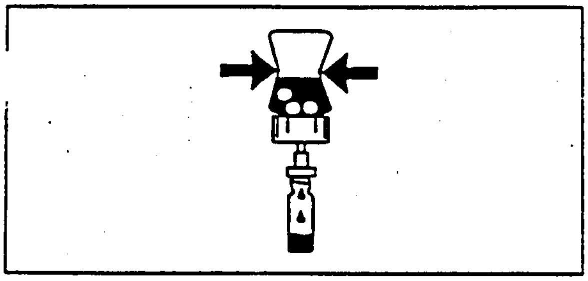
Filter the Sample by Squeezing the Bottle

Locate these items before you filter your sample(s):

- Filter cap
- Millex-HV_{13} filter unit.
- Glass storage vial and cap

1. Remove and discard the extraction bottle cap. Then tightly screw a filter cap on the bottle. Attach the Millex-HV_{13} filter unit to the filter cap.
2. Invert the extraction bottle. Insert the filter outlet into the mouth of the glass storage vial. Hold the vial steady and squeeze the bottle until you filter the necessary amount of soil extract.

   NOTE: The amount you need depends on the EnviroGard test kit you use. Refer to your kit instructions.



3. Remove the extraction bottle from the vial and discard appropriately.
4. Cap the glass storage vial.

Now you can analyze the soil extract with the EnviroGard test kit. See your kit for details.

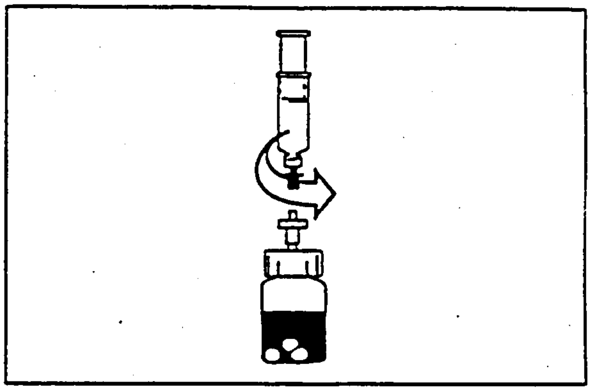
Filter the Sample by Pressurizing the Bottle

Locate these items before you filter your sample(s):

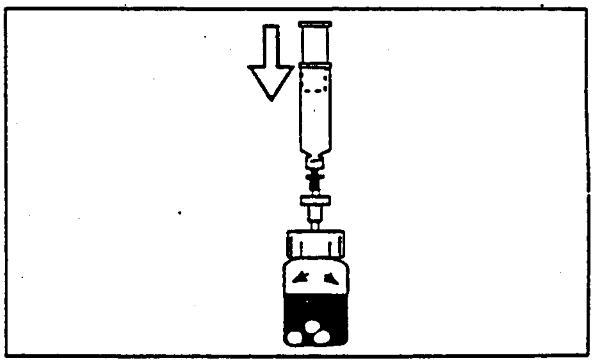
- Filter caps
- Millex-HV_{13} filter unit
- Syringe, 20 cc with coupler
- Glass storage vial with cap
- Stopper
- Soil extraction bottle rack, six-place (optional)

1. Remove and discard the extraction bottle cap. Then tightly screw a filter cap on the bottle. Attach the Millex-HV_{13} filter unit to the filter cap.
2. Draw air into the syringe by pulling the plunger to the 20 mL marker.

   Then Twist the syringe assembly firmly onto the open end of the filter unit.



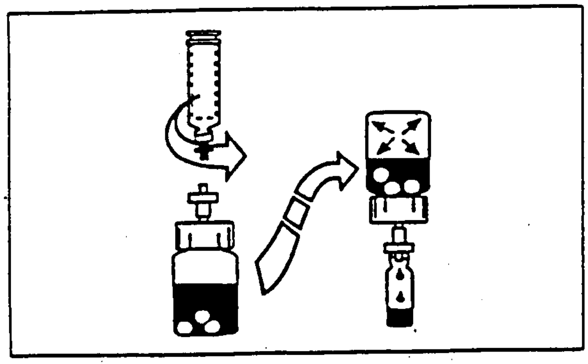
3. Push the plunger down. This creates enough pressure in the soil extraction bottle to drive the soil extract through the filter.



4. Hold the Millex-HV_{13} filter unit and twist off the syringe coupler to remove the syringe assembly. Immediately invert the pressurized extraction bottle and insert the filter outlet into the mouth of the glass storage vial.

   CAUTION: You must hold the assembly or place it in a rack to prevent tipping. If you use a rack, do not leave the assembly unattended; the soil extract may overflow and contaminate your work area.

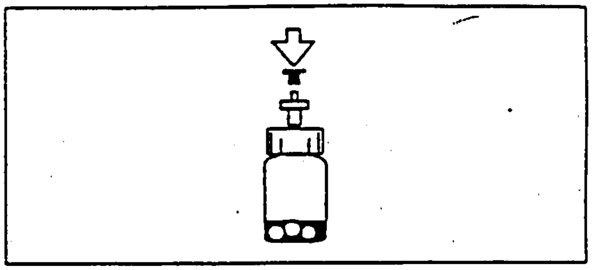
ne Sample by Pressurizing the Bottle, Continued



4. Wait until you filter the necessary amount of soil extract into the vial. Then remove the extraction bottle from the vial.

NOTE: The amount you need depends on the EnviroGard test kit you use. Refer to your kit instructions.

5. Put a stopper onto the filter outlet to stop the flow. Then discard the extraction bottle appropriately.



6. Cap the glass storage vial.

Now you can analyze the soil extract with the EnviroGard test kit. See your kit for details.

Ordering Information

The following table lists the catalogue numbers for the EnviroGard Soil Extraction Bottle Kit and related cts:

Description	Catalogue Number
EnviroGard Soil Extraction Bottle Kit, 14/pk	ENSP 000 30
Methanol, 100 mL	ELCR 000 07
EnviroGard Soil Field Lab	ENVR L00 09
Soil Extraction Bottle Rack, six-place	ENVR SP 030

Technical Assistance

Call the office in your country to get additional product information, technical service, or order parts.

NOTE: To receive the current edition of our *Laboratory Products Catalogue*, contact Technical Service at the Millipore office closest to you.

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APPENDIX C
LABORATORY ANALYTICAL RESULTS DOCUMENTS

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Purchase Order: Verbal
Invoice Number: 52839

Order #: N4-11-461
Date: May 11, 1995 16:43
Work ID: DPSC-Philadelphia
Date Received: 11/19/94
Date Completed: 12/08/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	BH 7	02	BH 7 4-6'
03	BH 7 6-8'	04	BH 7 8-10'
05	BH 7 10-12'	06	BH 7 12-14'
07	BH 7 14-16'	08	BH 7 16-18'
09	BH 7 18-20'	10	BH 6 4-6'
11	BH 6 6-8'	12	BH 6 8-10'
13	BH 6 10-12'	14	BH 6 12-14'
15	BH 6 14-16'	16	BH 6 16-18'

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Certified by
Leslie Bucina

Order # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
RESULTS BY SAMPLE

This is to certify that the following samples were analyzed using good laboratory practices to show the following results.

SAMPLE ID: 01 BH 7 Collected: 11/17/94 16:30 Category: WATER

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Petroleum Hydrocarbons	<1	1	mg/L	11/22/94	WDL	418.1

SAMPLE ID: 07 BH 7 14-16' Collected: 11/16/94 16:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	65	1	% wt.	11/28/94	WDL	Gravimetric
Petroleum Hydrocarbons	39,000	2500	mg/kg	11/28/94	WDL	3550/418.1

SAMPLE ID: 09 BH 7 18-20' Collected: 11/16/94 17:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	69	1	% wt.	11/28/94	WDL	Gravimetric
Petroleum Hydrocarbons	300	25	mg/kg	11/28/94	WDL	3550/418.1

SAMPLE ID: 13 BH 6 10-12' Collected: 11/18/94 10:45 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	84	1	% wt.	11/28/94	WDL	Gravimetric
Petroleum Hydrocarbons	260	25	mg/kg	11/28/94	WDL	3550/418.1

SAMPLE ID: 16 BH 6 16-18' Collected: 11/18/94 11:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	67	1	% wt.	11/28/94	WDL	Gravimetric
Petroleum Hydrocarbons	290	25	mg/kg	11/28/94	WDL	3550/418.1

Order # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH 7
Test Description: Special Request
Lab No: 01A
Collected: 11/17/94 16:30
Category: WATER

Analyst: ECL
Instrument: HP_IVR
Extracted: 11/23/94
Injected: 12/02/94
File #: 068R0501
Factor: 1
Units: ug/L
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	0.19	0.1

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH 7 14-16'
Test Description: Special Request

Lab No: 07A

Collected: 11/16/94 16:30
Category: SOIL

Analyst: MLS
Instrument: HP_10

Extracted: 11/28/94
Injected: 12/06/94

File #: 017R0101
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH 7 18-20'
Test Description: Special Request

