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Soil Vapor Extraction Testing of Selected Wells In the Northern Sector of A-Area

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DISCLAIMER

Soil Vapor Extraction Testing of Selected Wells

In the Northern Sector of A-Area

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Table Of Contents

List of Figures

List of Tables

LIST OF ACRONYMS

B&K	Brüel & Kjær
CVOC	Chlorinated volatile organic compound
ECD	Electron capture detector
FID	Flame ionization detector
GC	Gas chromatograph
HP	Hewlett Packard
LFG&E	Landfill Gas and Environmental Products, Inc.
PCE	Perchloroethylene
ppmv	part per million by volume
RTV	room temperature vulcanization
scfm	standard cubic feet per minute
STP	standard temperature and pressure
SRS	Savannah River Site
SRL	Savannah River Laboratory
SRTC	Savannah River Technology Center
SVE	Soil vapor extraction
SVEU	Soil vapor extraction unit
TCE	Trichloroethylene
WSRC	Westinghouse Savannah River Company

1.0 Executive Summary

The A/M-Area is located in the northern section of the Savannah River Site (SRS) and consists of facilities that fabricated reactor fuel and target assemblies for the SRS reactors (M-Area), laboratory facilities (SRTC, formally SRL), and administrative and support facilities (A-Area). Operations at these and other facilities within the A/M Area resulted in the release of chlorinated volatile organic compounds (CVOC) to the subsurface. Significant CVOC contamination has been detected in the groundwater in the Northern Sector of the SRTC complex. This contamination has resulted from past uses and disposal of organic solvents in several SRTC facilities (Colven et al.,1988). Waste solvents from degreasers and other SRTC operations facilities were discharged to the A-001 outfall via unlined earthen ditches and an underground process sewer.

CVOC contamination detected in water table wells in the Northern Sector of SRTC indicates that solvents discharged to the unlined ditches have seeped through the vadose zone and into the shallow groundwater. The purpose of this testing was to determine if a vadose zone source for the contamination remains and to begin collecting data to assist with determining the location of any significant source.

Vadose zone pumping tests were performed on water table monitoring wells MSB 47D, MSB 67D, and MSB 68D. These wells are located within the aqueous phase plume based on solvent concentrations measured in these wells as part of the SRS Groundwater Monitoring Program. Wells MSB 67D and MSB 68D produced soil vapor contaminated with CVOCs. MSB 47D, which exhibited the lowest aqueous phase solvent concentrations of the three wells, did not produce contaminated soil vapor. MSB 67D was pumped for a period of 10.76 days at a flow rate of 12.6 scfm and produced a total of 0.17 pounds of trichloroethylene. Two pumping tests were performed on MSB 68D. For the first test, MSB 68D was pumped for a period of 4.68 days at a flow rate of 32.3 scfm and produced 1.31 pounds of trichloroethylene. For the second test, MSB 68D was pumped for a period of 5.84 days at a flow rate of 38.6 scfm and produced 2.28 pounds of trichloroethylene.

The results of this testing indicate that there is CVOC contamination in the vadose zone of the Northern Sector; however, the results are inconclusive as to the location of the source for the contamination. Based on the CVOC concentrations observed in the groundwater for the three wells tested compared to the CVOC concentrations observed in the soil vapor from each well, none of the three wells are located in the most contaminated portion of the vadose zone plume. MSB 68D appears to be closest to a contaminated area. Future investigations should be focused upon the area surrounding MSB 68D to determine the source and extent of the vadose zone contamination.

A Hantush-Jacob leaky aquifer model was used to describe the vadose zone in the Northern Sector in an effort to estimate the permeability of the unsaturated sediments. The transmissivity of the unsaturated sediments was estimated to be 0.96 ft^2/min. The radial permeability of the sediments (k_r) was estimated to be on the order of 100 darcies, which is within the range previously measured for the central portion of A/M Area (Looney et al., 1991). Leakage values produced by the model simulations were found to be extremely small. This suggests that gas flow in this vadose zone system is similar to water flow in a confined aquifer with a competent confining layer preventing leakage from the overlying sediments.

2.0 Background

The A/M-Area is located in the northern section of the Savannah River Site (SRS) and consists of facilities that fabricated reactor fuel and target assemblies for the SRS reactors (M-Area), laboratory facilities (SRTC, formally SRL), and administrative and support facilities (A-Area). Operations at these and other facilities within the A/M Area resulted in the release of chlorinated volatile organic compounds (CVOC), primarily trichloroethylene (TCE), perchloroethylene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA) to the subsurface (Marine and Bledsoe, 1984). These releases have resulted in the contamination of the soil and groundwater within the area.

Significant CVOC contamination has been detected in the groundwater in the Northern Sector of the SRTC complex. This contamination has resulted from past uses and disposal of organic solvents in several SRTC facilities (Colven et al.,1988). Waste solvents from degreasers and other SRTC operations facilities were discharged to the A-001 outfall via unlined earthen ditches and an underground process sewer. Seepage of solvents from the unlined ditches has resulted in the contamination of both the vadose zone and the groundwater in the Northern Sector of SRTC.

CVOC contamination has been detected in well clusters MSB 47, MSB 67, and MSB 68. Figure 1 shows the layout of the well clusters in relation to nearby SRTC facilities. Table 1 gives the most recent trichloroethylene concentrations reported for the water table wells MSB 47D, MSB 67D, and MSB 68D. These results clearly show that volatile organic contaminants have reached the groundwater in this area. Unlike well clusters MSB 67 and 68, the maximum TCE concentrations observed in the MSB 47 cluster occur in the deeper wells. This suggests that contaminant migration has been more vertical than lateral (Colven et al., 1988). The A1/A2 air stripper system was placed into service to address the CVOC contamination in the groundwater in the Northern Sector of SRTC. The purpose of the air stripper was to treat the contaminated groundwater, and to provide hydraulic control of the contaminant plume to prevent it from migrating to the deeper aquifer systems.

The purpose of this testing was to determine if a vadose zone source for the contamination remains and to begin collecting data to assist with determining the location of any significant source. To date, there have been no characterization efforts undertaken to identify any vadose zone source for CVOC contamination in the Northern Sector of SRTC. In an effort to begin to identify and address any contamination source, soil vapor extraction (SVE) testing was undertaken on wells MSB 47D, MSB 67D, MSB 68D. These wells were chosen because of their proximity to the suspected source, the presence of dry screen, and because of the significant TCE concentrations measured in the groundwater from these wells. This testing represents the first step towards determining the source location for the vadose zone contamination. The results of this study are intended to aid in determining the path forward for remediation efforts for the Northern Sector.

3.0 Objectives

The objectives of the Northern Sector A-Area SVE testing were to establish the presence of CVOCs in the vadose zone in the vicinity of the test wells, and to collect data to assist in locating the source of the contamination.

4.0 Test Methods

4.1 SVE Testing

The Northern Sector SVE testing was conducted using the wells identified in Table 1. Figure 1 gives the location of the test wells in relation to the SRTC facilities. A portable, trailer mounted SVE unit was used for testing purposes. The unit consisted of a Tuthill™ Model 5507 heavy duty, high pressure, rotary type blower driven by a 25 HP 3ϕ 480 VAC motor. Power was supplied to the system with a portable diesel generator. The unit featured a variable speed controller with pressure and temperature protection. The unit was equipped with inlet and outlet silencers for noise control, and a cyclone separator on the inlet side to protect the blower from particulate matter in the air stream. Figure 2 gives a picture of the soil vapor extraction unit (SVEU).

The SVEU was connected to each well using 2 inch diameter heavy duty Newflex® spiral reinforced PVC flexible tubing manufactured by NewAge Industries, Inc. The Newflex® tubing was connected to each well using a well head assembly constructed of Schedule 40 PVC pipe. All connections were made using standard hose clamps. Teflon tape and RTV (room temperature vulcanization) silicone sealant were used as necessary to seal the connections. Air flow rate for each extraction well was measured using a LFG&E ORIPAC one inch diameter orifice plate flow meter. A differential pressure gauge (Magnehelic) was used to monitor the pressure drop across the plate. The differential pressure measurements were converted to flow rates using textbook equations for obstruction type flow devices (White, 1979).

4.2 Soil Gas Sampling and Analysis

Three single well extraction tests were conducted on wells MSB 47D, MSB 67D, and MSB 68D. During each test, a portable Bruel & Kjaer (B&K) Model 1302 infrared photoacoustic multi-gas monitor was used to monitor CVOC concentrations from each extraction well. The B&K uses a photoacoustic infra-red detection method to analyze for CVOCs in the gas stream. The B&K was configured to analyze for trichloroethylene, perchloroethylene, carbon tetrachloride, and carbon dioxide. Carbon dioxide was used to indicate the origin of the gas stream and to verify the seal between the blower and the extraction well. Soil gas and atmospheric air exhibit different concentrations of carbon dioxide gas. The concentration of carbon dioxide in atmospheric air is on the order of 500 ppmv, whereas soil gas carbon dioxide concentrations in the vadose zone (SRTC area) have been observed to be on the order of 13,000 ppmv.

Confirmation grab samples were routinely collected from the gas stream using a small vacuum pump and Tedlar™ bags. These samples were analyzed within 24 hours of collection using a Hewlett Packard 5890 gas chromatograph equipped with a flame ionization detector (FID), electron capture detector (ECD), and a mass spectrophotometer. The samples were analyzed for trichloroethylene, carbon tetrachloride, perchloroethylene. The results of these samples were used to verify the operation of the B&K multigas monitor.

4.3 Pressure Monitoring

For each test, the two wells not being pumped were used to monitor the air pressure in the vadose zone. These wells were fitted with press on PVC caps modified with tubing connections. One eighth inch polyethylene tubing was used to transmit air pressure from each well to a data logger. Air pressure in the vadose zone was monitored using a data logger equipped with a differential pressure transducer, a barometer, and a computer operated manifold.

