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SOIL GAS SURVEY FOR SITE ST16 BASE SERVICE STATION NAS FORT WORTH TX  
3/1/1993  
TARGET ENVIRONMENTAL SERVICES



101 00  
**NAVAL AIR STATION  
FORT WORTH JRB  
CARSWELL FIELD  
TEXAS**

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**ADMINISTRATIVE RECORD  
COVER SHEET**

AR File Number 131



**TARGET ENVIRONMENTAL SERVICES, INC.**

**SOIL GAS SURVEY**  
**SITE ST-16**  
**BASE SERVICE STATION**  
**CARSWELL AIR FORCE BASE**  
**TEXAS**

PREPARED FOR

**U.S. ARMY CORPS OF ENGINEERS**  
FORT WORTH DISTRICT  
819 TAYLOR STREET  
FORT WORTH, TEXAS

PREPARED BY

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MARCH 1993

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## EXECUTIVE SUMMARY

On February 24-26 and March 1, 1993, **TARGET Environmental Services, Inc.** (**TARGET**) conducted a soil gas survey at **Site ST-16, Base Service Station**, Carswell Air Force Base, Texas, where petroleum hydrocarbons have impacted the ground water. A total of 86 soil gas samples were collected from depths of 4 to 9 feet. The samples were analyzed on a gas chromatograph equipped with a flame ionization detector (**GC/FID**) for petroleum hydrocarbons. The objective of the survey was to help determine the areal extent of the contaminated ground water plume emanating from the Base Service Station.

High levels of Total FID Volatiles were present along the sewer line east of Rogner Drive. Moderate levels occurred along the western side of Rogner Drive and in a sample collected south of the sewer line. All of these samples were collected from a depth of 4 feet. Low levels were observed in three isolated areas along the eastern and southern survey boundaries. Significant levels of volatile hydrocarbons were not present at a depth of 9 feet throughout the grassy area in the central portion of the survey area.

The chromatogram signatures of the samples collected on the western side of Rogner Drive are characteristic of **relatively unweathered gasoline**. Early eluting peaks representing the most volatile and mobile gasoline hydrocarbons are observed in the signatures of the samples collected along the sewer line.

Soil gas data support the introduction of gasoline hydrocarbons into the subsurface at the base service station. Chromatographic data suggests that the sewer line may be providing a conduit for vapor migration in this area. The low levels of gasoline hydrocarbons observed along the eastern survey boundary may be the result of revolatilization of hydrocarbons dissolved in the ground water, suggesting that the ground water plume may extend this far. The connection between the source at the base service station and the low levels at the eastern site boundary were

not determined by this survey. Vertical vapor migration may have been impeded in the central portion of the survey area by the clay/silt soils.

## **Introduction**

The U.S. Army Corps of Engineers, Fort Worth District contracted Target Environmental Services, Inc. (TARGET) to conduct a soil gas survey at Site ST-16, Base Service Station, Carswell Air Force Base, Texas. Petroleum products have entered the subsurface at the service station and have impacted the shallow water table aquifer in the vicinity of the station. The purpose of the soil gas survey is to help determine the areal extent of the contaminated ground water plume emanating from the Base Service Station.

The survey was designed to cover the area to the east of the existing service station with a grid spacing of approximately 50 feet between samples. Ground water was determined to be at 10.5 feet below grade in the monitoring wells and soil gas sampling was planned for a depth of 9 feet. The site is bordered on the east by the West Fork of the Trinity River. Additional site information was not provided. The field phase of the soil gas survey was conducted on February 24-26 and March 1, 1993.

## **Sample Collection and Analysis**

Soil gas samples were collected at a total of 86 locations at the site, as shown in Figure 1. The planned sampling depth of 9 feet had to be modified following heavy rains on February 24 and 25. Soft ground and saturated soils then hampered vehicle access to some sampling locations, which were sampled using manual equipment at a depth of 4 feet. Sampling depths are reported in Table 1. Shallow ground water prevented the collection of a sample at location 73. All samples were screened in the field using a Microtip photoionization detector. A detailed explanation of the sampling procedure is provided in Appendix A.

All of the samples collected during the field phase of the survey were analyzed according to EPA Method 602 (modified) on a gas chromatograph equipped with a flame ionization detector (GC/FID), and using direct injection. Analytes selected for standardization were:

- benzene
- toluene
- ethylbenzene
- meta- and para- xylene
- ortho- xylene

These compounds were chosen because of their utility in evaluating the presence of petroleum products such as fuels, lubricating oils, and non-halogenated solvents. An explanation of the laboratory procedures is provided in Appendix B.

