Soil-Gas Investigation Report

354 Area Solvent Detections (Operable Unit 005) at Main Post Fort Riley, Kansas

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Prepared for

U.S. Army Corps of Engineers
Kansas City District

Prepared by

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&
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LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BMcD	Burns & McDonnell Engineering Company, Inc.
CCl_4	Carbon Tetrachloride
CoE	Corps of Engineers (U.S. Army)
DCE	Dichloroethene
DES	Directorate of Environment and Safety
DETMWP	Data Evaluation Technical Memorandum and Work Plan Addendum
DPW	Directorate of Public Works
EWMC	Environmental Waste Management Center
ft	feet
GC	Gas Chromatograph
IDW	Investigative Derived Waste
IDWMP	Investigative Derived Waste Management Plan
IRP	Installation Restoration Program
IWSSHP	Installation-Wide Site Safety and Health Plan
KCD-CoE	Kansas City District – Corps of Engineers (U.S. Army)
MP	Malcolm Pirnie, Inc.
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
NAVD	North American Vertical Datum
NPDES	National Pollutant Discharge Elimination System
OU	Operable Unit
PCE	Tetrachloroethene
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
QCSR	Quality Control Summary Report
RI	Remedial Investigation
RI Report	Remedial Investigation Report
SAP	Sampling and Analysis Plan
SGIR	Soil-Gas Investigation Report
SGWPA	Soil-Gas Work Plan Addendum

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TCE	Trichloroethene
UTM	Universal Transverse Mercator

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1.0 INTRODUCTION

1.1 PURPOSE OF THE SOIL-GAS INVESTIGATION REPORT

This Soil-Gas Investigation Report (SGIR) was written to provide the results of the investigation of soil gas conducted around eight structures at Main Post, Fort Riley, Kansas. A groundwater plume containing several chlorinated solvents is present in the subsurface at Main Post. This plume has been described in the *Remedial Investigation (RI) Report, 354 Area Solvent Detections (Operable Unit [OU] 005) at Main Post, Fort Riley Kans*as (Burns & McDonnell Engineering Company, Inc [BMcD], 2003a) (RI Report).

This SGIR was written in support of the Fort Riley Directorate of Environment and Safety (DES) Installation Restoration Program (IRP). This SGIR was prepared by BMcD under contract DACW41-96-D-8010 with the Kansas City District – Corps of Engineers (KCD - CoE) and represents Fort Riley's on-going commitment to investigate and take appropriate actions at sites posing a potential threat to human health and the environment.

Discussion of the 354 Site is provided in the RI Report and the *Data Evaluation Technical Memorandum and Work Plan Addendum, July 1999 – April 2000 Fieldwork for the RI/FS at the 354 Area Solvent Detections (OU 005) at Main Post, Fort Riley, Kansas* (BMcD, 2001) (DETMWP). These two reports provide detailed information on setting, previous investigations, the nature and extent of contamination, fate and transport, and both human and ecological risk assessments.

1.2 SITE HISTORY

Refer to Section 1.2 of the RI Report (BMcD, 2003a) for detailed information on the history of the 354 Site.

1.3 OBJECTIVE OF FIELD INVESTIGATION

The objective of this soil-gas investigation was to determine if elevated levels of soil gas are present in subsurface soils immediately adjacent to Buildings 330, 335, 364, 366, 367, 368, 407, and 415 at Main Post (see Figure 1-1). Buildings 330, 407, and 415 have basements. Analytes of interest are the chlorinated solvents that have been detected in the groundwater plume. These are tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and carbon tetrachloride (CCl_4). This data will be used to assist in determining if elevated concentrations of chlorinated solvents are present in soil gas at levels which could degrade indoor air quality and present a risk to building occupants.

1.4 SOIL-GAS INVESTIGATION REPORT ORGANIZATION

This SGIR is organized as follows:

- Section 1.0 Introduction
- Section 2.0 Field Activities
- Section 3.0 Results, Discussion, and Conclusions
- Section 4.0 References

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2.0 FIELD ACTIVITIES

2.1 OVERVIEW OF SOIL-GAS FIELD ACTIVITIES

This section of the SGIR describes the procedures used in the field during execution of the soil-gas investigation. Field activities related to the soil-gas investigation included the following:

- Clearing utilities around buildings at Main Post where samples were collected
- Conducting soil-gas collection and analysis
- Surveying direct-push boring locations

The sampling and analysis methods used were based on standard procedures discussed in the *Installation-Wide Sampling and Analysis Plan for Environmental Investigations at Fort Riley, Kansas: Volume I – Field Sampling Plan* (SAP) (Malcolm Pirnie, Inc./BMcD (MP-BMcD), 2004a). Safety and health procedures were discussed in the *Installation-Wide Site Safety and Health Plan for Environmental Investigations at Fort Riley, Kansas* (IWSSHP) (MP-BMcD, 2004b). Site specific procedures were discussed in *Soil-Gas Work Plan Addendum, 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas* (SGWPA) (BMcD, 2004a).

2.2 UNDERGROUND UTILITY MARKOUT

The markout of underground utilities by both commercial and Fort Riley utility locators was completed before beginning fieldwork. Prior to calling in to request the markout of underground utilities, all direct-push boring locations were marked with either a white flag or white paint on the ground. Commercial utilities were cleared by calling Kansas One Call one week before beginning field activities. Once Kansas One Call had assigned a ticket number for this field investigation, the Directorate of Public Works (DPW) at Fort Riley was notified and DPW-owned utilities were cleared. The BMcD field site manager coordinated with Fort Riley Dig Safe during on-going field activities to ensure that any direct-push location changes were properly cleared.