5.0 Results

Vadose zone pumping tests were performed on wells MSB 47D, MSB 67D, and MSB 68D located in the Northern Sector of SRTC. Testing was conducted with a portable trailer mounted SVEU. The unit was operated on each well at the maximum possible vacuum without causing the water level in the well to surge above the dry portion of the screen. The vacuum setting for each well was determined based on field observations and resulted in different flow rates for each well. Figure 3 shows the screened length for each well and the water level elevation in each well. This figure clearly shows that each well had dry screen making each suitable for SVE testing. Each test was operated for a period of sufficient duration to observe soil gas concentrations from each well and determine if significant changes in concentrations were occurring.

5.1 Contaminant Removal

The SVEU was operated on MSB 47D for a period of 6.8 days (163.2 hrs) at an average flow rate of 18.5 scfm (Table 2). CVOCs were not detected in the soil vapor from MSB 47D. This is consistent with soil gas sampling results reported by Colven et al. (1988), and corroborates the determination made by Colven et al. (1988) that migration of the contaminants away from the source has been primarily vertical rather than lateral. This is substantiated by TCE concentrations measured in the deeper wells of the cluster which range on the order of 2000 to 3000 µg/L (MSB 47C) compared to 1 to 2 µg/L for MSB 47D. Furthermore, the MSB 47 well cluster is located within a few hundred feet of a suspected source. Any significant lateral migration of the contaminant plume through the vadose zone in the direction of the MSB 47 well cluster would have likely resulted in CVOCs in the offgas from the SVE testing. Drawdown data collected while testing MSB 47D are presented in Appendix A, Table A-1.

The SVEU was operated on MSB 67D for a period of 10.8 days (258.3 hrs) at an average flow rate of 12.6 scfm (Table 2). TCE was detected in the soil vapor from MSB 67D, but the concentrations were relatively low compared to the dissolved phase concentrations observed in the groundwater (Table 1). No other CVOC was measured above the detection limit. Figure 4 shows the TCE concentration as a function of time for the test. TCE concentrations in the soil vapor ranged from 1.1 to 4.5 ppmv with concentrations increasing over the duration of the test. The low concentrations of TCE in the soil vapor indicates that MSB 67D is located away from the main area of vadose zone contamination. The increase in TCE concentration in the soil vapor suggests that relatively cleaner air in the vicinity of the well was replaced by more contaminated air as the vadose zone contaminant plume was influenced by pumping the well. Figure 5 shows the cumulative mass of TCE removed as function of time. A total of 0.17 pounds of TCE was removed from the vadose zone over the course of the test. Drawdown data collected while testing MSB 67D are presented in Appendix A, Table A-2.

Two vadose zone pumping tests were performed on MSB 68D. For the first test, MSB 68D was pumped for a period of 4.68 days at a flow rate of 32.3 scfm. During this test, a confirmation grab sample analyzed by gas chromatograph revealed an error with the B&K. Consequently, continuous VOC measurements were not obtained as part of the first test; however, based upon the grab sample, the TCE concentration in the soil vapor was 18.0 ppmv. Based on this concentration, a total of 1.31 pounds of TCE was removed from the vadose zone during the first test.

SVE testing was conducted a second time on MSB 68D to examine changes in VOC concentrations in the soil gas over time. During the second test, the SVEU was operated on MSB 68D for a period of 5.8 days (140.1 hrs) at an average flow rate of 38.6 scfm. TCE was detected in the soil vapor from MSB 68D; however, as with MSB 67D, the concentrations were relatively low compared to the dissolved phase concentrations observed in the groundwater (Table 1). No other CVOC was measured above the detection limit. Figure 6 shows the TCE concentrations as a function of time for the test. TCE concentrations in the soil vapor ranged from 19.8 to 20.7 ppmv with concentrations decreasing initially and then remaining relatively stable over the remainder of the test. These results indicate that MSB 68D is potentially located within a vadose zone contaminant plume, but it is still some distance from the source based on the low concentrations of TCE in the soil vapor. Figure 7 shows the cumulative mass of TCE removed as a function of time for the second test. For the second test at MSB 68D, 2.28 pounds of TCE was removed from the vadose zone. Drawdown data collected while testing MSB 68D are presented in Appendix A, Tables A-3 and A-4.

5.2 Vadose Zone Modeling

5.2.1 Model Description

The pressure response of the vadose zone due to SVE pumping was modeled in order to estimate the permeability of the unsaturated sediments. Drawdown data from the first pumping test performed on MSB 68D was used in the analysis. This test was chosen because the data set included both the drawdown and recovery periods, and because this test produced the greatest amount of drawdown in the observation well.

Barometric pressure fluctuates almost continually even during periods of high pressure. These pressure fluctuations are transmitted through the unsaturated subsurface in the form of pressure waves which are typically damped and delayed to degrees dependent on the effective permeability of the unsaturated media (Buckingham, 1904; Weeks, 1978). As a result of the attenuation and delay of the transmitted pressure wave, at a given time, the atmospheric pressure at the surface and the soil gas pressure in the subsurface will be different (Rossabi, 1999). The dampened pressure wave associated with barometric pressure fluctuations is manifested in any data collected from a pumping test. Thus, it is necessary prior to interpreting data from vadose zone pumping tests, to separate out the barometric component. This is particularly important when the measured drawdown is expected to be on the same scale as the barometric fluctuations. A common method for separating out barometric effects is to make use of a reference well (Massmann, 1989). Ideally, the reference well is located out of the area of influence of the pumping test, but screened within the zone of interest. Subsurface gas pressure is monitored in the reference well in addition to the observation wells used in the pumping test. Because the reference well is distant from the pumping well, there will be minimal drawdown observed at that location. Therefore, fluctuations in gas pressure in the reference well can be directly attributed to fluctuations in barometric pressure and the propagation of these fluctuations through the geologic section. The pressure wave from the reference well is then used to correct the pressure waves measured in the observation wells for barometric pressure fluctuations. This method was chosen for the analysis of the pumping data from MSB 68D.

For analysis purposes, MSB 47D was designated as the observation well. MSB 47D is located about 250 ft from the pumping well (MSB 68D), which is near the outer limits of the radius of influence of the test. This is corroborated by the small drawdown values measured at MSB 47D (~0.2 in H_2O). MSB 67D is located about 335 ft from the pumping well. Drawdown in MSB 67D was determined to be negligible and it was subsequently designated as the reference well.

Differential pressure was measured in both MSB 47D and 67D. Barometric pressure data was obtained from the SRTC weather center. The absolute gas pressure in each well was determined by adding the differential pressure to the barometric pressure. The absolute pressure measured in MSB 47D was then subtracted from the absolute pressure measured in MSB 67D. This removed any barometric fluctuations from the observation data. All pressure measurements were logged in units of millibars, which were converted into units of feet of water. The units of feet of water were then converted to feet of air by multiplying by the ratio of the density of water to the density of air.

The data from the test was analyzed using the program AQTESOLV, which is a program designed for pump test analysis (Geraghty and Miller Inc., 1996). A type curve matching procedure was employed using a model for leaky aquifers with partially penetrating wells. The model used was developed by

Hantush and Jacob (1955) and Hantush (1961a and b) to analyze data from pumping tests in leaky aquifers. It has been shown that under certain conditions, standard techniques used to model groundwater pumping tests may also be used in the interpretation of data from vadose zone pumping tests (Massmann, 1989; Massmann and Madden, 1994). In the case of a vadose zone pumping test, the fluid is air rather than water. Massmann (1989) gives the assumptions and limitations associated with modeling gas transport with conventional groundwater transport equations. One of the more significant assumptions is that gas transport can be modeled using the equation for incompressible fluid flow. Massmann (1989) found that for pressure variations on the order of one half atmosphere or less this assumption is valid. For the Northern Sector SVE testing, pressure variations were less than one tenth of an atmosphere.

Parameters used in the Hantush-Jacob model for leaky aquifers includes the saturated thickness of the aquifer, the thickness of the overlying confining layer, and the zone of penetration of the pumping and observation well (or wells). For the case of a vadose zone pumping test, the fluid is air and the "saturated thickness" is equal to the thickness of the unsaturated zone minus the confining layer. For the Northern Sector, the confining layer was taken to be 60 feet in thickness based upon lithologic logs prepared during the installation of the MSB 68 well series. The water table was taken as the underlying no flow boundary condition in the Hantush-Jacob leaky aquifer model. A "saturated thickness" of 72.5 feet was used to describe the sediments between the water table and the confining layer.

5.2.2 Model Results

AQTESOLV simulations were performed for each test and the resulting type curves are presented in Appendix B. Looney et al. (1991) recommended implementing calculated limits for the storage coefficient in the Hantush-Jacob leaky aquifer model. The use of calculated limits prevents AQTESOLV from predicting storage coefficients greater than physically possible based upon the expected moisture content of the unsaturated zone.

The specific storage, S_s, may be calculated using the following equation:

$$S_s = \frac{g\,\phi_a\,MW}{RT} \quad (1)$$

where:
g = gravitational constant = 980 cm/sec^2
ϕ_a = available porosity
MW = molecular weight of gas (air) = 28 g/mol
RT = gas constant * absolute temperature = 2.5 x 10^{10} cm^2 g/mol sec^2

The available porosity, ϕ_a may be calculated using the following equation:

$$\phi_a = \phi_t\,(1 - \theta_s) \quad (2)$$

where:
ϕ_t = total porosity, 0.4 (Eddy et al., 1991)
θ_s = saturation

The storage coefficient, S, may then be determined with the following equation:

$$S = S_s\, b$$

where:
b = thickness of the unsaturated zone

A storage coefficient of 0.00065 was calculated based on a saturation value of 0.3 for the unsaturated zone. For modeling purposes, the storage coefficient was fixed to 0.00065 and transmissivity and leakage were iterated to produce the best fit of the data.

