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SAMPLING PLAN FOR THE RI/FS FOR THE GROUNDWATER OPERABLE UNITS AT THE CHEMICAL PLANT AREA AND ORDNANCE WORKS AREA, WELDON SPRING, MISSOURI ADDENDUM 3: SOIL GAS SAMPLING AND ANALYSIS FOR TCE AT THE CHEMICAL PLANT AREA

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

JUNE 1997 **REV. 1**

U.S. Department of Energy

Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group

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MK-FERGUSON
A MORRISON KNUDSEN COMPANY

Weldon Spring Site Remedial Action Project
Contract No. DE-AC05-86OR21548

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PLAN TITLE: Sampling Plan for the RI/FS for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri Addendum 3: Soil Gas Sampling and Analysis for TCE at the Chemical Plant Area

APPROVALS

Environmental Documentation Manager	6-23-97 Date
Engineering Manager	6-26-97 Date
Data Administration Manager	6/26/97 Date
Project Quality Manager	06/27/97 Date
Project Director (or Deputy Project Director)	06/30/97 Date

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Weldon Spring Site Remedial Action Project

Sampling Plan for the RI/FS for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri: Addendum 3: Soil Gas Sampling and Analysis for TCE at the Chemical Plant Area

June 1997

Revision 1

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U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

SUMMARY OF CHANGES

Revision 1 of the *Sampling Plan for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri: Addendum 3: Soil Gas Sampling and Analysis for TCE at the Chemical Plant Area* incorporates changes made to the groundwater sampling methods and provides clarification on where groundwater samples can be collected (in the overburden material).

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1. INTRODUCTION

1.1 Purpose and Scope

This addendum describes the soil gas, soil, and groundwater sampling that will be conducted at the Weldon Spring Site Chemical Plant Area (WSCP) and the Weldon Spring Training Area (WSTA). This sampling will be used to try to identify the source of trichloroethylene (TCE) recently detected in the shallow aquifer. Soil gas within the overburden material will be analyzed to help determine if the soils or underlying groundwater are contaminated with TCE. The results of the soil gas analyses will be used to guide soil sampling in the overburden materials. Soil sampling will be used to try to locate a soil source that may be present and may account for the TCE contamination in the groundwater. Groundwater will also be sampled using similar equipment and methods employed by the soil gas technique to define the southwestern and northeastern boundary of TCE contamination.

1.2 Previous Sampling Activities

As part of the remedial investigation for the Weldon Spring Chemical Plant, groundwater, soils, and sludges were collected during 1988 to 1990 and analyzed for volatile organic compounds (VOCs) (Ref. 1). Five groundwater monitoring wells showed low concentrations of TCE ranging from 1.9 to 7.0 µg/1. In the soils, TCE was detected in seven samples taken from two locations in an area between Raffinate Pit 3 and Building 301. TCE concentrations in these samples ranged from 5 µg/kg to 4,800 µg/kg. Sludge samples were collected from the four raffinate pits as part of the remedial investigation. These samples were for volatiles. TCE was detected in one sample from Pit 3 at 23 µg/kg. Other sludge samples were collected in 1990 and 1991 from the southwestern corner of Raffinate Pit 3 for feasibility studies and showed TCE concentrations ranging from 23 µg/kg to 110 µg/kg. Based on these investigations, TCE (and volatiles in general) was deemed not to be a contaminant of concern for soils at the chemical plant due to the infrequency of detection and its low concentrations when detected (Ref. 2).

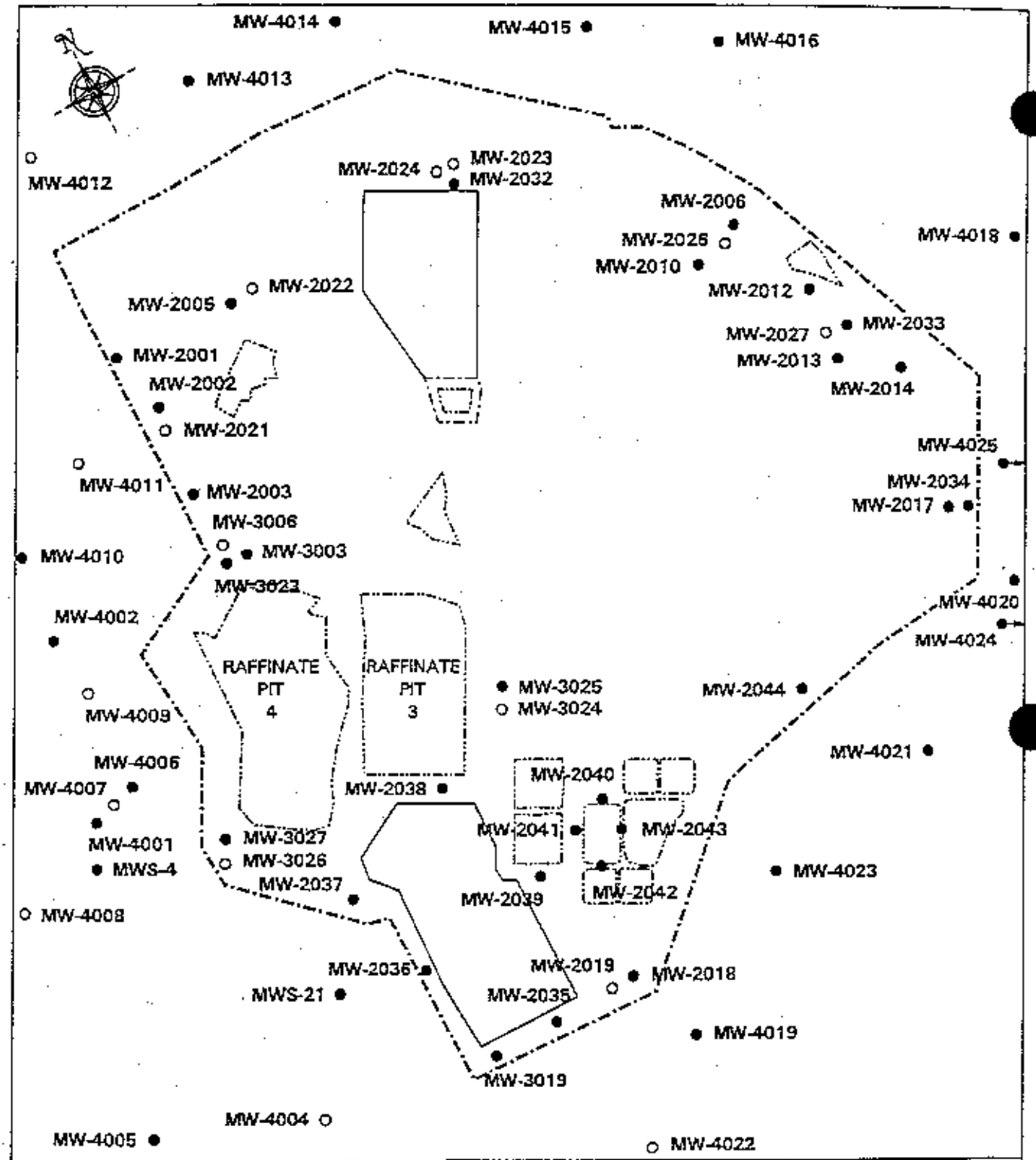
In September of 1995, routine workplace monitoring was conducted at the Chemical Solidification/Stabilization Pilot Plant at the chemical plant area. Hexane gas was detected in the headspace of sludge tanks at a concentration of 200 ppm. As a result, two monitoring wells near