2.3 SOIL-GAS SAMPLE COLLECTION AND ANALYSIS

Soil-gas samples were collected immediately adjacent to eight buildings identified by Fort Riley DES. These include Buildings 330, 335, 364, 366, 367, 368, 407, and 415 (Figure 1-1). The original intent was to collect samples at three locations around each structure. These were to be located 'side-gradient' and 'up-gradient' relative to the direction of flow of the groundwater within the terrace aquifer. Since the

direction of groundwater flow is from north to south, these direct-push borings were to be located generally on the southwest, northwest, and northeast sides of the structures. The only exception was at Building 330 where, because of its orientation, the three borings were located on the northwest, northeast, and southeast sides. At several buildings, direct-push boring locations had to be adjusted due to site conditions. These adjustments included the following:

- At Building 335, there was a dense grid of underground utilities located immediately to the northwest of the structure. Following discussion with the KCD – CoE project manager, the decision was made not to advance the boring (B354-SG335b) on this side of the building.

- Also at Building 335, it was not possible to locate a boring (B354-SG335a) on the southwest side of the structure due to a lack of vehicle access. This boring was relocated to the southeast side of Building 335.

- At Building 364, there was a dense grid of underground utilities located immediately to the southwest of the structure. This boring (B354-SG364a) was relocated to the southeast side of the building.

All direct-push soil-gas boring locations are depicted on Figure 1-1. An effort was made to place each boring within three to six feet (ft) of the exterior wall; however, in some cases this was not possible due to access issues, location of sidewalks and underground utilities, decorative vegetation, and other factors.

At each direct-push boring location, the intent was to collect seven soil-gas samples at depths of 5, 10, 15, 20, 30, 40, and 50 ft below ground surface (bgs). At four locations, samples could not be collected at a depth of 50 ft bgs because refusal was encountered at a shallower depth. Those borings where refusal occurred at a depth less than 50 ft bgs included B354-SG330c, B354-SG335a, B354-SG335c, and B354-SG367b. Information on depth of refusal is provided in Table 2-1.

Soil-gas samples were collected using direct-push equipment. Probe rods with a threaded point holder and disposable point were pushed hydraulically to the desired sampling depths. Polyethylene tubing was then lowered down the probe rods and threaded onto the point holder. The rods were then retracted to create a void in the soil and the drive point was disengaged. At this point a vacuum was applied to purge the tubing and draw a soil-gas sample. The soil gas was then withdrawn from the tubing using a disposable syringe and immediately injected into a Shimadzu GC-14A gas chromatograph (GC) for analysis. Soil-gas samples were analyzed for PCE, TCE, DCE, and CCl_4 only. Field quality control (QC)/quality assurance (QA) included blanks, calibration standards, and duplicates. Refer to the *Quality*

Control Summary Report, Soil-Gas Investigation, 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas (QCSR) (BMcD, 2004b) for details on field QA/QC. Analytical results are presented in Table 2-1.

Sample designators included the 354 Site designator (B354), and the number of the building the sample was collected at and the depth interval. For example, B354-SG330c/S03 identified the sample collected along the southeast wall of Building 330 at a depth of 15 ft bgs.

Following the collection of soil-gas samples, each direct-push boring was backfilled with bentonite granules. Any direct-push boring driven through pavement was repaired with asphalt patch.

2.4 SURVEYING

Following the completion of soil-gas collection, the individual direct-push borings were remarked so they could be located by the surveying crew. All locations were surveyed to determine both horizontal and vertical control. The northing and easting coordinates were determined with an accuracy of 0.1 ft and were referenced to Universal Transverse Mercator (UTM) coordinates. Elevations of the ground surface were determined with an accuracy of 0.1 ft and were referenced to the North American Vertical Datum (NAVD) 88 datum. All surveying was performed by a State of Kansas registered land surveyor.

The surveying data is included in this report as Appendix 2A.

2.5 INVESTIGATIVE DERIVED WASTE

Investigation derived waste (IDW) was handled in accordance with procedures described in the *Installation-Wide Investigative Derived Waste Management Plan for Environmental Investigations, Fort Riley, Kansas* (BMcD, 2003b) (IDWMP).

Liquid IDW included very small volumes of decontamination water used to clean rods and other direct-push equipment. These liquids were containerized and discharged daily directly to the Fort Riley sanitary sewer system under the existing National Pollutant Discharge Elimination System (NPDES) permit.

Solid waste included a small volume of items such as personal protective equipment (PPE) and tubing. These materials were bagged and deposited in a designated dumpster located at the Environmental Waste Management Center (EWMC) at Camp Funston.

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3.0 RESULTS, DISCUSSION, AND CONCLUSIONS

3.1 SOIL-GAS INVESTIGATION RESULTS

The results of the soil-gas investigation are presented in Tables 2-1 and 2-2. Table 2-1 presents comprehensive field results in units of micrograms per liter (µg/L). Table 2-2 presents results (positive detections only) in units of micrograms per cubic meter (µg/m^3). The following section will present athe discussion of results using units of µg/L. Figure 1-1 depicts the individual direct-push boring locations.

3.2 DISCUSSION

There were positive detections of target analytes in samples taken from seven of 23 direct-push borings advanced for this investigation. These direct-push borings were located adjacent to three of the eight buildings investigated. These were Buildings 367 (three borings), 368 (three borings), and 415 (one boring). At the other four buildings (330, 335, 366, and 407) there were not any detections of target analytes at levels above the reporting limit (2 µg/L).