Figure 8 gives the results of the simulation. The transmissivity of the unsaturated sediments was estimated to be 0.96 ft^2/min. The radial permeability of the sediments (k_r) was estimated to be on the order of 100 darcies, which is within the range previously measured for the central portion of A/M Area (Looney et al., 1991). The vertical permeability (k_z)of the sediments was estimated to be about 3 darcies. Leakage values produced by the model simulations were found to be extremely small ($1X10^{-20}$). This suggests that gas flow in this vadose zone system is similar to water flow in a confined aquifer with a competent confining layer preventing leakage from the overlying sediments. This model is consistent with the lithologic logs from MSB 68 well series which show a clay layer at about 60 ft bgs. In this case, the Theis (1935) confined aquifer model with no leakage would be expected to yield the same results as the Hantush-Jacob leaky model.

6.0 Summary

Vadose zone pumping tests were performed on wells MSB 47D, MSB 67D, and MSB 68D. Wells MSB 67D and MSB 68D produced soil vapor contaminated with CVOCs. MSB 47D did not produce contaminated soil vapor. MSB 67D was pumped for a period of 10.76 days at a flow rate of 12.6 scfm and produced a total of 0.17 pounds of trichloroethylene. Two pumping tests were performed on MSB 68D. For the first test, MSB 68D was pumped for a period of 4.68 days at a flow rate of 32.3 scfm and produced 1.31 pounds of trichloroethylene. For the second test, MSB 68D was pumped for a period of 5.84 days at a flow rate of 38.6 scfm and produced 2.28 pounds of trichloroethylene.

Based on the CVOC concentrations observed in the groundwater for the three wells tested compared to the CVOC concentrations observed in the soil vapor from each well, none of the three wells are located in the most contaminated portion of the vadose zone plume. MSB 68D appears to be closest to the contaminated area. Future investigations should be focused upon the area surrounding MSB 68D to determine the source and extent of the vadose zone contamination.

A Hantush-Jacob leaky aquifer model was used to describe the vadose zone in the Northern Sector. The transmissivity of the unsaturated sediments was estimated to be 0.96 ft^2/min. The radial permeability of the sediments (k_r) was estimated to be on the order of 100 darcies, which is within the range previously measured for the central portion of A/M Area (Looney et al., 1991). Leakage values produced by the model simulations were found to be extremely small. This suggests that gas flow in this vadose zone system is similar to water flow in a confined aquifer with a competent confining layer preventing leakage from the overlying sediments.

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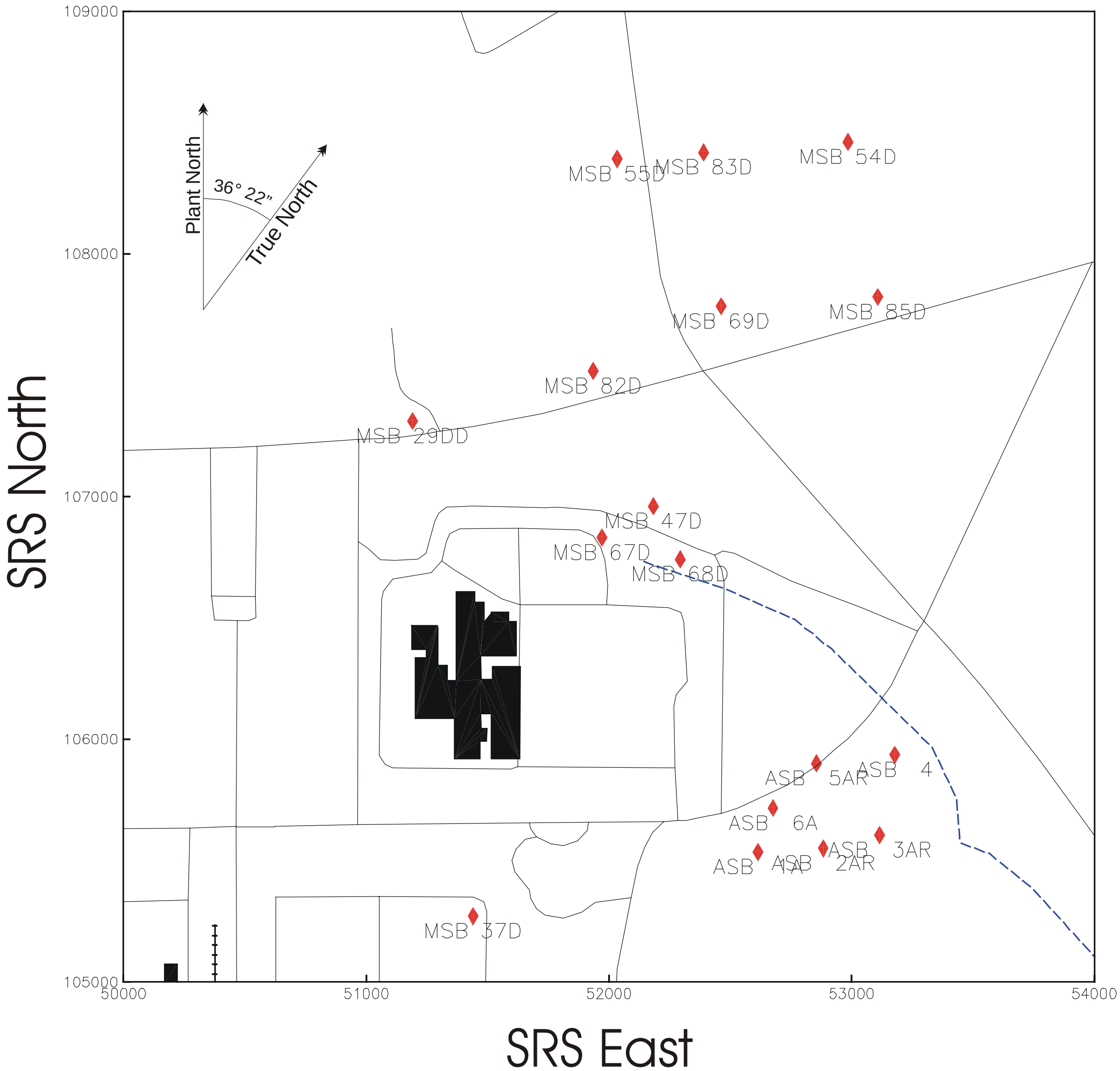