the raffinate pits, MW-2038 and MW-3025 were sampled in April of 1996 for VOCs (Figure 1-1). Hexane was not detected, but trichloroethylene (TCE) was measured at 766 µg/l in monitoring well MW-2038 and at 11 µg/l in MW-3025. Additionally, a breakdown product, 1,2-dichloroethyene (1,2-DCE) was detected in MW-2038 at 22.7 µg/l.

Additional characterization activities were conducted in 1996 and 1997 to define the extent of TCE contamination in groundwater and to define the potential source of TCE. Forty-five monitoring wells were sampled for volatiles in September and October of 1996. TCE was detected in six wells, with a high concentration of 9,000 µg/l in MW-2038. In general, TCE was detected in wells south and southwest of Raffinate Pits 3 and 4. Four springs (Burgermeister Spring [6301] 5303, 5304, 6303) were also sampled during 1996 and 1997, but no TCE or 1,2-DCE was detected at detection limits ranging from 5 µg/l to 10 µg/l.

Soil characterization sampling in the berms of Raffinate Pits 3 and 4 was conducted as part of the Engineering Soil Sampling Plan for Characterization of the Weldon Spring Raffinate Pits (Ref. 3). Soil samples were taken from, at a minimum, the top 12 in. to a maximum of 45 ft of soil, but neither TCE nor 1,2-DCE was detected in any of the 27 samples taken. Sludge samples from Raffinate Pit 3 were also sampled at three depths in each of six locations. No TCE or 1,2-DCE was detected in these samples.

In the summer and fall of 1996, several hundred drums and other debris were removed from the southeastern corner of Raffinate Pit 4 (former PCB drum area). Oil residues found in the drums were collected and analyzed for volatiles using the Toxicity Characteristic Leaching Procedure (TCLP). Concentrations of TCE (2,200 to 280,000 µg/kg) were present in the oil samples. Soils were also sampled in this location to determine if these drums could have been a source to groundwater and if TCE remained in soils within the drum area. No TCE or 1,2-DCE was detected in soil samples. During this soil sampling, perched groundwater at approximately 6 ft to 9 ft was sampled and analyzed, but again, neither TCE nor 1,2-DCE was detected.



GROUNDWATER MONITORING WELL NETWORK
(INCLUDES ARMY WELLS MWS-4 & MWS-21)

FIGURE 1-1

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ORIGINATOR: MT	DRAWN BY: GLN	DATE: 5/27/97	

1.3 Data Quality Objectives

Data quality objectives have been identified to support the development of this sampling plan and to define the needs and uses of the sampling data collected for soil gas, soils, and groundwater.

1.3.1 Statement of the Problem

TCE was found to be elevated in groundwater in the vicinity of Raffinate Pits 3 and 4. The source of TCE at the chemical plant area and training area has not been linked to a specific source area or event. A number of investigations to pinpoint a TCE surface source have been unsuccessful. Groundwater sampling has been limited to the areas where permanent wells are located. Soil samples have been taken in the Raffinate Pit 3 and 4 berms and the former PCB drum area of Raffinate Pit 4. Sludge samples were collected from Raffinate Pit 3.

1.3.2 Identification of the Decision

A soil gas investigation is proposed to provide information on the source of TCE in soils, if one exists, and to determine what the extent of TCE in soils may be. Results of the soil gas sampling and analysis will be used to determine areas where conventional soil sampling will be conducted. The detection of TCE in soil gas will be used to select locations where groundwater samples will be taken northeast and southwest of the raffinate pit area. Groundwater samples will be collected using an in situ groundwater sampling method. The soil and groundwater samples will be analyzed for volatile organic compounds, and this data will be used to determine whether a potential source of TCE contamination can be identified, and to define a northeastern and southwestern boundary of TCE contamination in groundwater.

1.3.3 Inputs to the Decision

Inputs to the decision include soil gas, soil, and groundwater sample analyses for volatiles. Soil gas samples will be collected by geoprobe techniques and analyzed for volatile organics (specifically TCE and 1,2-DCE) utilizing gas chromatography. Soil and groundwater samples will

be collected by geoprobe equipment and analyzed for volatile organic compounds utilizing a gas chromatography/mass spectroscopy methodology.

1.3.4 Definition of the Boundaries of the Study

Sampling for soil gas, soil, and groundwater using the geoprobe method will be limited to the overburden soils around the raffinate pit area and in the extreme eastern portion of the training area.

1.3.5 Development of the Decision Rule

Data on volatile organics obtained from soil gas analyses will be used to assist in defining areas where TCE may be located in the overburden soils. Positive TCE results from soil gas analyses will be used to determine when and where soil and/or groundwater samples need to be collected and analyzed quantitatively.

Concentrations of TCE in soil gas will be reviewed, and a map of the soil gas concentrations will be developed to determine a potential soil source area. Soil samples will be collected at the center of the potential soil source area and possibly in adjacent areas to obtain TCE concentrations in soils. In situ groundwater samples will be collected in areas northeast and southwest of the raffinate pit area. These locations will be selected on the basis of the locations of monitoring wells where detectable concentrations of TCE have been found and where the groundwater is located within the overburden. This information will be used to define the extent of TCE contamination in groundwater.

Soil-gas, soil, and groundwater samples collected will be analyzed off site using quantitative volatile organic analysis methodology. The resulting data will be used to define the potential human health risks associated with TCE contaminated soils.

