DRAFT FINAL

PILOT TEST STUDY RESULTS REPORT DRY CLEANING FACILITIES AREA

Fort Riley, Kansas

Prepared for:
United States Army Engineering District
Kansas City
601 East 12th Street
Kansas City, Missouri 64106-2896

Prepared by:
Louis Berger & Associates, Inc.
100 Halsted Street
East Orange, New Jersey 07019

March 1996

DCF_2_4_001

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LIST OF ACRONYMS

AOC	Areas of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing Materials
BGS	Below Ground Surface
BLRA	Baseline Risk Assessment
C	Centigrade
CAS	Continental Analytical Service
CD	Construction Debris
CEMRD	U.S. Army Corps of Engineers—Missouri River Division
CEMRK	U.S. Army Corps of Engineers—Missouri River Division, Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DCA	Dichloroethane
DCF	Dry Cleaning Facilities
DCFA	Dry Cleaning Facilities Area
DCFA-FS	Dry Cleaning Facilities Area-Feasibility Study
DCFA-RI	Dry Cleaning Facilities Area-Remedial Investigation
DoD	Department of Defense
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
EPA	Environmental Protection Agency
F	Fahrenheit
FB	Field Blank
FFA	Federal Facilities Agreement
FID	Flame Ionization Detector
FS	Feasibility Study
GAC	Granular Activated Carbon
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
gm	Gram
gpm	Gallons per Minute
Hg	Mercury
Hp	Horsepower
Hz	Hertz
IAG	Interagency Agreement
ID	Inside Diameter

LIST OF ACRONYMS (CONTINUED)

IFI	Initial Field Investigation
IRP	Installation Restoration Program
k	Soil Permeability to Air Flow
KS	Kansas
KDHE	Kansas Department of Health and the Environment
lbs	Pounds
LBA	Louis Berger & Associates, Inc.
LPGAC	Liquid-Phase Granular-Activated Carbon
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram
mg/l	Milligrams per Liter
MH	Manhole
ml	Milliliter
MS	Mass Spectrometer
NA	Not Analyzed
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OD	Outside Diameter
OVM	Organic Vapor Meter
oz	Ounce
ΔP	Pressure Difference
PA/SI	Preliminary Assessment/Site Investigation
PCE	Tetrachloroethylene
PE	Professional Engineer
PG	Professional Geologist
PID	Photoionization Detector
ppb	Parts per Billion
psi	Pounds per Square Inch
psig	Pounds per Square Inch Gauge
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QCSR	Quality Control Summary Report
R	Radius of Influence
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS (CONTINUED)

RF	Response Factor
RI	Remedial Investigation
scfm	Standard Cubic Feet per Minute
SS	Sanitary Sewer
ST	Stormwater Sewer
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TIC	Tentatively Identified Compound
TCL	Target Compound List
TCE	Trichloroethylene
TDH	Total Dynamic Head
TM	Technical Memorandum
TOC	Total Organic Carbon
TPH-GRO	Total Petroleum Hydrocarbon-Gasoline Range Organics
TPM	Technical Project Manager
μg/kg	Micrograms per Kilogram
μg/l	Micrograms per Liter
μl	Microliters
USACE	U.S. Army Corps of Engineers
USCERL	U.S. Army Construction Engineers Laboratory
U.S. DOT	U.S. Department of Transportation
USE	Underground Service Entrance
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
VPGAC	Vapor-Phase Granular-Activated Carbon
WC	Water Column
WW	Wastewater Treatment Plant

SYMBOLS

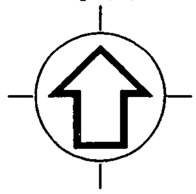
EXISTING FEATURES

SS	Sanitary Sewer Line
ST	Storm Sewer Line
CIP	Cast Iron Pipe
•	Manhole
	Catch Basin
1060	Topographic Contour
TRIBUTARY B	Stream
	Surface Water Flow Pathway
	Railroad Track
-x- -x-	Fence
	Curb With Gutter

SAMPLING DATA

.1	PCE CONCENTRATION CONTOUR
DCF94ES-2B	EXTRACTION WELL SYSTEM A-INDICATES SOIL VAPOR EXTRACTION WELL B-INDICATES GROUNDWATER EXTRACTION WELL
	POST EXTRACTION BORING
	BASELINE SOIL BORING
	GROUNDWATER MONITORING WELL
	AQUIFER TEST/REMEDIATION WELL
DCF94PV-1 ▲	PASSIVE WELL
(A)	BLDG. REFERENCE POINT
5	VACUUM MONITORING PROBE WITH DISTANCE FROM WELL IN FEET
	POTENTIOMETRIC SURFACE

NORTH

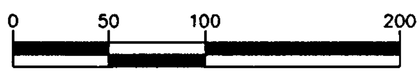


ABBREVIATIONS

PCE = TETRACHLOROETHYLENE

TCE = TRICHLOROETHYLENE

DCA = DICHLOROMETHANE



SCALE IN FEET
1" = 100'

1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 OVERVIEW

This *Draft Final Pilot Test Study Results Report* for the Dry Cleaning Facilities Area (DCFA) presents the activities conducted and the findings obtained during the performance of the Pilot Test Study Program at the DCFA located at the Fort Riley Military Reservation in Fort Riley, Kansas. The Pilot Test Study program was performed under contract DACA41-92-D-0001 with the U.S. Army Corps of Engineers—Missouri River Division, Kansas City District (CEMRK) in support of the Fort Riley, Directorate of Environment and Safety, Installation Restoration Program.

The Pilot Test Study Program at the DCFA was developed as a result of previous investigations which had shown that the soil and groundwater beneath the DCFA had been impacted by volatile organic compounds (VOCs). These investigations included a Preliminary Assessment/Site Investigation (PA/SI) conducted in February 1993 and a Remedial Investigation (RI) performed in 1993 through 1995. The chronology of events leading to and the performance of the Pilot Test Study, including specific dates relating to pilot test activities, is provided in Table 1-1.

As stated in the *Draft Final Work Plan, Pilot Test Study, Dual Phase Extraction System (Work Plan)* dated June 1994, the original objectives of the pilot test were to: 1) evaluate the effectiveness of the selected treatment technology at the DCF site; 2) obtain the information necessary to design a system for the overall site remediation with continued site treatment operations by establishing an efficient site-specific system design; and 3) evaluate the potential of this remedial technology as a "Removal Action." The pilot study program was modified from dual phase extraction operation to a single phase soil vapor extraction (SVE) operation. The groundwater extraction component of the pilot test was deleted from the program as discussed below in detail.

For the purpose of this report, the "DCFA," "Pilot Study Area," and "Site" are defined as follows:

- **DCFA:** Area of current and former laundry and dry cleaning operations and related facilities.
- **Pilot Study Area:** Northeast corner of Building 180/181.
- **Site:** For the purpose of this pilot study result report, "site" is the same as the DCFA.

1.2 PROJECT DESCRIPTION

The location of the DCFA is shown in Figure 1-1, and the pilot study area is shown in Figure 1-2.

The SVE pilot study program was initiated on November 21, 1994 and completed on April 6, 1995 at the DCFA. The pilot study consisted of two phases: an initial 30-day SVE test conducted during the period of November 21, 1994 through December 20, 1994, and an extended 60-day test conducted during the period of February 8, 1995 through April 6, 1995. The purpose of the pilot study was to evaluate the efficacy of SVE as a remedial technology for the cleanup of soils impacted by VOCs, particularly tetrachloroethylene (PCE), at the DCFA.

Work performed during the pilot study was conducted in accordance with the *Work Plan* dated June 1994, with two major exceptions: the deletion of the groundwater extraction portion as proposed in the *Work Plan*, and the addition of the extended 60-day SVE test. The groundwater extraction component of the pilot test was deleted from the program due to poor groundwater yield and subsequent lack of effective hydraulic influence which was determined from a pump test conducted from August 15, 1994 to August 22, 1994. A discussion on the DCFA groundwater and hydraulic characteristics, which nullify the efficacy of groundwater extraction as a groundwater treatment mechanism at the site, has been provided in Chapter 3.0 of the *Draft Final Remedial Investigation Report, Dry Cleaning Facility Area (DCFA-RI)*, dated March 1995.

1.3 SCOPE AND INTENT

The purpose of this report is to present the test procedures and results of the SVE pilot test study performed at the DCFA at the Fort Riley Military Reservation in Fort Riley Kansas.

Specifically, this report discusses in detail the following items:

- Pilot test operations and schedules, including sampling, analysis and pilot test modification;
- Pilot test system construction, equipment and materials;
- Pilot test study results; and
- Evaluations and interpretations of the pilot study results.

The performance of the SVE pilot system and effectiveness of the selected SVE technology have been evaluated based on the test results obtained. The site history, geology, and the nature and extent of the site contamination have been presented in the *DCFA-RI* Report, and as such are only briefly summarized in this report. Details on the selection of the SVE technology, system design and system layout have been presented in the *Work Plan,* and are only briefly summarized herein.

TABLE 1-1

CHRONOLOGY OF EVENTS ASSOCIATED WITH THE PILOT TEST STUDY PROGRAM AT THE DCFA

Date	Activity	Reports/ References
1914- 1988	Historical events and site activities during this period are provided in the *DCFA-RI* Report.	DCFA-RI Report (CEMRK 1995a)
August 1990	Fort Riley placed on the National Priorities List.	Federal Register Aug 30, 1990
June 1991	Federal Facilities Agreement (FFA) effective; requires site investigation of former dry cleaners.	IAG, U.S. EPA (1991)
1991-1992	PA/SI Planning Draft Planning Documents, Sep '91 Draft Final Planning Documents, Dec '91 Revisions to Planning Documents, Jan '92 Draft Modified Planning Documents, May '92 Draft Final Modified Planning Documents, Sep '92	
1991-1992	PA/SI Fieldwork Soil Gas Survey, Oct 29-Nov 2, '91 Soils Borings, Mar-Apr '92 Monitoring Well Installation, Apr '92 Monitoring Well Development, May-Jun '92 Groundwater Sampling, Jul '92 Exploratory Monitoring Well DCF92-07 installed (dry), Aug '92	
September 1992	Working Draft PA/SI is submitted. A decision was made to have the U.S. EPA and KDHE review this document instead of extending the schedule for submission of a Draft. A meeting was held on Oct 16, '92, during which the project managers for the parties to the IAG decided that the Working Draft would be approved as Final with comments attached.	
1992-1993	Periodic groundwater sampling of six monitoring wells installed during the PA/SI. Includes Nov '92, Feb '93, May '93 and Nov '93.	QCSRs (CEMRK 1992a; 1993a,b,d)
February-April 1993	RI/FS Initial Field Investigations (IFI), Feb - Mar '93 Soil Gas Survey Sewer/Surface Water/Sediment Sampling Supplemental IFI Activities, Mar - Apr '93 Sewer Survey and Tracing Dry Cleaning Operations Sampling	Results reported in Draft Final RI/FS Work Plan, July 1993 (CEMRK, 1993c)

TABLE 1-1 (CONTINUED)

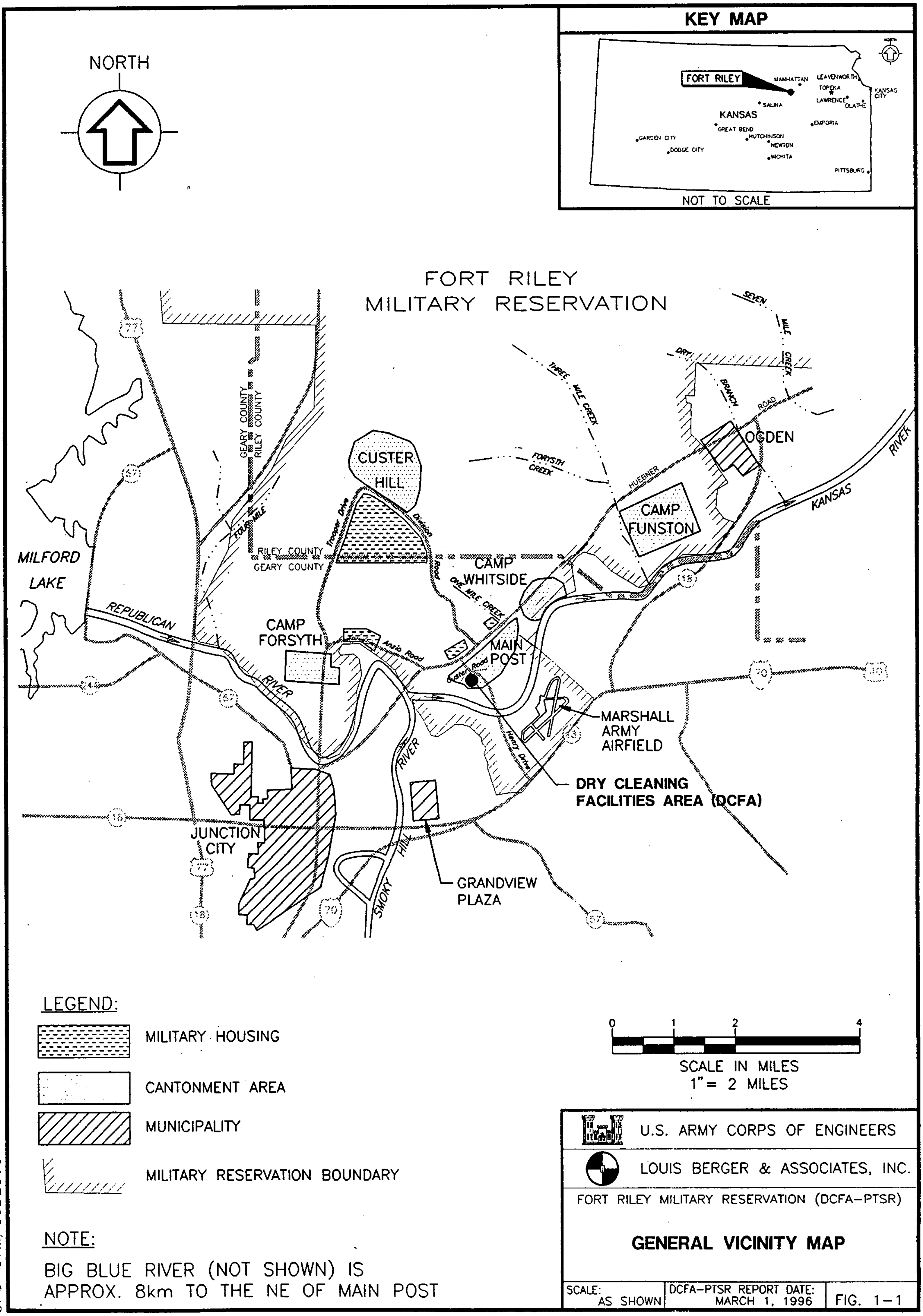
CHRONOLOGY OF EVENTS ASSOCIATED WITH THE PILOT TEST STUDY PROGRAM AT THE DCFA

Date	Activity	Reports/ References
July 1993	Draft Final RI/FS Work Plan Submitted.	(CEMRK, 1993c)
October 1993	Revised Draft Final RI Sampling and Analysis Plan. (Result of change in Contractor performing work.)	(CEMRK, 1993g)
November - December 1993	RI fieldwork. Soil Borings, Surface Soil, Surface Water & Sediment Sampling	
December 1993	"Baseline" RI groundwater sampling including new RI monitoring wells.	QCSR (CEMRK, 1994a)
February 1994	Periodic groundwater sampling (PA/SI & RI wells, 1st round after "Baseline")	QCSR (CEMRK, 1994b)
May 1994	Sewer line repair. A portion of sanitary sewer line was replaced between manholes 365 and 363 (portion of line serving 183 above 180/182) due to suspected leakage of the aged line.	
May 1994	Soil sampling in conjunction with SVE Pilot Study.	
April 1994 May 1994	USTs located. (Interview information about tanks unclear if removed or not. An electromagnetic survey performed by U.S. Army Construction Engineers Laboratory [USCERL] revealed the presence of the tanks. Previous methods had been unsuccessful.) UST contents sampled.	
July 1994	UST removal (two removed, one abandoned in place) due to depth and proximity to building foundation and utilities.	
May 1994	Soil Vapor and Groundwater Extraction Pilot Studies initiated near Building 180/181.	CEMRK (1994c)
June 1994	Installation of soil vapor and groundwater extraction wells. (Subsequent pumping tests performed on the groundwater wells proved extraction to be impractical due to extremely low yield rates; therefore, groundwater extraction pilot test terminated.)	QCSR (CEMRK, 1994d)

TABLE 1-1 (CONTINUED)

CHRONOLOGY OF EVENTS ASSOCIATED WITH THE PILOT TEST STUDY PROGRAM AT THE DCFA

Date	Activity	Reports/ References
June 1994	Periodic groundwater sampling (PA/SI and RI wells—2nd round).	QCSR (CEMRK, 1994e)
June - July 1994	Supplemental Sewer (flow) Investigations.	
August 1994	Monitoring Well DCF94-22 installed (driven well point) as a replacement for DCF94-11, which had gone dry).	
August 1994	Periodic groundwater sampling (PA/SI & RI wells—3rd round).	QCSR (CEMRK, 1994f)
October 1994	UST area soil borings performed.	
November 1994	Draft RI Report.	
November - December 1994	Soil Vapor Extraction Pilot Test—initial 30-day test performed. Individual Vapor Extraction Test on Well 1A Individual Vapor Extraction Test on Well 2A Individual Vapor Extraction Test on Well 3A Individual Vapor Extraction Test on Well DCF94-21 Combined Vapor Extraction Includes All Wells	
January 1995	Periodic groundwater sampling (PA/SI & RI wells—4th round). Partial Demobilization of Pilot Study Equipment (Removal of GC Van, Probes, Well Pumps).	CEMRK (1995b)
January 1995	Additional surface water and sediment sampling.	CEMRK (1995c)
Feb - Apr, 1995	Soil Vapor Extraction Pilot Test—extended 60-day test performed.	
March 1995	Draft Final RI Report completed.	DCFA-RI Report (CEMRK, 1995a)
April 1995	Soil Vapor Extraction Pilot Test—Demobilization performed. Post Extraction Soil Boring for Pilot Study Completed.	CEMRK (1995d)



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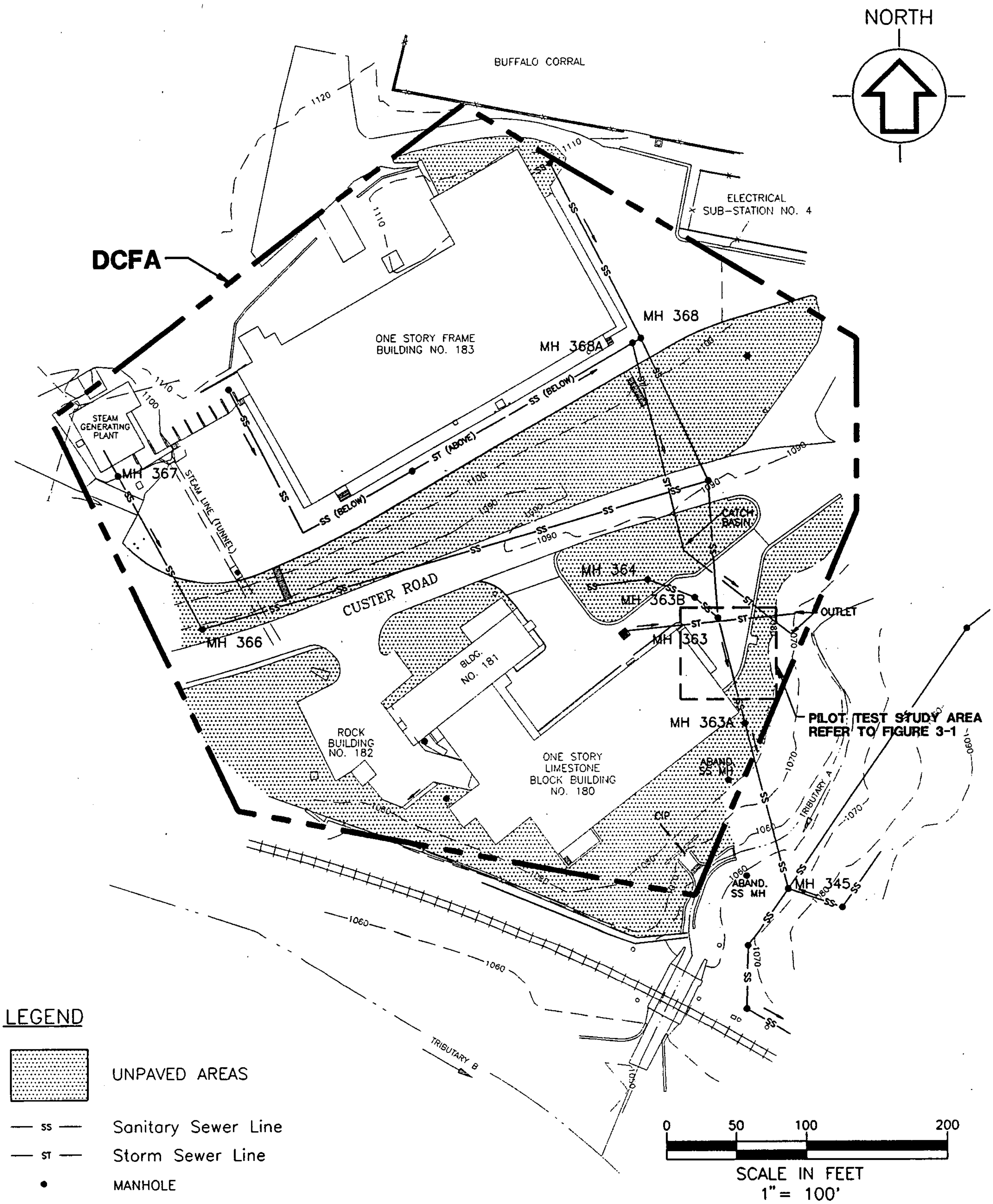
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

GENERAL VICINITY MAP

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 1-1



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FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

SITE MAP

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 1-2

NOTE

1. SEE LIST OF SYMBOLS AND ABBREVIATIONS.

CPS-SM/06DEC95

2.0 BACKGROUND

2.0 BACKGROUND

2.1 SITE HISTORY

As indicated in the *Work Plan* and in the *DCFA-RI*, the facilities within the DCFA have been used for the dry cleaning of uniforms since the 1930s. Dry cleaning operations at the site have incorporated the use of two solvents: Stoddard Solvent, a naphtha-based solvent used prior to 1966; and PCE, a VOC used in the dry cleaning process since 1966. Table 1-1 provides a chronology of events associated with DCFA operational history and environmental activities. A detailed description of the site history and dry cleaning facilities operations, as well as other site activities such as previous investigations, have been provided in sections 1.2.2 and 1.2.3 of the *DCFA-RI* Report.

2.2 SITE GEOLOGY

The subsurface conditions in the pilot test area consist of a relatively thin mantle of overburden consisting of either fill or residual soils. The residual soils consist of clays and silts interbedded with thin layers of clayey sand and sand. These soils vary in thickness from 30 to 40 feet throughout the site and are underlain by weathered rock extending into relatively more competent rock units. Figure 2-1 presents a geologic cross-section of the site.

During the installation of the extraction wells at the DCFA in May 1994, undisturbed and split spoon soil samples were collected for geotechnical testing. The results of these analyses indicate that the subsurface soils at the DCFA consist mainly of sandy silts and clays in the intervals tested based on geotechnical analysis (DCFA-RI, March 1995). A continuous clay layer, two to four feet thick, appears to extend across the site and occurs at a depth of approximately 18 feet below ground surface (BGS). Porosity of the soils range from approximately 40 to 50 percent, and water content ranges from 20 to 30 percent.

The underlying bedrock units consist primarily of limestone and shale. The bedrock formations identified within the site include the Bader, Easly Creek, Crouse, Blue Rapids and Funston formations. The Crouse Formation comprises an upper and lower limestone separated by a few feet of shale. An erosional feature occurs in the Crouse Formation as evidenced by the increased overburden thickness under and to the south of Building 180/181. This erosional trough feature controls the overburden groundwater flow in this area.

The groundwater table generally occurs within the bedrock in the northern portion of the site and in the unconsolidated soils in the southern portion of the site due to the presence of the erosional trough feature. Limited well development data indicate that the Crouse formation has limited "water-bearing" characteristics with limited hydraulic connectivity in isolated areas. Groundwater in the northern portion of the site occurs within the bedrock from 35 to 40 feet below grade. Flow direction is predominantly toward the southwest based on groundwater elevation measurements recorded between July 1992 and February 1993. The seasonal fluctuation of the groundwater at the site, based on 1992 field data, is approximately five feet.

2.3 NATURE AND EXTENT OF CONTAMINATION

The nature of contaminants encountered within the DCFA consists primarily of VOCs, as indicated in the *DCFA-RI* Report. The most frequently detected VOCs during the PA/SI and RI activities were tetrachloroethylene (PCE) and its breakdown products, trichloroethylene (TCE) and dichloroethane (DCA).

PCE is the primary site-related contaminant of concern. PCE has apparently entered the environment through leaking storm and sanitary sewers, and possibly through accidental spills and discharges directly to the ground on the west side of Building 180/181. Sampling and analysis of soils and groundwater indicate that these media have the highest concentrations centered primarily in two areas: the northeast corner of Building 180/181, and immediately west of Building 180/181. The concentrations adjacent to the northeast corner of Building 180/181 may be attributable to the leaking sewer, while the concentrations to the west of Building 180/181 may be a result of spills and discharges that reportedly occurred at that location.

Contaminant concentrations in soil at the northeast side of the building from various sampling events (refer to the DCFA-RI Report, March 1995) show that PCE concentrations ranged from 960 μg/kg to non-detection. Analyses of soil samples taken from the west side of the building generally indicate non-detectable PCE concentrations in soil at a depth less than 10 feet. No contamination was detected in any surface soil samples collected in this area. Groundwater PCE concentrations ranged from 1,600 μg/l to 32 μg/l and from 9.3 μg/l to non-detection for samples collected from the northeast corner and the west side of Building 180/181, respectively.

2.4 DESCRIPTION OF THE SVE TREATMENT TECHNOLOGY

The pilot test system originally selected in the *Work Plan* for remediative study at the DCFA site was a dual-phase extraction system, which was designed to recover both contaminated groundwater and soil vapor. The groundwater extraction component of the pilot test was deleted from the pilot study program based on the results of a pump test conducted from August 15, 1994 to August 22, 1994, as discussed briefly in Section 1.1 and in detail in Section 3.2.1 of this report.

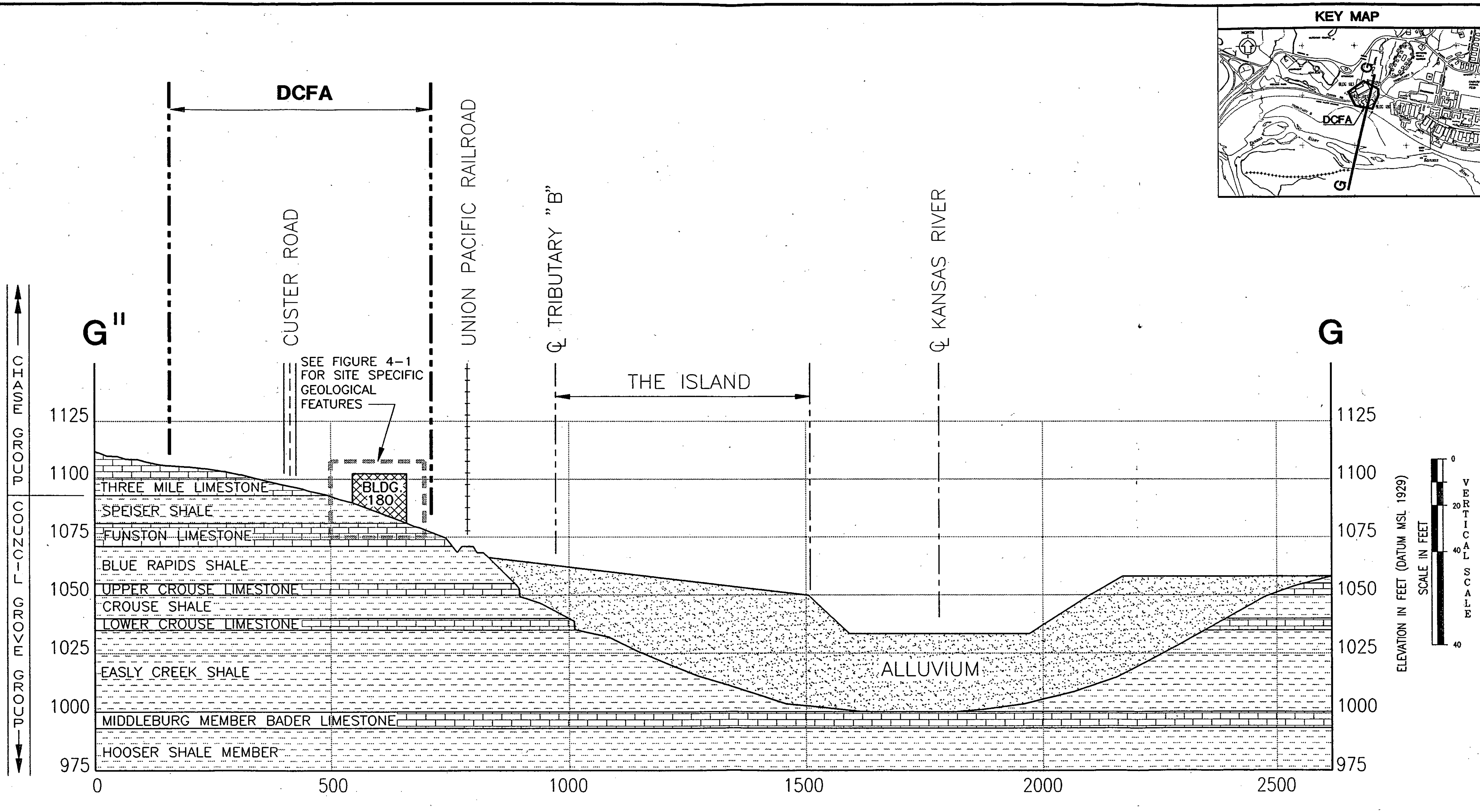
As a result of the deletion of the groundwater extraction component, the pilot study system essentially became a single-phase extraction system (i.e., an SVE system) as optioned in Section 4.4.1 of the *Work Plan*. SVE technology has been demonstrated to be successful at numerous sites as discussed in the *Work Plan*. Furthermore, the U.S. EPA has designated vacuum extraction as a presumptive remedy for remediating the vadose zone at sites contaminated with VOCs such as PCE. This is discussed in depth in the U.S. EPA document *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils* (U.S. EPA, 1993).

In the SVE system, soil vapor is extracted from an extraction well, or a cluster of extraction wells, as planned and implemented in this pilot study. The extracted soil vapor is then treated on site, as required in most cases, prior to ultimate discharge to ambient air. A vacuum pump, mounted at grade, is used to draw air through the extraction well from the adjacent VOC-impacted soils, thereby volatilizing the target contaminants in the process. The extraction well or wells are screened at a specified depth interval to cover the highest soil contamination zone so that VOC recovery efficiency of the SVE system can be optimized. The volatilized contaminants are transferred to the surface via piping for treatment by thermal oxidation or, as in this pilot study, by granular-activated carbon (GAC) adsorption prior to discharge to atmosphere.

SVE technology was selected for testing at the DCFA site for the following reasons:

- The primary contaminant (PCE) at the site is highly volatile based on a Henry's Law constant of 1,035 atmospheres and a vapor pressure of 14 mm of mercury (Hg) at 20°C; and

- Geotechnical testing indicated that the soil characteristics and soil permeability to air flow at the DCFA site were generally similar to those at other sites where SVE has been successfully used for soil remediation.



0 100 200 400

SCALE IN FEET
1" = 200'

NOTES:

1. GEOLOGY AFTER ZELLER, 1989.
2. LOCATION OF SECTION LINE SHOWN IN KEY MAP OF THIS FIGURE.
3. SEE LIST OF SYMBOLS AND ABBREVIATIONS.

CPS-XS/06DEC95

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FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

DCFA AND VICINITY GEOLOGIC CROSS SECTION

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 2-1

3.0 PILOT TEST OPERATIONS AND PROCEDURES

3.0 PILOT TEST OPERATIONS AND PROCEDURES

3.1 OVERVIEW

As previously indicated, the pilot test study at the DCFA consisted of two phases: an initial 30-day SVE test conducted during the period of November 21, 1994 through December 20, 1994, and an extended 60-day test conducted during the period of February 8, 1995 through April 6, 1995. The 30-day initial test included four individual SVE well tests and a combined well test employing all four wells. The extended 60-day test was a combined well test. Table 3-1 summarizes the pilot test operations schedule.

In general, all work performed during the pilot study was conducted in accordance with the *Work Plan*, with the following two exceptions: the deletion of the groundwater extraction portion as proposed in the *Work Plan* and the addition of the extended 60-day SVE test at the site. These modifications and their rationale are described below (Section 3.2). Other modifications such as the flow and vacuum levels applied to the SVE wells and duration during this pilot study which resulted from the actual subsurface soil permeability to air flow conditions are discussed in Section 5.0.

3.2 PILOT TEST MODIFICATIONS

3.2.1 Deletion of Groundwater Extraction Component

The groundwater extraction component of the pilot test system had consisted of wells DCF94ES-1B, -2B and -3B installed adjacent to the SVE well DCF94ES-1A, -2A and -3A, and the deep screened section of DCF94-21. These well locations are shown in Figure 3-1 which provides an "as-built" plan of the pilot test system.

The deletion of the groundwater extraction component was based on the results from three sustained yield pumping tests and one aquifer pump test. These tests were conducted over the period of August 15, 1994 through August 22, 1994. Details of the test procedures and results have been presented in *Technical Memorandum for Sustained Yield and Aquifer Pump Test* (August 23, 1994). This memorandum is provided in Appendix A of this report. In summary, results from the three sustained yield tests indicated that the sustainable yields were approximately 0.23 gallons per minute (gpm) for extraction well DCF94ES-1B, 0.16 gpm for DCF94ES-2B, and 0.34 gpm for DCF94ES-3B. A total of 0.72 gpm was sustained during the four-day aquifer pumping test which combined all three extraction wells. The recovery of only 0.72 gpm of groundwater and the resulting negligible influence on groundwater elevations in the pilot study area prompted the deletion of the groundwater extraction component from the pilot test study.

As a result of the pump test findings, the dual extraction pilot test study, as proposed in the *Work Plan*, was modified to a single-phase (i.e., SVE) pilot study, as discussed above.

3.2.2 Extended 60-Day SVE Test

The extended 60-day SVE test was performed to evaluate the longer-term impact of SVE operations at the site. Since the operational system was already on site, it was regarded as economically and environmentally prudent to continue SVE operations beyond its proposed 30-day operations to obtain more definitive data and to gain further, readily achieved reduction of the VOC levels in the vadose zone (refer to the Army's facsimile to U.S. EPA Region VII, dated February 6, 1995).

3.3 INITIAL 30-DAY PILOT TEST

3.3.1 Introduction

On November 21, 1994, a 30-day pilot test study program was initiated to evaluate the effectiveness of SVE treatment of soils at the DCFA. Details on the layout, procedures and protocol of the pilot test were presented in the *Work Plan*.

The pilot test study program involved the construction and operation of a SVE system consisting of four SVE wells for contaminant removal, a passive vent well to improve air movement and the effectiveness of SVE, a 250-gallon vapor/water separator for gas/liquid-phase separation, an equalization tank, connecting piping with necessary gauges, valves and controls, and a 30-horsepower (Hp) SVE unit as the vacuum source. The passive vent well was designated DCF94PV-1 and the four extraction wells were designated as DCF94ES-1A, 2A and 3A (referred to hereafter as SVE-1A, 2A and 3A, respectively), and DCF94-21. Figure 3-1 presents the layout and configuration of the constructed pilot test system. Figure 3-2 presents a detailed "as-built" pilot test system schematic.

The test, as proposed in the *Work Plan*, consisted of four individual tests at each SVE well (five days each) followed by a combined 12-day test engaging all four wells simultaneously. However, the actual duration of each test, as listed in Table 3-1, varied, based on the time required to achieve asymptotic conditions so that the optimum operating conditions (e.g., flow rate) could be determined. Optimum operating conditions were considered to represent the best case flow rate and corresponding vacuum level necessary to achieve maximum sustainable contaminant loadings.

The SVE wells were constructed as four-inch-diameter Polyvinyl Chloride (PVC) casings having 10 feet of PVC slotted screen set within the depth of soil indicating the highest concentration of VOCs. Prior to test startup, baseline soil sampling and analyses were conducted in May and October 1994 to establish initial soil contaminant isopleths and to confirm ideal well screen placement for the test. Results of the baseline sample analyses are presented in Table 5-2. Results of previous soil borings for the pilot test study are presented in Table 5-3. A presentation of the contaminants detected in the pilot test study borings is provided in Figure 5-1.

3.3.2 Test Procedure

Following the determination to abandon the groundwater extraction element of the pilot study, wells SVE 1A, 2A, 3A and DCF94-21 were tested, in sequence, under best sustained flow rates for contaminant removal. Each well was tested through the five-day period or until asymptotic levels of mass loading rates were achieved. Following the individual well tests, the combined extraction well test was conducted. During the combined test, the passive well, which was located at the center of the extraction well cluster, was activated for the first three days and then inactivated at the rest of the combined test. The intended utilization of this well and the duration of each test is discussed in Section 4.3 in the *Work Plan*. The purpose of testing this well is to evaluate its effects, if any, on air flow pathway.

The determination of asymptotic levels was accomplished through plotting the contaminant loadings (i.e., the VOC removal rates) against time for extracted soil vapor at each well head under given flows. The point at which the drawn curve became nearly constant, with respect to the x-axis (time) of the plot, marked the sought asymptotic extracted VOC loading rate. This point signaled completion of one well test and preparation for the next.

Throughout each test, extracted soil vapor samples were collected at various port locations in the system to evaluate VOC loading rates, vapor-phase carbon consumption, and discharge to atmosphere (system effluent quality). Details on the pilot system sampling are presented in Section 3.3.4. A discussion and presentation of the extracted vapor loading results are provided in Section 5.3.1.

At SVE 1A, the extracted flow rate was initiated on November 21, 1994 at 14:30, at 65 standard cubic feet per minute (scfm), and stepped systematically toward optimum recovery at 90 scfm. At optimum flow, the well was continuously operated for a period of 24 hours, at which time it was determined that the product of the VOC concentration in the extracted vapor and flow was relatively unchanged; hence, an asymptotic mass loading level was achieved. Test completion at SVE 1A occurred on November 25, 1994 at 11:07.

At SVE 2A, the extracted flow rate was initiated on November 25, 1994 at 11:07 at 54 scfm. Within hours of startup, however, the flow rate dropped, apparently due to the surrounding soil formation restricting air flow, thus increasing soil vacuum pressure. To reduce the vacuum pressure through the GAC units and relieve localized groundwater surging at the well, the flow rates were, in this case, systematically reduced to achieve a secure flow rate for sustained system operation. This was accomplished on November 27, 1994 at 12:30, at which time SVE 2A sustained an optimum flow rate of 28 scfm. Testing at this flow rate was continued for 45 hours until asymptotic loading levels were attained at 09:37 on November 29, 1994. The test was completed at 10:10 on November 29, 1994.

Wells SVE-3A and DCF94-21 were tested similarly to SVE 1A insofar as stepping up the initial flow rate toward an optimum rate. SVE 3A was engaged at an initial flow rate of 39 scfm and raised to a sustained flow rate of 77 scfm, whereas DCF94-21 was initiated at 40 scfm and raised to 100 scfm for operation toward asymptotic conditions. The SVE 3A test was started on November 29, 1994 at 10:10 and completed on December 2, 1994 at 13:15. Well DCF94-21 was subsequently engaged at 15:00 on December 2 and completed on December 6 at 17:00.

Following the individual tests, the combined SVE test was performed at a sustained flow rate under asymptotic conditions of 160 scfm. The combined test was operated from 10:00 on December 8 to 9:25 on December 20, totaling 12 days of operation.

3.3.3 Vacuum Pressure Monitoring

During each of the individual well tests and the combined well test, vacuum readings were obtained at the vacuum probes installed radially outward from each SVE well to evaluate subsurface vacuum levels. The as-built construction of the probes is discussed in Chapter 4.0. Figure 3-1 shows the location of the probe arrays.

Vacuum readings were collected via both magnehelic gauges and manometers for purposes of correlation. In general, the manometers were used to confirm the low vacuum pressures detected by the magnehelic gauges at the outermost probes. All readings collected were expressed in terms of gauge pressure for simplicity. Barometric monitoring of atmospheric pressure indicated an average pressure at the site of 14.2 pounds per square inch (psi). This data was used to compute flow rate from the ΔP readings obtained between the internal well head and piping pressure.

Throughout each test, vacuum readings were recorded every 10 minutes within the first hour of initiating flow and then at half-hour intervals until vacuum pressure stabilized under the sustained flow rate. Readings were then collected hourly until the flow rate was stepped up, in which case the collection frequency was repeated until the final optimum flow rate was established. The probes were capped when not used to prevent surface air infiltration (short circuiting).

It was originally intended, as indicated in the *Work Plan*, to use the vacuum monitoring data as a field permeability test to determine both the soil permeability to air flow and the effective radius of influence attainable from SVE at a given well. However, due to influences from the subsurface utilities and subsurface soil conditions as signified by data (discussed in detail in Section 5 and presented in Figures 5-7 through 5-10) obtained in the field, this could not be accomplished. Rather, to depict the influence on subsurface soils during the tests, vacuum distribution contours were constructed for each of the individual well tests and the combined SVE operation. A discussion on the results and the significance of the vacuum distribution contours is presented in Section 5.3.2.

3.3.4 Soil Vapor Sampling

During the SVE testing, the extracted soil vapor was sampled and analyzed for VOCs by an on-site gas chromatograph (GC). The instrument used was a Shimadzu GC-9A, which was housed in a temperature-controlled mobile van. A detailed description of the methodology of the portable GC analysis and justification for using on-site GC analysis has been documented in *Technical Memorandum for Sampling Activity and GC Methodology*, dated August 23, 1994, and is presented in Appendix B. Table 3-2 provides a list of the target VOCs selected for analysis by the instrument and the associated quality control (QC) quantitations.

For each of the four individual well tests, soil vapor samples were collected from four sample ports: the well head port, the total port (located at the influent side of the vapor/water separator), the primary (located after the first GAC unit), and the secondary (effluent) located on the exhaust stack as shown in Figure 3-2. Each sample port was constructed as an airtight tube installed for syringe extraction. Air samples were collected using a syringe by first filling the syringe and then purging the contained vapor back into the system pipe. This fill-and-purge procedure was typically conducted several times, after which a representative sample was collected for analysis.

The frequency of the sampling was approximately every hour during the individual well tests and three times a day during the combined test, with a decreased frequency of once a day toward the last four days of the test.

To determine mass loading rates, the air flow rates (scfm) were calculated by taking several field measurements concurrent with sample collection. First, vacuum was recorded in inches water using a water manometer, or inches mercury using a magnehelic gauge at the four sample ports described above. Then the pressure differential in the pipe was measured by connecting a manometer across the pitot tube. This measurement was ΔP. Lastly, temperature was recorded in degrees Fahrenheit, using a stainless steel dial thermometer inserted into the gauge port. Air flow for a four-inch-diameter pipe was computed from the vacuum, ΔP and temperature data at each port and converted to scfm by the following equation:

$$Q=K\cdot N\cdot D^{2}\cdot\sqrt{\frac{A_P}{A_T}}\cdot\sqrt{\Delta P}$$

K	=	Flow Coefficient (dimensionless).
N	=	Correction factor depends on units of measurement using scfm and (ΔP) inches of water. **N=128.52.**
D	=	Exact inside diameter of pipe in inches.
A_P	=	Absolute pressure (psia); Atmospheric pressure must be added to the gauge pressure.
A_T	=	Absolute temperature; Add 460 to degrees Fahrenheit to equal degrees Rankine.
ΔP	=	Pressure differential of flow sensor in inches of water.
Q	=	Volume flow rate in scfm.

Mass loading was calculated by multiplying the air flow by the VOC concentration at each respective location.

3.3.5 Soil Vapor Generation and Control

The soil vapor generated during the initial 30-day pilot study was treated through an off-gas treatment system. As depicted in Figure 3-1, the extracted soil vapor was first passed through a vapor/water separator, which was designed to separate water (in moisture and aerosol form) from the vapor. Although Liquid-Phase Granular-Activated Carbon (LPGAC) units were provided and remained on line in the treatment system, no water condensate was collected during the initial 30-day pilot study. The soil vapor discharged through the vapor/water separator was then drawn under vacuum into the Vapor-Phase Granular-Activated Carbon (VPGAC) units, where VOCs were treated through adsorption to the GAC surfaces. The treated soil vapor, referred to as off-gas emissions or effluent, was then discharged to atmosphere. As mentioned above, VOCs in the soil vapor were monitored at four different points (i.e., sampling ports) along the off-gas treatment system.

Based on the maximum effluent loading rate computed at 0.06 pound per day (lb/day), the pilot test system effluent was determined to be well below the Kansas Department of Health and the Environment (KDHE) regulatory discharge criteria of 2.3 pounds per hour (lbs/hr) for VOCs based on the 10-ton-per-year limit specified in the Kansas Air Quality Regulations (Section 28, Title 19).

In addition to the effluent monitoring, the pilot test area was field-screened with a photoionization detector (PID) for health and safety purposes. It should be noted that the vacuum blower was placed on the discharge side of the granular-activated carbon (GAC) units. Thus, the entire system was under vacuum, further minimizing a potential release of VOCs through system valves or piping. A description of the equipment design and placement is provided in Section 4.2.

3.4 EXTENDED 60-DAY PILOT TEST

The 60-day extended SVE pilot test study began on February 8, 1995 and ended on April 6, 1995. The test engaged all four SVE wells at the same time. All work was performed in the same manner as in the initial 30-day test, with the exception that the frequency of extracted vapor sampling was reduced and that the on-site GC analysis was discontinued. Also, based on the low loading rate results from the initial 30-day pilot study, which indicated an averaged loading rate of 0.78 lb/day, it was determined that the extracted soil vapor could be sampled and analyzed on a weekly basis during the extended pilot study.

Two vapor samples per week (one archived, one analyzed) were collected from the SVE system, and sent to Continental Analytical Service (CAS) (instead of using on-site GC) for VOC analysis, using EPA 8010 and 8020. Total petroleum hydrocarbon-gasoline range organics (TPH-GRO) was analyzed during the first two weeks but was determined to be below detection limits in the samples collected. Therefore, TPH-GRO analysis was discontinued in the subsequent sampling events. The on-site GC unit was removed from the site during the extended pilot study. Detailed discussions on sampling frequency and analysis was documented in the *Draft Technical Memorandum-DCF Extended Vapor Extraction System Pilot Study*, dated February 8, 1995 (Appendix C).

TABLE 3-1

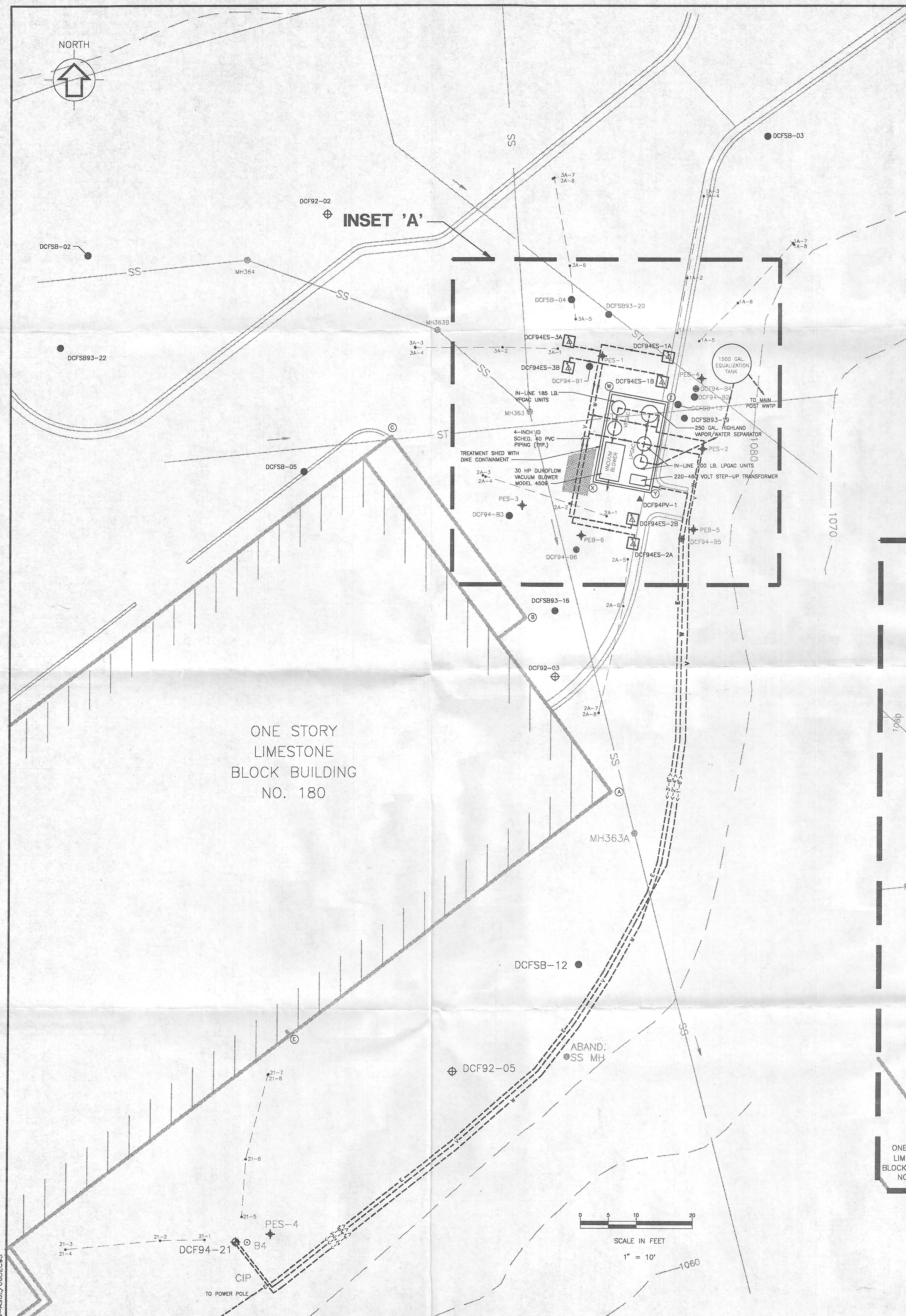
SVE PILOT TEST OPERATION SCHEDULE

	Operation Dates	SVE Well Tested	Operation Durations
Initial 30-Day Pilot Test	November 21 to November 25, 1994	SVE-1A	92 hr 38 min
	November 25 to November 29, 1994	SVE-2A	95 hr 3 min
	November 29 to December 2, 1994	SVE-3A	75 hr 8 min
	December 2 to December 6, 1994	DCF94-21	97 hr 55 min
	December 8 to December 20, 1994	All Wells Combined	12 days
Extended 60-Day Pilot Test	February 8 to April 6, 1995	All Wells Combined	2 months

TABLE 3-2

FIELD GC QUANTIFICATION LIMITS

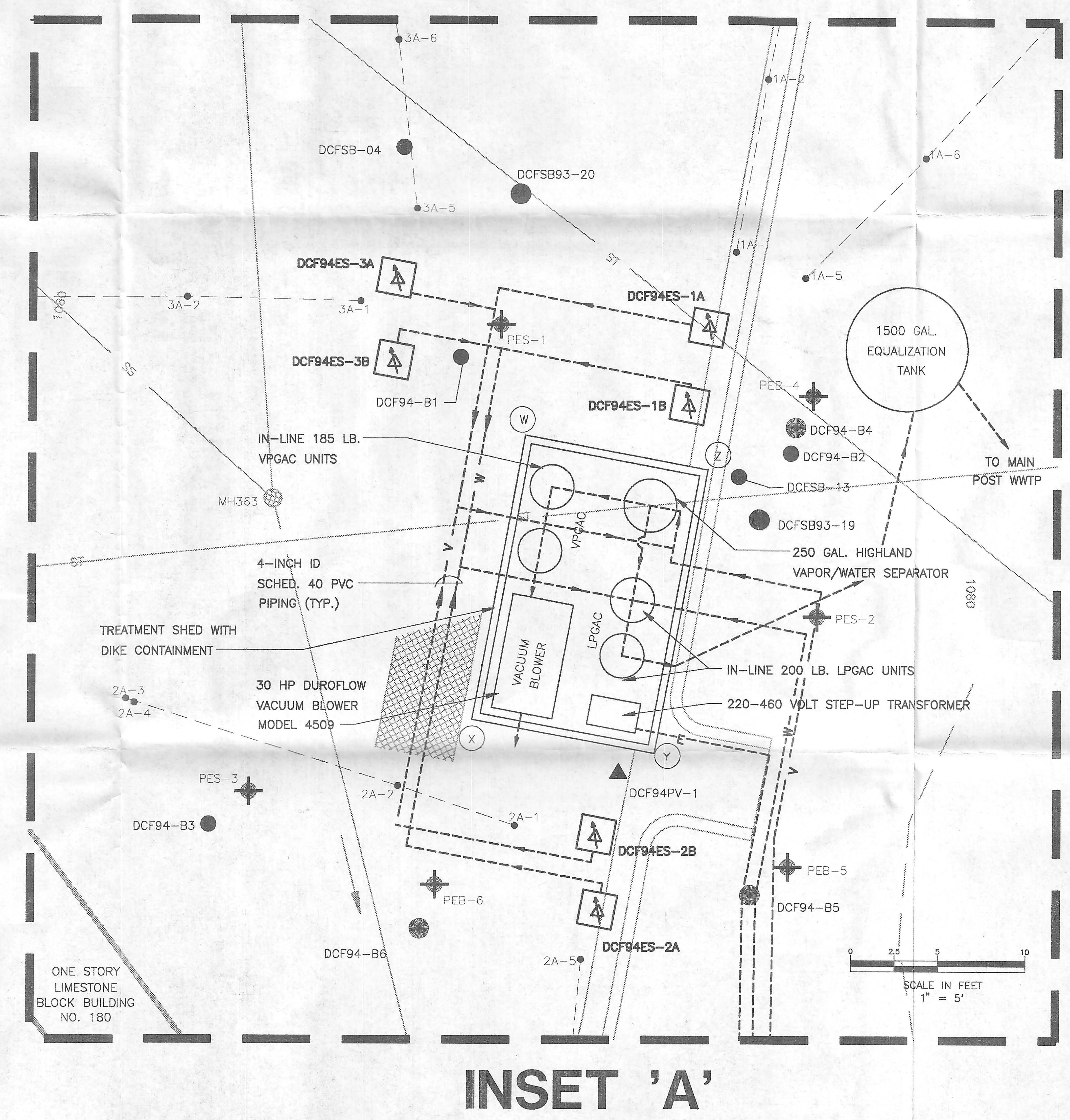
Compound	Soil Headspace Detection Limit (μg/l)
Dichloromethane	0.83
Trans-1,2-Dichloroethylene	0.43
Cis-1,2-Dichloroethylene	0.45
1,1,1-Trichloroethane	0.68
Trichloromethane	1.04
Benzene	0.12
Trichloroethylene	0.57
Toluene	0.13
Tetrachloroethylene	0.77



POINT	NORTHING	EASTING
A (SE Corner of Bldg.)	N 267852.659	E 2343382.173
B (SE Edge of Porch)	N 267883.549	E 2343366.673
C (NE Corner of Bldg.)	N 267913.265	E 2343343.945
DCF94ES-1A	N 267929.649	E 2343392.085
DCF94ES-1B	N 267925.159	E 2343390.932
DCF94ES-2A	N 267896.595	E 2343385.846
DCF94ES-2B	N 267900.853	E 2343385.667
DCF94ES-3A	N 267932.324	E 2343374.339
DCF94ES-3B	N 267927.658	E 2343374.159
DCF94-21	N 267772.869	E 2343315.373

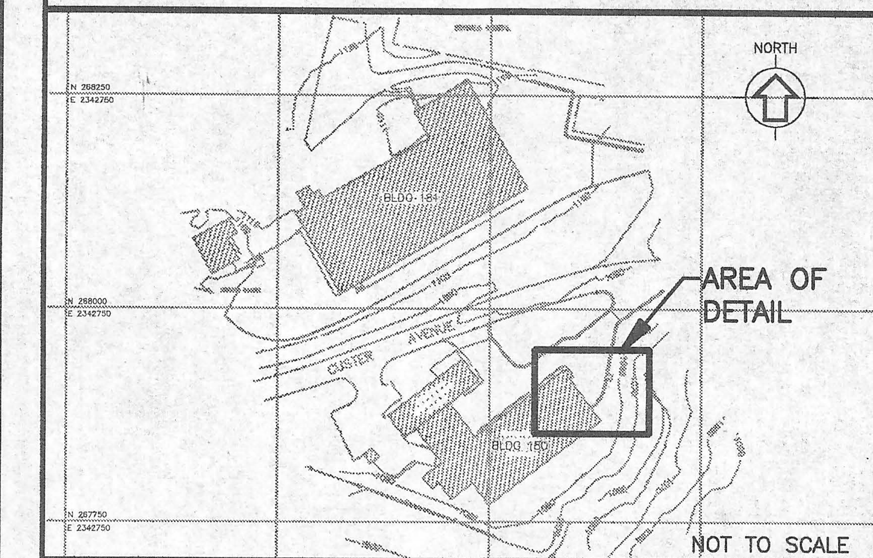
POINT	CORNER				
	A (ft.)	B (ft.)	C (ft.)	D (ft.)	E (ft.)
SVE WELL 1A	72.4	–	–	–	–
SVE WELL 1B	77.2	–	51.7	–	–
PROBE 1	82.0	–	54.2	–	–
PROBE 2	92.0	–	59.8	–	–
PROBE 3	106.8	–	70.1	–	–
PROBE 4	106.9	–	70.2	–	–
PROBE 5	81.3	–	57.5	–	–
PROBE 6	89.6	–	66.2	–	–
PROBE 7	102.3	–	79.3	–	–
PROBE 8	102.5	–	79.2	–	–
SVE WELL 2A	44.4	24.1	–	–	–
SVE WELL 2B	47.4	26.3	–	–	–
PROBE 1	48.9	22.9	41.1	–	–
PROBE 2	51.8	21.6	34.1	–	–
PROBE 3	60.7	25.5	17.8	–	–
PROBE 4	60.2	26.0	18.0	–	–
PROBE 5	41.3	21.0	47.6	–	–
PROBE 6	33.0	17.6	51.1	–	–
PROBE 7	14.2	21.5	–	–	–
PROBE 8	14.15	21.5	–	–	–

POINT	CORNER				
	A (ft.)	B (ft.)	C (ft.)	D (ft.)	E (ft.)
SVE WELL 3A	–	–	35.0	–	–
SVE WELL 3B	–	–	36.6	–	–
PROBE 1	–	47.9	33.5	–	–
PROBE 2	–	48.0	25.3	–	–
PROBE 3	–	51.8	16.3	–	–
PROBE 4	–	52.0	16.5	–	–
PROBE 5	–	–	38.9	–	–
PROBE 6	–	62.9	44.0	–	–
PROBE 7	–	77.9	54.2	–	–
PROBE 8	–	78.2	54.7	–	–
DCF94-21	–	–	–	69.1	38.1
PROBE 1	–	–	–	62.7	39.2
PROBE 2	–	–	–	55.4	42.8
PROBE 3	–	–	–	39.3	54.8
PROBE 4	–	–	–	39.2	54.9
PROBE 5	–	–	–	70.3	33.2
PROBE 6	–	–	–	75.0	23.3
PROBE 7	–	–	–	86.3	7.7
PROBE 8	–	–	–	86.0	8.0
SHED (W)	–	–	39.9	–	–
SHED (X)	55.0	26.8	–	–	–
SHED (Y)	53.4	31.4	–	–	–
SHED (Z)	–	–	–	–	–



INSET 'A'

KEY MAP



LEGEND:

- 1080 — EXISTING GROUND SURFACE CONTOUR (FEET)
- 5 — VACUUM MONITORING PROBE WITH DISTANCE FROM WELL IN FEET
- V <-1'-6"> — VAPOR LINE W/ FLOW DIRECTION & DEPTH BELOW GRADE
- W <-2'-4"> — DOUBLE WALLED GROUNDWATER LINE W/ FLOW DIRECTION & DEPTH BELOW GRADE
- EXTRACTION WELL SYSTEM
  - A–INDICATES SOIL VAPOR EXTRACTION WELL
  - B–INDICATES GROUNDWATER EXTRACTION WELL
- POST EXTRACTION BORING
- BASELINE SOIL BORING
- GROUNDWATER MONITORING WELL
- AQUIFER TEST/REMEDIATION WELL
- ST — STORM SEWER LINE
- SS — SANITARY SEWER LINE
- MH368 — MANHOLE
- PASSIVE WELL
- BLDG. REFERENCE POINT

NOTES:

1. MONITORING WELL DESIGNATIONS REPRESENT LOCATION (i.e. DRY CLEANING FACILITIES (DCF) FOLLOWED BY DATE OF INSTALLATION AND WELL NUMBER.
2. WELL AND SOIL BORING SYMBOLS USED FOR THIS DRAWING WERE SELECTED FOR EASE OF VISUALIZATION.
3. SEE LIST OF SYMBOLS AND ABBREVIATIONS.