All three direct-push borings advanced at Building 367 had detections of either PCE or DCE at concentrations above the detection limit. At Direct-Push Boring B354-SG367a, PCE was detected at concentrations ranging from 236 µg/L (10-ft bgs) to 2.5 µg/L (50-ft bgs). Two samples taken from Direct-Push Boring B354-SG367b had detections of PCE. The sample taken at 15-ft bgs had a concentration of 1.9 µg/L (J-flagged as estimated) and the sample taken at 40-ft bgs had a concentration of 6.1 µg/L. PCE and DCE were detected in soil-gas samples taken from Direct-Push Boring B354-SG367c. PCE was detected at four depths (15-, 30-, 40-, and 50-ft bgs) at concentrations ranging from 15.0 to 4.0 µg/L. DCE was detected at three depths (30-, 40-, and 50-ft bgs) at concentrations ranging from 2.6 µg/L to 1.5 µg/L (J-flagged as estimated).

All three direct-push borings advanced at Building 368 had at least one detection of PCE in soil gas and one boring had a single detection of TCE. Direct-Push Boring B354-SG368a had a detection of PCE at a concentration of 1.5 µg/L (J-flagged as estimated) in soil gas taken from a depth of 5-ft bgs. Direct-Push Boring B354-SG368b had a single detection of PCE in the sample taken from a depth of 10-ft bgs, at a concentration of 2.7 µg/L. Direct-Push Boring B354-SG368c had detections of PCE in samples taken at depths of 5-, 30-, and 50-ft bgs, at concentrations of 2.2 µg/L, 3.3 µg/L, and 2.4 µg/L, respectively. This boring also had a single detection of TCE at a concentration of 1.7 µg/L (J-flagged as estimated) in the sample taken at a depth of 30-ft bgs.

At Building 415, only one boring had a single detection of carbon tetrachloride. This was in the soil-gas sample taken from a depth of 50-ft bgs in Direct-Push Boring B354-SG415b. The concentration of carbon tetrachloride was 0.7 µg/L (J-flagged as estimated).

3.3 CONCLUSIONS

Based on an evaluation of the soil-gas results, indoor air quality could be an issue within Buildings 367 and 368.

- PCE was present at shallow depths in soil samples taken adjacent to Building 367. However, this structure has a history of sporadic occupancy by personnel, it is poorly sealed, and there is little likelihood that its current use will change in the future. Because Building 367 is rarely occupied for any significant length of time, Fort Riley proposes instructing individuals to open garage doors on the west side of the building and ventilate the workspace during use.

- TCE was present in shallow soil samples taken adjacent to Building 368. This structure is occupied on a continuing basis and some personnel are present up to 40 hours per week. Fort Riley proposes the installation of a passive vapor remediation system within Building 368 in order to ensure that indoor air quality is not an issue within this structure.

All the other detections at the other sample locations are sporadic and at low levels that do not indicate that the concentrations constitute a potential hazard. This includes the carbon tetrachloride that was detected at depth in soil adjacent to Building 415, which is a residence. This detection was at a depth of 50 ft bgs and was at a very low concentration (J-flagged as estimated).

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4.0 REFERENCES

BMcD, 2001, *Data Evaluation Technical Memorandum and Work Plan Addendum, July 1999 – April 2000 Fieldwork for the RI/FS at the 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas* [DETMWP].

BMcD, 2003a, *Remedial Investigation Report, 354 Area Solvent Detections (Operable Unit 005), Main Post, Fort Riley, Kansas* [RI]

BMcD, 2003b, *Installation-Wide Investigative Derived Waste Management Plan for Environmental Investigations, Fort Riley, Kansas* [IDWMP]

BMcD, 2004a, *Soil-Gas Work Plan Addendum, 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas* [SGWPA]

BMcD, 2004b, *Quality Control Summary Report, Soil-Gas Investigation, 354 Area Solvent Detections (Operable Unit 005) at Main Post, Fort Riley, Kansas* [QCSR]

Malcolm Pirnie, Inc./BMcD (MP-BMcD), 2004a, *Installation-Wide Sampling and Analysis Plan for Environmental Investigations at Fort Riley, Kansas: Volume I – Field Sampling Plan* [SAP]

MP-BMcD, 2004b, *Installation-Wide Site Safety and Health Plan for Environmental Investigations at Fort Riley, Kansas* [IWSSHP]

Tables

Table 2-1
Soil-Gas Results
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/L	TCE ug/L	PCE ug/L	CCl_4 ug/L	Comments
B354-SG330a / S01	5 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S02	10 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S03	15 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S04	20 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S05	30 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S55	30 ft	2 U	2 U	2 UJ	2 U	Duplicate
B354-SG330a / S06	40 ft	2 U	2 U	2 UJ	2 U	
B354-SG330a / S07	50 ft	2 U	2 U	2 UJ	2 U	
B354-SG330b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S22	10 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG330b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG330b / S07	46 ft	2 U	2 U	2 U	2 U	
B354-SG330c / S01	5 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S02	10 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S03	15 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S04	20 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S05	30 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S06	40 ft	2 U	2 U	2 UJ	2 U	
B354-SG330c / S07	45 ft	2 U	2 U	2 UJ	2 U	Refusal at 45 ft bgs
B354-SG335a / S01	5 ft	2 U	2 U	2 UJ	2 U	Note 1
B354-SG335a / S11	5 ft	2 U	2 U	2 UJ	2 U	Duplicate
B354-SG335a / S02	10 ft	2 U	2 U	2 UJ	2 U	
B354-SG335a / S03	15 ft	2 U	2 U	2 UJ	2 U	
B354-SG335a / S04	20 ft	2 U	2 U	2 UJ	2 U	
B354-SG335a / S05	30 ft	2 U	2 U	2 UJ	2 U	
B354-SG335a / S06	41 ft	2 U	2 U	2 UJ	2 U	
B354-SG335a / S07	50 ft	NS	NS	NS	NS	Refusal at 41 ft bgs
B354-SG335b / S01	5 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S02	10 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S03	15 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S04	20 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S05	30 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S06	40 ft	NS	NS	NS	NS	Note 2
B354-SG335b / S07	50 ft	NS	NS	NS	NS	Note 2
B354-SG335c / S01	5 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S02	10 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S03	15 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S04	20 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S05	30 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S55	30 ft	2 U	2 U	2 UJ	2 U	Duplicate
B354-SG335c / S06	40 ft	2 U	2 U	2 UJ	2 U	
B354-SG335c / S07	50 ft	NS	NS	NS	NS	Refusal at 42 ft bgs