Figure 1. Location of the Northern Sector SVE Test Wells

Figure 2. Trailer Mounted Portable SVE Unit Used in Northern Sector Testing

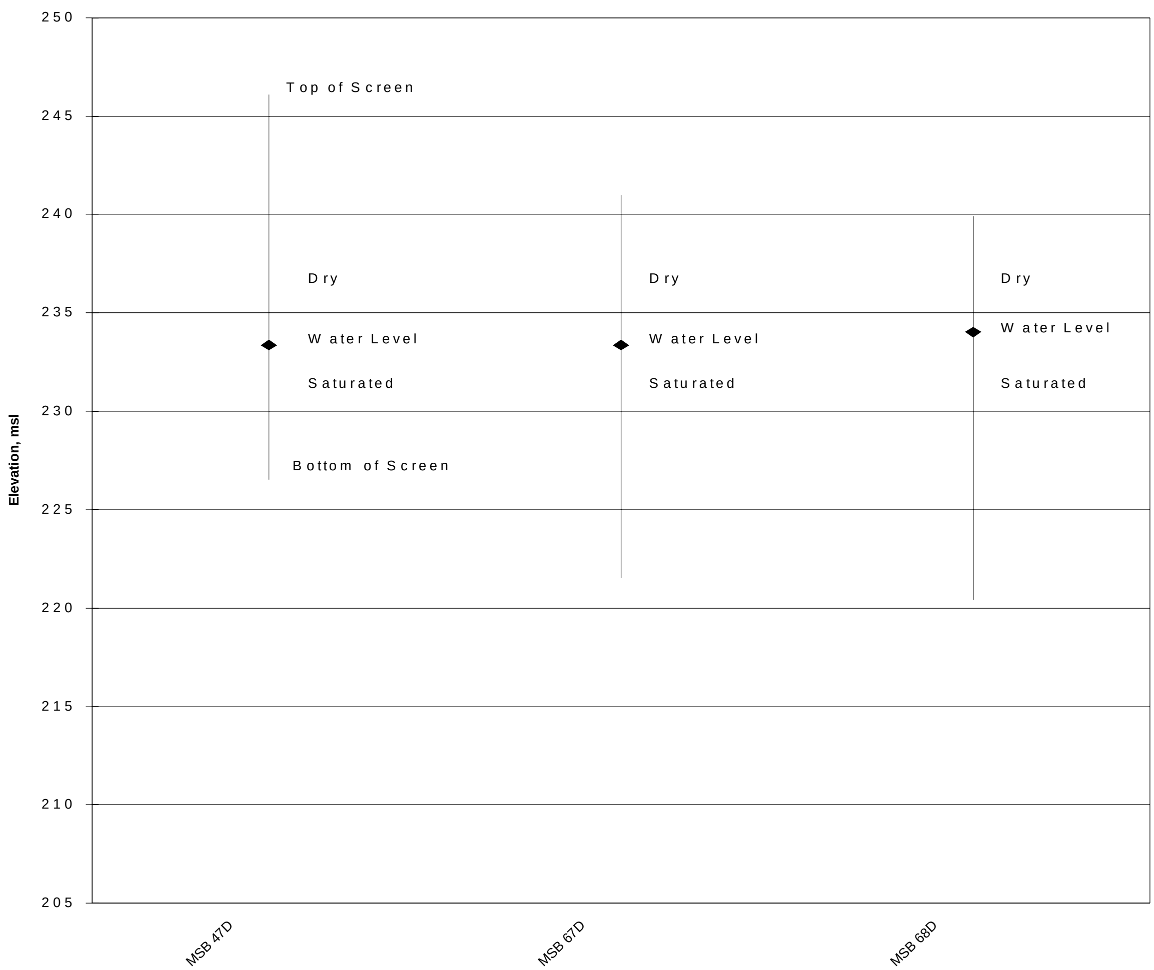

Figure 3. Well Construction Details for the Northern Sector Test Wells

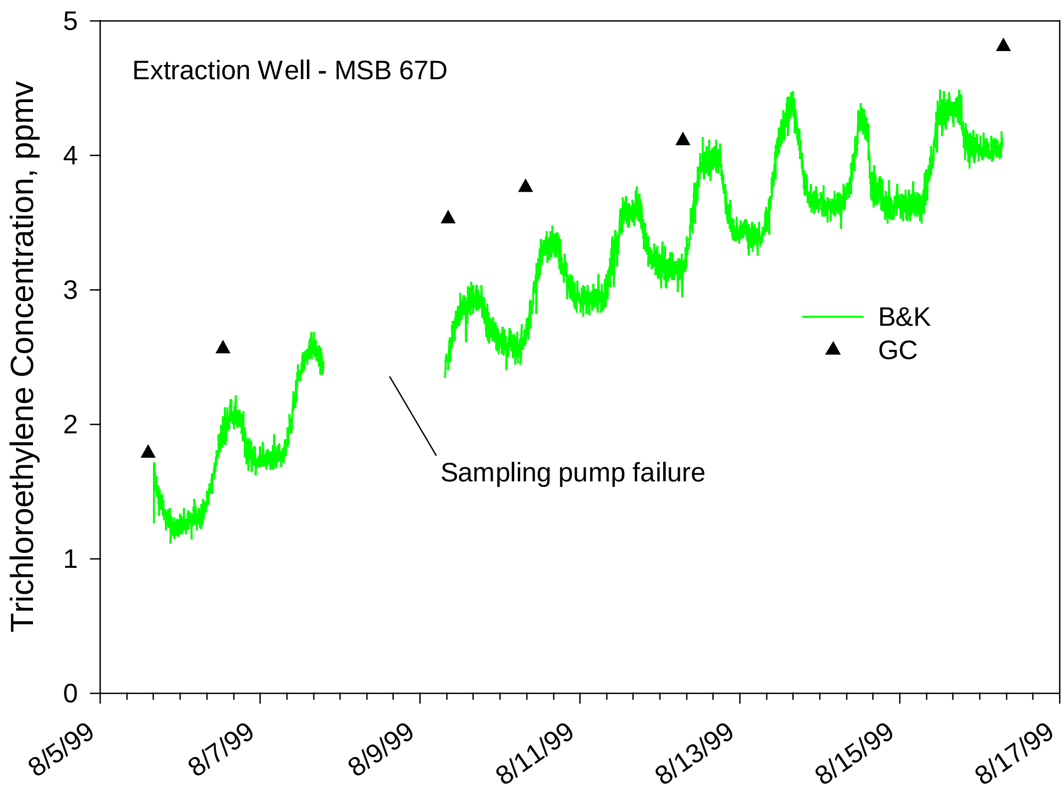

Figure 4. TCE Concentrations as a Function of Time for Test 3 on MSB 67D

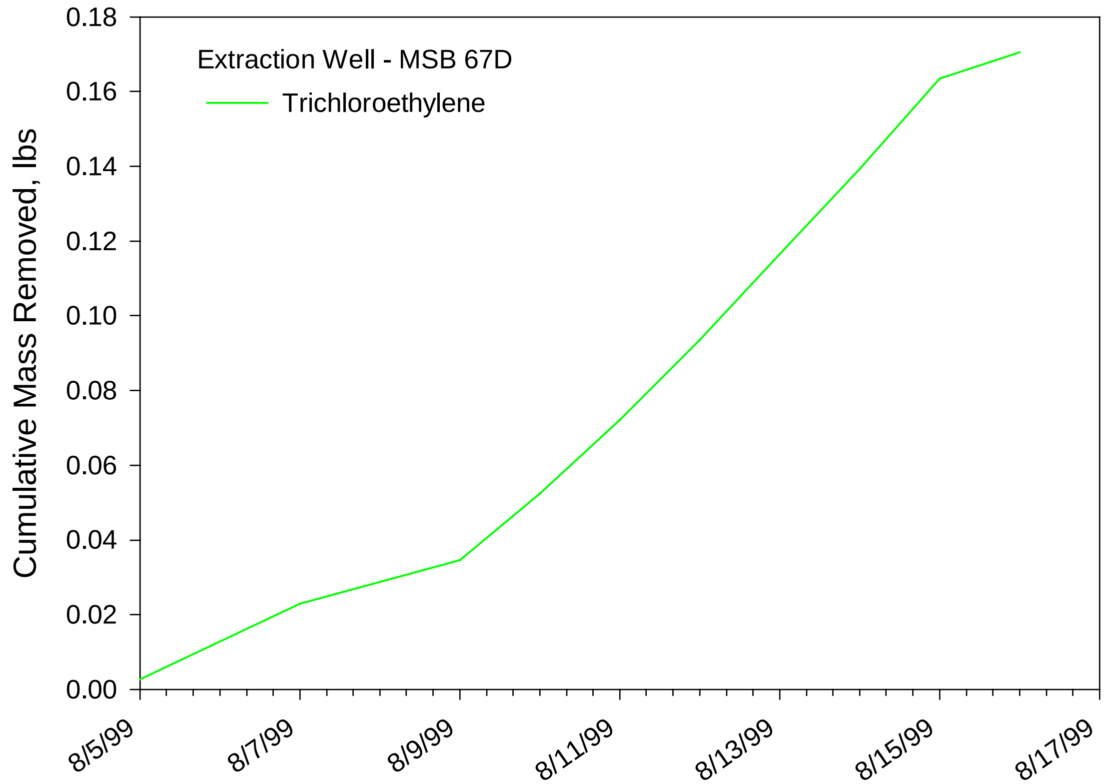

Figure 5. Cumulative TCE Mass Removed as a Function of Time for Test 3 on MSB 67D

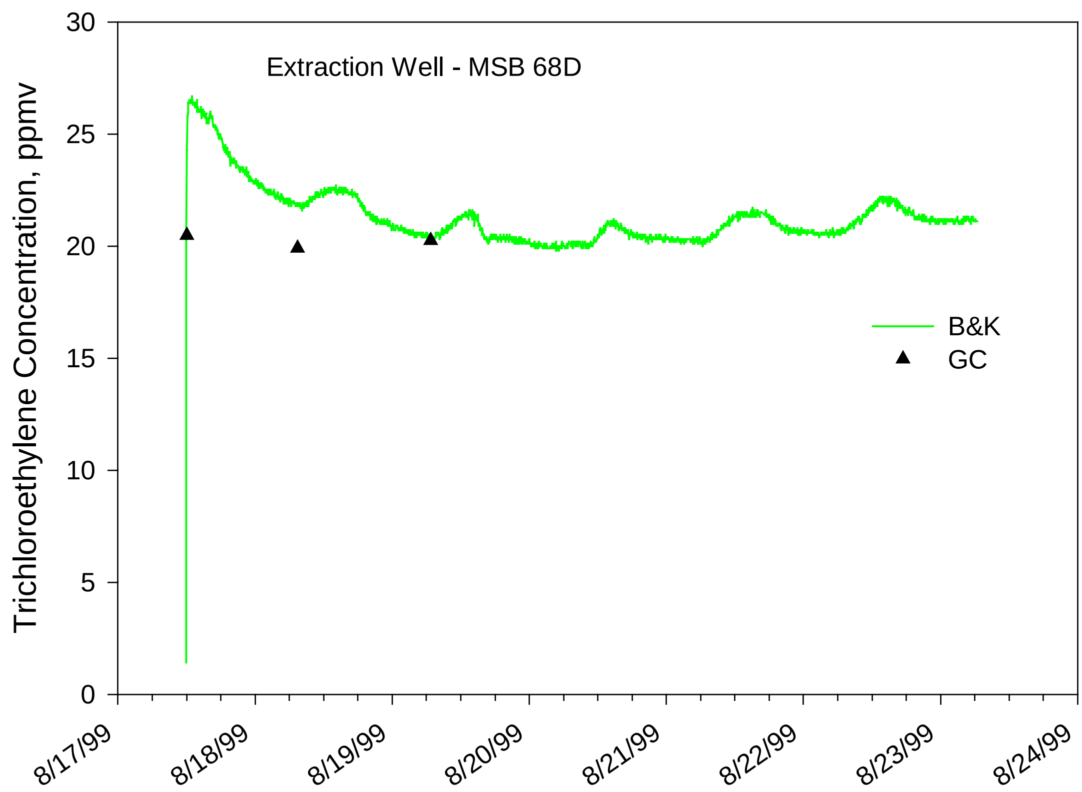

Figure 6. TCE Concentrations as a Function of Time for Test 4 on MSB 68D

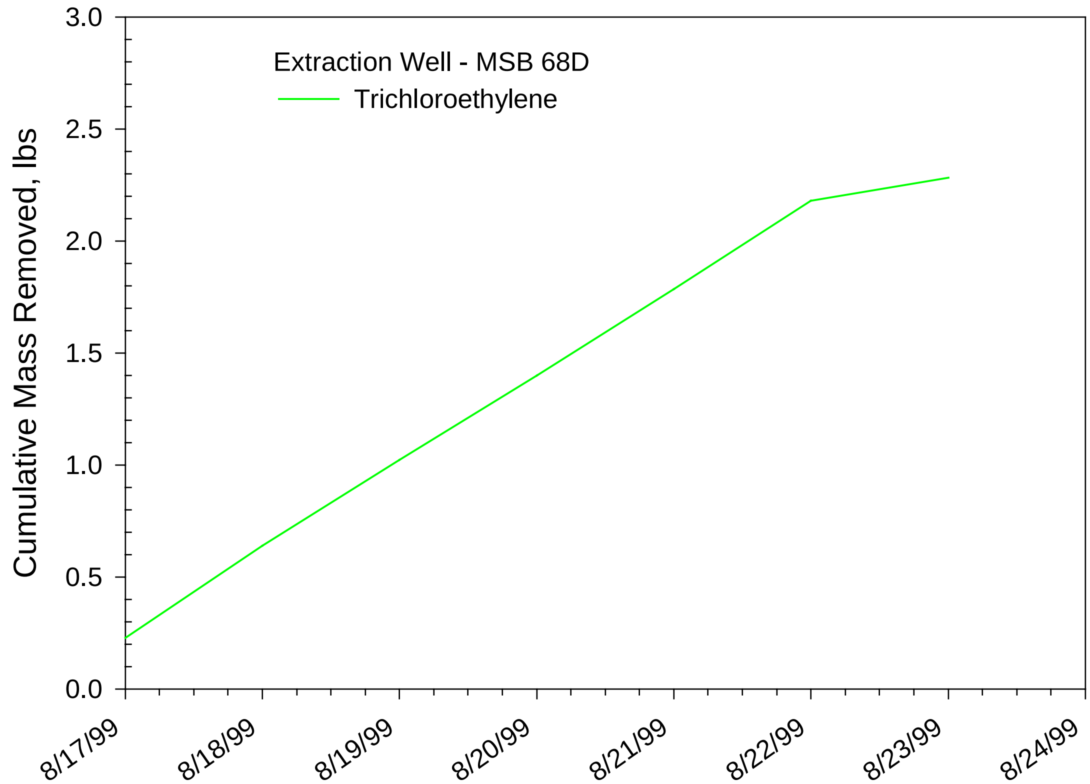

Figure 7. Cumulative TCE Mass Removed as a Function of Time for Test 4 on MSB 68D