1.3.6 Developing Uncertainty Constraints

The concentrations of TCE detected in groundwater have ranged from less than 10 μg/l to 9,000 μg/l. Soil gas analyses may range from nondetect (<1 part per billion [ppb]) to several hundred parts per million. Soil gas data can not be directly correlated to soil or groundwater

concentrations of TCE. Therefore, soil gas screening for TCE will be limited to identify areas where TCE may be present in the soil or groundwater. Intrusive sampling will be performed to quantify the soil and/or groundwater TCE concentrations.

It may not be possible to obtain soil gas from the extremely tight overburden materials at the chemical plant area and training area. Sampling at the specified intervals and within the overburden materials where TCE may be located may result in low or no soil gas recovery. As a result, data may yield a false negative condition.

No soil gas recovery is expected at locations where overburden material is saturated. Soil gas samples cannot be obtained at locations where groundwater is in the overburden. This condition also limits the use of soil gas sampling for TCE source identification. Also, groundwater samples cannot be obtained by geoprobe techniques where the groundwater is located within the bedrock. Therefore, sampling will be limited to those areas where groundwater is in the overburden. Therefore, the delineation of TCE in groundwater will be limited.

2. SAMPLING DESIGN

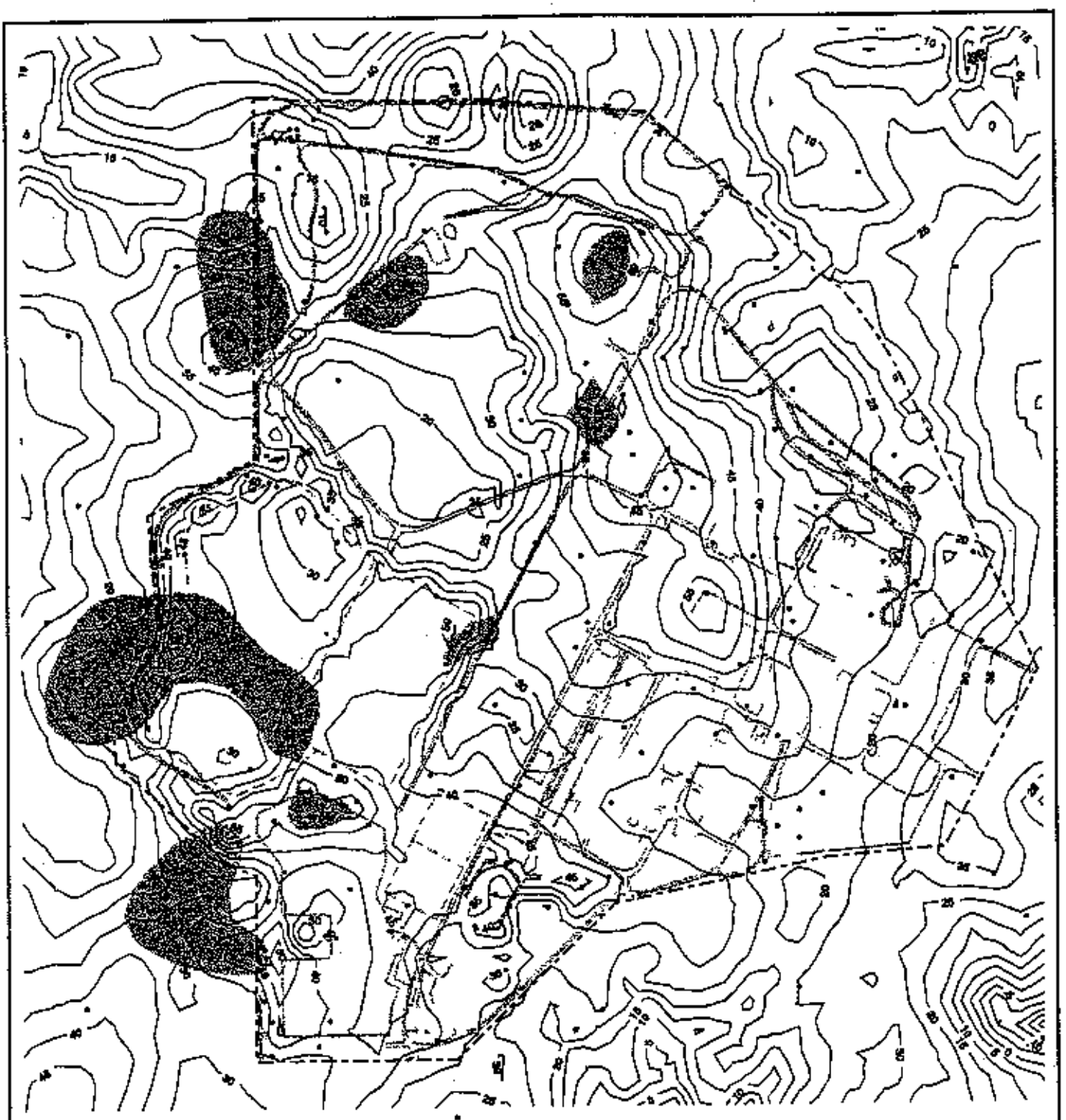
2.1 Hydrostratigraphy

The geology and hydrostratigraphy at the chemical plant and training area provide critical information for the design of the sampling program for this investigation.

Groundwater monitoring is conducted within the shallow aquifer system in the saturated overburden and the Burlington-Keokuk Limestone at the Weldon Spring Chemical Plant (WSCP) and Weldon Spring Training Area (WSTA). The Burlington-Keokuk aquifer has been divided into two hydrostratigraphic units on the basis of the degree of weathering in each unit. These two units are termed the weathered Burlington-Keokuk (upper portion of unit) and the unweathered Burlington-Keokuk (lower portion of unit). The contact between the two is gradational. The weathered unit occurs throughout the WSCP and WSTA, and the thickness of this unit varies between 0 and 50 ft. There is an increase in the hydraulic conductivity measured within the weathered unit as compared to the unweathered unit which results in a preferential horizontal flow of groundwater. TCE has been detected only in groundwater monitoring wells completed in the weathered unit and in the overburden units.

Figure 2-1 shows the depth to top of bedrock at the study area. This information will be used to target areas for soil gas analysis where bedrock lows or paleochannels have been identified. These lows are suspected to be the main areas where TCE contamination might be found due to known preferential flow in these areas. Additionally, the schematic of the groundwater surface to bedrock topography will be used to show those areas where saturated overburden may be encountered and those areas where the groundwater is in the bedrock (Figure 2-2). In the later cases, there will be either low or no recovery of soil gas, and therefore, soil gas and TCE contaminant information may not be obtained.