Lab No: 09A

Collected: 11/16/94 17:30
Category: SOIL

Analyst: MLS
Instrument: HP_10

Extracted: 11/28/94
Injected: 12/06/94

File #: 015R0101
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

rder # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH 6 10-12'
Test Description: Special Request

Lab No: 13A

Collected: 11/18/94 10:45
Category: SOIL

Analyst: MLS
Instrument: HP_10
Extracted: 11/28/94
Injected: 12/06/94
File #: 016R0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-11-461
May 11, 1995 16:44

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH 6 16-18'
Test Description: Special Request

Lab No: 16A

Collected: 11/18/94 11:30
Category: SOIL

Analyst: MLS
Instrument: HP_10
Extracted: 11/28/94
Injected: 12/05/94
File #: 012R0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Order #: N4-11-527
Date: December 6, 1994 16:41
Work ID: 8057-004/USAC-DDT Investigat.
Date Received: 11/29/94
Date Completed: 12/06/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	BH8/4-6'	02	BH8/6-8'
03	BH8/8-10'	04	BH8/10-12'
05	BH8/12-14'	06	BH8/14-16'
07	BH8/18-20'	08	BH9/4-6'
09	BH9/6-8'	10	BH9/8-10'
11	BH9/10-12'	12	BH9/12-14'
13	BH9/14-16'	14	BH9/20-22'
15	BH9/H2O		

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Leslie Bucina

Certified by
Leslie Bucina

This is to certify that the following samples were analyzed using good laboratory practices to show the following results.

SAMPLE ID: **05** **BH8/12-14'** Collected: **11/22/94 15:00** Category: **SOIL**

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	81	1	% wt.	11/29/94	BMK	Gravimetri
Petroleum Hydrocarbons	450	25	mg/kg	11/30/94	WDL	3550/418.1

SAMPLE ID: **07** **BH8/18-20'** Collected: **11/22/94 15:30** Category: **SOIL**

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	60	1	% wt.	11/29/94	BMK	Gravimetri
Petroleum Hydrocarbons	<25	25	mg/kg	11/30/94	WDL	3550/418.1

SAMPLE ID: **12** **BH9/12-14'** Collected: **11/21/94 16:25** Category: **SOIL**

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	83	1	% wt.	11/29/94	BMK	Gravimetri
Petroleum Hydrocarbons	<25	25	mg/kg	11/30/94	WDL	3550/418.1

SAMPLE ID: **14** **BH9/20-22'** Collected: **11/22/94 11:30** Category: **SOIL**

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	65	1	% wt.	11/29/94	BMK	Gravimetri
Petroleum Hydrocarbons	<25	25	mg/kg	11/30/94	WDL	3550/418.1

SAMPLE ID: **15** **BH9/H2O** Collected: **11/22/94 11:00** Category: **WATER**

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Petroleum Hydrocarbons	12	1	mg/L	11/29/94	WDL	418.1

Test Code: **SPE_GC**
Sample Description: **BH8/12-14'**
Test Description: **Special Request**

Lab No: **05A**

Collected: **11/22/94 15:00**
Category: **SOIL**

Analyst: MLS
Instrument: HP_9F

Extracted: 11/29/94
Injected: 11/30/94

File #: 009F0101
Factor: 66 **

Units: UG/KG

Verified: CLC

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMIT DUE TO SAMPLE MATRIX

Test Code: **SPE_GC**
Sample Description: **BH8/18-20'**
Test Description: **Special Request**

Lab No: **07A**

Collected: **11/22/94 15:**
Category: **SOIL**

Analyst: MLS
Instrument: HR_9F

Extracted: 11/29/94
Injected: 11/30/94

File #: 010F0101
Factor: 66**

Units: UG/KG

Verified: CLC

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMIT DUE TO SAMPLE MATRIX

Test Code: **SPE_GC**
Sample Description: **BH9/12-14'**
Test Description: **Special Request**

Lab No: **12A**

Collected: **11/21/94 16:25**
Category: **SOIL**

Analyst: MLS
Instrument: HP_9F
Extracted: 11/29/94
Injected: 11/30/94
File #: 011F0101
Factor: 66**
Units: UG/KG
Verified: CLC

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_GC**
Sample Description: **BH9/20-22'**
Test Description: **Special Request**

Lab No: **14A**

Collected: **11/22/94 11:3**
Category: **SOIL**

Analyst: MLS
Instrument: HP_9F

Extracted: 11/29/94
Injected: 11/30/94

File #: 012F0101
Factor: 66 **

Units: UG/KG

Verified: CLC

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_GC**
Sample Description: **BH9/H2O**
Test Description: **Special Request**

Lab No: **15B**

Collected: **11/22/94 11:00**
Category: **WATER**

Analyst: MLS
Extracted: 11/29/94
File #: 011F0101
Instrument: HP_10F
Injected: 12/05/94
Factor: 2
Units: UG/L
Verified: CLC

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4' DDT	1	0.2

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Percent Solids

EPA Method 160.3 - Gravimetric, Dried at 103-105 Degrees C

To convert test results to "Dry Weight Basis" use this formula:

```
                         RESULT (REPORTED) X 100
  RESULT (DRY WT.) =     ------------------------
                         PERCENT SOLIDS
```

EPA Method 3510/418.1 - Total Petroleum Hydrocarbons (IR)

EPA Method 3550/418.1 - Total Petroleum Hydrocarbons (IR)

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Invoice Number: 52841

Order #: N4-12-017
Date: May 11, 1995 16:46
Work ID: DPSC-DDT Investigation
Date Received: 12/01/94
Date Completed: 12/12/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	BH8 22-24'	02	BH8 24-25'
03	BH5 10-12'	04	BH5 12-14'
05	BH5 14-16'	06	BH5 16-18'
07	BH5 18-20'	08	BH16 10-12'
09	BH16 12-14'	10	BH16 14-16'
11	BH16 18-20'	12	BH15 4-6'
13	BH15 6-8'	14	BH15 8-10'
15	BH15 10-12'	16	HB15 12-14'
17	SB15 14-16'	18	HB-15 16-18'
19	HB-15 18-20'	20	15 20-22'
21	BH-1 4-6'	22	BH-1 6-8'
23	BH-1 8-10'	24	BH-1 10-12'
25	BH-1 12-14'	26	BH-1 14-16'
27	BH-1 16-18'	28	BH-1 18-20'

All results on solids/sludges are reported "AS RECEIVED" unless otherwise specified. This report shall not be reproduced, except in full, without the written approval of KEMRON.

Certified by
Leslie Bucina

Order # N4-12-017
May 11. 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
RESULTS BY SAMPLE

This is to certify that the following samples were analyzed using good laboratory practices to show the following results.

SAMPLE ID: 01 BH8 22-24' Collected: 11/23/94 09:00 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	89	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	310	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 02 BH8 24-25' Collected: 11/23/94 10:15 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	87	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	2000	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 06 BH5 16-18' Collected: 11/29/94 09:45 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	69	1	% wt.	12/01/94	BMK	Gravin
Petroleum Hydrocarbons	85	25	mg/kg	12/02/94	SSS	3550/4

SAMPLE ID: 07 BH5 18-20' Collected: 11/29/94 10:00 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	[illegible]	METHOD
Percent Solids	83	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 08 BH16 10-12' Collected: 11/29/94 14:00 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	83	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	930	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 11 BH16 18-20' Collected: 11/29/94 14:33 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	73	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 12 BH15 4-6' Collected: 11/30/94 09:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	84	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	760	25	mg/kg	12/02/94	SSS	3550/418.1

KEMRON ENVIRONMENTAL SERVICES
RESULTS BY SAMPLE

SAMPLE ID: 19 HB-15 18-20' Collected: 11/30/94 10:31 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	80	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 20 15 20-22' Collected: 11/30/94 10:49 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	76	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 24 BH-1 10-12' Collected: 11/30/94 15:14 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	84	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 26 BH-1 14-16' Collected: 11/30/94 15:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	73	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	36	25	mg/kg	12/02/94	SSS	3550/418.1

SAMPLE ID: 28 BH-1 18-20' Collected: 11/30/94 15:51 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	71	1	% wt.	12/01/94	BMK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/02/94	SSS	3550/418.1

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Page

Test Code: SPE_GC
Sample Description: BH8 22-24'
Test Description: Special Request

Lab No: 01A

Collected: 11/23/94 09:00
Category: SOIL

Analyst: MLS
Instrument: HP_10R
Extracted: 12/01/94
Injected: 12/07/94
File #: 029R0301
Factor: 33
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH8 24-25'
Test Description: Special Request

Lab No: 02A

Collected: 11/23/94 10:15
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/07/94

File #: 032R0301
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
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KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH5 16-18'
Test Description: Special Request