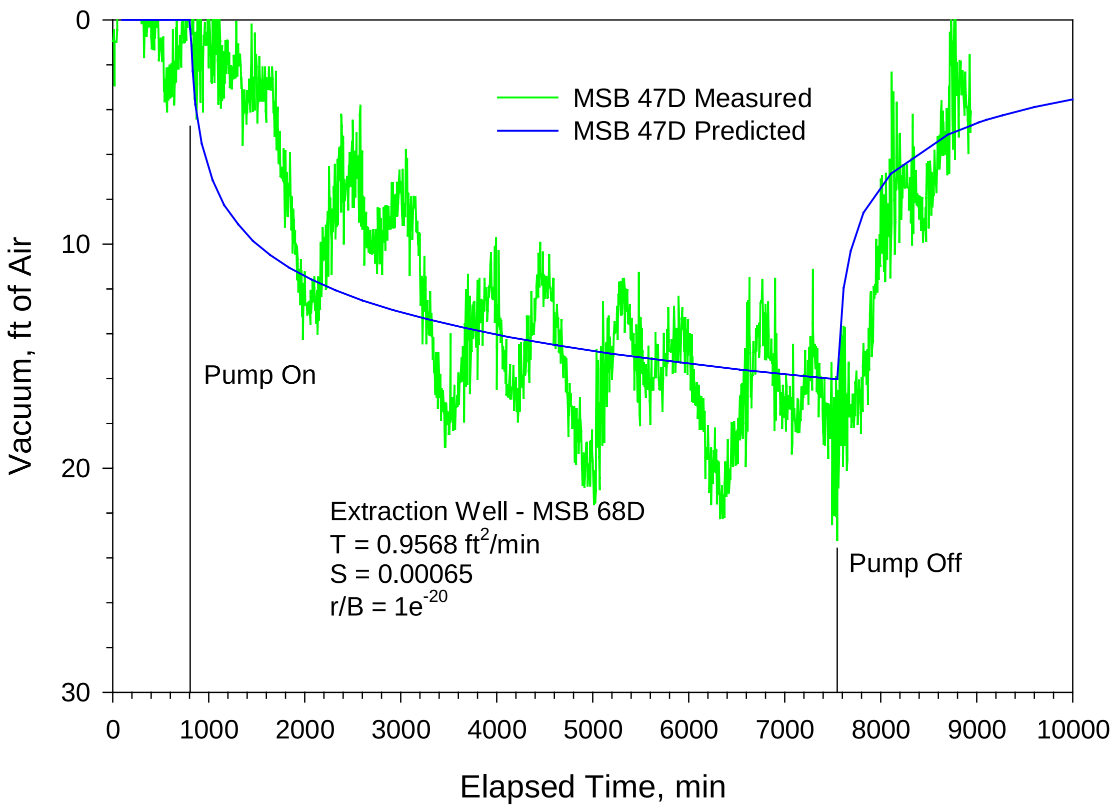

Figure 8. Vacuum Drawdown as Function of Time for MSB 68D.

Table 1. Wells Utilized in the Northern Sector SVE Test

Well ID	**SRS North**	**SRS East**	**Screen Elevation** Top/Bottom (ft, msl)	**Zone**	**TCE**[a] (µg/L)
MSB 47D	106960	52184	246.1/226.5		1.73 (2/9/99)
MSB 67D	106831	51972	241/221.5		3030 (3/16/99
MSB 68D	106741	52294	239.9/220.4		2190 (1/30/95)

[a]Trichloroethylene concentrations for the most recent sampling event.

Table 2. Results of SVE Testing on the Northern Sector Wells

Test	**Well**	Start **Date/Time**	Stop **Date/Time**	Duration **(Days)**	Flow **(scfm)**	TCE[a] **(ppmv)**	**Cumulative TCE (lbs)**
1	MSB 47D	7/21/99 13:45	7/28/99 8:55	6.80	18.5	0.0	0.00
2	MSB 68D	7/29/99 14:00	8/3/99 6:26	4.68	32.3	18.0	1.31
3	MSB 67D	8/5/99 12:54	8/16/99 7:10	10.76	12.6	1.1-4.5	0.17
4	MSB 68D	8/17/99 11:55	8/23/99 7:59	5.84	38.6	19.8-20.7	2.28

[a]Trichloroethylene

Appendix A

Drawdown Data

Table A-1. Vadose Zone Differential Pressures and Barometric Pressure Recorded During SVE Testing on MSB 47D.

Date/Time	MSB 67D (mb)	MSB 68D (mb)	Barometric Pressure (mb)	Date/Time	MSB 67D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
7/20/99 0:30	1.52158	1.66780	1009.08	7/21/99 23:30	0.71849	0.69767	1007.10
7/20/99 1:30	1.74116	1.93447	1009.06	7/22/99 0:30	0.76812	0.75898	1007.32
7/20/99 2:30	2.08255	2.29769	1008.71	7/22/99 1:30	1.08093	1.10841	1007.20
7/20/99 3:30	2.18181	2.42030	1008.29	7/22/99 2:30	1.43736	1.51761	1006.74
7/20/99 4:30	1.95923	2.18581	1008.14	7/22/99 3:30	1.38924	1.46703	1006.28
7/20/99 5:30	1.47797	1.63408	1008.39	7/22/99 4:30	1.23734	1.30304	1006.26
7/20/99 6:30	1.02529	1.14825	1008.87	7/22/99 5:30	0.72450	0.72220	1006.47
7/20/99 7:30	0.70796	0.77430	1009.30	7/22/99 6:30	0.29438	0.25323	1006.96
7/20/99 8:30	0.50343	0.55361	1009.62	7/22/99 7:30	-0.20342	-0.30923	1007.46
7/20/99 9:30	0.66435	0.70227	1009.71	7/22/99 8:30	-0.25004	-0.37820	1007.86
7/20/99 10:30	0.65683	0.67162	1009.55	7/22/99 9:30	-0.15680	-0.30463	1007.91
7/20/99 11:30	0.89745	0.93369	1009.47	7/22/99 10:30	-0.09664	-0.21728	1007.87
7/20/99 12:30	1.25389	1.29232	1009.24	7/22/99 11:30	-0.10867	-0.20655	1007.81
7/20/99 13:30	1.83591	1.92374	1008.86	7/22/99 12:30	0.35454	0.28541	1007.69
7/20/99 14:30	2.49463	2.66551	1008.21	7/22/99 13:30	0.68239	0.66549	1007.19
7/20/99 15:30	2.81045	3.00881	1007.45	7/22/99 14:30	1.34863	1.40420	1006.74
7/20/99 16:30	3.06612	3.30307	1007.06	7/22/99 15:30	1.52158	1.56818	1006.46
7/20/99 17:30	3.24358	3.48084	1006.73	7/22/99 16:30	2.04646	2.16436	1005.94
7/20/99 18:30	2.86459	3.07931	1006.47	7/22/99 17:30	2.16527	2.28543	1005.19
7/20/99 19:30	2.57584	2.76206	1006.78	7/22/99 18:30	1.65092	1.71684	1005.13
7/20/99 20:30	2.39086	2.58122	1006.99	7/22/99 19:30	1.71108	1.80113	1005.49
7/20/99 21:30	1.48850	1.60190	1007.11	7/22/99 20:30	1.50504	1.58504	1005.37
7/20/99 22:30	1.23885	1.33216	1007.93	7/22/99 21:30	1.28697	1.34289	1005.52
7/20/99 23:30	1.03281	1.09002	1008.09	7/22/99 22:30	1.32006	1.38580	1005.62
7/21/99 0:30	1.40127	1.51607	1008.21	7/22/99 23:30	0.89294	0.92143	1005.57
7/21/99 1:30	1.60881	1.75209	1007.76	7/23/99 0:30	0.92453	0.94442	1005.99
7/21/99 2:30	1.54866	1.69232	1007.57	7/23/99 1:30	1.32758	1.38887	1005.85
7/21/99 3:30	1.57723	1.71684	1007.47	7/23/99 2:30	1.52309	1.61263	1005.34
7/21/99 4:30	1.31254	1.44557	1007.43	7/23/99 3:30	1.89005	2.01416	1005.06
7/21/99 5:30	0.85083	0.94749	1007.70	7/23/99 4:30	1.79831	1.92068	1004.54
7/21/99 6:30	0.41921	0.46625	1008.11	7/23/99 5:30	1.71559	1.84558	1004.61
7/21/99 7:30	0.01615	0.02027	1008.53	7/23/99 6:30	1.35164	1.42872	1004.58
7/21/99 8:30	-0.27260	-0.31383	1008.94	7/23/99 7:30	0.84933	0.86013	1005.05
7/21/99 9:30	-0.30870	-0.37360	1009.24	7/23/99 8:30	0.44928	0.40342	1005.49
7/21/99 10:30	-0.40194	-0.47475	1009.26	7/23/99 9:30	0.48688	0.41415	1005.90
7/21/99 11:30	-0.29817	-0.38739	1009.41	7/23/99 10:30	0.52899	0.45399	1005.84
7/21/99 12:30	0.18760	0.14135	1009.25	7/23/99 11:30	0.84331	0.79423	1005.75
7/21/99 13:30	0.73353	0.75131	1008.79	7/23/99 12:30	1.36066	1.35822	1005.44
7/21/99 14:30	1.25389	1.25707	1008.14	7/23/99 13:30	1.99382	2.03409	1004.81
7/21/99 15:30	1.72762	1.76435	1007.66	7/23/99 14:30	2.33070	2.42183	1004.13
7/21/99 16:30	2.09157	2.15823	1007.11	7/23/99 15:30	2.83151	2.97049	1003.64
7/21/99 17:30	2.02540	2.09539	1006.52	7/23/99 16:30	3.19245	3.34904	1003.06
7/21/99 18:30	1.95772	2.00650	1006.53	7/23/99 17:30	3.56542	3.77510	1002.61
7/21/99 19:30	1.55918	1.59270	1006.50	7/23/99 18:30	3.53535	3.73525	1002.15
7/21/99 20:30	0.98167	0.95975	1006.80	7/23/99 19:30	3.01047	3.16053	1002.14
7/21/99 21:30	0.81925	0.81875	1007.30	7/23/99 20:30	2.16677	2.24252	1002.55
7/21/99 22:30	0.98919	0.99653	1007.30	7/23/99 21:30	1.33359	1.32757	1003.44