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FORT RILEY MILITARY RESERVATION (DCFA–PTSR)

PILOT TEST SYSTEM PLAN, AS-BUILT (EXISTED AS OF NOV. 21, 1994 & THROUGH THE PILOT TEST PROGRAM)

SCALE: AS SHOWN	DCFA–PTSR REPORT DATE: MARCH 1, 1996	FIG. 3–1

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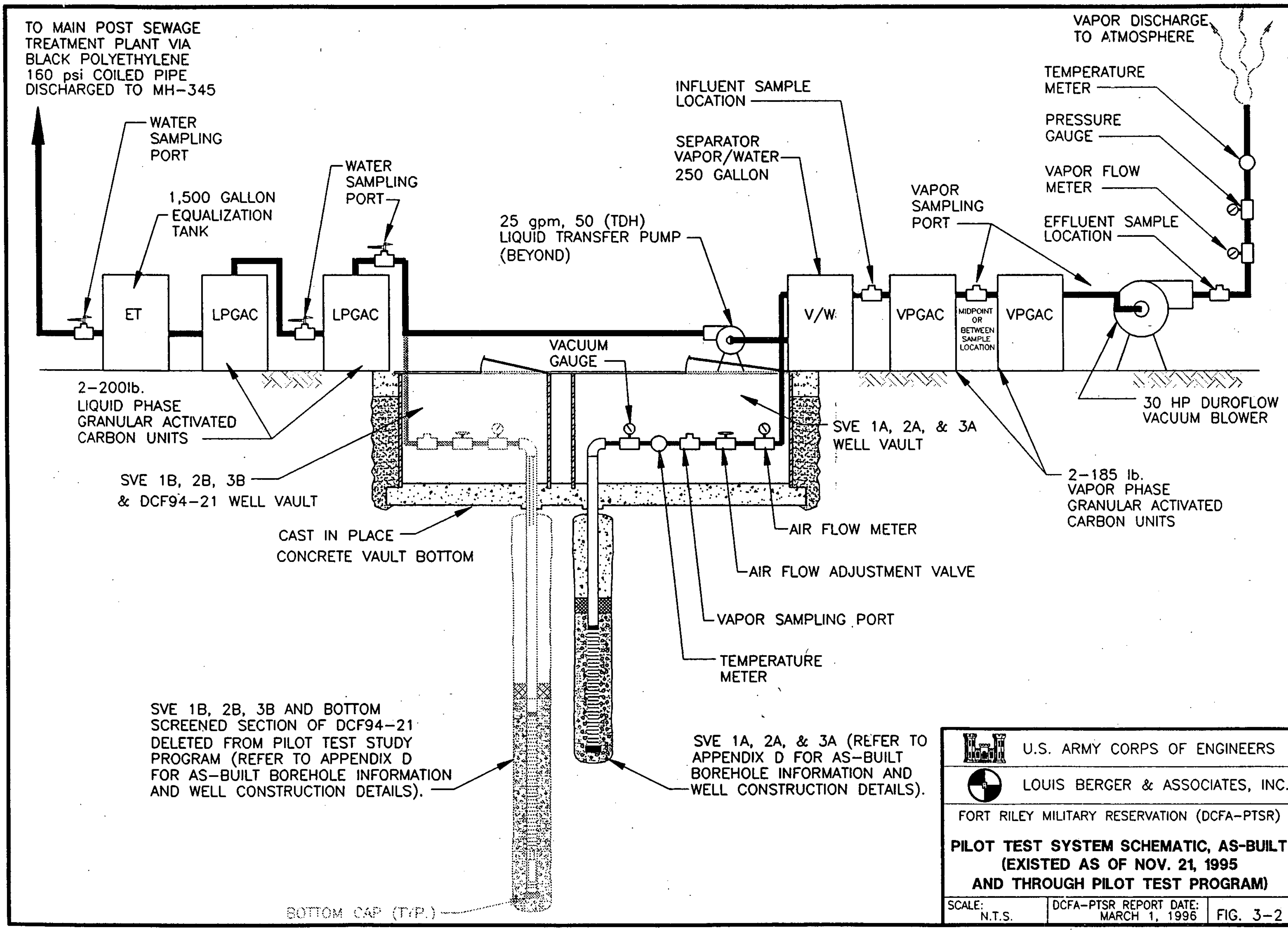

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PILOT TEST SYSTEM SCHEMATIC, AS-BUILT (EXISTED AS OF NOV. 21, 1995 AND THROUGH PILOT TEST PROGRAM)

SCALE: N.T.S.	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 3-2

4.0 EQUIPMENT AND MATERIALS

4.0 EQUIPMENT AND MATERIALS

4.1 INTRODUCTION

Figure 3-1 presents the layout and configuration of the pilot test system "as-built." Figure 3-2 presents the "as-built" system schematic. As shown in this figure, the system was constructed within a field-assembled woodshed. A diked concrete containment pad formed the floor of the shed and served as a mechanical pad for equipment support. As previously discussed, the originally proposed groundwater pump system and controls were disengaged following the decision to abandon the groundwater extraction component of the system. To minimize the potential for extracted vapor losses through pipe joints, valves and sample ports, the vacuum blower was installed at the discharge side of the VPGAC units. This allowed the entire pilot test system, from well heads to the SVE blower outlet, to be under vacuum. The size and specifications of each pilot test system unit operated during the pilot test study are described in the following sections.

4.2 30-DAY TEST SYSTEM

4.2.1 SVE Well Construction

The three wells SVE-1A, 2A and 3A and Passive Well DCF94PV-1 were constructed in accordance with the *Work Plan* using hollow stem augering equipment in unconsolidated formations. The SVE wells were constructed of four-inch inside diameter (ID) PVC Schedule 40 flush threaded joint risers extended to 25 feet below grade. The well screens were slotted PVC and 10 feet in length extending from approximately 15 feet to 25 feet below grade where the wells were terminated. Bottom caps were placed on the well risers to focus SVE laterally throughout the well screens. Figure 4-1 shows the as-built screen diagram through the pilot study area. As-built well construction details are provided in Appendix D.

The wells were installed within 12-inch-diameter boreholes with a filter of coarse No. 4 sand placed in the annular space between the well screen and borehole to maximize air flow. This packing media was favored over the originally proposed 3/16- to ¼-inch pea gravel based on field conditions which warranted consideration of finer materials to screen silts and sands.

Well DCF94-21 was constructed as proposed in the *Work Plan*, with a total depth of approximately 40 feet. The screened intervals for DCF94-21 were from 38 feet to 28 feet for groundwater extraction, and 26 feet to 16 feet for soil vapor extraction. DCF94-21 was constructed using No. 4 sand as packing material, which was similar to packing material for wells SVE-1A, 2A and 3A. However, the well was designated for SVE operations only, so that the originally proposed dual-phase capability of the well was abandoned.

4.2.2 Soil Vapor Extraction Unit

The SVE unit originally proposed in the *Work Plan* was similar to that installed with the exception of its placement in the system and power requirements. The unit selected for the pilot test system was a Duroflow Model 4509 with a design flow capacity of 550 scfm (with a low range potential of 1 scfm) against a total dynamic head of 10 inches mercury or 136 inches water suction. The low 1 scfm range operating requirement was not necessary, as the soil permeability to air flow was found to be significantly greater than expected, resulting in a "naturally" occurring high flow rate during testing.

The power performance specifications for the unit were 30 Hp with a demand of 460-volt, three-phase, 60-hertz (Hz) service, which was provided by a step-up transformer wired to a 220-volt underground service entrance (USE) cable connected to a three-phase power pole installed at the site.

4.2.3 Vapor Water Separator, Transfer Pump and Equalization Tank

The vapor/water separator for the pilot test system was selected as a 250-gallon unit with level sensors and controls wired to a 25 gpm capacity transfer pump for removal of any condensate generated during the SVE operations. The vapor phase piping associated with this unit was connected to the VPGAC units, whereas the liquid phase piping from the transfer pump was connected to the LPGAC units located along the east wall of the treatment shed, as shown in Figure 3-1. The equalization tank which was installed to handle any condensate generated was a 1,500-gallon unit with a discharge pump for conveying the treated condensate to the Main Post Wastewater Treatment Plant.

4.2.4 Vacuum Monitoring Probes

Vacuum pressure was monitored using vacuum probes and magnehelic gauges. Vacuum probes were constructed of ½-inch-diameter standard steel pipe. Eight vapor probes were installed at each of the four SVE wells, as shown in Figure 3-1. The probes were installed in two arrays at each well, each array consisting of four probes located as follows:

- The first vapor probe in each array was mounted five feet from the well and installed at a depth of approximately 25 feet.
- The second probe in each array was mounted 15 feet from the well and installed at a depth of 15 feet.
- The third and fourth vapor probes in each array were installed 30 feet from each SVE well, at depths of seven and 25 feet, respectively.

4.2.5 GAC Treatment Units

The in-line GAC units selected for treatment consisted of two 185-pound vapor-phase units and two 200-pound liquid-phase units. The VPGAC units were placed between the vapor/water separator and SVE unit, and the LPGAC units were placed between the transfer pump and the equalization tank. All units were placed in series. The vapor-phase carbon was capable of withstanding pressures up to 12 pounds per square inch gauge (psig).

4.2.6 Pilot Test System Appurtenances

The valves, gauges and controls for the pilot test system were of various manufacture. Coiled hoses with sample ports were installed between the carbon units and the SVE and vapor/water separator units. All SVE piping was four-inch ID Schedule 40 PVC and was placed below ground where practical to avoid freezing of valves and gauges from entrained condensate collected during the winter operation. Heaters were placed in the treatment shed to safeguard the LPGAC and sound blankets were placed around the SVE unit to minimize noise.

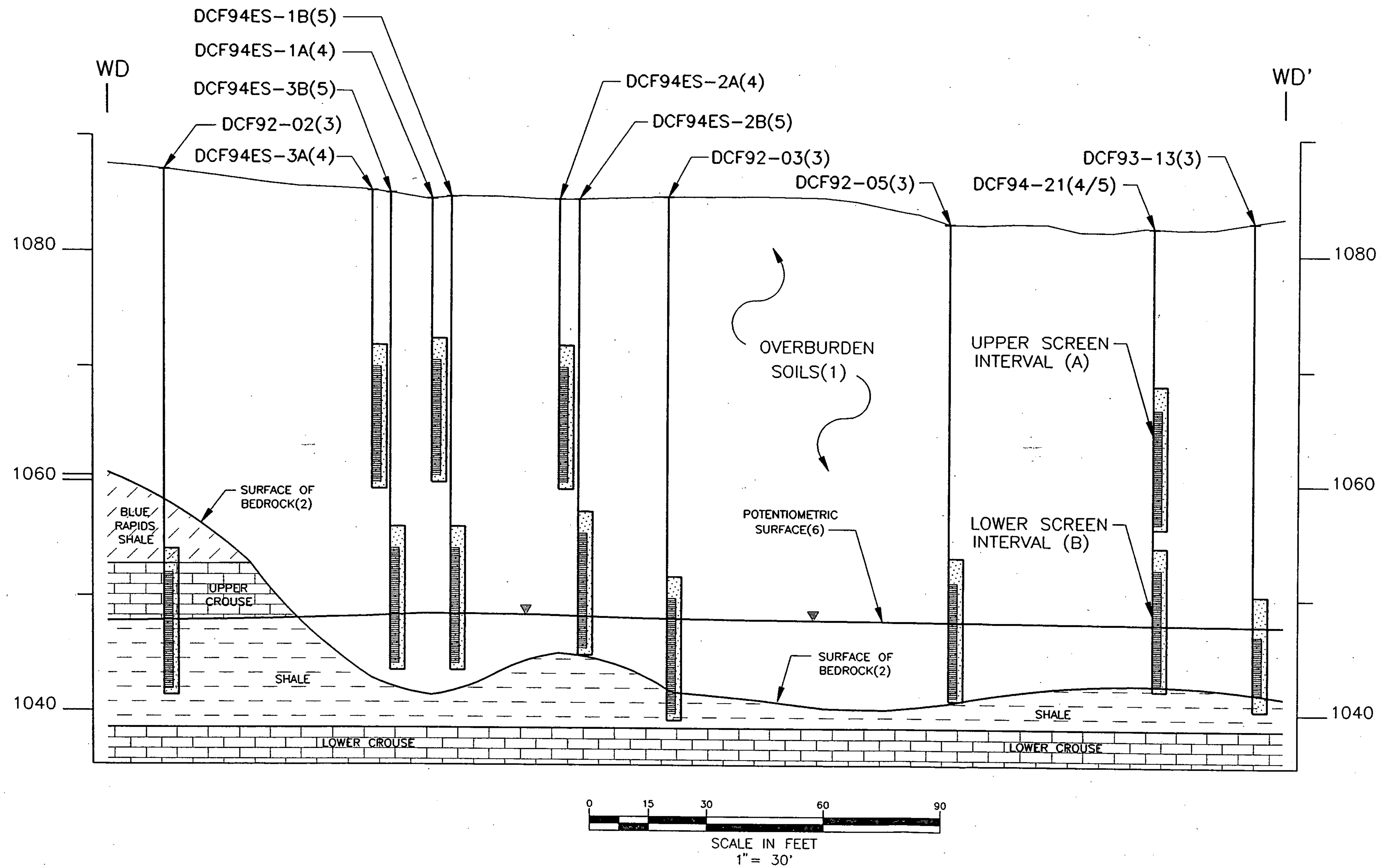
4.3 EXTENDED TEST STUDY SYSTEM

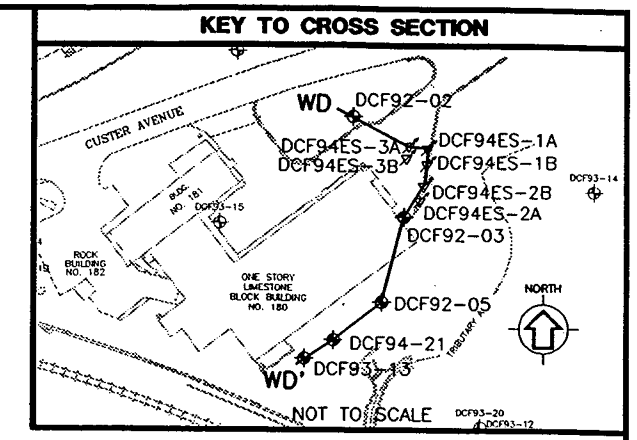
The extended pilot test used the same SVE system as in the initial 30-day test, with the following modifications:

- Vapor treatment units (i.e., GAC) were not used, since the average total GAC contaminant loading rate from the SVE wells generated at the end of the initial 30-day test was approximately 0.78 lb/day, well below the KDHE emission rate standard of 2.3 lbs/hr or 55 lbs/day.

- The on-site GC unit was removed. Vapor samples collected were sent to an off-site laboratory for VOC analysis as discussed in Section 3.4.1.

A partial demobilization was performed on January 21, 1995, i.e., before the extended pilot study. Activities included GC van removal, vacuum probe removal and removal of well pumps from the groundwater extraction wells. The vapor/water separator was kept on line to protect the SVE unit in the event of any moisture generation due to potential changes in soil conditions.





BOTTOM OF SCREEN ELAVATIONS	
WELL	SCREEN EL.
DCF92-02	1042.90
DCF94ES-3A	1059.95
DCF94ES-3B	1044.28
DCF94ES-1A	1060.64
DCF94ES-1B	1044.16
DCF94ES-2A	1059.35
DCF94ES-2B	1046.20
DCF92-03	1039.90
DCF92-05	1041.30
DCF94-21(A)	1056.74
DCF94-21(B)	1044.24
DCF93-13	1037.40

NOTES:

1. OVERBURDEN SOILS CONSIST OF CLAY AND SILT INTERBEDDED WITH CLAYEY SAND AND SAND.
2. BEDROCK LINE SHOWN IS GENERALIZED BASED UPON ORIENTATION OF CROSS SECTION CUT THROUGH EACH WELL. THE ACTUAL BEDROCK LINE AND CHANGE IN SLOPE WOULD DIFFER IN A STRAIGHT-LINE CROSS SECTION THROUGH THESE WELLS.
3. EXISTING GROUNDWATER MONITORING WELLS.
4. SOIL VAPOR EXTRACTION WELLS FOR PILOT TEST STUDY.
5. GROUNDWATER EXTRACTION WELLS DELETED FROM USE IN THE PILOT TEST STUDY.
6. POTENTIOMETRIC SURFACE BASED ON 2/94 SAMPLING EVENT.
7. ALL SCREEN LENGTHS SHOWN ARE 10 FEET LONG, EXCEPT FOR WELL DCF93-13, WHICH IS 5 FEET LONG.
8. SEE LIST OF SYMBOLS AND ABBREVIATIONS.

CPS-WSD/06DEC95

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AS-BUILT WELL SCREEN DIAGRAM THROUGH PILOT STUDY AREA (EXISTED AS OF NOVEMBER 21, 1994 & THROUGH THE PILOT TEST STUDY PROGRAM)

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 4-1

5.0 PILOT TEST DATA RESULTS AND INTERPRETATIONS

5.0 PILOT TEST DATA RESULTS AND INTERPRETATIONS

5.1 OVERVIEW

The initial 30-day SVE operation consisted of four individual tests at each SVE well, followed by a combined test engaging all four wells simultaneously. The extended SVE operation employed all four SVE wells, and was essentially a continuation of the combined test conducted during the initial-phase operation.

During the initial 30-day SVE test, on-site VOC monitoring was conducted using a portable on-site GC. In addition to VOC monitoring, air flow and subsurface soil vacuum were also monitored over time to evaluate system performance and optimum flow. During the extended SVE operation, only VOCs in extracted soil vapor and air flow rates were monitored. VOC samples were submitted to an off-site laboratory for analysis, as the on-site GC unit had been removed. Throughout the pilot study, data obtained was maintained in a field log with corresponding collection times. Data management involved field plots and preliminary evaluation of VOC loading rates to guide the duration of the individual SVE operations. The individual operation schedule is presented in Table 3-1.

In summary, the DCFA SVE system was determined to be effective in VOC reduction. Twenty-one pounds of VOCs were removed from the pilot study area in the first 30-day SVE test, whereas approximately three pounds of VOCs were removed during the extended 60-day SVE operation. Based on the baseline soil analytical soils results, it was conservatively estimated that a total of 45-55 pounds of VOCs were present in the site soils before the pilot study operation began. Thus, approximately 50 percent of the contaminant mass has been removed from the site, as a result of the pilot test study program.

Based on the results from the individual well tests, VOC removal rates varied from well to well. A comprehensive summary of the pilot study operations schedule, sustained flow rates, VOC loading rates and cumulative VOC mass removals is presented in Table 5-1. As indicated in Table 5-1, VOC loading rates from wells SVE-1A and 3A were much higher than SVE well 2A and DCF94-21. A detailed discussion of each well response to SVE application is provided in Section 5.3.

5.2 BASELINE SAMPLING AND TEST RESULTS

5.2.1 Baseline Soil Sampling and Analytical Results

Soil samples were collected at various depths via split spoon sampling during installation of the four extraction wells in May 1994 to establish baseline soil conditions prior to the pilot test study. Baseline soil samples were collected again in October 1994 because the pilot test study had been delayed as a result of the sewer line repair and underground storage tank (UST) removal activities, which have been discussed in Section 3.3 of the *DCFA-RI* Report. Boring locations and sample depths for both sampling events are identified in Figure 5-1. The soil samples were sampled and analyzed in accordance with the *Work Plan* to establish the baseline of the pre-test soil contamination. These results and associated QA/QC data have been documented in a QCSR report, entitled *Analytical Data Reported for Baseline Soil Boring Samples and Soils from Underground Storage Tank Locations,* dated December 2, 1995.

Baseline analytical results were intended to be compared to post-extraction soil analytical results. On the basis of this comparison, the performance of the SVE system could be evaluated by determining the overall reduction of soil contamination within the DCF pilot study area. Of the May and October sampling events, the analytical results for samples collected in October 1994 were used for mass reduction calculations. The October data was considered to be more representative for determining baseline conditions, as it was representative of conditions just prior to the pilot test startup. Results of October sampling are presented in Table 5-2A and Figure 5-1, while May data is provided in Table 5-2B for reference. As shown in Table 5-2A and Figure 5-1, PCE was detected in eight of nine baseline samples collected in October. PCE levels ranged from 4.5 to 100 μg/kg, with the highest concentration, 100 μg/kg, detected in soil boring DCF94-B4 at a depth of 17.5-19.5 feet below grade. Breakdown products of PCE, i.e., TCE and 1,2-DCA, were also detected in sample DCF94-B5-3 (collected at a depth of 15-17 feet below grade) at 4.7 μg/kg and 3.4 μg/kg, respectively. Sample descriptions (including soil boring number, sampling time and depth below grade) are provided in Tables 5-12, 5-13 and 5-14. These results confirm that the primary contaminant of concern at the DCFA site was PCE.

5.2.2 Baseline Groundwater Sampling and Analytical Results

Although the groundwater extraction component was deleted from the pilot study program as discussed in Sections 1.2 and 3.2, for documentation of any potential remediative effect from the pilot test system on groundwater quality, baseline groundwater sampling results are presented in Table 5-2C. The baseline samples were collected in June 1994. As discussed above, the pilot test study was delayed as a result of the sewer line repair and the UST removal activities. Therefore, analytical results of August 1994 pre-test quarterly sampling are considered to be more representative for determining the baseline conditions, and are provided in Table 5-2D. It should be noted, however, that well DCF94ES-1B, -2B -3B, and DCF94-21 were not sampled during the pre-test sampling event since the pumps and piping in place as part of the original plan for groundwater extraction were not yet removed to facilitate sampling. The August 1996 analytical results are compared to the post test - groundwater sampling results, to evaluate any potential remediative effects from the pilot test study on groundwater at the DCFA.

5.2.3 Geotechnical Testing and Results

In addition to the baseline sampling and analyses performed at the DCFA prior to the start of the Pilot Test Study program, samples were obtained during the advancement of the extraction well for geotechnical analysis. These samples which were collected in May 1994 included both undisturbed (Shelby tube) and split spoon samples. Analyses performed included grain size distribution, water content, Atterberg limits, dry density and specific gravity. Porosity and degree of saturation were computed based on these test data. The soils were classified using the Unified Soil Classification System (USCS). Results of these analyses are summarized in Table 5-3 and laboratory test results are presented in Appendix E.

These results support the geological profile described in Section 2.2. The results indicate that the soils consist predominantly of clays, sandy clays and silty sands in the intervals tested. The USCS symbol for these samples are mainly CL but some samples are classified as SM, SC, and ML.

5.3 INITIAL 30-DAY TEST RESULTS

5.3.1 Introduction

One of the principal pilot test objectives cited in the *Work Plan* was to obtain the optimum operational conditions for the system constructed at the site. This was to be established by determining the best flow rate (vacuum) at each SVE well so that the highest VOC removal rate could be achieved for the given system. In order to define optimum VOC recovery at each SVE well, system air flow was systematically stepped up throughout each individual and combined well test, and allowed to operate over a certain time period until asymptotic conditions were obtained as discussed below.

Asymptotic conditions were attained when both air flow rate and VOC mass loading remained relatively unchanged over a certain time period. To determine the sought asymptotic condition in a timely manner for both air flow and VOC loading under each SVE operation, the VOC loading rate and air flow rate were reviewed on site to evaluate the changing trends over time. By definition, VOC loading rate is the product of air flow rate and VOC concentration. VOC concentrations were monitored and obtained by the on-site GC analysis as described in Section 3.3.4. At the same time, system air flow rate was recorded over time. The GC analytical data and the air flow rate data were then used to develop the extracted VOC loading rates as presented in Appendix F.

Three different air flow rates were used in most cases to determine the optimum operational condition for each SVE well. Based on the responses of VOC loading rates to air flow, SVE wells were divided into two groups. One group of wells, SVE-1A and 2A, showed a linear response to air flow, indicating that VOC loading rates in general increased linearly as flow rates increased. This was signified by the parallel relationship between the curves of air flow and VOC loading rates, and by the straight line of cumulative VOC removal during each air flow operation period. The second group, consisting of SVE-3A and DCF94-21, indicated a non-linear response to air flow. At a given air flow rate, VOC loading decreased over time (non-parallel relationship between flow and VOC loading rates). Some differences within each group also occurred. These are discussed in detail in sections 5.3.2 through 5.3.5.

The different responses to air flow observed necessitated case-specific determinations of optimum operation conditions. For wells with linear response, when both the maximum air flow and corresponding mass loading rate became simultaneously constant, the mass loading rate was considered the optimum VOC recovery at each SVE well for the test system. This is because such a mass loading rate was the maximum VOC removal rate that could be recovered from these wells for the given test system. The maximum air flow rates that the test system could deliver to these wells was considered the optimum operational flow for the pilot test system. Therefore, the optimum conditions for those wells with linear response were characterized by asymptotic conditions for both air flow and VOC loading under the highest operational flow conditions. For wells with non-linear response, an air flow rate that could sustain the highest leveled-off VOC loading rate was deemed as the optimum operational flow for the individual well.

For the combined well test, determination of optimum operational conditions was based, in part, on the optimum operational conditions for individual wells. This is not only because of the different responses, but also because of the interactions or interferences between wells (e.g., overlap of vacuum distribution and formation of preferential pathway). In addition, the magnitudes of VOC removal potentials from SVE wells were different, which signified that a weighted air flow distribution should be used in the combined test. The asymptotic conditions identified for each individual SVE well test and for the combined test are summarized in Table 5-1, and are discussed in detail in sections 5.3.2 to 5.3.6 below.

VOCs removed from individual SVE operations have been summarized in Table 5-1. Table 5-4 summarizes mass removals of the primary contaminant PCE, and its removal percentages to overall PCE mass present at the site prior to pilot study. PCE results were selected for reporting in Table 5-4 because PCE as previously indicated had been evaluated as the primary contaminant of concern at the DCFA site. The total PCE mass prior to the pilot study was estimated to be in the range of 40-50 pounds (see Appendix F-1 in the *DCFA-RI* Report), and was approximately 90-95 percent of total VOCs which, in turn, was estimated to be in the range of 45-55 pounds. As demonstrated in Table 5-4, PCE constituted the majority (approximately 94 percent) of the total mass removed over time. Detailed field data for each individual and combined SVE test is presented in Tables 5-5 through 5-9 for SVE wells 1A, 2A, 3A, DCF94-21, and combined test, respectively. As indicated in the tables, approximately 21 pounds of VOCs were removed from the study area over the initial 30-day pilot study. The well tests yielded 4.79 pounds at SVE Well 1A, 0.60 pound at SVE-2A, 6.12 pounds at SVE-3A, 0.23 pound at DCF94-21, and 9.07 pounds at the completion of the combined test. The field GC data presenting a breakdown of the VOC constituent concentrations and flow rates is presented in Appendix F.

The data representing air flow and VOC removal is graphed in Figures 5-2 through 5-6, VOC removals for SVE-1A, 2A, 3A, DCF94-21 and combined test, respectively. Values for flow vary, with values ranging from 28 to 160 scfm.

5.3.2 SVE Well DCF94ES-1A

Table 5-5 summarizes the VOC loading rates and cumulative VOC removals from SVE well DCF94ES-1A under sustained air flow rates of 65, 75, 80 and 90 scfm. Results are plotted in Figure 5-2.

SVE operations at DCF94ES-1A began at 14:30 on November 21, 1994, with an initial air flow rate of 65 scfm, as indicated in Table 5-5 and Figure 5-2. Plotted VOC removal rates ranged from 0.78 to 1.06 lbs/day under the initial flow rate of 65 scfm, with a sustained loading rate of 1.0 lb/day. At the next stepped flow rates of 80 scfm, the VOC loading rates ranged from 1.17 to 1.24 lbs/day, but did not stabilize. The flow rate was then stepped to 90 scfm, at which time a VOC loading rate of 1.33 lbs/day was sustained. The total mass of contaminant removed was calculated as 4.79 pounds, recorded at the end of SVE-1A test at 11:07 on November 25, 1994.

As shown in Figure 5-2, VOC removal rates increased with increasing system flow through each stepped flow rate. The response of this SVE well to air flow was almost linear. This is signified by the fact that the VOC loading curve and the air flow curve are parallel to each other. This linear relationship between VOC loading and air flow rate was further evidenced by the straight line of the cumulative VOC removal curve. The linear relationship is the direct result of the relatively constant concentrations of total VOCs in the extracted soil vapor, as documented in the on-site GC data provided in Appendix F.

Given the linear relationship between the VOC loading rate and air flow for well DCF94ES-1A, the optimum operational flow was found to be the highest air flow rate that could be achieved at this SVE well, using the SVE test system. As a result, an air flow of 90 scfm was selected as the optimum flow rate for SVE-1A.

5.3.3 SVE Well DCF94ES-2A

SVE operations at well DCF94ES-2A (SVE-2A) started at 11:07 on November 25, 1994 with an air flow rate of 55 scfm and ended at 10:10 on November 29, 1994 with an air flow rate of 28 scfm. Table 5-6 presents VOC loading rates, air flows and VOC removals from this SVE well. These results are further plotted in Figure 5-3.

As shown in Figure 5-3, air flow rates were stepped down (instead of being stepped up as in DCF94ES-1A) from 55 scfm to 28 scfm over the test period due to operational restrictions. The 55 scfm flow rate had apparently caused development of excessive localized groundwater surging, resulting in a partial vapor lock. Therefore, the flow rate was required to be stepped down to seek a maintainable vacuum level. At the initial flow rate of 55 scfm, the corresponding VOC removal rate was 0.16 lb/day, but this loading rate did not stabilize. Unlike a typical SVE loading curve, which indicates a decreasing VOC removal rate over time, the VOC removal rates increased at the beginning of the SVE operation under each flow rate operation. The opposite trends observed were not unexpected, however, and are considered to suggest that the VOC concentration distribution in soil vapor under vacuum was not at equilibrium or steady state. As shown in Figure 5-3, during the beginning of SVE operation, the air flow was not stable, indicating non-steady state air flow in subsurface soil.

However, the overall VOC removal rates are shown to decrease almost linearly with decreasing system flow in the process of attaining a sustained flow. Calculated VOC removal rates ranged from 0.16 to 0.26 lb/day under the initial flow rate of 55 scfm, and from 0.13 to 0.22 lb/day at 35 scfm. At the final stage of SVE operation at this well, an air flow of 28 scfm was sustained (i.e., at steady state as shown in Figure 5-3), with an asymptotic VOC loading rate of 0.10 lb/day. These conditions of 28 scfm and 0.10 lb/day were selected as the optimum flow rate and asymptotic mass loading for SVE-2A. The total mass of contaminant removed was calculated as 0.60 pound recorded at the end of the SVE 2A individual well test, on November 29, 1994.

5.3.4 SVE Well DCF94ES-3A

SVE operations at well DCF94ES-3A began at 10:10 on November 29, 1994, and ended at 13:15 on December 2, 1994. Air flow rates applied ranged from 39 scfm to 77 scfm over the test period for SVE-3A.

Table 5-7 and Figure 5-4 present the VOC loading rates, air flows and VOC removals from SVE-3A. Unlike SVE-1A and 2A, a typical VOC loading rate curve, which suggests a decreasing VOC loading rate over time under a given air flow, was obtained under each air flow condition. As shown in the figure, VOC removal started with the highest loading rate of 3.44 lbs/day at the very beginning of SVE operation, and continued to decrease during the given 39 scfm flow rate. When the air flow was stepped up to 65 scfm, the VOC loading rate immediately increased from 1.05 lbs/day to 2.53 lbs/day, and then continued to decrease before the air flow rate was stepped up to 70 scfm. Although at 70 scfm the corresponding VOC loading rate was increased, the increase was not significant, as shown in Figure 5-4. Therefore, the 65 scfm air flow rate was considered the optimum air flow rate for SVE-3A.

It is should be noted that the subsurface air flow almost immediately reached its steady state under each given flow or applied vacuum condition. As shown in Figure 5-4, no significant fluctuation of measured air flow rates was observed. It is also important to note that, unlike well SVE-1A and 2A, which showed linear responses of VOC loading rates to air flows, SVE-3A indicated a non-linear response. As shown in Figure 5-4, the VOC loading curve for SVE-3A does not parallel the air flow rate curve. Rather, VOC loading rates continued to decrease when air flow rates were constant.

The total mass of VOCs removed was calculated as 6.12 pounds at the end of the SVE-3A individual well test, on December 2, 1994. As shown in Table 5-4, total VOC mass removed from this well is the highest among the four individual wells, suggesting that a weighted air flow should be allocated to this well so that a potential higher contribution from this well could be obtained in the combined well SVE operation.

5.3.5 SVE Well DCF94-21

SVE operation at well DCF94-21 started on December 2, 1994 and ended on December 6, 1994. Applied air flows ranged from 40 to 112 scfm over the test period for DCF94-21.

Results on VOC loading rates, air flows and total VOC removals for DCF94-21 are presented in Table 5-8, and plotted against time in Figure 5-5. As listed in Table 5-8, calculated VOC removal rates ranged from

0.12 to 0.02 lb/day under the initial flow rate of 40 scfm, with a sustained loading rate of approximate 0.02 lb/day. When the air flow rates were stepped up to 78, 86, 94 and 100 scfm, VOC loading rates ranged from 0.04 to 0.07 lb/day. No significant increase in VOC loading rates was observed. In fact, compared to other SVE wells, VOC removal rates from this well were far below other wells. Although 100 scfm and 0.07 lb/day were selected as the optimum flow rate and asymptotic mass loading for DCF94-21, contribution of VOC removal from this well was considered minor. The total mass of contaminant removed is identified as 0.23 pound at the end of SVE 21 well test, on December 6, 1994. As listed in Table 5-4, the total mass removed from this well is the lowest among the four SVE wells. The low VOC recovery at DCF94-21 is consistent with the baseline soil data confirming negligible VOC impact to soil at this location.

5.3.6 Combined SVE Well Operation

The combined SVE well operation was initiated on December 8, 1994 at an initial air flow rate of 150 scfm and was stepped from 150 to 160 scfm over the test period for combined SVE well operation. The test was terminated on December 20, 1994.

Table 5-9 and Figure 5-6 present the results of VOC loading rates, air flows and VOC removals for the test. As shown in Figure 5-6, the VOC removal rate decreased with increasing system flow through each stepped flow rate. The trend of decreasing loading rate over time is typical for SVE operations when SVE wells are placed in the center of contamination and effects of site heterogeneity are minimized. Stepping up air flow from 150 to 160 scfm did not increase VOC loading, suggesting that further stepping up of the air flow was unnecessary. As shown in Figure 5-6, measured air flow rates were stabilized at the very beginning of the SVE operations, indicating that a steady state subsurface air flow condition was established at the very beginning of each SVE operation. It should be noted here that the passive well, identified as DCF94PV-1 in Figure 3-1, had been tested during the combined test. The well was left open (i.e., not capped) during the first three days of testing. No noticeable effects were observed as shown in Figure 5-6. Therefore, the well was capped with an airtight well plug for the rest of the pilot test.

Calculated VOC removal rates ranged from 0.71 to 1.17 lbs/day under the initial flow rate 150 scfm, and from 0.46 to 0.73 lb/day at the air flow rate of 160 scfm. An asymptotic VOC loading rate of approximately 0.47 lb/day was attained at the 160 scfm air flow rate. Since no increase in VOC loading was observed when air flow was stepped from 150 to 160 scfm, an air flow rate of 150 was considered a better choice for any future combined well operation condition. The smooth transition of VOC loading rate from 150 scfm to 160 scfm further confirmed the selection of 150 scfm for combined system operations.

The total mass of contaminants removed was 9.07 pounds over the combined well operations test. Mass removed from each individual well is presented in Table 5-4, together with air flow rate allocations, and corresponding VOC loading rate for each well. Of the 9.07 pounds of total VOCs removed, well SVE-3A contributed 7.40 pounds, approximately 80 percent of the total mass removed during the combined well operations. This result was expected. As discussed in Section 5.3.1.4, SVE-3A generated the highest mass removal during the individual well tests. The significant contribution from SVE-3A was attributed to the largest radius of influence that had been achieved at this well, as shown in Figure 5-9. Figure 5-10 further indicates that the vacuum distribution centered around the SVE-3A well during the combined test, suggesting that this well covered a wide area of impacted soil, including the highest contamination area at soil boring DCF94-B4.

Theoretically, total system air flow rate and allocation of this total flow to the four well heads during the combined well tests should be determined based on the optimum flows obtained during the individual well tests as discussed in sections 5.3.1.1 through 5.3.1.5. In practice, however, this was not attainable for two reasons. First, each well response to air flow differed, as evidenced in the individual test data. The fact that some wells responded linearly and some non-linearly complicated the determination of true optimum total flow. Second, interactions or overlaps of vacuum distribution between wells forced the optimum total system flow to be determined on a trial basis. Before SVE started, all valves on the well heads were positioned on the locations which corresponded to optimum conditions for individual wells during the individual tests. The final distribution of air flow was the result of subsurface interactions of vacuum distributions or adjusted by the preferential pathway in the soil. The total air flow values are indicated in Table 5-9.

5.4 VACUUM PROBE MEASUREMENTS

5.4.1 Introduction

As indicated in the *Work Plan*, the intent of subsurface vacuum monitoring was to obtain values of the two important parameters: radius of influence (*R*) and soil permeability to air flow (*k*). These two parameters are factors necessary in spacing SVE wells and in sizing the SVE system.

However, results from field monitoring data precluded ordinary determination of *R* and *k*, due to subsurface soil heterogeneities (i.e., introduced or disturbed soils influencing preferential air pathways), short circuiting from below-grade utilities (i.e., sewer lines), and, vacuum probe anomalies such as probe blockage. At all well locations, readings at arrays along sewer piping responded instantaneously, while others developed slowly (i.e., no curves could be plotted). Furthermore, the actual vacuum distribution differed from the predicted response which formed the basis for probe placement. That is, for particular SVE well tests, probe responses occurred rapidly in unexpected areas, and radially outward from other SVE wells, while some of the probes closer to the test well showed a slow or no response. As such, data could not be sufficiently plotted to determine *R* and *k*. In lieu of plotting, vacuum distribution contours were constructed to illustrate SVE influence as shown in Figures 5-7 through 5-10.

Vacuum probe results were monitored continuously for 30 days during the initial-phase pilot study, at each of the vacuum extraction probes in the study area. Each probe was fitted with a vacuum gauge, and monitored for pressure in inches water (gauge). Vacuum probes were located in two arrays of four probes each, emanating from each SVE well, as shown in Figure 3-1.

All probes at each well were read at time intervals discussed in Section 3.3.3. A summary of vacuum probe measurements is presented in Appendix G. This summary demonstrates that vacuum probe measurements tended to generally increase, as expected, with increasing applied system vacuum. Overall vacuum readings ranged from 0 to 2.5 inches water (gauge) during the study period. Individual SVE well operations gave higher vacuum probe readings than at probes for wells that were not operating. It is also noteworthy that vacuum pressure measurements were significantly higher for combined well operation than for individual operations.

Tables 5-5 through 5-9 identify stabilized flow rates for each individual and combined SVE well operation in the study area. The vacuum pressure measurements determined to best represent each stabilized flow rate are plotted in Figures 5-7 through 5-10. The figures presented indicate that the extent of the SVE system, under individual and combined SVE well operation (with the exception of SVE-2A), encompassed the majority of the study area, though influence from preferential pathways through the soil column and along the sewer piping was evident.

5.4.2 SVE Well DCF94ES-1A

Figure 5-7 shows the vacuum distributions for the stabilized flow rate of about 65 scfm. Vacuum distributions at SVE-1A ranged from 0.1 to 0.9 inch water (gauge). The entire vacuum distribution area encompasses a 30- to 40-foot width, extending from approximately 35 feet north of SVE-1A to 45 feet southwest of the well.

The vacuum distribution is oriented in a northeast-southwest direction across the study area. In general, the contorted shape of the vacuum influence appears to be affected by preferred pathways for flow and does not follow the predicted extent of the subsurface vacuum. For example, the north probe array for SVE-1A indicates a response at the outermost probe, whereas the closest probe indicated no response. At the outermost probe of the west array for Well SVE-2A, an unexpected vacuum reading was recorded, suggesting an overall preferred air pathway along a northeast-southwest plane. Detailed contouring was not attainable due to limitations in the vacuum probe layout which was established prior to the test on the basis of a predicted response.

5.4.3 SVE Well DCF94ES-2A

Figure 5-8 shows the vacuum distributions for the stabilized flow rate at of about 28 scfm. Vacuum distributions at SVE-2A ranged from 0.05 to 0.1 inch water (gauge). The entire vacuum distribution area was determined to encompass a small area of approximately eight feet in width by 25 feet in length with an apparent preferential pathway in a north-south direction. The area of influence is thus far less than that of SVE-1A, which may explain the lesser contribution of this well to overall VOC recovery as discussed in Section 5.3.1.3.

5.4.4 SVE Well DCF94ES-3A

Figure 5-9 shows the vacuum distribution for the stabilized flow rate of 65 scfm. Vacuum distributions from SVE-3A ranged from 0.1 to 1.1 inches water (gauge). The entire vacuum distribution area encompasses a 20- to 25-foot width, which extends from approximately 40 feet northeast of SVE-3A to 50 feet south of the well.

The vacuum distribution area is oriented in a northeast-southwest direction across the study area similar to the vacuum influence noted for Well SVE-1A, thus confirming a preferential pathway in this direction. Vacuum distributions between 0.3 and 0.9 inch water (gauge) were observed with a preferred pathway noted at the south end of the vacuum influence along the sanitary sewer line. Below manhole (MH) 363, vacuum distributions appear to extend for approximately 40 feet south southeast along the sewer piping toward MH 363A.

5.4.5 Combined SVE Well Operation

Figure 5-10 shows vacuum distribution for the combined stabilized flow rate of about 160 scfm. Vacuum distributions from combined well operations were determined to range from 0.2 to 2.2 inches water (gauge). The entire vacuum distribution area encompasses an approximate 20- to 35-foot width, extending as noted in the individual tests, in a northeast-southwest direction.

The vacuum influence from the combined test indicates that wells SVE-1A and 3A are the principal extraction wells as the flow and vacuum influence are greatest at these well locations. No quantifiable influence was observed. This is believed to be due primarily to the limitations of the manometers, but nevertheless representing a shift in flow balance or preferential pathway toward SVE-1A and SVE-3A. This preferential pathway seems to explain the relatively larger contributions from SVE-1A and 3A in the individual tests, and in the combined test, as discussed in Section 5.3.

5.5 EXTENDED PILOT TEST STUDY RESULTS

The extended 60-day SVE pilot study began on February 8, 1995 and ended on April 6, 1995. The pilot study engaged all four extraction wells (SVE-1A, 2A, 3A and 21) at the same time. The combined air flow ranged from 191 to 243 scfm.

As planned in *Draft Tech Memo* dated February 8, 1995 (Appendix C), extracted soil vapor was collected on a weekly basis. Vapor samples were taken from the total sampling port as used in the initial 30-day test. During the sampling events, temperature and vacuum levels were also collected to calculate the actual air flow rate. All samples were then sent to an off-site laboratory for VOCs and TPH-GRO analysis. The sampling procedure and methodology of laboratory analysis have been discussed in Section 3.4. In total, eight sampling events were conducted.

The analytical results are presented in Table 5-10 and graphed in Figure 5-11. As shown in Figure 5-11, low VOC loading rates with a decreasing trend were observed during the eight sampling events, which eventually ended in non-detection of the target VOCs as shown in Table 5-10 (i.e., week 7 analytical data). On the basis of non-detection of VOCs in the extracted vapor, the extended pilot study was terminated. The total amount of VOCs removed during the extended pilot study was estimated to be 3.41 pounds, as indicated in Table 5-1. TPH-GRO was not detected in the samples taken during the first two weeks; therefore, TPH-GRO analysis was discontinued after the second week's sampling.

5.6 POST EXTRACTION ANALYTICAL RESULTS AND COMPARISON TO BASELINE RESULTS

5.6.1 Post Extraction Soil Sampling and Analytical Results

The sampling locations and procedures have been documented in a memo dated April 13, 1995 (Appendix H). Three soil borings were advanced at locations close to the baseline soil borings DCF94-B4 to -B6, and three samples from each boring were collected in a similar manner as in the baseline sampling procedures. Sampling identification, location, sampling depths and analytical results are presented in Table 5-11. Results of the post extraction sampling are depicted in Figure 5-12. As indicated in Table 5-11 and Figure 5-12, the only target VOC detected was PCE. The concentrations of PCE in the samples collected ranged from non-detection to 23.0 μg/kg. DCA and TCE, which were detected in the baseline sampling event, were not detected in any of the post-extraction samples. All these results and associated QA/QC data have been documented in a QCSR report, entitled *Pilot Study Post-Extraction Soil and Ground Water Quarterly Monitoring*, dated June 1995.

5.6.2 Comparison to Baseline Results

Tables 5-12 through 5-14 compare the post-extraction soil analytical results to the baseline soil analytical results for soil boring 4, 5 and 6, respectively. Figures 5-13 and 5-14 illustrate the extent of PCE (i.e., the primary contaminant) contaminations in soil, before and after the pilot test. As illustrated in the figures, a significant reduction of the size of the contamination zone has occurred. This is attributed to the SVE operations, which resulted in an estimated 22.3 pounds of PCE and 24.23 pounds of total VOCs being removed as indicated in Table 5-4.

5.6.3 Post Test—Quarterly Groundwater Sampling and Analytical Results

As discussed in Section 5.2.2, although the groundwater extraction component was deleted from the pilot study program, post test - quarterly sampling analytical results are presented in Table 5-15 for documentation of any potential remediative effects from pilot test study on the groundwater quality. The groundwater samples were collected in the May 1995 quarterly sampling event, which was the closest event to the date of pilot test study program completion, thus best representing the post test groundwater conditions. Results of the baseline, pre-test and post test - quarterly sampling results are further presented in Figures 5-15 through 5-18. No remediative effect from SVE operations during the pilot study program was observed.

TABLE 5-1

SUMMARY OF VOC LOADING RATES UNDER SUSTAINED AIR FLOW RATES FOR ALL SVE OPERATIONS DURING THE INITIAL PILOT TEST STUDY

SVE Operation	Operation Type	Well No	Begin	End	Flow Rates (scfm)	Time (days)	Total VOC Removed (lb)	Avg Loading Rate (lb/day)	Unit Loading Rate (lb/scfm)
Initial	**Individual**								
		1A	11/21/94 14:30	11/22/94 12:22	65	0.91	0.94	1.03	0.0159
			11/22/94 12:22	11/23/94 14:05	80	1.07	1.27	1.19	0.0148
			11/23/94 14:05	11/25/94 11:07	90	1.88	2.58	1.37	0.0153
		2A	11/25/94 11:07	11/25/94 16:36	40	0.23	0.05	0.22	0.0055
			11/25/94 16:36	11/27/94 12:30	32	1.83	0.35	0.19	0.0060
			11/27/94 12:30	11/29/94 10:10	28	1.90	0.20	0.11	0.0038
		3A	11/29/94 10:10	11/30/94 12:04	40	1.08	1.98	1.83	0.0459
			11/30/94 12:04	12/01/94 16:03	62	1.17	2.40	2.06	0.0332
			12/01/94 16:03	12/02/94 13:15	75	0.88	1.74	1.97	0.0263
		DCF-21	12/02/94 15:00	12/03/94 14:50	40	0.99	0.02	0.02	0.0005
			12/03/94 14:50	12/04/94 14:18	84	0.98	0.06	0.06	0.0007
			12/04/94 14:18	12/06/94 17:00	100	2.11	0.14	0.07	0.0007
	Combined								
		1A	12/08/94 09:15	12/12/94 14:50	52	4.23	0.4	0.09	0.0018
			12/12/94 14:50	12/20/94 11:10	54	7.85	0.36	0.05	0.0008
		2A	12/08/94 09:15	12/12/94 14:30	16	4.22	0.13	0.03	0.0019
			12/12/94 14:30	12/20/94 11:10	20	7.86	0.12	0.02	0.0008
		3A	12/08/94 09:15	12/12/94 15:30	50	4.26	4.21	0.99	0.0198
			12/12/94 15:30	12/20/94 11:10	51	7.82	3.2	0.41	0.0080
		DCF-21	12/08/94 09:15	12/12/94 15:30	43	4.26	0.21	0.05	0.0011
			12/12/94 15:30	12/20/94 11:10	49	7.82	0.47	0.06	0.0012
Extended	**Combined**								
		1A 2A 3A DCF-21	02/08/95 09:00	04/06/95 17:00	225	57.33	3.41	0.06	0.0003

TABLE 5-2A

ANALYTICAL RESULTS OF BASELINE SOIL SAMPLES FOR DCFA PILOT TEST STUDY

Samples collected October 4-8, 1994
All results are μg/kg, unless otherwise noted

Analyte	DCF 94-B6-2	DCF 94-B6-3	DCF 94-B6-4	DCF 94-B5-2	DCF 94-B5-3	DCF 94-B5-4	DCF 94-B4-2	DCF 94-B4-3	DCF 94-B4-4
Dichloromethane	<1.2	<1.2	<1.1	<1.2	3.4	<1.1	<1.3	<1.2	<1.1
Tetrachloroethylene	62	6.8	<1.1	4.5	16	1.8	22	100	9.8
Trichloroethylene	<1.2	<1.2	<1.1	<1.2	4.7	<1.1	<1.3	<1.2	<1.1

<u>Notes</u>:

< Not detected above the reporting limit.
NA Not Analyzed.

For a complete list of analytes, see reference CEMRK, 1994c.

TABLE 5-2B

ANALYTICAL RESULTS OF PREVIOUS SOIL SAMPLES FOR DCFA PILOT TEST STUDY

Samples collected 5/24-25/94
All results are μg/kg, unless noted

Analyte	DCF 94-B2-1	DCF 94-B2-2	DCF 94-B2-3	DCF 94-B1-1	DCF 94-B1-2	DCF 94-B1-3
Dichloromethane	<5.8	<6.3	13	<6.0	<6.3	<6.1
Tetrachloroethylene	<5.8	<6.3	<5.4	17	16	<6.1

Notes:

NA Not Analyzed.

For a complete list of analytes, see reference CEMRK, 1994b.

TABLE 5-2C
BASELINE GROUNDWATER ANALYTICAL RESULTS AT DRY CLEANING FACILITIES AREA
SAMPLES COLLECTED 6/6/94
All results are μg/l, unless noted

Analyte	DCF93-10	DCF93-09	DCF93-11	DCF93-19	DCF92-04	DCF93-18	DCF93-17	DCF92-01	DCF92-02
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10	11	<10	<10
Bis 2-ethylhexyl phthalate	<10	30	NA	<10	<10	14	<10	<10	<10
1,2-Dichloroethylene	3.5	5.3	78	5.5	2.1	<0.5	<0.5	<0.5	<0.5
Trichloromethane	<0.5	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	<0.6	<0.6	2.1	1.2	<0.6	<0.6	<0.6	<0.6	<0.6
Tetrachloroethylene	<1.1	<2.2	<1.1	2.3	<1.1	<1.1	<1.1	<1.1	64

Notes:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1994b.

TABLE 5-2C (CONTINUED)
BASELINE GROUNDWATER ANALYTICAL RESULTS AT DRY CLEANING FACILITIES AREA
SAMPLES COLLECTED 6/6/94

All results are μg/l, unless noted

Analyte	DCF93-20	DCF93-14	DCF92-06	DCF92-03	DCF93-13	DCF92-05
1,2-Dichloroethylene	3.8	<0.5	<0.5	2.3	<2.5	12
Trichloroethylene	9.9	<0.6	<0.6	5.0	35	7.6
Trichloromethane	<0.5	<0.5	<0.5	7.6	<2.5	<0.5
Tetrachloroethylene	2.2	<1.1	<1.1	230	160	62

<u>Notes</u>:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1994b.

TABLE 5-2C (CONTINUED)
BASELINE GROUNDWATER ANALYTICAL RESULTS AT DRY CLEANING FACILITIES AREA SAMPLES COLLECTED 6/6/94

All results are μg/l, unless noted

Analyte	DCF94ES-1B-GW	DCF94ES-3B-GW	DCF94ES-2B-GW	DCF94-21-GW	DCF92-02
Chloroform	6.5	10	6.3	1.0	NA
cis-1,2-Dichloroethylene	5.4	1.9	9.6	12	NA
Trichloroethylene	3.3	1.5	8.1	4.5	NA
Tetrachloroethylene	46	62	280	62	NA
Fe, Total mg/l	0.4	0.1	0.7	11.0	<0.1
Mn, Total mg/l	0.08	0.05	0.07	0.5	<0.01
Total Suspended Solids mg/l	14	8	12	392	6

<u>Notes</u>:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1994b.

TABLE 5-2D
PRE-TEST GROUNDWATER ANALYTICAL RESULTS AT DRY CLEANING FACILITIES AREA
SAMPLES COLLECTED 29 AUGUST 1994

All results are μg/l, unless noted

Analyte	DCF-93-09	DCF-93-10	DCF94-22	DCF-93-13	DCF-92-05[a]	DCF-92-03[a]
DCE	<0.5	7.6	1.0	31	30	1.3
PCE	28	<1.1	<1.1	420	55	140
TCE	3.9	<0.6	<0.6	200	7.6	4.4
Toluene	<0.4	<0.4	0.8	<4.0	<0.4	<0.4
$CHCl_3$	<0.5	<0.5	<0.5	<5.0	<0.5	4.7

Analyte	DCF-93-20	DCF-92-01	DCF-93-19	DCF-92-02[a]	DCF-92-06	DCF-94-22
DCE	5.7	<0.5	8.7	<0.5	<0.5	4.1
TCE	14	<0.6	2.8	<0.6	<0.6	<0.6
PCE	10	<1.1	5.4	84	1.2*	<1.1
C_2H_3Cl	<0.8	<0.8	4.4	<0.8	<0.8	<0.8

Notes:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1994d.
* The source of this analyte may not be attributable to site conditions.
$CHCl_3$ Trichloromethane
C_2H_3Cl Vinyl Chloride

TABLE 5-3

SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS FOR DCF PILOT TEST STUDY

Samples collected 5/94

Sample ID	Depth Interval	Soil Description	Natural Moisture (%)	Dry Density (pcf)	Atterberg Limits (%)			USCS Class	% Passing No. 200	Porosity (%)	Saturation (%)
					LL	PL	PI				
DCF94ES-1-1	1 - 2	Clayey Sand w/Gravel	--	--	25	18	7	SC	25	--	--
DCF94ES-1A-G	19.4 - 21.9	Sandy Lean Clay	18.1	102.5	24	14	10	CL	65	38.5	77.2
DCF94ES-1B-1	1- 2	Sandy Lean Clay	--	--	25	15	10	CL	52	--	--
DCF94ES-1B-2	14 - 21.8	Sandy Lean Clay	--	--	28	14	14	CL	70	--	--
DCF94ES-1B-3	21.8 - 34	Sandy Silt	--	--	18	16	2	ML	60	--	--
DCF94ES-2A-G	19.5 - 22	Lean Clay w/Sand	24.9	96.1	31	14	17	CL	74	42.7	89.7
DCF94ES-2B-2	19.7 - 24.7	Lean Clay w/Sand	--	--	30	16	14	CL	75	--	--
DCF94ES-2B-3	32 - 34	Silty Sand	--	--	NP	NP	NP	SM	40	--	--
DCF94ES-3B-G	17 - 19.5	Silt	32	83.5	31	14	17	CL	98	49.9	85.8
DCF94ES-3B-1	3 - 5	Sandy Lean Clay	--	--	33	18	15	CL	58	--	--
DCF94ES-3B-2	15 - 17	Lean Clay w/Sand	--	--	28	18	10	CL	82	--	--
DCF94ES-3B-3	26.5 - 29.5	Sandy Lean Clay	--	--	23	16	7	CL	58	--	--
DCF94ES-21-G	19.5 - 21	Lean Clay w/Sand	21	92.8	33	15	18	CL	85	44.7	69.5
DCF94ES-21-1	3 - 5	Lean Clay	--	--	40	19	21	CL	92	--	--
DCF94ES-21-2	15 - 17	Lean Clay	--	--	37	17	20	CL	93	--	--
DCF94ES-21-3	34.5 - 38	Silty Sand	--	--	NP	NP	NP	SM	19	--	--

Notes:

Samples analyses performed by Terracon Consultants, Inc.