A stratigraphic column of the overburden and bedrock units at the Weldon Spring Chemical Plant Area is shown in Figure 2-3. The overburden materials include fill, loess,



LEGEND

- Modeled Depth To Bedrock Surface Contour (feet)
- Chemical Plant Boundary
- Borehole Location

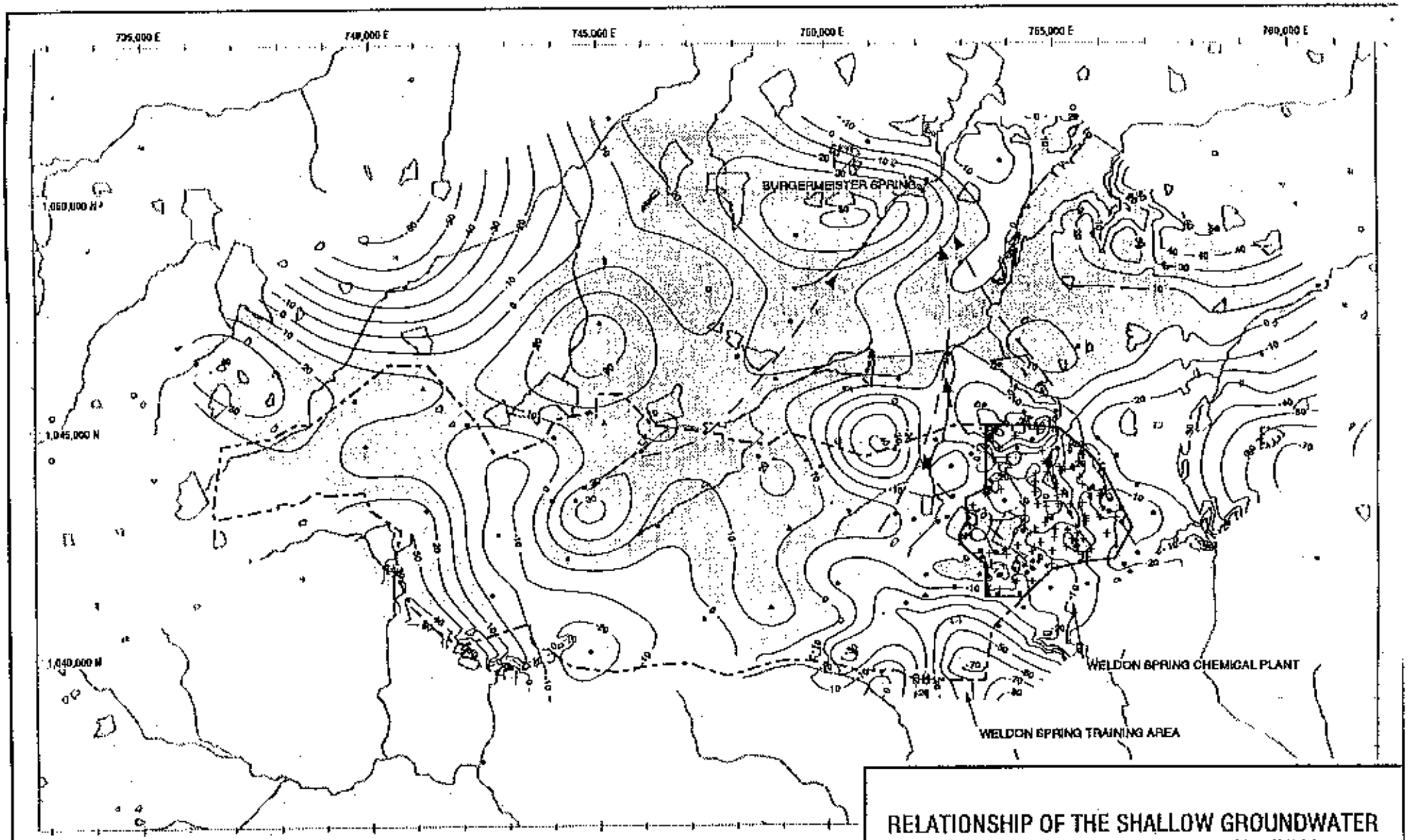
Note: Shaded area is where groundwater is above bedrock (Measured July 1995).

500 250 0 500 FEET

DEPTH TO BEDROCK

Figure 2-1

REPORT NO.: DOE/OR/21548-445-3	EXHIBIT NO.:	
ORIGINATOR: JR	DRAWN BY: CLC	DATE: 05/30/97



500 250 0 500 METERS

500 0 1000 2000 3000 4000 FEET

NOTE: This map is constructed from the shallow groundwater surface (Fig. 3-16) and the bedrock topography (Fig. 3-5). Map coverage is limited to the geographic extent of these surfaces.

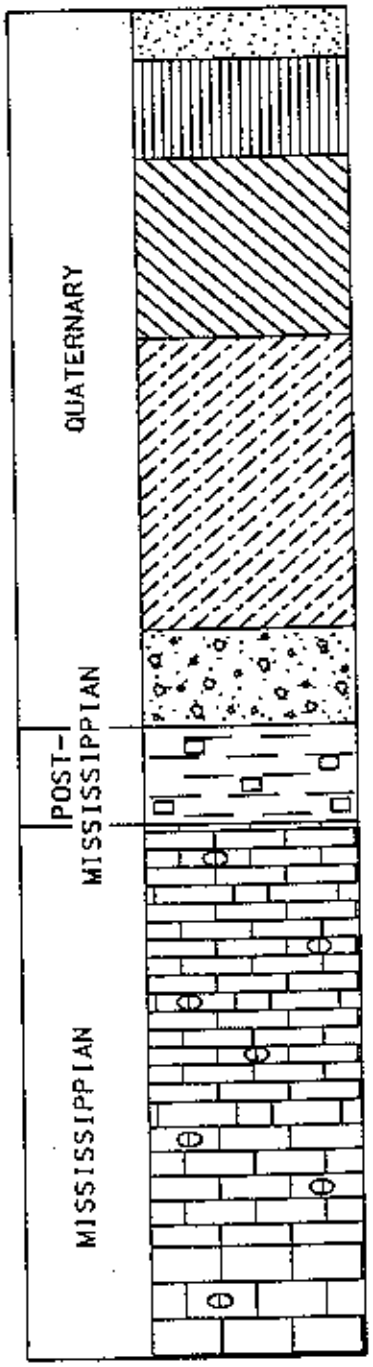
Legend

- Depth of Groundwater ABOVE or BELOW Bedrock in Feet
- Chemical Plant Boundary
- WSTA Boundary
- Spring
- Monitoring Well
- Domestic Well
- Trenches
- Analytical/Geotechnical
- Area [illegible] Groundwater Abo[illegible]ck