Table A-1. Continued.

Date/Time	MSB 67D (mb)	MSB 68D (mb)	Barometric Pressure (mb)	Date/Time	MSB 67D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
7/23/99 22:30	0.80271	0.74825	1004.17	7/25/99 21:30	-0.09664	-0.16210	1002.68
7/23/99 23:30	0.82978	0.80649	1004.53	7/25/99 22:30	-0.16883	-0.24333	1003.11
7/24/99 0:30	1.33209	1.37508	1004.38	7/25/99 23:30	-0.11770	-0.18356	1003.11
7/24/99 1:30	1.89306	1.99577	1003.69	7/26/99 0:30	-0.17485	-0.22494	1003.09
7/24/99 2:30	2.10361	2.24405	1003.09	7/26/99 1:30	0.00262	-0.01804	1003.14
7/24/99 3:30	1.95020	2.07240	1002.85	7/26/99 2:30	-0.00189	-0.03643	1002.86
7/24/99 4:30	1.92915	2.02949	1002.96	7/26/99 3:30	0.02668	0.01414	1002.86
7/24/99 5:30	1.77124	1.86857	1002.85	7/26/99 4:30	0.06578	0.04020	1002.84
7/24/99 6:30	1.41029	1.47929	1002.91	7/26/99 5:30	0.04623	0.03560	1002.76
7/24/99 7:30	0.68239	0.66243	1003.35	7/26/99 6:30	-0.33276	-0.38433	1002.70
7/24/99 8:30	0.15451	0.06932	1004.07	7/26/99 7:30	-0.38376	-0.48711	1003.22
7/24/99 9:30	-0.00641	-0.12226	1004.52	7/26/99 8:30	-0.40576	-0.45687	1003.58
7/24/99 10:30	0.18459	0.06625	1004.65	7/26/99 9:30	-0.43474	-0.50177	1003.83
7/24/99 11:30	0.30340	0.19499	1004.45	7/26/99 10:30	-0.47276	-0.54544	1004.02
7/24/99 12:30	0.73052	0.64250	1004.29	7/26/99 11:30	-0.37860	-0.44826	1004.05
7/24/99 13:30	1.70206	1.70611	1003.72	7/26/99 12:30	-0.26875	-0.33262	1003.84
7/24/99 14:30	2.67209	2.76973	1002.68	7/26/99 13:30	-0.03516	-0.07490	1003.52
7/24/99 15:30	3.21952	3.37510	1001.59	7/26/99 14:30	0.16583	0.15514	1002.91
7/24/99 16:30	3.49173	3.69387	1000.99	7/26/99 15:30	0.35475	0.36735	1002.45
7/24/99 17:30	3.45263	3.63564	1000.61	7/26/99 16:30	0.51410	0.53649	1001.88
7/24/99 18:30	2.59689	2.70536	1000.64	7/26/99 17:30	0.63542	0.66812	1001.42
7/24/99 19:30	1.48549	1.50535	1001.43	7/26/99 18:30	0.65835	0.66997	1000.97
7/24/99 20:30	0.23723	0.18119	1002.25	7/26/99 19:30	0.40666	0.41225	1001.05
7/24/99 21:30	0.24475	0.17200	1003.54	7/26/99 20:30	0.17609	0.17236	1001.61
7/24/99 22:30	-0.12822	-0.22341	1003.63	7/26/99 21:30	-0.04603	-0.06506	1002.15
7/24/99 23:30	-0.28915	-0.41192	1003.89	7/26/99 22:30	-0.16795	-0.20530	1002.63
7/25/99 0:30	-0.15530	-0.24793	1003.83	7/26/99 23:30	-0.17218	-0.20161	1002.83
7/25/99 1:30	0.30641	0.26855	1003.72	7/27/99 0:30	-0.11303	-0.13272	1002.82
7/25/99 2:30	0.45981	0.43101	1003.28	7/27/99 1:30	0.01010	0.00629	1002.60
7/25/99 3:30	0.65382	0.66549	1002.96	7/27/99 2:30	0.01010	0.00875	1002.31
7/25/99 4:30	0.42522	0.41261	1002.81	7/27/99 3:30	-0.05629	-0.07059	1002.31
7/25/99 5:30	0.12143	0.09077	1003.01	7/27/99 4:30	-0.16192	-0.17762	1002.44
7/25/99 6:30	-0.28012	-0.35521	1003.31	7/27/99 5:30	-0.32971	-0.36337	1002.73
7/25/99 7:30	-0.58091	-0.68778	1003.68	7/27/99 6:30	-0.57054	-0.63340	1003.12
7/25/99 8:30	-0.63354	-0.74755	1004.02	7/27/99 7:30	-0.81801	-0.90895	1003.84
7/25/99 9:30	-0.71025	-0.88395	1004.06	7/27/99 8:30	-0.93873	-1.04058	1004.47
7/25/99 10:30	-0.89372	-1.06633	1004.25	7/27/99 9:30	-0.90855	-1.01044	1004.79
7/25/99 11:30	-0.59745	-0.74449	1004.30	7/27/99 10:30	-0.91157	-1.02766	1004.78
7/25/99 12:30	-0.31321	-0.42418	1004.00	7/27/99 11:30	-0.75705	-0.86344	1004.86
7/25/99 13:30	0.18910	0.13368	1003.65	7/27/99 12:30	-0.68643	-0.77794	1004.51
7/25/99 14:30	0.68690	0.66089	1003.09	7/27/99 13:30	-0.44560	-0.50546	1004.37
7/25/99 15:30	1.26441	1.31990	1002.60	7/27/99 14:30	-0.31161	-0.35907	1003.75
7/25/99 16:30	1.52459	1.57584	1001.97	7/27/99 15:30	-0.09130	-0.12964	1003.40
7/25/99 17:30	1.37270	1.39500	1001.72	7/27/99 16:30	-0.00921	-0.03738	1002.92
7/25/99 18:30	1.15463	1.14519	1001.84	7/27/99 17:30	-0.01887	-0.04599	1002.71
7/25/99 19:30	0.73503	0.71147	1002.08	7/27/99 18:30	-0.02189	-0.05891	1002.75
7/25/99 20:30	0.38913	0.36204	1002.35	7/27/99 19:30	-0.16735	-0.20468	1002.73

Table A-1. Continued.