The tabulated results of the laboratory analysis of the soil gas samples are reported in micrograms per liter ( $\mu\text{g/l}$ ) in Table 1. Although "micrograms per liter" is equivalent to "parts per billion (v/v)" in water analyses, they are not equivalent in gas analyses, due to the difference in the mass of equal volumes of water and gas matrices. The xylenes concentrations reported in the data table are the sum of the m- and p-xylene and the o-xylene concentrations for each sample.

### **Quality Assurance/Quality Control (QA/QC) Evaluation**

#### **Field QA/QC Samples**

Field control samples were collected at the beginning and end of each day's field activities and after every twentieth soil gas sample. These QA/QC samples were obtained by filtering ambient air through a dust and organic vapor filter cartridge and encapsulating as described in the "Field Procedures" in Appendix A. The laboratory results are reported in Table 1. Concentrations of all analytes were below the reporting limit in all field control samples,

indicating that the QA/QC measures employed were sufficient to prevent cross-contamination of the samples during collection.

### **Laboratory QA/QC Samples**

To document analytical repeatability, a duplicate analysis was performed on every tenth field sample. Laboratory blanks of nitrogen gas were also analyzed after every tenth field sample. The results of these analyses are reported in Table 1. The duplicate analyses were within acceptable limits. Concentrations of all analytes were below the reporting limit in all laboratory blanks.

### **Results**

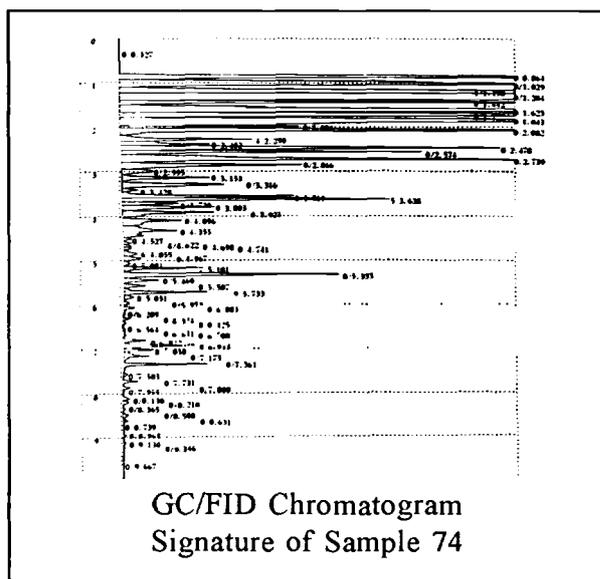
In order to provide graphic presentation of the results, selected individual data sets in Table 1 have been mapped and contoured to produce Figures 2 through 5. Dashed contours are used where patterns are extrapolated into areas of less complete data, or as auxiliary contours. Map sample points with no data shown indicate that the analyte concentrations in the sample were below the reporting limit. An explanation of the terminology used in this report is provided in Appendix C.

The Total FID Volatiles map (Figure 2) reveals high levels along the sewer line east of Rogner Drive. The highest level is present in Sample 80. Moderate levels occur along the western side of Rogner Drive and in Sample 76, collected south of the sewer line. All of these samples were collected from a depth of 4 feet. Low levels are observed in three isolated areas along the northeastern, southeastern and southern survey boundaries. Significant levels of volatile hydrocarbons were not present at a depth of 9 feet throughout the grassy area in the central

portion of the survey area. Volatile hydrocarbons were not present at a depth of 7 feet along the western boundary of the survey area.

Except for a low level of benzene in Sample 91, collected along the northeastern survey boundary, benzene was present only in samples collected along the sewer line and on the western side of Rogner Drive, as shown in Figure 3. The toluene occurrence is mapped in Figure 4. Both benzene and toluene were highest in Sample 80, which had the highest level of Total FID Volatiles. In contrast, ethylbenzene and xylenes were highest in Sample 74, collected on the western side of Rogner Drive, as exemplified by the xylenes map (Figure 5).