Table 2-1 (continued)
Soil-Gas Results
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/L	TCE ug/L	PCE ug/L	CCl_4 ug/L	Comments
B354-SG364a / S01	5 ft	2 U	2 U	2 U	2 U	Note 3
B354-SG364a / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG364a / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG364a / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG364a / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG364a / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG364a / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG364b / S66	40 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG364b / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S33	15 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG364c / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG364c / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG366a / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG366b / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG366c / S01	5 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S02	10 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S03	15 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S04	20 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S05	30 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S06	40 ft	2 U	2 U	2 UJ	2 U	
B354-SG366c / S07	50 ft	2 U	2 U	2 UJ	2 U	

Table 2-1 (continued)
Soil-Gas Results
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/L	TCE ug/L	PCE ug/L	CCl_4 ug/L	Comments
B354-SG367a / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG367a / S02	10 ft	2 U	2 U	NA	2 U	
B354-SG367a / S22	10 ft	2 U	2 U	236	2 U	Reanalysis
B354-SG367a / S03	15 ft	4 U	4 U	145	4 U	
B354-SG367a / S04	20 ft	4 U	4 U	6.2	4 U	
B354-SG367a / S05	30 ft	2 U	2 U	4	2 U	
B354-SG367a / S06	40 ft	2 U	2 U	5.4	2 U	
B354-SG367a / S07	50 ft	2 U	2 U	2.5	2 U	
B354-SG367b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG367b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG367b / S03	15 ft	2 U	2 U	1.9 J	2 U	
B354-SG367b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG367b / S44	20 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG367b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG367b / S06	40 ft	2 U	2 U	6.1	2 U	
B354-SG367b / S07	50 ft	NS	NS	NS	NS	Refusal at 40 ft bgs
B354-SG367c / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG367c / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG367c / S03	15 ft	2 U	2 U	4	2 U	
B354-SG367c / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG367c / S05	30 ft	2.6	2 U	15	2 U	
B354-SG367c / S06	40 ft	1.5 J	2 U	8	2 U	
B354-SG367c / S07	50 ft	2.3	2 U	11	2 U	
B354-SG368a / S01	5 ft	2 U	2 U	1.5 J	2 U	
B354-SG368a / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG368a / S77	50 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG368b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG368b / S02	10 ft	2 U	2 U	2.7	2 U	
B354-SG368b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG368b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG368b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG368b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG368b / S66	40 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG368b / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG368c / S01	5 ft	2 U	2 U	2.2	2 U	
B354-SG368c / S02	10 ft	4 U	4 U	4 U	4 U	
B354-SG368c / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG368c / S33	15 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG368c / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG368c / S05	30 ft	2 U	1.7 J	3.3	2 U	
B354-SG368c / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG368c / S07	50 ft	2 U	2 U	2.4	2 U	

Table 2-1 (continued)
Soil-Gas Results
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/L	TCE ug/L	PCE ug/L	CCl_4 ug/L	Comments
B354-SG407a / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG407a / S77	50 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG407b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S33	15 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG407b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG407b / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG407c / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S07	50 ft	2 U	2 U	2 U	2 U	
B354-SG415a / S77	50 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG415b / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG415b / S07	50 ft	2 U	2 U	2 U	*0.7 J*	
B354-SG415c / S01	5 ft	2 U	2 U	2 U	2 U	
B354-SG415c / S02	10 ft	2 U	2 U	2 U	2 U	
B354-SG415c / S03	15 ft	2 U	2 U	2 U	2 U	
B354-SG415c / S33	15 ft	2 U	2 U	2 U	2 U	Duplicate
B354-SG415c / S04	20 ft	2 U	2 U	2 U	2 U	
B354-SG415c / S05	30 ft	2 U	2 U	2 U	2 U	
B354-SG415c / S06	40 ft	2 U	2 U	2 U	2 U	
B354-SG-415c / S07	50 ft	2 U	2 U	2 U	2 U	

Table 2-1 (continued)
Soil-Gas Results
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/L	TCE ug/L	PCE ug/L	CCl_4 ug/L	Comments

Notes:
1. Due to clutter on the southwest side of Building 335, this boring was moved to the southeast side of the structure.
2. Due to a high density of utilities to the northwest of Building 335, the decision was made to not advance this boring.
3. Due to a high density of utilities to the southwest of Building 364, this boring was moved to the southeast side of the structure.
4. Detections are shaded and highlighted.

CCl_4 = Carbon Tetrachloride
DCE = cis-1,2-Dichloroethene
PCE = Tetrachloroethene
TCE = Trichloroethene
J = Estimated value
U = Not detected above reporting limit
NS = Not Sampled
ft = feet
bgs = below ground surface
ug/L = micrograms per liter

Table 2-2
Soil-Gas Results
(Units of ug/m^3)
November 2004 Soil-Gas Sampling
354 Area Solvent Detections