Lab No: 06A

Collected: 11/29/94 09:45
Category: SOIL

Analyst: MLS
Instrument: HP_9R

Extracted: 12/01/94
Injected: 12/07/94

File #: 033R0301
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH5 18-20'
Test Description: Special Request

Lab No: 07A

Collected: 11/29/94 10:00
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/07/94

File #: 034R0301
Factor: 33

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH16 10-12'
Test Description: Special Request

Lab No: 08A

Collected: 11/29/94 14:00
Category: SOIL

Analyst: MLS
Instrument: HP_10R
Extracted: 12/01/94
Injected: 12/07/94
File #: 035R0301
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH16 18-20'
Test Description: Special Request

Lab No: 11A

Collected: 11/29/94 14:33
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/07/94

File #: 036R0301
Factor: 33

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH15 4-6'
Test Description: Special Request

Lab No: 12A

Collected: 11/30/94 09:30
Category: SOIL

Analyst: MLS
Instrument: HP_10R
Extracted: 12/01/94
Injected: 12/07/94
File #: 037R0301
Factor: 66
Units: ug/kg
Verified: K W

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: HB-15 18-20'
Test Description: Special Request
Lab No: 19A
Collected: 11/30/94 10:31
Category: SOIL

Analyst: MLS
Instrument: HP_10R
Extracted: 12/01/94
Injected: 12/07/94
File #: 038R0301
Factor: 33
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
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KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: 15 20-22'
Test Description: Special Request

Lab No: 20A

Collected: 11/30/94 10:49
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/08/94

File #: 015R0301
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH-I 10-12'
Test Description: Special Request

Lab No: 24A

Collected: 11/30/94 15:14
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/09/94

File #: 009R0201
Factor: 1650

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	380	165

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH-1 14-16'
Test Description: Special Request
Lab No: 26A
Collected: 11/30/94 15:30
Category: SOIL

Analyst: MLS
Instrument: HP_10R
Extracted: 12/01/94
Injected: 12/08/94
File #: 017R0301
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	19	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-017
May 11, 1995 16:46

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH-1 18-20'
Test Description: Special Request

Lab No: 28A

Collected: 11/30/94 15:51
Category: SOIL

Analyst: MLS
Instrument: HP_10R

Extracted: 12/01/94
Injected: 12/08/94

File #: 018R0301
Factor: 66

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	59	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Lab No: **07A**
Collected: **12/01/94 10**
Sample Description: **NBH-2 16-18'**
Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: MDA
File #: 2KE00212
Instrument: HPMS_2
Injected: 12/08/94
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	108	% Recovery	(70% - 121%)
Toluene-d8	95	% Recovery	(81% - 117%)
p-Bromofluorobenzene	88	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **NBH-2 16-18'**
Test Description: **Special Request**

Lab No: **07B**

Collected: **12/01/94 10:42**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F

Extracted: 12/08/94
Injected: 12/08/94

File #: 014F0101
Factor: 66 **

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **NBH-2 20-22'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **08A**

Collected: **12/01/94 11:**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/13/94

File #: 1KE04495
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	96 % Recovery	(70% - 121%)
Toluene-d8	86 % Recovery	(81% - 117%)
p-Bromofluorobenzene	77 % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-2 20-22'**
Test Description: **Special Request**

Lab No: **08B**

Collected: **12/01/94 11:10**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F

Extracted: 12/08/94
Injected: 12/09/94

File #: 015F0101
Factor: 66**

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Order # N4-12-086
December 14, 1994 15:51

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **BH-4 4-6'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **09A**

Collected: **12/03/94 0**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/09/94

File #: 1KE04437
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	118	% Recovery	(70% - 121%)
Toluene-d8	110	% Recovery	(81% - 117%)
p-Bromofluorobenzene	104	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-4 4-6'**
Test Description: **Special Request**

Lab No: **09B**

Collected: **12/03/94 09:00**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F
Extracted: 12/08/94
Injected: 12/09/94
File #: 016F0101
Factor: 66 **
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **BH-4 6-8'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **10A**

Collected: **12/03/94 0**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/08/94

File #: 1KE04419
Factor: 1

Units: ug/kg

Verified: RJ

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	122 *	% Recovery	(70% - 121%)
Toluene-d8	98	% Recovery	(81% - 117%)
p-Bromofluorobenzene	76	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-4 6-8'**
Test Description: **Special Request**

Lab No: **10B**

Collected: **12/03/94 09:15**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F

Extracted: 12/08/94
Injected: 12/09/94

File #: 017F0101
Factor: 66**

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **BH-4 8-10'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **11A**

Collected: **12/03/94 09.**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/09/94

File #: 1KE04441
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	110 % Recovery	(70% - 121%)
Toluene-d8	98 % Recovery	(81% - 117%)
p-Bromofluorobenzene	92 % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-4 8-10'**
Test Description: **Special Request**

Lab No: **11B**

Collected: **12/03/94 09:30**
Category: **SOIL**

Analyst: MLS Extracted: 12/08/94 File #: 021R0101
Instrument: HP_10R Injected: 12/09/94 Factor: 66 ** Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-4 10-12'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **12A**

Collected: **12/03/94 0**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/08/94
File #: 1KE04421
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	114	% Recovery	(70% - 121%)
Toluene-d8	90	% Recovery	(81% - 117%)
p-Bromofluorobenzene	71 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-4 10-12'**
Test Description: **Special Request**

Lab No: **12B**

Collected: **12/03/94 09:40**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 010F0201
Factor: 1650
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	770	165

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **BH-4 14-16'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **13A**

Collected: **12/03/94 09:**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/08/94

File #: 1KE04422
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	111	% Recovery	(70% - 121%)
Toluene-d8	83	% Recovery	(81% - 117%)
p-Bromofluorobenzene	57 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-4 14-16'**
Test Description: **Special Request**

Lab No: **13B**

Collected: **12/03/94 09:55**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F

Extracted: 12/08/94
Injected: 12/09/94

File #: 023F0101
Factor: 66**

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-4 16-18'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **14A**

Collected: **12/03/94 1**
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/09/94

File #: 1KE04444
Factor: 1

Units: ug/kg

Verified: RJV

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	107	% Recovery	(70% - 121%)
Toluene-d8	96	% Recovery	(81% - 117%)
p-Bromofluorobenzene	86	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-4 16-18'**
Test Description: **Special Request**

Lab No: **14B**

Collected: **12/03/94 10:10**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 024F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	17	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **BH-4 18-20'**
Test Description: **Volatile Organics-Spec/MS**
Lab No: **15A**
Collected: **12/03/94 11.**
Category: **SOIL**

Analyst: TLD
File #: 1KE04445
Instrument: HPMS_1 Injected: 12/09/94 Factor: 1 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	103	% Recovery	(70% - 121%)
Toluene-d8	96	% Recovery	(81% - 117%)
p-Bromofluorobenzene	95	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **BH-4 18-20'**
Test Description: **Special Request**
Lab No: **15B**
Collected: **12/03/94 11:00**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 025F0101
Factor: 66 **
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-4 20-22'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **16A**

Collected: **12/03/94 11**
Category: **SOIL**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/09/94
File #: 2KE00218
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	104	% Recovery	(70% - 121%)
Toluene-d8	95	% Recovery	(81% - 117%)
p-Bromofluorobenzene	78	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-4 20-22'**
Test Description: **Special Request**

Lab No: **16B**

Collected: **12/03/94 11:30**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 026F0101
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Lab No: **17A**
Collected: **12/06/94 1**
Sample Description: **BH-14 8-10'**
Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: MDA
File #: 2KE00219
Instrument: HPMS_2 Injected: 12/09/94 Factor: 1 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	102 % Recovery	(70% - 121%)
Toluene-d8	99 % Recovery	(81% - 117%)
p-Bromofluorobenzene	71 * % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-14 8-10'**
Test Description: **Special Request**

Lab No: **17B**

Collected: **12/06/94 10:30**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 027F0101
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **BH-14 10-12'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **18A**

Collected: **12/06/94 10**
Category: **SOIL**

Analyst: TLD
Instrument: FINN2 Injected: 12/13/94
File #: 2KE40510
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	73	% Recovery	(70% - 121%)
Toluene-d8	122 *	% Recovery	(81% - 117%)
p-Bromofluorobenzene	61 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **BH-14 10-12'**
Test Description: **Special Request**

Lab No: **18B**

Collected: **12/06/94 10:40**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10R
Extracted: 12/08/94
Injected: 12/09/94
File #: 028R0101
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-14 12-14'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **19A**

Collected: **12/06/94 10:**
Category: **SOIL**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/09/94
File #: 2KE00221
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	91	% Recovery	(70% - 121%)
Toluene-d8	79 *	% Recovery	(81% - 117%)
p-Bromofluorobenzene	55 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-14 12-14'**
Test Description: **Special Request**

Lab No: **19B**

Collected: **12/06/94 10:05**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 011F0201
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-14 14-16'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **20A**

Collected: **12/06/94 11**
Category: **SOIL**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/09/94