RELATIONSHIP OF THE SHALLOW GROUNDWATER SURFACE TO THE TOP OF BEDROCK - JULY 1995

FIGURE 2-2

REPORT NO: DOE/OR/21548-445-3	EXHIBIT NO.: A/[illegible]014/0597		
ORIGINATOR: JD	DRAWN BY: SRS	DATE: 5/22/97	



STRATIGRAPHIC UNIT & HYDRAULIC CONDUCTIVITY (K)	LITHOLOGY	THICKNESS (FT.)
TOPSOIL/FILL	SILT, SAND, GRAVEL	0-30
LOESS (INCLUDING ROXANA SILT) 10^{-6} cm/s	SILTY CLAY TO SILT	0-11
FERRELVIEW FORMATION 8.9×10^{-6} cm/s	CLAY TO SILTY CLAY	0-22
CLAY TILL 7.6×10^{-6} cm/s	SANDY SILTY CLAY TO CLAYEY SILT WITH MINOR GRAVEL	0-47
BASAL TILL 3.8×10^{-6} cm/s	SANDY, CLAYEY, SILTY GRAVEL OR GRAVELLY SILT	0-10
RESIDUUM 4.2×10^{-4} cm/s TO 1.1×10^{-7} cm/s	GRAVELLY CLAY TO CLAYEY GRAVEL	0-38
WEATHERED BURLINGTON-KEOKUK LIMESTONE 10^{-2} to 10^{-5} cm/s (10^{-6} TO 10^{-8} IN LOWER WEATHERED)	LIMESTONE, ARGILLACEOUS, CHERTY, POROUS, VUGGY, FRACTURED	0-113
UNWEATHERED BURLINGTON-KEOKUK LIMESTONE 10^{-5} to 10^{-7} cm/s	LIMESTONE-CHERTY, STYLOLITIC, LOCALLY DOLLOMITE & SILTSTONE	0-113
FERN GLEN LIMESTONE	LIMESTONE TO DOLOMITIC LIMESTONE, SLIGHTLY ARGILLACEOUS	0-67

STRATIGRAPHIC COLUMN OF OVERBURDEN MATERIALS IN THE WELDON SPRINGS AREA

FIGURE 2-3

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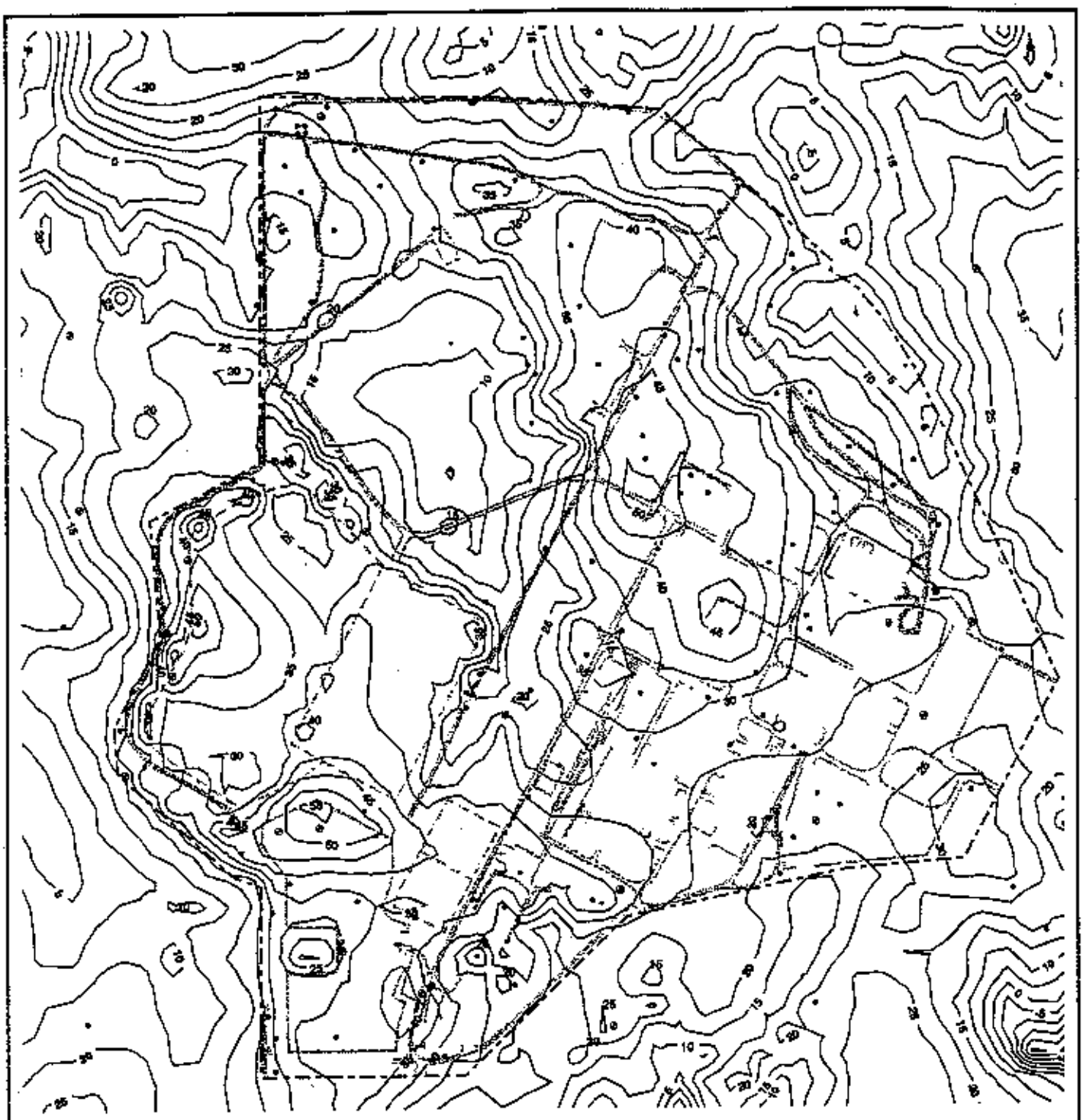
the Ferrelview formation, clay till, basal till, and residuum units. The permeability of the Ferrelview and clay till units is extremely low, ranging from approximately 7.6×10^{-8} cm/s to 8.4×10^{-8} cm/sec (Figure 2-3). Because of the tightness of these soil units and the lack of near-surface TCE soil contamination found to date, it has been suggested that the migration pathway that TCE traveled to reach the groundwater is isolated. If this is the case, the limited source area may now be primarily depleted and not currently contributing TCE to the groundwater. However, residual contamination may also persist, possibly in a more permeable zone along the pathway such as exists at the base of the residuum/top of bedrock. This situation may contribute TCE to the groundwater via percolating meteoric waters or through seasonal fluctuations in the groundwater surface.