Sample ID	Sample Depth	DCE ug/m^3	TCE ug/m^3	PCE ug/m^3	CCl_4 ug/m^3	Comments
B354-SG367a / S22	10 ft	2,000 U	2,000 U	236,000	2,000 U	Reanalysis
B354-SG367a / S03	15 ft	4,000 U	4,000 U	145,000	4,000 U	
B354-SG367a / S04	20 ft	4,000 U	4,000 U	6,200	4,000 U	
B354-SG367a / S05	30 ft	2,000 U	2,000 U	4,000	2,000 U	
B354-SG367a / S06	40 ft	2,000 U	2,000 U	5,400	2,000 U	
B354-SG367a / S07	50 ft	2,000 U	2,000 U	2,500	2,000 U	
B354-SG367b / S03	15 ft	2,000 U	2,000 U	1,900 J	2,000 U	
B354-SG367b / S06	40 ft	2,000 U	2,000 U	6,100	2,000 U	
B354-SG367c / S03	15 ft	2,000 U	2,000 U	4,000	2,000 U	
B354-SG367c / S05	30 ft	2,600	2,000 U	15,000	2,000 U	
B354-SG367c / S06	40 ft	1,500 J	2,000 U	8,000	2,000 U	
B354-SG367c / S07	50 ft	2,300	2,000 U	11,000	2,000 U	
B354-SG368a / S01	5 ft	2,000 U	2,000 U	1,500 J	2,000 U	
B354-SG368b / S02	10 ft	2,000 U	2,000 U	2,700	2,000 U	
B354-SG368c / S01	5 ft	2,000 U	2,000 U	2,200	2,000 U	
B354-SG368c / S05	30 ft	2,000 U	1,700 J	3,300	2,000 U	
B354-SG368c / S07	50 ft	2,000 U	2,000 U	2,400	2,000 U	
B354-SG415b / S07	50 ft	2,000 U	2,000 U	2,000 U	700 J	

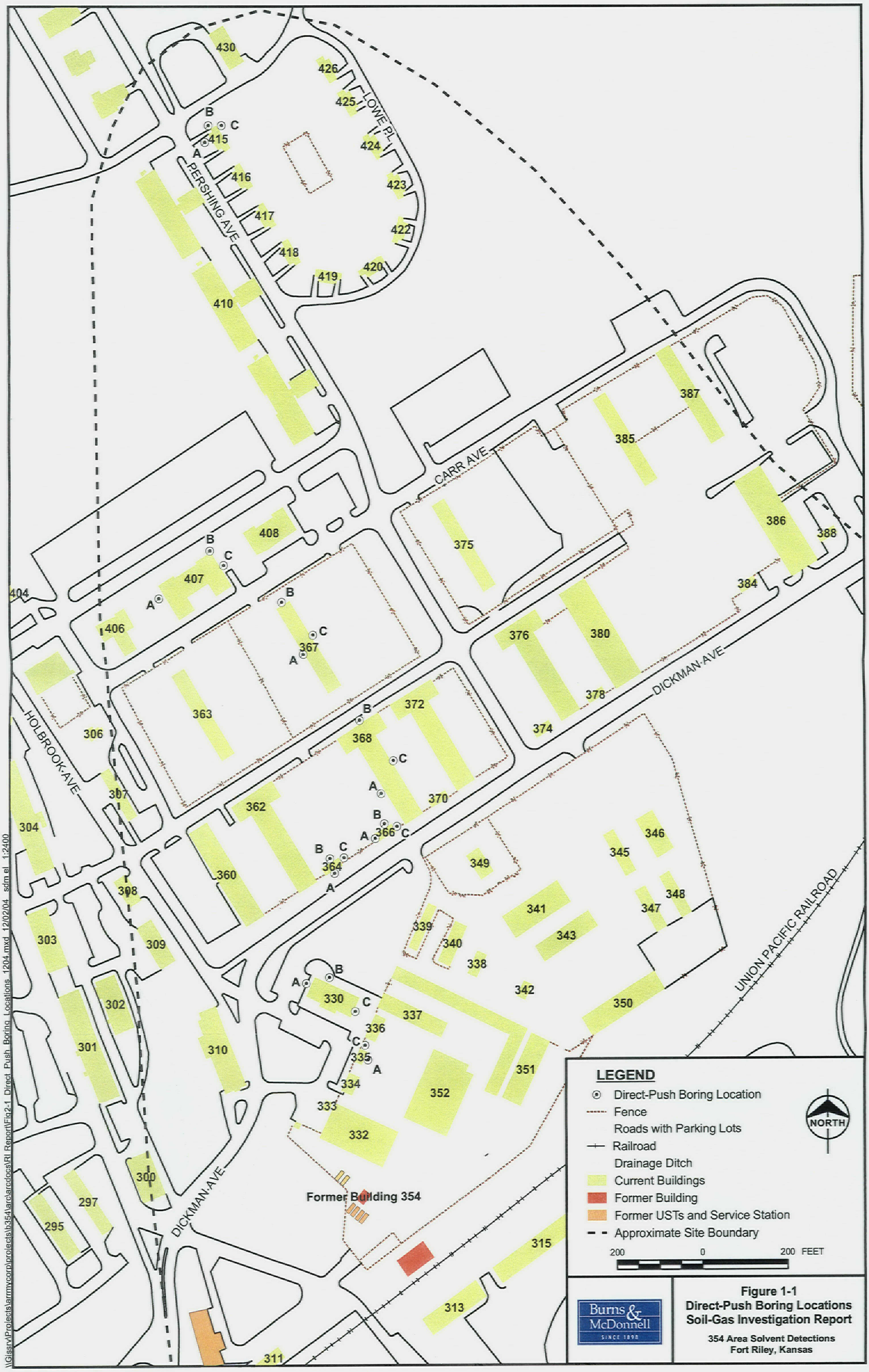
This is incorrect!