File #: 2KE00222
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	89 % Recovery	(70% - 121%)
Toluene-d8	98 % Recovery	(81% - 117%)
p-Bromofluorobenzene	91 % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-14 14-16'**
Test Description: **Special Request**

Lab No: **20B**

Collected: **12/06/94 11:05**
Category: **SOIL**

Analyst: MLS
Instrument: HP_10F
Extracted: 12/08/94
Injected: 12/09/94
File #: 014F0201
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-14 16-18'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **21A**

Collected: **12/06/94 11.**
Category: **SOIL**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/09/94
File #: 2KE00223
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	99	% Recovery	(70% - 121%)
Toluene-d8	94	% Recovery	(81% - 117%)
p-Bromofluorobenzene	72 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **BH-14 16-18'**
Test Description: **Special Request**

Lab No: **21B**

Collected: **12/06/94 11:20**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/09/94
File #: 019F0101
Factor: 66 **
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Lab No: **22A**
Collected: **12/06/94 1:**
Sample Description: **BH-14 18-20'**
Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: MDA
File #: 2KE00224
Instrument: HPMS_2 Injected: 12/09/94 Factor: 1 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	104	% Recovery	(70% - 121%)
Toluene-d8	98	% Recovery	(81% - 117%)
p-Bromofluorobenzene	92	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**	Lab No: **22B**		Collected: **12/06/94 11:35**
Sample Description: **BH-14 18-20'**			Category: **SOIL**
Test Description: **Special Request**			

Analyst: ECL	Extracted: 12/08/94	File #: 020F0101		
Instrument: HP_IVF	Injected: 12/10/94	Factor: 66 **	Units: ug/kg	Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
- DET LIMIT = DETECTION LIMIT
- ND = NONE DETECTED
- * = SEMI-QUANTITATIVE SCREEN ONLY
- ** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **BH-14 20-22'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **23A**

Collected: **12/06/94 11**
Category: **SOIL**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/09/94
File #: 2KE00225
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	102	% Recovery	(70% - 121%)
Toluene-d8	93	% Recovery	(81% - 117%)
p-Bromofluorobenzene	80	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-14 20-22'**
Test Description: **Special Request**

Lab No: **23B**

Collected: **12/06/94 11:55**
Category: **SOIL**

Analyst: ECL Extracted: 12/08/94 File #: 021F0101
Instrument: HP_IVF Injected: 12/10/94 Factor: 33 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **BH-14 22-24'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **24A**

Collected: **12/06/94 11**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/13/94
File #: 1KE04497
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	94	% Recovery	(70% - 121%)
Toluene-d8	85	% Recovery	(81% - 117%)
p-Bromofluorobenzene	85	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **BH-14 22-24'**
Test Description: **Special Request**

Lab No: **24B**

Collected: **12/06/94 11:37**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 022F0101
Factor: 66 **
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	Nd	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Volatile analytes analyzed by purge and trap GC/MS.
SW-846 METHOD 8240 (MODIFIED FOR MEGABORE COLUMN)

Test Code: **SPE_GC**
Sample Description: **NBH-3/14-16'**
Test Description: **Special Request**

Lab No: **06B**

Collected: **12/01/94 16:16**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 039F0501
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	60	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO** Lab No: **07A** Collected: **12/01/94 1**
Sample Description: **NBH-3/16-18'** Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: MDA File #: 2KE00229
Instrument: HPMS_2 Injected: 12/09/94 Factor: 1 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	105	% Recovery	(70% - 121%)
Toluene-d8	98	% Recovery	(81% - 117%)
p-Bromofluorobenzene	86	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **NBH-3/16-18'**
Test Description: **Special Request**

Lab No: **07B**

Collected: **12/01/94 16:23**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 040F0501
Factor: 33
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **NBH-3/20-22'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **08A**

Collected: **12/01/94 1**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/12/94
File #: 1KE04490
Factor: 5 *
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	25

SURROGATES:

1,2-Dichloroethane-d4	102	% Recovery	(70% - 121%)
Toluene-d8	91	% Recovery	(81% - 117%)
p-Bromofluorobenzene	157 **	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = ELEVATED DETECTION LIMIT DUE TO SAMPLE MATRIX
** = DILUTION ANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-3/20-22'**
Test Description: **Special Request**

Lab No: **08B**

Collected: **12/01/94 16:37**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 041F0501
Factor: 33
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	3.3

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Volatile analytes analyzed by purge and trap GC/MS.
SW-846 METHOD 8240 (MODIFIED FOR MEGABORE COLUMN)

Test Code: **SPE_GC**
Sample Description: **NBH-2 4-6'**
Test Description: **Special Request**

Lab No: **01B**

Collected: **12/01/94 09:51**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F
Extracted: 12/08/94
Injected: 12/08/94
File #: 008F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	12	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **NBH-2 8-10'**
Test Description: **Volatile Organics-Spec/MS**
Lab No: **02A**
Collected: **12/01/94 1**
Category: **SO**

Analyst: MDA
Instrument: HPMS_2 Injected: 12/08/94
File #: 2KE00205
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	102	% Recovery	(70% - 121%)
Toluene-d8	93	% Recovery	(81% - 117%)
p-Bromofluorobenzene	75	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Order # N4-12-086
December 14, 1994 15:51

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-2 8-10'**
Test Description: **Special Request**

Lab No: **02B**

Collected: **12/01/94 10:06**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F
Extracted: 12/08/94
Injected: 12/08/94
File #: 009F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	11	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **NBH-2 6-8'**
Test Description: **Volatile Organics-Spec/MS**
Lab No: **03A**
Collected: **12/01/94 09**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/12/94
File #: 1KE04485
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	115	% Recovery	(70% - 121%)
Toluene-d8	99	% Recovery	(81% - 117%)
p-Bromofluorobenzene	89	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

Test Code: **SPE_GC**
Sample Description: **NBH-2 6-8'**
Test Description: **Special Request**

Lab No: **03B**

Collected: **12/01/94 09:58**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F

Extracted: 12/08/94
Injected: 12/08/94

File #: 010F0101
Factor: 66**

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE INTERFERENCE

Test Code: **SPE_VO**
Sample Description: **NBH-2 10-12'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **04A**

Collected: **12/01/94 1C**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/12/94
File #: 1KE04491
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	102	% Recovery	(70% - 121%)
Toluene-d8	86	% Recovery	(81% - 117%)
p-Bromofluorobenzene	78	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-2 10-12'**
Test Description: **Special Request**
Lab No: **04B**
Collected: **12/01/94 10:14**
Category: **SOIL**

Analyst: DST
Extracted: 12/08/94
File #: 011F0101
Instrument: HP_8F
Injected: 12/08/94
Factor: 66**
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY
** = ELEVATED DETECTION LIMITS DUE TO SAMPLE MATRIX

Test Code: **SPE_VO**
Sample Description: **NBH-2 12-14'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **05A**

Collected: **12/01/94 1C**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/12/94

File #: 1KE04492
Factor: 1

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	98	% Recovery	(70% - 121%)
Toluene-d8	82	% Recovery	(81% - 117%)
p-Bromofluorobenzene	62 *	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
* = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-2 12-14'**
Test Description: **Special Request**

Lab No: **05B**

Collected: **12/01/94 10:23**
Category: **SOIL**

Analyst: DST
Instrument: HP_8F
Extracted: 12/08/94
Injected: 12/08/94
File #: 012F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	28	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Order #: N4-12-086
Date: December 14, 1994 15:51
Work ID: DPSC-Philadelphia
Date Received: 12/07/94
Date Completed: 12/14/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	NBH-2 4-6'	02	NBH-2 8-10'
03	NBH-2 6-8'	04	NBH-2 10-12'
05	NBH-2 12-14'	06	NBH-2 14-16'
07	NBH-2 16-18'	08	NBH-2 20-22'
09	BH-4 4-6'	10	BH-4 6-8'
11	BH-4 8-10'	12	BH-4 10-12'
13	BH-4 14-16'	14	BH-4 16-18'
15	BH-4 18-20'	16	BH-4 20-22'
17	BH-14 8-10'	18	BH-14 10-12'
19	BH-14 12-14'	20	BH-14 14-16'
21	BH-14 16-18'	22	BH-14 18-20'
23	BH-14 20-22'	24	BH-14 22-24'

All results on solids/sludges are reported "AS RECEIVED" unless otherwise specified. This report shall not be reproduced, except in full, without the written approval of KEMRON.