Date/Time	MSB 67D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
7/27/99 20:30	-0.37559	-0.43042	1003.06
7/27/99 21:30	-0.56330	-0.63278	1003.51
7/27/99 22:30	-0.64901	-0.71951	1004.02
7/27/99 23:30	-0.59408	-0.65369	1004.11
7/28/99 0:30	-0.48725	-0.53252	1004.00
7/28/99 1:30	-0.40999	-0.44580	1003.79
7/28/99 2:30	-0.33273	-0.35968	1003.53
7/28/99 3:30	-0.39430	-0.42119	1003.45
7/28/99 4:30	-0.39550	-0.42611	1003.53
7/28/99 5:30	-0.52709	-0.57066	1003.59
7/28/99 6:30	-0.70333	-0.76441	1003.94
7/28/99 7:30	-0.85543	-0.93663	1004.44
7/28/99 8:30	-0.95684	-1.04796	1004.88
7/28/99 9:30	-0.99788	-1.08118	1005.19
7/28/99 10:30	-1.06186	-1.14145	1005.48
7/28/99 11:30	-0.92424	-0.98276	1005.75
7/28/99 12:30	-0.70092	-0.74288	1005.44
7/28/99 13:30	-0.41723	-0.42181	1004.96
7/28/99 14:30	-0.14321	-0.11734	1004.23
7/28/99 15:30	0.13987	0.19328	1003.62
7/28/99 16:30	0.39760	0.48237	1002.93
7/28/99 17:30	0.51470	0.59677	1002.26
7/28/99 18:30	0.48331	0.55002	1001.98
7/28/99 19:30	0.31371	0.36611	1002.14
7/28/99 20:30	0.22558	0.27877	1002.44
7/28/99 21:30	0.15979	0.21234	1002.62
7/28/99 22:30	0.15617	0.21726	1002.77
7/28/99 23:30	0.20023	0.26278	1002.71
7/29/99 0:30	0.15376	0.21788	1002.59
7/29/99 1:30	0.36260	0.45161	1002.55
7/29/99 2:30	0.54729	0.65705	1001.96
7/29/99 3:30	0.55514	0.66197	1001.48
7/29/99 4:30	0.55454	0.66074	1001.41
7/29/99 5:30	0.35596	0.43500	1001.41
7/29/99 6:30	0.29439	0.36981	1001.93
7/29/99 7:30	0.27266	0.34766	1002.04
7/29/99 8:30	0.25757	0.25663	1002.11
7/29/99 9:30	0.33302	0.18836	1002.10
7/29/99 10:30	0.44649	0.47683	1001.93
7/29/99 11:30	0.63481	0.68104	1001.60
7/29/99 12:30	0.79174	0.85265	1001.11
7/29/99 13:30	0.98127	1.05747	1000.67
7/29/99 14:30	1.19071	1.26291	1000.13
7/29/99 15:30	1.36515	1.43144	999.47
7/29/99 16:30	1.54140	1.59751	998.76
7/29/99 17:30	1.54019	1.59874	998.12
7/29/99 18:30	1.20761	1.26844	998.09
7/29/99 19:30	0.97704	1.02425	998.50
7/29/99 20:30	0.94747	0.99596	998.73
7/29/99 21:30	0.81710	0.85695	999.05
7/29/99 22:30	0.85331	0.90124	999.11
7/29/99 23:30	0.73984	0.75915	998.92
7/30/99 0:30	0.75432	0.78376	999.08
7/30/99 1:30	0.80321	0.83727	998.87
7/30/99 2:30	0.76398	0.79606	998.66
7/30/99 3:30	0.78873	0.81882	998.63
7/30/99 4:30	0.73380	0.75977	998.50
7/30/99 5:30	0.49176	0.48114	998.57
7/30/99 6:30	0.20506	0.17052	999.13
7/30/99 7:30	0.09702	0.04812	999.79
7/30/99 8:30	-0.07983	-0.15855	999.98
7/30/99 9:30	-0.25487	-0.36214	1000.43
7/30/99 10:30	-0.21564	-0.33200	1000.86
7/30/99 11:30	-0.11786	-0.22929	1000.74
7/30/99 12:30	-0.04543	-0.15486	1000.53
7/30/99 13:30	0.22136	0.14161	1000.30
7/30/99 14:30	0.39760	0.33475	999.50
7/30/99 15:30	0.55091	0.51189	998.96
7/30/99 16:30	0.68129	0.65336	998.54
7/30/99 17:30	0.79174	0.75854	998.15
7/30/99 18:30	0.85391	0.83173	997.85
7/30/99 19:30	0.66016	0.63983	997.65
7/30/99 20:30	0.32457	0.26278	998.05
7/30/99 21:30	0.03666	-0.03738	998.84
7/30/99 22:30	0.06503	-0.01093	999.42
7/30/99 23:27	0.05960	-0.00909	999.29

Table A-2. Vadose Zone Differential Pressures and Barometric Pressure Recorded During SVE Testing on MSB 67D.

Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
8/4/99 7:30	-0.97644	-1.88166	1004.32	8/6/99 6:30	-1.48778	-1.79737	1002.94
8/4/99 8:30	-1.41108	-1.77438	1004.57	8/6/99 7:30	-1.89684	-2.28013	1003.23
8/4/99 9:30	-1.38852	-1.78664	1004.47	8/6/99 8:30	-2.08634	-2.46558	1003.60
8/4/99 10:30	-1.20053	-1.55675	1004.50	8/6/99 9:30	-2.09236	-2.52994	1003.84
8/4/99 11:30	-0.71476	-1.06633	1004.40	8/6/99 10:30	-2.00814	-2.45178	1003.91
8/4/99 12:30	-0.17184	-0.45330	1003.90	8/6/99 11:30	-1.76600	-2.20504	1003.95
8/4/99 13:30	0.42071	0.19652	1003.30	8/6/99 12:30	-1.39453	-1.81729	1003.72
8/4/99 14:30	1.33961	1.21262	1002.64	8/6/99 13:30	-0.98697	-1.34679	1003.40
8/4/99 15:30	1.99833	1.91301	1001.60	8/6/99 14:30	-0.36735	-0.68472	1002.96
8/4/99 16:30	2.21339	2.13064	1000.91	8/6/99 15:30	0.07029	-0.19889	1002.41
8/4/99 17:30	2.20738	2.16436	1000.71	8/6/99 16:30	0.15151	-0.13145	1002.04
8/4/99 18:30	2.20738	2.14443	1000.64	8/6/99 17:30	0.19211	-0.08088	1001.96
8/4/99 19:30	1.67047	1.61876	1000.70	8/6/99 18:30	-0.05904	-0.34601	1001.89
8/4/99 20:30	1.16365	1.06703	1001.26	8/6/99 19:30	-0.59595	-0.91000	1002.16
8/4/99 21:30	0.58013	0.46012	1001.77	8/6/99 20:30	-1.42160	-1.81423	1002.75
8/4/99 22:30	0.65382	0.56894	1002.18	8/6/99 21:30	-2.13146	-2.56673	1003.67
8/4/99 23:30	0.66435	0.58733	1002.03	8/6/99 22:30	-2.22169	-2.65408	1004.23
8/5/99 0:30	0.81173	0.77124	1001.95	8/6/99 23:30	-2.37058	-2.83493	1004.32
8/5/99 1:30	0.84632	0.82641	1001.73	8/7/99 0:30	-2.05927	-2.47784	1004.47
8/5/99 2:30	1.01777	1.03791	1001.62	8/7/99 1:30	-1.65020	-2.01959	1004.08
8/5/99 3:30	1.01326	1.00113	1001.45	8/7/99 2:30	-1.58704	-1.97975	1003.79
8/5/99 4:30	1.02378	1.03025	1001.40	8/7/99 3:30	-1.92542	-2.34910	1003.86
8/5/99 5:30	0.66735	0.64403	1001.47	8/7/99 4:30	-2.12544	-2.56979	1004.16
8/5/99 6:30	0.39213	0.32679	1001.79	8/7/99 5:30	-2.55406	-3.03416	1004.43
8/5/99 7:30	0.13195	0.02334	1002.02	8/7/99 6:30	-2.90448	-3.41118	1004.95
8/5/99 8:30	0.00412	-0.14984	1002.32	8/7/99 7:30	-3.17518	-3.68091	1005.32
8/5/99 9:30	0.00562	-0.17436	1002.45	8/7/99 8:30	-3.39325	-3.97211	1005.75
8/5/99 10:30	0.07029	-0.11919	1002.45	8/7/99 9:30	-3.46845	-4.08092	1006.11
8/5/99 11:30	0.54253	0.38043	1002.36	8/7/99 10:30	-3.46544	-4.10237	1006.25
8/5/99 12:30	0.98468	0.85553	1001.87	8/7/99 11:30	-3.21128	-3.83571	1006.34
8/5/99 13:30	1.35615	1.24787	1001.38	8/7/99 12:30	-2.70596	-3.30850	1006.14
8/5/99 14:30	1.63588	1.56818	1000.96	8/7/99 13:30	-2.23372	-2.77363	1005.71
8/5/99 15:30	2.00585	1.93600	1000.53	8/7/99 14:30	-1.26219	-1.71921	1005.26
8/5/99 16:30	2.10962	2.07547	1000.12	8/7/99 15:30	-0.62753	-1.01882	1004.35
8/5/99 17:30	2.07804	2.04635	999.95	8/7/99 16:30	-0.54030	-0.92380	1003.78
8/5/99 18:30	1.81335	1.77355	999.95	8/7/99 17:30	-0.33126	-0.66632	1003.75
8/5/99 19:30	1.25539	1.23255	1000.14	8/7/99 18:30	-0.37637	-0.74142	1003.52
8/5/99 20:30	0.71097	0.60725	1000.57	8/7/99 19:30	-0.62603	-0.99736	1003.61
8/5/99 21:30	-0.08311	-0.26019	1001.16	8/7/99 20:30	-1.09074	-1.45407	1003.90
8/5/99 22:30	-0.58241	-0.78127	1001.91	8/7/99 21:30	-1.51334	-1.90465	1004.36
8/5/99 23:30	-0.92080	-1.15215	1002.35	8/7/99 22:30	-1.80962	-2.23416	1004.81
8/6/99 0:30	-0.97343	-1.20426	1002.58	8/7/99 23:30	-1.85323	-2.27094	1005.09
8/6/99 1:30	-0.78995	-1.01422	1002.58	8/8/99 0:30	-1.46973	-1.83568	1005.11
8/6/99 2:30	-0.67716	-0.89774	1002.37	8/8/99 1:30	-1.15541	-1.48626	1004.70
8/6/99 3:30	-0.77040	-1.01422	1002.31	8/8/99 2:30	-0.60046	-0.88242	1004.41
8/6/99 4:30	-0.91779	-1.17361	1002.36	8/8/99 3:30	-0.49970	-0.77667	1003.86
8/6/99 5:30	-1.23361	-1.54296	1002.54	8/8/99 4:30	-0.46661	-0.71843	1003.71