Samples designated with G indicates an undisturbed sample (Shelby tube sample); all other samples are split spoon samples.

-- = analysis not performed.

NP = None plastic - Sample not tested for Atterberg Limits.

TABLE 5-4
SUMMARY OF TOTAL PCE MASS REMOVAL (lbs) AND % OF PCE REMOVED OVER TOTAL VOCs FROM EACH SVE OPERATIONS

SVE Operations		Wells	Period of Operation	Total VOC Removed (lbs)	PCE Removed (lbs)	% of PCE Removed Over Total VOCs
Initial Phase	Individual	1A	11/21-11/25/94	4.79	4.46	93.11
		2A	11/25-11/29/94	0.60	0.58	96.67
		3A	11/29-12/02/94	6.12	5.68	92.81
		DCF-21	12/02-12/06/94	0.23	0.20	86.96
	Combined	1A	12/08-12/20/94	0.76	0.63	82.89
		2A	12/08-12/20/94	0.24	0.20	83.33
		3A	12/08-12/20/94	7.40	6.72	90.81
		DCF-21	12/08-12/20/94	0.67	0.59	88.06
Subtotal (Initial Phase)				**20.81**	**19.06**	**Average % of PCE Removed during Initial Phase = 89.33**
Extended Phase	Combined	1A 2A 3A DCF-21	02/08-02/17/95	1.03	0.87	84.47
			02/17-02/24/95	0.56	0.56	100.00
			02/24-03/03/95	0.31	0.31	100.00
			03/03-03/10/95	0.40	0.40	100.00
			03/10-03/17/95	0.36	0.36	100.00
			03/17-03/24/95	0.58	0.58	100.00
			03/24-03/31/95	0.00	0.00	100.00
			03/31-04/06/95	0.18	0.18	100.00
Subtotal (Extended Phase)				**3.42**	**3.26**	**Average % of PCE Removed during Extended Phase = 98.06**
Total (Initial & Extended Phase)				**24.23**	**22.32**	**Average % of PCE Removed for Entire Pilot Test Study = 93.69**

TABLE 5-5

SVE WELL DCF94ES-1A MASS REMOVAL RATE SUMMARY

Date, Time	Air Flow Range (Q-scfm)	VOC Rate Removed (lbs/day)	Total Contaminant Removed (lbs)
11/21/94 14:30	65	0.78	0.00
11/21/94 14:45	65	0.78	0.01
11/21/94 15:23	65	0.92	0.03
11/21/94 16:01	65	0.95	0.06
11/21/94 16:36	65	1.06	0.08
11/21/94 17:16	65	1.06	0.11
11/22/94 9:09	65	1.00	0.79
11/22/94 10:28	65	1.01	0.85
11/22/94 11:08	75	1.18	0.88
11/22/94 11:45	75	1.17	0.91
11/22/94 12:22	75	1.17	0.94
11/22/94 14:24	80	1.20	1.04
11/22/94 15:05	80	1.14	1.07
11/22/94 17:32	80	1.17	1.19
11/23/94 9:30	80	1.20	1.98
11/23/94 10:48	80	1.23	2.04
11/23/94 12:44	80	1.24	2.14
11/23/94 14:05	80	1.29	2.21
11/23/94 14:45	90	1.43	2.25
11/23/94 15:03	90	1.46	2.29
11/23/94 15:24	90	1.46	2.33
11/23/94 16:03	90	1.44	2.37
11/23/94 16:42	90	1.42	2.41
11/23/94 17:20	90	1.46	3.43
11/24/94 10:42	90	1.36	3.43
11/24/94 12:09	90	1.41	3.51
11/24/94 12:52	90	1.39	3.55
11/24/94 14:25	90	1.32	3.64
11/24/94 15:06	90	1.36	3.68
11/24/94 16:00	90	1.33	3.73
11/25/94 9:57	90	1.34	4.73
11/25/94 11:07	90	1.34	4.79

TABLE 5-6

SVE WELL DCF94ES-2A MASS REMOVAL RATE SUMMARY

Date, Time	Air Flow Range (Q-scfm)	VOC Rate Removed (lbs/day)	Total Contaminant Removed (lbs)
11/25/94 11:07	55	0.16	0.00
11/25/94 11:15	54	0.16	0.00
11/25/94 11:52	54	0.20	0.01
11/25/94 12:28	50	0.24	0.01
11/25/94 13:59	50	0.26	0.03
11/25/94 14:59	46	0.25	0.04
11/25/94 15:59	46	0.26	0.05
11/25/94 16:36	41	0.22	0.05
11/26/94 10:05	40	0.20	0.21
11/26/94 11:23	40	0.19	0.22
11/26/94 13:50	34	0.17	0.24
11/26/94 15:10	28	0.13	0.25
11/26/94 15:47	34	0.15	0.25
11/26/94 16:26	34	0.16	0.25
11/26/94 17:02	28	0.13	0.26
11/27/94 10:13	35	0.22	0.38
11/27/94 11:31	35	0.20	0.39
11/27/94 12:30	28	0.08	0.40
11/27/94 13:42	28	0.09	0.41
11/27/94 15:09	28	0.11	0.41
11/27/94 16:08	28	0.10	0.42
11/28/94 9:44	28	0.10	0.49
11/28/94 11:06	28	0.10	0.50
11/28/94 11:58	28	0.10	0.50
11/28/94 13:26	28	0.11	0.51
11/28/94 14:04	28	0.11	0.51
11/28/94 14:50	28	0.11	0.51
11/28/94 15:30	28	0.11	0.52
11/28/94 16:10	28	0.12	0.52
11/28/94 17:15	28	0.11	0.53
11/29/94 9:37	28	0.10	0.60
11/29/94 10:10	28	0.10	0.60

TABLE 5-7

SVE WELL DCF94ES-3A MASS REMOVAL RATE SUMMARY

Date, Time	Air Flow Range (Q-scfm)	VOC Rate Removed (lbs/day)	Total Contaminant Removed (lbs)
11/29/94 10:22	39	3.44	0.03
11/29/94 10:59	39	2.91	0.11
11/29/94 11:38	39	2.81	0.19
11/29/94 12:41	39	2.44	0.30
11/29/94 14:03	39	2.22	0.44
11/29/94 14:40	39	2.14	0.49
11/29/94 15:22	39	2.15	0.55
11/29/94 16:00	39	1.05	0.61
11/29/94 16:40	39	1.87	0.66
11/29/94 17:19	39	1.87	0.71
11/30/94 10:20	39	1.30	1.84
11/30/94 12:04	63	2.53	1.98
11/30/94 13:34	63	2.40	2.13
11/30/94 14:40	63	2.34	2.24
11/30/94 15:27	63	2.27	2.32
11/30/94 16:08	63	2.23	2.38
11/30/94 16:47	63	2.16	2.44
11/30/94 17:28	63	2.12	2.50
12/1/94 9:57	65	1.93	3.89
12/1/94 10:38	65	1.97	3.95
12/1/94 11:33	65	1.92	4.02
12/1/94 12:27	65	1.91	4.09
12/1/94 15:10	65	1.87	4.31
12/1/94 15:18	65	1.86	4.32
12/1/94 16:03	70	2.09	4.38
12/1/94 16:44	70	2.07	4.44
12/1/94 17:33	70	1.96	4.51
12/2/94 10:00	77	1.97	5.86
12/2/94 12:32	77	1.96	6.06

TABLE 5-8

SVE WELL DCF94-21 MASS REMOVAL RATE SUMMARY

Date, Time	Air Flow Range (Q-scfm)	VOC Rate Removed (lbs/day)	Total Contaminant Removed (lbs)
12/2/94 15:25	40	0.12	0.00
12/2/94 16:11	40	0.06	0.00
12/2/94 16:51	40	0.04	0.01
12/2/94 17:37	40	0.04	0.01
12/3/94 10:07	40	0.02	0.02
12/3/94 10:58	40	0.02	0.02
12/3/94 11:46	40	0.02	0.02
12/3/94 12:35	40	0.02	0.02
12/3/94 14:05	40	0.02	0.02
12/3/94 14:50	78	0.07	0.02
12/3/94 15:41	78	0.04	0.03
12/3/94 16:27	78	0.05	0.03
12/3/94 17:06	78	0.06	0.03
12/4/94 10:34	86	0.06	0.07
12/4/94 11:16	86	0.05	0.07
12/4/94 12:04	86	0.05	0.07
12/4/94 13:25	86	0.05	0.08
12/4/94 14:18	94	0.06	0.08
12/4/94 15:00	94	0.06	0.08
12/4/94 15:41	94	0.06	0.08
12/4/94 16:27	94	0.06	0.08
12/5/94 9:55	100	0.07	0.13
12/5/94 10:35	100	0.07	0.13
12/5/94 11:18	100	0.06	0.14
12/5/94 12:09	100	0.07	0.14
12/5/94 13:26	100	0.07	0.14
12/5/94 14:14	100	0.07	0.14
12/5/94 15:06	100	0.07	0.15
12/5/94 15:57	100	0.07	0.15
12/5/94 16:48	100	0.07	0.15
12/6/94 10:11	112	0.09	0.22
12/6/94 12:07	43	0.04	0.22

TABLE 5-9

SVE COMBINED OPERATION MASS REMOVAL SUMMARY

Date, Time	Air Flow Range (Q-scfm)	VOC Rate Removed (lbs/day)	Contaminant Removed (lbs) Combined Operation (12/8/94-12/20/94)
12/8/94 10:00	150	1.72	0.0
12/9/94 10:43	150	1.48	1.5
12/10/94 10:06	150	1.28	2.8
12/10/94 16:19	150	1.15	3.1
12/11/94 10:54	150	1.04	3.9
12/12/94 11:15	150	0.89	4.8
12/12/94 16:25	150	0.81	5.0
12/13/94 10:02	150	0.71	5.5
12/13/94 13:49	150	0.72	5.6
12/13/94 14:26	160	0.73	5.6
12/13/94 15:29	160	0.73	5.7
12/13/94 16:28	160	0.71	5.7
12/14/94 9:43	160	0.67	6.2
12/14/94 12:51	160	0.59	6.2
12/14/94 14:49	160	0.58	6.3
12/14/94 17:02	160	0.55	6.3
12/15/94 9:45	160	0.59	6.8
12/16/94 9:27	160	0.55	7.3
12/17/94 9:32	160	0.49	7.8
12/18/94 9:46	160	0.47	8.3
12/19/94 9:43	160	0.46	8.7
12/20/94 9:25	160	0.46	9.1

TABLE 5-10

SVE COMBINED WELL OPERATION MASS REMOVAL RATE SUMMARY DURING EXTENDED PHASE OPERATION

Sampling Date	Air Flow Rate	Chemical Concentrations (μg/l)		VOC Loading Rates (lb/day)		Total VOC Loading
	(scfm)	PCE	Cis-1,2 DCE	PCE	Cis-1,2 DCE	Rates (lb/day)
02/09/95 9:00 (week 1)	191	6.2	1.1	0.11	0.02	0.13
02/17/95 9:00 (week 2)	213	4.2	0.0	0.08	0.00	0.08
02/24/95 9:00 (week 3)	224	2.2	0.0	0.04	0.00	0.04
03/03/95 9:00 (week 4)	226	2.8	0.0	0.57	0.00	0.57
03/10/95 9:00 (week 5)	230	2.5	0.0	0.05	0.00	0.05
03/17/95 9:00 (week 6)	241	3.8	0.0	0.08	0.00	0.08
03/24/95 9:00 (week 7)	233	ND	ND	0.00	0.00	0.00
03/31/95 9:00 (week 8)	243	1.3	0.0	0.03	0.00	0.03
04/06/95 9:00 (week 9)	243	1.3	0.0	0.03	0.00	0.03

ND Not Detected

TABLE 5-11

ANALYTICAL RESULTS OF POST EXTRACTION SOIL SAMPLES FOR DCFA PILOT TEST STUDY

Samples collected 04/27-28/95

All results are μg/kg, unless otherwise noted

Boring/ Sample Location	DCF-95-B4			DCF-95-B5				DCF-95-B6		
Analyte	DCF95-PEB-4-1	DCF95-PEB-4-2	DCF 95-PEB-4-3	DCF 95-PEB-5-1	DCF95-PEB-5-2	DCF95-PEB-5-3	DCF95-PEB-5-4	DCF95-PEB-6-1	DCF95-PEB-6-2	DCF95-PEB-6-3
Tetrachloroethylene	13.0	3.8	23.0	4.3	8.2	<1.0	4.2	5.0	<1.2	<1.1

Notes:

< Not detected above the reporting limit.

DCA and TCE were detected in baseline soil samples, but were not detected in post extraction soil samples.

For a complete list of analytes, see CEMRK, 1995d.

TABLE 5-12

COMPARISON OF SOIL BASELINE AND POST EXTRACTION SAMPLING DEPTHS, LOCATIONS, AND ANALYTICAL RESULTS AT SOIL BORING 4

Boring	Boring 4					
Sampling Order	1		2		3	
Sampling Events (B/P)	B	P	B	P	B	P
Sampling Time	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95
Sample ID	DCF-94-B4-2	DCF-95-PEB-4-1	DCF-94-B4-3	DCF-95-PEB-4-2	DCF-94-B4-4	DCF-95-PEB-4-3
Sampling Depth	1.0′-2.0′	1.3′-1.9′	17.5′-19.5′	15′-17′	31.0′-32.0′	36.8′-39.3′
Analyte						
Dichloromethane	< 1.3	< 1.1	< 1.2	< 1.2	< 1.1	< 1.2
Tetrachloroethylene	22	13	100	3.8	9.8	23
Trichloroethylene	< 1.3	< 1.1	< 1.2	< 1.2	< 1.1	< 1.2
Total Solids (%)	91	90	84	84	89	85

<u>Notes</u>:

B Baseline soil sampling event
P Post-extraction sampling event
— Dichloromethane and Trichloroethylene were not detected in any post-extraction soil samples.

TABLE 5-13

COMPARISON OF BASELINE AND POST EXTRACTION SOIL SAMPLING DEPTHS, LOCATIONS, AND ANALYTICAL RESULTS AT SOIL BORING 5

Boring	Boring 5					
Sampling Order	1		2		3	
Sampling Events (B/P)	B	P	B	P	B	P
Sampling Time	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95
Sample ID	DCF-94-B5-2	DCF-95-PEB-5-1	DCF-94-B5-3	DCF-95-PEB-5-2	DCF-94-B5-4	DCF-95-PEB-5-3
Sampling Depth	1.0′ - 2.0′	0′ - 1.0′	15.0′ - 17.0′	15.6′ - 17′	31.9′ - 33.9′	33.9′ - 34.4′
Analyte						
Dichloromethane	<1.2	<1.2	3.4	<1.3	<1.1	<1.0
Tetrachloroethylene	4.5	4.3	16	8.2	1.8	<1.0
Trichloroethylene	<1.2	<1.2	4.7	<1.3	<1.1	<1.0
Total Solids (%)	85	85	76	78	89	96

Notes:

B Baseline soil sampling event
P Post-extraction sampling event
— Dichloromethane and Trichloroethylene were not detected in any post-extraction soil samples.

TABLE 5-14

COMPARISON OF BASELINE AND POST EXTRACTION SOIL SAMPLING DEPTHS, LOCATIONS, AND ANALYTICAL RESULTS AT SOIL BORING 6

Boring	Boring 6					
Sampling Order	1		2		3	
Sampling Events (B/P)	B	P	B	P	B	P
Sampling Time	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95	10/4-6/94	4/27-28/95
Sample ID	DCF-94-B6-2	DCF-95-PEB-6-1	DCF-94-B6-3	DCF-95-PEB-6-2	DCF-94-B6-4	DCF-95-PEB-6-3
Sampling Depth	1.2′ - 3.0′	1.0′ - 1.9′	15.0′ - 17.5′	15′ - 17′	32′ - 32.5′	29.8′ - 32.5′
Analyte						
Dichloromethane	<1.2	<1.2	<1.2	<1.2	<1.1	<1.1
Tetrachloroethylene	62	5.0	6.8	<1.2	<1.1	<1.1
Trichloroethylene	<1.2	<1.2	<1.2	<1.2	<1.1	<1.1
Total Solids (%)	82	85	81	84	95	85

<u>Notes</u>:

B Baseline soil sampling event
P Post-extraction sampling event
— Dichloromethane and Trichloroethylene were not detected in any post-extraction soil samples.

TABLE 5-15
POST TEST—QUARTERLY GROUNDWATER ANALYTICAL RESULTS AT DCFA

SAMPLES COLLECTED 1 MAY 1995

All result are μg/l, unless noted

Analyte	DCF 94-22	DCF 93-10	DCF 93-09	DCF 92-01	DCF 92-06
1,2-Dichloroethylene	4.4	14	1.5	<0.5	<0.5
Meta &/or Para-Xylene	0.9	<0.6	<0.6	<0.6	<0.6
Tetrachloroethylene	1.2	6.8	21	<1.1	1.5
Trichloroethylene	<0.6	9.1	2.6	<0.6	<0.6

SAMPLES COLLECTED 2 MAY 1995

All results are μg/l, unless noted

Analyte	DCF 93-13	DCF 92-05	DCF 94-21	DCF ES 94-02B	DCF 92-03	DCF 92-02	DCF ES 94-03B	DCF 93-20
1,2-Dichloro ethylene	25	4.2	4.4	0.9	0.9	<0.5	<0.5	18
Bromo dichloro methane	2.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetra chloro ethylene	210	34	28	54	89	15	100	3.4
Toluene	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Trichloro ethylene	190	2.2	2.2	2.1	1.5	<0.6	0.9	21
Trichloro methane	1.2	<0.5	<0.5	1.3	1.8	1.4	1.5	<0.5

Notes:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1995d.

TABLE 5-15 (CONTINUED)
POST TEST—QUARTERLY GROUNDWATER ANALYTICAL RESULTS AT DCFA

SAMPLES COLLECTED 2 MAY 1995

All result are μg/l, unless noted

Analyte	DCF ES 94-01B
1,1,1-Trichloroethane	0.7
1,2-Dichloroethylene	11
1,4-Dichlorobenzene	3.7
Benzene	0.9
Bromodichloromethane	0.6
Tribromomethane	1.5
Chlorobenzene	2.0
Dibromochloromethane	1.3
Ethylbenzene	1.7
Meta &/or Para-Xylene	4.4
Ortho-Xylene	2.1
Tetrachloroethylene	35
Toluene	1.3
Trichloroethylene	3.0
Trichloromethane	1.6

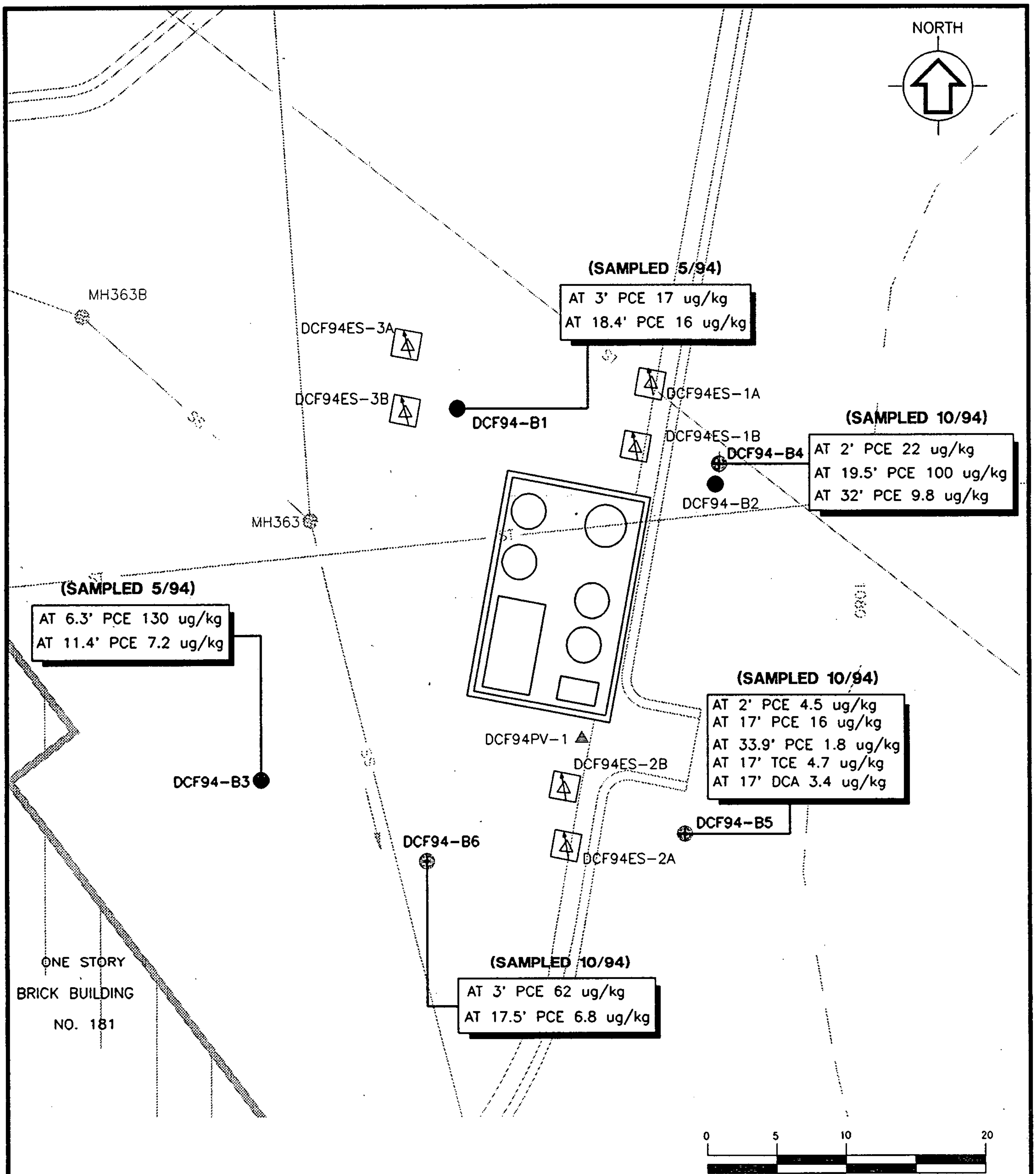
TABLE 5-15 (CONTINUED)
POST TEST—QUARTERLY GROUNDWATER ANALYTICAL RESULTS AT DCFA

SAMPLES COLLECTED 3 MAY 1995

Analyte	DCF 93-12	DCF 93-14	DCF 93-18	DCF 92-04	DCF 92-07	DCF 93-15	DCF 93-19
TPH-GRO	NA	NA	NA	1300	<100	140	<100
TPH-DRO	NA	NA	NA	4100	<400[a]	430	<100
1,2-Dichloroethylene	<0.5	<0.5	<0.5	1.9	<0.5	7.4	5.3
Dichloromethane	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Meta &/or Para-Xylene	<0.6	<0.6	<0.6	8.0	<0.6	<0.6	<0.6
Ortho-Xylene	<0.6	<0.6	<0.6	5.4	<0.6	<0.6	<0.6
Tetrachloroethylene	7.1	<1.1	<1.1	<1.1	1.7	150	<1.1
Trichloroethylene	<0.6	<0.6	<0.6	<0.6	<0.6	12	1.0
Trichloromethane	<0.5	<0.5	<0.5	<0.5	<0.5	2.9	<0.5

<u>Notes</u>:

< Not detected above the reporting limits.
NA Not analyzed.
For complete list of analytes, see reference CEMRK 1995d.
(a) Sample quantitation limit raised due to limited sample volume.



SCALE IN FEET
1 inch = 10 feet

LEGEND

DCF94-B3 ● SOIL BORING LOCATION; NO.; SAMPLING DATE 5/94

DCF94-B6 ⊕ SOIL BORING LOCATION; NO.; SAMPLING DATE 10/94

DCF94ES-1B EXTRACTION WELL

NOTE

1. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
2. WELL AND SOIL BORING SYMBOLS WERE SELECTED FOR EASE OF VISUALIZATION.

U.S. ARMY CORPS OF ENGINEERS

LOUIS BERGER & ASSOCIATES, INC.

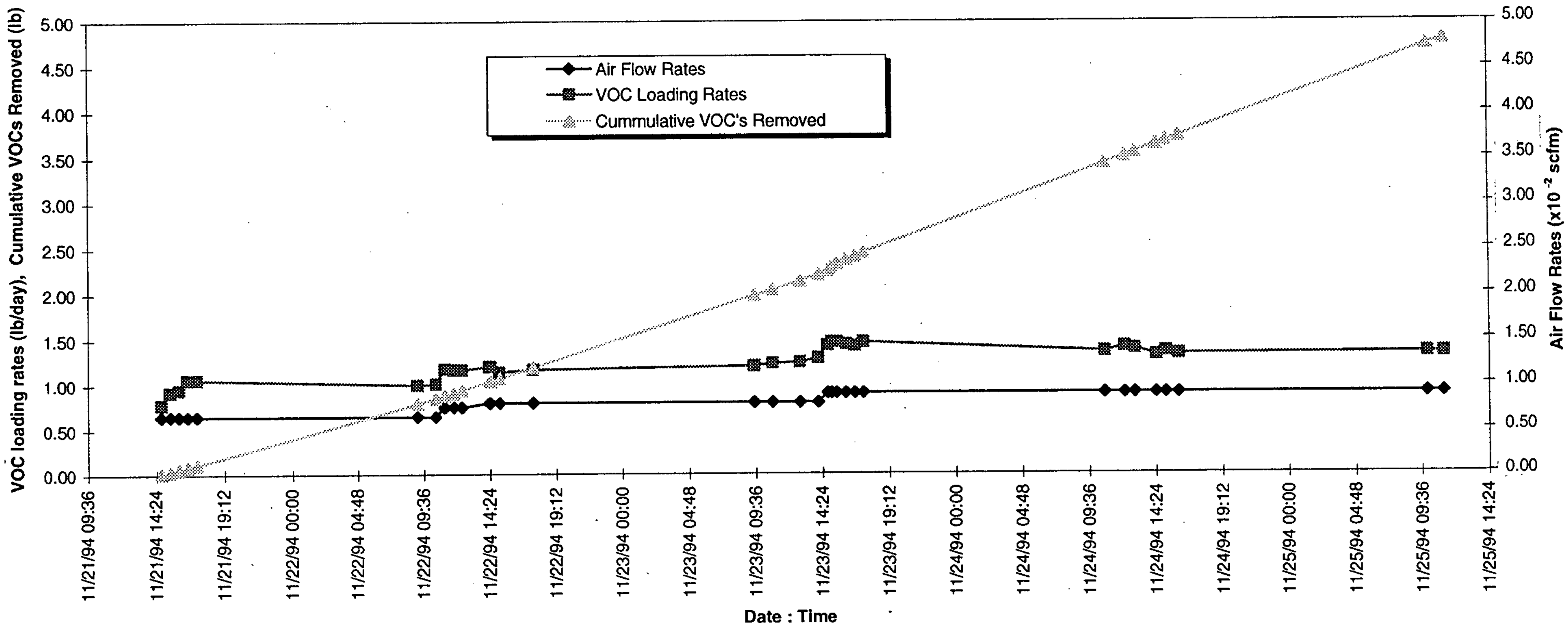
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

BASELINE SOIL SAMPLING LOCATIONS & ANALYTICAL RESULTS (MAY & OCTOBER 1994)

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-1

CPS-PPTS/06DEC95

CPS-f5_2/5DEC95/U4



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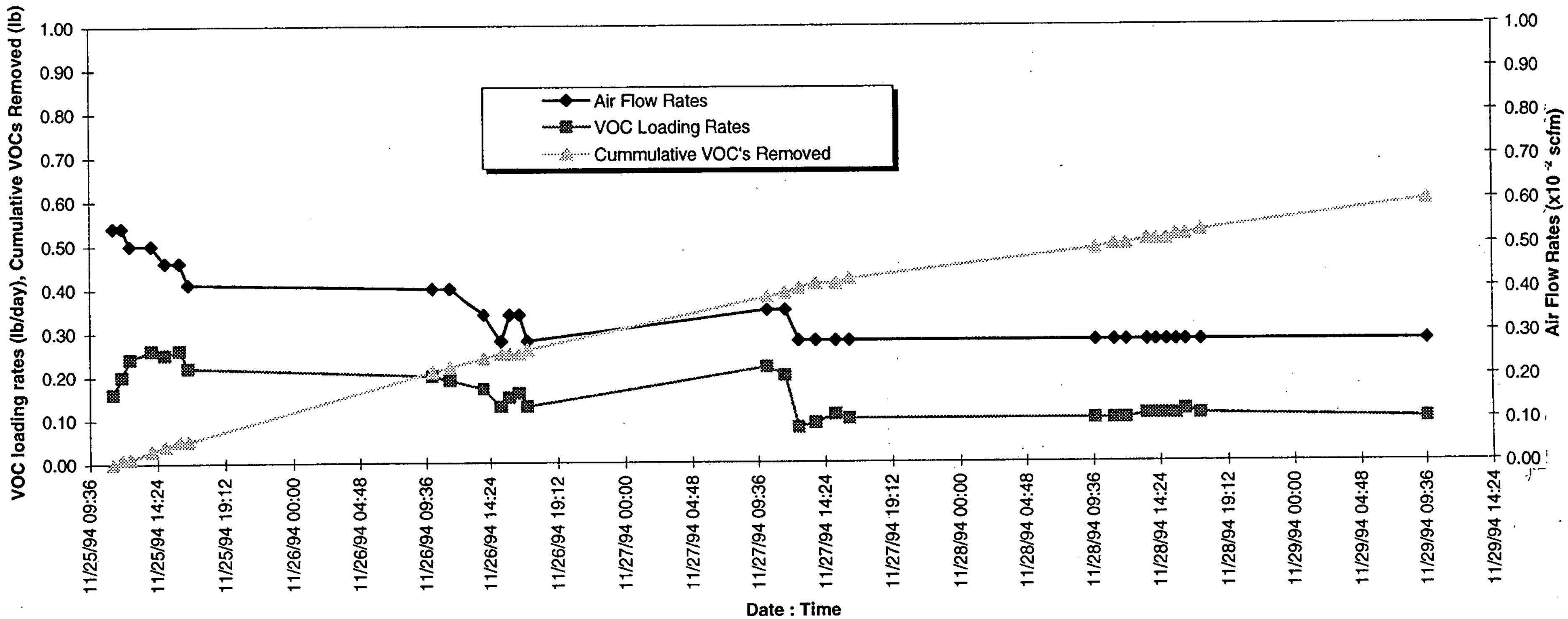
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates, Air Flows and VOC Removals at SVE Well DCF94ES-1A During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-2

CPS-f5_3/5DEC95/U4



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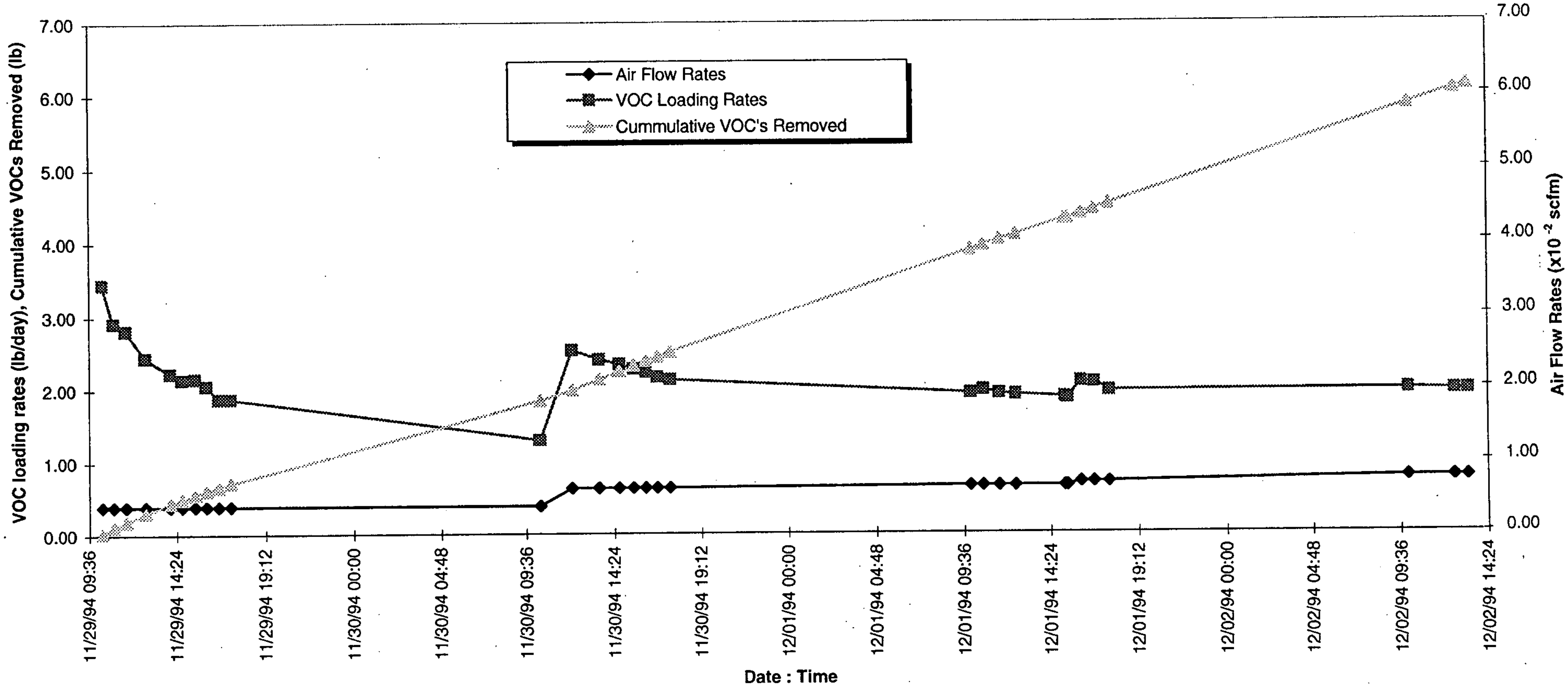
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates, Air Flows and VOC Removals at SVE Well DCF94ES-2A During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-3

CPS-f5_4/5DEC95/U4



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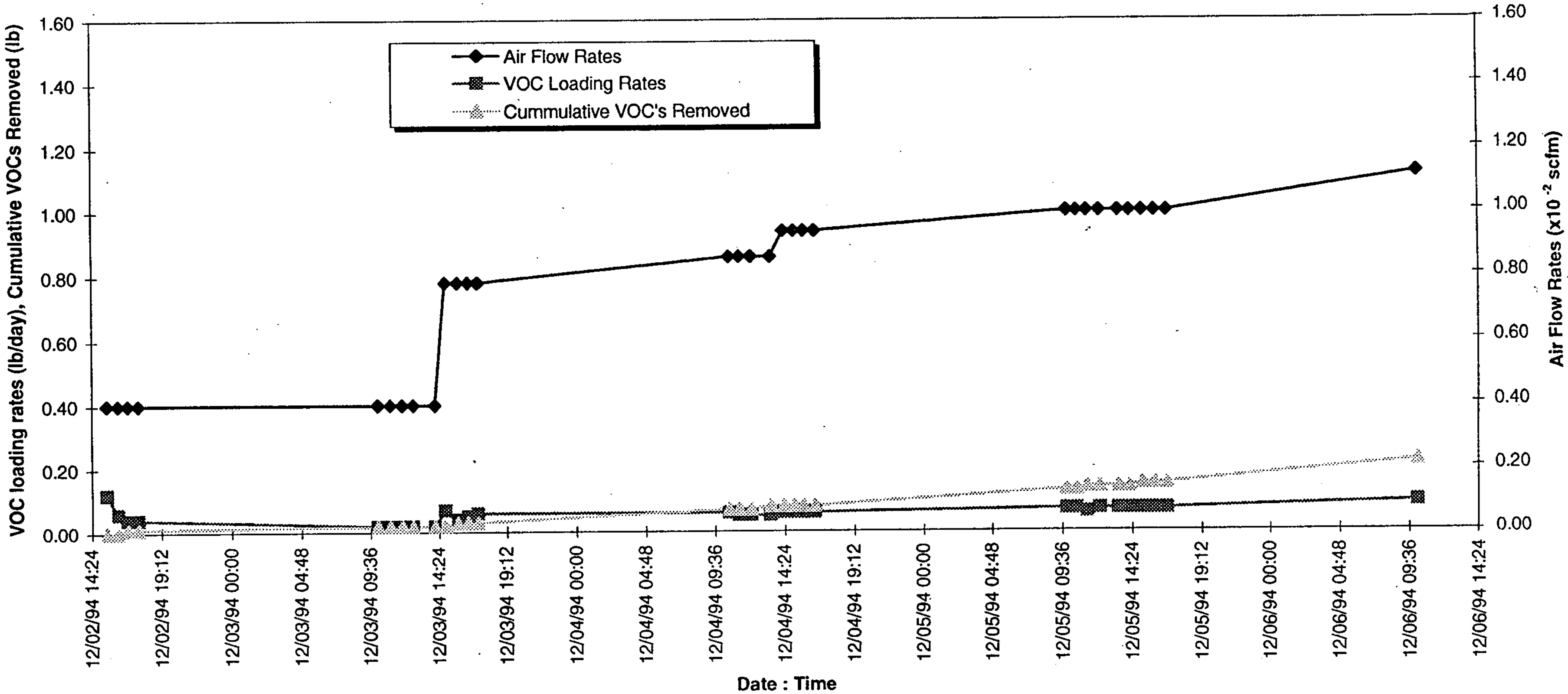
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates, Air Flows and VOC Removals at SVE Well DCF94ES-3A During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-4

CPS-F5_5/5DEC95/U4



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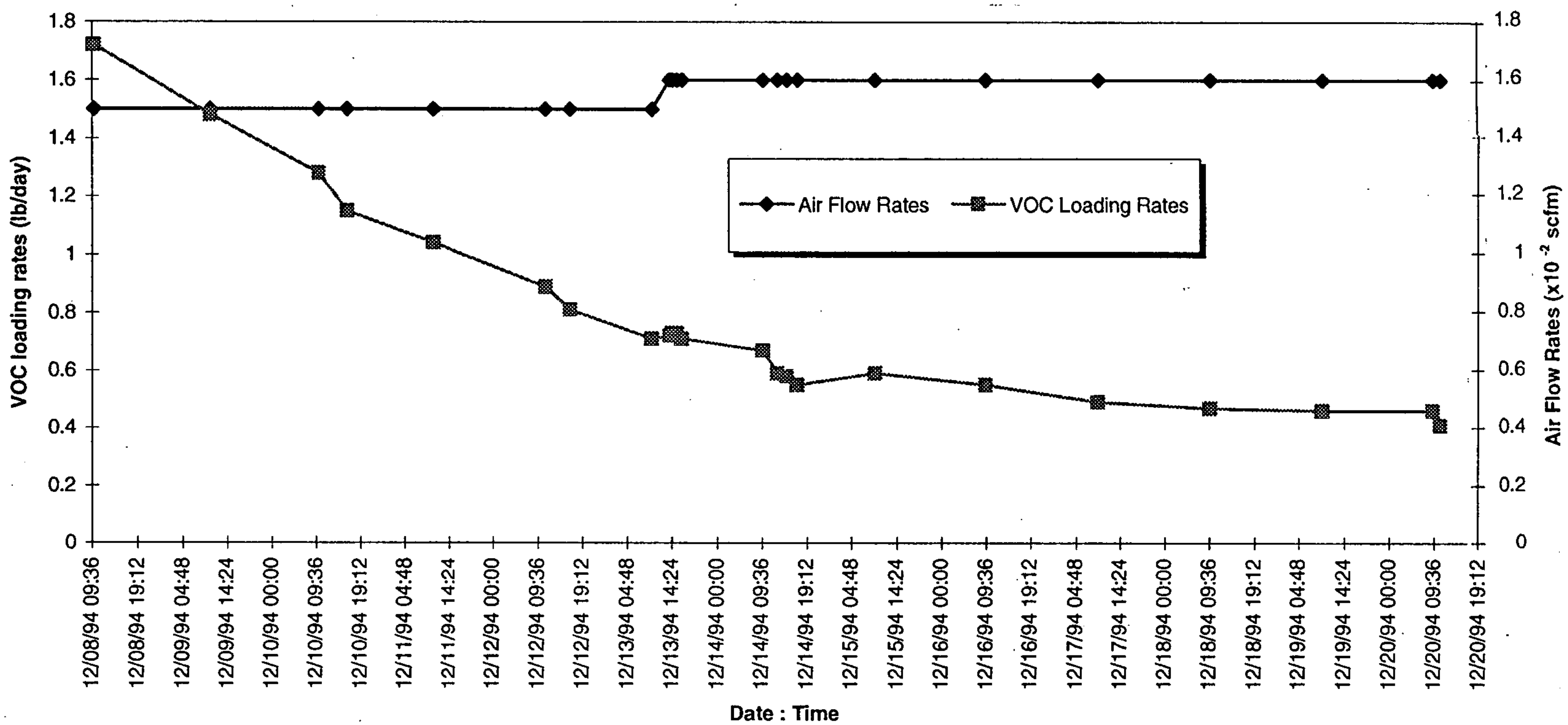
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates, Air Flows and VOC Removals at SVE Well DCF94-21 During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-5

CPS-F56A/5DEC95/U4



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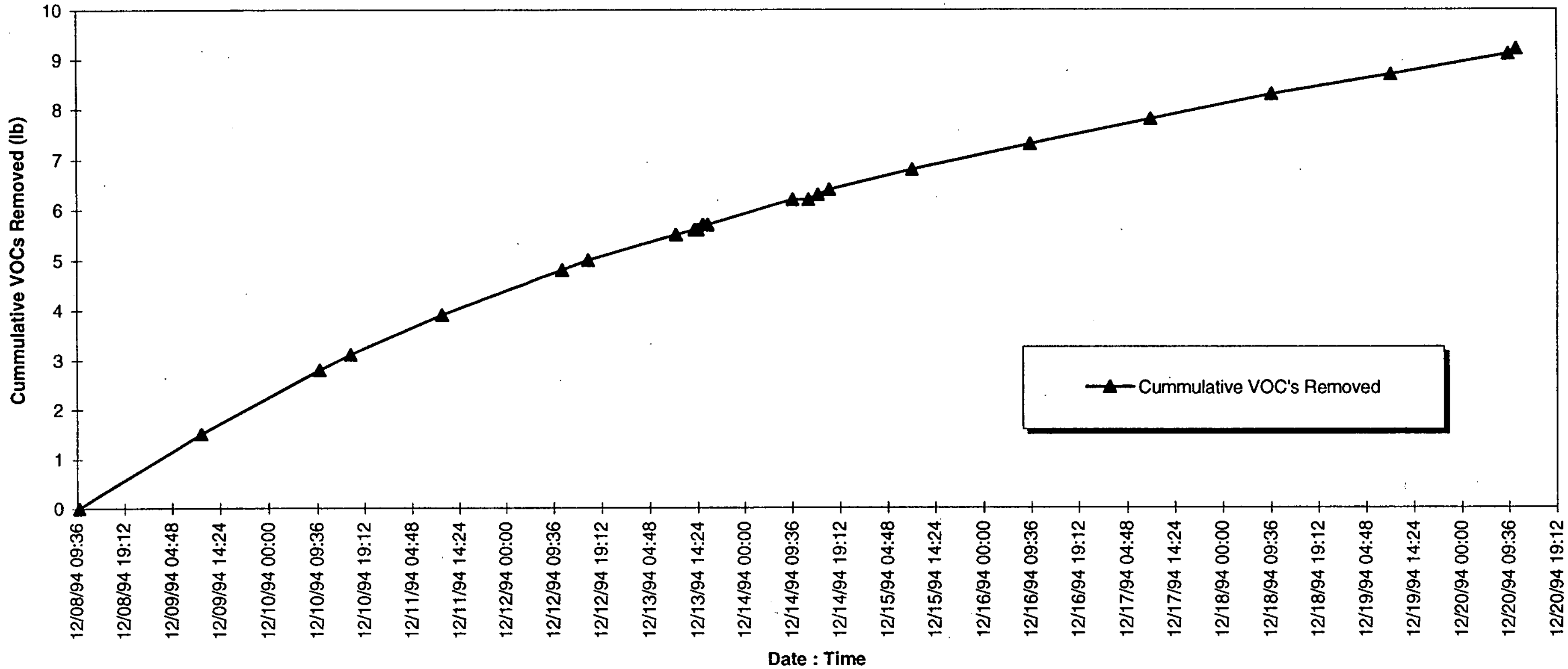
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates and Air Flows for Combined Operation During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-6A

CPS-F56b/5DEC95/U4



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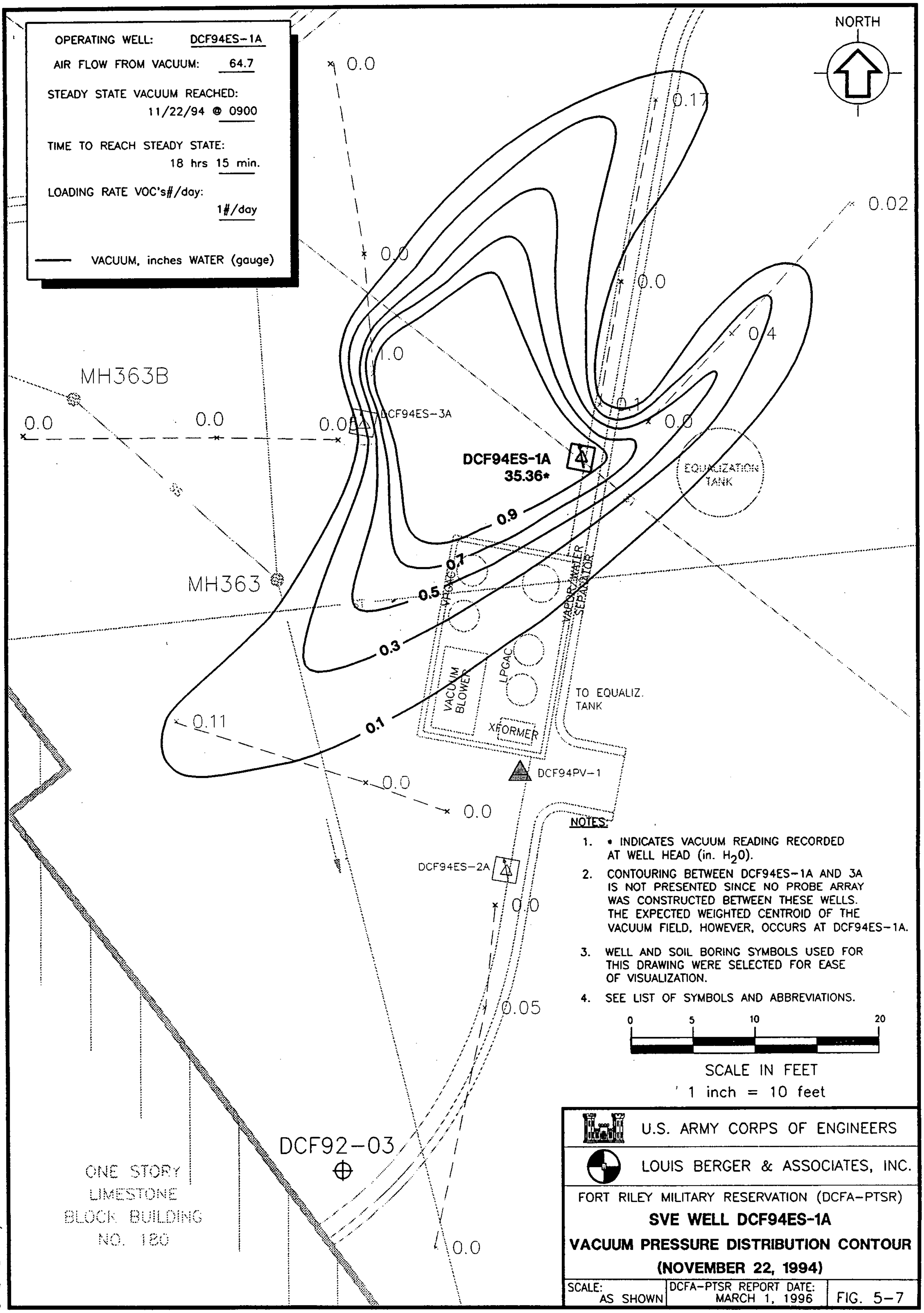
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

Cumulative VOC Removal (lbs) for Combined Operation During the Initial Phase Pilot Test Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-6B



NOTES:

1. * INDICATES VACUUM READING RECORDED AT WELL HEAD (in. H_2O).
2. CONTOURING BETWEEN DCF94ES-1A AND 3A IS NOT PRESENTED SINCE NO PROBE ARRAY WAS CONSTRUCTED BETWEEN THESE WELLS. THE EXPECTED WEIGHTED CENTROID OF THE VACUUM FIELD, HOWEVER, OCCURS AT DCF94ES-1A.
3. WELL AND SOIL BORING SYMBOLS USED FOR THIS DRAWING WERE SELECTED FOR EASE OF VISUALIZATION.
4. SEE LIST OF SYMBOLS AND ABBREVIATIONS.

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FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

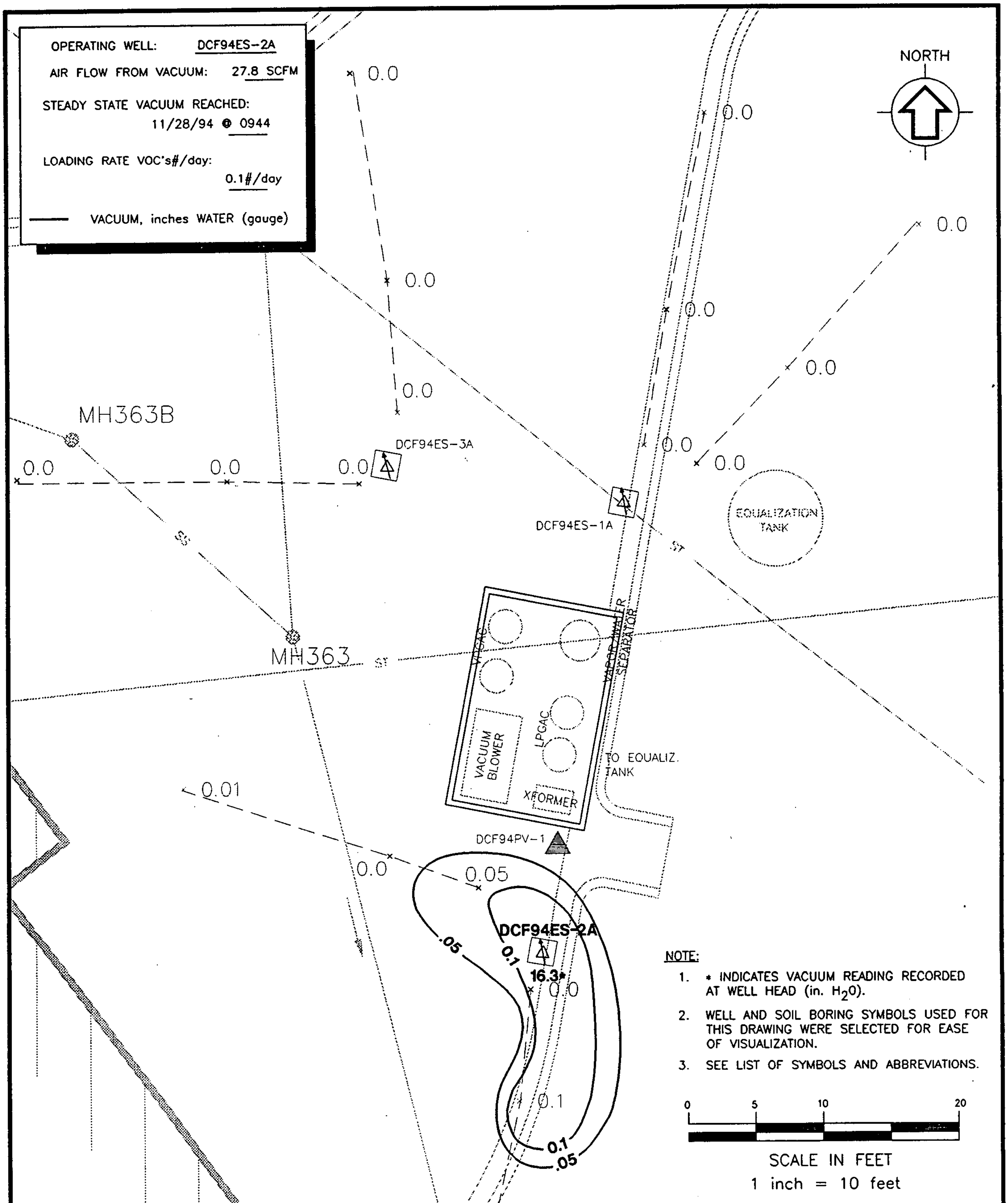
SVE WELL DCF94ES-1A

VACUUM PRESSURE DISTRIBUTION CONTOUR

(NOVEMBER 22, 1994)

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-7

CPS-SV1A/06DEC95



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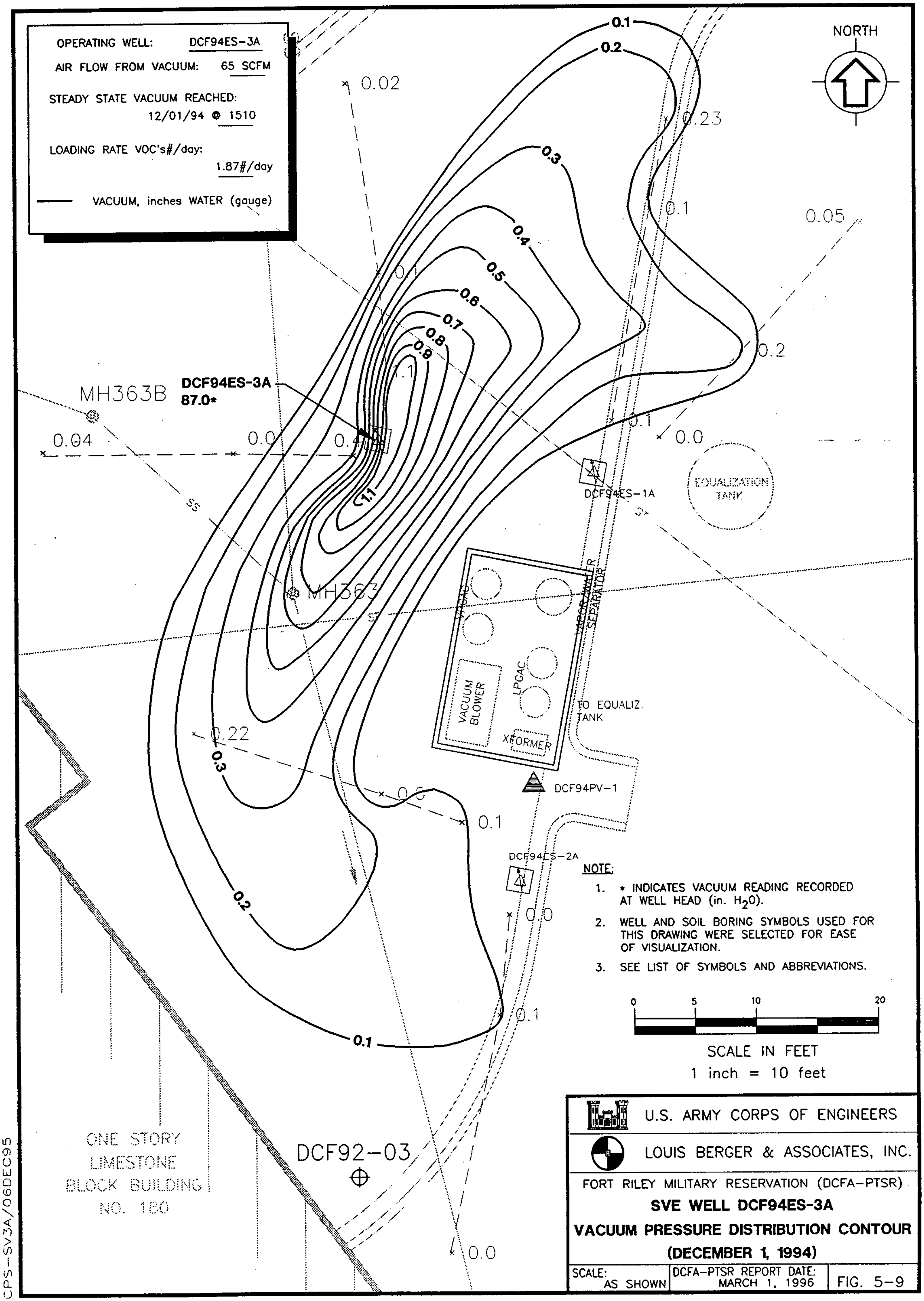
LOUIS BERGER & ASSOCIATES, INC.