### Interpretation

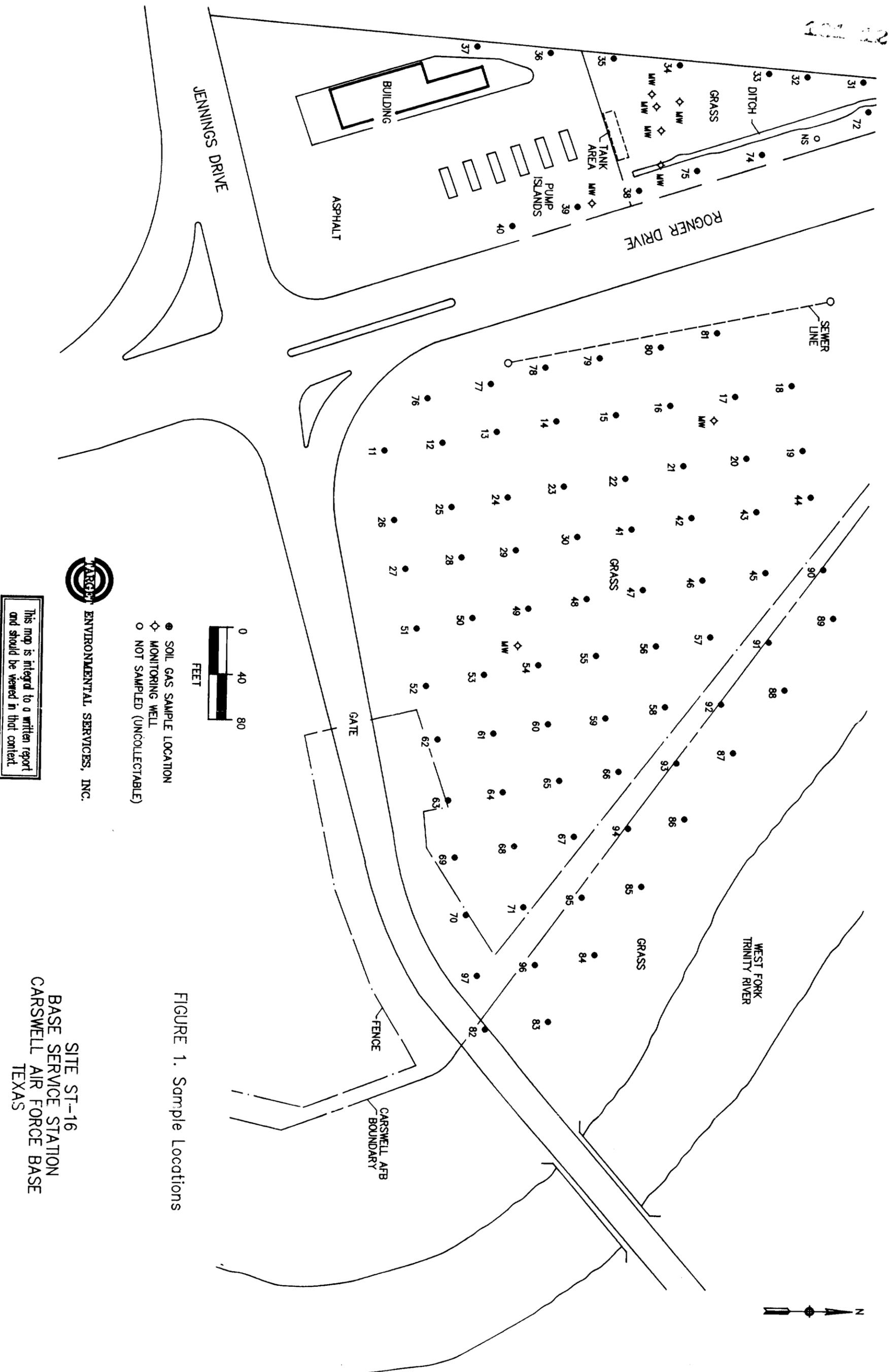


volatile and less soluble than the other analytes, adsorb more readily to the soil particles, and tend to remain nearer to the source. As a result, the xylenes are usually good indicators of source locations. The xylene map patterns are consistent with the expected source at the base service station. Early eluting peaks representing the most volatile and mobile gasoline hydrocarbons are observed in the signatures of the samples collected along the sewer line, as shown by the signature of Sample 80 (previous page, right). This pattern is suggestive of vapor phase migration. It appears that the sewer line may be providing a conduit for migration in this area. Low levels of gasoline hydrocarbons are depicted in the signatures of samples from the eastern survey boundary. The pattern seen in these signatures is sometimes observed when the source of the hydrocarbons is revolatilization of hydrocarbons dissolved in the ground water.

It is interesting to note that except at location 52 from the southern boundary, volatile hydrocarbons were not present at a depth of 9 feet throughout the central portion of the survey area, but low levels did occur at a depth of 4 feet at a few locations along the eastern site boundary. The connection between the source at the base service station and the low levels at the eastern site boundary were not determined by this survey. Vertical vapor migration may have been impeded in this area by the clay/silt soils.