Notes:

1. Detections are shaded and highlighted.

CCl_4 = Carbon Tetrachloride
DCE = cis-1,2-Dichloroethene
PCE = Tetrachloroethene
TCE = Trichloroethene
J = Estimated value
U = Not detected above reporting limit
NS = Not Sampled
ft = feet
bgs = below ground surface
ug/m^3 = micrograms per cubic meter (1,000 liters)

Figure



\\Gissrv\Projects\armycorp\projects\b354\arc\arcdocs\RI Report\Fig2-1 Direct Push Boring Locations 1204.mxd 12/02/04 sdm el 1:2400

Appendix 2A
Surveying Data

2319 N. Jackson, PO Box 1304
Junction City, Kansas 66441
www.kveng.com

Tel: 785-762-5040
Fax: 785-762-7744
E-mail: JC@kveng.com

KAW VALLEY ENGINEERING, INC.

Monitor Well & Boring Locations
Main Post & Camp Funston
Fort Riley, Kansas
KVE# A04S1995

Horizontal Datum: UTM (Universal Transverse Mercator)
Vertical Datum: NAVD88

Monitor Well #	Northing	Easting	Monument Elev.	Top of Casing
FP-04-33B	4328382.934	695338.889	317.429	318.310
FP-04-33C	4328383.046	695337.131	317.416	318.343

Boring #	Northing	Easting	Elevation
330-A	4326172.048	692277.597	335.098
330-B	4326176.232	692294.083	335.878
330-C	4326152.558	692312.302	335.768
335-A	4326118.668	692321.179	334.622
335-C	4326129.102	692319.218	335.019
367-A	4326400.991	692275.787	340.319
367-B	4326436.990	692260.615	340.593
367-C	4326414.298	692282.874	340.246
364-A	4326248.586	692297.916	337.786
364-B	4326258.874	692294.544	338.045
364-C	4326259.485	692304.600	338.438
366-A	4326272.638	692326.940	339.261
366-B	4326282.889	692333.344	339.755
366-C	4326281.083	692342.253	339.350
368-A	4326303.709	692331.096	339.016
368-B	4326354.515	692315.950	339.530
368-C	4326326.427	692339.964	338.521
407-A	4326439.890	692173.437	342.648
407-B	4326472.974	692209.704	342.053
407-C	4326462.889	692219.360	341.617
415-A	4326756.866	692207.112	343.916
415-B	4326768.454	692209.383	343.983
415-C	4326768.406	692218.899	343.772