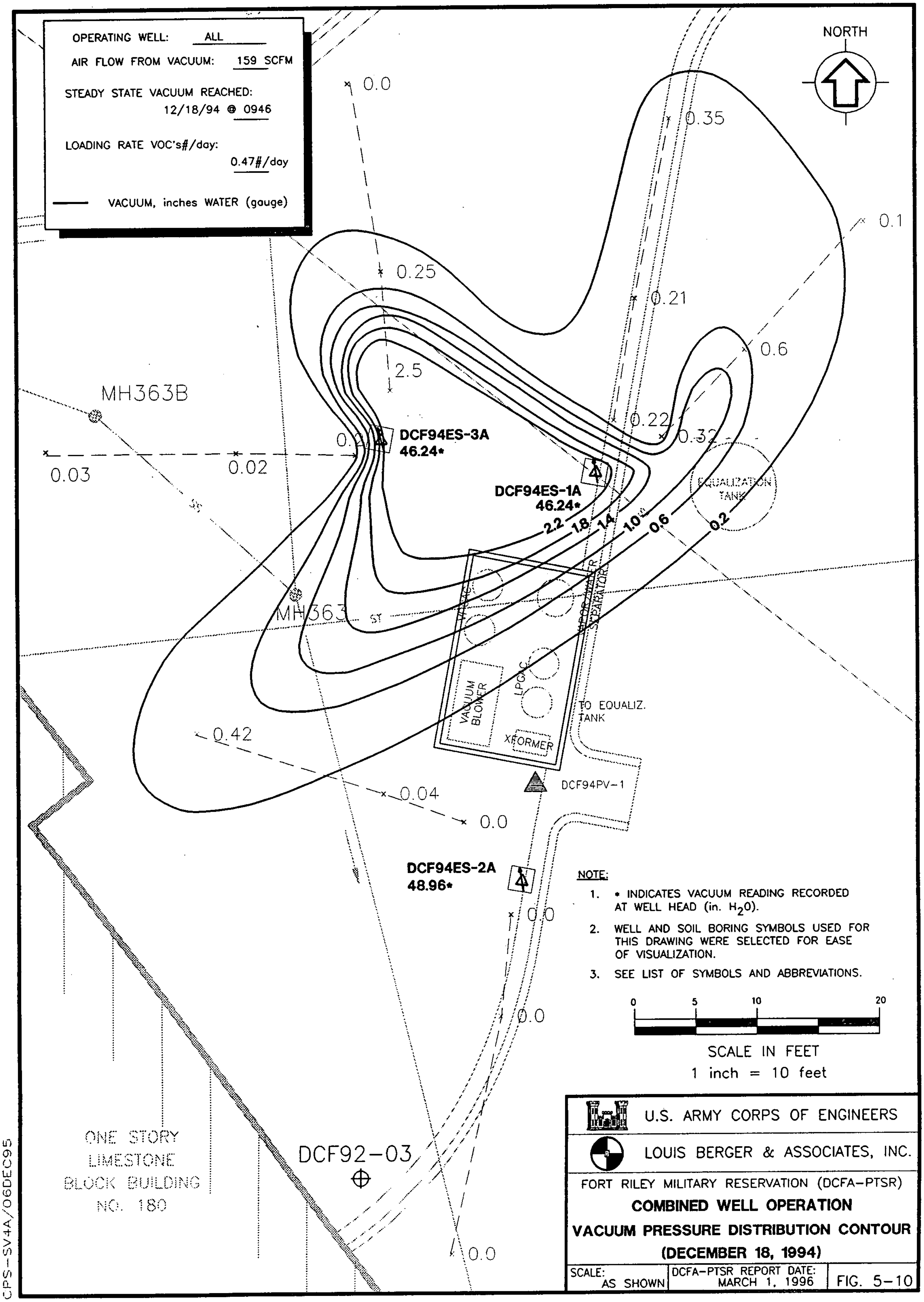
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

SVE WELL DCF94ES-2A
VACUUM PRESSURE DISTRIBUTION CONTOUR
(NOVEMBER 28, 1994)

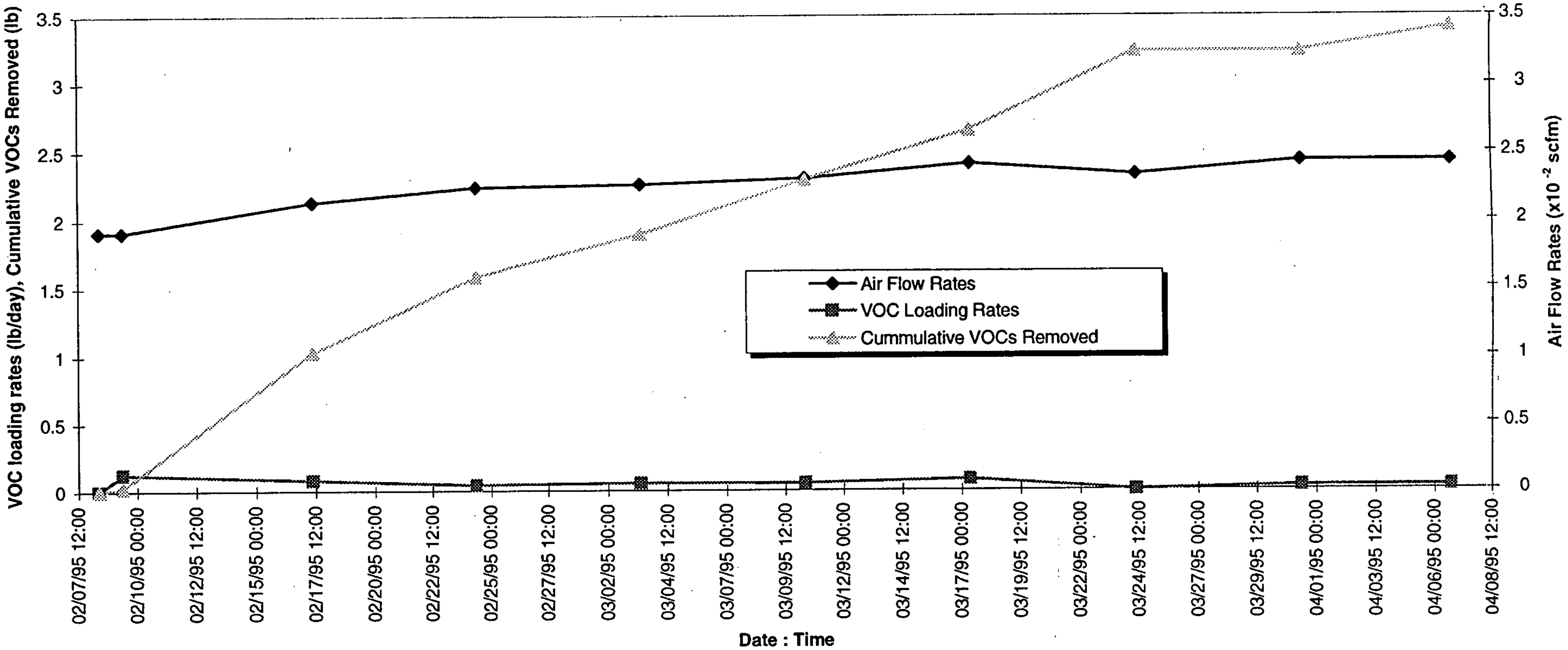
SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-8

CPS--SV2A/06DEC95


OPERATING WELL: DCF94ES-3A
AIR FLOW FROM VACUUM: 65 SCFM
STEADY STATE VACUUM REACHED: 12/01/94 @ 1510
LOADING RATE VOC's#/day: 1.87#/day
VACUUM, inches WATER (gauge)
NORTH
MH363B
DCF94ES-3A
87.0*
MH363
EQUALIZATION TANK
DCF94ES-1A
VAPOR/WATER SEPARATOR
VACUUM BLOWER
LPGAC
XFORMER
TO EQUALIZ. TANK
DCF94PV-1
DCF94ES-2A
NOTE:
1. * INDICATES VACUUM READING RECORDED AT WELL HEAD (in. H_2O).
2. WELL AND SOIL BORING SYMBOLS USED FOR THIS DRAWING WERE SELECTED FOR EASE OF VISUALIZATION.
3. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
0 5 10 20
SCALE IN FEET
1 inch = 10 feet
ONE STORY LIMESTONE BLOCK BUILDING NO. 180
DCF92-03
U.S. ARMY CORPS OF ENGINEERS
LOUIS BERGER & ASSOCIATES, INC.
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)
SVE WELL DCF94ES-3A
VACUUM PRESSURE DISTRIBUTION CONTOUR
(DECEMBER 1, 1994)
SCALE: AS SHOWN
DCFA-PTSR REPORT DATE: MARCH 1, 1996
FIG. 5-9


OPERATING WELL: ALL
AIR FLOW FROM VACUUM: 159 SCFM
STEADY STATE VACUUM REACHED: 12/18/94 @ 0946
LOADING RATE VOC's#/day: 0.47#/day
VACUUM, inches WATER (gauge)
NORTH
0.0
0.35
0.1
0.25
0.21
0.6
2.5
MH363B
0.22
0.32
DCF94ES-3A 46.24*
0.2
0.03
0.02
DCF94ES-1A 46.24*
EQUALIZATION TANK
2.2
1.8
1.4
1.0
0.6
0.2
MH363
ST
VAPOR/WATER SEPARATOR
VACUUM BLOWER
LPGAC
XFORMER
TO EQUALIZ. TANK
0.42
0.04
0.0
DCF94PV-1
DCF94ES-2A 48.96*
0.0
NOTE:
1. * INDICATES VACUUM READING RECORDED AT WELL HEAD (in. H2O).
2. WELL AND SOIL BORING SYMBOLS USED FOR THIS DRAWING WERE SELECTED FOR EASE OF VISUALIZATION.
3. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
0
5
10
20
0.0
SCALE IN FEET
1 inch = 10 feet
ONE STORY LIMESTONE BLOCK BUILDING NO. 180
DCF92-03
0.0
U.S. ARMY CORPS OF ENGINEERS
LOUIS BERGER & ASSOCIATES, INC.
FORT RILEY MILITARY RESERVATION (DCFA-PTSR)
COMBINED WELL OPERATION
VACUUM PRESSURE DISTRIBUTION CONTOUR
(DECEMBER 18, 1994)
SCALE: AS SHOWN
DCFA-PTSR REPORT DATE: MARCH 1, 1996
FIG. 5-10
CPS-SV4A/06DEC95

CPS-F511/5DEC95/U4



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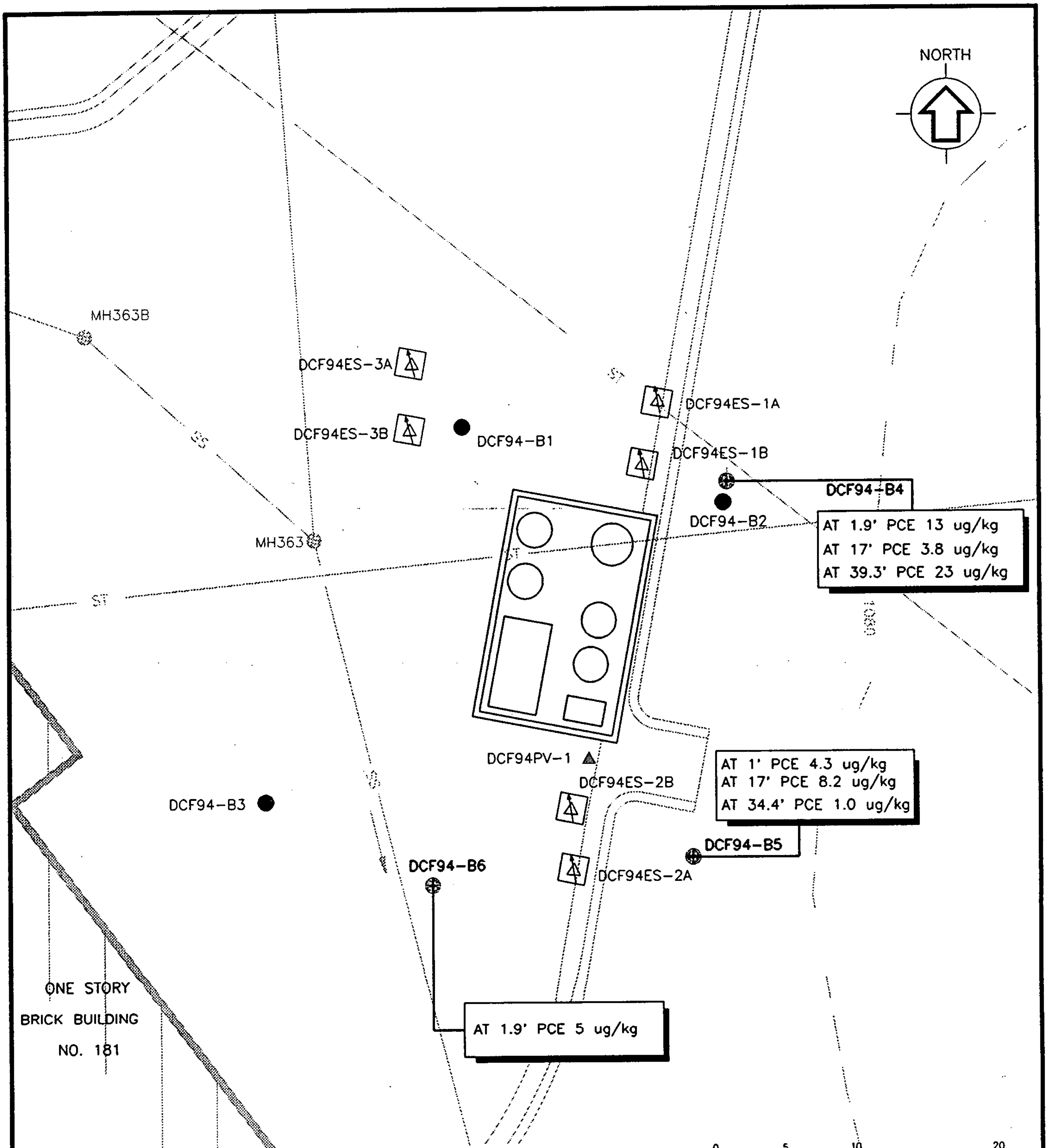
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

VOC Loading Rates, Air Flows, and VOC Removals During the Extended Phase Pilot Study

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-11



LEGEND

DCF94-B3 ● SOIL BORING LOCATION; NO.; SAMPLING DATE 5/94

DCF94-B6 ⊕ SOIL BORING LOCATION; NO.; SAMPLING DATES 10/94 & 4/95

DCF94ES-1B △ EXTRACTION WELL

NOTES

1. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
2. WELL AND SOIL BORING SYMBOLS WERE SELECTED FOR EASE OF VISUALIZATION.

U.S. ARMY CORPS OF ENGINEERS

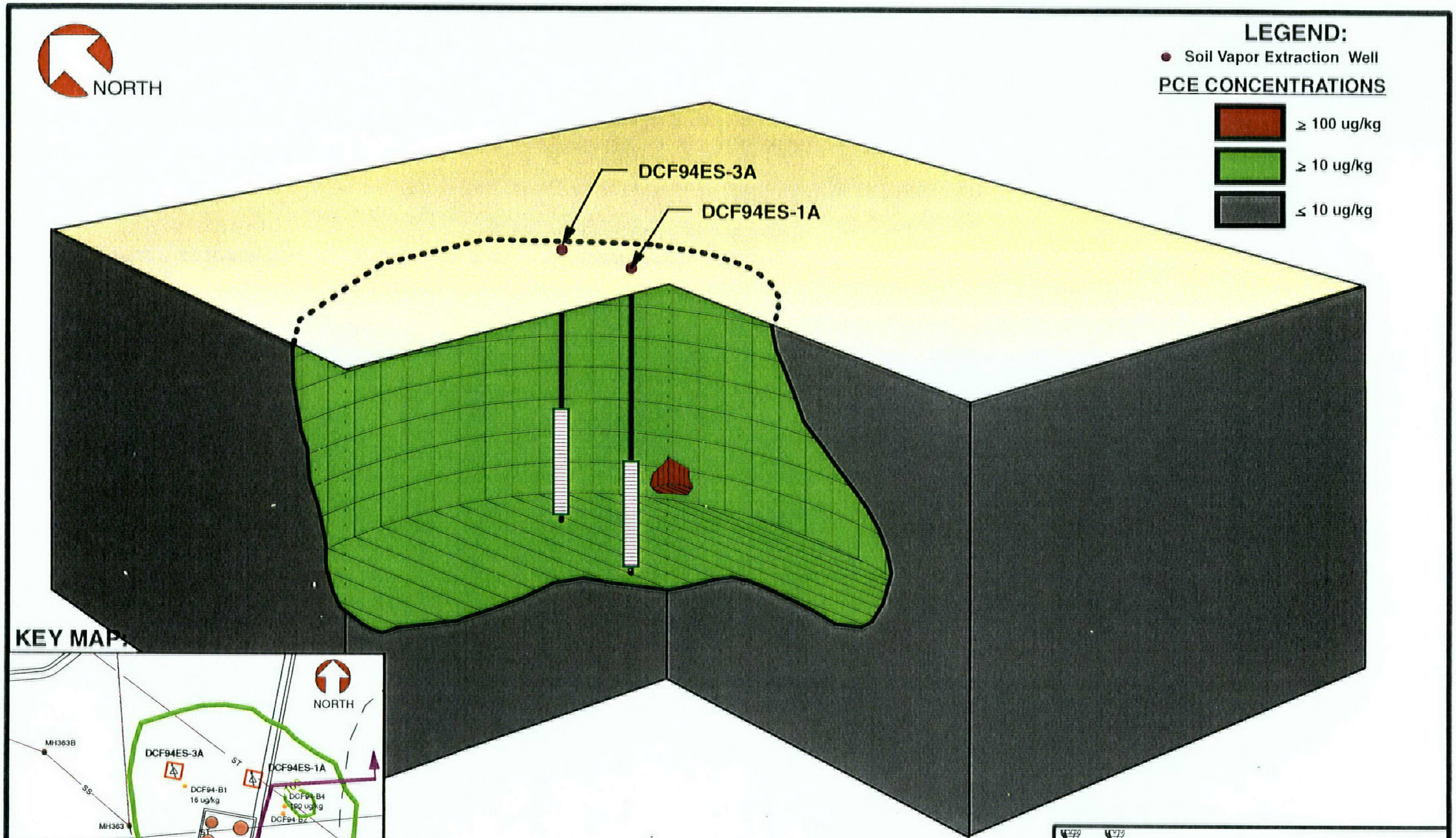
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

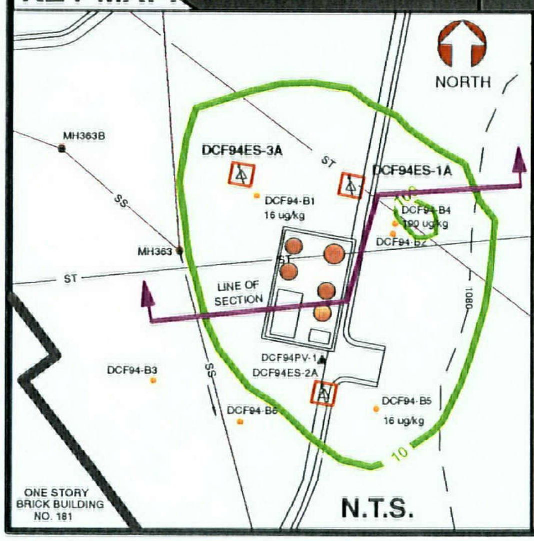
POST-EXTRACTION SOIL SAMPLING LOCATIONS & ANALYTICAL RESULTS (APRIL 1995)

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-12

CPS-PETS/06DEC95



KEY MAP:



NOTE:

1. THIS FIGURE DEPICTS THE NOT TO SCALE ISOMETRIC VIEW OF THE EXTENT OF PCE CONTAMINATION IN SOIL AT THE DCFA.
2. THE PCE CONTOURS SHOWN IN THE KEY MAP ARE REPRESENTATIVE OF THE DEPTH INTERVAL (i.e. 15'- 20' BGS) INDICATING THE HIGHEST PCE CONCENTRATIONS.

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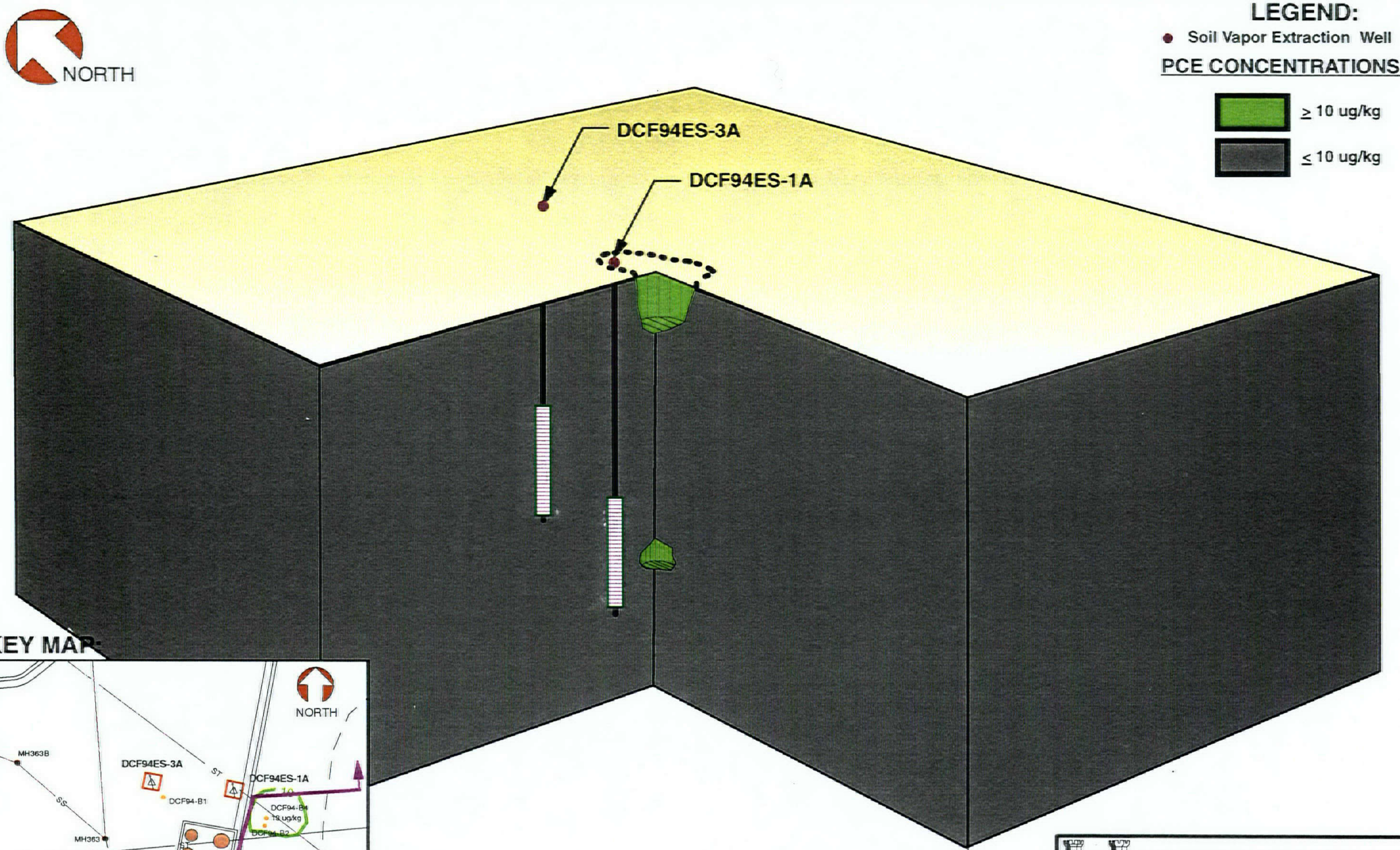
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

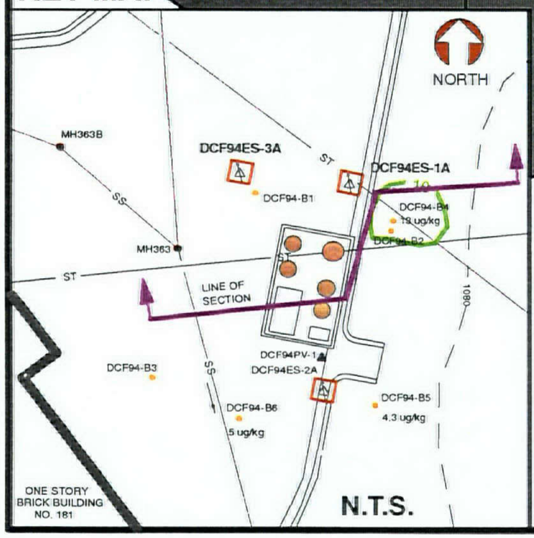
EXTENT OF PCE CONTAMINATION IN SOIL- BASELINE CONDITIONS (OCTOBER 1995)

Scale: N.T.S.	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-13

BASECUT/06DEC95



KEY MAP:



NOTE:

1. THIS FIGURE DEPICTS THE NOT TO SCALE ISOMETRIC VIEW OF THE EXTENT OF PCE CONTAMINATION IN SOIL AT THE DCFA.
2. THE PCE CONTOURS SHOWN IN THE KEY MAP ARE REPRESENTATIVE OF THE DEPTH INTERVAL OF 1 foot to 5 foot B.G.S.

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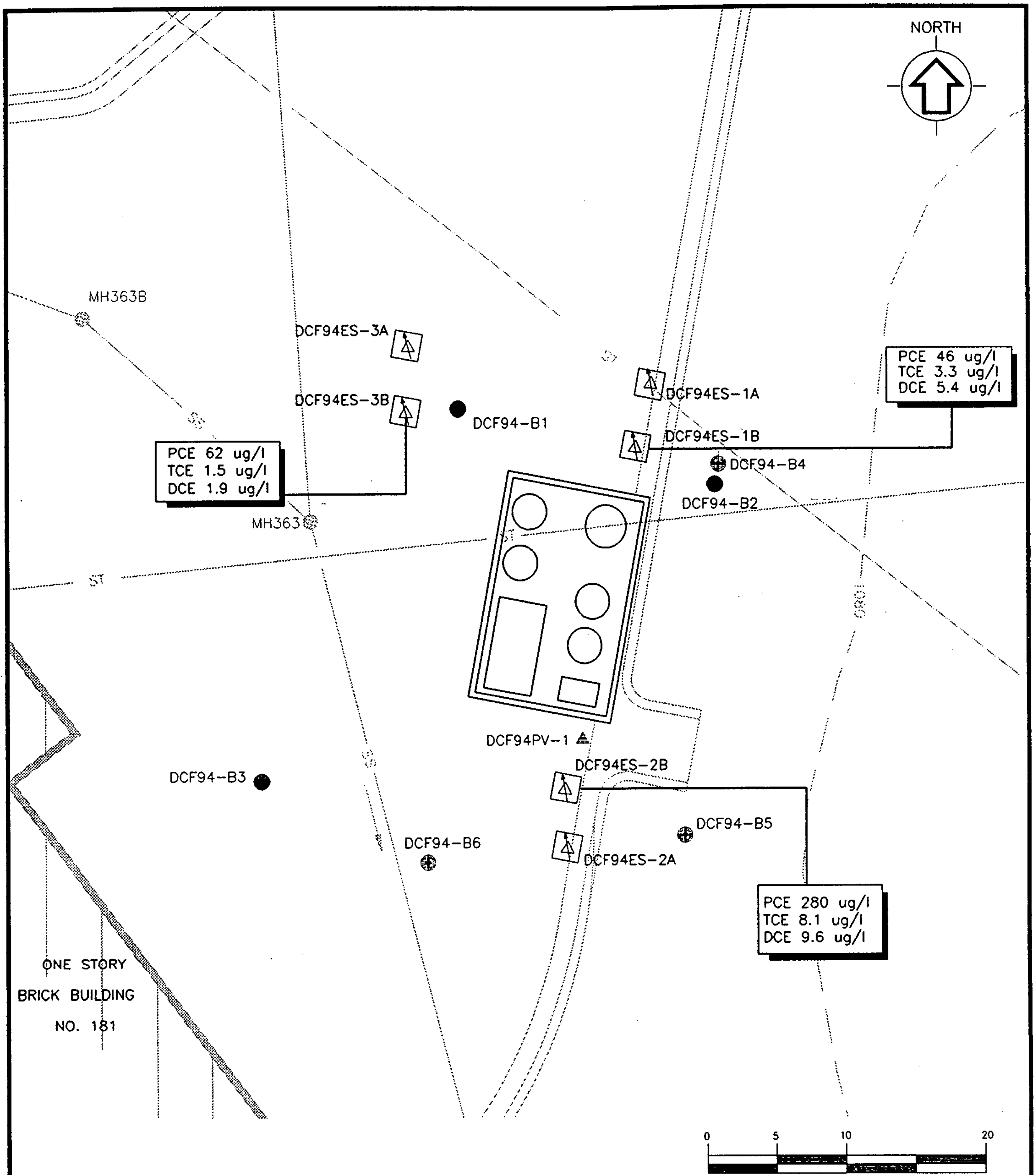
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

EXTENT OF PCE CONTAMINATION IN SOIL-POST PILOT TEST CONDITION (JUNE 1995)

Scale: N.T.S.	DCFA-PTSR REPORT DATE: MARCH 1,1996	FIG. 5-14



LEGEND

DCF94-B3 ● SOIL BORING LOCATION; NO.; SAMPLING DATE 5/94

DCF94-B6 ⊕ SOIL BORING LOCATION; NO.; SAMPLING DATE 10/94

DCF94ES-1B EXTRACTION WELL

NOTE

1. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
2. WELL AND SOIL BORING SYMBOLS WERE SELECTED FOR EASE OF VISUALIZATION.

U.S. ARMY CORPS OF ENGINEERS

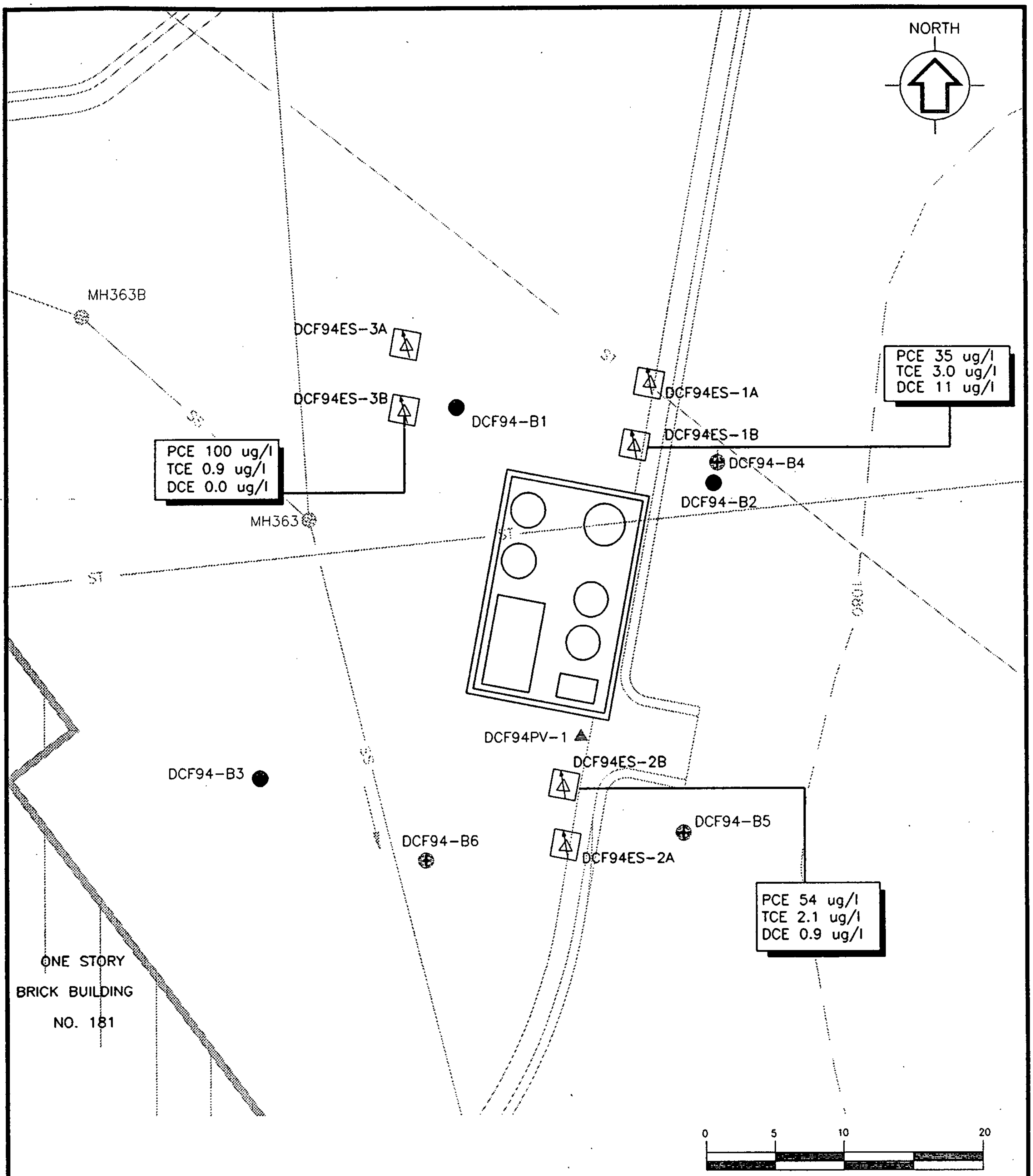
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

PCE AND ITS BREAKDOWN PRODUCTS DETECTED IN GROUNDWATER SAMPLES COLLECTED FROM EXTRACTION WELLS FOR THE PILOT TEST STUDY BASELINE SAMPLED 6/94

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-15

4-PPT1/27FEB96



LEGEND

DCF94-B3 ● SOIL BORING LOCATION; NO.; SAMPLING DATE 5/94

DCF94-B6 ⊕ SOIL BORING LOCATION; NO.; SAMPLING DATE 10/94

DCF94ES-1B △ EXTRACTION WELL

NOTE

1. SEE LIST OF SYMBOLS AND ABBREVIATIONS.
2. WELL AND SOIL BORING SYMBOLS WERE SELECTED FOR EASE OF VISUALIZATION.

U.S. ARMY CORPS OF ENGINEERS

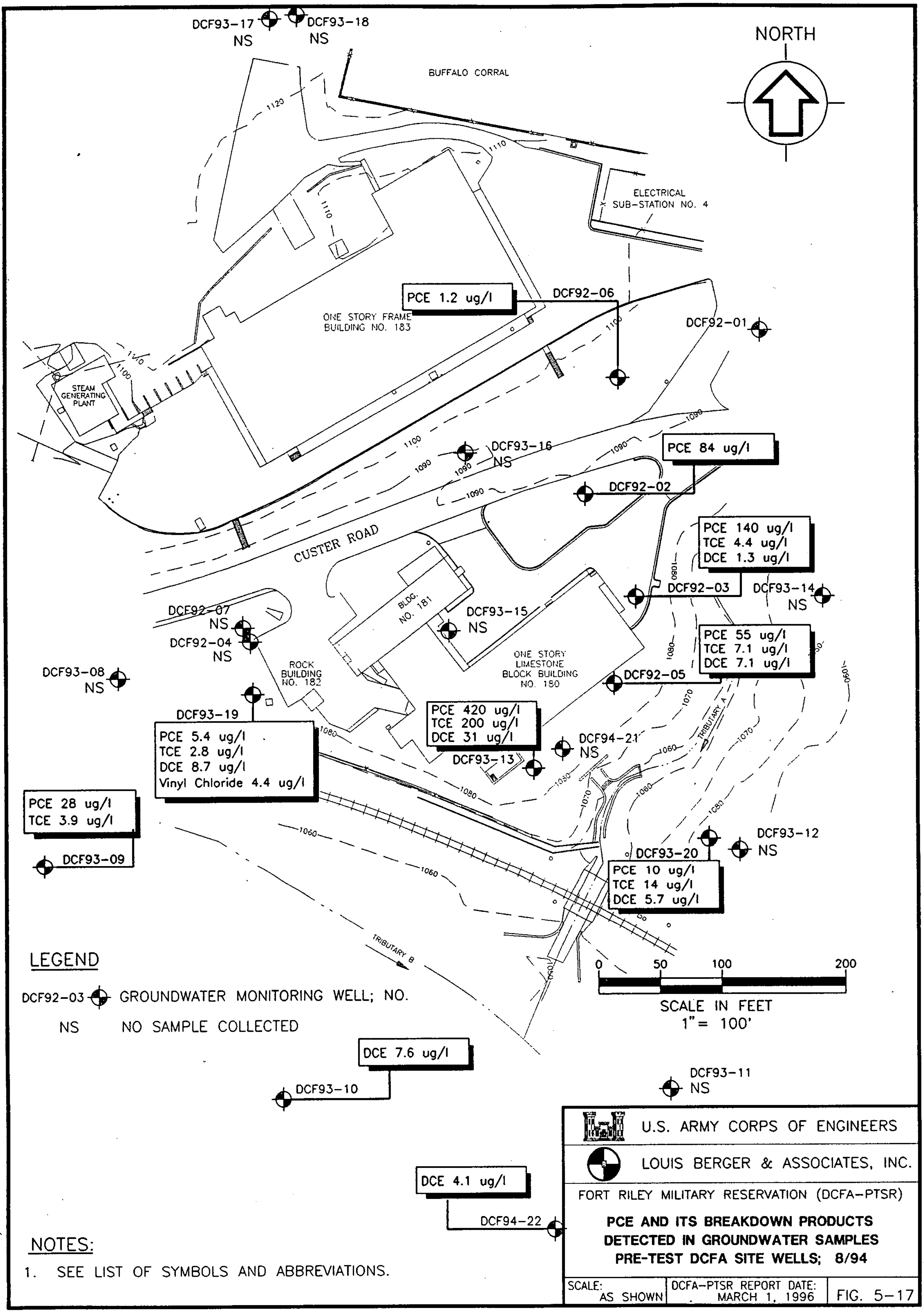
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

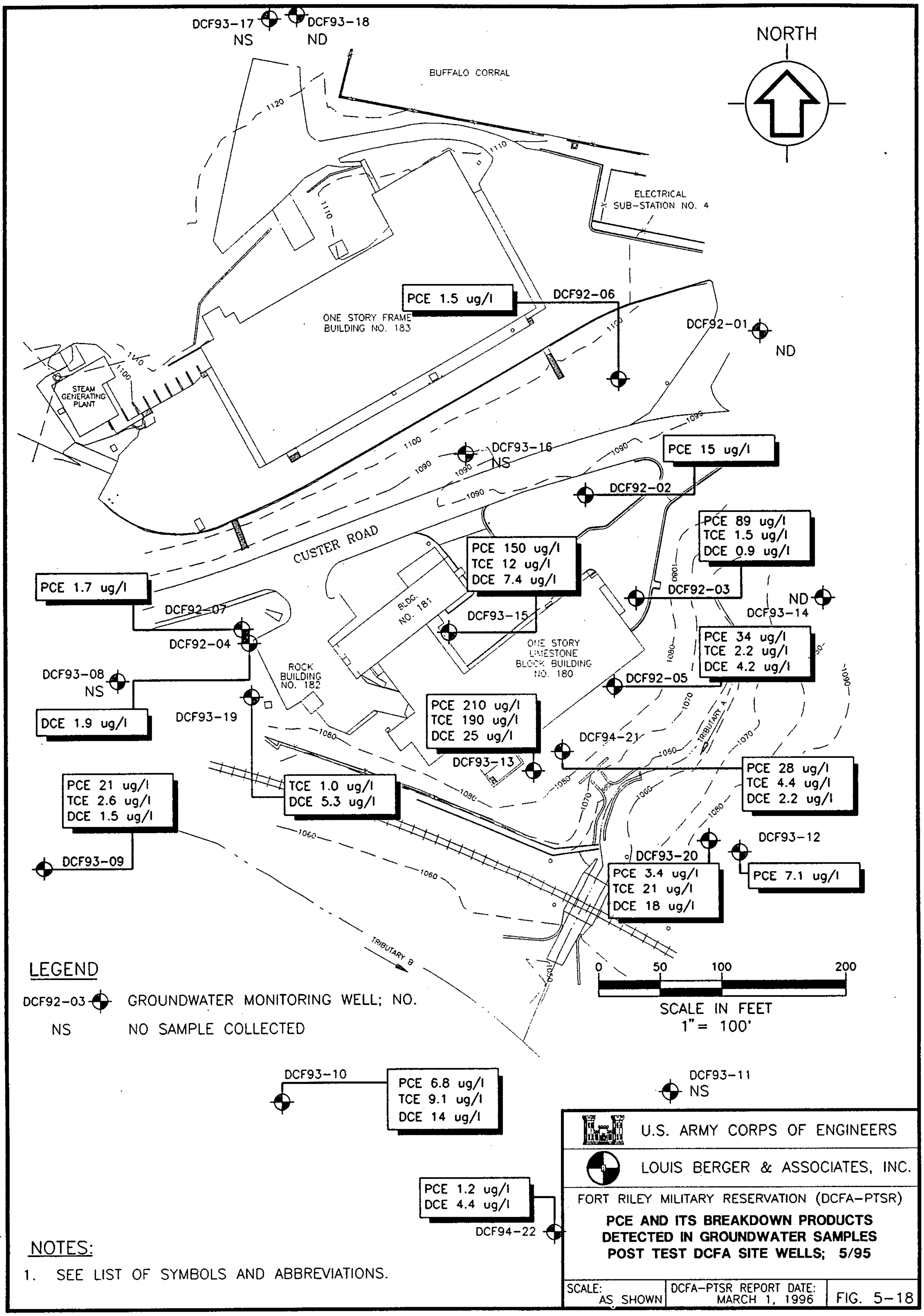
PCE AND ITS BREAKDOWN PRODUCTS DETECTED IN GROUNDWATER SAMPLES COLLECTED FROM POST TEST EXTRACTION WELLS; 5/95

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-16

4-PPT2/06DEC95



4-WC894/27FEB96



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LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA-PTSR)

PCE AND ITS BREAKDOWN PRODUCTS DETECTED IN GROUNDWATER SAMPLES POST TEST DCFA SITE WELLS; 5/95

SCALE: AS SHOWN	DCFA-PTSR REPORT DATE: MARCH 1, 1996	FIG. 5-18

4-WC195/27FEB96

6.0 WASTE GENERATION AND MANAGEMENT

6.0 WASTE GENERATION AND MANAGEMENT

During the DCFA pilot test study program, several types of wastes were generated. The waste generated was a result of work associated with the installation of wells and the extraction of groundwater and soil vapor as part of the SVE operations. The waste generated was managed and discharged in accordance with the *Work Plan* and applicable U.S. EPA and KDHE regulations. Details on IDW management and ultimate disposal procedures are presented in sections 6.1 through 6.5.

6.1 SOIL

Soil waste was generated during pilot study trenching, well drilling and soil boring activities as excavated spoils and drill cuttings. During trenching activities, soil excavated from the trench was temporarily staged on polyethylene liners until header piping was constructed and electrical conduit and wires were placed in the trench. As part of the health and safety monitoring, field screening with a PID was conducted to assess ambient conditions and to evaluate the excavated soils.

Throughout drilling operations, soil cuttings were field-screened with a PID to assist in determining soil waste characteristics. In both well drilling and soil boring operations as well as trenching activities, the PID indicated no detectable readings above background. Therefore, the soil was used to backfill the soil boring holes and conduit trench.

6.2 EXTRACTED GROUNDWATER

Groundwater was generated during the pilot test study program as a result of slug tests, pump tests, temperature monitoring activities and system operation during or related to the DCFA pilot study program. Extracted groundwater was temporarily stored in U.S. Department of Transportation (U.S. DOT)-approved 55-gallon drums or pumped directly through the pilot test system for treatment. Treated water was stored in the 1,500-gallon equalization tank, and sampled and analyzed for VOCs prior to ultimate discharge to the Main Post Wastewater Treatment Plant. Wastewater contained in the equalization tank was sampled and analyzed by the on-site GC; however, additional samples were collected and submitted to CAS for confirmatory analysis. Analytical results are provided in Tables 6-1 and 6-2, together with discharge volumes.

In total, an estimated 2,460 gallons of extracted groundwater were generated and treated on site prior to discharge to the Main Post Wastewater Treatment Plant during the Pilot Test Study program operations. The breakdown of the groundwater generated is as follows:

- 150 gallons were generated during step and sustained yield aquifer tests on wells DCF92-05, DCF93-13 and DCF94-21, conducted in June 1994.

- Also in June 1994, water was manually collected from the groundwater wells which were included in the temperature and conductivity monitoring program. Over a period of approximately one week, an estimated 65 gallons of water were collected.

- Between August 14 and 16, 1994, the Pilot Test Study groundwater treatment system was turned on for three separate five-hour pump tests on wells DCF94ES-1B, 2B and 3B. Each test generated approximately 95 gallons of water, for a total three-day volume of 285 gallons.

- A combined well pump test was performed between August 18 and 22, 1994, which generated a total of 1,915 gallons.

The total estimated 2,460 gallons of the extracted groundwater was treated prior to discharge, using the pilot test system's equalization tank for management and the LPGAC units for treatment. In some instances, the water was recirculated through the units until non-detectable VOC concentrations were obtained in the confirmatory samples.

6.3 EXTRACTED SOIL VAPOR

The soil vapor extracted during the SVE pilot study was drawn through VPGAC units for treatment prior to atmospheric discharge. Samples were collected prior to, in between and after GAC to evaluate the soil vapor quality and consumption rate of the GAC. The samples were analyzed by on-site GC to determine when the lead GAC (i.e., the first GAC in series) was no longer capable of treating the vapor stream for VOCs. As VOCs became evident in the "between" sample, the first GAC unit was removed, the second GAC unit was placed in the lead position, and a new GAC unit was connected to the end for secondary treatment. Post GAC analysis was performed to demonstrate that VOCs were not being discharged in excess of allowable air quality discharge criteria.

6.4 SPENT GRANULAR-ACTIVATED CARBON (GAC) UNITS

The LPGACs and VPGACs used in preparation for and in the course of the Pilot Test Study as previously indicated in sections 6.2 and 6.3 were staged in a designated area for characterization prior to off-site disposal. A total of three LPGACs and four VPGACs were sampled for waste characterization analysis and determined to be non-hazardous. During the pilot test demobilization, the GAC units were moved off site for staging prior to disposal.

For the LPGACs, the three units consisted of one primary GAC and one secondary GAC (185 pounds each) that were placed in line and used to treat VOC-impacted groundwater during the start of the pump test in August 1994 and a third LPGAC used to replace the primary GAC determined to be leaking later on that date. For the VPGACs, a total of four units (185 pounds each) were spent during the course of the Pilot Test Study program.

For both the LPGAC and VPGAC units, unless a unit was used and replaced due to failure (i.e., leaking canister), the GAC changeout procedure involved the replacement of the primary GAC upon establishment of breakthrough with the secondary carbon and the placement of a fresh GAC canister as the new secondary unit. Breakthrough was determined on the basis of VOC concentrations in midpoint samples approaching influent VOC levels. Leaking units were replaced with like units (i.e., primary for primary or secondary for secondary) and staged with spent carbon for characterization prior to off-site regeneration.

For all GAC units, the analytical results indicated the units to be non-hazardous. On November 2, 1995, all of the LPGAC and VPGAC units were transported off site for regeneration. The three overpack units were sent to Barneby & Sutcliffe and the remainder of the units were sent to Envirotrol, Inc. Each facility received the shipment by November 5, 1995.

6.5 CONSTRUCTION DEBRIS AND MISCELLANEOUS WASTE MATERIALS

During demobilization activities, before underground pipes were abandoned, each pipe was rinsed for the purpose of decontamination. A confirmation rinsate sample was collected to verify that the pipes were clean before backfilling. Rinsate from well DCF94-21 was transferred through the pilot system's LPGAC and stored in the equalization tank. All water which was not directly pumped through preconnected LPGAC was collected in the 1,000-gallon equalization tank. After all laboratory samples were collected, the Pilot Test Study equipment was reconfigured and the water in the tank, estimated at 600 gallons, was cycled through LPGAC overnight (roughly 15 hours). The cycle time was the equivalent of many complete volumes of the stored water. After the recycling period which was certain to reduce the VOC concentrations to non-detectable levels, the water was pumped through the pilot system discharge hose to MH 345 and ultimately to the Main Post Wastewater Treatment Plant.

In addition to the rinsate waste, the demolition of the pilot study shed and concrete containment pad generated a considerable amount of construction debris consisting of wood, concrete, pipes, steel plates, vaults and vault covers. Since all of this material was either cleaned or never in contact with contamination, it was either salvaged by contractors or discarded at the Post C/D Landfill.

6.6 DEMOBILIZATION AND SITE RESTORATION

Demobilization consisted of two phases: a partial demobilization at the end of the 30-day pilot test and a complete demobilization at the end of the extended pilot test operation.

In January 1995, the 30-day pilot test operation was completed according to the work plan schedule. SVE activities were continued, however, pending decisions on an extended operation schedule. As a result, a partial demobilization was implemented to remove those unnecessary equipment and constructions. The partial demobilization commenced on January 21, 1995. The activities included the removal of the GC van and its equipment, all vacuum/pressure probes and gauges, well pumps and connecting electrical wiring in groundwater extraction wells DCF94ES-1B, -2B, and -3B. In addition, all GAC canisters were removed from the site and staged with other GAC units at Marshall Army Airfield for future removal.

In April 1995, the extended operation was completed according to plan. A full decommissioning and removal of all pilot study equipment and restoration of the site commenced on April 26, 1995. The principal components of the demobilization consisted of the dismantling of the pilot study shed and removing of all SVE equipment. In dismantling the building, both the structure and its concrete containment pad were removed. The SVE equipment removed included the air/water separator, water transfer pump, equalization tank, and all associated above grade piping and hoses including roll pipe connected to MH 345. In addition, power was disconnected from the service pole in the rear of the property and the wires were cut several feet below the ground surface and abandoned in place. Because rainy weather prevented access to the rear of the property, the pole was left in place until a later date when vehicular access was possible. Removal of the utility pole was completed during the last week of July 1995.

Risers were attached to SVE wells DCF94ES-1A, -2A, -3A, and former groundwater extraction wells DCF94ES-1B, -2B, and -3B, to bring the top of casing up to near ground surface. The well vaults were filled with sand to secure the risers and the wells were finished with concrete and flush mounted covers consistent with other monitoring wells on-site. The groundwater extraction wells, i.e., DCF94ES-1B, -2B and -3B and DCF94-21, were intended to be used as monitoring wells. In the case of well DCF94-21 which was located in a grassy area behind building 180, a minimal amount of concrete was used below surface so that the well could be restored with top soil and grass. Additional top soil and grass was applied to any other area behind building 180 that indicated evidence of wear.

Final restoration of the parking lot area in the former location of the shed included the removal of all protruding probes and other piping to a level that was slightly below grade. The metal covers were removed from the pipe trenches and the soil was compacted to a level that was approximately 8″ below grade. After all probes and pipes were cut and the soil was compacted, the resulting depressions were filled with concrete to the previously existing grade level. Excess concrete was used to extend the parking area drainage spillway leading to the ravine on the eastern side of the site. The site was seeded and restored to pre-pilot test conditions. Excavated soil, which indicated no PID readings above background during previous screening, was taken to the Marshall Army Airfield and used to improve the condition of the gravel road by the site.

TABLE 6-1
EQUALIZATION TANK DATA (FIELD G.C.)
AUGUST 1994 THROUGH DECEMBER 1994
DRY CLEANING FACILITIES AREA

Sample Date	8/16/94	8/18/94	8/19/94	8/19/94	8/20/94	8/21/94	8/22/94	11/23/94	12/21/94
Sample Description	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite	Eq. Tank Composite
Discharge Volume	95 gal.	450	1190 gal.		275 gal.	100 gal.	200 gal.	100 gal.	50 gal.
Analyzed By:	Field GC	Field GC	Field GC	Field GC	Field GC	Field GC	Field GC	Field GC	Field GC
Units:	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)
Analyte:									
Methylene Chloride	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
t-1,2-Dichloroethylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
1,1-Dichloroethane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
cis-1,2-Dichloroethylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Trichloromethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dichloroethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
Benzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Trichloroethylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Toluene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Tetrachloroethylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chlorobenzene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
Ethylbenzene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
Xylene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
Other VOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL
Total VOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	BDL	BDL

Notes:

(1) BDL = Below Detection Limit

(2) N/A = Not Analyzed

(3) ppb = Parts Per Billion

(4) GC = Gas Chromatograph

TABLE 6-2
EQUALIZATION TANK DATA (CONTINENTAL ANALYTICAL DATA)
AUGUST 1994 THROUGH DECEMBER 1994
DRY CLEANING FACILITIES AREA

Sample Date	8/16/94	8/19/94	8/20/94	8/20/94	8/20/94
Sample Description	Eq. Tank Effluent	Effluent	Influent	Effluent	Effluent
Discharge Volume	95 gal.	1190 gal.		275 gal.	
Analyzed By:	CAS	CAS	CAS	CAS	CAS
Time:	1546	1645	1550	1555	1559
Units:	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)
Analyte:					
Methylene Chloride	ND	ND	ND	ND	ND
1,1,2-Dichloroethylene	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND
cis-1,2-Dichloroethylene	ND	ND	3.6	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND
Chloroform	ND	ND	4.1	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND
Trichloroethylene	ND	ND	4	ND	ND
Toluene	ND	ND	ND	ND	ND
Tetrachloroethylene	ND	ND	99	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND
Xylene	ND	ND	ND	ND	ND
Other VOC	ND	ND	ND	ND	ND
Total VOC	ND	ND	ND	ND	ND

Notes:

(1) ND = Not Detected

(2) CAS = Continental Analytical Services

(3) ug/l = Microgram Per Liter

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY OF PILOT TEST STUDY RESULTS

7.1.1 Overview

The results of the pilot test study, including total VOC mass removal, PCE mass removal and average VOC loading rates, are summarized in Table 7-1. Figures 7-1 and 7-2 present an overview of VOC loading rates, air flows and cumulative VOC mass removals for both the initial 30-day and the extended 60-day pilot study. As indicated in Table 7-1, VOC removal rates were found to differ from well to well. VOC loading rates from wells SVE-1A and 3A were observed to be much higher than SVE-2A and DCF94-21.

The DCFA SVE system was effective in reducing VOC levels in the vadose zone. Twenty-one pounds of VOCs were removed from the study area in the initial 30-day pilot study, whereas approximately three pounds of VOCs were removed during the extended 60-day SVE operation. Based on the baseline soil analytical results, it was estimated that a total of 45-55 pounds of contaminants were present in the DCFA pilot study area soil before the pilot study operation began. Thus, it is estimated that 50 percent of the contaminant mass has been removed from the site.

Analytical results for the extracted soil vapor samples collected from the extended pilot study indicate that low concentrations to non-detectable levels of VOCs now remain as of April 1995.

7.1.2 Initial 30-Day Pilot Study Results

At SVE-1A, the average VOC loading rate observed was 1.24 lbs/day, with the maximum rate of 1.46 lbs/day. A total of 4.79 pounds of VOCs were recovered from SVE-1A at test completion. At SVE-2A, the average VOC loading was 0.15 lb/day, with the maximum of 0.26 lb/day. Total VOC mass removed was 0.60 pound.

The average VOC loading rate at SVE-3A was 1.96 lbs/day, with the maximum removal rate of 3.44 lbs/day. Both the average and the maximum VOC loading rates for SVE-3A were the highest among the four extraction wells. A total of 6.12 pounds of VOCs were removed from SVE-3A. At DCF94-21, 0.06 lb/day was the average VOC removal rate, with a maximum of 0.12 lb/day. A total of 0.23 pound of VOC mass was removed from DCF94-21. Considering the combined test, which contributed an additional 9.26 pounds of VOC removal, the estimated total VOC mass removed during the initial 30-day pilot study was 21 pounds. The maximum loading rate observed during the combined test was 1.72 lbs/day.

With regard to the vacuum influence observed during each individual well test and during the combined test, it is believed that significant subsurface heterogeneities result in preferred pathways during SVE. These conditions are believed attributable to disturbances from previous construction activities (i.e., sewer and utility installations), and, from potential subsurface scouring from leaking sewer lines, pathways along sewer line piping and probe placement. As indicated in Section 5.3, the probes were located prior to the test on the basis of predicted vacuum influences, which differed from those observed in the field. Based on a post-test review, a significant number of additional probes would have been required to cover the unexpected responses observed. It is noted, however, that due to the presence of sensitive below-grade utilities (e.g., the sewer piping, telephone lines and main fiber-optic cable), additional probe placement would still have been limited.

7.1.3 Extended Phase Pilot Study Results

The extended SVE pilot study engaged all four extraction wells at the same time using the "optimum" combined flow rate from the 30 day test, and was therefore essentially a continuation of the combined well test from the initial-phase pilot study. A total of 3.41 pounds of VOCs were removed from the extended pilot study. The extended pilot study resulted in non-detection of VOCs in the extracted soil vapor, which led to the eventual termination of the SVE operation at the DCFA and the performance of post extraction soil sampling. Analytical results from the post extraction soil samples indicated that the only contaminant still detected in the vadose zone was PCE. The highest concentration of PCE detected was only 23 μg/kg, which is an order of magnitude below the most stringent published cleanup level from the U.S. EPA which is 300 μg/kg.

7.1.4 Conclusions

In comparing the baseline soil contaminant distribution with the post pilot study condition, the SVE pilot test system has significantly reduced the VOC contaminant mass in the DCF site soil. This is illustrated in Figures 5-13 and 5-14. The reduced horizontal and vertical extent of VOC impacted soil and the rate of recovery and influence, considering the noted subsurface interferences, demonstrate the effectiveness of SVE as a remediative technology for the DCFA. In fact, the highest total VOC concentration detected in the post test samples was 23 μg/kg, which is an order of magnitude below the most stringent published cleanup level from the U.S. EPA which is 300 μg/kg.

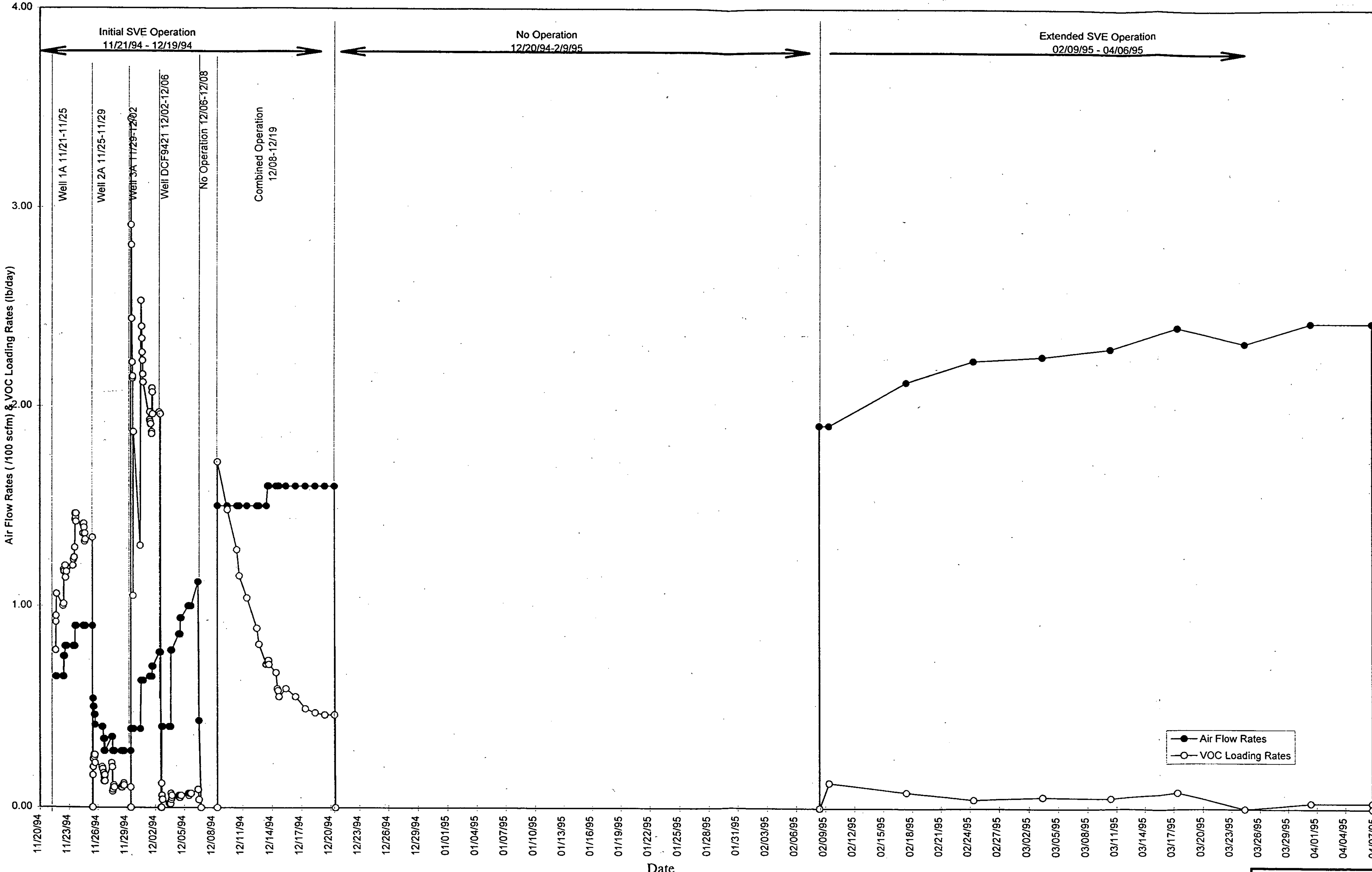
7.2 RECOMMENDATIONS

Although the pilot test study results demonstrate that SVE is an effective remedial technology for the DCFA, further SVE operations or long-term remediation activities do not appear to be warranted at this time based on the results of the baseline risk assessment and contaminant migration modeling performed as part of the *DCFA-RI*. If in the future, however, VOC levels in the vadose zone are indicated to be above some regulatory or risk-based action level, SVE technology can be effectively utilized to further reduce any elevated PCE levels.