### Conclusions

- ▶ Significant levels of petroleum hydrocarbons are present along the sewer line east of Rogner Drive and along the western side of Rogner Drive.
- ▶ The chromatogram signatures of the samples collected on the western side of Rogner Drive are characteristic of **relatively unweathered gasoline**. The xylene map patterns are consistent with the expected source at the base service station.
- ▶ Chromatographic data suggests that the volatile hydrocarbons observed along the sewer line are the result of vapor phase migration into this area.
- ▶ The low levels of gasoline hydrocarbons observed along the eastern survey boundary may be the result of revolatilization of hydrocarbons dissolved in the ground water, suggesting that the ground water plume may extend to the eastern site boundary.
- ▶ The connection between the source at the base service station and the low levels at the eastern site boundary were not determined by this survey. Vertical vapor migration may have been impeded in the central portion of the survey area by the clay/silt soils.



- SOIL GAS SAMPLE LOCATION
- ◇ MONITORING WELL
- NOT SAMPLED (UNCOLLECTABLE)



This map is intended to a written report and should be viewed in that context.

FIGURE 1. Sample Locations

SITE ST-16  
 BASE SERVICE STATION  
 CARSWELL AIR FORCE BASE  
 TEXAS



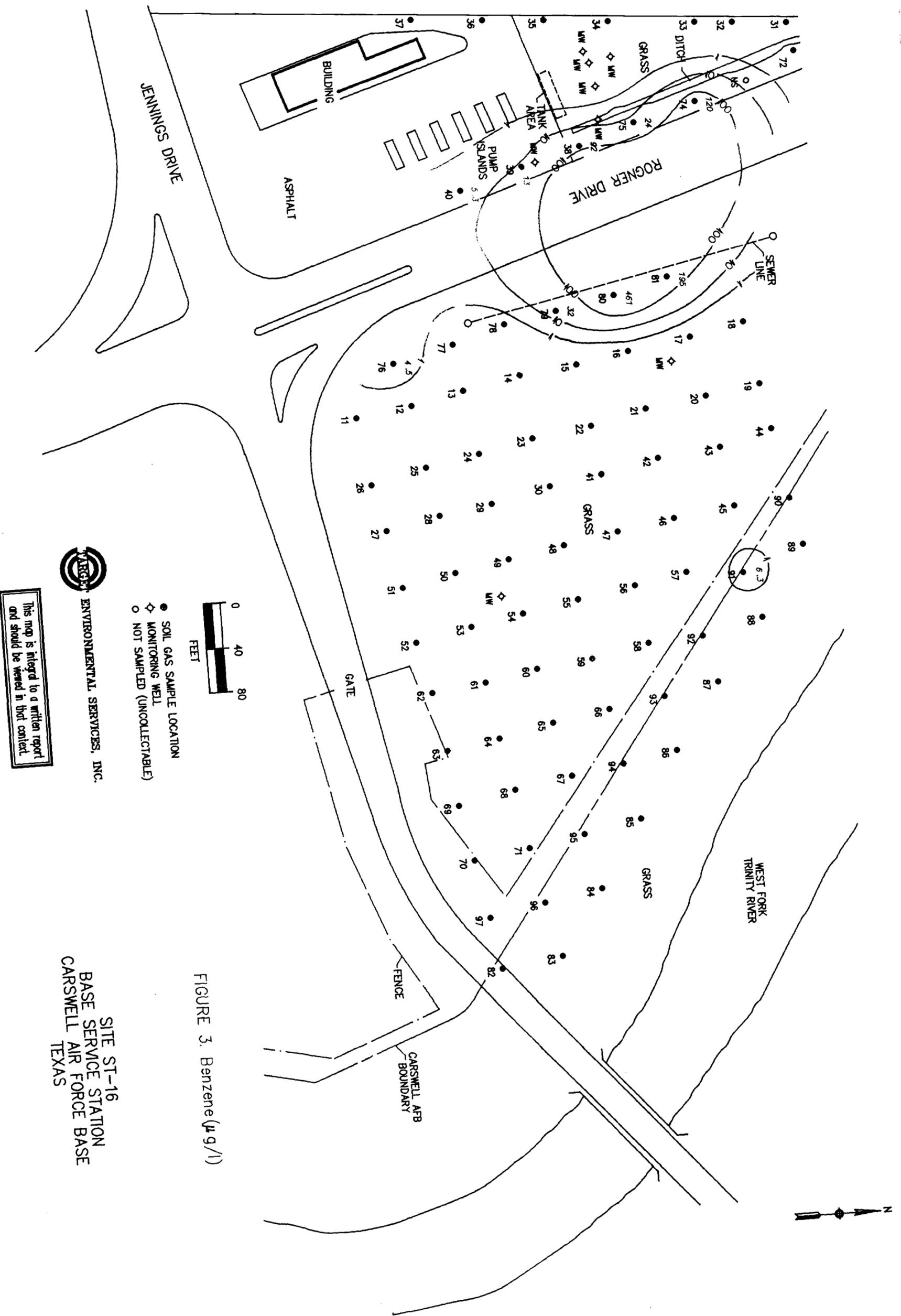


FIGURE 3. Benzene ( $\mu\text{g/l}$ )

This map is integral to a written report and should be viewed in that context.