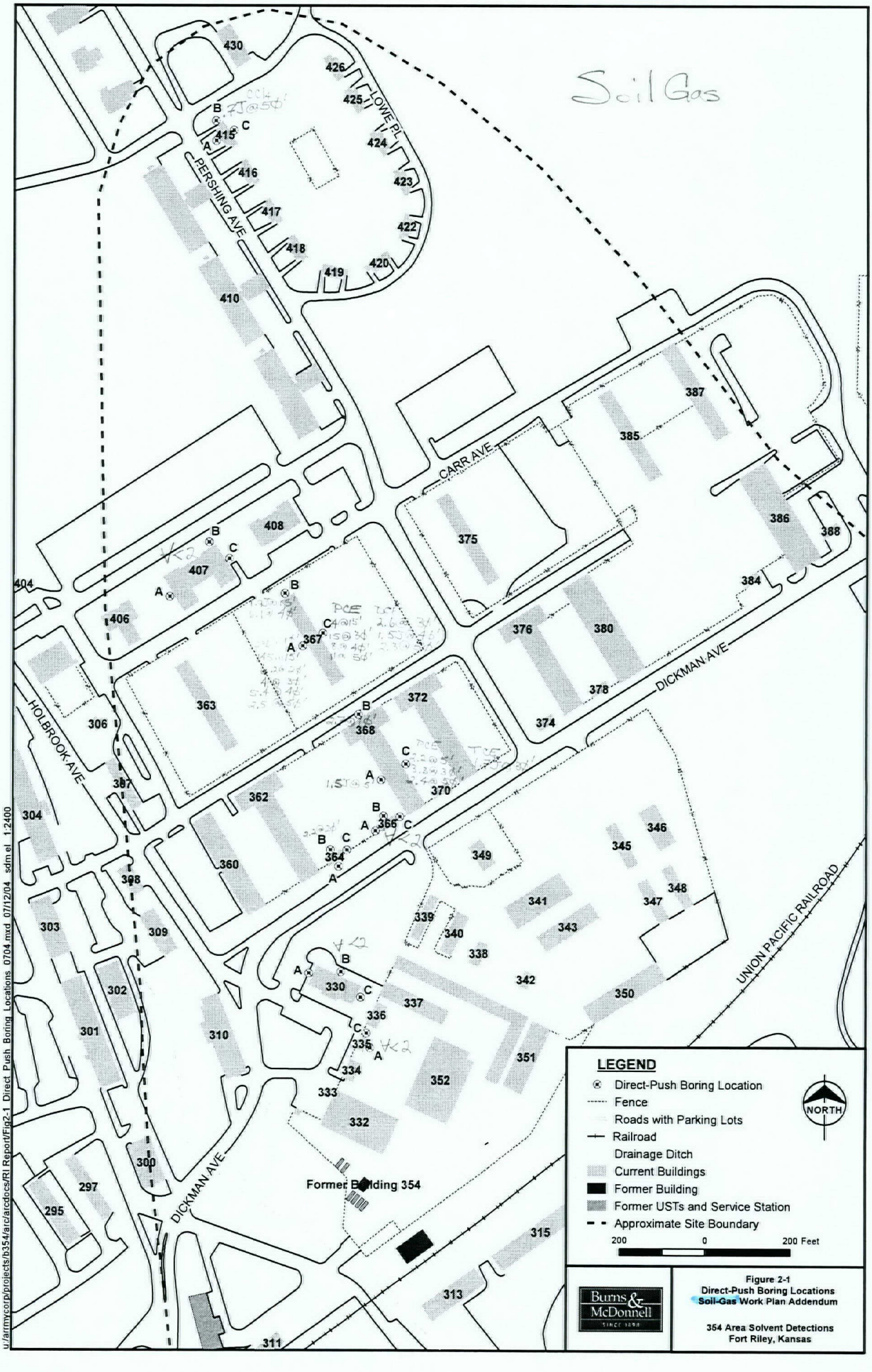

Soil Gas
LOWE PL
PERSHING AVE
CARR AVE
DICKMAN AVE
HOLBROOK AVE
UNION PACIFIC RAILROAD
Former Building 354
LEGEND
Direct-Push Boring Location
Fence
Roads with Parking Lots
Railroad
Drainage Ditch
Current Buildings
Former Building
Former USTs and Service Station
Approximate Site Boundary
200 0 200 Feet
NORTH
Burns & McDonnell
Figure 2-1
Direct-Push Boring Locations
Soil-Gas Work Plan Addendum
354 Area Solvent Detections
Fort Riley, Kansas
u:/armycorp/projects/b354/arc/arcdocs/RI Report/Fig2-1 Direct Push Boring Locations 0704.mxd 07/12/04 sdm.el 1:2400

Figure 1 D-P Boring Locations
A, B, or C Not Compass directions

415 NW 5ϕ' CCl ϕ.7J ∀ others < 2ppb = ND
SW ∀ ND
NE

335ϕ NW ∀ ND PCE J flagged ND
NE ∀ ND
SE ∀ ND PCE J flagged ND

335 SW ∀ ND PCE J flagged ND
NW not done - too many utilities

335 NE ∀ ND PCE J flagged ND

364 SW ∀ ND
NW ∀ ND
NE ∀ ND

366 SW ∀ ND
366 NW ∀ ND
NE ∀ ND PCE J flagged ND

367 SW	PCE		∀ others ND
	1ϕ'	23%	
	15'	45	
	2ϕ'	6.2	
	3ϕ'	4	
	4ϕ'	5.4	
	5ϕ'	2.5	
367 NW	15'	1.9J	∀ others ND
	4ϕ'	6.1	
367 NE	15'	4	TCE
	3ϕ'	15	3ϕ' 2.6
	4ϕ'	8	4ϕ' 1.5J
	5ϕ'	11	5ϕ' 2.3

∀ others ND

368 SW 5' 1.5J ∀ others ND
NW 1ϕ' 2.7 ∀ others ND
NE 5' 2.2 TCE
3ϕ' 3.3 1.7J
5ϕ 2.4

407 SW ∀ ND
NW ∀ ND
SE ∀ ND

Burns & McDonnell
SINCE 1898

May 27, 2005

DPW - Environmental Division
IMNW-RLY-PWE
ATTN: Dr. Richard Shields
407 Pershing Court
Fort Riley, Kansas 66442-6016

Draft Final Soil-Gas Investigation Report
354 Area Solvent Detections
Fort Riley, Kansas
BMcD Project No. 27828
Contract No. DACA41-96-D-8010 Task Order #0036

Dr. Shields:

Please find enclosed one copy of the draft final Soil-Gas Investigation Report for the subject site. Also find enclosed a copy of the distribution list and comment responses for this document.

If you have any questions, please call me at (816) 822-3595.

Sincerely,

E. D. Lindgren
Senior Project Manager

EDL/shields.doc

Enclosures

9400 Ward Parkway
Kansas City, Missouri 64114-3319
Tel: 816 333-9400
Fax: 816 333-3690
www.burnsmcd.com

DISTRIBUTION LIST

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DPW – Environmental Division IMNW-RLY-PWE ATTN: Dr. Richard Shields 407 Pershing Court Fort Riley, Kansas 66442-6016	1 copy, plus distribution list and comment responses
Robin Paul Federal Facilities/Special Emphasis Section U.S. Environmental Protection Agency, Region VII 901 North 5th Street Kansas City, KS 66101	2 copies, plus comment responses
Jim Anstaett Bureau of Environmental Remediation Kansas Department of Health and Environment 1000 SW Jackson, Suite 410 Topeka, KS 66612-1367	1 copy, plus comment responses

Site-specific

Indoor Worker Risk-Based Screening Levels (RSL) for Air
ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	Inhalation Unit Risk ($ug/m^3)^{-1}$	IUR Ref	Subchronic RfC (mg/m^3)	SRfC Ref	Carcinogenic SL TR=1.0E-6 (ug/m^3)	Noncarcinogenic SL HI=1 (ug/m^3)	Screening Level (ug/m^3)
Tetrachloroethylene	127-18-4	2.60E-07	U	-		7.86E+04	1.17E+04	1.17E+04 nc

Site-specific

Indoor Worker Equation Inputs for Air

Variable	Value
TR (target cancer risk) unitless	1.0E-6
THQ (target hazard quotient) unitless	1
AT_{w} (averaging time)	365
EF_{w} (exposure frequency) d/yr	30
ED_{w} (exposure duration) years	1
ET_{w} (exposure time) hours	1
LT (lifetime) yr	70

Subject: Soil-Gas Investigation Report
354 Area Solvent Detections (Operable Unit 005)
Main Post, Fort Riley, Kansas