TABLE 7-1

SUMMARY OF VOC LOADING RATES AND CUMULATIVE REMOVAL OF PCE AND TOTAL VOCs FOR INDIVIDUAL SVE OPERATIONS

SVE Operation	Operation Type	Begin	End	Time (days)	Total VOC Removed (lb)	Avg Loading Rate (lb/day)	Total PCE Removed	
							Mass (lbs)	% Over Total VOCs Removed
	Well 1A	11/21/94 14:30	11/25/94 11:07	3.86	4.79	1.24	4.46	93.11
	Well 2A	11/25/94 11:07	11/29/94 10:10	3.96	0.60	0.15	0.58	96.67
	Well 3A	11/29/94 10:10	12/02/94 13:15	3.13	6.12	1.96	5.68	92.81
	Well DCF-21	12/02/94 15:00	12/06/94 17:00	4.08	0.23	0.06	0.20	86.96
Initial	**Combined Well**							
	Well 1A	12/08/94 09:15	12/20/94 11:10	12.08	0.76	0.06	0.63	82.89
	Well 2A	12/08/94 09:15	12/20/94 11:10	12.08	0.25	0.02	0.20	83.33
	Well 3A	12/08/94 09:15	12/20/94 11:10	12.08	7.41	0.61	6.72	90.81
	Well DCF-21	12/08/94 09:15	12/20/94 11:10	12.08	0.68	0.06	0.59	88.06
Extended	**Combined Well**							
	All Wells	02/08/95 09:00	04/06/95 17:00	57.33	3.41	0.06	3.26	98.06



U.S. ARMY CORPS OF ENGINEERS

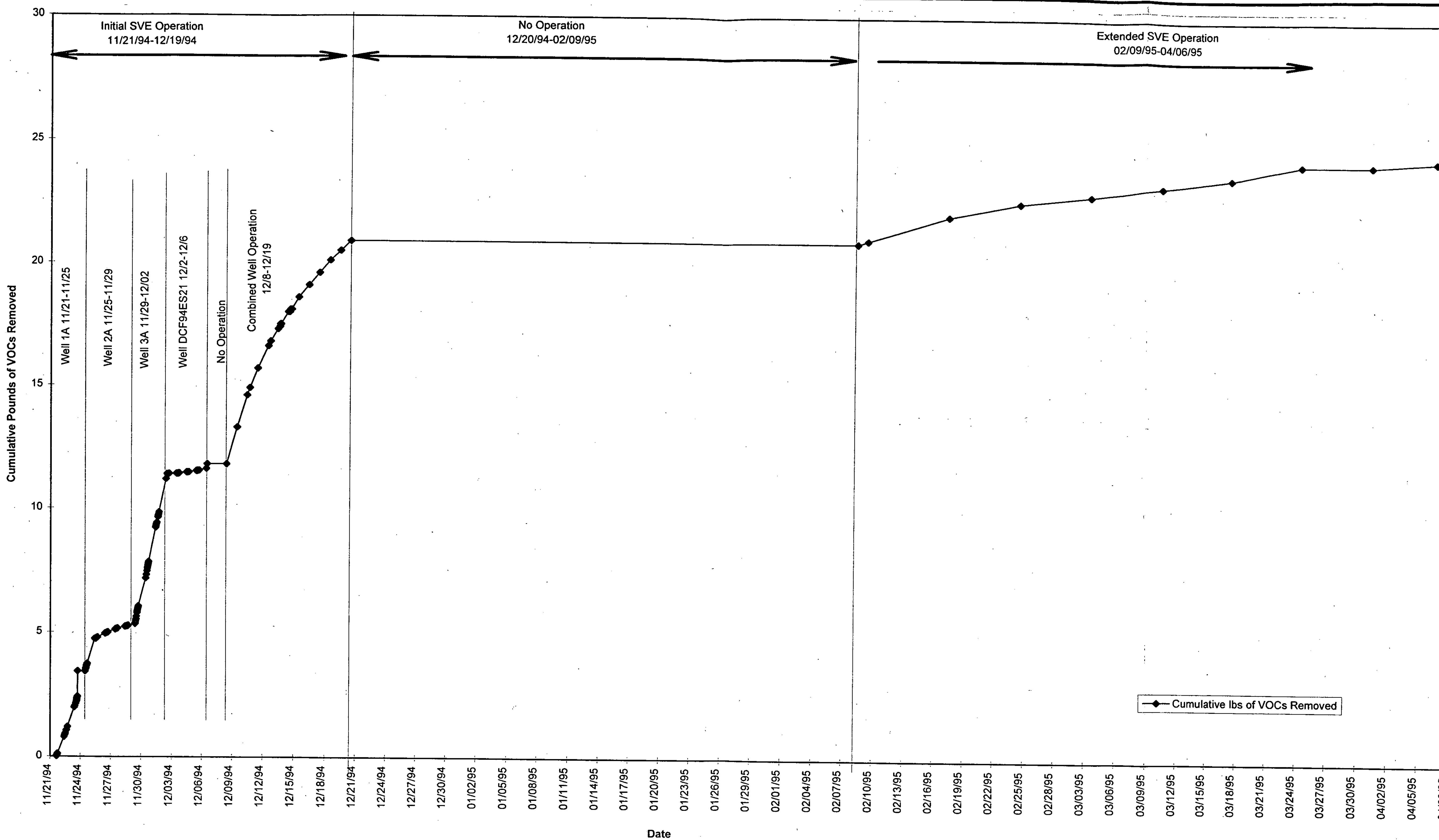
LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA–PTSR)

VOC LOADING RATES AND AIR FLOWS FOR BOTH INITIAL AND EXTENDED PILOT TEST STUDY AT DCFA

SCALE: NONE	DCFA–PTSR REPORT DATE: MARCH 1, 1996	FIG. 7–1

CPS–f7_1/06DEC95



U.S. ARMY CORPS OF ENGINEERS

LOUIS BERGER & ASSOCIATES, INC.

FORT RILEY MILITARY RESERVATION (DCFA–PTSR)

CUMULATIVE VOC MASS REMOVAL DURING INITIAL AND EXTENDED PILOT TEST STUDY AT DCFA

SCALE: NONE	DCFA–PTSR REPORT DATE: MARCH 1, 1996	FIG. 7–2

CPS–f7_2/06DEC95

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8.0 REFERENCES

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APPENDICES

APPENDIX A
TECHNICAL MEMORANDUM FOR SUSTAINED YIELD TEST AND AQUIFER PUMP TEST

TECHNICAL MEMORANDUM
FOR SUSTAINED YIELD TEST AND AQUIFER PUMP TEST

To: Commander, Engineer District Kansas City
Attn: CEMRK -MD -H, Garth Anderson
Kansas City, MO 64106

Date: August 23, 1994

Subject: Dry Cleaning Facilities, Fort Riley, Kansas
Dual Phase Extraction Pilot Test Program
Sustained Yield Test And Aquifer Pump Test

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1 Introduction

This Technical Memorandum (TM) presents a detailed description of the sustained yield and pump test results, and the effect of the pump test on aquifer water levels. The entire test was conducted over the period of August 15, 1994 through August 22, 1994. The sustained yield test was proposed to measure the maximum continuous flow rate from the extraction well pumps. The pump test was proposed to evaluate the effects of aquifer water elevations while well pumps were operating at their sustained yield. Only three extraction wells were selected for the actual pump test. The wells consisted of DCF94ES-1B (1B), DCF94ES-2B (2B), and DCF94ES-3B (3B). The procedure for the sustained yield test consisted of operating one pump at a time for a period of six to eight hours in order to determine a maximum sustained pump flow rate. After the sustained yield was determined for each of the three well pumps, then the pump test would begin. All three pumps would operate continuously for 24 hours a day over a four day period at their sustained yield rate. During the course of each test, water level, temperature, and specific conductance were recorded in adjacent ground water monitoring wells. Water level measurements were recorded in extraction wells that were not operating during the sustained yield test. The ground water monitoring wells selected were DCF92-03, DCF92-05, DCF94-21 (only water levels), DCF93-13, and DCF92-06. Well DC F93-16 was determined to be dry.The entire pump test was conducted after the sewer diversion pump was disengaged allowing full flow to enter the sewer line from MH-363 to MH-345.

2 Sustained Yield Test

On Tuesday August 15, 1994 an 8-hour sustained yield test was conducted on extraction well 3B. No other well pumps were operating during this segment of the test. A maximum well yield of 0.5 gallons per minute (GPM) was produced from the well which was unsustained. Therefore, the pump was throttled back to enable a sustained flow rate of 0.226 GPM.On Wednesday August 17, 1994, a 6-hour yield test was conducted on extraction well 2B. A maximum unsustained well yield of 0.5 GPM was produced. After throttling back on the pump a sustained yield of 0.158 GPM was observed. The pump in well 1B was also individually tested on Thursday August 18, 1994. The maximum yield pumped from the well was 0.75 GPM unsustained. The maximum sustained yield was 0.339 GPM after the pump was throttled back.

During the course of the sustained yield test there were no recorded changes in ground water elevations in the adjacent monitoring wells. There were also no deviations in temperature cycling during the sustained yield test. Results of the field data are presented in Attachment A.

3 Aquifer Pump Test

All three pumps were running continuously on Friday August 19 through Monday August 22, 1994. These pumps were operating at their combined sustained yields totaling 0.723 GPM. The pumps were operating in each well at the minimum water levels required to prevent tripping of the pump sensors. These sensors, when engaged, shut down pump power and initiate a timer for a fixed period of time until minimum water levels are regained. Each sensor is controlled by amperage as a function of increased resistance developed when the pumps operate under dry conditions. Throughout the pump test the pump sensors were not engaged allowing a continuous flow of ground water to occur without cycling. The recharge rate of the aquifer was slow, however all three pumps were able to operate continuously for the four day test.

The data collected from the adjacent monitoring wells is also presented in Attachment A. The results of the water level measurements indicated no drop in elevations in any of the adjacent wells around the DCF area. There were also no deviations in temperature cycling from the observed wells following termination of the sanitary sewer diversion.

4 Conclusion

The results of the pump test reveal a lower than expected combined well yield of 0.723 GPM. This is believed attributable to aquifer characteristics (i.e. surrounding formation) which produces low aquifer recharge. The aquifer is believed to be affected by the infiltration of leaking sewer water from the pipe line that connects from MH-363 to MH-345. The results from the Sewer Diversion Study revealed an average loss of approximately 5.5 GPM from the sewer line impacting the aquifer. At 160 GPM the loss was estimated at 13.7 GPM

As the pump operations did not influence groundwater levels, hydraulic characteristic could not be accurately determined.

ATTACHMENT A

	Date	Time	Well I.D.	Water Level
	8/15/94	8:09	1B	35.22
		8:11	3B	35.4
		8:14	2B	35.4
		8:16	92-03	38.42
		8:22	92-05	34.84
		8:29	94-21	35.12
		8:32	93-13	35.92
		8:38	92.06	43.24
		8:43	93-16	44.18
		10:02	1B	35.22
		10:04	3B	35.42
		10:06	2B	35.42
		10:08	92-03	38.42
		10:15	92-05	34.82
		10:19	94-21	35.12
		10:21	93-13	35.92
		10:27	92.06	43.24
		10:33	93-16	44.18
		11:34	1B	35.21
		11:36	3B	35.42
		11:37	2B	35.39
		11:39	92-03	38.4
		11:42	92-05	34.83
		11:40	94-21	35.12
		11:46	93-13	35.91
		11:51	92.06	43.23
		11:49	93-16	44.18
		13:47	1B	40.2
		13:35	3B	35.28
		13:45	2B	35.44
		13:39	92-03	38.4
		13:51	92-05	34.84
		13:56	94-21	35.14
		13:58	93-13	35.91
		14:05	92.06	43.22
		14:04	93-16	44.18
		16:19	1B	39.4
		15:36	3B	35.5
		15:39	2B	35.4

	Date	Time	Well I.D.	Water Level
		15:41	92-03	38.42
		15:46	92-05	34.84
		15:51	94-21	35.12
		15:53	93-13	35.92
		16:01	92.06	43.24
		16:08	93-16	44.18
	8/16/94	8:40	1B	35.22
		8:13	3B	35.44
		8:10	2B	35.44
		8:19	92-03	38.42
		8:27	92-05	34.86
		8:30	94-21	35.14
		8:34	93-13	35.94
		8:44	92.06	43.24
		8:49	93-16	44.18
		10:04	1B	36.38
		10:05	3B	36
		10:11	2B	35.44
		10:14	92-03	38.44
		10:18	92-05	34.87
		10:22	94-21	35.16
		10:24	93-13	35.95
		10:30	92.06	43.24
		10:36	93-16	44.18
		11:34	1B	35.37
		11:29	3B	—
		11:35	2B	35.44
		11:37	92-03	38.44
		11:42	92-05	34.86
		11:45	94-21	35.15
		11:47	93-13	34.94
		11:53	92.06	43.22
		11:58	93-16	44.18
		13:55	1B	35.27
		NG	3B	NG
		14:15	2B	35.42
		14:22	92-03	38.44
		14:31	92-05	34.86
		14:40	94-21	35.16
		14:43	93-13	35.94

Pump 3B ON

	Date	Time	Well I.D.	Water Level
		15:03	92.06	43.24
		15:08	93-16	44.18
		NG	1B	NG
		NG	3B	NG
		NG	2B	NG
		16:00	92-03	38.44
		16:05	92-05	34.84
		16:08	94-21	35.16
		16:10	93-13	35.96
		16:16	92.06	43.24
		16:20	93-16	44.18
	8/17/94	8:23	1B	35.26
		8:41	3B	35.47
		8:46	2B	35.48
		8:48	92-03	38.46
		8:57	92-05	34.9
		9:01	94-21	35.18
		9:02	93-13	36.9
		9:09	92.06	43.25
		9:13	93-16	44.18
		10:04	1B	35.26
		10:09	3B	35.47
		10:13	2B	35.48
		10:17	92-03	38.46
		10:22	92-05	34.9
		10:24	94-21	35.19
		10:27	93-13	
		10:33	92-06	43.26
		10:37	93-16	44.18
		11:44	1B	35.28
		11:47	3B	35.47
		11:50	2B	35.47
		11:53	92-03	38.47
		11:59	92-05	34.9
		12:00	94-21	35.18
		12:03	93-13	36
		12:09	92-06	43.26
		12:13	93-16	44.18
		13:50	1B	35.28

	Date	Time	Well I.D.	Water Level
		13:52	3B	35.45
		13:55	2B	35.46
		14:07	92-03	38.46
		14:10	92-05	34.89
		14:12	94-21	35.19
		14:13	93-13	35.17
		14:20	92-06	43.25
		14:25	93-16	44.18
		16:15	1B	35.28
		16:18	3B	35.45
		16:21	2B	35.48
		16:25	92-03	38.46
		16:30	92-05	34.9
		16:32	94-21	35.2
		16:35	93-13	35.98
		16:41	92-06	43.24
			93-16	
	8/18/94	11:32	1B	
		11:35	3b	35.95
		11:38	2b	
		11:44	92-03	38.51
		11:49	92-05	34.92
		11:49	94-21	35.21
		11:50	93-13	36.01
		11:53	93-06	43.25
		11:55	93-16	44.18
		12:00	92-03	38.52
		12:02	92-05	34.94
		12:03	94-21	35.22
		12:05	93-13	36
		12:08	92-06	43.25
		12:10	93-16	44.18
		12:27	92-03	38.54
		12:29	92-05	34.93
		12:31	94-21	35.22
		12:32	93-13	36
		12:36	92-06	43.25
		12:38	93-16	44.18
		14:09	92-03	38.54

	Date	Time	Well I.D.	Water Level
		14:15	92-05	34.46
		14:18	94-21	35.24
		14:22	93-13	36
		14:29	92-06	43.25
		14:32	93-16	44.18
		13:00	92-03	38.56
		13:02	92-05	34.98
		13:03	94-21	35.25
		13:05	93-13	36
		13:10	92-06	43.23
		13:12	93-16	44.18
		16:17	92-03	38.56
		16.23	92-05	34.98
		16:24	94-21	35.25
		16:28	93-13	36
		16:35	92-06	43.23
		16:37	93-16	44.18
	8/19/94	8:22	1B	40.1
		8:25	3B	36.89
		8:27	2B	PUMP ON
		8:31	92-03	38.65
		8:35	92-05	35.05
		8:37	94-21	35.3
		8:40	93-13	36.05
		8:45	92-06	43.27
		8:58	93-16	44.17
		10:07	1B	PUMP ON
		10:09	3B	PUMP ON
		10:11	2B	PUMP ON
		10:13	92-03	38.65
		10:16	92-05	35.05
		10:18	94-21	35.31
		10:20	93-13	36.06
		10:25	92-06	43.28
		10:27	93-16	44.17
		12:15	1B	PUMP ON
		12:16	3B	PUMP ON
		12:17	2B	PUMP ON
		12:20	92-03	38.66

	Date	Time	Well I.D.	Water Level
		12:23	92-05	35.66
		12:27	94-21	35.32
		12:29	93-13	36.06
		12:33	92-06	43.28
		12:36	93-16	44.18
		14:21	1B	PUMP ON
		14:23	3B	PUMP ON
		14:25	2B	PUMP ON
		14:29	92-03	38.67
		14:32	92-05	35.07
		14:35	94-21	35.32
		14:37	93-13	36.08
		14:41	92-06	43.27
		14:45	93-16	44.18
		16:05	1B	PUMP ON
		16:07	3B	PUMP ON
		16:09	2B	PUMP ON
		16:13	92-03	38.68
		16:20	92-05	35.08
		16:25	94-21	35.35
		16:26	93-13	36.09
		16:32	92-06	43.28
		16:34	93-16	44.18
	8/20/94	8:24	1B	PUMP ON
		8:28	3B	PUMP ON
		8:30	2B	PUMP ON
		8:37	92-03	38.72
		8:41	92-05	35.12
		8:43	94-21	35.37
		8:47	93-13	36.11
		8:54	92-06	43.29
		8:58	93-16	44.17
		10:02	1B	PUMP ON
		10:05	3B	PUMP ON
		10:08	2B	PUMP ON
		10:13	92-03	38.72
		10:22	92-05	35.11
		10:27	94-21	35.38
		10:28	93-13	36.11
		10:36	92-06	43.3

	Date	Time	Well I.D.	Water Level
		10:43	93-16	44.17
		12:02	1B	PUMP ON
		12:08	3B	PUMP ON
		12:05	2B	PUMP ON
		12:13	92-05	38.71
		12:18	92-05	35.11
		12:19	94-21	35.38
		12:24	93-13	36.11
		12:32	92-06	43.28
		12:34	93-16	44.17
		14:08	1B	PUMP ON
		14:10	3B	PUMP ON
		14:12	2B	PUMP ON
		14:18	92-03	38.73
		14:21	92-05	35.12
		14:15	94-21	35.39
		14:26	93-13	36.11
		14:32	92-06	43.28
		14:39	93-16	44.17
		16:10	1B	PUMP ON
		16:12	3B	PUMP ON
		16:14	2B	PUMP ON
		16:18	92-03	38.73
		16:21	92-05	35.13
		16:26	93-13	36.12
		16:32	92-06	43.29
		16:36	93-16	44.17
	8/21/94	8:34	1B	PUMP ON
		8:37	2B	PUMP ON
		8:39	3B	PUMP ON
		8:43	92-03	38.79
		8:50	92-05	35.2
		8:52	94-21	35.43
		8:53	93-13	36.17
		8:59	92-06	43.2
		9:05	93-16	44.17
		10:07	1B	PUMP ON
		10:10	2B	PUMP ON
		10:12	3B	PUMP ON

	Date	Time	Well I.D.	Water Level
		10:16	92-03	38.79
		10:20	92-05	35.2
		10:24	94-21	35.44
		10:26	93-13	36.19
		10:32	92-06	43.3
		10:39	93-16	44.17
		12:03	1B	PUMP ON
		12:05	2B	PUMP ON
		12:08	3B	PUMP ON
		12:10	92-03	38.79
		12:15	92-05	35.2
		12:19	94-21	35.44
		12:20	93-13	36.17
		12:28	92-06	43.29
		12:34	93-16	44.17
		14:01	1B	PUMP ON
		14:02	2B	PUMP ON
		14:05	3B	PUMP ON
		14:08	92-03	38.29
		14:14	92-05	35.2
		14:18	94-21	35.45
		14:19	93-13	36.18
		14:26	92-06	43.29
		14:32	93-16	44.17
		16:04	1B	PUMP ON
		16:06	2B	PUMP ON
		16:07	3B	PUMP ON
		16:10	92-03	38.79
		16:14	92-05	35.2
		16:17	94-21	35.45
		16:19	93-13	36.2
		16:25	92-06	43.28
		16:31	93-16	44.17
	8/22/94	8:22	1B	PUMP ON
		8:24	2B	PUMP ON
		8:26	3B	PUMP ON
		8:28	92-03	38.83
		8:33	92-05	35.24
		8:37	94-21	35.48
		8:38	93-13	36.2

	Date	Time	Well I.D.	Water Level
		8:44	92-06	43.28
		8:49	93-16	44.17
		10:03	1B	PUMP ON
		10:05	2B	PUMP ON
		10:06	3B	PUMP ON
		10:09	92-03	38.83
		10:14	92-05	35.22
		10:17	94-21	35.48
		10:18	93-13	36.2
		10:26	92-06	43.28
		10:31	93-16	44.17
		12:00	1B	PUMP OFF
		12:00	2B	PUMP OFF
		12:00	3B	PUMP OFF
		12:34	92-03	38.81
		12:41	92-05	35.25
		12:45	94-21	35.48
		12:48	93-13	36.2
		12:53	92-06	43.27
		12:57	93-16	44.17

Sustained Yield and Pump Test Temperature Data
Dry Cleaning Facility, Fort Riley Kansas

Date	Well 1B		Well 2B		Well 3B	
	Time	Temp (F)	Time	Temp (F)	Time	Temp (F)
8/14/94	8:08	75.1	8:17	79.2	8:13	75.4
	10:00	71.8	10:04	80.4	10:02	80.3
	11:32	73.1	11:36	82.4	11:34	81.9
	13:48	76.5	13:59	81.8	13:50	82.9
	15:57	80.2	NG	NG	15:59	87.9
8/15/94	8:09	69.7	8:14	77.3	8:11	80.4
	10:02	72.0	10:06	81.1	10:04	81.7
	11:34	76.8	11:37	83.3	11:36	82.0
	13:47	83.2	13:45	86.0	13:35	86.1
	16:19	81.0	15:39	88.8	15:36	90.5
8/16/94	8:10	80.3	8:10	80.0	8:13	85.1
	10:00	83.4	10:11	84.2	10:05	82.7
	11:34	83.1	11:35	83.6	11:29	85.2
	13:55	81.7	14:15	89.0	NG	NG
8/17/94	8:23	80.0	8:46	89.9	8:41	83.2
	10:04	81.8	10:13	83.7	10:09	86.1
	11:44	86.0	11:50	84.4	11:47	85.7
	13:50	87.5	13:55	87.4	13:52	89.5
	16:15	87.8	16:21	87.8	16:18	89.4
8/18/94	8:22	81.8	8:27	84.9	8:25	83.9
	10:00	83.7	10:10	82.7	10:06	87.9
	11:50	83.7	11:56	82.7	11:53	87.9
	14:00	85.8	14:08	86.2	14:04	90.1
	16:09	93.4	16:12	86.9	16:06	89.2
8/19/94	8:22	83.4	8:27	83.1	8:25	89.1
	10:07	83.8	10:11	83.6	10:09	90.3
	12:15	85.7	12:17	85.5	12:16	90.9
	14:21	87.1	14:25	86.6	14:23	92.3
	16:05	87.5	16:09	87.2	16:07	92.6
8/20/94	8:24	81.5	8:30	84.4	8:28	85.6
	10:02	81.6	10:08	84.6	10:05	86.5
	12:02	82.9	12:05	83.4	12:08	86.3
	14:08	84.8	14:10	89.9	14:12	89.9
	16:10	85.9	16:12	85.6	16:14	88.8
8/21/94	8:34	72.0	8:37	82.0	8:39	86.3
	10:07	83.2	10:10	84.2	10:12	88.0
	12:03	84.5	12:05	85.5	12:08	87.6
	14:01	87.2	14:02	87.8	14:05	91.4
	16:04	89.0	16:06	88.8	16:07	91.2
8/22/94	8:22	82.7	8:24	83.0	8:26	87.4
	10:03	83.2	10:05	83.6	10:06	87.8

Manual readings recorded with a Hydac Temperature/pH/Conductivity meter
NG = Not Gauged

APPENDIX B
TECHNICAL MEMORANDUM FOR SAMPLING ACTIVITIES AND GC METHODOLOGY

TECHNICAL MEMORANDUM
FOR SAMPLING ACTIVITIES AND GC METHODOLOGY

TO: Commander, Engineer District Kansas City
Attn: CEMRK -MD - H, Garth Anderson
Kansas City, MO 64106

Date: August 23, 1994

Subject: Dual Phase Extraction Pilot Test Program
Discharge of Effluent Water from Post GAC System
Sampling and Analysis Activities
GC Methodology of On-site Sample Analysis

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1 Introduction

This Technical Memorandum (TM) presents a detailed description of sampling and analysis activities conducted for the seven day post sewer diversion pump test and proposed for pilot test study. The sampling and analysis activities are proposed to evaluate the pilot test system effluent (treated groundwater) which is intended for discharge to the Main Post Wastewater Treatment Plant via manhole (MH) 345. Performance of these activities is intended to safeguard against the potential discharge of system effluent with volatile organic compounds (VOCs) concentrations in exceedance of EPA's MCL's for potable water. A list of EPA's MCL for selected target compounds on DCF site is enclosed (Attachment A).

In addition, included with this TM is a discussion on the use of a Static Headspace Method (SHM) with a portable GC to monitor the quality of effluent water from pilot test system. A detailed methodology of portable GC analysis headspace analysis, GC quantification limit and justification for using SHM with a portable GC is presented.

2 Background

On August 14, a sustained yield and pump test was initiated at the DCF site. This yield and pump test continued for seven (7) days. During the course of this yield and pump test, an estimated 4,500 gallons of water was pumped out of the aquifer through extraction wells. Due to the presence of VOC contaminants, the pumped water was treated by the on-site pilot test system prior to ultimate discharge to the Main Post Wastewater Treatment Plant. The on-site system uses two liquid phase GAC canisters in series to treat the pumped water. To safeguard the environment and human health and to closely monitor the change of groundwater quality, groundwater was sampled and analyzed for VOCs at influent, effluent, and midpoint location between the two GAC canisters, at approximately 50 to 100 gallons, to ensure that the water quality has met EPA's potable drinking water standards. These standards were selected in the absence of NPDES discharge limits for the site, as they represent the most stringent criteria for water protection. A portable field GC was used for the on-site sample analysis. The effluent water from the pilot test system was temporarily stored in the pilot test system's 1,500 gallon equalization tank. A sample was taken from the tank and sent to a certified laboratory to further confirm that the groundwater quality met EPA's potable water drinking standard, before it was discharged to the Main Post Wastewater Treatment Plant, via MH 345. Based on a comparison of the GC results to those obtained from a certified laboratory, the GC unit appears to be reliable. For example, PCE concentrations detected by on site GC unit are in the range of 7.97 to 87.6 ppb, which is comparable to laboratory result of 99 ppb. Given the nature of dynamic change of contaminant concentration along with flow fluctuation, and trace level of contaminant concentration, it is reasonable to expect any small discrepancy. Both analysis indicated effluent concentrations are below method detection limits. A presentation of all results is provided in Attachment B.

The portable GC is proposed to be used during the scheduled Pilot Test Study period. In terms of methodology of on-site GC analysis, it appears that SHM is more sensitive, more accurate and reliable for the DCF site in comparing SHM method with direct injection. The low concentration of contaminants in the groundwater at DCF site seems to warrant the use SHM rather than direct injection, because direct injection is suitable only for concentration of VOCs higher than 1 ppm. A detailed analysis of each method is presented in the following sections.

3 Proposed Methodology of Portable GC Monitoring

3.1 Instrument and Associated Equipment

The instrument used for the pump test and proposed for the pilot test is a Shimadzu GC-9A, currently in place at the DCF site. The associated equipment is listed in Attachment B. A list of the target VOCs selected for analysis by the unit and their QC Quantification Limits are provided in Attachment D.

3.2 Justification of Using Portable GC

Portable GC analysis belongs to intermediate level (Level II) of sample analysis. Intermediate level analysis was introduced by the EPA in order to reduce the time required for sample turnaround and the high costs associated with laboratory analysis. It has been widely used in site investigation and remediation process. Portable GCs have been used for characterization of volatile organic compounds, semivolatile organics, pesticides, and even PCBs.

A portable GC is chosen for the DCF site, because of the requirement for frequent sampling and the demand of timely turnarounds of analysis results. This is especially true for Pilot Test Study in the next step.

3.3 GC Methodology Proposed

It is proposed that a Static Headspace Method (SHM) will be used for all on-site sample analysis. The detailed methodology and its merit are presented in Attachment E. A detailed procedures for on-site SHM analysis is provided in Attachment F. As a brief introduction, this method utilizes the volatility of VOCs or thermodynamic partitioning of VOCs between water and air. A water sample (less than 40 ml) is placed into a 40 ml VOA vial, and allowed a certain volume of headspace in the vial for water sample to equilibrate with the air in the headspace. Differing from direct injection of the water sample to a GC unit, the vapor headspace of the sample is injected into the GC unit. Utilizing vapor injection facilitates the placement of a much larger volume of vapor sample, hence, more mass of VOCs into GC than a direct injection method. Thus SHM can increase the sensibility of GC. In direct injection, the volume of water sample that can be injected into the GC column (a wide-bore capillary column) is very limited (<2 microliters). The same column can accept 1000 microliters of vapor sample. Calculation result indicates that for a compound with partitioning coefficient less than 500 the resulting mass injected through a 1000 microliter vapor sample is greater than direct injection of 2 microliters of water sample. Since most chlorinated hydrocarbons and aromatic hydrocarbons encountered on the site have partitioning coefficients significantly lower than 500. Therefore, SHM should be chosen for DCF site.

SHM has been used and accepted on superfund sites. In addition to its high sensitivity, SHM provides more reliable and accurate data. This is because samples are analyzed sooner than purge and trap methods, and therefore, less loss of VOCs will occur. This method also provides faster turnaround of the results because of less sample preparation. Less sample preparation not only reduces time and cost but also prevents cross contamination and loss of contaminants. Quick turnaround is necessary for Pilot Test Studies, which require frequent sampling and fast turnaround of sample results, in order to timely monitor the removal efficiency and to evaluate process kinetics.

3.3 QA/QC Procedures

To ensure the accuracy and precision of on site SHM analysis, the following QA/QC procedures were performed during the pump test and are proposed for the pilot study.

A standard field blank is analyzed daily to verify syringe and container cleanness and to demonstrate that the analytical system is free of interferences. Duplicate samples are then collected at a minimum of once per day to establish the precision of the analytical methodology. Due to limitations of field analytical conditions, minimum quantification limits are established in lieu of Method Detection Limits. Minimum Quantification Limits are established based on each compound's detector response and a minimum peak area which is well above background noise levels.

To safeguard the discharge of effluent water from post GAC treatment system, and to ensure that above proposed SHM on site analysis results are reliable, split effluent water samples tested by the GC unit are collected and sent to a certified laboratory to check the accuracy of the on-site analysis. For the pump test, 10% of the total samples tested by the GC unit were sent to a certified laboratory for analysis by EPA method 8010. The selection of the method was based on the intent to focus on the target contaminants detected in the groundwater; namely halogenated VOCs. For the pilot test study, it is proposed to collect split effluent samples at a frequency of one (1) sample for every 1,500 gallons (i.e., one volume of equalization tank) of treated water.These split samples will also be analyzed using EPA Method 8010. Results of these split samples would be representative of the VOC concentrations of treated water in the equalization tank before discharging to the Main Post Treatment Plant, and will serve to further validate the GC unit operation.

4 Conclusion

Based on the results of the certified laboratory analysis, it is believed that SHM is an accurate and reliable method for field analysis. In addition, it provides a faster turnaround of results, which is critical to both pump test and pilot test study on DCF site. On this basis it is proposed to continue the use of the GC unit with Static Headspace Method. It is also proposed to continue backup sampling of split water samples for direct laboratory analysis to further validate the GC unit operation and to prevent potential discharging of VOC contaminants to the DCF sanitary sewer system.

Attachment A
A List OF EPA's MCL For Selected Target VOCs on DCF Site

Phase II National Primary Drinking Water Regulations

Contaminants	Drinking Water Health Effects	EPA Standards (mg/l)[1] Final MCLG	Final MCL	Current MCL	Sources	Analytic Method	BAT
Volatile Organics							
o-Dichlorobenzene	nervous system, lung, liver, kidney	0.6	0.6	-	industrial solvent; chemical manufacturing	All VOCS: 502.1 502.2 503.1 524.1 524.2	All VOCs: GAC/PTA
cis-1,2 dichloroethylene	nervous system, liver, circulatory	0.07	0.07	-	industrial extraction solvent		
trans-1,2 dichloroethylene	nervous system, liver, circulatory	0.1	0.1	-	industrial extraction solvent		
1,2 Dichloropropane	probable cancer, liver, lungs, kidney	0	0.005	-	soil fumigant; industrial solvent		
Ethylbenzene	kidney, liver, nervous system	0.7	0.7	-	present in gasoline & insecticides; chemical manufacturing		
Monochlorobenzene	kidney, liver, nervous system	0.1	0.1	-	pesticide manufacturing; metal cleaner; industrial solvent		
Styrene	liver, nervous system	0.1	0.1	-	plastic manufacturing; resins used in water treatment equipment		
Tetrachloroethylene	probable cancer	0	0.005	-	dry cleaning/industrial solvent		
Toluene	kidney, nervous system, lung	1	1	-	chemical manufacturing; gasoline additive; indust. solvent		
Xylenes	liver, kidney, nervous system	10	10	-	paint/ink solvent; gasoline refining by-product; component of detergents		

[1] Final MCLGs and MCLs become effective July 1992. At that time, the current MCLs cease to be effective.

Attachment B
Analytical Results of Groundwater Samples For Selected Target VOCs on DCF Site

Continental Analytical
SERVICES, INC

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/20/94
Date Sample Recd: 08/19/94
CAS File No: 94-6151
CAS Order No: 24390
Client P.O.: JH1021 Q-DCF

Lab Number: 94081641
Sample Description: DCFETANK-819

Date Sampled: 08/19/94
Time Sampled: 1645

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010			08/20/94	/
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L		1766/21
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/21
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/21
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/21
1,1-Dichloroethane	ND(0.2)	µg/L		1766/21
1,1-Dichloroethene	ND(0.2)	µg/L		1766/21
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/21
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/21
1,2-Dichloroethane	ND(0.2)	µg/L		1766/21
1,2-Dichloropropane	ND(0.2)	µg/L		1766/21
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/21
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/21
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/21
Benzyl Chloride	ND(0.2)	µg/L		1766/21
Bromobenzene	ND(0.2)	µg/L		1766/21
Bromodichloromethane	ND(0.2)	µg/L		1766/21
Bromoform	ND(0.2)	µg/L		1766/21
Bromomethane	ND(0.2)	µg/L		1766/21
Carbon Tetrachloride	ND(0.2)	µg/L		1766/21
Chlorobenzene	ND(0.2)	µg/L		1766/21
Chloroethane	ND(0.2)	µg/L		1766/21
Chloroform	ND(0.2)	µg/L		1766/21
Chloromethane	ND(0.2)	µg/L		1766/21
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/21
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/21
Dibromochloromethane	ND(0.2)	µg/L		1766/21
Dibromomethane	ND(0.2)	µg/L		1766/21
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/21
Methylene Chloride	ND(0.2)	µg/L		1766/21
Tetrachloroethene	ND(0.2)	µg/L		1766/21
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/21
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/21
Trichloroethene	ND(0.2)	µg/L		1766/21
Trichlorofluoromethane	ND(0.2)	µg/L		1766/21
Vinyl Chloride	ND(0.2)	µg/L		1766/21

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3231	DKT	8010

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986. ND(), where noted, indicates none detected with the detection limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.
Gregory J. Greene for
Clifford J. Baker
Laboratory Director

1804 Glendale Road • Salina, Kansas 67401-6675
913-827-1273 • 800-535-3076 • FAX 913-823-7830

Continental Analytical
S E R V I C E S , I N C .

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/20/94
Date Sample Recd: 08/19/94
CAS File No: 94-6151
CAS Order No: 24390
Client P.O.: JH1021 Q-DCF

Lab Number: 94081642
Sample Description: Trip Blank #D123

Date Sampled: 08/19/94
Time Sampled: 1645

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L	08/20/94	/
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/21
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/21
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/21
1,1-Dichloroethane	ND(0.2)	µg/L		1766/21
1,1-Dichloroethene	ND(0.2)	µg/L		1766/21
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/21
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/21
1,2-Dichloroethane	ND(0.2)	µg/L		1766/21
1,2-Dichloropropane	ND(0.2)	µg/L		1766/21
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/21
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/21
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/21
Benzyl Chloride	ND(0.2)	µg/L		1766/21
Bromobenzene	ND(0.2)	µg/L		1766/21
Bromodichloromethane	ND(0.2)	µg/L		1766/21
Bromoform	ND(0.2)	µg/L		1766/21
Bromomethane	ND(0.2)	µg/L		1766/21
Carbon Tetrachloride	ND(0.2)	µg/L		1766/21
Chlorobenzene	ND(0.2)	µg/L		1766/21
Chloroethane	ND(0.2)	µg/L		1766/21
Chloroform	ND(0.2)	µg/L		1766/21
Chloromethane	ND(0.2)	µg/L		1766/21
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/21
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/21
Dibromochloromethane	ND(0.2)	µg/L		1766/21
Dibromomethane	ND(0.2)	µg/L		1766/21
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/21
Methylene Chloride	ND(0.2)	µg/L		1766/21
Tetrachloroethene	ND(0.2)	µg/L		1766/21
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/21
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/21
Trichloroethene	ND(0.2)	µg/L		1766/21
Trichlorofluoromethane	ND(0.2)	µg/L		1766/21
Vinyl Chloride	ND(0.2)	µg/L		1766/21

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3231	DKT	8010

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986. ND(), where noted, indicates none detected with the detection limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.

Gregory J. Greene for
Clifford J. Baker
Laboratory Director

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913-827-1273 • 800-535-3076 • FAX 913-823-7830

Continental Analytical
S E R V I C E S , I N C .

Page: 1

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/18/94
Date Sample Recd: 08/16/94
CAS File No: 94-6151
CAS Order No: 24302
Client P.O.: JH1073 -DCF

Lab Number: 94081189
Sample Description: DCFWWTANK-1

Date Sampled: 08/16/94
Time Sampled: 1546

Analysis	Concentration	Units	Date Analyzed	Book/Page
TCL Volatiles				
1,1,1-Trichloroethane	ND(0.7)	µg/L	08/17/94	/ 2009/74
1,1,2,2-Tetrachloroethane	ND(0.6)	µg/L		2009/74
1,1,2-Trichloroethane	ND(0.6)	µg/L		2009/74
1,1-Dichloroethane	ND(0.5)	µg/L		2009/74
1,1-Dichloroethylene	ND(0.6)	µg/L		2009/74
1,2-Dichloroethane	ND(0.6)	µg/L		2009/74
1,2-Dichloroethylene (Total)	ND(0.5)	µg/L		2009/74
1,2-Dichloropropane	ND(0.4)	µg/L		2009/74
1,4-Dichlorobenzene	ND(1.0)	µg/L		2009/74
2-Butanone	ND(100)	µg/L		2009/74
2-Chloroethyl Vinyl Ether	ND(5.0)	µg/L		2009/74
2-Hexanone	ND(50)	µg/L		2009/74
4-Methyl-2-Pentanone	ND(50)	µg/L		2009/74
Acetone	ND(100)	µg/L		2009/74
Benzene	ND(0.4)	µg/L		2009/74
Bromodichloromethane (THM)	ND(0.5)	µg/L		2009/74
Bromoform (THM)	ND(1.5)	µg/L		2009/74
Bromomethane	ND(1.2)	µg/L		2009/74
Carbon Disulfide	ND(5.0)	µg/L		2009/74
Chlorobenzene	ND(0.4)	µg/L		2009/74
Chloroethane	ND(3.7)	µg/L		2009/74
Chloromethane	ND(5.0)	µg/L		2009/74
Cis-1,3-Dichloropropene	ND(0.9)	µg/L		2009/74
Dibromochloromethane (THM)	ND(0.7)	µg/L		2009/74
Dichloromethane	ND(0.9)	µg/L		2009/74
Ethylbenzene	ND(0.7)	µg/L		2009/74
Meta &/or Para-Xylene	ND(0.6)	µg/L		2009/74
Ortho-Xylene	ND(0.6)	µg/L		2009/74
Styrene	ND(5.0)	µg/L		2009/74
Tetrachloroethylene	ND(1.1)	µg/L		2009/74
Tetrachloromethane	ND(0.7)	µg/L		2009/74
Toluene	ND(0.4)	µg/L		2009/74
Trans-1,3-Dichloropropene	ND(0.8)	µg/L		2009/74
Trichloroethylene	ND(0.6)	µg/L		2009/74
Trichloromethane (THM)	ND(0.5)	µg/L		2009/74
Vinyl Acetate	ND(50)	µg/L		2009/74
Vinyl Chloride	ND(0.8)	µg/L		2009/74

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
TCL Volatiles	NA	1MS3229	CLS	624/8240

-Continued-

LABORATORY REPORT

Client: Louis Berger and Associates, Inc.
Lab Number: 94081189

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986. ND(), where noted, indicates none detected with the detection limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.

Clifford J. Baker
Laboratory Director

Continental Analytical
SERVICES, INC

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/18/94
Date Sample Recd: 08/16/94
CAS File No: 94-6151
CAS Order No: 24302
Client P.O.: JH1073 -DCF

Lab Number: 94081190
Sample Description: Trip Blank

Date Sampled: 08/16/94
Time Sampled:

Analysis	Concentration	Units	Date Analyzed	Book/Page
TCL Volatiles				
1,1,1-Trichloroethane	ND(0.7)	µg/L	08/17/94	/
1,1,2,2-Tetrachloroethane	ND(0.6)	µg/L		2009/73
1,1,2-Trichloroethane	ND(0.6)	µg/L		2009/73
1,1-Dichloroethane	ND(0.5)	µg/L		2009/73
1,1-Dichloroethylene	ND(0.6)	µg/L		2009/73
1,2-Dichloroethane	ND(0.6)	µg/L		2009/73
1,2-Dichloroethylene (Total)	ND(0.5)	µg/L		2009/73
1,2-Dichloropropane	ND(0.4)	µg/L		2009/73
1,4-Dichlorobenzene	ND(1.0)	µg/L		2009/73
2-Butanone	ND(100)	µg/L		2009/73
2-Chloroethyl Vinyl Ether	ND(5.0)	µg/L		2009/73
2-Hexanone	ND(50)	µg/L		2009/73
4-Methyl-2-Pentanone	ND(50)	µg/L		2009/73
Acetone	ND(100)	µg/L		2009/73
Benzene	ND(0.4)	µg/L		2009/73
Bromodichloromethane (THM)	ND(0.5)	µg/L		2009/73
Bromoform (THM)	ND(1.5)	µg/L		2009/73
Bromomethane	ND(1.2)	µg/L		2009/73
Carbon Disulfide	ND(5.0)	µg/L		2009/73
Chlorobenzene	ND(0.4)	µg/L		2009/73
Chloroethane	ND(3.7)	µg/L		2009/73
Chloromethane	ND(5.0)	µg/L		2009/73
Cis-1,3-Dichloropropene	ND(0.9)	µg/L		2009/73
Dibromochloromethane (THM)	ND(0.7)	µg/L		2009/73
Dichloromethane	ND(0.9)	µg/L		2009/73
Ethylbenzene	ND(0.7)	µg/L		2009/73
Meta &/or Para-Xylene	ND(0.6)	µg/L		2009/73
Ortho-Xylene	ND(0.6)	µg/L		2009/73
Styrene	ND(5.0)	µg/L		2009/73
Tetrachloroethylene	ND(1.1)	µg/L		2009/73
Tetrachloromethane	ND(0.7)	µg/L		2009/73
Toluene	ND(0.4)	µg/L		2009/73
Trans-1,3-Dichloropropene	ND(0.8)	µg/L		2009/73
Trichloroethylene	ND(0.6)	µg/L		2009/73
Trichloromethane (THM)	ND(0.5)	µg/L		2009/73
Vinyl Acetate	ND(50)	µg/L		2009/73
Vinyl Chloride	ND(0.8)	µg/L		2009/73
				2009/73

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
TCL Volatiles	NA	1MS3229	CLS	624/8240

-Continued-

1804 Glendale Road • Salina, Kansas 67401-6675
913-827-1273 • 800-535-3076 • FAX 913-823-7830

Client: Louis Berger and Associates, Inc.
Lab Number: 94081190

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986. ND(), where noted, indicates none detected with the detection limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.

Clifford J. Baker

Clifford J. Baker
Laboratory Director

Continental Analytical
SERVICES, INC.

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/22/94
Date Sample Recd: 08/20/94
CAS File No: 94-6151
CAS Order No: 24399
Client P.O.: Proj:JG1073

Lab Number: 94081714
Sample Description: DCF Inflow

Date Sampled: 08/20/94
Time Sampled: 1550

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(1.0)	µg/L	08/22/94	/
1,1,1-Trichloroethane	ND(1.0)	µg/L		1766/24
1,1,2,2-Tetrachloroethane	ND(1.0)	µg/L		1766/24
1,1,2-Trichloroethane	ND(1.0)	µg/L		1766/24
1,1-Dichloroethane	ND(1.0)	µg/L		1766/24
1,1-Dichloroethene	ND(1.0)	µg/L		1766/24
1,2,3-Trichloropropane	ND(1.0)	µg/L		1766/24
1,2-Dichlorobenzene	ND(1.0)	µg/L		1766/24
1,2-Dichloroethane	ND(1.0)	µg/L		1766/24
1,2-Dichloropropane	ND(1.0)	µg/L		1766/24
1,3-Dichlorobenzene	ND(1.0)	µg/L		1766/24
1,4-Dichlorobenzene	ND(1.0)	µg/L		1766/24
2-Chloroethylvinyl Ether	ND(1.0)	µg/L		1766/24
Benzyl Chloride	ND(1.0)	µg/L		1766/24
Bromobenzene	ND(1.0)	µg/L		1766/24
Bromodichloromethane	ND(1.0)	µg/L		1766/24
Bromoform	ND(1.0)	µg/L		1766/24
Bromomethane	ND(1.0)	µg/L		1766/24
Carbon Tetrachloride	ND(1.0)	µg/L		1766/24
Chlorobenzene	ND(1.0)	µg/L		1766/24
Chloroethane	ND(1.0)	µg/L		1766/24
Chloroform	ND(1.0)	µg/L		1766/24
Chloromethane	4.1	µg/L		1766/24
cis-1,2-Dichloroethene	ND(1.0)	µg/L		1766/24
cis-1,3-Dichloropropene	3.6	µg/L		1766/24
Dibromochloromethane	ND(1.0)	µg/L		1766/24
Dibromomethane	ND(1.0)	µg/L		1766/24
Dichlorodifluoromethane	ND(1.0)	µg/L		1766/24
Methylene Chloride	ND(1.0)	µg/L		1766/24
Tetrachloroethene	ND(1.0)	µg/L		1766/24
trans-1,2-Dichloroethene	99.	µg/L		1766/24
trans-1,3-Dichloropropene	ND(1.0)	µg/L		1766/24
Trichloroethene	ND(1.0)	µg/L		1766/24
Trichlorofluoromethane	4.0	µg/L		1766/24
Vinyl Chloride	ND(1.0)	µg/L		1766/24
	ND(1.0)	µg/L		1766/24

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3232	DKT	8010

Laboratory analyses were performed on samples utilizing procedures published in Title 40 of the Code of Federal Regulations, Parts 136 or 141, or in EPA Publication, SW-846, 3rd edition, September, 1986. ND(), where noted, indicates none detected with the detection limit in parentheses. Samples will be retained for thirty days unless otherwise notified.

CONTINENTAL ANALYTICAL SERVICES, INC.

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4

Continental Analytical
S E R V I C E S , I N C .

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/22/94
Date Sample Recd: 08/20/94
CAS File No: 94-6151
CAS Order No: 24399
Client P.O.: Proj:JG1073

Lab Number: 94081715
Sample Description: DCF Trip Blank 1

Date Sampled: 08/20/94
Time Sampled: 1550

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L	08/21/94	/
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/23
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethene	ND(0.2)	µg/L		1766/23
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/23
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,2-Dichloroethane	ND(0.2)	µg/L		1766/23
1,2-Dichloropropane	ND(0.2)	µg/L		1766/23
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/23
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/23
Benzyl Chloride	ND(0.2)	µg/L		1766/23
Bromobenzene	ND(0.2)	µg/L		1766/23
Bromodichloromethane	ND(0.2)	µg/L		1766/23
Bromoform	ND(0.2)	µg/L		1766/23
Bromomethane	ND(0.2)	µg/L		1766/23
Carbon Tetrachloride	ND(0.2)	µg/L		1766/23
Chlorobenzene	ND(0.2)	µg/L		1766/23
Chloroethane	ND(0.2)	µg/L		1766/23
Chloroform	ND(0.2)	µg/L		1766/23
Chloromethane	ND(0.2)	µg/L		1766/23
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Dibromochloromethane	ND(0.2)	µg/L		1766/23
Dibromomethane	ND(0.2)	µg/L		1766/23
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/23
Methylene Chloride	ND(0.2)	µg/L		1766/23
Tetrachloroethene	ND(0.2)	µg/L		1766/23
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Trichloroethene	ND(0.2)	µg/L		1766/23
Trichlorofluoromethane	ND(0.2)	µg/L		1766/23
Vinyl Chloride	ND(0.2)	µg/L		1766/23
				1766/23

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3232	DKT	8010

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Continental Analytical
S E R V I C E S , I N C .

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/22/94
Date Sample Recd: 08/20/94
CAS File No: 94-6151
CAS Order No: 24399
Client P.O.: Proj:JG1073

Lab Number: 94081716
Sample Description: DCF Intermed

Date Sampled: 08/20/94
Time Sampled: 1552

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L	08/21/94	/
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/24
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/24
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/24
1,1-Dichloroethane	ND(0.2)	µg/L		1766/24
1,1-Dichloroethene	ND(0.2)	µg/L		1766/24
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/24
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/24
1,2-Dichloroethane	ND(0.2)	µg/L		1766/24
1,2-Dichloropropane	ND(0.2)	µg/L		1766/24
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/24
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/24
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/24
Benzyl Chloride	ND(0.2)	µg/L		1766/24
Bromobenzene	ND(0.2)	µg/L		1766/24
Bromodichloromethane	ND(0.2)	µg/L		1766/24
Bromoform	ND(0.2)	µg/L		1766/24
Bromomethane	ND(0.2)	µg/L		1766/24
Carbon Tetrachloride	ND(0.2)	µg/L		1766/24
Chlorobenzene	ND(0.2)	µg/L		1766/24
Chloroethane	ND(0.2)	µg/L		1766/24
Chloroform	ND(0.2)	µg/L		1766/24
Chloromethane	ND(0.2)	µg/L		1766/24
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/24
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/24
Dibromochloromethane	ND(0.2)	µg/L		1766/24
Dibromomethane	ND(0.2)	µg/L		1766/24
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/24
Methylene Chloride	ND(0.2)	µg/L		1766/24
Tetrachloroethene	ND(0.2)	µg/L		1766/24
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/24
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/24
Trichloroethene	ND(0.2)	µg/L		1766/24
Trichlorofluoromethane	ND(0.2)	µg/L		1766/24
Vinyl Chloride	ND(0.2)	µg/L		1766/24
				1766/24

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3232	DKT	8010

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Continental Analytical
SERVICES, INC.