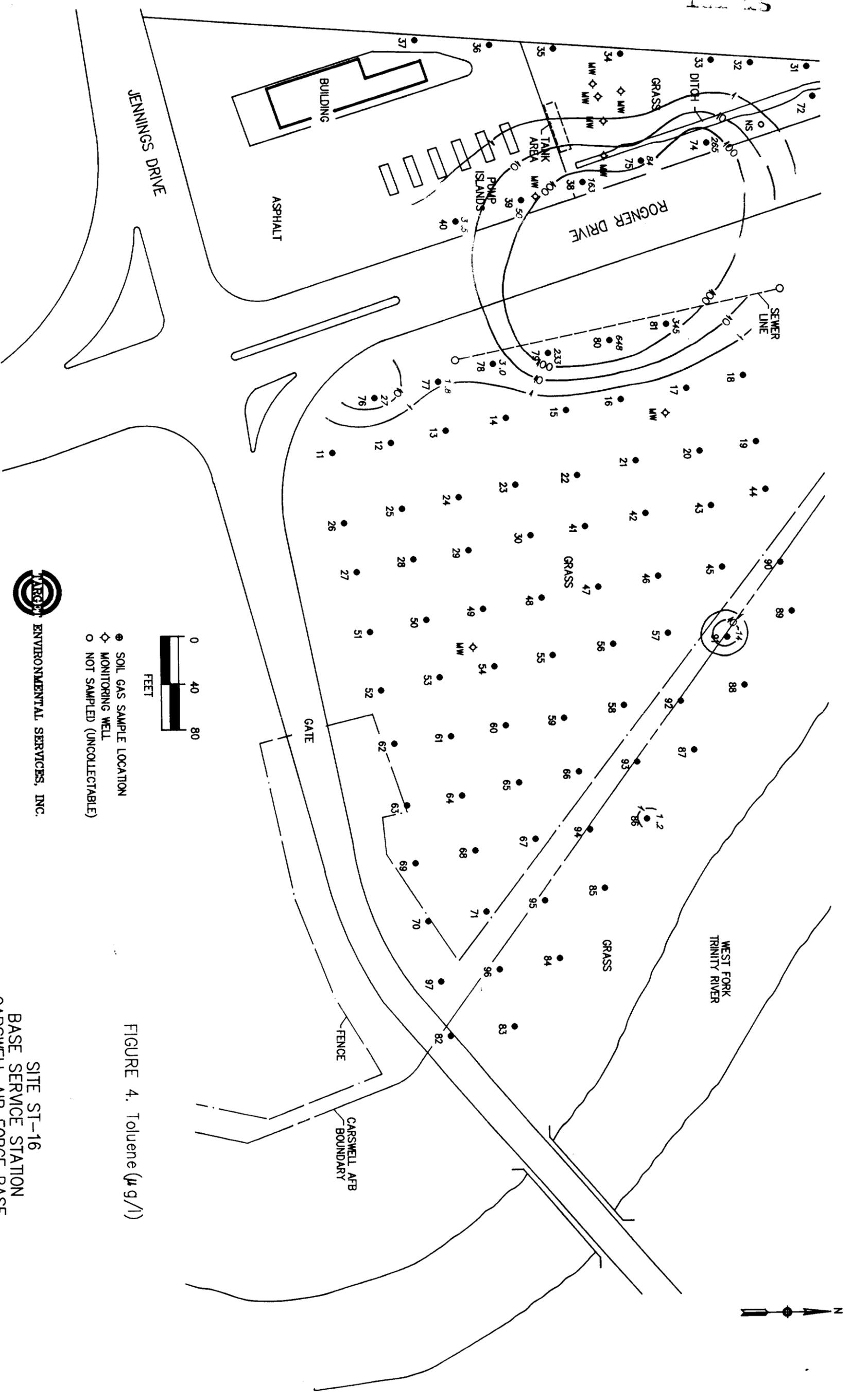


FIGURE 4. Toluene ( $\mu\text{g/l}$ )

SITE ST-16  
BASE SERVICE STATION  
CARSWELL AIR FORCE BASE  
TEXAS



This map is integrated to a written report and should be viewed in that context.