Figure 2-4, a map of the depth to top of residuum, and Figure 2-1, the map of the depth to bedrock (or groundwater), will be used to pinpoint the locations and depths where the residuum and bedrock are present and for selection of soil gas sample depth locations.

2.2 Sampling Locations and Methods

2.2.1 Soil Gas

Approximately 34 locations have been targeted for soil gas analysis (Figure 2-5). The locations were selected nearest to the groundwater monitoring wells where elevated TCE concentrations have been reported and in areas where bedrock lows may occur. The maximum concentrations of TCE were found at monitoring wells MW-2037 and MW-2038. The proposed strategy is to begin sampling at this center of the TCE plume (MW-2037) and select locations north, south, east, and west of the center at 300 ft intervals. To avoid surface structures such as the raffinate pits and storage areas, locations were selected on the basis of accessibility. Final sampling locations will be determined by the field team.



LEGEND

- Modeled Depth To Top Of Residuum Contour (feet)
- Chemical Plant Boundary
- Borehole Location w/ Positive Residuum Thickness
- Borehole Location w/ Zero Residuum Thickness

500 250 0 500 FEET

DEPTH TO TOP OF RESIDUUM

Figure 2-4

REPORT NO.: DOE/OR/21548-445-3	EXHIBIT NO.:	
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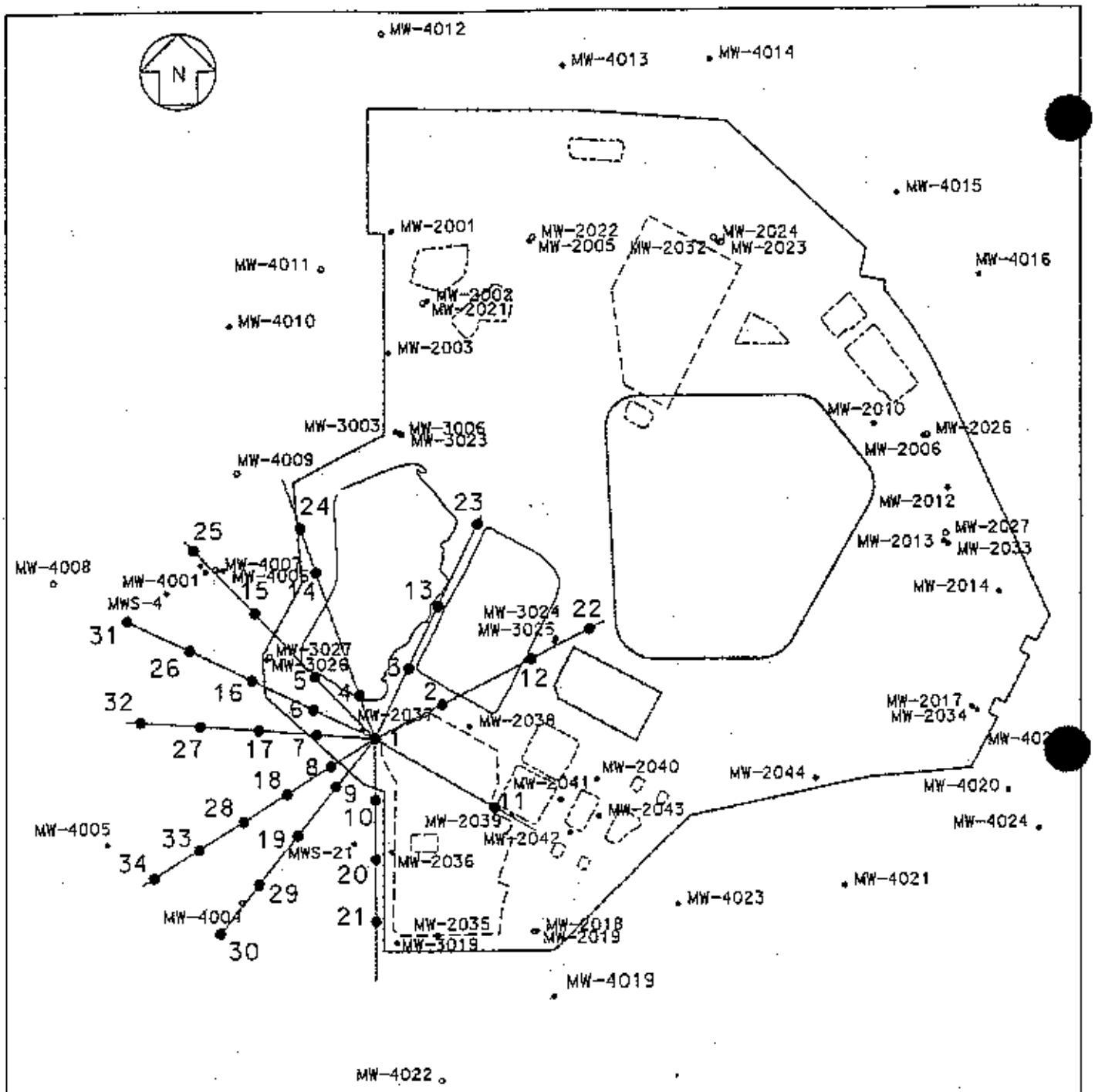

LEGEND

● SAMPLING LOCATION

MONITORING WELLS

• WEATHERED ZONE

∘ UNWEATHERED ZONE

0 700

SCALE FEET

SAMPLING LOCATIONS FOR SOIL GAS ANALYSIS

FIGURE 2-5

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ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/14/97	

Some sample locations will be selected on the basis of an increase or decrease in soil gas TCE concentrations found at previously sampled locations.. If concentrations decrease to undetected levels between 300 ft sample locations, additional locations may be established at 100 and 200 ft or smaller intervals between the two locations as deemed appropriate.