Certified by
Leslie Bucina

Test Code: **SPE_VO** Lab No: **01A** Collected: **12/01/94 09:51**
Sample Description: **NBH-2 4-6'** Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: MDA File #: 2KE00204
Instrument: HPMS_2 Injected: 12/08/94 Factor: 1 Units: ug/kg Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	99	% Recovery	(70% - 121%)
Toluene-d8	103	% Recovery	(81% - 117%)
p-Bromofluorobenzene	101	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Order #: N4-12-149
Date: December 16, 1994 15:55
Work ID: 8057-004/DPSC- Philadelphia
Date Received: 12/09/94
Date Completed: 12/16/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	BH-17 8-10'	02	BH-17 10-12'
03	BH-17 12-14'	04	BH-17 14-16'
05	BH-17 16-18'	06	BH-17 18-20'
07	BH-17 W2	08	BH-18 8-10'
09	BH-18 12-14'	10	BH-18 14-16'
11	BH-18 16-18'	12	BH-18 18-20'
13	BH-14 W	14	BH-17 W3
15	BH-18 W4		

All results on solids/sludges are reported "AS RECEIVED" unless otherwise specified. This report shall not be reproduced, except in full, without the written approval of KEMRON.

Leslie Bucina

Certified by
Leslie Bucina

Order # N4-12-149
December 16, 1994 15:56

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: BH-14 W
Test Description: Special Request
Lab No: 13A
Collected: 12/07/94 10:01
Category: WATER

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/09/94
Injected: 12/16/94
File #: 019F0401
Factor: 2
Units: ug/L
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'DDT	0.55	0.2

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE VO
Sample Description: BH-17-W3
Test Description: Volatile Organics-Spec/MS

Lab No: 14A

Collected: 12/07/94 13:30
Category: WATER

Analyst: TKT
Instrument: HPMS_1
Injected: 12/11/94
File #: 1KE04470
Factor: 1
Units: ug/L
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	98	% Recovery	(76% - 114%)
Toluene-d8	98	% Recovery	(88% - 110%)
p-Bromofluorobenzene	95	% Recovery	(86% - 115%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_VO
Sample Description: BH-18 W4
Test Description: Volatile Organics-Spec/MS

Lab No: 15A

Collected: 12/08/94 11:30
Category: WATER

Analyst: TKT
Instrument: HPMS_1
Injected: 12/11/94
File #: 1KE04471
Factor: 1
Units: ug/L
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	103	% Recovery	(76% - 114%)
Toluene-d8	101	% Recovery	(88% - 110%)
p-Bromofluorobenzene	101	% Recovery	(86% - 115%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)

Volatile analytes analyzed by purge and trap GC/MS.
SW-846 METHOD 8240 (MODIFIED FOR MEGABORE COLUMN)

KEMRON ANALYST LIST

Ohio Valley Laboratory

11/17/94

AJS - - Ashlee J. Scott
ALC - - Ann L. Clark
BAR - - Beth A. Raper
BMK - - Bently M. Knight
CEB - - Chad E. Barnes
DIH - - Deanna I. Hesson
DJP - - Douglas J. Poling
DLP - - Dorothy L. Payne
DST - - Dennis S. Tepe
ECL - - Eric C. Lawson
EDG - - Eric D. Gerkin
FEH - - Fay E. Harmon
FRM - - Fred R. Montgomery
GWH - - George W. Hutchison
GSS - - Greg S. Smith
HV - - Hema Vilasagar
JA - - Judy Amador
JBC - - Jim B. Crawford
JEC - - Jesse E. Chapman
JYH - - Ji Y. Hu
JKM - - June K. Morris
JLH - - Janice L. Holland
JLL - - Janice L. Landshof
JMM - - Jim M. Monk
JWR - - John W. Richards
KHA - - Kim H. Archer
KMM - - Kevin M. McDonald
KPO - - Kevin P. Overstreet
LMW - - Lisa M. Wagner
MBJ - - Matthew B. Jarrell
MDA - - Mike D. Albertson
MDC - - Michael D. Cochran
MLS - - Michael L. Schimmel
MZL - - Melanie Z. Lewis
PJH - - Pamela J. Holtz
PNW - - Phillip N. Wright
PST - - Pam S. Tornes
REB - - Russell E. Burton
REK - - Robert E. Kyer
RJS - - Rick J. Santos
RWC - - Rodney W. Campbell
SCM - - Susan C. Moellendick
SCW - - Stephen C. West
SLM - - Stephanie L. Mossburg
SPL - - Steve P. Learn
SR - - Shahla Rogers
SSS - - Susan S. Snodgrass
TAS - - Tamela A. Sams
TKT - - Tonya K. Troutner
TLD - - Teresa L. Davis
WCD - - Wade C. Dawson
WDL - - William D. Landshof

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Order #: N4-12-264
Date: December 22, 1994 17:25
Work ID: 8057-004/DPSC-Philadelphia
Date Received: 12/15/94
Date Completed: 12/22/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	CH-1	02	CH-2
03	CH-3	04	CH-4
05	CH-5	06	CH-6

All results on solids/sludges are reported "AS RECEIVED" unless otherwise specified. This report shall not be reproduced, except in full, without the written approval of KEMRON.

Certified by
Leslie Bucina

PRELIMINAR

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
RESULTS BY SAMPLE

This is to certify that the following samples were analyzed using good laboratory practices to show the following results.

SAMPLE ID: 01 CH-1 Collected: 12/14/94 10:00 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	85	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/15/94	BMK	3550/418.1

SAMPLE ID: 02 CH-2 Collected: 12/14/94 10:30 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	83	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/15/94	BMK	3550/418.1

SAMPLE ID: 03 CH-3 Collected: 12/14/94 10:55 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	81	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/15/94	BMK	3550/418.1

SAMPLE ID: 04 CH-4 Collected: 12/14/94 11:15 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	83	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/15/94	BMK	3550/418.1

SAMPLE ID: 05 CH-5 Collected: 12/14/94 11:40 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	81	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	<25	25	mg/kg	12/15/94	BMK	3550/418.1

SAMPLE ID: 06 CH-6 Collected: 12/14/94 12:20 Category: SOIL

TEST DESCRIPTION	RESULT	DETECTION LIMIT	UNITS	DATE ANALYZED	BY	METHOD
Percent Solids	84	1	% wt.	12/15/94	REK	Gravimetric
Petroleum Hydrocarbons	35	25	mg/kg	12/15/94	BMK	3550/418.1

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: CH-I
Test Description: Special Request

Lab No: 01A

Collected: 12/14/94 10:00
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/22/94

File #: 009F0301
Factor: 660

Units: ug/kg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	410	66

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: CH-2
Test Description: Special Request

Lab No: 02A

Collected: 12/14/94 10:30
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/21/94

File #: 033F0901
Factor: 66

Units: ug/kg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	18	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-264
December , 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: CH-3
Test Description: Special Request

Lab No: 03A

Collected: 12/14/94 10:55
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/22/94

File #: 003F0101
Factor: 330000

Units: ug/lg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	220000	33000

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: CH-4
Test Description: Special Request

Lab No: 04A

Collected: 12/14/94 11:15
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/22/94

File #: 011F0301
Factor: 3300

Units: ug/kg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	3100	330

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Page

Test Code: SPE_GC
Sample Description: CH-5
Test Description: Special Request

Lab No: 05A

Collected: 12/14/94 11:40
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/22/94

File #: 006F0101
Factor: 165000

Units: ug/kg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	64000	16500

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Order # N4-12-264
December 22, 1994 17:26

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: SPE_GC
Sample Description: CH-6
Test Description: Special Request

Lab No: 06A

Collected: 12/14/94 12:20
Category: SOIL

Analyst: MLS
Instrument: HP_10F

Extracted: 12/15/94
Injected: 12/22/94

File #: 013F0301
Factor: 330

Units: ug/kg

Verified: DAB

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	120	33

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

APPENDIX D
CHAIN-OF-CUSTODY FORMS

KE[illegible]RON
ENVIRONMENTAL SERVICES

CHAIN-OF-CUSTODY RECORD

[illegible]57945

Page ______ of ______

Project Contact: Dana Jackson

Turn Around Requirements: Regular

Project No.: 8057-004

Project Name: DPSC - Philadelphia

Sampler (print): T. L. Gullette

Signature:

Sample I.D. No.	Comp'	Grab	Date	Time	Protocol		NUMBER OF SAMPLES	Hold	Pesticides	TPH		ADDITIONAL REQUIREMENTS
					CWA	SW846						
BH 7 4-6'		✓	11-16-94	3:00			1	X	✓	✓		
BH 7 6-8'		✓		3:15			1	X	✓	✓		
BH 7 8-10'		✓		3:30			1	X	✓	✓		
BH 7 10-12'		✓		4:00			1	X	✓	✓		
BH 7 12-14'		✓		4:15			1	X	✓	✓		
BH 7 14-16'		✓		4:30			1	X	✓	✓	?	RUN (8ppm)
BH 7 16-18'		✓	↓	5:00			1	X	✓	✓		
BH 7 18-20'		✓	11-16-94	5:30			1	X	✓	✓	?	RUN
BH 6 4-6'		✓	11-18-94	10:30			1	X	✓	✓		
BH 6 6-8'		✓		10:35			1	✓	✓	✓		
BH 6 8-10'		✓		10:40			1	X	✓	✓		
BH 6 10-12'		✓		10:45			1	X	✓	✓	?	RUN
BH 6 12-14'		✓		10:50			1	X	✓	✓		
BH 6 14-16'		✓	↓	11:10			1	X	✓	✓		
BH 6 16-18'		✓	11-18-94	11:30			1	X	✓	✓	?	RUN