101 27

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	DEPTH (FT.)	BENZENE	TOLUENE	ETHYL- BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT		1.0	1.0	1.0	1.0	10
11	6	<1.0	<1.0	<1.0	<1.0	17
12	6	<1.0	<1.0	<1.0	<1.0	46
13	6	<1.0	<1.0	<1.0	<1.0	<10
14	9	<1.0	<1.0	<1.0	<1.0	<10
15	9	<1.0	<1.0	<1.0	<1.0	<10
16	9	<1.0	<1.0	<1.0	<1.0	<10
17	9	<1.0	<1.0	<1.0	<1.0	<10
18	9	<1.0	<1.0	<1.0	<1.0	<10
19	9	<1.0	<1.0	<1.0	<1.0	<10
20	9	<1.0	<1.0	<1.0	<1.0	<10
21	9	<1.0	<1.0	<1.0	<1.0	<10
22	9	<1.0	<1.0	<1.0	<1.0	<10
23	9	<1.0	<1.0	<1.0	<1.0	<10
24	9	<1.0	<1.0	<1.0	<1.0	<10
25	9	<1.0	<1.0	<1.0	<1.0	<10
26	9	<1.0	<1.0	<1.0	<1.0	<10
27	9	<1.0	<1.0	<1.0	<1.0	<10
28	9	<1.0	<1.0	<1.0	<1.0	<10
29	9	<1.0	<1.0	<1.0	<1.0	<10
30	9	<1.0	<1.0	<1.0	<1.0	<10
31	9	<1.0	<1.0	<1.0	<1.0	<10
32	7	<1.0	<1.0	<1.0	<1.0	<10
33	7	<1.0	<1.0	<1.0	<1.0	<10
34	7	<1.0	<1.0	<1.0	<1.0	<10
35	7	<1.0	<1.0	<1.0	<1.0	<10
36	7	<1.0	<1.0	<1.0	<1.0	<10
37	7	<1.0	<1.0	<1.0	<1.0	<10
38	4	92	163	44	146	2,733
39	4	13	50	13	67	743
40	4	5.3	3.5	2.2	3.3	113
41	9	<1.0	<1.0	<1.0	<1.0	<10
42	9	<1.0	<1.0	<1.0	<1.0	<10
43	9	<1.0	<1.0	<1.0	<1.0	<10
44	9	<1.0	<1.0	<1.0	<1.0	<10
45	9	<1.0	<1.0	<1.0	<1.0	<10

\* CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

## TARGET Project DCBS

TABLE 1 (CONT.)

ANALYTE CONCENTRATIONS VIA GC/FID ( $\mu\text{g/l}$ )

SAMPLE	DEPTH (FT.)	BENZENE	TOLUENE	ETHYL- BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT		1.0	1.0	1.0	1.0	10
46	9	<1.0	<1.0	<1.0	<1.0	<10
47	9	<1.0	<1.0	<1.0	<1.0	<10
48	9	<1.0	<1.0	<1.0	<1.0	<10
49	9	<1.0	<1.0	<1.0	<1.0	<10
50	9	<1.0	<1.0	<1.0	<1.0	<10
51	9	<1.0	<1.0	<1.0	<1.0	<10
52	9	<1.0	<1.0	<1.0	<1.0	27
53	9	<1.0	<1.0	<1.0	<1.0	<10
54	9	<1.0	<1.0	<1.0	<1.0	<10
55	9	<1.0	<1.0	<1.0	<1.0	<10
56	9	<1.0	<1.0	<1.0	<1.0	<10
57	9	<1.0	<1.0	<1.0	<1.0	<10
58	9	<1.0	<1.0	<1.0	<1.0	<10
59	9	<1.0	<1.0	<1.0	<1.0	<10
60	9	<1.0	<1.0	<1.0	<1.0	<10
61	9	<1.0	<1.0	<1.0	<1.0	<10
62	9	<1.0	<1.0	<1.0	<1.0	<10
63	9	<1.0	<1.0	<1.0	<1.0	<10
64	9	<1.0	<1.0	<1.0	<1.0	<10
65	9	<1.0	<1.0	<1.0	<1.0	<10
66	9	<1.0	<1.0	<1.0	<1.0	<10
67	9	<1.0	<1.0	<1.0	<1.0	<10
68	9	<1.0	<1.0	<1.0	<1.0	<10
69	9	<1.0	<1.0	<1.0	<1.0	<10
70	9	<1.0	<1.0	<1.0	<1.0	<10
71	9	<1.0	<1.0	<1.0	<1.0	<10
72	6	<1.0	<1.0	<1.0	<1.0	<10
74	4	120	265	98	484	24,760
75	4	24	84	7.2	43	2,691
76	4	4.5	27	<1.0	3.4	3,592
77	4	<1.0	1.8	<1.0	<1.0	<10
78	4	<1.0	3.0	<1.0	1.4	383
79	4	32	233	1.0	<1.0	28,080
80	4	461	648	5.4	7.0	144,800
81	4	195	345	3.5	4.8	62,610

\* CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

TARGET Project DCBS

TABLE 1 (CONT.)ANALYTE CONCENTRATIONS VIA GC/FID ( $\mu\text{g/l}$ )

<u>SAMPLE</u>	<u>DEPTH (FT.)</u>	<u>BENZENE</u>	<u>TOLUENE</u>	<u>ETHYL- BENZENE</u>	<u>XYLENES</u>	<u>TOTAL FID VOLATILES*</u>
REPORTING LIMIT		1.0	1.0	1.0	1.0	10
82	4	<1.0	<1.0	<1.0	<1.0	47
83	4	<1.0	<1.0	<1.0	<1.0	<10
84	4	<1.0	<1.0	<1.0	<1.0	<10
85	4	<1.0	<1.0	<1.0	<1.0	<10
86	4	<1.0	1.2	<1.0	<1.0	187
87	4	<1.0	<1.0	<1.0	<1.0	<10
88	4	<1.0	<1.0	<1.0	<1.0	<10
89	4	<1.0	<1.0	<1.0	<1.0	<10
90	4	<1.0	<1.0	<1.0	<1.0	<10
91	4	6.3	14	<1.0	<1.0	237
92	4	<1.0	<1.0	<1.0	<1.0	<10
93	4	<1.0	<1.0	<1.0	<1.0	<10
94	4	<1.0	<1.0	<1.0	<1.0	<10
95	4	<1.0	<1.0	<1.0	<1.0	<10
96	4	<1.0	<1.0	<1.0	<1.0	<10
97	4	<1.0	<1.0	<1.0	<1.0	54
<u>FIELD CONTROL SAMPLES</u>						
1		<1.0	<1.0	<1.0	<1.0	<10
2		<1.0	<1.0	<1.0	<1.0	<10
3		<1.0	<1.0	<1.0	<1.0	<10
4		<1.0	<1.0	<1.0	<1.0	<10
5		<1.0	<1.0	<1.0	<1.0	<10
6		<1.0	<1.0	<1.0	<1.0	<10
7		<1.0	<1.0	<1.0	<1.0	<10
8		<1.0	<1.0	<1.0	<1.0	<10
9		<1.0	<1.0	<1.0	<1.0	<10
10		<1.0	<1.0	<1.0	<1.0	<10
<u>LABORATORY DUPLICATE ANALYSIS</u>						
18		<1.0	<1.0	<1.0	<1.0	<10
18R		<1.0	<1.0	<1.0	<1.0	<10
28		<1.0	<1.0	<1.0	<1.0	<10
28R		<1.0	<1.0	<1.0	<1.0	<10

\* CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

TARGET Project DCBS

TABLE 1 (CONT.)

ANALYTE CONCENTRATIONS VIA GC/FID ( $\mu\text{g/l}$ )

SAMPLE	DEPTH (FT.)	BENZENE	TOLUENE	ETHYL- BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT		1.0	1.0	1.0	1.0	10
<b>LABORATORY DUPLICATE ANALYSIS (CONT.)</b>						
34		<1.0	<1.0	<1.0	<1.0	<10
34R		<1.0	<1.0	<1.0	<1.0	<10
44		<1.0	<1.0	<1.0	<1.0	<10
44R		<1.0	<1.0	<1.0	<1.0	<10
55		<1.0	<1.0	<1.0	<1.0	<10
55R		<1.0	<1.0	<1.0	<1.0	<10
65		<1.0	<1.0	<1.0	<1.0	<10
65R		<1.0	<1.0	<1.0	<1.0	<10
78		<1.0	3.0	<1.0	1.4	383
78R		1.1	3.5	<1.0	1.4	399
88		<1.0	<1.0	<1.0	<1.0	<10
88R		<1.0	<1.0	<1.0	<1.0	<10
97		<1.0	<1.0	<1.0	<1.0	54
97R		<1.0	<1.0	<1.0	<1.0	46
<b>LABORATORY BLANKS</b>						
18B		<1.0	<1.0	<1.0	<1.0	<10
28B		<1.0	<1.0	<1.0	<1.0	<10
34B		<1.0	<1.0	<1.0	<1.0	<10
44B		<1.0	<1.0	<1.0	<1.0	<10
55B		<1.0	<1.0	<1.0	<1.0	<10
65B		<1.0	<1.0	<1.0	<1.0	<10
78B		<1.0	<1.0	<1.0	<1.0	<10
88B		<1.0	<1.0	<1.0	<1.0	<10
97B		<1.0	<1.0	<1.0	<1.0	<10

\* CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

## FIELD PROCEDURES

Two sampling procedures were employed. For both methods, the entire sampling system was first purged with ambient air drawn through an organic vapor filter cartridge. In general, deep (>4 foot) samples were collected using a van-mounted hydraulic probe to advance connected 3 foot sections of 1 inch diameter threaded steel casing down to the sampling depth. A teflon line was inserted into the casing to the bottom of the hole, and the bottom-hole line perforations were isolated from the up-hole annulus by an inflatable packer. Shallow samples (4 feet or less) were collected manually using a drive rod to produce a 1/2 inch hole. A stainless steel probe was inserted to the full depth of the hole and sealed off from the atmosphere. Where pavement was present, a rotary hammer was employed for penetration prior to using the drive rod.

Following isolation of the sampling zone, a sample of in-situ soil gas was then withdrawn through the probe or line and used to purge atmospheric air from the sampling system. A second sample of soil gas was withdrawn through the probe and encapsulated in a pre-evacuated glass vial at two atmospheres of pressure (15 psig). The self-sealing vial was detached from the sampling system, packaged, labeled, and stored for laboratory analysis.

Prior to the day's field activities all sampling equipment, slide hammer rods and probes were decontaminated by washing with soapy water and rinsing thoroughly. Internal surfaces were flushed dry using pre-purified nitrogen or filtered ambient air, and external surfaces were wiped clean using clean paper towels.

## LABORATORY PROCEDURES

The analytical equipment was calibrated using a 3-point instrument-response curve and injection of known concentrations of the target analytes. Retention times of the standards were used to identify the peaks in the chromatograms of the field samples, and their response factors were used to calculate the analyte concentrations.

Total FID Volatiles values were generated by summing the areas of all integrated chromatogram peaks and calculated using the instrument response factor for toluene. Injection peaks, which also contain the light hydrocarbon methane, were excluded to avoid the skewing of Total FID Volatiles values due to injection disturbances and biogenic methane. For samples with low hydrocarbon concentrations, the calculated Total FID Volatiles concentration is occasionally lower than the sum of the individual analytes. This is because the response factor used for the Total FID Volatiles calculation is a constant, whereas the individual analyte response factors are compound specific. It is important to understand that the Total FID Volatiles levels reported are relative, not absolute, values.

## DETECTABILITY & TERMINOLOGY

### Detectability

The soil gas survey data presented in this report are the result of precise sampling and measurement of contaminant concentrations in the vadose zone. Analyte detection at a particular location is representative of vapor, dissolved, and/or liquid phase contamination at that location. The presence of detectable levels of target analytes in the vadose zone is dependent upon several factors, including the presence of vapor-phase hydrocarbons or dissolved or liquid concentrations adequate to facilitate volatilization into the unsaturated zone.

### Terminology

In order to prevent misunderstanding of certain terms used in **TARGET's** reports, the following clarifications are offered:

**Analyte** refers to any of the hydrocarbons standardized for quantification in the chromatographic analysis.

**Anomaly** refers to an area where hydrocarbons were measured in excess of what would normally be considered "natural" or "background" levels.

**Elevated and significant** are used to describe concentrations of analytes which indicate the existence of a potential problem in the soil or ground water.

**Feature** is used in reference to a discernible pattern in the contoured data. It denotes a contour form rather than a definite or separate chemical occurrence.

**Indicates** is used when evidence dictates a unique conclusion. **Suggests** is used when several explanations of certain evidence are possible, but one in particular seems more likely. As a result, "indicates" carries a higher degree of confidence in a conclusion than does "suggests."

## APPENDIX C

**Occurrence** is used to indicate an area where chemical compounds are present in sufficient concentrations to be detected by the analysis of soil vapors. The term is not indicative of any specific mode of occurrence (vapor, dissolved, etc.), and does not necessarily indicate or suggest the presence of "free product" or "phase-separated hydrocarbons."

**Reporting Limit** refers to the minimum concentration reported for each analyte.

**Vadose zone** represents the unsaturated zone between the ground water table and the ground surface.

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