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/22/94
Date Sample Recd: 08/20/94
CAS File No: 94-6151
CAS Order No: 24399
Client P.O.: Proj:JG1073

Lab Number: 94081717
Sample Description: DCF Outflow

Date Sampled: 08/20/94
Time Sampled: 1555

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L	08/21/94	/
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/23
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethene	ND(0.2)	µg/L		1766/23
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/23
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,2-Dichloroethane	ND(0.2)	µg/L		1766/23
1,2-Dichloropropane	ND(0.2)	µg/L		1766/23
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/23
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/23
Benzyl Chloride	ND(0.2)	µg/L		1766/23
Bromobenzene	ND(0.2)	µg/L		1766/23
Bromodichloromethane	ND(0.2)	µg/L		1766/23
Bromoform	ND(0.2)	µg/L		1766/23
Bromomethane	ND(0.2)	µg/L		1766/23
Carbon Tetrachloride	ND(0.2)	µg/L		1766/23
Chlorobenzene	ND(0.2)	µg/L		1766/23
Chloroethane	ND(0.2)	µg/L		1766/23
Chloroform	ND(0.2)	µg/L		1766/23
Chloromethane	ND(0.2)	µg/L		1766/23
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Dibromochloromethane	ND(0.2)	µg/L		1766/23
Dibromomethane	ND(0.2)	µg/L		1766/23
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/23
Methylene Chloride	ND(0.2)	µg/L		1766/23
Tetrachloroethene	ND(0.2)	µg/L		1766/23
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Trichloroethene	ND(0.2)	µg/L		1766/23
Trichlorofluoromethane	ND(0.2)	µg/L		1766/23
Vinyl Chloride	ND(0.2)	µg/L		1766/23
				1766/23

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3232	DKT	8010

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Continental Analytical
SERVICES, INC

Client: Louis Berger and Associates, Inc.
Attn: Susan Knauf
100 Halsted Street
East Orange, NJ 07019

Date Sample Rptd: 08/22/94
Date Sample Recd: 08/20/94
CAS File No: 94-6151
CAS Order No: 24399
Client P.O.: Proj:JG1073

Lab Number: 94081718
Sample Description: DCF Tank

Date Sampled: 08/20/94
Time Sampled: 1559

Analysis	Concentration	Units	Date Analyzed	Book/Page
EPA Method 8010				
1,1,1,2-Tetrachloroethane	ND(0.2)	µg/L	08/21/94	/
1,1,1-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1,2,2-Tetrachloroethane	ND(0.2)	µg/L		1766/23
1,1,2-Trichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethane	ND(0.2)	µg/L		1766/23
1,1-Dichloroethene	ND(0.2)	µg/L		1766/23
1,2,3-Trichloropropane	ND(0.2)	µg/L		1766/23
1,2-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,2-Dichloroethane	ND(0.2)	µg/L		1766/23
1,2-Dichloropropane	ND(0.2)	µg/L		1766/23
1,3-Dichlorobenzene	ND(0.2)	µg/L		1766/23
1,4-Dichlorobenzene	ND(0.2)	µg/L		1766/23
2-Chloroethylvinyl Ether	ND(0.2)	µg/L		1766/23
Benzyl Chloride	ND(0.2)	µg/L		1766/23
Bromobenzene	ND(0.2)	µg/L		1766/23
Bromodichloromethane	ND(0.2)	µg/L		1766/23
Bromoform	ND(0.2)	µg/L		1766/23
Bromomethane	ND(0.2)	µg/L		1766/23
Carbon Tetrachloride	ND(0.2)	µg/L		1766/23
Chlorobenzene	ND(0.2)	µg/L		1766/23
Chloroethane	ND(0.2)	µg/L		1766/23
Chloroform	ND(0.2)	µg/L		1766/23
Chloromethane	ND(0.2)	µg/L		1766/23
cis-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
cis-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Dibromochloromethane	ND(0.2)	µg/L		1766/23
Dibromomethane	ND(0.2)	µg/L		1766/23
Dichlorodifluoromethane	ND(0.2)	µg/L		1766/23
Methylene Chloride	ND(0.2)	µg/L		1766/23
Tetrachloroethene	ND(0.2)	µg/L		1766/23
trans-1,2-Dichloroethene	ND(0.2)	µg/L		1766/23
trans-1,3-Dichloropropene	ND(0.2)	µg/L		1766/23
Trichloroethene	ND(0.2)	µg/L		1766/23
Trichlorofluoromethane	ND(0.2)	µg/L		1766/23
Vinyl Chloride	ND(0.2)	µg/L		1766/23
				1766/23

Analysis	Date Prepared	QC Batch	Analyst	Analytical Method
EPA Method 8010	NA	1GC3232	DKT	8010

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TERRA VAC PROJECT # 24-0050 DATE 8/19/94 ANALYST MSW PAGE W-8

SAMPLE	TIME	UNIT HOURS	VAC	FLOW	TEMP	CH	VOL (ul)	ANAL #	ANAL TIME	CH_2Cl_2 ug/l	t-1,2-DCE ug/l	c-1,2-DCE ug/l	$CHCl_3$ ug/l	B ug/l	TCE ug/l	T ug/l	PCE ug/l	OTHER ug/l	TOTAL ug/l	FLOW (cfm)	RATE (#/day)	COMMENTS
Water Blank						1	1000		0945	–	–	–	–	–	–	1.24	–					
Water Blank						2	1000		0945	–	–	–	–	–	–	0.728	–					
Cal. Check						1	100		1024	RECALIBRATED												
Cal. Check						2	100		1024													
Cal. Check						1	100		1048	240	221	229	269	155	250	147	250	X	1773			
Cal. Check						2	100		1048	235	217	224	262	150	243	142	254	X	1730			
ET	0840					1	1000		1104	–	–	–	–	–	–	–	–		-0-			
Inlet	0835					2	1000		1105	–	–	–	–	–	2.88	–	85.9		88.8			
1° outlet	0835					1	1000		1124	–	–	–	–	–	–	–	–		-0-			
2° outlet	0835					2	1000		1125	–	–	–	–	–	–	–	–		-0-			
Inlet Dup	0835					1	(100)		1143	–	–	–	–	–	–	–	(9.05)		(9.05)			
Inlet Dup Rep	0835					2	(100)		1143	–	–	–	–	–	–	–	7.97		7.97			
Inlet	1015					1	1000		1201	–	–	–	–	–	2.49	–	87.6		90.1			
1° outlet	1015					2	1000		1204	–	–	–	–	–	–	–	–		-0-			
2° outlet	1015					1	1000		1303	–	–	–	–	–	–	–	–		-0-			
Inlet spike	0840/1136					2	(100)		1304	245	240	240	284	165	282	169	342		1967			
Inlet spike	0840/1136					1	(100)		1357	250	239	243	293	167	278	165	302		1936			
Inlet	1155					2	1000		1357	–	–	–	–	–	2.11	–	80.9		83.0			
RT check	~~1430~~					1	1000		1430	EDITED RT's												
RT check	~~1431~~					2	1000		1431													
1° out	1155					1	1000		1459	–	–	–	–	–	–	–	–		-0-			
2° out	1155					2	1000		1500	–	–	–	–	–	–	–	–		-0-			
Inlet	1400					1	1000		1517	–	–	–	4.06	–	2.03	–	75.2		86.2			
1° out	1400					2	1000		1517	–	–	–	–	–	–	–	–		-0-			
2° out	1400					1	1000		1535	–	–	–	–	–	–	–	–		-0-			
Inlet	1530					1	1000		1613	–	–	–	–	–	1.62	–	69.0		70.6			
1° out	1530					2	1000		1614	–	–	–	–	–	–	–	–		-0-			
2° out	1530					2	1000		1634	–	–	–	–	–	–	–	–		-0-			
ET	1645					1	1000		1719	–	–	–	–	–	–	–	–		-0-			
Inlet	1635					2	1000		1720	–	–	–	–	–	1.33	–	71.0		72.3			
1° out	1635					1	1000		1736	–	–	–	–	–	–	–	–		-0-			
2° out	1635					2	1000		1737	–	–	–	–	–	–	–	–		-0-			

AUG 22 '94 11:03 PAGE .010

TERRA VAC PROJECT # 24-0050 DATE 8/20/94 ANALYST MSW PAGE W-9

SAMPLE	TIME	UNIT HOURS	VAC	FLOW	TEMP	CH	VOL (ml)	ANAL #	ANAL TIME	CH2CL2 ug/l	t-1,2-DCE ug/l	c-1,2-DCE ug/l	CHCL3 ug/l	B ug/l	TCE ug/l	T ug/l	PCE ug/l	OTHER ug/l	TOTAL ug/l	FLOW (scfm)	RATE (#/day)	COMMENTS
Water Blank						1	1000		1023	—	—	—	—	—	—	0.808	—		0.808			40°c isothermal
Water Blank						2	1000		1024	—	—	—	—	—	—	0.856	—		0.856			I=40°c D=60°c
Std						1	100		1115	RECALIBRATED												change in conditions
Std						2	100		1116													.. .. ..
Cal ✓						1	100		1139	209	202	206	260	142	222	133	(229)					RECAL
Cal ✓						2	100		1140	231	211	217	254	147	236	139	(245)					
Cal ✓						1	100		1201	239	215	228	252	151	241	143	(243)					
Cal ✓						2	100		1202	—	—	—	—	—	—	1.17	—					?
Cal ✓						1	100		1341	(201)	200	201	(197)	(131)	222	(115)	(219)					new std RECAL
Cal ✓						2	100		1341	(201)	192	197	(203)	(128)	(210)	(111)	(204)					new std
Cal ✓						1	100		1400	(201)	(189)	(193)	(194)	(124)	263	(104)	(187)					
Cal ✓						2	100		1400	(198)	(180)	(190)	(196)	(121)	(189)	(95.7)	(169)					
Cal ✓						1	100		1422	237	242	217	267	148	240	140	(242)					New septa
Cal ✓						2	100		1422	235	198	213	251	140	(214)	(126)	(205)					
Cal ✓						1	100		1532	RECALIBRATED →												6140°c
Cal ✓						2	100		1502													
Cal ✓						1	100		1522	245	231	236	281	160	261	151	266		1832			OK
Cal ✓						2	100		1522	239	226	236	259	158	257	151	270		1797			
Inlet	0835					1	1000		1540	(29.5)	—	—	—	—	2.04	—	48.6		(50.7)			
Inlet Rep	0835					2	1000		1540	(29.5)	—	—	—	—	2.60	—	53.7		(85.8)			
1° out	0835					1	1000		1601	—	—	—	—	—	—	0.236	—		0.236			
2° out	0835					2	1000		1602	—	—	—	—	—	—	—	—		Ø			
Inlet	1010					1	1000		1619	—	—	—	—	—	1.48	—	53.5		55.0			
1° out	1010					2	1000		1620	—	—	—	—	—	—	—	—		Ø			
ET	1550					1	1000		1638	—	—	—	—	—	—	—	—		Ø			
2° out	1550					2	1000		1639	—	—	—	—	—	—	—	—		Ø			
2° out	1010					1	1000		1657	—	—	—	—	—	—	—	—		Ø			

TERRA VAC PROJECT # 24-0050 DATE 8/20/94 (cont) ANALYST rgw PAGE W-10

SAMPLE	TIME	UNIT HOURS	VAC	FLOW	TEMP	CH	VOL (ul)	ANAL #	ANAL TIME	CH2Cl2 ug/l	t-1,2-DCE ug/l	c-1,2-DCE ug/l	CHCl3 ug/l	B ug/l	TCE ug/l	T ug/l	PCE ug/l	OTHER ug/l	TOTAL ug/l	FLOW (hr/day)	RATE (#/hr)	COMMENTS
Inlet	1210					2	1000		1657	–	–	–	–	–	1.04	~~NOT~~	62.1		63.2			
1° out	1210					1	1000		1714	–	–	–	–	–	–	–	–		0			
2° out	1210					2	1000		1715	–	–	–	–	–	–	–	–		0			
Inlet	1405					1	1000		1731	–	–	–	–	–	0.991	–	58.8		59.8			
Inlet Dup	1405					2	1000		1732	–	–	–	–	–	1.19	–	70.5		71.7			
1° out	1405					1	1000		1748	–	–	–	–	–	–	–	–		0			
2° out	1405					2	1000		1749	–	–	–	–	–	–	–	–		0			
Inlet	1550					1	1000		1804	–	–	–	–	–	1.05	–	55.0		56.0			
1° out	1550					2	1000		1805	–	–	–	–	–	–	–	–		0			
Inlet Spike	1833/1608					1	1000		1820	224	224	228	212	142	234	117	213		1594			
Inlet spike Rep	1835/1608					2	1000		1820	222	223	223	224	145	238	121	223		1618			

TERRA VAC PROJECT # 24-0050 DATE 8/21/94 ANALYST MSW PAGE W-11

SAMPLE	TIME	UNIT HOURS	VAC	FLOW	TEMP	CH	VOL (ul)	ANAL #	ANAL TIME	CH2CL2 ug/l	t-1,2-DCE ug/l	c-1,2-DCE ug/l	CHCL3 ug/l	B ug/l	TCE ug/l	T ug/l	PCE ug/l	OTHER ug/l	TOTAL ug/l	FLOW (scfm)	RATE (#/day)	COMMENTS
Water Blank						1	1000		0827	—	—	—	—	—	—	0.294	—		0.294			
Water Blank						2	1000		0827	—	—	—	—	—	—	0.288	—		0.288			
Cal ✓						1	110		0929	~~229~~	~~247~~		~~226~~	~~153~~	~~264~~	~~130~~	~~242~~					
Cal ✓						2	100		0929	224	~~244~~	~~232~~	~~234~~	~~154~~	~~266~~	~~132~~	~~251~~					~~Bad Injection~~
Cal ✓						1	100		0950	272	702	282	316	199	360	199	412		2342			
Cal ✓						2	100		0950	268	298	270	335	196	356	194	396		2312			
Cal ✓						1	100		1017	271	284	270	307	185	322	174	318		2130			
Cal ✓						2	100		1017	274	294	279	316	195	342	188	359		2246			RECAL
Cal ✓						1	100		1043	226	210	217	256	148	234	140	239					
Cal ✓						2	100		1043	238	212	219	260	149	235	141	238					
Std @ 25°C						1	100		1153	RECALIBRATED												new std/new tips
Std @ 25°C						2	100		1153													new std/new tips
Cal ✓						1	100		1400	229	226	228	264	157	258	150	276		1789			
Cal ✓						2	100		1400	235	224	227	265	156	254	152	278		1791			
Inlet	0810					1	1000		1429	—	—	—	—	—	1.37	—	86.0		87.4			
Inlet Dup	0810					2	1000		1430	—	—	—	—	—	—	—	82.2		82.2			
1° out	0810					1	1000		1449	—	—	—	—	—	—	—	—		0			
2° out	0810					2	1000		1450	—	—	—	—	—	—	—	—		0			
Inlet	1010					1	1000		1506	—	—	—	—	—	1.21	—	73.2		74.4			
1° out	1010					2	1000		1507	—	—	—	—	—	—	—	—		0			
2° out	1010					1	1000		1523	—	—	—	—	—	—	—	—		0			
Inlet	1210					2	1000		1523	—	—	—	—	—	—	—	49.6		49.6			
1° out	1210					1	1000		1548	—	—	—	—	—	—	—	0		0			
2° out	1210					2	1000		1541	—	—	—	—	—	—	—	0		0			
Inlet	1410					1	1000		1602	—	—	—	—	—	—	—	39.9		39.9			
1° out	1410					2	1000		1603	—	—	—	—	—	—	—	—		0			
2° out	1410					1	1000		1619	—	—	—	—	—	—	—	—		0			

TERRA VAC PROJECT # 24-0050 DATE 8/21/94 (cont.) ANALYST MGW PAGE W-12

SAMPLE	TIME	UNIT HOURS	VAC	FLOW	TEMP	CH	VOL (ul)	ANAL #	ANAL TIME	CH_2Cl_2 ug/l	t-1,2-DCE ug/l	c-1,2-DCE ug/l	$CHCl_3$ ug/l	B ug/l	TCE ug/l	T ug/l	PCE ug/l	OTHER ug/l	TOTAL ug/l	FLOW (scfm)	RATE (#/day)	COMMENTS
ET	1600					1	1000		1638	—	—	—	—	—	—	—	—		0			
2° out	1600					2	1000		1639	—	—	—	—	—	—	—	—		0			
Inlet	1600					1	1000		1656	—	—	—	—	—	—	—	44.6		48.6			
1° out	1600					2	1000		—	—	—	—	—	—	—	—	—		0			
Inlet Dup Spike	0810/1439					1	100		1713	248	243	257	283	173	285	172	308		1969			
Spike Rep	0810/[illegible]					2	100		1713	249	238	252	277	170	275	168	300		1930			

Attachment C
List of On-site GC and Associated Equipment

GC Model

Shimadzu GC-9A

Equipment

Pre-marked 40 milliliter vials
10 microliter liquid syringes
1000 microliter gas-tight syringes
Blank water
Neat standards of compounds of interest
Gas chromatograph equipped with flame ionization detector
Wide-bore capillary column
Integrator

Attachment D
GC Quantification Limits for Selected Target VOCs

FIELD GC QUANTIFICATION LIMITS
DCF FACILITY PILOT TEST STUDY

COMPOUNDS	SOIL HEADSPACE DETECTION LIMIT (ug/l)	WATER HEADSPACE DETECTION LIMITS (ug/l)
Methylene Chloride	0.83	9.60
Trans-1,2-Dichloroethene	0.43	1.47
Cis-1,2-Dichloroethene	0.45	3.45
1,1,1-Trichloroethane	0.68	1.36
Chloroform	1.04	7.46
Benzene	0.12	0.63
Tricholoroethene (TCE)	0.57	1.97
Toluene	0.13	0.69
Tetrachloroethylene (PCE)	0.77	2.00

Note: Values indicated are for guidance purpose due to potentially indefinite field interferences.

Attachment E
Static Head Space Methodology

TERRA VAC CORPORATION
STANDARD OPERATING PROCEDURE
FIELD SCREENING WATER ANALYSIS BY THE STATIC HEADSPACE METHOD

Theory of Method

The partition of slightly soluble compounds in water between the liquid and vapor phases is well established. The static Headspace Method takes advantage of this partition to increase the sensitivity of field analysis of slightly soluble compounds in water.

Direct injection of water into a wide-bore capillary column is limited to 2 microliters. The same column can accept 1000 microliters of vapor. If the partition coefficient of a compound is less than 500 the resulting mass injected will be greater for 1000 microliters of vapor. The partition coefficient of the chlorinated hydrocarbons and aromatic hydrocarbons usually encountered in field analysis are significantly lower than 500.

Equipment

Premarked 40 milliliter vials
10 microliter liquid syringes
1000 microliter gas-tight syringes
Blank water
Neat standards of compounds of interest
Gas chromatograph equipped with flame ionization detector
Wide-bore capillary column
Integrator

Procedure

A premarked 40 milliliter vial is filled to the mark with Blank Water, capped and allowed to equilibrate at constant temperature for at least 30 minutes. An aliquot of the headspace is withdrawn with a gas-tight syringe and injected onto the GC column. The Blank Water is then spiked with a neat standard mix of the compounds of interest. After at least 30 minutes of equilibration at constant temperature, an aliquot of the spiked water headspace is withdrawn with a gas-tight syringe and injected onto the GC column. A response factor is calculated for each compound and stored in the memory of the integrator.

Water samples are collected to the same volume mark, capped and allowed to equilibrate at least 30 minutes at constant temperature. A 1000 microliter aliquot of the sample headspace is withdrawn with a gas-tight syringe and injected onto the GC column. Peaks are identified and quantified by the integrator.

Static Headspace Method (SHM)

The SHM for soil analysis is based on EPA Methods 5030, 8015, and 8020, from SW-846. In these methodologies, samples are analyzed by gas chromatography using either an FID and PID. Direct injection of the sample into the chromatographic system is suitable for concentrations of VOCs greater than 1 ppm. As concentrations of this magnitude or higher are expected at most cleanup sites, we have opted for the direct injection approach. Since the concentrations of a VOC in the vapor and aqueous phases are related by a thermodynamic partition coefficient, it follows that either the vapor or aqueous phases can be injected to obtain identical results. Partition coefficients for the distribution of environmentally important VOCs between aqueous and vapor phases are well established and therefore points toward water as the best extraction medium.

The sensitivity of the chromatographic response to the vapor or liquid phases is governed by the following equation, where 'a' represents the ratio of the quantities of a substance introduced into the chromatograph:

$$a = \frac{vg}{vl*(K + Va/Vl)} \qquad \text{(equation 1)}$$

where:

vg = volume of gas injected
vl = volume of liquid injected
K = partition coefficient (reciprocal of Henry's Constant)
Va/Vl = ratio of volumes of headspace to the aqueous phase

Since the limiting volumes of the liquid introduced into our magabore is on the order of 1 ul, and the limiting volume of the gas is about 1000 ul, the above equation becomes:

$$a = \frac{10\ \text{exp}3}{(K + Va/Vl)} \qquad \text{(equation 2)}$$

1000 / 1 + 8

This relationship indicates that the gain in sensitivity of the analysis(a > 1.0) is attained when K < (10 exp3 - Va/Vl) for average volumes of Va and Vl (typically Va/Vl is less than 10). The VOCs to be analyzed at Sites have K's in the 4 to 50 range, therefore the above equation indicates a considerable increase in sensitivity when the vapor is injected compared to the liquid. We therefore opt for direct injection of the vapor phase. 1-5

Soil samples will be extracted with water and the VOC concentration calculated from known partition coefficients of the VOC's between the vapor and aqueous phases ;viz,

$$Cs = \frac{\text{Mass in (Headspace + Water)}}{\text{Mass of soil}}$$

$$Cs = \frac{Ch*Va + (Ch*Vl)/Hc}{Ms} \qquad \text{(equation 3)}$$

Where Cs = concentration in soil sample (mg/Kg)
Ch = concentration in headspace (mg/L)
Va = Headspace Volume (L)
Vl = Volume of Aqueous Phase (L)
Hc = Henry's Law Constant
Ms = Mass of Soil Sample(Kg)

To minimize transfer and handling, the soil samples (10-15g) will be placed directly into the jars containing water (300 ml) at the time the split spoon is opened. Once soil samples are received at the field laboratory, the sample will be placed in a constant temperature bath held at 20.0± 0.1 deg.C. The headspace will be sampled with a 1.0 ml gas-tight syringe and injected directly into the GC. The advantage of this approach is evident in the simplicity and lack of sample preparation steps during which contamination and/or analyte losses are known to occur with extraction and purge-and-trap procedures. Also this approach provides faster turnaround of results as well as more reliable and accurate data since samples are analyzed sooner than purge and trap methods.

The sensitivity (S) of the Static Headspace Method (SHM) is given by the following variant of equation 1:

$$S = \frac{d * Vi}{(K + Va/Vl)} \qquad \text{(equation 4)}$$

where:

d = chromatographic detector sensitivity
Vi = Volume injected into Chromatograph
Va/Vl = ratio of Volume of Headspace to the aqueous phase

By suitably adjusting the volume ratio, the injection size (100 to 1000 ul) and taking into account the approximate 50 fold increase in sensitivity of the PID over the FID, then according to the above equation, the SHM sensitivity can be adjusted to a factor of almost 1000 for any given analysis. The interaction of these three parameters provides a considerable amount of control over the analytical procedure. At values of Hc < 10exp-3, the sensitivity decreases and the usefulness of the SHM is questionable. The Hc's of the VOC's at this site are 10exp-2 or larger, well above this lower limit.

Example: Rochester Project

The implications of Equation (1) relative to our work at [redacted]

the Hc of the ketones and alcohol is about 0.001 and we were limited to 0.1µl liquid injections. Therefore

$$a = 1000/(0.1(1000 + Va/Vl))$$

if $Va/Vl \approx 1$ then $a = 10$

In spite of the unfavorable Hc, if you can only shoot 0.1µl (instead of 1µl) then you are better off with the Headspace Method..

For VOC's less water sol'y than these the advantage of the HSM increases. For example, a 25 ppb sol'n of VCM (Hc = 1) give 170,000 area unit when 1000 µl vapor is injected at range setting of 0. (Va/Vl = 0.16)

The treachery of dealing with Hc (or Hv for Henry's variable) can be reduced by making a calibration curve based on the equation :

$$PPM(sol'n) = Ch(K + Va/Vl)$$

which becomes, $PPM(sol'n) = Ch*K_{voc}$ when Va/Vl = constant or each VOC has its own K_{voc}

The use of the Equation: PART 1

PPB = Ch*Kvoc (5) Ch in ug/l in the case

Equipment: A Mason Jar is filled with water to the point where the opening is sealed to the main body of the jar. This setup gives a Va = 65 and Vl = 409 ml for a Va/Vl ratio of 0.16.

Procedure: Shoot a 1 ml blank of the headspace, then add 1 ul of a mixture of ACE, DCM, 111-TCA, BEN, TCE, TOL, PCE, oXYL, mXYL, p-XYL and shake periodically over a one hour period. (Thermostat Jar at 20°C if possible). Shoot 1 ml of the Headspace; the data is shown below

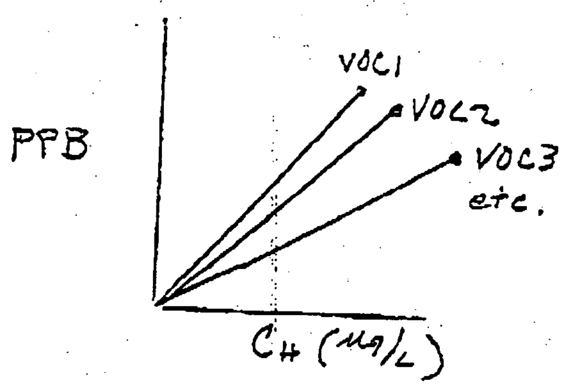
VOC	CONC PPB	GC AREA (VOC)	GC AREA BLANK	H/S CONC (ug/l)	Kvoc
ACE	198	470	0	.37	535
DCM	329	2059	0	29.62	11
111-TCA	337	15914	0	213.2	1.58
BEN	220	15381	0	48.57	4.53
TCE	365	9350	0	144.05	2.53
TOL	217	16480	0	59.62	3.64
PCE	407	17377	0	307.82	1.32
pm-XYL	532	34971	0	163.36	3.26
o-XYL	220	11707	0	53.01	3.79

NOTES:

CONC(PPB) is based on fact that each VOC is 10% of 1 ul sample added to the jar which contains ca. 400 ml water or 0.25 ul/l water. Therefore the CONC(PPB) is 0.25 * density of each VOC. GC AREA BLANK is zero in all cases so there is no need to correct the GC AREA(VOC). Kvoc. This slope is CONC(PPB)/H-S CONC

SUMMARY:

This simple experiment has given us 9 calibration curves which go thru the origin. While Hc is implicit in the constant, Kvoc no prior knowledge of it is necessary. If Hc's are available we can calculate Kvoc and use this theory value in Equation 5, as a rough estimate of PPB.



THE USE OF THE EQUATION: PART 2

PPB = Ch*Kvoc (Ch in ug/l)

"To do Headspace or not to do Headspace,
or whether it is nobler to Purge
and Trap,
that is the Question"

Furthermore if you choose the Headspace Method, what ratio of air/water is the best. Do you half fill the jar or fill it almost to the top? There are limitations on how low a Ch value we can measure and still report our usual ±15% precision; at some point all we can say is "IT's THERE". We prefer a Ch above our Practical Quantification Limit (PQL), but this may not be achievable with some very soluble VOC's.

Let's assign a low value to PPB, say 20. Obviously, the product of Ch and Kvoc must equal 20 (no problem here). We have a number of choices:

Ch	Kvoc	COMMENT
2	10.00	Ch too close to MDL
20	1.00	better
200	.10	best. but is Kvoc = .1 practical?

Kvoc in turn is a function of Henry's constant and the air/water ratio(Va/Vw).

Kvoc = (1/Hc)+Va/Vw

We can use this equation to calculate a table of Kvoc's from a reasonable range of Hc (1 to .001) and Va/Vw (9 to .15):

Hc	Va/Vw 9.00	1.50	.15
1	10.00	2.50	1.15
.1	19.00	11.50	10.15
.01	109.00	101.50	100.15
.001	1009	1001.50	1000.2

To answer the original question; NO, a Kvoc = .1 is not practical. Furthermore, if the solution contains a very sol'y VOC such as acetone (HC ≈ .001) we a stuck with a Kvoc = 1000. If this same sol'n contains an ordinary VOC with an Hc between .1 and 1, then there is an advantage in choosing a Va/Vw ≈ 0.15. This choice will give us a Ch some 2 to 10 times higher than the Va/Vw ≈ 9 choice. (as mentioned earlier if we fill a mason jar up to the line on the neck we get Va/Vw = .15).

To translate all this stuff to GC AREA units we assume PPB = 2 Va/Vw = .15, FID range=0, and a RES. Factor ≈ 0.0026 (TCE,DCE,DCA,TCA) and 0.00065 (BEN,TOL,XYL),Quadrex col'm.

Kvoc	AREA* RF=.0026	RF=.00065
1.15	3344.48	13378
10.15	378.93	1516
100.15	38.40	154
1000.15	3.85	15

* based on 0.5 ml injection--double for 1.0ml.
For the PID and 1ml shot mult by ca. 100

Assuming an area of 1000 is quantifiable, then a PPB=20 sol'n is either a piece of cake or just do-able for all but the most soluble VOC. Even for the most soluble, we are still better off shooting the Headspace so long as we are limited to a 0.1 ul liquid injection on our megabore columns - as we found out at [redacted]. The evidence at this point suggests that shooting the Headspace is the best choice although at some concentration levels it becomes the best of two poor alternates. At these levels we switch to Purge-n-Trap.

As a final step in this section, lets translate the 20 ppb to a soil concentration. Using the FID and 409 ml water we feel comfortable with 20 ppb; if the jar contains 20 g soil then the soil conc is

$$PPB(soil) = 20*V1/Kg\ soil = 20*0.409/.020 = \quad 409$$

This is a very respectable level to operate at, compared to a lot of cleanup criteria. Also bear in mind that we can reduce our comfort zone to ca. 5ppb with the PID. (See Example 4).

EXAMPLE 3: The HSM on soil using the PID.

This example covers a complete [illegible] analysis and spike recovery.

CONDITIONS: [illegible] megabore column, PID detector at range 1. Temp Bath = 20°C

function	SAMPLE ID	Va/V	CONC(ug/l) MMA	TOL	CONC(ppWATER MMA	TOL	derived Kvoc MMA	TOL
BLANKS	syr blnk	--		0	--			
BLANKS	jar blnk	1.03	.06	.015				
CALIBRN	jar+std²	1.03	1.18	.780	205	7.5[illegible]	[illegible]	[illegible]
CALIBRN	dupe	"	1.20	.820	205	7.59	180	9.[illegible]
ANALYSIS	soil(10g)	1.01	1.77	.41	325	3.89		
ANALYSIS	dupe	"	1.77	.4	321	3.80		
SPIKE	soil	"	2.26	.17	% recovery			
RECOVRY	soil+std⁴	"	3.65	1.1	86	86		
DATA	PPB of the SOIL				3230	38.40		

NOTES: ² 1 ul tol, 25 ul mma in 10 ml meoh - 20 ul this sol'n injected.

This is a simple straight forward example based on some real data. The intent here is to illustrate the possibilities and internal consistency of the HSM.

[redacted] Gas Chromatograph

GC Model
Shimadzu GC-9A (GC-15A)

Associated Equipment

Shimadzu C-R 5A Integrator (CR 4A)
Supelco SPB-1 Wide Bore Capillary Columns
Zenith Supersport Laptop Computer
Balston Zero Air Generator
Speedaire Compressor and Tank
Compressed Gas Cylinders and Regulators
Syringes - Assorted
Chemical Standards
Glassware - Assorted
Ford Van

[redacted] Quality Control

A standard bulb blank will be analyzed daily to verify syringe and bulb cleanliness and to demonstrate that the analytical system is free of interferences. Duplicate samples will be collected at a minimum of once per day to establish the precision of the analytical methodology. Due to limitations of field analytical conditions, minimum quantification limits will be established in lieu of Method Detection Limits. Minimum Quantification Limits are established based upon each compound's detector response and a minimum peak area which is well above background noise levels.

APPENDIX C
DRAFT TECHNICAL MEMORANDUM—EXTENDED SOIL VAPOR EXTRACTION SYSTEM PILOT STUDY

DRAFT TECHNICAL MEMORANDUM
DRY CLEANING FACILITY
EXTENDED SOIL VAPOR EXTRACTION SYSTEM PILOT STUDY
8 FEBRUARY 1995

1.0 Overview

Data from the 30 day Soil Vapor Extraction System (SVE) Pilot Study at Dry Cleaning Facilities (DCF), completed in December 1994, indicates that small amounts of volatile organic compounds (VOC's) were being extracted from the soils. The vapor extraction test will be extended for an additional 30 days in order to further evaluate the removal trend over time. Data from this extended study will used to evaluated whether the test should continue.

2.0 Issue

The 30 day SVE extended pilot study will be performed in accordance with DCF Work Plan Pilot Test Study Dual Phase Extraction System dated June 17, 1994, with the following modifications:

(1) Vapor treatment will not be necessary due to the GAC contaminant load rate of approximately 0.5 lbs/day achieved at the completion of the 30-day pilot study ending December 20, 1994. This level is below both KDHE hourly emission rate standard of 2.3 lbs./hr and the maximum daily rate of 55 lbs/day.

(2) Vapor samples will be collected weekly and transported to a laboratory for VOC analysis.

3.0 Proposed Action

Two vapor samples per week will be obtained from the DCF SVE system using the following materials:

Desiccator, Gas sampling Bags, Hand Pump, Tygon Tubing.

The sampling procedure and laboratory analyses are comparable to collection and sampling in original pilot study, and shall be conducted as described below:

Report vacuum level, temperature, and gaseous flow as read directly from gauges on manifold pipe. Attach desiccator/Gas sampling bag apparatus to pipe sampling location using Tygon tubing. Reduce vacuum in desiccator using hand pump. Gaseous flow will discharge into Gas sampling Bag as a result of vacuum differential. Increase and decrease vacuum in desiccator two times in order to purge bag. Upon completion of second purge, fill bag a third time and retain gaseous material in Gas sampling bag for transport to laboratory for analysis. Two samples shall be collected - one to be analyzed, and a second to be archived should 1st sample become damaged or lost in transport.

The sample shall be analyzed for VOC's in air (14 compounds) as per (1) Modified EPA SW-846 method using EPA 8010 and 8020, and (2) TPH-GRO in air using modified EPA 8015. Sample results shall be reported to LBA in 4 days.

DRAFT MEMORANDUM

TO: Commander, Engineer District, Kansas City
CEMRK-MD-H, Garth Anderson
Kansas City, MO 64106

Katie Watson, Fort Riley - DEH

FROM: Susan Parslow, LBA

RE: Fort Riley, Dry Cleaning Facility
Draft Technical Memorandum - Extended Pilot Study

CC: Jim Stamatis, LBA
George Parris, LBA
Susan Knauf, LBA
Fred McCarthy, LBA

Enclosed please find the Technical Memorandum concerning sampling precedures and frequencis for analysis of VOC concentrations in extracted vapor for the 30-day Extented SVE Pilot Study at the Dry Cleaning Facility.

If you have any questions, please call me at (201)-678-1960, extension 467.

APPENDIX D
SOIL BORING LOGS AND
AS-BUILT WELL CONSTRUCTION DETAILS

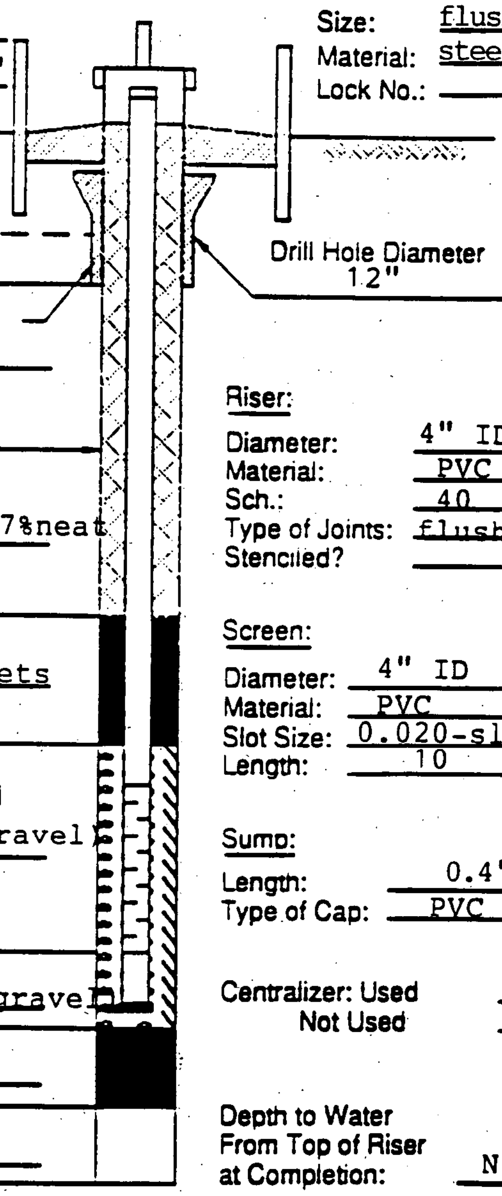
LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

Client: Corps of Engineers, ~~Kansas City~~
Project: Dry Cleaning Facility, ~~Pilot Test Study~~
Project No.: JH1021Q
Page: 1
Prepared by: T. Kelly Date: 8/5/94
Checked by: A. Smith Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

Driller: Charles Riffle
Well No.: DCF94ES-1A
Drilling Method: 4.25" ID HSA (drill & samples), 8.25" ID HSA (ream)
Date Installed: 5/21/94

Coordinates: N-267929.64939 E-2343392.08465



Ground Elev. 1085.24'
Elevation 1084.17'
Stick-up (-1.07)
N/A Rock/Soil Interface
2'
Surface Seal Material: Concrete
Drill Hole Diameter: 12"
Type of Annular Seal: 3% bentonite 97% neat cement mixture
10.5
Type of Seal: bentonite pellets
12.7
Type of Filter Material: #4 sand (pea gravel)
24.6'
24.6
Ground Surface to Tip of Well Screen: 24.6'
27.1
Type of Filter Material: #4 sand (pea gravel)
Type of Seal: N/A
Type of Backfill: N/A

PROTECTOR CASING
Size: flush mount
Material: steel vault
Lock No.:

Riser:
Diameter: 4" ID
Material: PVC
Sch.: 40
Type of Joints: ~~flush~~threaded
Stenciled?

Screen:
Diameter: 4" ID
Material: PVC
Slot Size: 0.020-slot
Length: 10

Sump:
Length: 0.4'
Type of Cap: PVC

Centralizer: Used
Not Used x

Depth to Water From Top of Riser at Completion: N/A vapor well

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

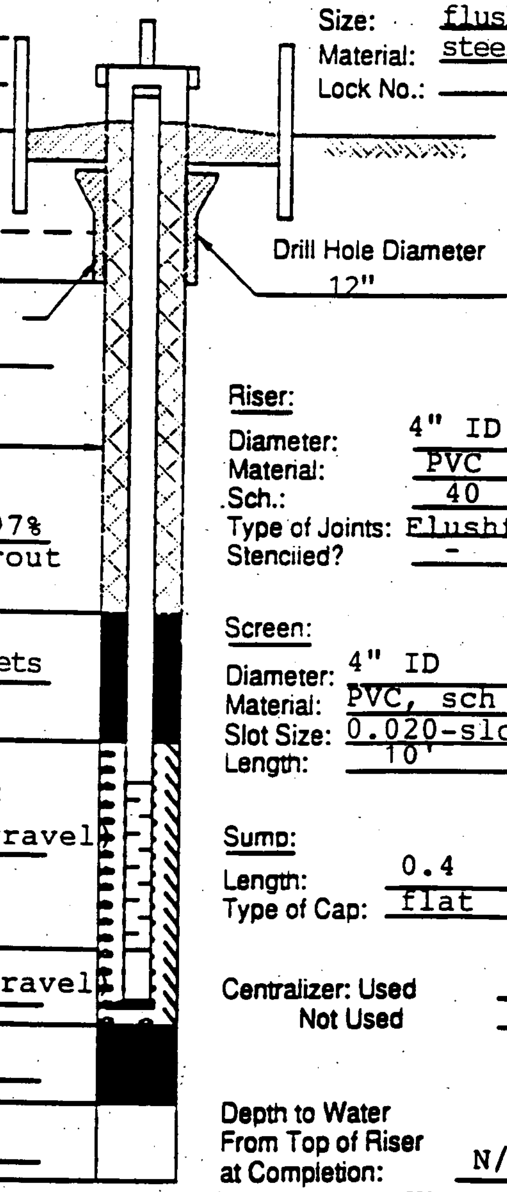
Client: Corps of Engineers, Kansas City District
Project No.: JH1021Q
Project: Dry Cleaning Facility Pilot Test Study
Page: 1
Prepared by: T. Kelly
Date: 8/8/94
Checked by: A. Smith
Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

Driller: Charles Riffle
Drilling Method: TK 8/2at 8.25" ID HSA

Well No.: DCF94ES-2A
Date Installed: 5/21/94

Coordinates: N-267896.59545 E-2343385.84587



Ground Elev. 1084.25'

Elevation 1083.76'
Stick-up (-0.49')

N/A Rock/Soil Interface

2.0

Surface Seal Material
concrete

Drill Hole Diameter
12"

Ground Surface to Tip of Well Screen
24.9'

Type of Annular Seal
3% bentonite 97% neat cement grout mixture

9.9

Type of Seal
bentonite pellets 3/8"

12.1

Type of Filter Material
#4 sand (pea gravel)

24.9'

Type of Filter Material
#4 sand (pea gravel)

27.1

Type of Seal
N/A

Type of Backfill
N/A

PROTECTOR CASING

Size: flush mount
Material: steel vault
Lock No.:

Drill Hole Diameter
12"

Riser:
Diameter: 4" ID
Material: PVC
Sch.: 40
Type of Joints: Flushthreaded
Stenciled? -

Screen:
Diameter: 4" ID
Material: PVC, sch 40
Slot Size: 0.020-slot
Length: 10'

Sump:
Length: 0.4
Type of Cap: flat

Centralizer: Used
Not Used x

Depth to Water From Top of Riser at Completion: N/A
vapor well only

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

Client: US Army Corps of Engineers
Project No.: 1021
Project: Dry Cleaning Facility - Ft Riley
Page: ______
Prepared by: T. Kelly
Date: 8/10/94
Checked by: A. Smith
Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

Driller: David Robinson (Layne)
Drilling Method: 4.25" ID HSA (drilling & sampling)
8.25" ID HSA (reaming)

Well No.: DCF 94ES-3A
Date Installed: 5/22/94

Coordinates: N-267932.32384 E-2343374.33876

PROTECTOR CASING
Size: flush mount
Material: steel vault
Lock No.: ______

Ground Elev. 1085.15'

Elevation 1084.24'
Stick-up (-0.91')

N/A Rock/Soil Interface

3'
Surface Seal Material: concrete

Drill Hole Diameter: 12"

25.2' Ground Surface to Tip of Well Screen

Type of Annular Seal: 3% bentonite/97% neat cement mixture

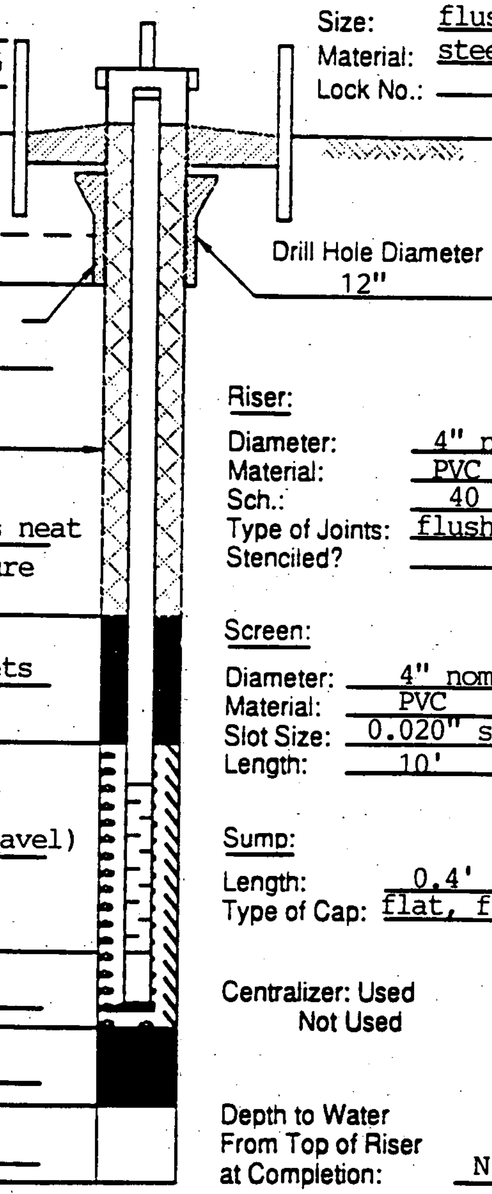
9.4' bgs
Type of Seal: bentonite pellets

11.3' bgs
Type of Filter Material: #4 sand (pea gravel)

25.2' bgs
Type of Filter Material

26.8' bgs
Type of Seal: N/A

Type of Backfill: N/A



Riser:
Diameter: 4" nominal
Material: PVC
Sch.: 40
Type of Joints: flush thread
Stenciled? ______

Screen:
Diameter: 4" nominal
Material: PVC
Slot Size: 0.020" slot
Length: 10'

Sump:
Length: 0.4'
Type of Cap: flat, flush thread

Centralizer: Used ___ Not Used X

Depth to Water From Top of Riser at Completion: N/A
vapor only

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

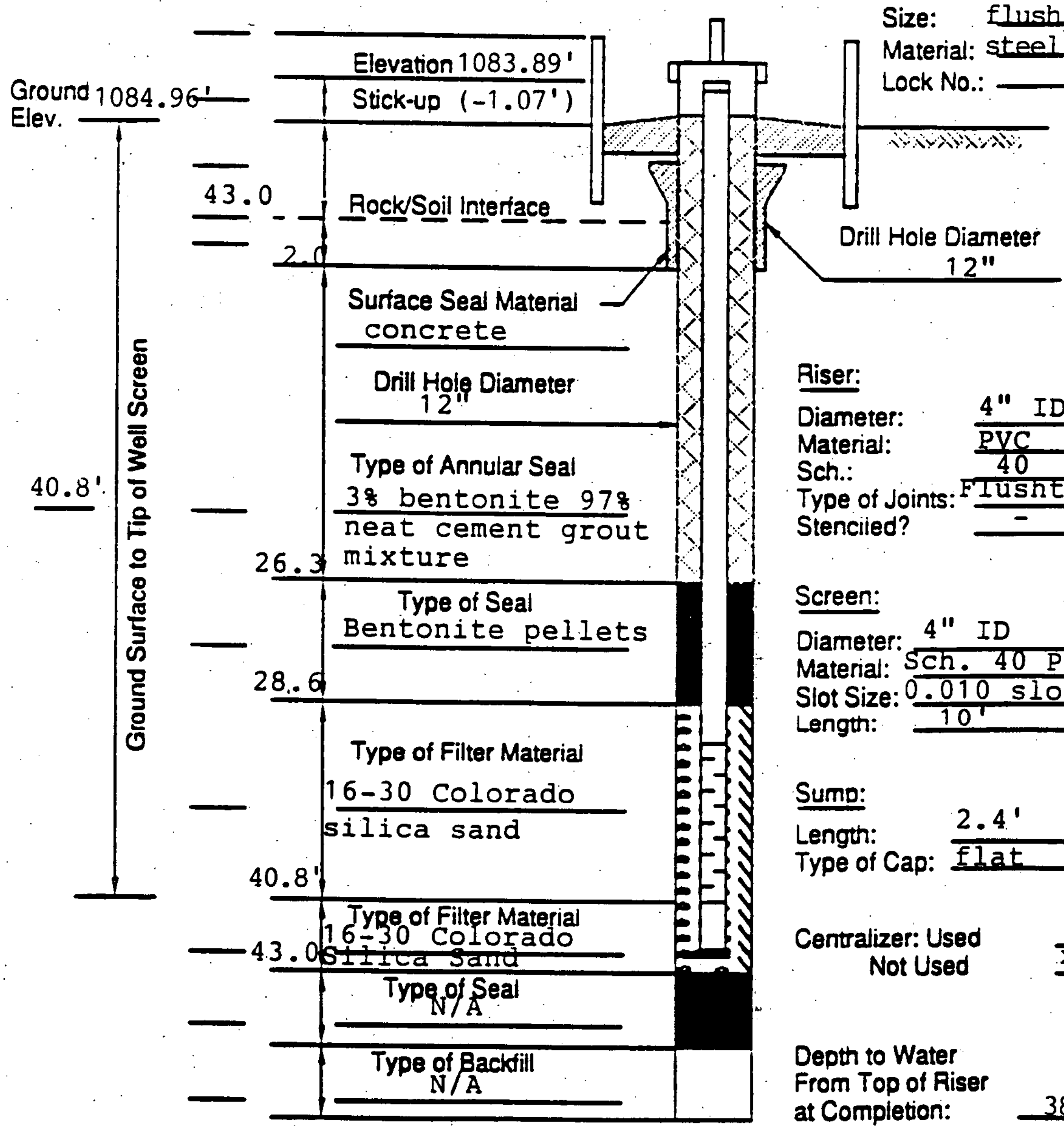
Client: Corps of Engineers, Kansas City Dr.
Project No.: JH1021Q
Project: ~~Dry Cleaning Facility~~ Pilot Test Study
Page: 1
Prepared by: T. Kelly
Date: 8/5/94
Checked by: A. Smith
Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

Driller: Dave Robinson
Drilling Method: 4.25" ID HSA (Drill/Sump with 8.25" ID HSA (ream)
Well No.: DCF94ES-1B
Date Installed: 5/22/94

Coordinates: N-267925.15875 E-2343390.93211

PROTECTOR CASING
Size: flush mount
Material: steel vault
Lock No.:



Riser:
Diameter: 4" ID
Material: PVC
Sch.: 40
Type of Joints: Flushthreaded
Stenciled? -

Screen:
Diameter: 4" ID
Material: Sch. 40 PVC
Slot Size: 0.010 slot
Length: 10'

Sump:
Length: 2.4'
Type of Cap: flat

Centralizer: Used x
Not Used

Depth to Water From Top of Riser at Completion: 38.21'

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

Client: Corps of Engineer, Kansas City District Project No.: JH1021Q
Project: Dry Cleaning Facility ~~Pilot Test Study~~ Page: 1
Prepared by: T. Kelly Date: 8/5/94
Checked by: A. Smith Date: 2/23/95

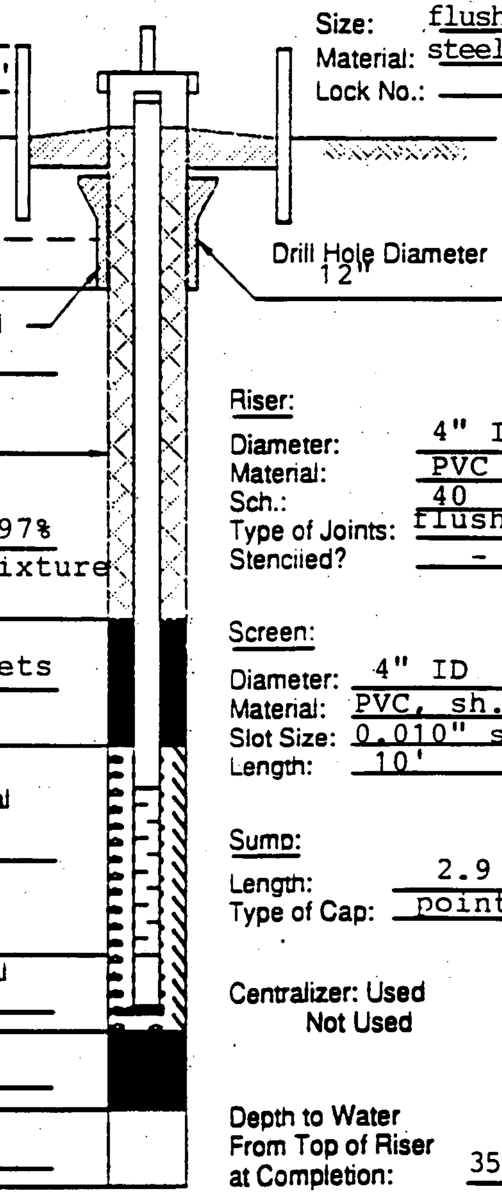
MONITORING WELL AS-BUILT DIAGRAM

Driller: John Gornick
Drilling Method: 4.25" HSA drilling/sampling
8.25" ID HSA-ream

Well No.: DCF94ES-2B
Date Installed: 5/20/94

Coordinates: N-267900.85319 E-2343385.66734

PROTECTOR CASING
Size: flush mount
Material: steel vault
Lock No.:



Elevation 1083.65'
Stick-up (-0.65')
Ground Elev. 1084.30'
39.5 Rock/Soil Interface
3.0
Drill Hole Diameter 12"
Surface Seal Material: Concrete
Drill Hole Diameter: 12"
Type of Annular Seal: 3% bentonite 97% neat cement mixture
38.1' Ground Surface to Tip of Well Screen
23.5
Type of Seal: bentonite pellets
25.5
Type of Filter Material: 16-30 Colorado Silica Sand
Type of Filter Material:
41.0
Type of Seal: N/A
Type of Backfill: N/A

Riser:
Diameter: 4" ID
Material: PVC
Sch.: 40
Type of Joints: flushthread
Stenciled?: -

Screen:
Diameter: 4" ID
Material: PVC, sh. 40
Slot Size: 0.010" slot
Length: 10'

Sump:
Length: 2.9
Type of Cap: point

Centralizer: Used
Not Used x

Depth to Water From Top of Riser at Completion: 35.52'

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

LOUIS BERGER & ASSOCIATES, INC. 100 Halsted Street East Orange, N.J.	Client: Corps of Engineers, Kansas City District	Project No.: JH1021Q
	Project: Dry Cleaning Facility Pilot Test Study	Page: 1
	Prepared by: T. Kelly	Date: 8/8/94
	Checked by: A. Smith	Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

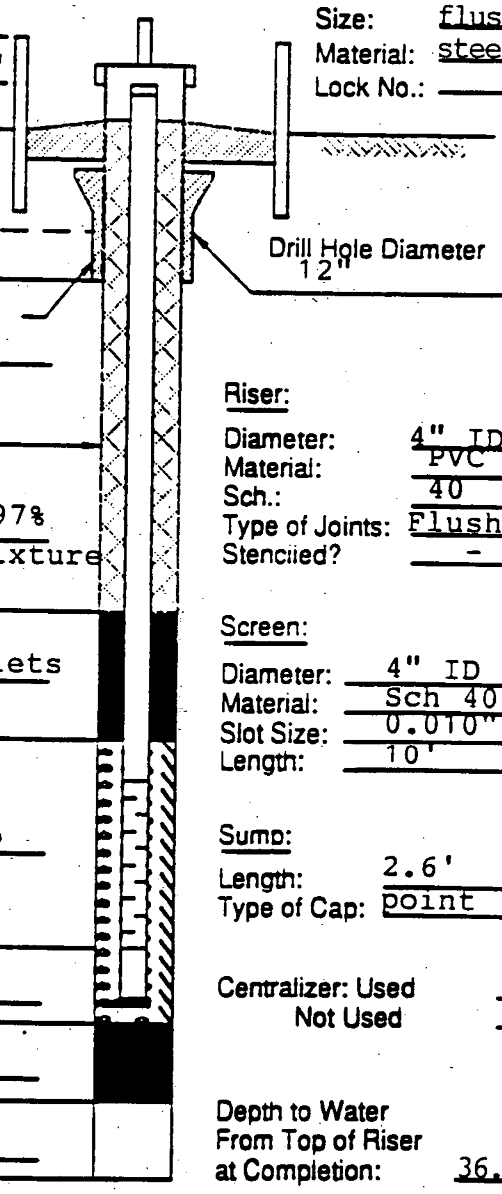
Driller: Charles Riffle

Drilling Method: 4.25" ID hollow stem auger (drill/sample) 8.25" ID hollow stem auger (ream)

Well No.: DCF94ES-3B

Date Installed: 5/19/94

Coordinates: N-267927.65833 E-2343374.15788



Ground Elev. 1084.93

Elevation 1083.87'

Stick-up (-1.06)

41.8 Rock/Soil Interface

3.0

Surface Seal Material: concrete

Drill Hole Diameter: 12"

Type of Annular Seal: 3% bentonite 97% neat cement mixture

26.3

Type of Seal: bentonite pellets

28.4

Type of Filter Material: 16-30 Colorado silica sand

40.7

Type of Filter Material: 16-30 Colorado silica sand

43.3

Type of Seal: N/A

Type of Backfill: N/A

Ground Surface to Tip of Well Screen: 40.7'

PROTECTOR CASING

Size: flush mount

Material: steel vault

Lock No.:

Drill Hole Diameter: 12"

Riser:

Diameter: 4" ID

Material: PVC

Sch.: 40

Type of Joints: Flushthreaded

Stenciled? -

Screen:

Diameter: 4" ID

Material: Sch 40 PVC

Slot Size: 0.010" - slot

Length: 10'

Sump:

Length: 2.6'

Type of Cap: point

Centralizer: Used

Not Used: X

Depth to Water From Top of Riser at Completion: 36.29

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

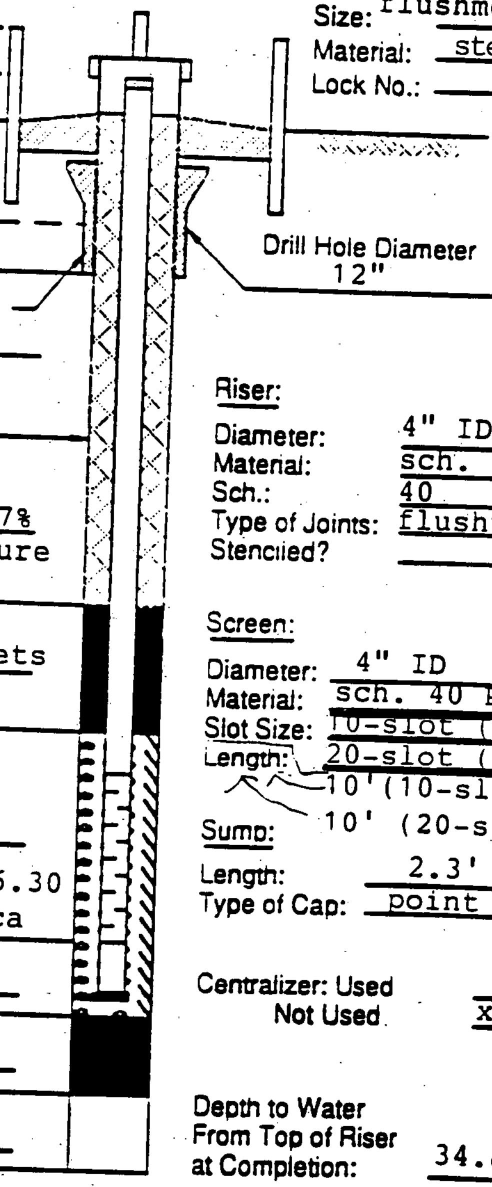
LOUIS BERGER & ASSOCIATES, INC.
100 Halsted Street
East Orange, N.J.

Client: Corps of Engineers, Kansas City, MO
Project: Dry Cleaning Facility ~~Pilot Study~~
Prepared by: T. Kelly
Checked by: A. Smith
Project No.: JH1021Q
Page: 1
Date: 8/5/94
Date: 2/23/95

MONITORING WELL AS-BUILT DIAGRAM

Driller: John Gornick/Layne Western Company
Drilling Method: 4.25" HSA (ID), 8.25" ID HSA - reamed
Well No.: DCF94-21
Date Installed: 5/18/94

Coordinates: N-267772.86913 E-2343315.37325



PROTECTOR CASING
Size: flushmount vault
Material: steel
Lock No.:

Ground Elev. 1082.64'
Elevation 1082.37'
Stick-up (-0.27')
39.4 Rock/Soil Interface
3.0'
Drill Hole Diameter 12"
Surface Seal Material concrete
Drill Hole Diameter 12"
Type of Annular Seal 3% bentonite 97% perthenol mixture
28.4 Ground Surface to Tip of Well Screen
11-0 (upper)
25.8 (lower) Type of Seal bentonite pellets
13.2 (upper)
26.9 (lower)
Type of Filter Material Upper screen - #4 pea gravel Lower screen 16.30 Colorodo silica sand
(Upper) 25.8
(lower) 28.4
Type of Filter Material same as above
40.7
Type of Seal N/A
Type of Backfill N/A

Riser:
Diameter: 4" ID
Material: sch. 40 PVC
Sch.: 40
Type of Joints: flushthreaded
Stenciled?