At each sample location, a soil gas sample will be taken at the clay till/residuum contact and the bedrock/residuum contact. A map of the depth of bedrock and depth to the residuum (Figure 2-1 and 2-4) has been prepared to assist in determining depths to residuum for this sampling event. The geoprobe will first be lowered to the clay till/residuum interface and a sample will be collected. The geoprobe tool will then be advanced to the residuum/bedrock interface and a second sample will be taken. An attempt will be made to collect a minimum of two samples at each location. However, if the sample location occurs within the saturated overburden, no sample will be collected since soil gas cannot be recovered in saturated soils. It may not be possible to obtain soil gas from the extremely tight overburden material. The subcontractor and field geologists will determine gas flow volumes using vacuum gauges and will determine if a representative soil gas sample can be collected. Additionally, tip resistance measurements may be made to assist in determining overburden stratigraphy. If concentrations of TCE are elevated at the two depths sampled, and soil gas recovery is adequate, additional samples may be taken in the upper clay till unit.

A geoprobe sampling tool will be used to sample soil gas by penetrating into the overburden soils at each sample location. The stainless steel geoprobe tool will be used with an expendable drive point attached to a probe rod. The point will be driven into the ground using a hydraulic powered drive unit mounted to a van or 4 x 4 mule vehicle. Once the desired depth has been reached, an inner tubing system will be inserted. The estimated sampling depths are approximately 30 ft to 45 ft. The sample will be drawn through the driver point, through the probe, and into the sample tubing. Samples will be collected in 1 liter Tedlar bags marked with the appropriate identification numbers and analyzed at an off-site laboratory. The volume of each sample should be between 500 and 700 ml of gas, although a minimum of 200 ml is required to perform volatile analysis. The Tedlar bags should not be filled to capacity. Sample tubing will be replaced after each sample. If subsurface conditions prevent advancement of the probe to the desired depth at any location, the hole may be abandoned and a replacement hole may be attempted. If difficulties persist, a 4.25 in. solid stem auger may be used to drill a pilot hole to near the target sampling depth. This will ease penetration of the geoprobe.

Soil gas samples will be identified using the protocol, SG-397001-01, where SG stands for soil gas sample, 3 is the raffinate pit area, 97 is the year sampled, 001 is a three digit sample location identified within the raffinate pit area, and 01 is the shallowest sample depth obtained. Sample locations are identified in Table 2-1 and on Figure 2-5. At a minimum, soil gas will be analyzed at two elevations (depths) above bedrock. 01 will indicate that the sample was taken at approximately the clay till/residuum interface, and 02 that the sample was taken at the residuum/bedrock contact. Additional samples and their depths will be identified by successional numbers 03, 04, etc., and depths will be recorded on the field data forms.

Field data will be recorded on the Soil Gas Field form illustrated in Appendix A. Data recorded will include the sample location, sample identification number, date sampled, depth sampled, analysis requested, soil type defined for the depth, and other pertinent information such as probe refusal or encountering perched water or groundwater at a specific depth.

Soil gas samples will be analyzed using gas chromatography-flame ionization detector (GC-FID) methodology or gas chromatography mass spectrometry (GC/MS) methodology. Detection limits will be 1.0 μg/l of air for the GC/MS methodology and 2.0 mg/l for the GC-FID methodology. The GC-FID methodology will be used if the volume of gas recovered is less than 200 liters of air.

2.2.2 Soil Samples

The soil gas data will be used to plot a map of the TCE gas contaminant plume. A soil sample will be collected at the location and depth where the highest soil gas concentration is found. Additional soil samples may be collected if soil gas data indicate several high concentrations or anomalously high soil gas concentrations.

Soil samples will be collected using the geoprobe tool with a large bore sampler. Samples of approximately 80 gms will be collected from each depth or location selected for sampling. Field data will be recorded on the field data form in accordance with procedure ES&H 4.4.5, *Soil Sampling*. Soil samples will be collected into a stainless steel or Teflon sleeve used in the large bore sampler. Samples will be capped with no headspace remaining, kept cool at 4° Celsius, and shipped to an off-site laboratory for analysis of volatiles by U.S. Environmental Protection Agency Contract Laboratory Program (CLP) methodology.

Soil samples will be identified using the protocol, SO-397001-01, where SO stands for soil sample, 3 is the raffinate pit area, 97 is the year sampled, 001 is a three digit sample location (Figure 2-6), and 01 or 02 is the depth where sample was taken.

Table 2-1 Soil Gas Sampling Locations and Identification Numbers

Sample Location (Figure 2-6)	Sample Identification	Approximate Northing Coordinate	Approximate Easting Coordinate
1	SG-397001	1042210.93	753396.99
2	SG-397002	1042369.90	753718.46
3	SG-397003	1042540.89	753559.04
4	SG-397004	1042415.66	753322.79
5	SG-397005	1042503.77	753111.47
6	SG-397006	1042348.97	753104.98
7	SG-397007	1042231.52	753121.76
8	SG-397008	1042080.71	753189.46
9	SG-397009	1041985.32	753212.62
10	SG-397010	1041920.77	753399.07
11	SG-397011	1041884.42	753966.88
12	SG-397012	1042579.14	754141.57
13	SG-397013	1042827.16	753699.62
14	SG-397014	1042984.39	753116.69
15	SG-397015	1042796.61	752825.94
16	SG-397016	1042487.02	752812.96
17	SG-397017	1042252.11	752846.53
18	SG-397018	1041950.49	752981.94
19	SG-397019	1041755.23	753031.76
20	SG-397020	1041643.02	753401.01
21	SG-397021	1041354.20	753403.14
22	SG-397022	1042714.77	754415.85
23	SG-397023	1043207.66	753886.49
24	SG-397024	1043191.06	753041.79
25	SG-397025	1043089.45	752540.42
26	SG-397026	1042625.07	752520.95
27	SG-397027	1042272.70	752571.30
28	SG-397028	1041820.26	752774.41
29	SG-397029	1041527.38	752849.14
30	SG-397030	1041299.53	752666.52
31	SG-397031	1042763.11	752228.93
32	SG-379032	1042293.29	752296.07

Table 2-1 Soil Gas Sampling Locations and Identification Numbers

Sample Location (Figure 2-6)	Sample Identification	Approximate Northing Coordinate	Approximate Easting Coordinate
33	SG-379033	1041690.04	752566.88
34	SG-379034	1041559.82	752359.35

2.2.3 Groundwater Samples

At selected locations, the geoprobe tube will be used to sample groundwater so that the extent of TCE can be better defined. Groundwater samples will be taken in the northeast axes and in the southwestern axes labeled in Figure 2-6 as A, G, H, and I. Along these axes, a minimum of nine locations will be sampled (identified as 12, 22, 33, 34, 19, 29, 30, 20, and 21 in Figure 2-6). These locations have been selected on the basis of the locations of monitoring wells where detected concentrations of TCE have been found and where no definite boundary of TCE contamination in groundwater exists. Groundwater will be sampled from the first water encountered. These samples will be collected using a microbailer method with an inner tube inserted into the geoprobe, which will draw the sample up into a sample container.