Date: March 9, 2005
Reviewer: USEPA

No.	Page	Section	Comment:	Response:
Specific Comments				
1.			Sample B354-SG415b / S07 is probably not a significant indication of a problem, due to the depth of the sample and its qualification (J-flagged). A short explanation of this should be included in the conclusions section of this document.	**Concur.** Section 3.3 of the report will be re-written as follows: *"Based on an evaluation of the soil-gas results, indoor air quality could be an issue within Buildings 367 and 368.* • *PCE was present at shallow depths in soil samples taken adjacent to Building 367. However, this structure has a history of sporadic occupancy by personnel, it is poorly sealed, and there is little likelihood that its current use will change in the future. Because Building 367 is rarely occupied for any significant length of time, Fort Riley proposes instructing individuals to open garage doors on the west side of the building and ventilate the workspace during use.* • *TCE was present in shallow soil samples taken adjacent to Building 368. This structure is occupied on a continuing basis and some personnel are present up to 40 hours per week. Fort Riley proposes the installation of a passive vapor remediation system within Building 368 in order to ensure that indoor air quality is not an issue within this structure.* *All the other detections at the other sample locations were sporadic and at low levels that do not indicate that the concentrations constitute a potential hazard. This includes the carbon tetrachloride that was detected at depth in soil adjacent to Building 415, which is a residence. This detection was at a depth of 50 ft bgs and*

Date: March 9, 2005
Reviewer: USEPA

No.	Page	Section	Comment:	Response:
				was at a very low concentration (J-flagged as estimated)."
2.			PCE detections in soil gas at depths of 10 and 15 ft probably do not constitute a problem at Building 367. This is because of the history of the use of this building (as a gun shed and motor pool), its limited occupancy, little likelihood of a change in use, and its poorly sealed nature. These facts should also be addressed in the conclusions.	**Concur.** See response to comment #1.

End of Comment and Responses

Subject: Soil-Gas Investigation Report
354 Area Solvent Detections (Operable Unit 005)
Main Post, Fort Riley, Kansas

Date: March 28, 2005
Reviewer: Jim Anstaett, KDHE

No.	Page	Section	Comment:	Response:
Specific Comments				
1.			The soil gas data is presented in units of micrograms per liter. However, indoor air is measured in units of micrograms per cubic meter. It is suggested that Fort Riley convert the units from liters to cubic meters for comparison purposes.	**Concur.** A second table (positive detections only) will be provided, presenting positive detections in units of micrograms per cubic meter.
2.			When extrapolating soil gas concentrations to indoor air concentrations for general evaluation purposes, KDHE/BER uses attenuation factors. Soil gas detections that are 10 feet below ground surface (bgs) or less are attenuated by one order of magnitude. Soil gas detections deeper than 10 feet bgs are attenuated by two orders of magnitude. Fort Riley may wish to use these attenuation factors when evaluating the data.	**Do Not Concur.** The soil gas data were compared to the USEPA's 2002 draft vapor intrusion guidance. However, this guidance was written for residential scenarios. Only one of the eight buildings evaluated is a residence, and the guidance numbers indicate that there is no indoor air quality hazard based on soil gas results. As discussed at the May 10th LIR meeting, text will be added to the report to address potential problems with indoor air quality in Buildings 367 and 368. See the response to USEPA comment #1.
3.			It is suggested that Fort Riley compare the soil gas data results to occupational exposure criteria for Buildings 367 and 368. Generally speaking, Building 367 is unoccupied. Building 368 is an occupied structure. It is suggested that Fort Riley determine the number of hours Building 367 and 368 are occupied when comparing to occupational exposures.	**See response to Comment #2.**
4.			Building 415 is an occupied residential structure. The single detection at this site was presented as an estimated concentration (below laboratory reporting limits) at a depth of 50 feet bgs. The samples collected above this location from 45 feet bgs to 5 feet bgs were non detect. Based on these data, it appears that no further action is needed at this	**Concur.** See the response to USEPA comment #1.

Date: March 28, 2005
Reviewer: Jim Anstaett, KDHE

No.	Page	Section	Comment:	Response:
			location.	
5.			The conclusions section of the report indicated that indoor air quality sampling would be required to determine if contaminant seepage from soil gas was occurring within a building. If occupational exposure criteria are exceeded in Building 368, low cost methods such as radon pumps and vapor barriers exist to mitigate potential exposures in lieu of extensive sampling. If occupational criteria were exceeded in Building 367, one option to minimize human exposure in lieu of extensive sampling may be to ventilate the building via its multiple garage door openings.	**Concur.** Based on discussion held during the May 10, 2005 LIR meeting, a vapor remediation system is proposed for installation at Building 368. Because of the 'drafty' nature of Building 367 and the fact that this building is only sporadically occupied, the building will be ventilated by opening up garage door openings. These recommendations will be incorporated into the discussion in Section 3.3.

End of Comment and Responses

Subject: Soil-Gas Investigation Report
354 Area Solvent Detections (Operable Unit 005)
Main Post, Fort Riley, Kansas

Date: February 28, 2005
Reviewer: Debby Snodgrass, CENWK-EC-EF

No.	Page	Section	Comment:	Response:
Specific Comments				
1.	Page 1-1	Section 1.3	Consider stating whether the buildings to be investigated have basements. This is critical information for interpreting the results.	**Concur.**
2.	Page 2-1	Bullets	Consider using "Clearing", "Conducting", and "Surveying" to describe "activities".	**Concur.**
3.	Page 2-1, Line 10		Since you are reporting what has been completed, it is suggested that you use past tense verbs; "were based" instead of "are based". Same for line 13 and line 14.	**Concur.**
4.	Page 2-1, Line 25		Consider stating, "location changes" instead of "locations relocated".	**Concur.**
5.	Page 3-1	Section 3	Have you considered comparing the data to USEPA's 2002 draft vapor intrusion guidance numbers for soil gas measured in shallow and deep soils?	**Concur.** The soil gas data was compared to the USEPA's 2002 draft vapor intrusion guidance. However, this guidance was written for residential scenarios. Only one of the eight buildings evaluated is a residence, and the guidance numbers indicate that there is no indoor air quality hazard based on soil gas results. As discussed at the May 10th LIR meeting, text will be added to the report to address potential problems with indoor air quality in Buildings 367 and 368. See the response to USEPA comment #1.
6.		Table 2-1	Please provide units on the table.	**Concur.**

End of Comment and Responses