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
	11-18-94	2:00					

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

Homogenize all composite samples prior to analysis

White - Lab Yellow - Office Pink - Field

ENVIRONMEN SERVICES

№ 4113

CHAIN-OF-CUSTODY RECORD

Project Contact: Dana Jackson

Turn Around Requirements: 7 days

Project No.: 8057-004

Project Name: DPGC - Philadelphia

Sampler (print): T. L. Gullette

Signature: Lau Gullette

Page 1 of 2

Sample I.D. No.	Comp	Grab	Date	Time	Sample Location	NUMBER OF SAMPLES	HOLD	% SOLIDS	VOA	ACID EXTRACT.	BASE/NEUTR. EXT.	EP TOX.-METALS	EP TOX.-ORGAN.	TOT. METALS-P.P.L.	TOT. METALS-RCRA	PCBs	PESTICIDES	TPH	BETX	PHENOLICS	PCE	ADDITIONAL REQUIREMENTS
NBH-2 4-6'		✓	12-1-94	0951	BH-2	1											✓				✓	
NBH-2 8-10'		✓	↓	1006	BH-2	1											✓				✓	
NBH-2 6-8'		✓	↓	0958	BH-2	1											✓				✓	
NBH-2 10-12'		✓	↓	1014	BH-2	1											✓				✓	
NBH-2 12-14'		✓	↓	1023	BH-2	1											✓				✓	
NBH-2 14-16'		✓	↓	1031	BH-2	1											✓				✓	
NBH-2 16-18'		✓	↓	1042	BH-2	1											✓				✓	
NBH-2 20-22'		✓	12-1-94	1110	BH-2	1											✓				✓	
BH-4 4-6'			12-3-94	9:00	BH-4	1											✓				✓	
BH-4 6-8'			↓	9:15	BH-4	1											✓				✓	
BH-4 8-10'			↓	9:30	BH-4	1											✓				✓	
BH-4 10-12'			↓	9:40	BH-4	1											✓				✓	
BH-4 14-16'			↓	9:55	BH-4	1											✓				✓	
BH-4 16-18'			↓	10:10	BH-4	1											✓				✓	
BH-4 18-20'			↓	11:00	BH-4	1											✓				✓	
BH-4 20-22'			12-3-94	11:30	BH-4	1											✓				✓	
BH-14 8-10'			12-6-94	10:30	BH-14	1											✓				✓	

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Lau Gullette	12-6-94	5:00					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:
			Angelina R. Brown	12/7/94	9:30	CofC sealed samples intact Cooler temp 12°

HYDE BROS PRTG CO - MARIETTA, OHIO 45750

'0347

ENVIRON SERVICES

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Contact: Dana Jackson

Turn Around Requirements: 7-day

Project No.: 8057-004

Project Name: VSAC - DDT Investigation

Sampler (print): M.F. Davey

Signature:

Sample I.D. No	Comp*	Grab	Date	Time	Protocol CWA	Protocol SW846	NUMBER OF SAMPLES	Hold	Pesticides - DDT	TPH		ADDITIONAL REQUIREMENTS
BH8 4-6'		X	11/22/94	2:00			1	X	X	X		
BH8 6-8'		X	11/22/94	2:15			1	X	X	X		
BH8 8-10'		X	11/22/94	2:30			1	X	X	X		
BH8 10-12'		X	11/22/94	2:45			1	X	X	X		
BH8 12-14'		X	11/22/94	3:00			1		X	X	✓	HOLD AFTER RUNNING SAMPLE
BH8 14-16'		X	11/22/94	3:15			1	X	X	X		
BH8 18-20'		X	11/22/94	3:30			1		X	X	✓	HOLD AFTER RUNNING SAMPLE
BH9 4-6'		X	11/21/94	4:00			1	X	X	X		
BH9 6-8'		X	11/21/94	4:05			1	X	X	X		
BH9 8-10'		X	11/21/94	4:10			1	X	X	X		
BH9 10-12'		X	11/21/94	4:15			1	X	X	X		
BH9 12-14'		X	11/21/94	4:25			1		X	X	✓	HOLD AFTER RUNNING SAMPLE
BH9 14-16'		X	11/21/94	4:30			1	X	X	X		
BH9 20-22'		X	11/22/94	11:30			1		X	X	✓	HOLD AFTER RUNNING SAMPLE
BH9 H2O		X	11/22/94	11:00			1		X	X	✓	2 Sample Jars (1 l)

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Matthew F Davey	11/28/94	3:45					

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

*Homogenize all composite samples prior to analysis

White – Lab Yellow – Office Pink – Field

KEMRON
ENVIRONMENTAL SERVICES

CHAIN-OF-CUSTODY RECORD

0346

Page 1 of 2

Project Contact: Dana Jackson

Turn Around Requirements: 7-DAY

Project No.: 3057-004

Project Name: DPSC- DDT Investigation

Sampler (print): M. F. Davey

Signature: Matthew Davey

Sample I.D. No.	Comp*	Grab	Date	Time	Protocol CWA	Protocol SW846	NUMBER OF SAMPLES	Hold	Pesticides - DDT	TPH		ADDITIONAL REQUIREMENTS
BH8 22-24'		X	11/23/94	0900			1		X	X	?	Hold after running sample
BH8 24 25'		X	11/23/94	1015			1		X	X	?	Hold after running sample
BH5 10-12'		X	11/29/94	910			1	X	X	X		
BH5 12-14'		X	11/29/94	923			1	X	X	X		
BH5 14-16'		X	11/29/94	933			1	X	X	X		
BH5 16-18'		X	11/29/94	945			1		X	X	?	Hold after running sample
BH5 18-20'		X	11/29/94	1000			1		X	X	?	Hold after running sample
BH16 10-12'		X	11/29/94	1400			1		X	X	?	Hold after running s[illegible]
BH16 12-14'		X	11/29/94	1409			1	X	X	X		
BH16 14-16'		X	11/29/94	1416			1	X	X	X		
BH16 18-20'		X	11/29/94	1433			1		X	X	?	Hold after running [illegible]
BH15 4-6'		X	11/30/94	930			1		X	X	?	Hold after running sample
BH15 6-8'		X	11/30/94	937			1	X	X	X		
BH15 8-10'		X	11/30/94	949			1	X	X	X		
BH15 10-12'		X	11/30/94	953			1	X	X	X		
HB15 12-14'		X	11/30/94	1000			1	X	X	X		
SB15 14-16'		X	11/30/94	1010			1	X	X	X		

Relinquished by: (Signature) Matthew Davey	Date 11/30/94	Time 1705	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:	

*Homogenize all composite samples prior to analysis

White – Lab Yellow – Office Pink – Field

ENVIRONM SERVICES

№ 402

CHAIN-OF-CUSTODY RECORD

Project Contact: Dana Jackson

Turn Around Requirements: 7 days

Page 2 of 2

Project No.: 8057-004

Project Name: DPSC – Philadelphia

Sampler (print): T.L. Gullette

Signature:

Sample I.D. No.	Comp	Grab	Date	Time	Sample Location	NUMBER OF SAMPLES	HOLD	% SOLIDS	VOA	ACID EXTRACT.	BASE/NEUTR. EXT.	EP TOX.-METALS	EP TOX.-ORGAN.	TOT. METALS-P.P.L.	TOT. METALS-RCRA	PCBs	PESTICIDES	TPH	BETX	PHENOLICS	PCE	ADDITIONAL REQUIREMENTS
BH-14 10-12'		✓	12-6-94	10:40	BH-14	1											✓				✓	
BH-14 12-14'		✓		10:50	BH-14	1											✓				✓	
BH-14 14-16'		✓		11:05	BH-14	1											✓				✓	
BH-14 16-18'		✓		11:20	BH-14	1											✓				✓	
BH-14 18-20'		✓		11:35	BH-14	1											✓				✓	
BH-14 20-22'		✓	↓	11:55	BH-14	1											✓				✓	
BH-14 22-24'		✓	12-6-94	11:37	BH-14	1											✓				✓	
NBH-3 4-6'		✓	12-1-94	1540	BH-3	1											✓				✓	
NBH-3 6-8'		✓		1546	BH-3	1											✓				✓	
NBH-3 8-10'		✓		1553	BH-3	1											✓				✓	
NBH-3 10-12'		✓		1600	BH-3	1											✓				✓	
NBH-3 12-14'		✓		1606	BH-3	1											✓				✓	
NBH-3 14-16'		✓		1616	BH-3	1											✓				✓	
NBH-3 16-18'		✓	↓	1623	BH-3	1											✓				✓	
NBH-3 20-22'		✓	[illegible]-94	1637	BH-3	1											✓				✓	