Screen:
Diameter: 4" ID
Material: sch. 40 PVC
Slot Size: 10-slot (lower); 20-slot (upper)
Length: 10' (10-slot) 10' (20-slot)

Sump:
Length: 2.3'
Type of Cap: point

Centralizer: Used
Not Used x

Depth to Water From Top of Riser at Completion: 34.88

FORM: *LBAMONW.DRW/Feb.1992*

NOTE: Not to Scale

HTW DRILLING LOG

HOLE NO.	DCF94-21
1. COMPANY NAME	Louis Berger & Assoc., Inc
2. DRILLING SUBCONTRACTOR	Layne Western Company, Inc.
SHEET	1 OF 5 SHEETS
3. PROJECT	Dry Cleaning Facility
4. LOCATION	Fort Riley, KS
5. NAME OF DRILLER	John Gornick
6. MANUFACTURER'S DESIGNATION OF DRILL	~~CM~~ CRV-57
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	4.25" ID hollow stem augers; 3" OD continuous sampler
8. HOLE LOCATION	100.4 SW of E corner of Bldg 180, 23.8 SE
9. SURFACE ELEVATION	1088' above mean sea level
10. DATE STARTED	5/17/94
11. DATE COMPLETED	5/18/94
12. OVERBURDEN THICKNESS	39.4
15. DEPTH GROUNDWATER ENCOUNTERED	35'
13. DEPTH DRILLED INTO ROCK	0.8
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	33.76 BGS 5 days, 21 hr, 40 min
14. TOTAL DEPTH OF HOLE	40.2
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	3	1	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
None - TC 5/26/94	~~EPA 8240 (3)~~					66

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
			Aquifer test / remediation	Timothy J Kelly

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO e	ANALYTICAL SAMPLE NO f	BLOW COUNTS g	REMARKS h
1088	0	0.0 to 3.2 SM SILTY SAND 65% fine, subrounded, quartz sand, 35% medium to low plasticity fines, very dark gray (7.5YR 3/1), moist, trace medium to coarse sand, rootlets, Alluvium + Fill	hnu 0	N/A	DCF94-21-1 (1-2') @ 1145	N/A	1135 Begin drilling w/ 4.25" ID hollow stem augers & 3" OD continuous sampler. Soil described using Unified Soil Classification System, color with Munsell Soil color chart. hnu readings given as ppm equivalents (isob.) above background. isob. = isobutylene
1087	1.0						
1086	2.0				2.0-3 DCF94-21-1 (geotech)		
1085	3.0						
		3.2 to ~~4.5~~ TK 5/17 4.7 SM SILTY SAND 80% fine & medium, subrounded quartz sand with 20% medium to high plasticity fines, trace coarse gravel and coarse sand moist, very dark gray (10YR 3/1), fill at 3.4 to 3.5 Alluvium + Fill					
1084	4.0			end run @ 4.5' @ 11:40			4.5' depth taped
				Begin run 1145			
1083	5.0						

HTW DRILLING LOG

HOLE NO. DCF94-21

PROJECT: Dry Cleaning Facility Pilot Study | INSPECTOR: Timothy J. Kelly | SHEET 2 OF 5 SHEETS

Elev.	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1083	5.0	4.7 to 6.9 SP POORLY GRADED SAND 95% fine, sub rounded quartz sand, with 5% non plastic fines, moist, grayish brown (2.5Y 5/2), Poorly graded ← moist Max part size = ~0.1mm Alluvium	hnu 0	N/A (this page)	N/A (this page)	N/A	
1082	6.0						
1081	7.0	6.9 to 9.8 SP POORLY GRADED SAND WITH GRAVEL 75% fine, subangular, quartz sand, with 20% fine, lithic (ash/cinders) subangular gravel and 5% non plastic fines, moist, dark gray (2.5Y 4/1) (moist) mostly poorly graded, maximum particle size = ~1/2" Alluvium					
1080	8.0						
1079	9.0	TK 5/17/94		recov = 2.5' End run @ 1155 hr 9.5' / 1338 begin run			~~Top of~~ TKS/16 Sounded ~~Run~~ depth = 9.5'
1078	10.0	9.8 to 10.7 SW-SM WELL-GRADED SAND WITH SILT AND GRAVEL 70% fine to medium sand (coal, quartz, cinders) with 20% fine lithic gravel 10% nonplastic fines, trace cobbles, well-graded dark reddish brown (5YR 2.5/2, moist) Fill moist, weak to no reaction	0				
1077	11.0	10.7 to 12.0 SC CLAYEY SAND FILL + ALLUVIUM 80% fine subrounded quartz sand (locally 100% sand), 20% low to medium plasticity fines, moist fine rootlets, weak to no HCl reaction black (7.5YR 2.5/1, moist)					
1076	12.0	12.0 to 17.6 SM SILTY SAND 65% fine to medium, subrounded quartz sand, 35% nonplastic fines, moist, very dark greyish brown (10YR 3/2, moist), roots Alluvium					
1075	13.0						
1074	14.0						

MRK FORM JUN 89 55-2 | PROJECT: Dry Cleaning Facility, Fort Riley, Pilot Study | HOLE NO. DCF94-21

HTW DRILLING LOG

PROJECT: Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

HOLE NO.: DCF94-21

SHEET 3 OF 5 SHEETS

Elev.	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1074	14.0	12.0 to 17.6 SM SILTY SAND	hnu	recov = 2.4' ended run @ 1346, 14.5'		N/A	Sounded run depth = 14.5'
				1356 begin run			
1073	15.0			DCF94-21 -2	DCF94 -21-2 VOC's c̄ geotech.		
1072	16.0		0				
1071	17.0						
1070	18.0	17.6 to 21.8 SM SILTY SAND 85% fine to medium, subrounded quartz sand, 15% nonplastic fines, moist, brown (10YR 4/3, moist) maximum particle size (Avg): 1mm, trace fine gravel (½")					
1069	19.0	~~X X X~~ TK 5/17/94		1410 end run @ 19.5' 4.9' recov			sounded run depth = 19.5' 1413 Collect Shelby tube
1068	20.0	Shelby tube sample collected, Not observed		DCF94 -21-G			
1067	21.0	As above (17.6 to 21.8)		1445 begin run from 19.5'			
1066	22.0	21.8 to 25.5 SC CLAYEY SAND brown (10YR 4/3, moist) 85% fine, subrounded quartz sand, poorly graded, maximum particle size = <0.1 mm, with 15% high plasticity fines, moist,	0				
1065	23.0	locally weak to strong HCl reaction					

MRK FORM JUN 89 55-2 PROJECT: Dry Cleaning Facility Pilot Study HOLE NO. DCF94-21

HTW DRILLING LOG

HOLE NO. DCF94-21

PROJECT: Dry Cleaning Facility Pilot Study | INSPECTOR: Timothy J. Kelly | SHEET 4 OF 5 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1065	23.0	21.8 to 25.5 SC CLAYEY SAND 85% fine sand, 15% high plasticity fines	hnu			N/A	
1064	24.0		0	recov = 2.6' 1454 end run @ 24.5'			run depth not recorded
		medium to coarse, lithic to quartz gravel		Begin run @ 1512			
1063	25.0	medium to ~~coarse~~ fine					
		25.5 to 27.5 SC CLAYEY SAND					
1062	26.0	As Above but finer .7 1" stringers of ~~fine~~ TK 5/17 100% fine to medium sand, strong HCl reaction, moist trace coarse	0				
1061	27.0	gravel (chert)		TK 5/17 ~~end run @ 27.9' 1517~~			
		27.5 to 30.8 SP POORLY GRADED SAND					
1060	28.0	95% fine to medium poorly graded subrounded quartz sand with 5% nonplastic fines, moist, fine clay to silt stringer at 30.5		~~1545 begin run~~ recov = 3.5'			
1059	29.0			TK 5/17 ~~End run @ 1517~~ end run @ 29.5 1517			Sounded run depth = 29.5'
				1546 Begin run			
1058	30.0		0				
1057	31.0	30.8 to 31.2' SP-SC POORLY GRADED SAND WITH CLAY AND GRAVEL 60% fine to medium sand 30% fine to coarse gravel 10% medium to high plasticity fines brown (10YR 4/3, moist), moist towards (fine interbed) grading bimodal, poorly					
1056	32.0						

MRK FORM JUN 89 55-2 | PROJECT Dry Cleaning Facility Pilot Study | HOLE NO. DCF94-21

HTW DRILLING LOG

PROJECT	INSPECTOR	HOLE NO.
Fort Riley Dry Cleaning Facility P.S	Timothy J. Kelly	DCF94-21
		SHEET 5 OF 5 SHEETS

Elev.	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1056	32.0	31.2 to 38.3 SW WELL-GRADED SAND 100% fine to medium, subrounded quartz sand, with a trace of lithic gravel light brownish gray (2.5Y 6/2, wet), ~~wet to~~ TK 5/17 moist to wet, no HCl reaction, well graded.	hnu			N/A	
1055	33.0		0				
1054	34.0			2.5' recov 34.4' @ 1550, end run			Sampled run length = 34.4'
1053	35.0			1605 begin run			1630 ~~TK~~ TK 5/18 DCF94-21 drilling complete to 40.2'
1052	36.0						5/18/94 0925 ream DCF94-21 from 0' to 40.2' below grade with 12" augers to allow for construction Wood block auger plug used, will leave @ bottom of hole
1051	37.0		0				1153 plug pushed up ~1.5' into augers, drive out w/ inner bit, complete hole to 40.7'
1050	38.0	38.3 to 39.4 ML SANDY SILT, dark gray (N4/, wet) 80% rapid dilatancy, low plasticity, low toughness, high dry strength fines with 20% fine sand laminated, strong HCl reaction		recov = 2.3' end run, at 39.4' 1612hr			
1049	39.0		up to 0.5 ppm @39.4'	TK ~~up to 0.5 ppm @ 39.4'~~			
1048	40.0	39.4 to 40.2 light olive gray (5Y 6/2, moist) weathered shale locally iron stained		No fines recorded, bedrock verification run			Drilled & sampled
		Bottom of hole reamed w/ 8.25" ID hollow stem augers.					cuttings not observed
1047	41.0						

MRK FORM JUN 89 55-2 | PROJECT: Dry Cleaning Facility Pilot Study | HOLE NO. DCF94-21

HTW DRILLING LOG

HOLE NO.	DCF94ES-1B
1. COMPANY NAME	Louis Berger & Associates, Inc
2. DRILLING SUBCONTRACTOR	Layne Western Company
SHEET 1 OF 6 SHEETS	
3. PROJECT	Fort Riley Dry Cleaning Facility Pilot Study
4. LOCATION	Fort Riley, KS Dry Cleaning Facility
5. NAME OF DRILLER	John Gornick
6. MANUFACTURER'S DESIGNATION OF DRILL	ORV-57
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	4.25" ID hollow stem auger; 3" OD continuous sampler
8. HOLE LOCATION	53.3' NW of E corner of Bldg 180, 51.4' NE
9. SURFACE ELEVATION	1085' Amsl estimated from DCF92-3 elevation
10. DATE STARTED	5/20/94
11. DATE COMPLETED	5/22/94
12. OVERBURDEN THICKNESS	43.0'
15. DEPTH GROUNDWATER ENCOUNTERED	34.0'
13. DEPTH DRILLED INTO ROCK	0.0
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	36.48, 4days, 7hr
14. TOTAL DEPTH OF HOLE	43.0
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	N/A
18. GEOTECHNICAL SAMPLES	DISTURBED: ✓; UNDISTURBED:
19. TOTAL NUMBER OF CORE BOXES	N/A
20. SAMPLES FOR CHEMICAL ANALYSIS	N/A (VOC; METALS; OTHER (SPECIFY); OTHER (SPECIFY); OTHER (SPECIFY))
21. TOTAL CORE RECOVERY	59.4 %
22. DISPOSITION OF HOLE	BACKFILLED; MONITORING WELL; OTHER (SPECIFY): ground water extraction wells
23. SIGNATURE OF INSPECTOR	Timothy J Kelly

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1085	0.0	0.0 to 0.6 Concrete	hnu		N/A	N/A	1430 5/20/90 Begin drilling with 4.25" ID hollow stem augers and 3" OD continuous sampler from 0.6' (0-0.6' is concrete). Soil described according to Unified Soil Classification System and the Munsell Soil Color Chart. hnu readings given as ppm equivalents isobutylene above background.
		0.6 to 1.0 Road bed - 2B stone		1430 begin run			
1084	1.0	1.0 to 3.8 GC CLAYEY GRAVEL very dark grey (2.5Y 3/1, moist) 60% fine to coarse, subangular limestone gravel, with 10% fine to coarse lithic & quartz sand and 30% high plasticity fines, moist, FILL	0	DCF94ES-1B-1 1.0 to 2.0			
1083	2.0						
1082	3.0			0.7 recov			
1081	4.0	3.8 to 8.4 GC CLAYEY GRAVEL WITH SAND Very dark brown (10YR 2/2, moist) locally olive, 45% fine to coarse gravel (lithic, quartz, brick) with 35% fine to coarse lithic & quartz sand (continued)	0	end run 1435; 1438 begin run			1435 sounded depth = 4.1'
1080	5.0						

MRK FORM JUN 89 55 PROJECT Fort Riley Dry Cleaning Facility Pilot Study HOLE NO. DCF94ES-1B

HTW DRILLING LOG

HOLE NO. DCF94ES-1B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 2 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1080	5.0	3.8 to 8.4 (Continued) 20% high plasticity fines, moist, maximum particle size = 3" gravel & sand subangular, FILL Strong HCl reaction locally	hnu 0		N/A	N/A	
1079	6.0	GC CLAYEY GRAVEL WITH SAND					
		~~AL~~ TK 5/20' FILL					
1078	7.0						
1077	8.0			recov = 2.5			
		8.4 to 14.0 SM SILTY SAND					
1076	9.0	black (10YR 2/1 moist) grading to grayish brown (2.5Y5/2, moist) 80% fine, sub~~angular~~ rounded TK 5/20, quartz sand with 20% nonplastic fines, maximum particle size = ~0.1mm, moist, weak HCl reaction locally		end run 1405			Sounded depth = 9.0'
				~~1430~~ ~~1525~~ TK 5/20 1450 begin run			
1075	10.0		0				
1074	11.0	ALLUVIUM					
1073	12.0						
1072	13.0			recov = 4.2'			
1071	14.0			end run 1457			Sounded depth = 14.0'

MRK FORM JUN 89 55-2

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

HOLE NO. DCF94ES-1B

HTW DRILLING LOG

HOLE NO. DCF94ES-1B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study | INSPECTOR: Timothy J. Kelly | SHEET 3 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1071	14.0	14.0 to 18.3 80% fine, subrounded quartz sand with 20% high plasticity fines, moist, trace coarse sand maximum particle size = 1/8", no HCl reaction, dark yellowish brown (10YR 4/4, moist) ALLUVIUM	nnu	DCF94ES -1B-2 14.0 to 21.8 (frozen zone, exact depth unknown) 5/22/94	N/A	N/A	
1070	15.0		0				
1069	16.0						
1068	17.0						
1067	18.0	18.3 to 21.8 As Above, with ~ 60% sand and 40% fines	7				
1066	19.0			recov = 5.0' end run 1530			sounded depth = 19.2'
				1538 begin run			
1065	20.0						
1064	21.0						
1063	22.0	21.8 to 34.0 SM SILTY SAND interbeds of 100% fine to medium, subrounded quartz sand and olive grey (5Y 5/2, moist) 70% fine sand, quartz, subrounded (continued)					
1062	23.0						

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HTW DRILLING LOG

HOLE NO. DCF94ES-1B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study | INSPECTOR: Timothy J. Kelly | SHEET 4 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1062	23.0	21.8 to 34.0 (continued) SM with 30% medium plasticity fines, moist maximum particle size ≈ 2mm moist to wet locally, locally ironstained ALLUVIUM	hnu	recov = 3.8' End run 1544	N/A	N/A	bentonitic interbeds(?)
1061	24.0		0	1608 7/25/?? Begin run			sounded depth = 24.0
1060	25.0						
1059	26.0						
1058	27.0						
1057	28.0		0	recov = 2.1'			
1056	29.0			end run 1614 / 1645 begin run			sounded depth = 29.0
1055	30.0						
1054	31.0		0				
1053	32.0						

HTW DRILLING LOG

HOLE NO. DCF94ES-1B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 5 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1053	32.0	21.8 to 34.0 SM SILTY SAND 70% fine, subrounded quartz sand w/ 30% medium to low plasticity fines, iron stained locally, olive grey (5Y 5/2, moist) moist to wet locally Maximum particle size = 2mm Alluvium	hnu	DCF94ES-1B-3, 5/22/94, depth from 21.8 to 34.0	N/A	N/A	
1052	33.0		0	recov=2.0' end run 1655			
1051	34.0	34.0 to 43.8 SP-SM POORLY GRADED SAND WITH SILT olive grey (5Y 5/2, moist to wet) 90% fine to medium, subrounded quartz sand with 10% non-plastic fines, grades from above, locally iron-stained layers (usually corser, "cleaner" sand), poorly graded, moist to wet Alluvium		1707 begin run			sounded depth = 34.1'
1050	35.0						
1049	36.0						
1048	37.0		0				
1047	38.0			recov=2.0			
1046	39.0			end run 1712			sounded depth = 39.2'
				1731 begin run			
1045	40.0		0				
1044	41.0						

HTW DRILLING LOG

HOLE NO. DCF54ES - 1B

PROJECT Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR Timothy J. Kelly

SHEET 6 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1044	41	39.0 to 42.8 SPSM POORLY GRADED SAND WITH SILT alluvium	hnu		N/A	N/A	
1043	42		0	recov = 2.9'			
				end run 1737			
1042	43	42.8 grades to coarser sand and fine gravel with clasts of chert & variegated shale	Bottom of hole				Auger refusal at 43.0'
		43.0 CROUSE LIMESTONE black (N2.5/ wet) silty limestone, strong HCl reaction hard, fresh to slightly weathered moist, laminated					17:50 pull 4.25' ID augers
	44						

MRK FORM JUN 89 55-2

PROJECT

HOLE NO.

HTW DRILLING LOG

HOLE NO. DCF94ES-2B

1. COMPANY NAME: Louis Berger & Associates, Inc
2. DRILLING SUBCONTRACTOR: Layne Western Company
SHEET 1 OF 6 SHEETS
3. PROJECT: Fort Riley Dry Cleaning Facility Pilot Study
4. LOCATION: Fort Riley, KS
5. NAME OF DRILLER: John Gornick
6. MANUFACTURER'S DESIGNATION OF DRILL: ORV -57
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 4.25" ID hollow stem augers; 3" OD continuous sampler
8. HOLE LOCATION: 32.8' NW of E corner of Bldg 180, 30.0 NE
9. SURFACE ELEVATION: 1085 estimated relative to DCF92-3 elevation
10. DATE STARTED: 5/19/94
11. DATE COMPLETED: 5/20/94
12. OVERBURDEN THICKNESS: 39.5'
15. DEPTH GROUNDWATER ENCOUNTERED: ~36' below ground surface
13. DEPTH DRILLED INTO ROCK: 1.3'
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 36.66 BTOC, 7 days, 21hr, 21m
14. TOTAL DEPTH OF HOLE: 41.8
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A
18. GEOTECHNICAL SAMPLES: N/A — DISTURBED: — UNDISTURBED: —
19. TOTAL NUMBER OF CORE BOXES: N/A
20. SAMPLES FOR CHEMICAL ANALYSIS: N/A — VOC: — METALS: — OTHER (SPECIFY): — OTHER (SPECIFY): — OTHER (SPECIFY): —
21. TOTAL CORE RECOVERY: 56.7 %
22. DISPOSITION OF HOLE: BACKFILLED: — MONITORING WELL: — OTHER (SPECIFY): Extraction Well
23. SIGNATURE OF INSPECTOR: Timothy J Kelly

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1085	0.0	0.0 to 0.6 concrete and road bed, cut away prior to drilling	hnu		N/A	N/A	1655 5/19/94 Begin drilling, 3" OD continuous sampler, 4.25" ID hollow stem augers. Soil described according to Unified Soil Classification System and Munsell soil color chart. hnu readings given as ppm equivalents of isobutylene above background
		0.6 to 0.8 (fine to coarse gravel road bed)		1655 Begin run			
1084	1.0	0.8 to ~~1.4~~ 3.2 SM SILTY SAND WITH GRAVEL 60% fine to medium, subrounded quartz sand, moist, with ~~35~~ 15% fine to coarse gravel and 25% medium plasticity fines, very dark grayish brown (2.5Y 3/2, moist) maximum particle size = 2.5" FILL	0				
1083	2.0						
1082	3.0	3.2 to 4.1 SM SILTY SAND WITH GRAVEL reddish black (2.5YR 2.5/1, moist) 60% fine to coarse, angular to subangular, lithic sand, 25% fine to coarse lithic gravel and 15% nonplastic fines, moist, maximum particle size = ≥3/4" weak HCl reaction FILL					
1081	4.0			recov = 2.0'			
				1704 end run			Sounded depth = 4.5'
				1706 begin run			
1080	5.0						

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study — HOLE NO. DCF94ES-2B

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HTW DRILLING LOG

HOLE NO. DCF94ES-2B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 2 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1080	5.0	4.1 to 9.9 GC CLAYEY GRAVEL WITH SAND olive gray (5Y 4/2, moist) mottled, 50% fine to coarse, angular, lithic gravel, with ~~soft cl~~ TK 5% soft clasts, 30% medium to high plasticity fines, 20% fine to coarse lithic ~~gravel~~ sand TK with cobbles, moist	hnu		N/A	N/A	
1079	6.0		G				
1078	7.0						
1077	8.0		G				
1076	9.0			recov = 0.6 9.9 1719 end run			sounded depth = 9.9'
1075	10.0	9.9 to 15.5 SP-SM POORLY GRADED SAND WITH SILT black (5Y 5/1, moist) grading to light olive brown (2.5Y 5/3 moist) 90% fine, subrounded quartz sand poorly graded, with 10% nonplastic fines, moist, maximum particle size ≅ 0.2 mm		1724 begin run			
1074	11.0		G				
1073	12.0						
1072	13.0		G				
1071	14.0						

MRK FORM JUN 89 55-2

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

HOLE NO. DCF94ES-2B

HTW DRILLING LOG

HOLE NO.	
DCF94ES-2B	

PROJECT	INSPECTOR	SHEET
Fort Riley Dry Cleaning Facility Pilot Study	Timothy J Kelly	SHEET 5 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1071	14.0	9.9 to 15.5 SP-SM POORLY GRADE SAND WITH SILT	hnu	recov = 3.1' end run 1729	N/A	N/A	sounded depth = 14.7'
1070	15.0			1810 begin run			
		15.5 to 17.4 MH SANDY ELASTIC SILT					
1069	16.0	black (2.5Y 2.5/1, wet) 70% slow dilatancy ~~medium to~~ low toughness, med to high dry strength, low plasticity fines	0				
1068	17.0	30% fine sand, wet, with rodent jaw @ ~16', roots					
		17.4 to 19.5 MH SANDY ELASTIC SILT As Above, but grading to dark					
1067	18.0	brown (7.5YR 3/2, moist), with ~ 40% fine to med sand, roots					
1066	19.0			recov = 3.6' end run 1816			sounded depth = 19.7'
		19.5 to 27.8 SC CLAYEY SAND		1818 begin run			
1065	20.0	brown (10YR 4/3, moist), 60% fine to medium, subrounded quartz sand with 40% high plasticity fines, moist, maximum particle size = 1.0mm ~~roots~~					
1064	21	moist, ~~maximum particle size = 1.0mm~~ TK 5/19	0				
1063	22						
1062	23.0						

MRK FORM JUN 89 55-2 | PROJECT Fort Riley Dry Cleaning Facility Pilot Study | HOLE NO. DCF94ES-2B

HTW DRILLING LOG

HOLE NO. DCF94ES-2B

PROJECT Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR Timothy J. Kelly

SHEET 4 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
~~1063~~ TJK 5/20 1062	23	19.5 to 27.8 (continued) SC CLAYEY SAND Brown (10YR 4/3, moist) 60% fine to medium subrounded quartz sand with 40% high plasticity fines, moist, maximum particle size = 1mm. Alluvium	hnu		N/A	N/A	
1061	24			recov = 5.0' end run 1825			sounded depth = 24.5'
			0	1905 begin run			
1060	25						
1059	26						
1058	27		0				
1057	28	27.8 to 29.5 SP POORLY GRADED SAND light yellowish brown (10YR 6/4, moist) 95% poorly graded, fine to medium, subrounded quartz sand with 5% ~~locally~~ high plasticity fines locally (clay-rich interbeds) ALLUVIUM		recov = 3.3			
1056	29			end run 1915			sounded depth = 29.5'
		29.5 to 30.3 SM SILTY SAND brown (10YR 5/3, moist) 70% fine, subrounded quartz sand with 30% nonplastic fines, moist to wet. ALLUVIUM		~~0805~~ 0830 TK 5/20			0830 5/20/94 continue drilling from 29.5'
1055	30						
1054	31	30.3 to 39.5 SP POORLY GRADED SAND light yellowish brown (10YR 6/4, moist) grading to (2.5Y 5/2, wet) grayish brown with iron-stained layers locally.	0				
1053	32						

HTW DRILLING LOG

HOLE NO. DCF94ES-2B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 5 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1053	32	30.3 to 39.5 (continued) 95% fine to medium, poorly graded, subrounded quartz sand, with 5% nonplastic fines, wet maximum particle size: 1/8" Alluvium	hnu		N/A	N/A	
1052	33		0				
		SP POORLY GRADED SAND		recov= 1.9' end run 0838			
1051	34			0843 begin run			sounded depth = 34.2' estimate first water at ~36' & 35'
1050	35						
1049	36						
1048	37		0				
1047	38						
1046	39			recov= 2.2 end run 0848			sounded depth = 39.5'
		39.5 to 41.8 CROUSE FORMATION		0939 begin run			
1045	40	light olive gray (5Y 6/2, moist) and black (N2.5/ wet) Calcareous, locally shaley siltstone Strong HCl reaction, weathered soft to hard, moist Alluvium	0				
1044	41						

HTW DRILLING LOG

HOLE NO. DCF94ES-2B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 6 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h 5/20
1044	41	39.5 to 41.8 light olive gray (5Y 6/2, moist) and black (N2.5, wet) calcareous, weathered shale.	recov = 2.0 → 0950 → end run	~~N/A~~ Tk 5/20	N/A	N/A	0950 complete 8" Drilling, logging of hole, pull augers, prep to rea[illegible]
		Bottom of hole @ 41.8' (sounded)					
1043	42						
1042	43						

MRK FORM JUN 89 55-2

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

HOLE NO. DCF94ES-2B

HTW DRILLING LOG

HOLE NO.	DCF94ES-3B
1. COMPANY NAME	Louis Berger & Associates, Inc
2. DRILLING SUBCONTRACTOR	Layne Western Company
SHEET 1 OF 6 SHEETS	
3. PROJECT	Fort Riley Dry Cleaning Facility Pilot Study
4. LOCATION	Fort Riley, KS
5. NAME OF DRILLER	Charles Riffle
6. MANUFACTURER'S DESIGNATION OF DRILL	CME - 750
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	4.25" ID hollow stem auger; 2" OD split spoon sampler
8. HOLE LOCATION	63.9' NE of Bldg 180 E corner, 39.3' NE ~~[illegible]~~
9. SURFACE ELEVATION	1085' estimated from DCF93-3 elevation
10. DATE STARTED	5/18/94
11. DATE COMPLETED	5/19/94
12. OVERBURDEN THICKNESS	41.8'
15. DEPTH GROUNDWATER ENCOUNTERED	36.0' BGL
13. DEPTH DRILLED INTO ROCK	1.4'
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	(Stickup ≅ 2') 38.16' BTOC, 8 days, 15 hr, 16 m
14. TOTAL DEPTH OF HOLE	43.2
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	N/A
18. GEOTECHNICAL SAMPLES	DISTURBED ✓; UNDISTURBED ✓
19. TOTAL NUMBER OF CORE BOXES	N/A
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC: EPA 8240 (Chlorinated); METALS: ; OTHER (SPECIFY): ; OTHER (SPECIFY): ; OTHER (SPECIFY):
21. TOTAL CORE RECOVERY	81.5 ~~75.6~~ % TK 5/24
22. DISPOSITION OF HOLE	BACKFILLED: ; MONITORING WELL: ; OTHER (SPECIFY): Groundwater extraction well
23. SIGNATURE OF INSPECTOR	Timothy J Kelly

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1085	0.0	0.0 to 0.6 Concrete	hnu			Not taken from 0.6 to 3.5	5/18/94 1900 Begin drilling DCF94ES-3B,
1084	1.0	0.6 to 1.0 Road bed 80% 2B stone with 10% sand, 10% ~~[illegible]~~ fines TK 5/18	0				start by sampling from 1.0' to 3.0' (concrete cut away & road bed shoveled out). Continuous split spoons
1083	2.0	1.0 to 3.0 CL SANDY LEAN CLAY 60% high plasticity, medium toughness, slow dilatancy (to none dilatancy), medium dry strength fines moist, with 30% fine to medium to coarse lithic sand and 10% fine gravel, maximum particle size = 1/2" strong HCl reaction olive gray (5Y5/2, moist)	0		DCF94ES-3B-1 @1545		from 1.0' to refusal, hammered in with 140# hydraulic hammer,
1082	3.0	3.0 to 5.0 CL SANDY LEAN CLAY As above, but more brown (10YR 4/3, moist)		3-5 DCF94ES-3B-1 (geotech) 3-5' 1.8' recovery		3' to 5' 1-2-1-1	soil described ~~with~~ TK 5/18 according to unified soil classification system and
1081	4.0		0				Munsell soil color chart. hnu readings given as ppm equivalents iso-butylene above background 35°
1080	5.0						

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HTW DRILLING LOG

HOLE NO. DCF94ES-3B

PROJECT Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR Timothy J Kelly

SHEET 2 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1080	5.0	5.0 to 5.4 As Above	hnu	5'-7' recovery = 1.8'	N/A	5'-7' W-1-1	W = weight of the hammer
		60% fine, subangular, quartz sand, 40% low plasticity fines, moist to wet, odor (?), clean sand interbed @ ~ 5.6', max particle size = ~ 0.5mm 5.4 to SM, SILTY SAND TK 5/18					
1079	6.0	~~6.4 to~~ usually no HCl reaction, locally strong. black (2.5Y 2.5/1, moist)	~~1.0~~ TK 5/18 1.0				
1078	7.0	7.0 to 9.0 As Above locally very dark grey (5Y 3/1, moist)		recov = 1.6		7'-9' W-2 for 18"	
1077	8.0		1.8 @ ~7.8'				
1076	9.0	SM. SILTY SAND 9.0 to 11.0 As Above but brown & black mottled		recov = 1.7		9'-11' W-1-2-3	
1075	10.0						
1074	11.0	11.0 SM SILTY SAND grades from greater % fines to ~~60~~ 70% fine, ~~subangular~~ rounded. quartz sand with ~~40~~ 30% low plasticity fines, moist, sewage odor (organic) grades to dark grayish brown	0.4	recov = 1.8		12" ~~W-3~~ 3 ~~3~~ TK 5/18	1645 pull out spoon
1073	12.0		1.0				
1072	13.0	13.0 to 15.0 As Above SM SILTY sand	1.2	recov = 1.7		13'-15' 1-1-2-2	
1071	14.0						

MRK FORM JUN 89 55-2 PROJECT Fort Riley Dry Cleaning Facility Pilot Study HOLE NO. DCF94ES-3B

HTW DRILLING LOG

HOLE NO. DCF94ES-3B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

INSPECTOR: Timothy J. Kelly

SHEET 3 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1071	14.0	13.0 to 15.0 SM SILTY SAND	hnu				
						15-17'	
1070	15.0			DCF94ES -3B@ 1730	DCF94ES -3B-2 @1725	W-2-2-2	
			0	recov=1.8'			
1069	16.0						
1068	17.0	undisturbed sample collected in shelby tube		DCF94ES-3B-G			collect shelby tube sample from 17.0 to 19.5' (bottom depth taped, tube is 2.5' long)
1067	18.0	SAMPLE NOT OBSERVED					
1066	19.0						
		19.5 - 21.5 As Above				W-1-1-2	
1065	20.0	SM Silty Sand, (brown (10YR 4/3, moist) maximum particle size: <1mm		1.7' recov		19.5-21.5	
1064	21.0						
		21.5 to 23.5 SM SILTY SAND		recov=2.0'		21.5' to 23.5'	
1063	22.0	As Above but fines more plastic, approximately 80% fine, subrounded quartz sand, 20% fines, 100% sand stringers locally mostly no HCl reaction, weak to strong locally, max particle size: 1mm				W-1-2-3	
1062	23.0						

MRK FORM JUN 89 55-2

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study

HOLE NO. DCF94ES-3B

HTW DRILLING LOG

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INSPECTOR: Timothy J. Kelly

SHEET 4 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1062	23.0	SM SILTY SAND (21.5 to 23.8)	Anu				
1061	24.0	23.8 to 27.5 SC CLAYEY SAND 80% fine to medium, subrounded quartz sand with local stingers to 100% fine to medium sand, with 20% high plasticity fines, brown (10Y 4/3, moist)	0	recov = 2.0'			5/18/94 1800 shutdown for the day, hole advanced to 25.5
1060	25.0	to grayish brown (2.5Y 5/2) (moist), iron-stained sand interlamina after 26.5' moist to wet		recov = 2.0'	DCF94ES-3B-3 from 25.5' to 27.5', @0840hr 5/19/94	25.5-27.5 W-1-2	5/19/94 0840 Continue drilling and split spooning from 25.5'
1059	26.0		0				
1058	27.0			recov = 1.6'			
1057	28.0	27.5 to 29.5 As Above, with 100% sand interlayers up to 0.2' thick moist to wet				27.5-29.5 5-4-4-4	
1056	29.0						
1055	30.0	29.5 to 31.5 SC CLAYEY SAND 60% fine to medium subrounded quartz sand, medium toughness medium plasticity, ~~rapid~~ slow dilatancy, fines, moist to wet, (2.5Y 5/1 moist) gray	0	recov = 1.7'		29.5 to 31.5 1-5-6-7	
1054	31.0						
1053	32.0	31.5 to 32.5 As Above		recov = 1.5'		31.5 to 33.5 1-3-4-6	

HTW DRILLING LOG

HOLE NO. DCF94ES-3B

PROJECT: Fort Riley Dry Cleaning Facility Pilot Study | INSPECTOR: Timothy J. Kelly | SHEET ~~4~~ 5 TK 5/20 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1053	32.0	SC CLAYEY SAND	hnu				
		TK5/19/94 32.5 to ~~34.0~~ 35.8 SP-SM POORLY GRADED SAND WITH SILT					
1052	33.0	90% fine to medium, subrounded quartz sand, poorly graded, with ~10% none to low plasticity fines, moist to wet (locally) maximum particle	0	recov = 1.8'		32.5 to 35.5 ~~6-12-18-22~~ 2-3-4-4	
1051	34.0	size = ~~[illegible]~~ 1.5mm, TK5/19 moist to wet gray (2.5Y5/1, moist) with iron-stained interlaminae					
		~~34.0~~ ~~35~~ 35.8 to 41.5 SP POORLY GRADED SAND					estimate water @ 36.0' based on color change & water/saturated
1050	35.0	95% fine to medium, subrounded quartz sand with 5% nonplastic fines and a trace of fine lithic gravel,	0	recov = 1.8		35.5 to 37.5 6-12-18-22	
1049	36.0	maximum particle size = 1/2" color change from grey (2.5Y5/1, moist to wet) to strong brown (7.5YR4/6, wet) saturated through entire spoon, thin black laminae					
1048	37.0	@ ~37.4, poorly graded					
		37.5 to 39.5 As above, back to dark grey (10YR 4/1, wet) @ 39.5, saturated, mottled	0	recov = 1.7		37.5 to 39.5 5-10-13-10	
1047	38.0						
1046	39.0						
		39.5 to 41.5 as above, with 0.4' interlayer of ML (SANDY SILT) @ 39.9 to 40.3 white clay interlaminae from 41.0 to bottom of spoon	0	recov = 2.0		39.5 to 41.5 4-3-15-16	
1045	40.0						
1044	41.0						

HTW DRILLING LOG

HOLE NO. DCF94ES-3B

PROJECT Fort Riley Dry Cleaning Facility Pilot Study | INSPECTOR Timothy J Kelly | SHEET 5 OF 6 SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
1044	41.0	SP POORLY GRADED SAND (35.8 to 41.5)	hnu	N/A			
		41.5 to 41.8 Interbed - SP POORLY GRADED SAND 100% fine to medium, subrounded quartz sand, maximum particle size ≅ 1mm, wet, poorly graded			recov = 1.8	41.5 to 43.5 49-28-45-50/3"	
1043	42	41.8 to 43.2	0				
		olive grey (5Y 4/2, moist) to ~~black~~ very dark grey calcareous (N3/, moist) weathered, laminated silty shale, soft moist to dry, strong HCl reaction					
1042	43	Bottom of hole sounded at 43.2'					
1041	44						1520 Begin reaming w/ 12" OD augers and inner bit

MRK FORM JUN 89 55-2

PROJECT Fort Riley Dry Cleaning Facility Pilot Study

HOLE NO. DCF94ES-3B

APPENDIX E
GEOTECHNICAL LABORATORY TEST RESULTS

Terracon
CONSULTANTS, INC.
14700 W. 107th Street
Lenexa, Kansas 66215
(913) 492-7777 Fax (913) 492-7443

7810 N. W. 100th
P. O. Box 901541
Kansas City, Missouri 64190-1541
(816) 891-7717 FAX (816) 891-7048

Date: June 14, 1994

Louis Berger & Associates
100 Halsted Street
East Orange, NJ 07019

Attention: Dr. Rao Nivargikar

Re: Ft. Riley Lab Tests

Job No: 02941153

Gentlemen:

We are transmitting [X] herewith
[ ] under separate cover ____2____ copies of the

[ ] Field Data [X] Laboratory Data [ ] Report

Regarding:

- [ ] Compacted Fills
- [ ] Footings
- [ ] Drilled Piers
- [ ] Piles
- [ ] Concrete
- [ ] Asphalt
- [ ] Roofing
- [ ] Aggregate
- [ ] Non-destructive Testing of Steel
- [ ] Non-destructive Testing of Concrete
- [X] Grain Size Analysis
- [ ] Boring Logs
- [ ] Location Diagram
- [X] Soil Samples
- [ ] Rock Core Samples
- [ ] Construction Material Samples
- [X] Moisture-Density
- [ ] Consolidation
- [ ] Triaxial Compression
- [ ] Permeability
- [ ] Field Boring Logs
- [X] Atterberg Limits
- X Porosity
- [ ] Geologic Report of
  - [ ] Seismic Survey
  - [ ] Resistivity Survey
  - [ ] Site Rock Conditions
  - [ ] Aggregate Development
- [ ] General Information
  - [ ] Technical Expertise
  - [ ] Resumes
  - [ ] Other
- [ ] Report will follow under separate cover

On-site observation services were provided [ ] Full time [ ] Part time

We have not been asked to interpret the data or to make design and/or construction recommendations based on the data, and cannot assume responsibility or liability for interpretation of this data by others.

Remarks: ______________________________

Yours truly,

TERRACON CONSULTANTS, INC.

Richard M. Scott, C.E.T.

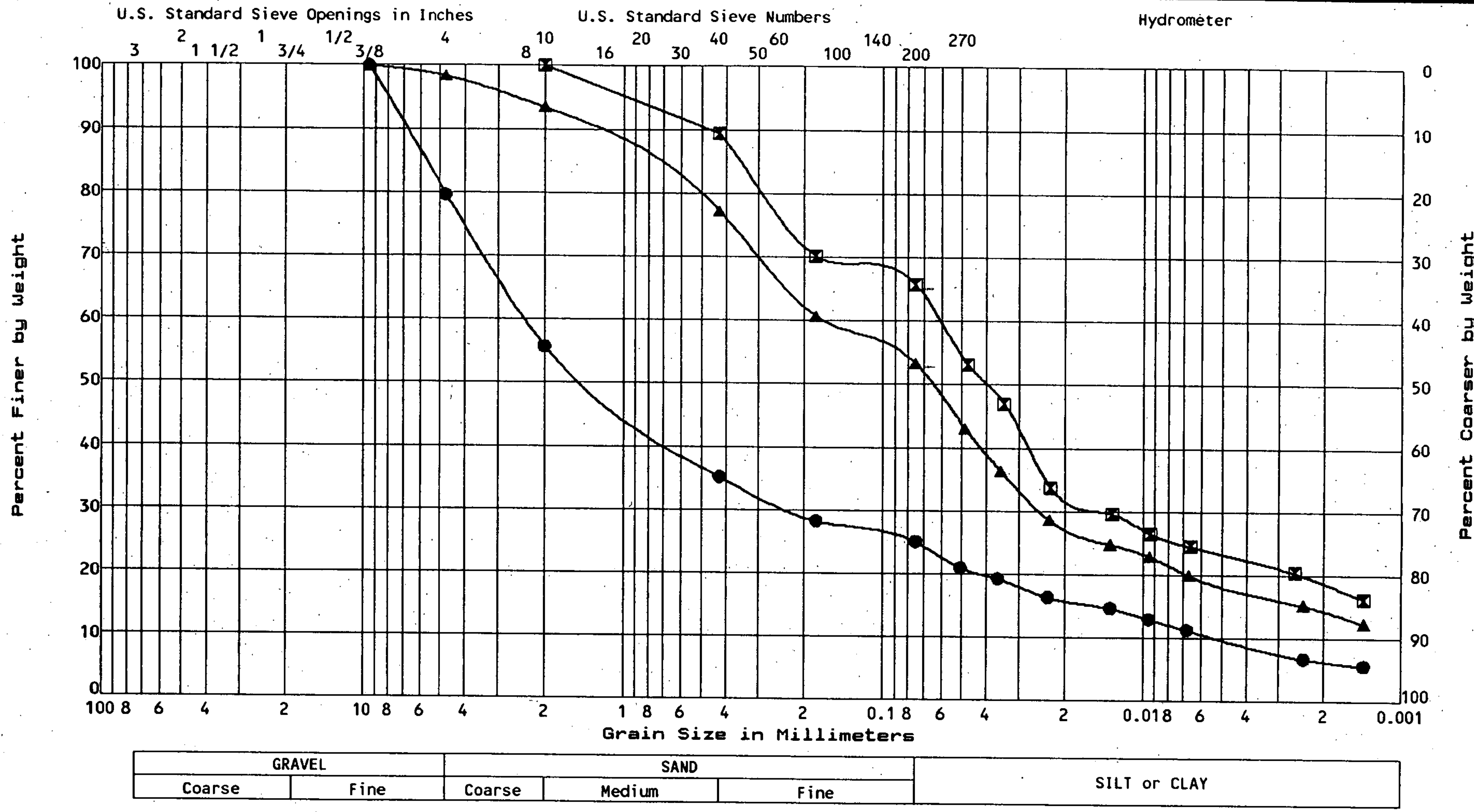
FORT RILEY
02941153
6/11/94

LABORATORY ANALYSIS RESULTS

BORING #	SAMPLE #	VISUAL DESCRIPTION	WATER CONTENT, %	DRY DENSITY, pcf	SPECIFIC GRAVITY	POROSITY, %	SATURATION, %
1	1				2.620		
1A	G	SANDY LEAN CLAY, GRAY BROWN	18.1	102.5	2.672	38.5	77.2
1B	1				2.640		
1B	2				2.663		
1B	3				2.662		
21	G	LEAN CLAY WITH SAND, GRAY BROWN	21.0	92.8	2.679	44.7	69.5
21	1				2.647		
21	2				2.679		
21	3				2.645		
2A	G	LEAN CLAY WITH SAND, GRAY BROWN	24.9	96.1	2.686	42.7	89.7
3B	G	SILT, GRAY BROWN	32.0	83.5	2.672	49.9	85.8
3B	2				2.660		
3B	3				2.659		
B-2	2				2.664		
B-2	3				2.663		
ES	3B				2.663		

TEST PROCEDURES ON ENCLOSED RESULTS:
ASTM D421
ASTM D422
ASTM D854
ASTM D2216
ASTM D4318
EM 1110-2-1906, APPENDIX II

Terracon



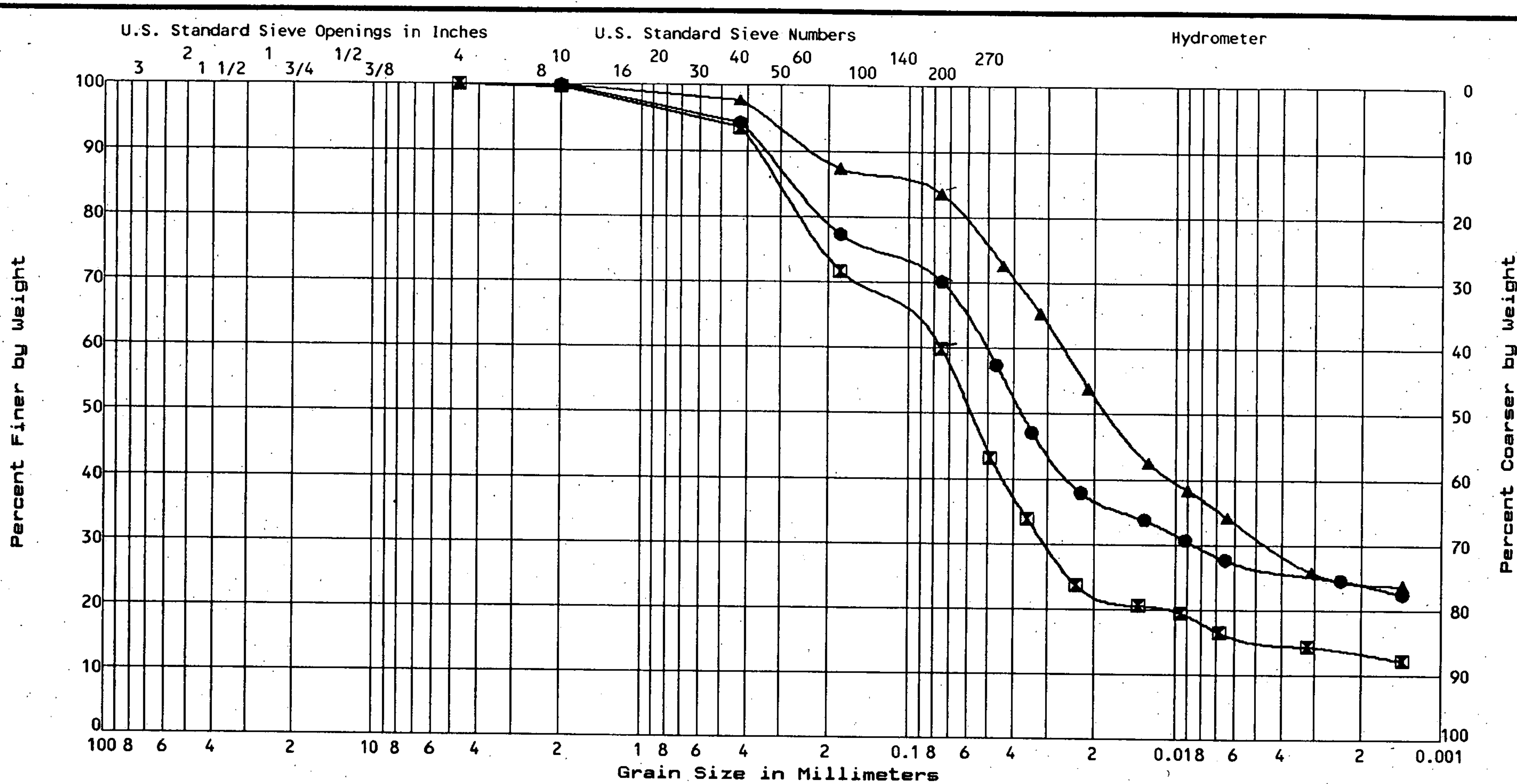
GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● 1	1		CLAYEY SAND WITH GRAVEL	SC		25	18	7
⊠ 1A	G		SANDY LEAN CLAY	CL	18	24	14	10
▲ 1B	1		SANDY LEAN CLAY	CL		25	15	10

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

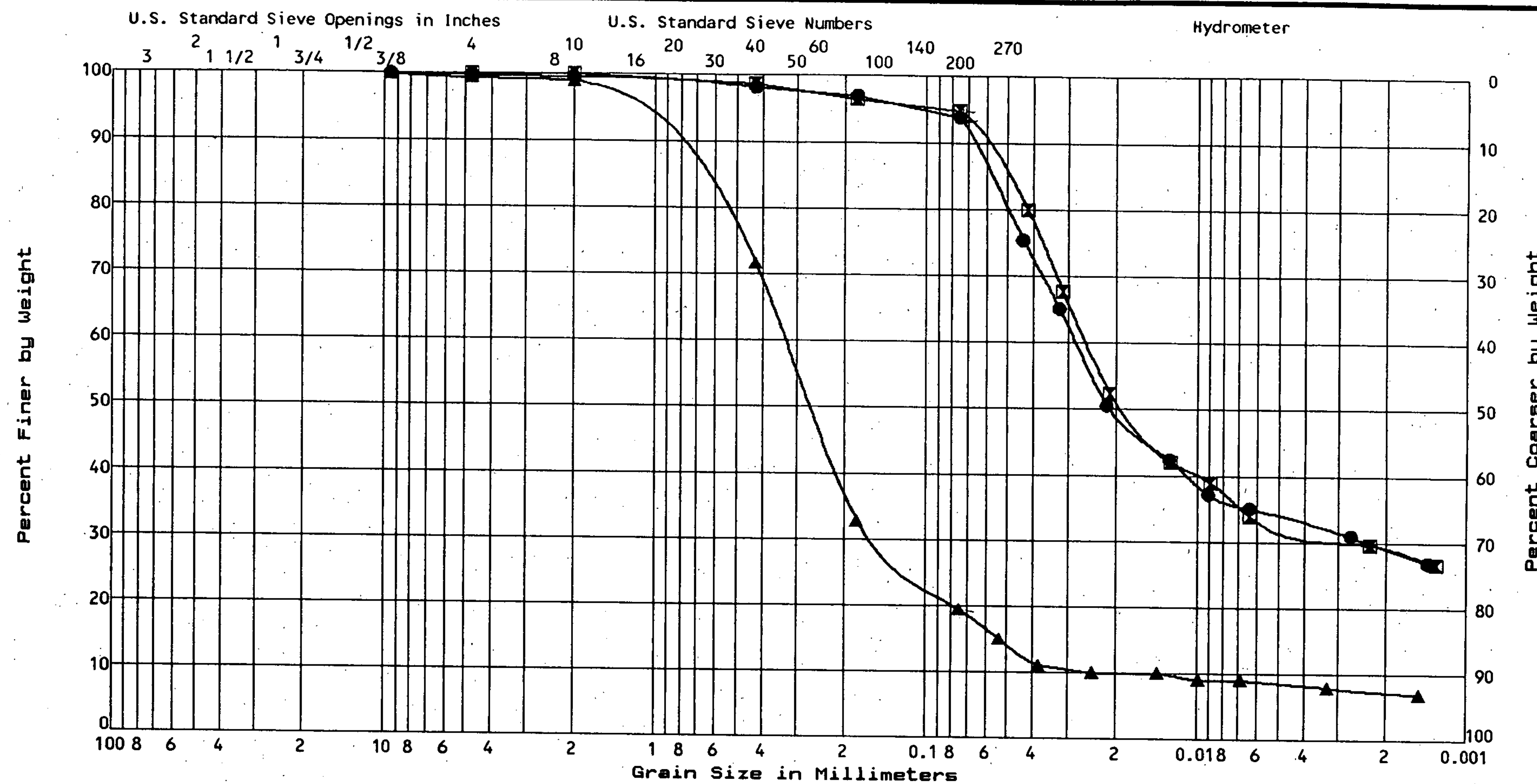
GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● 1B	2		SANDY LEAN CLAY	CL		28	14	14
⊠ 1B	3		SANDY SILT	ML		18	16	2
▲ 21	G		LEAN CLAY WITH SAND	CL	21	33	15	18

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

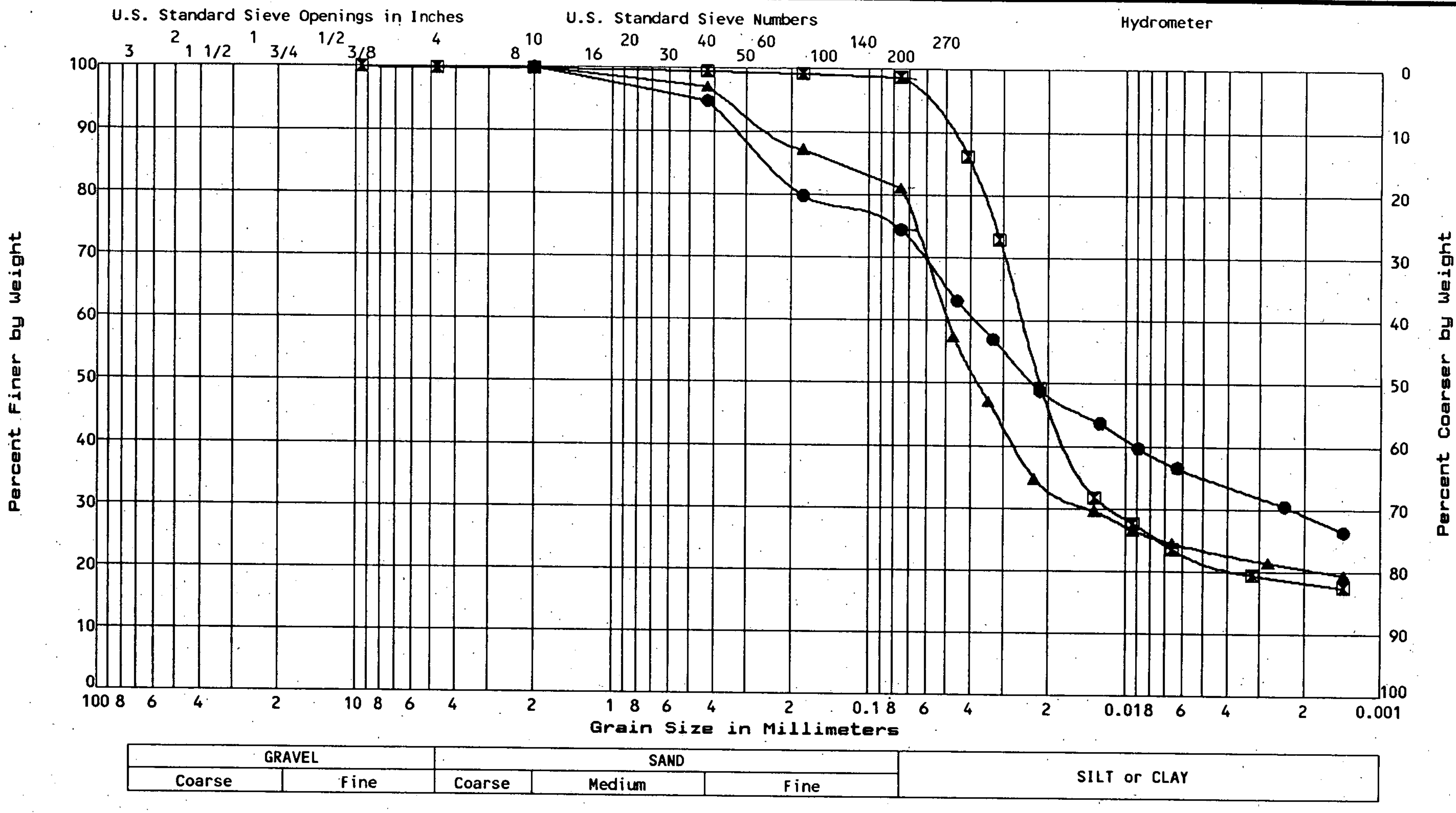
GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● 21	1		LEAN CLAY	CL		40	19	21
⊠ 21	2		LEAN CLAY	CL		37	17	20
▲ 21	3		SILTY SAND	SM		NP	NP	NP

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon



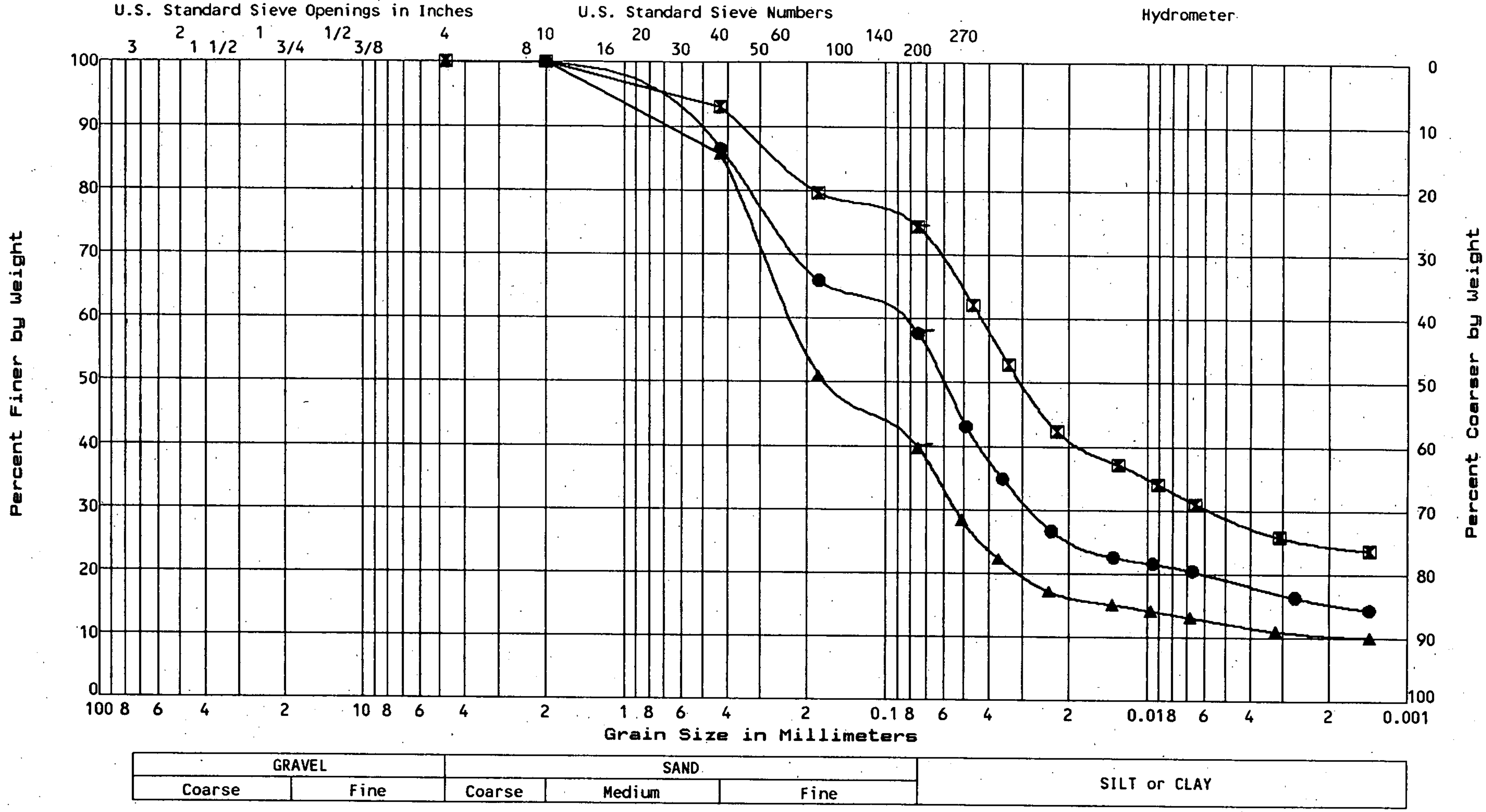
GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● 2A	G		LEAN CLAY WITH SAND	CL	25	31	14	17
⊠ 3B	G		SILT	ML	32	29	24	5
▲ 3B	2		LEAN CLAY WITH SAND	CL		28	18	10