Groundwater samples will be transferred into two sets of two 40 ml glass vials (four vials total) and filled so that no headspace remains. The samples will be preserved with 2 drops of hydrochloric acid (to a pH of < 2) and prepared for shipment to an off-site laboratory for analysis. The samples will be analyzed for Volatiles by EPA CLP and volatiles by the gas chromatography method for TCE to obtain a lower detection limit. If it is not possible to obtain 160 ml of water in a sample, the first priority should be to analyze the sample for volatiles using gas chromatography.

Groundwater samples will be identified as in situ groundwater samples using the protocol, IS-3012-053097. The IS prefix indicates an in situ sample, "3" indicates the raffinate pit area, "012" indicates the sample location identified in Figure 2-6; and "053097" is the date the sample was taken (month, date, and year). Field data will be recorded in accordance with Procedure ES&H 4.4.1, *Groundwater Sampling*.

3. Quality Control

3.1 Quality Control Samples

Quality control samples will be collected on a frequency of one per 20 samples and in accordance with WSSRAP procedure ES&H 4.1.4, *Quality Control Samples for Aqueous and Solid Matrices: Definitions, Identification Codes, and Collection Procedures*. Quality control samples for this task will include equipment blanks, trip blanks, field duplicate samples, matrix spikes, and matrix spike duplicates for soil and groundwater. Soil-gas samples will have field duplicate samples only. Trip blanks will be included for every off-site laboratory shipment of samples.

3.2 Chain of Custody

Chain-of-custody forms will be prepared for shipment of samples to the off-site analytical laboratory and placed in the sample coolers. Sample coolers prepared for shipment will be sealed with chain-of-custody control seals that are signed and dated by the shipper. Chain-of-custody forms and seals will be prepared in accordance with WSSRAP Procedure ES&H 4.1.2, *Initiation, Generation, and Transfer of Environmental Chain of Custody*.

3.3 Equipment Decontamination

Sampling equipment and tools used to collect or transfer samples will be cleaned and decontaminated between samples. Decontamination will be performed in accordance with WSSRAP procedure ES&H 4.1.3, *Sampling Equipment Decontamination*.

3.4 Data Verification, Review, and Validation

All off-site analytical results for soil and groundwater samples will be reviewed in accordance with ES&H 4.9.1, *Environmental Monitoring Data Verification*. The data verification process consists of a preliminary review of the quality impacting aspects of sampling,

analysis, and reporting. This review also assists in identifying analytical problems with data or unusual concentrations that may require further action. Data review will be performed to determine whether the quality control samples from each matrix and internal laboratory are acceptable.

The data validation process is described in Procedure ES&H 4.9.2, *Environmental Monitoring Data Validation*. Data validation consists of two primary functions: review of the analytical process, and assessment of the data quality. The analytical process consists of reviewing all records related to sample integrity, preparation, and the analytical measurement system, and comparing data to method-specific and site-specific data requirements.

3.5 Sample Event Closure Report

In accordance with the *Sample Management Guide* (Ref. 4), a Sample Event Closure Report will be prepared for the soil gas characterization effort. This report will detail actual sample collection locations, depths, coordinates, instrumentation, and analysis. A closure report is required to document actual field activities and document any modifications to the sample plan that may have occurred (e.g., samples not collected or locations offset due to field conditions, limited analysis due to sample volume problems). The report will also provide both field sample and quality control sample results.

4. REFERENCES

1. MK-Ferguson Company and Jacobs Engineering Group. *Remedial Investigation for the Chemical Plant Area of the Weldon Spring Site*, Rev. 0, 2 Vols. DOE/OR/21548-074. Prepared for the U.S. Department of Energy, Oak Ridge Field Office, Weldon Spring Site Remedial Action Project. St. Charles, MO. November 1992.

2. U. S. Department of Energy. *Baseline Assessment for the Chemical Plant Area of the Weldon Spring Site*. DOE/OR/21548-091. Prepared with technical assistance from Environmental Assessment and Information Sciences Division, Argonne National Laboratory. November 1992.

3. MK-Ferguson Company and Jacobs Engineering Group. *Engineering Soil Sampling Plan for Characterization of the Weldon Spring Raffinate Pits: Addendum 1: Volatiles Sampling; Engineering Soil Sampling Plan for Characterization of the Weldon Spring Raffinate Pits*. Rev. 1. DOE/OR/21548-653. Prepared for the U. S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. November 1996.

4. MK-Ferguson Company and Jacobs Engineering Group. *Sample Management Guide*. Rev. 0. DOE/OR/21548-499. Prepared for the U. S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. March 1995.

PROCEDURES

ES&H 4.1.2, *Initiation, Generation, and Transfer of Environmental Chain of Custody*

ES&H 4.1.3, *Sampling Equipment Decontamination*

ES&H 4.1.4, *Quality Control Samples for Aqueous and Solid Matrices: Definitions, Identification Codes, and Collection Procedures*

ES&H 4.4.1, *Groundwater Sampling*

ES&H 4.4.5, *Soil Sampling*

ES&H 4.9.1, *Environmental Monitoring Data Verification*

ES&H 4.9.2, *Environmental Monitoring Data Validation*

Appendix A
Soil Gas Sampling Form

Weldon Spring Site Remedial Action Project
Soil Gas Sample Form

Identification Number _____

Location: _____

Location Description: _____

Date: _____ Volume of Air Recovered: _____

Depth: _____ Soil Gas Concentration: _____

Soil Type Encountered: _____
(Clay Till, Basal Till, Residuum Ferrelview)

Analysis Performed: _____

Comments: _____

Corresponding GW Sample ID: _____

Corresponding Soil Sample ID: _____

Signature _____ Date _____