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
	12-6-94	5:00					

Relinquished by: (Signature)	Date	Time	Received for Laboratory by: (Signature)	Date	Time	Remarks:
			Angelica R. Brown	12/7/94	9:20	Cooler temp @ 10 ARB. C of C sealed samples intact

W-AD6

White - Lab Yellow - Office Pink - Field

HYDE BROS PRTG CO - MARIETTA, OHIO 45750 388-334-

KEMRON
ENVIRONMENTAL SERVICES

CHAIN-OF-CUSTODY RECORD

7943

Page ____ of ____

Project Contact: Dana Jackson

Turn Around Requirements: 7 days

Project No.: 8057-004

Project Name: DPSC- Philadelphia

Sampler (print): T. L. Collette

Signature:

Sample I.D. No.	Comp*	Grab	Date	Time	Protocol CWA	Protocol SW846	NUMBER OF SAMPLES	Hold	Pesticides	PCE	ADDITIONAL REQUIREMENTS
BH-17 8-10'		✓	12-7-94	10:00			1		✓	✓	
BH-17 10-12'		✓	↓	10:10			1		✓	✓	
BH-17 12-14'		✓	↓	10:30			1		✓	✓	
BH-17 14-16'		✓	↓	11:00			1		✓	✓	
BH-17 16-18'		✓	↓	11:15			1		✓	✓	
BH-17 18-20'		✓	↓	11:40			1		✓	✓	
BH-17 W2		✓	12-7-94	13:45			1		✓		
BH-18 8-10'		✓	12-7-94	3:15			1		✓	✓	
BH-18 12-14'		✓	↓	3:40			1		✓	✓	
BH-18 14-16'		✓	↓	4:00			1		✓	✓	
BH-18 16-18'		✓	↓	4:15			1		✓	✓	
BH-18 18-20'		✓	12-7-94	4:45			1		✓	✓	
BH-14 W		✓	12-7-94	10:01			1		✓		
BH-17 W3		✓	12-7-94	1:30			1			✓	
BH-18 W4		✓	12-8-94	11:30			1				

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Relinquished by: (Signature)	Date	Time	Received by: (Signature)
	12-8-94	12:00					

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

*Homogenize all composite samples prior to analysis

White – Lab Yellow – Office Pink – Field

Attachment 2

FIGURE SUMMARIZING LOCATIONS, SIZES, AND CONTENTS FOR DPSC USTS AND ASTS

KEMRON Environmental Services
109 Starlite Park
Marietta, Ohio 45750

Phone: (614) 373-4071

KEMRON
ENVIRONMENTAL SERVICES

KEMRON Environmental Services
7926 Jones Branch Drive
McLean, VA 22102

Attn: Dana Jackson

Order #: N4-12-123
Date: December 14, 1994 17:04
Work ID: 8057-004/DPSC-Philadelphia
Date Received: 12/07/94
Date Completed: 12/14/94

Client Code: KEMRON_MC

SAMPLE IDENTIFICATION

Sample Number	Sample Description	Sample Number	Sample Description
01	NBH-3/4-6'	02	NBH-3/6-8'
03	NBH-3/8-10'	04	NBH-3/10-12'
05	NBH-3/12-14'	06	NBH-3/14-16'
07	NBH-3/16-18'	08	NBH-3/20-22'

All results on solids/sludges are reported "AS RECEIVED" unless otherwise specified. This report shall not be reproduced, except in full, without the written approval of KEMRON.

Certified by
Leslie Bucina

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Lab No: **01A**
Collected: **12/01/94 1**
Sample Description: **NBH-3/4-6'**
Category: **SOIL**
Test Description: **Volatile Organics-Spec/MS**

Analyst: TLD
File #: 1KE04446
Instrument: HPMS_1
Injected: 12/09/94
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	107	% Recovery	(70% - 121%)
Toluene-d8	99	% Recovery	(81% - 117%)
p-Bromofluorobenzene	93	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-3/4-6'**
Test Description: **Special Request**

Lab No: **01B**

Collected: **12/01/94 15:40**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF

Extracted: 12/08/94
Injected: 12/12/94

File #: 004F0101
Factor: 660

Units: ug/kg

Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	160	66

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **NBH-3/6-8'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **02A**

Collected: **12/01/94 1** [illegible]
Category: **SOIL**

Analyst: TLD
Instrument: HPMS_1 Injected: 12/09/94

File #: 1KE04449
Factor: 1

Units: ug/kg

Verified: RJ

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	101	% Recovery	(70% - 121%)
Toluene-d8	78 **	% Recovery	(81% - 117%)
p-Bromofluorobenzene	53 **	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
** = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE

Test Code: **SPE_GC**
Sample Description: **NBH-3/6-8'**
Test Description: **Special Request**

Lab No: **02B**

Collected: **12/01/94 15:46**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 024F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **NBH-3/8-10'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **03A**

Collected: **12/01/94 15**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/11/94
File #: 1KE04465
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	97 % Recovery	(70% - 121%)
Toluene-d8	87 % Recovery	(81% - 117%)
p-Bromofluorobenzene	77 % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-3/8-10'**
Test Description: **Special Request**

Lab No: **03B**

Collected: **12/01/94 15:53**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/12/94
File #: 005F0101
Factor: 660
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	390	66

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_VO**
Sample Description: **NBH-3/10-12'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **04A**

Collected: **12/01/94 1**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1 Injected: 12/11/94
File #: 1KE04466
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	98 % Recovery	(70% - 121%)
Toluene-d8	88 % Recovery	(81% - 117%)
p-Bromofluorobenzene	82 % Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-3/10-12'**
Test Description: **Special Request**

Lab No: **04B**

Collected: **12/01/94 16:00**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 026F0101
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	ND	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: PE_VO
Sample Description: H-3/12-14'
Test Description: **Volatile Organics-Spec/MS**
Lab No: **05A**
Collected: **12/01/94 16**
Category: **SOIL**

Analyst: TKT
Instrument: HPMS_1
Injected: 12/11/94
File #: 1KE04467
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	89	% Recovery	(70% - 121%)
Toluene-d8	72 **	% Recovery	(81% - 117%)
p-Bromofluorobenzene	50 **	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD DETECTION LIMIT (MDL)
** = SAMPLE DILUTION CONFIRMS SAMPLE MATRIX INTERFERENCE

KEMRON ENVIRONMENTAL SERVICES
TEST RESULTS BY SAMPLE

Test Code: **SPE_GC**
Sample Description: **NBH-3/12-14'**
Test Description: **Special Request**

Lab No: **05B**

Collected: **12/01/94 16:06**
Category: **SOIL**

Analyst: ECL
Instrument: HP_IVF
Extracted: 12/08/94
Injected: 12/10/94
File #: 038F0501
Factor: 66
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
50-29-3	4,4'-DDT	22	6.6

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NONE DETECTED
* = SEMI-QUANTITATIVE SCREEN ONLY

Test Code: **SPE_VO**
Sample Description: **NBH-3/14-16'**
Test Description: **Volatile Organics-Spec/MS**