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon



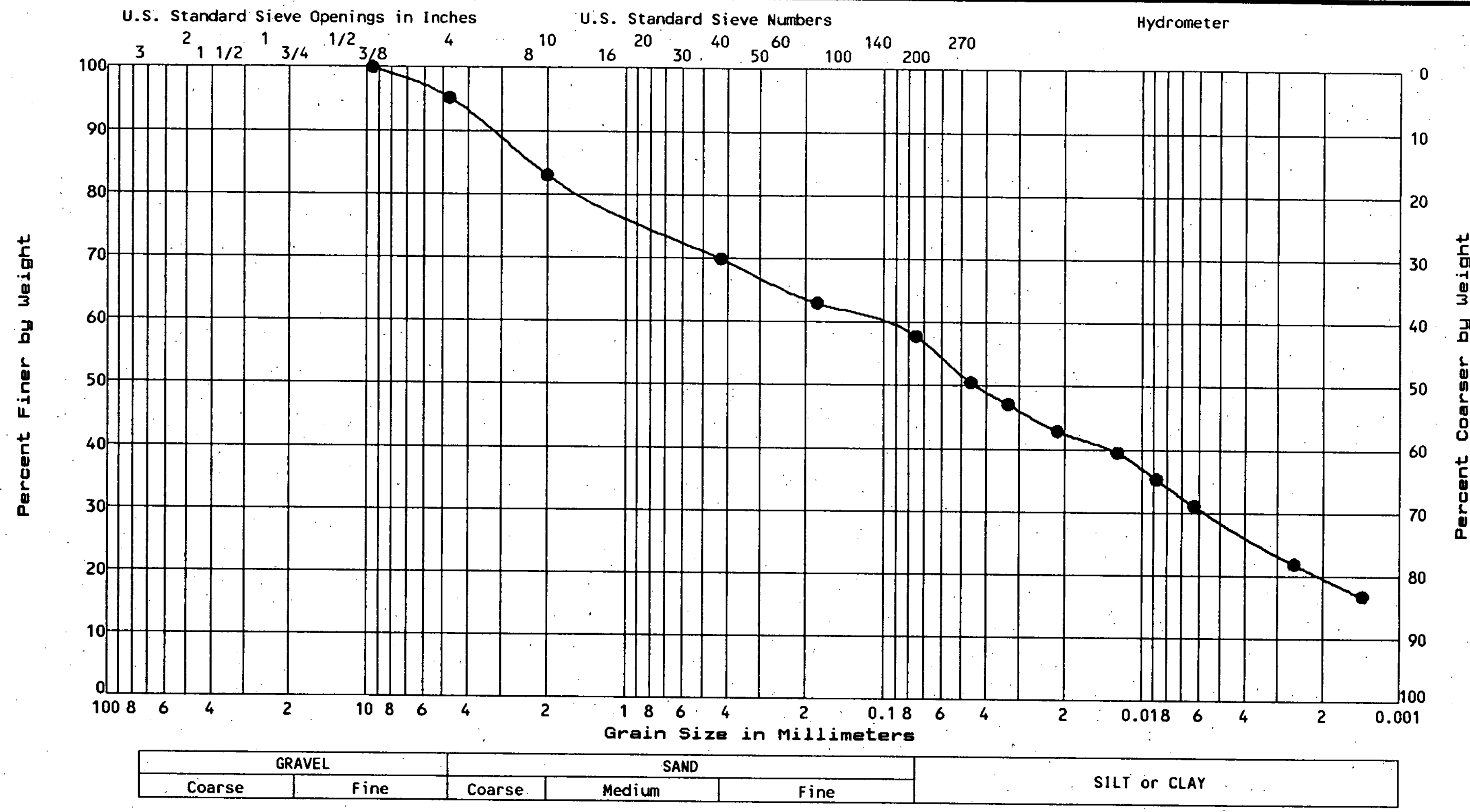
GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● 3B	3		SANDY LEAN CLAY	CL		23	16	7
⊠ B-2	2		LEAN CLAY WITH SAND	CL		30	16	14
▲ B-2	3		SILTY SAND	SM		NP	NP	NP

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon



GRAIN SIZE DISTRIBUTION CURVE

Boring No.	Sample No.	Depth	Description	Unified Symbol	Natural WC	LL	PL	PI
● ES	3B		SANDY LEAN CLAY	CL		33	18	15

Project **FORT RILEY -**

Job No. **02941153** Date **6/9/94**

Terracon

APPENDIX F
FIELD GC DATA—VOC ANALYTICAL RESULTS

TERRA VAC CORPORATION
PROJECT #24-0050
VE - 1

LOUIS BERGER & ASSOCIATES
DRY CLEANING FACILITY
VE - 1

DATE	TIME	CH2CL2 (ug/l)	t-1,2-DCE (ug/l)	1,1-DCA (ug/l)	c-1,2-DCE (ug/l)	CHCL3 (ug/l)	1,2-DCA (ug/l)	1,1,1-TCA (ug/l)	BENZENE (ug/l)	TCE (ug/l)	TOLUENE (ug/l)	PCE (ug/l)	CHLORO-BENZENE (ug/l)	ETHYL BENZENE (ug/l)	XYLENES (ug/l)	OTHER VOC (ug/l)	TOTAL VOC (ug/l)	FLOW (SCFM)	VACUUM ("Hg)	RATE (LB/DAY)	RUN TIME (DAYS)	TOTAL POUNDS REMOVED
11/21/94	14:30																	START		0	0	0
11/21/94	14:45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2.32	BDL	139	BDL	BDL	0.34	4.62	146	59.7	2.4	0.78	0.01	0.01
11/21/94	15:23	BDL	BDL	BDL	1.27	BDL	BDL	BDL	BDL	3.31	BDL	149	BDL	BDL	BDL	2.78	157	65.2	2.3	0.92	0.04	0.03
11/21/94	16:01	BDL	BDL	BDL	2.09	BDL	BDL	BDL	BDL	3.52	BDL	153	BDL	BDL	BDL	4.27	163	65.0	2.4	0.95	0.06	0.06
11/21/94	16:38	BDL	BDL	BDL	2.82	BDL	BDL	BDL	BDL	3.89	BDL	160	BDL	BDL	BDL	5.90	173	68.5	2.4	1.06	0.09	0.08
11/21/94	17:16	BDL	BDL	BDL	3.73	BDL	BDL	BDL	BDL	4.06	BDL	165	BDL	BDL	0.23	7.76	181	65.0	2.4	1.06	0.12	0.11
11/22/94	09:09	BDL	BDL	BDL	10.5	BDL	BDL	BDL	BDL	3.44	BDL	151	BDL	BDL	BDL	8.18	173	64.7	2.8	1.00	0.78	0.79
11/22/94	10:28	BDL	BDL	BDL	10.7	BDL	BDL	BDL	BDL	3.44	BDL	153	BDL	BDL	0.57	6.47	174	64.6	2.7	1.01	0.83	0.85
11/22/94	11:08	BDL	BDL	BDL	10.6	BDL	BDL	BDL	BDL	3.38	BDL	152	BDL	BDL	0.23	7.71	174	75.0	4.3	1.18	0.86	0.88
11/22/94	11:45	BDL	BDL	BDL	10.4	BDL	BDL	BDL	BDL	3.33	BDL	152	BDL	BDL	0.28	7.67	174	75.0	4.3	1.17	0.89	0.91
11/22/94	12:22	BDL	BDL	BDL	10.3	BDL	BDL	BDL	BDL	3.27	BDL	152	BDL	BDL	0.22	7.80	174	75.0	4.3	1.17	0.91	0.94
11/22/94	14:24	BDL	BDL	BDL	9.81	BDL	BDL	BDL	BDL	3.11	BDL	152	BDL	BDL	BDL	6.90	172	78.0	4.2	1.20	1.00	1.04
11/22/94	15:05	BDL	BDL	BDL	9.56	BDL	BDL	BDL	BDL	3.11	BDL	150	BDL	BDL	BDL	6.32	169	75.0	4.3	1.14	1.02	1.07
11/22/94	17:32	BDL	BDL	BDL	9.21	BDL	BDL	BDL	BDL	3.74	BDL	149	BDL	BDL	BDL	5.88	168	77.8	4.3	1.17	1.13	1.19
11/23/94	09:30	BDL	BDL	BDL	6.48	BDL	BDL	BDL	BDL	1.92	BDL	156	BDL	BDL	BDL	2.42	166	80.0	4.7	1.20	1.79	1.98
11/23/94	10:48	BDL	BDL	BDL	6.87	BDL	BDL	BDL	BDL	2.02	BDL	161	BDL	BDL	BDL	2.37	172	79.8	4.8	1.23	1.85	2.04
11/23/94	12:44	BDL	BDL	BDL	6.53	BDL	BDL	BDL	BDL	2.83	BDL	161	BDL	BDL	BDL	1.85	172	79.9	4.7	1.24	1.93	2.14
11/23/94	14:05	BDL	BDL	BDL	6.38	BDL	BDL	BDL	BDL	1.98	BDL	169	BDL	BDL	BDL	2.79	180	79.9	4.7	1.29	1.98	2.21
11/23/94	14:45	BDL	BDL	BDL	6.42	BDL	BDL	BDL	BDL	1.73	BDL	169	BDL	BDL	BDL	2.34	179	89.0	6.4	1.43	2.01	2.25
11/23/94	15:24	BDL	BDL	BDL	5.67	BDL	BDL	BDL	BDL	1.38	BDL	169	BDL	BDL	BDL	2.10	178	91.2	6.4	1.46	2.04	2.29
11/23/94	16:03	BDL	BDL	BDL	6.36	BDL	BDL	BDL	BDL	1.81	BDL	170	BDL	BDL	BDL	2.19	180	89.0	6.4	1.44	2.06	2.33
11/23/94	16:42	BDL	BDL	BDL	6.12	BDL	BDL	BDL	BDL	1.79	BDL	169	BDL	BDL	BDL	1.53	178	89.0	6.4	1.42	2.09	2.37
11/23/94	17:20	BDL	BDL	BDL	6.16	BDL	BDL	BDL	BDL	1.69	BDL	173	BDL	BDL	BDL	2.42	183	89.0	6.4	1.46	2.12	2.41
11/24/94	10:42	BDL	BDL	BDL	4.99	BDL	BDL	BDL	BDL	BDL	BDL	160	BDL	BDL	BDL	2.11	167	90.4	6.8	1.36	2.84	3.43
11/24/94	12:09	BDL	BDL	BDL	5.41	BDL	BDL	BDL	BDL	1.54	BDL	170	BDL	BDL	BDL	1.64	179	87.7	7.0	1.41	2.90	3.51
11/24/94	12:52	BDL	BDL	BDL	5.29	BDL	BDL	BDL	BDL	1.25	BDL	168	BDL	BDL	BDL	1.55	176	87.7	7.0	1.39	2.93	3.55
11/24/94	14:25	BDL	BDL	BDL	4.66	BDL	BDL	BDL	BDL	1.27	BDL	160	BDL	BDL	BDL	1.57	167	87.7	7.0	1.32	3.00	3.64
11/24/94	15:06	BDL	BDL	BDL	4.98	BDL	BDL	BDL	BDL	1.36	BDL	164	BDL	BDL	BDL	2.51	172	87.7	7.0	1.36	3.03	3.68
11/24/94	16:00	BDL	BDL	BDL	5.06	BDL	BDL	BDL	BDL	BDL	BDL	162	BDL	BDL	BDL	1.43	169	87.7	7.0	1.33	3.06	3.73
11/25/94	09:57	BDL	BDL	BDL	4.60	BDL	BDL	BDL	BDL	BDL	BDL	170	BDL	BDL	BDL	0.32	175	84.9	7.4	1.34	3.81	4.73
11/25/94	11:07																	STOP	7.4	1.34	3.86	4.79
12/06/94	10:20																	START	0.0	0.00	3.86	4.79
12/06/94	11:02	BDL	BDL	BDL	1.62	BDL	BDL	BDL	BDL	1.10	BDL	29.8	BDL	BDL	BDL	BDL	32.5	41.9	2.8	0.12	3.89	4.79
12/06/94	17:00																	STOP	2.8	0.12	4.14	4.82
12/08/94	09:15																	START	0.0	0.00	4.14	4.82
12/08/94	10:20	BDL	BDL	BDL	3.06	BDL	BDL	BDL	BDL	0.96	BDL	27.6	BDL	BDL	BDL	BDL	31.6	47.3	2.9	0.13	4.18	4.83
12/08/94	15:42	BDL	BDL	BDL	3.27	BDL	BDL	BDL	BDL	BDL	BDL	26.2	BDL	BDL	BDL	BDL	29.5	47.3	2.9	0.13	4.41	4.85
12/09/94	10:45	BDL	BDL	BDL	2.59	BDL	BDL	BDL	BDL	BDL	BDL	21.1	BDL	BDL	BDL	0.33	24.0	52.1	3.0	0.11	5.20	4.95
12/09/94	14:41	BDL	BDL	BDL	2.41	BDL	BDL	BDL	BDL	BDL	BDL	19.4	BDL	BDL	BDL	BDL	21.8	56.8	3.2	0.11	5.36	4.97
12/10/94	11:43	BDL	BDL	BDL	1.93	BDL	BDL	BDL	BDL	BDL	BDL	16.6	BDL	BDL	BDL	BDL	18.5	56.4	3.6	0.09	6.24	5.06
12/10/94	14:01	BDL	BDL	BDL	1.98	BDL	BDL	BDL	BDL	BDL	BDL	16.5	BDL	BDL	BDL	BDL	18.4	51.9	3.4	0.09	6.34	5.07
12/11/94	13:55	BDL	BDL	BDL	1.55	BDL	BDL	BDL	BDL	BDL	BDL	14.9	BDL	BDL	BDL	BDL	16.4	51.9	3.4	0.08	7.33	5.15
12/12/94	13:05	BDL	BDL	BDL	1.25	BDL	BDL	BDL	BDL	BDL	BDL	12.0	BDL	BDL	BDL	BDL	13.3	54.0	3.6	0.06	8.30	5.21
12/12/94	14:50	BDL	BDL	BDL	1.43	BDL	BDL	BDL	BDL	BDL	BDL	12.3	BDL	BDL	BDL	BDL	13.7	54.0	3.6	0.07	8.37	5.22
12/13/94	11:23	BDL	BDL	BDL	1.21	BDL	BDL	BDL	BDL	BDL	BDL	11.7	BDL	BDL	BDL	BDL	12.9	54.2	3.4	0.06	9.23	5.27
12/14/94	11:17	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.8	BDL	BDL	BDL	BDL	12.8	56.2	3.5	0.06	10.2	5.34
12/14/94	15:27	BDL	BDL	BDL	0.93	BDL	BDL	BDL	BDL	BDL	BDL	10.3	BDL	BDL	BDL	BDL	11.3	54.0	3.6	0.05	10.4	5.35
12/15/94	11:08	BDL	BDL	BDL	0.83	BDL	BDL	BDL	BDL	BDL	BDL	9.5	BDL	BDL	BDL	0.57	10.9	49.3	3.5	0.05	11.2	5.39
12/15/94	20:30																	STOP	3.5	0.05	11.6	5.41
12/15/94	21:00																	START	0.0	0.00	11.6	5.41
12/16/94	11:24	BDL	BDL	BDL	0.86	BDL	BDL	BDL	BDL	BDL	BDL	9.1	BDL	BDL	BDL	BDL	10.0	51.7	3.5	0.05	12.2	5.42
12/17/94	11:25	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.97	BDL	BDL	BDL	BDL	8.97	54.1	3.5	0.04	13.2	5.47
12/18/94	11:01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.94	BDL	BDL	BDL	BDL	7.94	49.4	3.4	0.04	14.2	5.51
12/19/94	11:34	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.25	BDL	BDL	BDL	BDL	8.25	49.3	3.5	0.04	15.2	5.54
12/20/94	11:10																	STOP	3.5	0.04	16.2	5.58

BELOW DETECTION LIMIT

TERRA VAC CORPORATION
PROJECT #24-0050
VE - 2

LOUIS BERGER & ASSOCIATES
DRY CLEANING FACILITY
VE - 2

DATE	TIME	CH2CL2 (ug/l)	t-1,2-DCE (ug/l)	1,1-DCA (ug/l)	c-1,2-DCE (ug/l)	CHCL3 (ug/l)	1,2-DCA (ug/l)	1,1,1-TCA (ug/l)	BENZENE (ug/l)	TCE (ug/l)	TOLUENE (ug/l)	PCE (ug/l)	CHLORO-BENZENE (ug/l)	ETHYL BENZENE (ug/l)	XYLENES (ug/l)	OTHER VOC (ug/l)	TOTAL VOC (ug/l)	FLOW (SCFM)	VACUUM (" Hg)	RATE (LB/DAY)	RUN TIME (DAYS)	TOTAL POUNDS REMOVED
11/25/94	11:07																	START		0	0	0
11/25/94	11:15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	33.6	BDL	BDL	BDL	BDL	33.6	54.1	6.2	0.16	0.01	0.00
11/25/94	11:52	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	41.2	BDL	BDL	BDL	BDL	41.2	54.3	5.8	0.20	0.03	0.01
11/25/94	12:28	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	52.8	BDL	BDL	BDL	BDL	52.8	50.2	6.0	0.24	0.06	0.01
11/25/94	13:59	BDL	BDL	BDL	1.17	BDL	BDL	BDL	BDL	BDL	BDL	55.6	BDL	BDL	BDL	0.27	57.0	50.2	6.4	0.26	0.12	0.03
11/25/94	14:59	BDL	BDL	BDL	1.87	BDL	BDL	BDL	BDL	BDL	BDL	58.6	BDL	BDL	BDL	0.49	61.0	45.8	6.4	0.25	0.16	0.04
11/25/94	15:59	BDL	BDL	BDL	2.24	BDL	BDL	BDL	BDL	1.07	BDL	59.7	BDL	BDL	BDL	0.48	63.5	45.8	6.4	0.26	0.20	0.05
11/25/94	16:36	BDL	BDL	BDL	2.28	BDL	BDL	BDL	BDL	BDL	BDL	56.9	BDL	BDL	BDL	0.23	59.5	40.9	6.4	0.22	0.23	0.05
11/26/94	10:05	BDL	BDL	BDL	3.69	BDL	BDL	BDL	BDL	BDL	BDL	53.0	BDL	BDL	BDL	0.50	57.2	39.8	7.8	0.20	0.96	0.21
11/26/94	11:23	BDL	BDL	BDL	3.75	BDL	BDL	BDL	BDL	BDL	BDL	50.6	BDL	BDL	BDL	BDL	54.3	39.5	7.8	0.19	1.01	0.22
11/26/94	13:50	BDL	BDL	BDL	3.28	BDL	BDL	BDL	BDL	BDL	BDL	52.0	BDL	BDL	BDL	BDL	55.2	34.2	7.9	0.17	1.11	0.24
11/26/94	15:10	BDL	BDL	BDL	3.08	BDL	BDL	BDL	BDL	BDL	BDL	46.6	BDL	BDL	BDL	BDL	49.7	28.2	4.6	0.13	1.17	0.25
11/26/94	15:47	BDL	BDL	BDL	1.99	BDL	BDL	BDL	BDL	BDL	BDL	47.0	BDL	BDL	BDL	BDL	49.0	34.4	4.6	0.15	1.19	0.25
11/26/94	16:26	BDL	BDL	BDL	3.14	BDL	BDL	BDL	BDL	BDL	BDL	49.3	BDL	BDL	BDL	0.55	53.0	34.4	4.4	0.16	1.22	0.25
11/26/94	17:02	BDL	BDL	BDL	3.19	BDL	BDL	BDL	BDL	BDL	BDL	49.5	BDL	BDL	BDL	BDL	52.6	28.1	4.4	0.13	1.25	0.26
11/27/94	10:13	BDL	BDL	BDL	2.97	BDL	BDL	BDL	BDL	BDL	BDL	67.6	BDL	BDL	BDL	0.14	70.7	34.5	5.8	0.22	1.96	0.38
11/27/94	11:31	BDL	BDL	BDL	2.92	BDL	BDL	BDL	BDL	BDL	BDL	58.8	BDL	BDL	BDL	1.62	63.3	34.6	5.8	0.20	2.02	0.39
11/27/94	12:30	BDL	BDL	BDL	2.10	BDL	BDL	BDL	BDL	BDL	BDL	31.3	BDL	BDL	BDL	0.26	33.6	28.0	2.0	0.08	2.06	0.40
11/27/94	13:42	BDL	BDL	BDL	2.15	BDL	BDL	BDL	BDL	BDL	BDL	34.2	BDL	BDL	BDL	0.34	36.7	28.0	1.6	0.09	2.11	0.41
11/27/94	15:09	BDL	BDL	BDL	1.79	BDL	BDL	BDL	BDL	BDL	BDL	41.5	BDL	BDL	BDL	0.30	43.6	28.0	1.4	0.11	2.17	0.41
11/27/94	16:08	BDL	BDL	BDL	1.60	BDL	BDL	BDL	BDL	BDL	BDL	40.0	BDL	BDL	BDL	BDL	41.6	28.1	1.4	0.10	2.21	0.42
11/28/94	09:44	BDL	BDL	BDL	1.61	BDL	BDL	BDL	BDL	BDL	BDL	39.6	BDL	BDL	BDL	0.32	41.5	27.8	1.2	0.10	2.94	0.49
11/28/94	11:06	BDL	BDL	BDL	1.79	BDL	BDL	BDL	BDL	BDL	BDL	39.6	BDL	BDL	BDL	0.45	41.8	27.8	1.1	0.10	3.00	0.50
11/28/94	11:58	BDL	BDL	BDL	1.71	BDL	BDL	BDL	BDL	BDL	BDL	38.9	BDL	BDL	BDL	0.47	41.1	27.7	1.2	0.10	3.04	0.50
11/28/94	13:26	BDL	BDL	BDL	1.75	BDL	BDL	BDL	BDL	BDL	BDL	40.0	BDL	BDL	BDL	0.61	42.4	27.6	1.2	0.11	3.10	0.51
11/28/94	14:04	BDL	BDL	BDL	2.02	BDL	BDL	BDL	BDL	BDL	BDL	42.3	BDL	BDL	BDL	0.42	44.8	27.6	1.2	0.11	3.12	0.51
11/28/94	14:50	BDL	BDL	BDL	1.79	BDL	BDL	BDL	BDL	BDL	BDL	41.9	BDL	BDL	BDL	0.67	44.3	27.8	1.1	0.11	3.15	0.51
11/28/94	15:30	BDL	BDL	BDL	2.06	BDL	BDL	BDL	BDL	BDL	BDL	42.1	BDL	BDL	BDL	0.61	44.7	27.7	1.4	0.11	3.18	0.52
11/28/94	16:10	BDL	BDL	BDL	2.11	BDL	BDL	BDL	BDL	BDL	BDL	44.2	BDL	BDL	BDL	0.66	47.0	27.8	1.1	0.12	3.21	0.52
11/28/94	17:15	BDL	BDL	BDL	1.91	BDL	BDL	BDL	BDL	BDL	BDL	42.3	BDL	BDL	BDL	0.74	45.0	27.8	1.4	0.11	3.26	0.53
11/29/94	09:37	BDL	BDL	BDL	1.86	BDL	BDL	BDL	BDL	BDL	BDL	39.4	BDL	BDL	BDL	0.78	42.0	27.2	1.4	0.10	3.94	0.60
11/29/94	10:10																	STOP	1.4	0.10	3.96	0.60
12/06/94	10:20																	START	0.0	0.00	3.96	0.60
12/06/94	12:07	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	22.2	BDL	BDL	BDL	BDL	22.2	22.4	2.8	0.04	4.03	0.60
12/06/94	17:00																	STOP	2.8	0.04	4.24	0.61
12/08/94	09:15																	START	0.0	0.00	4.24	0.61
12/08/94	11:10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	29.0	BDL	0.27	BDL	BDL	29.3	15.7	2.8	0.04	4.32	0.61
12/08/94	15:42	BDL	BDL	BDL	1.03	BDL	BDL	BDL	BDL	BDL	BDL	21.9	BDL	0.23	BDL	BDL	23.2	15.8	2.8	0.03	4.51	0.62
12/09/94	10:45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	19.6	BDL	BDL	BDL	0.26	19.8	11.2	3.0	0.02	5.30	0.64
12/09/94	14:41	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18.7	BDL	BDL	BDL	BDL	18.7	27.2	3.2	0.05	5.47	0.65
12/10/94	11:43	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18.4	BDL	BDL	BDL	BDL	18.4	19.1	3.4	0.03	6.34	0.68
12/11/94	13:55	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18.2	BDL	BDL	BDL	BDL	18.2	15.6	3.4	0.03	7.43	0.71
12/12/94	13:05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.0	BDL	BDL	BDL	BDL	13.0	11.1	3.2	0.01	8.40	0.73
12/12/94	14:30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.8	BDL	BDL	BDL	BDL	12.8	11.1	3.2	0.01	8.46	0.73
12/13/94	11:23	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.0	BDL	BDL	BDL	BDL	13.0	8.56	3.4	0.01	9.33	0.74
12/14/94	11:17	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.8	BDL	BDL	BDL	BDL	12.8	8.53	3.5	0.01	10.3	0.75
12/14/94	15:27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10.9	BDL	BDL	BDL	BDL	10.9	8.52	3.6	0.01	10.5	0.75
12/15/94	11:08	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.9	BDL	BDL	BDL	BDL	11.9	6.97	3.5	0.01	11.3	0.76
12/15/94	20:30																	STOP	3.5	0.01	11.7	0.76
12/15/94	21:00																	START	0.0	0.00	11.7	0.76
12/16/94	11:24	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.2	BDL	BDL	BDL	BDL	13.2	15.5	3.6	0.02	12.3	0.77
12/17/94	12:01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.6	BDL	BDL	BDL	BDL	11.6	19.1	3.4	0.02	13.3	0.79
12/18/94	11:01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.9	BDL	BDL	BDL	BDL	11.9	20.8	3.6	0.02	14.3	0.81
12/19/94	12:10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.4	BDL	BDL	BDL	BDL	11.4	24.6	3.5	0.03	15.3	0.83
12/20/94	11:10																	STOP	3.5	0.03	16.3	0.85

BELOW DETECTION LIMIT

TERRA VAC CORPORATION
PROJECT #24-0050
VE - 3

LOUIS BERGER & ASSOCIATES
DRY CLEANING FACILITY
VE - 3

DATE	TIME	CH2CL2 (ug/l)	t-1,2-DCE (ug/l)	1,1-DCA (ug/l)	c-1,2-DCE (ug/l)	CHCL3 (ug/l)	1,2-DCA (ug/l)	1,1,1-TCA (ug/l)	BENZENE (ug/l)	TCE (ug/l)	TOLUENE (ug/l)	PCE (ug/l)	CHLORO-BENZENE (ug/l)	ETHYL BENZENE (ug/l)	XYLENES (ug/l)	OTHER VOC (ug/l)	TOTAL VOC (ug/l)	FLOW (SCFM)	VACUUM (" Hg)	RATE (LB/DAY)	RUN TIME (DAYS)	TOTAL POUNDS REMOVED
11/29/94	10:10																	START		0	0	0
11/29/94	10:22	BDL	BDL	BDL	18.1	BDL	BDL	BDL	BDL	3.11	BDL	954	BDL	BDL	BDL	2.77	978	39.1	4.0	3.44	0.01	0.03
11/29/94	10:59	BDL	BDL	BDL	14.3	BDL	BDL	BDL	BDL	2.73	BDL	806	BDL	BDL	BDL	6.86	830	39.0	3.6	2.91	0.03	0.11
11/29/94	11:38	BDL	BDL	BDL	13.9	BDL	BDL	BDL	BDL	2.55	BDL	773	BDL	BDL	BDL	11.0	800	39.1	3.6	2.81	0.06	0.19
11/29/94	12:41	BDL	BDL	BDL	12.7	BDL	BDL	BDL	BDL	2.35	BDL	671	BDL	BDL	BDL	9.52	695	39.1	3.4	2.44	0.10	0.30
11/29/94	14:03	BDL	BDL	BDL	11.4	BDL	BDL	BDL	BDL	1.96	BDL	607	BDL	BDL	BDL	8.94	629	39.2	3.2	2.22	0.16	0.44
11/29/94	14:40	BDL	BDL	BDL	11.6	BDL	BDL	BDL	BDL	1.92	BDL	589	BDL	BDL	BDL	5.71	608	39.2	3.2	2.14	0.19	0.49
11/29/94	15:22	BDL	BDL	BDL	11.5	BDL	BDL	BDL	BDL	1.86	BDL	589	BDL	BDL	BDL	9.53	612	39.2	3.0	2.15	0.22	0.55
11/29/94	16:00	BDL	BDL	BDL	10.9	BDL	BDL	BDL	BDL	1.64	BDL	562	BDL	BDL	BDL	8.34	583	39.2	3.0	2.05	0.24	0.61
11/29/94	16:40	BDL	BDL	BDL	9.86	BDL	BDL	BDL	BDL	1.63	BDL	515	BDL	BDL	BDL	7.03	534	39.0	3.0	1.87	0.27	0.66
11/29/94	17:19	BDL	BDL	BDL	10.1	BDL	BDL	BDL	BDL	1.72	BDL	513	BDL	BDL	BDL	6.07	531	39.2	3.0	1.87	0.30	0.71
11/30/94	10:20	BDL	BDL	BDL	6.22	BDL	BDL	BDL	BDL	0.57	BDL	362	BDL	BDL	BDL	4.90	374	38.8	2.8	1.30	1.01	1.84
11/30/94	12:04	BDL	BDL	BDL	6.72	BDL	BDL	BDL	BDL	BDL	BDL	431	BDL	BDL	BDL	8.46	447	63.0	7.3	2.53	1.08	1.98
11/30/94	13:34	BDL	BDL	BDL	6.73	BDL	BDL	BDL	BDL	1.39	BDL	409	BDL	BDL	BDL	6.61	424	62.9	7.3	2.40	1.14	2.13
11/30/94	14:40	BDL	BDL	BDL	6.62	BDL	BDL	BDL	BDL	1.18	BDL	397	BDL	BDL	BDL	7.43	413	63.2	7.2	2.34	1.19	2.24
11/30/94	15:27	BDL	BDL	BDL	6.27	BDL	BDL	BDL	BDL	1.28	BDL	386	BDL	BDL	BDL	6.81	401	62.9	7.3	2.27	1.22	2.32
11/30/94	16:08	BDL	BDL	BDL	6.05	BDL	BDL	BDL	BDL	BDL	BDL	383	BDL	BDL	BDL	6.85	396	62.8	7.4	2.23	1.25	2.38
11/30/94	16:47	BDL	BDL	BDL	5.87	BDL	BDL	BDL	BDL	BDL	BDL	371	BDL	BDL	BDL	5.51	382	62.8	7.6	2.16	1.28	2.44
11/30/94	17:28	BDL	BDL	BDL	5.80	BDL	BDL	BDL	BDL	BDL	BDL	364	BDL	BDL	BDL	5.45	375	62.8	7.7	2.12	1.30	2.50
12/01/94	09:57	BDL	BDL	BDL	4.43	BDL	BDL	BDL	BDL	BDL	BDL	327	BDL	BDL	BDL	1.78	334	64.4	7.8	1.93	1.99	3.89
12/01/94	10:38	BDL	BDL	BDL	4.31	BDL	BDL	BDL	BDL	BDL	BDL	334	BDL	BDL	BDL	1.77	340	64.3	7.6	1.97	2.02	3.95
12/01/94	11:33	BDL	BDL	BDL	4.19	BDL	BDL	BDL	BDL	BDL	BDL	327	BDL	BDL	BDL	1.46	332	64.3	7.6	1.92	2.06	4.02
12/01/94	12:27	BDL	BDL	BDL	4.06	BDL	BDL	BDL	BDL	BDL	BDL	324	BDL	BDL	BDL	1.76	330	64.6	7.5	1.91	2.10	4.09
12/01/94	15:10	BDL	BDL	BDL	3.95	BDL	BDL	BDL	BDL	BDL	BDL	316	BDL	BDL	BDL	1.73	322	64.6	7.4	1.87	2.21	4.31
12/01/94	15:18	BDL	BDL	BDL	4.06	BDL	BDL	BDL	BDL	BDL	BDL	314	BDL	BDL	BDL	1.15	319	64.8	7.4	1.86	2.21	4.32
12/01/94	16:03	BDL	BDL	BDL	4.11	BDL	BDL	BDL	BDL	BDL	BDL	332	BDL	BDL	BDL	1.16	337	69.0	8.3	2.09	2.25	4.38
12/01/94	16:44	BDL	BDL	BDL	4.00	BDL	BDL	BDL	BDL	BDL	BDL	329	BDL	BDL	BDL	0.78	334	69.0	8.3	2.07	2.27	4.44
12/01/94	17:33	BDL	BDL	BDL	3.92	BDL	BDL	BDL	BDL	BDL	BDL	325	BDL	BDL	BDL	1.21	330	66.0	8.3	1.96	2.31	4.51
12/02/94	10:00	BDL	BDL	BDL	3.17	BDL	BDL	BDL	BDL	BDL	BDL	281	BDL	BDL	BDL	0.35	284	77.2	8.2	1.97	2.99	5.86
12/02/94	12:32	BDL	BDL	BDL	3.12	BDL	BDL	BDL	BDL	BDL	BDL	279	BDL	BDL	BDL	0.31	282	77.1	8.2	1.96	3.10	6.06
12/02/94	13:15																	STOP	8.2	1.96	3.13	6.12
12/06/94	10:20																	START	0.0	0.00	3.13	6.12
12/06/94	12:07	BDL	BDL	BDL	3.53	BDL	BDL	BDL	BDL	BDL	BDL	352	BDL	BDL	BDL	1.11	356	47.6	2.7	1.52	3.20	6.18
12/06/94	17:00																	STOP	2.7	1.52	3.41	6.49
12/08/94	09:15																	START	0.0	0.00	3.41	6.49
12/08/94	14:04	BDL	BDL	BDL	2.52	BDL	BDL	BDL	BDL	BDL	BDL	282	BDL	BDL	BDL	BDL	285	46.8	2.9	1.20	3.61	6.61
12/08/94	16:27	BDL	BDL	BDL	2.58	BDL	BDL	BDL	BDL	BDL	BDL	289	BDL	BDL	BDL	BDL	292	49.3	2.8	1.29	3.71	6.73
12/09/94	12:59	BDL	BDL	BDL	2.32	BDL	BDL	BDL	BDL	BDL	BDL	280	BDL	BDL	BDL	0.38	283	46.7	3.0	1.19	4.56	7.79
12/09/94	15:35	BDL	BDL	BDL	1.95	BDL	BDL	BDL	BDL	BDL	BDL	274	BDL	BDL	BDL	0.28	277	51.5	3.1	1.28	4.67	7.93
12/10/94	13:15	BDL	BDL	BDL	1.65	BDL	BDL	BDL	BDL	BDL	BDL	212	BDL	BDL	BDL	BDL	214	51.2	3.4	0.98	5.57	8.95
12/10/94	14:45	BDL	BDL	BDL	1.78	BDL	BDL	BDL	BDL	BDL	BDL	211	BDL	BDL	BDL	BDL	213	48.8	3.4	0.93	5.64	9.01
12/11/94	15:45	BDL	BDL	BDL	1.45	BDL	BDL	BDL	BDL	BDL	BDL	181	BDL	BDL	BDL	0.62	183	51.3	3.3	0.84	6.68	9.94
12/12/94	14:05	BDL	BDL	BDL	1.06	BDL	BDL	BDL	BDL	BDL	BDL	144	BDL	BDL	BDL	BDL	145	51.4	3.2	0.67	7.61	10.6
12/12/94	15:30	BDL	BDL	BDL	1.07	BDL	BDL	BDL	BDL	BDL	BDL	141	BDL	BDL	BDL	BDL	142	51.4	3.2	0.66	7.67	10.7
12/13/94	12:04	BDL	BDL	BDL	0.97	BDL	BDL	BDL	BDL	BDL	BDL	135	BDL	BDL	BDL	BDL	136	50.0	3.5	0.61	8.53	11.2
12/14/94	11:55	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	111	BDL	BDL	BDL	BDL	111	51.0	3.6	0.51	9.52	11.8
12/14/94	16:08	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	95.4	BDL	BDL	BDL	BDL	95.4	48.9	3.4	0.42	9.69	11.9
12/15/94	11:46	BDL	BDL	BDL	0.77	BDL	BDL	BDL	BDL	BDL	BDL	99.5	BDL	BDL	BDL	BDL	100	48.8	3.5	0.44	10.5	12.2
12/15/94	20:30																	STOP	3.5	0.44	10.9	12.4
12/15/94	21:00																	START	0.0	0.00	10.9	12.4
12/16/94	12:00	BDL	BDL	BDL	0.81	BDL	BDL	BDL	BDL	BDL	BDL	92.4	BDL	BDL	BDL	BDL	93.2	48.8	3.4	0.41	11.5	12.5
12/17/94	12:38	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	79.2	BDL	BDL	BDL	BDL	79.2	51.1	3.5	0.36	12.5	12.9
12/18/94	11:37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	70.5	BDL	BDL	BDL	BDL	70.5	53.5	3.4	0.34	13.5	13.2
12/19/94	12:47	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	66.5	BDL	BDL	BDL	BDL	66.5	55.8	3.4	0.33	14.5	13.6
12/20/94	11:10																	STOP	3.4	0.33	15.5	13.9

BELOW DETECTION LIMIT

TERRA VAC CORPORATION
PROJECT #24-0050
VE - 4

LOUIS BERGER & ASSOCIATES
DRY CLEANING FACILITY
VE - 4

DATE	TIME	CH2CL2 (ug/l)	t-1,2-DCE (ug/l)	1,1-DCA (ug/l)	c-1,2-DCE (ug/l)	CHCL3 (ug/l)	1,2-DCA (ug/l)	1,1,1-TCA (ug/l)	BENZENE (ug/l)	TCE (ug/l)	TOLUENE (ug/l)	PCE (ug/l)	CHLORO-BENZENE (ug/l)	ETHYL BENZENE (ug/l)	XYLENES (ug/l)	OTHER VOC (ug/l)	TOTAL VOC (ug/l)	FLOW (SCFM)	VACUUM ("Hg)	RATE (LB/DAY)	RUN TIME (DAYS)	TOTAL POUNDS REMOVED
12/02/94	15:00																	START		0	0	0
12/02/94	15:25	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.59	BDL	BDL	BDL	27.6	32.2	42.8	3.0	0.12	0.02	0.00
12/02/94	16:11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.46	BDL	BDL	BDL	11.6	16.1	42.7	3.0	0.06	0.05	0.00
12/02/94	16:51	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.21	BDL	BDL	BDL	7.21	11.4	42.7	3.0	0.04	0.08	0.01
12/02/94	17:37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.02	BDL	BDL	BDL	5.52	9.55	42.8	3.0	0.04	0.11	0.01
12/03/94	10:07	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.16	BDL	BDL	BDL	2.29	5.45	38.1	3.0	0.02	0.80	0.02
12/03/94	10:58	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.32	BDL	BDL	BDL	2.53	5.85	37.9	3.0	0.02	0.83	0.02
12/03/94	11:46	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.38	BDL	BDL	BDL	2.96	6.34	38.0	3.0	0.02	0.87	0.02
12/03/94	12:35	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.25	BDL	BDL	BDL	2.34	5.59	42.4	2.9	0.02	0.90	0.02
12/03/94	14:05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.16	BDL	BDL	BDL	2.50	5.67	37.9	2.9	0.02	0.96	0.02
12/03/94	14:50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.35	BDL	BDL	BDL	5.08	9.44	77.4	6.2	0.07	0.99	0.02
12/03/94	15:41	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.27	BDL	BDL	BDL	2.39	5.65	77.4	6.2	0.04	1.03	0.03
12/03/94	16:27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.02	BDL	BDL	BDL	2.88	6.90	77.4	6.0	0.05	1.06	0.03
12/03/94	17:06	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.18	BDL	BDL	BDL	3.76	7.95	77.8	6.0	0.06	1.09	0.03
12/04/94	10:34	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.99	BDL	BDL	BDL	1.17	7.16	85.6	5.6	0.06	1.82	0.07
12/04/94	11:16	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.84	BDL	BDL	BDL	1.17	7.02	85.5	5.6	0.05	1.84	0.07
12/04/94	12:04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.90	BDL	BDL	BDL	0.78	6.68	85.7	5.5	0.05	1.88	0.07
12/04/94	13:25	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.17	BDL	BDL	BDL	0.55	6.72	85.8	5.5	0.05	1.93	0.08
12/04/94	14:18	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.15	BDL	BDL	BDL	0.86	7.01	93.2	6.3	0.06	1.97	0.08
12/04/94	15:00	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.13	BDL	BDL	BDL	0.99	7.13	93.2	6.2	0.06	2.00	0.08
12/04/94	15:41	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.19	BDL	BDL	BDL	0.80	6.99	93.6	6.0	0.06	2.03	0.08
12/04/94	16:27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.20	BDL	BDL	BDL	0.83	7.03	93.6	6.0	0.06	2.06	0.08
12/05/94	09:55	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.49	BDL	BDL	BDL	BDL	7.49	101	6.0	0.07	2.79	0.13
12/05/94	10:35	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.28	BDL	BDL	BDL	BDL	7.28	101	6.0	0.07	2.82	0.13
12/05/94	11:18	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.96	BDL	BDL	BDL	BDL	6.96	99.3	6.0	0.06	2.85	0.14
12/05/94	12:09	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.50	BDL	BDL	BDL	BDL	7.50	101	6.0	0.07	2.88	0.14
12/05/94	13:26	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.79	BDL	BDL	BDL	BDL	7.79	99.1	6.0	0.07	2.93	0.14
12/05/94	14:14	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.03	BDL	BDL	BDL	BDL	8.03	99.1	6.0	0.07	2.97	0.14
12/05/94	15:06	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.00	BDL	BDL	BDL	BDL	8.00	97.3	6.0	0.07	3.00	0.15
12/05/94	15:57	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.37	BDL	BDL	BDL	BDL	8.37	96.7	6.0	0.07	3.04	0.15
12/05/94	16:48	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.91	BDL	BDL	BDL	BDL	7.91	99.2	6.0	0.07	3.08	0.15
12/06/94	10:11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.28	BDL	BDL	BDL	BDL	9.28	112	5.8	0.09	3.80	0.22
12/06/94	12:07	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.92	BDL	BDL	BDL	BDL	9.92	42.8	1.6	0.04	3.88	0.22
12/06/94	17:00																	STOP	1.6	0.04	4.08	0.23
12/08/94	09:15																	START	0.0	0.00	4.08	0.23
12/08/94	14:04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.18	BDL	BDL	BDL	BDL	9.18	32.4	2.0	0.03	4.28	0.24
12/08/94	16:27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	16.5	BDL	BDL	BDL	BDL	16.5	32.4	2.0	0.05	4.38	0.24
12/09/94	12:59	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.36	BDL	BDL	BDL	0.30	9.66	45.8	2.0	0.04	5.24	0.28
12/09/94	15:35	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.60	BDL	BDL	BDL	BDL	9.60	48.5	2.1	0.04	5.35	0.28
12/10/94	13:15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10.3	BDL	BDL	BDL	0.22	10.5	42.5	2.4	0.04	6.25	0.32
12/10/94	14:45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10.2	BDL	BDL	BDL	BDL	10.2	48.3	2.3	0.04	6.31	0.32
12/11/94	15:45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14.0	BDL	BDL	BDL	BDL	14.0	48.3	2.3	0.06	7.35	0.38
12/12/94	14:05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14.0	BDL	BDL	BDL	BDL	14.0	45.6	2.2	0.06	8.28	0.44
12/12/94	15:30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10.3	BDL	BDL	BDL	BDL	10.3	45.6	2.2	0.04	8.34	0.44
12/13/94	12:04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.8	BDL	BDL	BDL	BDL	12.8	45.6	2.2	0.05	9.20	0.48
12/14/94	11:55	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.2	BDL	BDL	BDL	BDL	12.2	53.4	2.3	0.06	10.2	0.54
12/14/94	16:08	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.9	BDL	BDL	BDL	BDL	11.9	55.7	2.3	0.06	10.4	0.55
12/15/94	11:46	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.9	BDL	BDL	BDL	BDL	12.9	45.6	2.2	0.05	11.2	0.60
12/15/94	20:30																	STOP	2.2	0.05	11.6	0.61
12/15/94	21:00																	START	0.0	0.00	11.6	0.61
12/16/94	12:38	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.1	BDL	BDL	BDL	0.36	13.5	48.5	2.1	0.06	12.2	0.65
12/17/94	13:15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.8	BDL	BDL	BDL	BDL	13.8	51.0	2.2	0.06	13.2	0.72
12/18/94	11:37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14.4	BDL	BDL	BDL	BDL	14.4	48.5	2.1	0.06	14.2	0.78
12/19/94	13:24	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	16.5	BDL	BDL	BDL	BDL	16.5	45.7	2.1	0.07	15.2	0.85
12/20/94	11:10																	STOP	2.1	0.07	16.1	0.91

BELOW DETECTION LIMIT

APPENDIX G
SUMMARY OF PILOT STUDY
VACUUM PROBE MEASUREMENTS

DCF - Fort Riley - Vacuum Extraction Test Data Stabilized Daily Vacuum Probe Readings, In. - Summarized from LBA Daily Log Sheets

	Air Flow From Vacuum, scfm				Well #1 - Northeast Array				Well #1 - Northwest Array.				Well #2 - South Array				Well #2 - West Array			
Date	Well #1	Well #2	Well #3	Well #4	Probe 1	Probe 2	Probe 3(7'-d)	Probe 4 (25'd	Probe 1	Probe 2	Probe 3(7')	Probe 4(25'	Probe 1	Probe 2	Probe 3(7')	Probe 4(25'	Probe 1	Probe 2	Probe 3(7')	Probe 4(25')
11/21/94 9:00	65				0		0-.02 (.01)	.04-.05 (.045)	0.05	0	0.05	0.1	0	0.1	0.01	0	0	0	0	0
11/22/94 9:00	65				0	.25-.45 (.4)	0-.02 (.02)	.04-.08 (.08)	0.1	0	0.17	0.08	0	0.05	0.005	0	0	0	0.11	0
11/22/94 11:00	75												0	0	0	0	0	0	0.145	0
11/23/94 9:00	80				0	.4 (.45)	0.02	.07-.08 (.08)	0.1	0.05	0.17	0.08	0	0-.1(.05	0-.01(0)	0-.01(0)	0	0	.12-.15(.15)	0
11/23/94 14:00	90				0.2	.6-.55 (.55)	0.04	0.11	0.2	0.1	0.24	0.12	0	0.1	0.01	0	0	0	.16-.19	0
11/24/94 9:00	90				0.2	0.5	0.03	.08-.09 (.085)	0.2	0.1	0.19	.09-.1(.09)	0	0.1	0.01	0.01	0	0-.5	.16-.19	0.01
11/25/94 9:00	65				0.2	0.5	0.02	.07-.08 (.075)	0.1	0.05	0.175	0.075	0	0.05	0	0	0	0	0.15	0
11/25/94 11:00		55-45			0	.05-.1	0	0	0	0	0.01	0.01	0	0.1	0	0	0	0	0.11	0
11/26/94 9:00		40-35			0	0-.05	0	0	0	0	0	0	0	0.1	0	0	0	0	.03-.05	0
													0	0.1	0.01	0.01				0
11/27/94 13:00		35-28			0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	.01-.06	0
11/28/94 9:00		28			0	0-.01	0	0	0	0	0	0	0	0.1	0	0	0-.1(.05)	0	.01-.03(.01)	0
11/29/94 9:00		27			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0
11/29/94 10:00			39		0	.05-.1(.05)	0.02	0.03	0	0	.04-.08(.07)	.02-.04(.04)	0	0.1	0	0	0	0	.05-.09(.075	0.01
11/30/94 9:00			39		0	0.1	0.01	0.02	0	0	0.07	0.03	0	0.1	0	0	0	0	.05-.08	0.01
11/30/94 12:00			63		0	0.2	0.04	.05-.06(.55)	0.1	0	.18-.2(.2)	.07-.09(.08)	0	0.1	0	0	0.1	0	.19-.21(.2)	0.01
12/1/94 10:00			65		0	0.2	0.05	0.06	0.1	0	.18-.2(.19)	.06-.09(.08)	0	0.1	0	0	0.1	0	.22-.26	0.01
12/1/94 15:00			70		0	0.2	0.05	0.07	0.1	0.1	.23-.25(.23)	0.11	0	0.1	0	0	0.1	0	.22-.26	0.01
12/2/94 10:00			77	43	0	0.2	0.04	0.06	0.1	0.1	.22-.26(.24)	.1-.125(.12)	0	0.1	0	0	0.05	0	.23-.29	0.015
12/2/94 11:00			0	43	0	0.2	0.06	0.08					0	0	0	0	0	0	.22-.24	0
12/3/94 10:00				39																
12/3/94 12:00				78																
12/4/94 10:00				86																
12/4/94 13:00				94																
12/4/94 15:00				94																
12/5/94 9:00				100																
12/6/94 9:00				112																
12/6/94 11:00	42	22	48	43																
12/7/94 0:00	Ice Storm																			
12/8/94 9:00	47	16	48	33	0	0.5	0.09	0.16	0.02	0.02	0.4	0.2	0	0	0	0	0	.04-.05	.36-.43(.38)	0
12/9/94 9:00	55	27	47	33	0	0.5	0.08	0.15	0.2	0.2	0.37	0.23	0	0	0	0	0	0.035	0.38	0
12/9/94 13:00				46-49	0	0.5	0.09	0.15	0.2	0.2	0.38	0.25					0	0.04	0.38	0
				46-49	0	0.5	0	0.15	0.2	0.2	0.44	0.37								
12/10/94 0:00	55	19	52	46-49	.3-.32(.3)	.5-.6(.5)	0.1	.17-.18(.175)	0.2	0.2	0.44	0.28	0	0.01	0	0	0	.035-.0	.385-.435	0
									0.2	0.25	0.44	0.24	0	.05-.08	0	0				
12/11/94 0:00	52	15	51	48	.3-.32(.3)	0.5	0.09	0.165	0.2	0.2	0.4	0.2	0	.04-.09	0	0	0	0.04	.39-.43	0
12/12/94 0:00	55	11	50	46	0.33	0.55	0.1	0.175	0.2	.2-.25(	0.4	0.19	0	.03-.04	0	0	0.025	0.045	0.375	0
12/13/94 0:00	54	9	50	46	0.34	0.55	0.1	0.18	0.2	0.22	0.37	0.18	0	0-.08	0	0	0-.03	0.04	.36-.4(.38)	0
12/14/94 0:00	54	8.5	51	55	0.35	0.55	0.1	0.18	0.2	0.22	.36-.43(.38)	.15-.18	0	0-.08	0	0	0-.03	0.04	.36-.4(.36)	0
12/15/94 0:00	49	7	49	46	0.35	0.6	0.1	0.18	0.2	.2-.3	.38-.43(.4)	.16-.19(.19)	0	0-.06	0	0	0-.03	0.04	.36-.38(.36)	0
12/16/94 0:00	52	16	49	49	0.35	0.55	0.1	0.18	0.2	0.21			0	0-.03	0	0	0-.04	0.045	.37-.4	0
									0.2	0.25	.37-.41(.38)	.15-.19								
12/17/94 0:00	54	19	51	51	0.34	0.6	0.1	0.18	0.21	.21-.28	.33-.41	.13-.19	0	0	0	0	0	0.04	0.42	0
12/18/94 0:00	49	21	54	49	0.32	0.6	0.1	0.17	0.22	.21-.25	.35-.37	.13-.17	0	0	0	0	0	0.04	0.42	0
12/19/94 0:00	49	25	56	46	0.31	0.6	0.1	0.17	0.2	.21-.25	.35-.42	.13-.19	0	0	0	0	0	0.05	.33-.43	0
12/20/94 0:00	49	25	56	46	0.31	0.5	0.095	0.155	0.2	0.2	0.36	0.18	0	0	0	0	0	0.045	0.33	0

DCF - Fort Riley - Vacuum Extraction Test Data Stabilized Daily Vacuum Probe Readings, in.

Date	Air Flow From Vacuum, scfm				Well #3 - North Array				Well #3 - West Array				Well #4 - Southwest Array				Well #4 - Northwest Array			
	Well #1	Well #2	Well #3	Well #4	Probe 1	Probe 2	Probe 3(7')	Probe 4(25')	Probe 1	Probe 2	Probe 3(7')	Probe 4(25'	Probe 1	Probe 2	Probe 3(7')	Probe 4(25'	Probe 1	Probe 2	Probe 3(7')	Probe 4(25')
11/21/94 9:00	65				0	0	0	0.12	0.05	0	0	0								
11/22/94 9:00	65				1	0	0	0.15	0.05	0	0	0								
11/22/94 11:00	75				0.5	0	0	0.15												
11/23/94 9:00	80				1	0	0	0.14	0.05	0	0.02	0.02								
11/23/94 14:00	90						0.02	0.22	.05-.1	0	0.02	.02-.04(.02)								
11/24/94 9:00	90				0.4	0.1	0.01	0.17	0.05	0.5	.01-.02	.01-.03(.02)								
									0.1	0	0.01	.01-.04								
11/25/94 9:00	85				0.4	0.1	0	0.11	0.1	0	0	0								
11/25/94 11:00		45-55			0-.05	0	0	0.01	0	0	0	0								
11/26/94 9:00		35-40			0	0	0	0	0	0	0	0								
11/27/94 13:00		35-28			0	0	0-.01	0	0	0	0	0.03								
11/28/94 9:00		28			0	0	.0-.01(.01)	.0-.01(.01)	0	0	0	0.01								
11/29/94 9:00		27			0	0	0	0	0	0	0-.01(0)	0.01								
11/29/94 10:00			39		0.3	0	0	0.1	0.1	0	0-.01	.0-.04								
11/30/94 9:00			39		0.4	0	0	0.07	0.1	0	0.01	.01-.03(.03)								
11/30/94 12:00			63		2	0.1	0.01	0.24	0.3	0	0.01	.01-.03								
			63		0.85*	0.1	0	0.24	0.3	0	.02-.03 (.01	.04-.05(.04)								
12/1/94 10:00			65		0.9	0.1	.01-.02(.02)	.19-.27	0.4	0	0.02	.05-.06(.05)								
12/1/94 15:00			70		1.1	0.1	.01-.03(.02)	.35-.4	0.4	0	.02-.05(.04)	.06-.07(.06)								
12/2/94 10:00			77	43	1.1	0.1	.01-.02(.01)	.3-.41	0.4	0	.04-.055(.0	.06-.07(.06)	0	0	0	0.01	0.05	0	0	0
12/2/94 1:00				43																
12/3/94 10:00				39									0	.0	0	0.005	0.05	0	0	0
12/3/94 12:00				78									.05-.1	0	0	.01-.03	.1-.2	0	.01-.02(.02)	.01-.02 (.02)
12/4/94 10:00				86									0.1	0	0	0.035	0.2	0	0.02	0.03
12/4/94 13:00				94									0.15	0	0	0.045	0.25	0	0.03	0.035
12/4/94 15:00				94									0.1	0	0	0.045	0.25	0	0.025	0.035
12/5/94 9:00				100									0.05	0	0	0.04	0.2	0	0.015	0.025
12/6/94 9:00				112									0.05	0	0	0.04	0.2	0	0.02	0.04
12/6/94 11:00	42	22	48	43									0	0	0	0.01	0	0	0	0
12/7/94 9:00	Ice Storm																			
12/8/94 9:00	47	16	48	33	3	0	0	0.2	2	0	0	.1-.2(.15)	0	0	0	0.005	0.05	0	0	0
12/9/94 9:00	55	27	47	33	2.5	0	0	0.15	1.9	0	0	0.1	0	0	0	0.01	0.1	0	0	0.005
12/9/94 13:00				46-49	2.5	0	.05-.1(.1)	0.25	0.5	0	0	0.1	0	0.02	0	0.02	0.15	0	0.005	0.015
									0.25	0	0	0.1								
12/10/94 9:00	55	19	52	43-49	2-2.5	.2-.38	0-.15(0)	.05-.1	0.65	0.02	0.06	0.28	.02-.04	0	0	0.02	.1-.17(.1	0	0.02	0.01
									0.39	0.02	0.06	0.15					0.15	0	0.02	0.02
12/11/94 9:00	52	15	51	48	2.0-2.5(2.4	0.5	.03-.11(.07)	.03-.06(.05)	.31-.38	.02-.03	.06-.08	.11-.13(.11)	.01-.04	0	0	0.01	0.1	0	0.01	.01-.02(.02)
12/12/94 9:00	55	11	50	46	2.2-2.5	0.8	0.1	.045-.07	.25-.3	.02-.03	.07-.1	.12-.18 (.14	0.04	0	0	0.01	.15-.18	0	0.01	.0-.02(.02)
12/13/94 9:00	54	9	50	46	2.2-2.5	0.5	0-.1	.02-.08	.28-.38	0.03	0.08	0.12	.04-.05	0	0	0.01	0.17	0	0.01	0.01
12/14/94 9:00	54	8.5	51	55	2.2	0.26	0-.11	.01-.06	2.2-2.8	.01-.03	0.03	0.14	0.04	0	0	0.01	0.17	0	0.01	0.01
12/15/94 9:00	49	7	49	46	2.8	0.29	.0-.09	.06-.1(.1)	2.1	0.03	0.03	0.07	0.04	0	0	0.01	.12-.17	0	.0-.02	0.01
12/16/94 9:00	52	16	49	49	2.5	0.3	0-.06	0.1	.25-.36	0.03	0.04	.05-.1(.1)	0.04	0	0	0.01	0.1	0	0-.02	0.01
12/17/94 9:00	54	19	51	51	2.2-2.5(2.4	0.28	0	.04-.1	.28-.3	0.02	.03-.04	.08-.1(.09)	0.04	0	0	0.01	0.1	0	0	0.01
12/18/94 9:00	49	21	54	49	2.5	0.25	0	.05-.1	0.2	0.02	0.03	.07-.1 (.08)	0.04	0	0	0.01	0.1	0	0	0.01
12/19/94 9:00	49	25	56	46	2.5	.25-.28	0	.05-.1	0.2	.01-.02	0.03	0.11	0.04	0	0	0.01	0.1	0	0	0.01
12/20/94 9:00	49	25	56	46	2.2	0.25	0	0.06	0.2	0.02	0.04	0.08	0.04	0	0	0.01	0.1	0	0	0.01

APPENDIX H
MEMORANDUM ON DCF PILOT STUDY
POST EXTRACTION SOIL AND GROUNDWATER SAMPLING

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MEMORANDUM

TO: Commander, Engineer District Kansas City
Attn: CEMRK-EP-EA, Garth Anderson
Kansas City, MO 64106

FROM: Fred McCarthy

DATE: 13 April 1995

RE: DCF Pilot Test Study Post Extraction Soil and Groundwater Sampling

CC: Katie Watson, Mike Greene, Jim Stamatis, Susan Knauf, Larry Cerrillo, George Parris

Introduction

The purpose of this memorandum is to present the proposed locations and sampling procedures for the post-extraction subsurface soil and groundwater sampling at the Dry Cleaning Facilities Area located in Fort Riley, Kansas. The intent of performing post extraction sampling is to compare results with baseline soil and groundwater data so as to evaluate the effectiveness of the pilot test system operation.

Proposed Locations and Sampling Methodology

Subsurface Soil Sampling Locations

The three post-extraction soil borings will be located as shown on Figure 1. These soil borings are located approximately two feet northeast of the baseline borings which were sampled in October 1994. No post extraction soil samples are proposed for collection adjacent to DCF94-21 because baseline results for this area indicated non-detection of VOCs. At each of the three boring locations, three (3) split spoon samples will be obtained. They will represent the shallow depth (approximately 1.0 - 3.0 ft); intermediate depth (approximately 15.0 - 17.0 ft); and a six inch interval above the groundwater table. Specific sample depths will be determined based upon soil screening with a PID and the intervals sampled during baseline sampling. Samples with the highest PID reading will be collected for analysis. A total of nine samples will be collected and analyzed for VOCs by EPA method 8010. Sampling will be performed according to the procedures established in the QAPP dated 9 January 1995 and the Draft Final Workplan dated March 1994.

Groundwater Sampling Locations

Post extraction groundwater samples will be collected from four wells: DCF94ES-1B, -2B, -3B, and DCF94-21. Samples will be analysed for VOCs by EPA Method 8010. Sampling will be performed according to the QAPP dated 9 January 1995 and the Draft Final Workplan dated March 1994.

Schedule

The Post extraction subsurface soil sampling is scheduled for 24 through 27 April 1995 and the groundwater sampling will follow on 1 through 3 May.

Attachment