Lab No: **06A**

Collected: **12/01/94 16:**
Category: **SOIL**

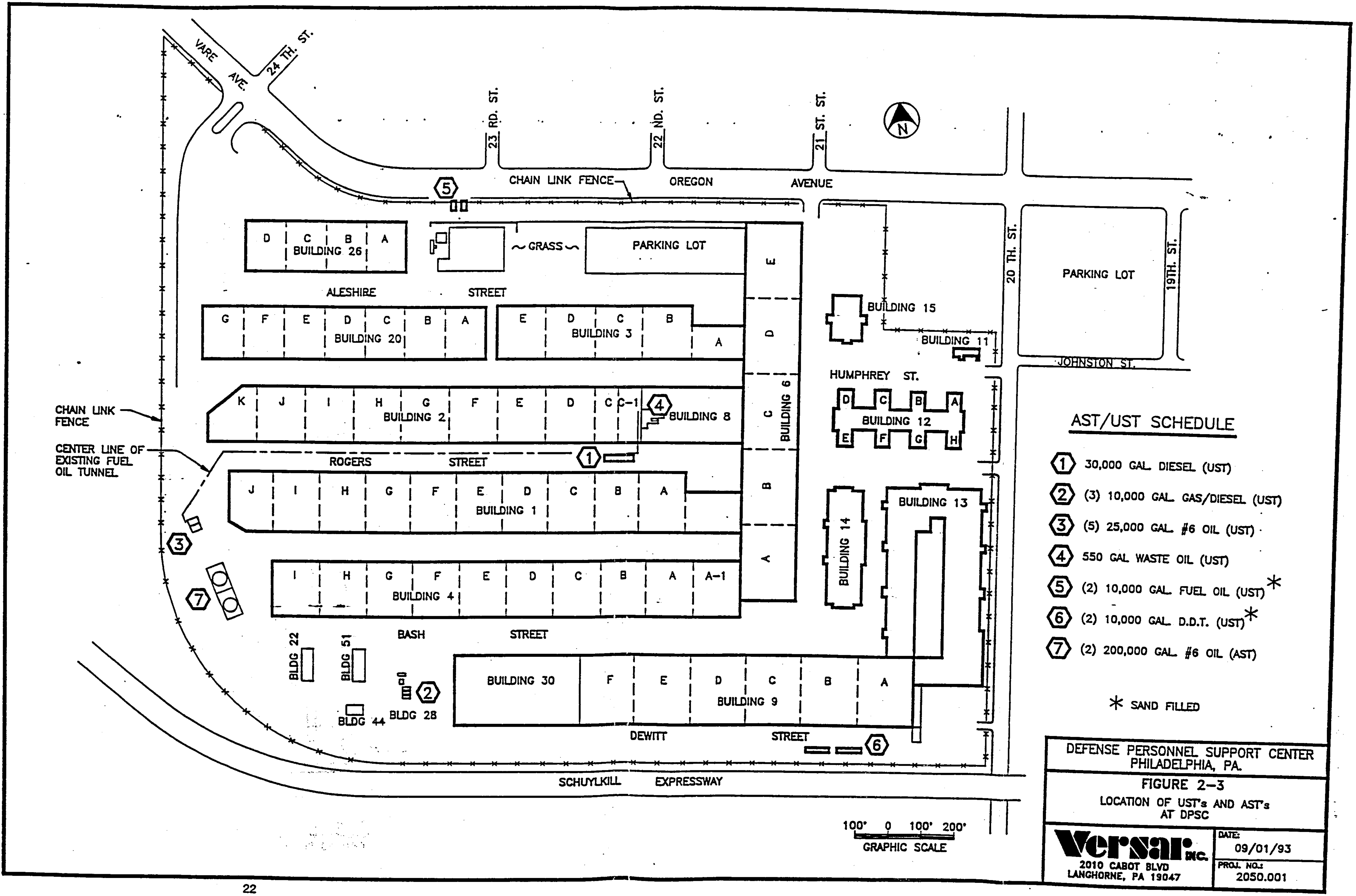
Analyst: TKT
Instrument: HPMS_1 Injected: 12/11/94
File #: 1KE04468
Factor: 1
Units: ug/kg
Verified: RJW

CAS#	COMPOUND	RESULT	DETECTION LIMIT
127-18-4	Tetrachloroethylene	ND	5

SURROGATES:

1,2-Dichloroethane-d4	96	% Recovery	(70% - 121%)
Toluene-d8	78 **	% Recovery	(81% - 117%)
p-Bromofluorobenzene	58 **	% Recovery	(74% - 121%)

NOTES AND DEFINITIONS FOR THIS SAMPLE
DET LIMIT = DETECTION LIMIT
ND = NOT DETECTED AT OR ABOVE THE METHOD
DETECTION LIMIT (MDL)
** = REANALYSIS CONFIRMS SAMPLE MATRIX INTERFERENCE



AST/UST SCHEDULE

①	30,000 GAL. DIESEL (UST)
②	(3) 10,000 GAL. GAS/DIESEL (UST)
③	(5) 25,000 GAL. #6 OIL (UST)
④	550 GAL. WASTE OIL (UST)
⑤	(2) 10,000 GAL. FUEL OIL (UST)*
⑥	(2) 10,000 GAL. D.D.T. (UST)*
⑦	(2) 200,000 GAL. #6 OIL (AST)

* SAND FILLED

DEFENSE PERSONNEL SUPPORT CENTER
PHILADELPHIA, PA.

FIGURE 2-3
LOCATION OF UST's AND AST's AT DPSC

Versar INC.
2010 CABOT BLVD
LANGHORNE, PA 19047

DATE: 09/01/93
PROJ. NO.: 2050.001

Attachment 3

SUMMARY OF FIELD INVESTIGATION TASKS

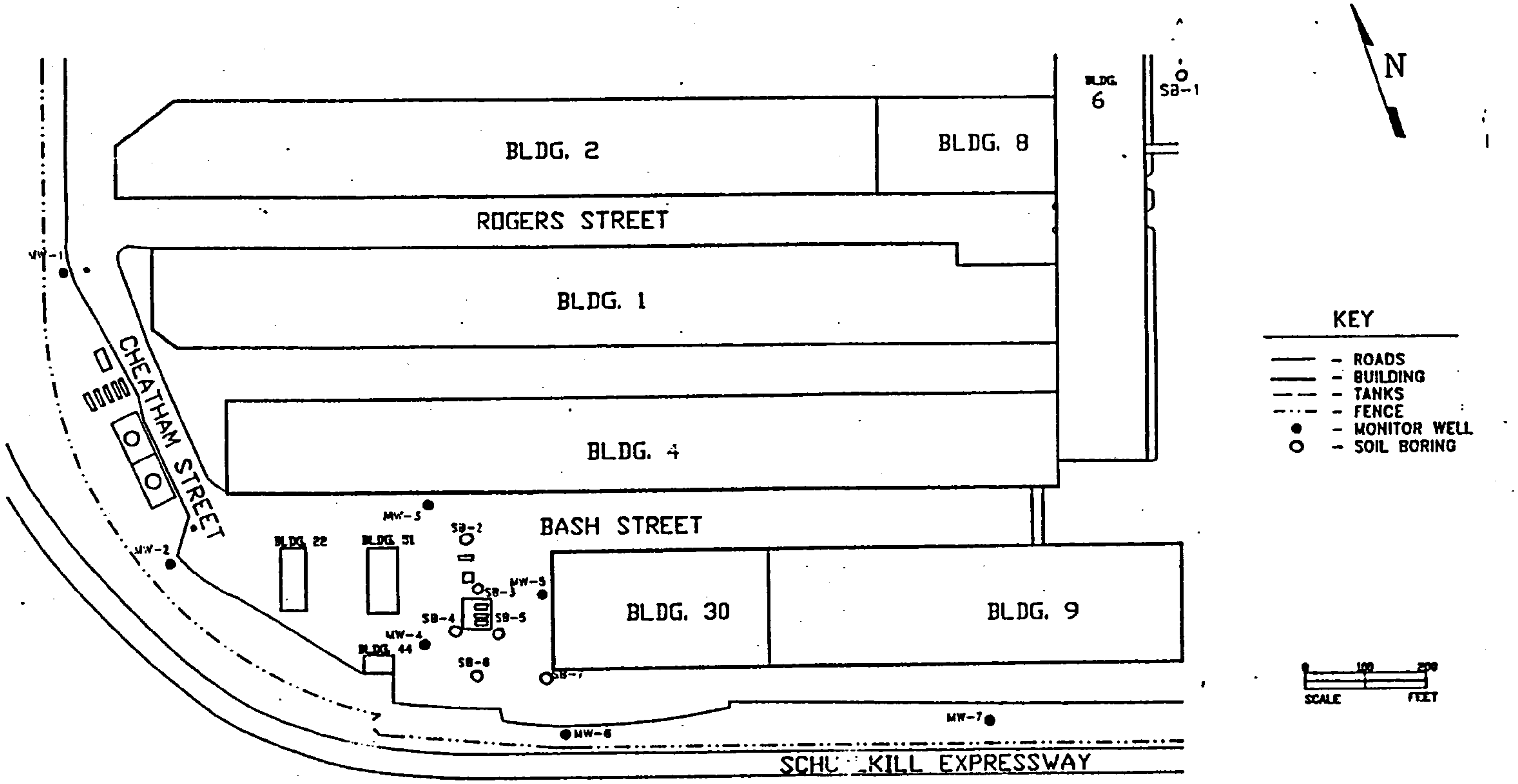


Figure 3-1

MONITOR WELL AND SOIL BORING LOCATIONS

SOURCE: DLA, 1989; ESE.

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE DIVISION

ENVIRONMENTAL SCIENCE
& ENGINEERING, INC.

Attachment 4

ES&E MONITORING WELL AND SOIL BORING LOCATION MAP (ADDENDUM TO APPENDIX F)

SUMMARY OF FIELD INVESTIGATION TASKS
DPSC, PHILADELPHIA, PENNSYLVANIA

TASK	CONTRACTOR	DATES PERFORMED
Ground Penetrating Radar Survey	Environmental Services of America, Inc.	September 1994
Active Soil Gas Survey	Kemron/Versar	September-October 1994
SCAPS/Hydropunch	Versar/U.S. Army Corps of Engineers	October-November 1994
DDT UST Contamination Investigation	Kemron	November-December 1994
Soil Boring and Sampling/Monitoring Well Installation	Huntingdon Empire Soils/Versar	November 1994-March 1995
Surveying of Sampling Locations	James M. Stewart Surveyors	January-March 1995
Water Table Elevation Measurements	Versar/GES	October 1994 December 1994 March 1995
Passive (PETREX) Soil Gas Survey	Northeast Research Institute	February 1995
Free Product/ Groundwater Sampling	Versar	March 1995
Aquifer (Slug) Testing	Versar	March 1995