Table A-2 Continued

Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
8/8/99 5:30	-0.75085	-1.04181	1003.69	8/10/99 4:30	1.17568	1.19117	998.68
8/8/99 6:30	-1.27723	-1.64105	1004.08	8/10/99 5:30	0.78616	0.80036	998.89
8/8/99 7:30	-1.78104	-2.14986	1004.73	8/10/99 6:30	0.37559	0.31759	999.23
8/8/99 8:30	-1.51485	-1.85254	1005.10	8/10/99 7:30	-0.27862	-0.41038	999.69
8/8/99 9:30	-1.11931	-1.46786	1004.77	8/10/99 8:30	-0.75837	-0.94372	1000.35
8/8/99 10:30	-0.84710	-1.17974	1004.43	8/10/99 9:30	-1.02005	-1.26710	1000.77
8/8/99 11:30	-0.49669	-0.80426	1004.14	8/10/99 10:30	-1.18549	-1.47553	1001.08
8/8/99 12:30	0.11692	-0.12226	1003.78	8/10/99 11:30	-0.84109	-1.10618	1001.23
8/8/99 13:30	1.08996	0.89231	1003.21	8/10/99 12:30	-0.26207	-0.49927	1000.84
8/8/99 14:30	2.33521	2.28696	1002.18	8/10/99 13:30	0.18158	-0.01038	1000.31
8/8/99 15:30	3.16688	3.21877	1000.83	8/10/99 14:30	0.83128	0.71147	999.82
8/8/99 16:30	3.00295	3.03333	999.97	8/10/99 15:30	1.45090	1.35975	999.07
8/8/99 17:30	2.72774	2.71455	1000.10	8/10/99 16:30	1.58024	1.50841	998.47
8/8/99 18:30	2.05999	2.03102	1000.38	8/10/99 17:30	1.54565	1.42872	998.34
8/8/99 19:30	1.70958	1.69845	1001.23	8/10/99 18:30	1.19222	1.05630	998.40
8/8/99 20:30	1.38473	1.36895	1001.33	8/10/99 19:30	0.65983	0.51683	998.76
8/8/99 21:30	1.02980	0.99193	1001.46	8/10/99 20:30	0.33348	0.14748	999.10
8/8/99 22:30	1.23283	1.23714	1001.59	8/10/99 21:30	-0.31471	-0.54372	999.50
8/8/99 23:30	1.53662	1.56818	1001.32	8/10/99 22:30	-0.68167	-0.92380	1000.10
8/9/99 0:30	1.68852	1.73677	1000.94	8/10/99 23:30	-0.95839	-1.20579	1000.46
8/9/99 1:30	1.68702	1.75516	1000.69	8/11/99 0:30	-0.70122	-0.93606	1000.56
8/9/99 2:30	1.97427	2.04022	1000.49	8/11/99 1:30	-0.54181	-0.76134	1000.38
8/9/99 3:30	1.87802	1.97125	1000.20	8/11/99 2:30	-0.44555	-0.65253	1000.14
8/9/99 4:30	1.72612	1.79194	1000.28	8/11/99 3:30	-0.60647	-0.82571	1000.07
8/9/99 5:30	1.26742	1.28925	1000.49	8/11/99 4:30	-0.73130	-0.95598	1000.23
8/9/99 6:30	1.24937	1.29845	1000.79	8/11/99 5:30	-1.05164	-1.36518	1000.37
8/9/99 7:30	1.41932	1.48389	1000.67	8/11/99 6:30	-1.72690	-2.08090	1000.84
8/9/99 8:30	1.32307	1.35209	1000.34	8/11/99 7:30	-2.08784	-2.44719	1001.51
8/9/99 9:30	1.16064	1.14366	1000.52	8/11/99 8:30	-2.14650	-2.60811	1001.86
8/9/99 10:30	1.08845	1.04097	1000.71	8/11/99 9:30	-2.28185	-2.73684	1001.97
8/9/99 11:30	1.43737	1.41646	1000.71	8/11/99 10:30	-2.19462	-2.63723	1002.12
8/9/99 12:30	1.90358	1.92068	1000.30	8/11/99 11:30	-1.78706	-2.21577	1002.11
8/9/99 13:30	2.45402	2.53677	999.70	8/11/99 12:30	-1.38701	-1.77898	1001.72
8/9/99 14:30	3.26464	3.40268	999.06	8/11/99 13:30	-0.63204	-0.94525	1001.30
8/9/99 15:30	3.97148	4.18583	998.01	8/11/99 14:30	0.26129	0.01414	1000.54
8/9/99 16:30	4.05420	4.25020	997.27	8/11/99 15:30	0.70946	0.48465	999.64
8/9/99 17:30	4.01811	4.23488	997.10	8/11/99 16:30	0.76962	0.56127	999.28
8/9/99 18:30	3.53234	3.68774	997.02	8/11/99 17:30	0.88392	0.67009	999.11
8/9/99 19:30	2.79240	2.87547	997.37	8/11/99 18:30	0.48538	0.23790	999.04
8/9/99 20:30	2.02239	2.08773	998.11	8/11/99 19:30	0.18459	-0.06862	999.43
8/9/99 21:30	1.47797	1.49768	998.76	8/11/99 20:30	-0.24854	-0.54065	999.63
8/9/99 22:30	1.38774	1.42259	999.10	8/11/99 21:30	-0.86365	-1.17361	1000.13
8/9/99 23:30	1.39826	1.44558	999.08	8/11/99 22:30	-1.12232	-1.51384	1000.54
8/10/99 0:30	1.52459	1.59270	998.98	8/11/99 23:30	-1.62614	-2.00427	1001.04
8/10/99 1:30	1.49903	1.56358	998.74	8/12/99 0:30	-1.51785	-1.90312	1001.38
8/10/99 2:30	1.48399	1.53753	998.74	8/12/99 1:30	-1.23060	-1.58128	1001.33
8/10/99 3:30	1.40428	1.44404	998.66	8/12/99 2:30	-1.21707	-1.50465	1000.99

Table A-2 Continued

Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 68D (mb)	Barometric Pressure (mb)
8/12/99 3:30	-1.08623	-1.41116	1000.91	8/12/99 6:30	-1.64870	-1.99661	1001.30
8/12/99 4:30	-1.18097	-1.52304	1000.87	8/12/99 7:02	-1.75397	-2.12841	1001.54
8/12/99 5:30	-1.50733	-1.88319	1001.01				

Table A-3. Vadose Zone Differential Pressures and Barometric Pressure Recorded During SVE Testing on MSB 68D.

Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)
7/26/99 7:40	-0.93168	-0.83615	1003.33	7/28/99 13:30	-1.05100	-1.03961	1004.96
7/26/99 8:30	-1.13836	-1.01103	1003.58	7/28/99 14:30	-0.29237	-0.35682	1004.23
7/26/99 9:30	-1.25024	-1.08322	1003.83	7/28/99 15:30	0.48158	0.34852	1003.62
7/26/99 10:30	-1.35905	-1.17797	1004.02	7/28/99 16:30	1.20189	0.99070	1002.93
7/26/99 11:30	-1.11690	-0.94335	1004.05	7/28/99 17:30	1.48695	1.28246	1002.26
7/26/99 12:30	-0.82878	-0.66964	1003.84	7/28/99 18:30	1.37048	1.20426	1001.98
7/26/99 13:30	-0.18663	-0.08762	1003.52	7/28/99 19:30	0.91224	0.78165	1002.14
7/26/99 14:30	0.38656	0.41319	1002.91	7/28/99 20:30	0.69461	0.56208	1002.44
7/26/99 15:30	0.91530	0.88392	1002.45	7/28/99 21:30	0.52909	0.39815	1002.62
7/26/99 16:30	1.33676	1.28096	1001.88	7/28/99 22:30	0.54135	0.38913	1002.77
7/26/99 17:30	1.66473	1.58325	1001.42	7/28/99 23:30	0.65476	0.49891	1002.71
7/26/99 18:30	1.66933	1.64040	1000.97	7/29/99 0:30	0.54288	0.38311	1002.59
7/26/99 19:30	1.02718	1.01326	1001.05	7/29/99 1:30	1.12527	0.90347	1002.55
7/26/99 20:30	0.42947	0.43876	1001.61	7/29/99 2:30	1.63715	1.36367	1001.96
7/26/99 21:30	-0.16210	-0.11469	1002.15	7/29/99 3:30	1.64941	1.38322	1001.48
7/26/99 22:30	-0.51153	-0.41848	1002.63	7/29/99 4:30	1.64634	1.38172	1001.41
7/26/99 23:30	-0.50234	-0.42901	1002.83	7/29/99 5:30	1.08389	0.88693	1001.41
7/27/99 0:30	-0.33069	-0.28163	1002.82	7/29/99 6:30	0.92143	0.73353	1001.93
7/27/99 1:30	0.01568	0.02518	1002.60	7/29/99 7:30	0.86626	0.67938	1002.04
7/27/99 2:30	0.02181	0.02518	1002.31	7/29/99 8:30	0.63944	0.64179	1002.11
7/27/99 3:30	-0.17590	-0.14026	1002.31	7/29/99 9:30	0.46932	0.82978	1002.10
7/27/99 4:30	-0.44257	-0.40344	1002.44	7/29/99 10:30	1.18810	1.11252	1001.93
7/27/99 5:30	-0.90541	-0.82154	1002.73	7/29/99 11:30	1.69692	1.58174	1001.60
7/27/99 6:30	-1.57821	-1.42160	1003.12	7/29/99 12:30	2.12451	1.97276	1001.11
7/27/99 7:30	-2.26481	-2.03821	1003.84	7/29/99 13:30	2.63486	2.44500	1000.67
7/27/99 8:30	-2.59278	-2.33900	1004.47	7/29/99 14:30	3.14674	2.96686	1000.13
7/27/99 9:30	-2.51768	-2.26380	1004.79	7/29/99 15:30	3.56667	3.40150	999.47
7/27/99 10:30	-2.56060	-2.27132	1004.78	7/29/99 16:30	3.98047	3.84064	998.76
7/27/99 11:30	-2.15140	-1.88632	1004.86	7/29/99 17:30	3.98353	3.83764	998.12
7/27/99 12:30	-1.93837	-1.71036	1004.51	7/29/99 18:30	3.16054	3.00897	998.09
7/27/99 13:30	-1.25943	-1.11029	1004.37	7/29/99 19:30	2.55210	2.43447	998.50
7/27/99 14:30	-0.89468	-0.77642	1003.75	7/29/99 20:30	2.48160	2.36078	998.73
7/27/99 15:30	-0.32303	-0.22748	1003.40	7/29/99 21:30	2.13524	2.03593	999.05
7/27/99 16:30	-0.09314	-0.02295	1002.92	7/29/99 22:30	2.24558	2.12616	999.11
7/27/99 17:30	-0.11459	-0.04701	1002.71	7/29/99 23:30	1.89156	1.84343	998.92
7/27/99 18:30	-0.14678	-0.05453	1002.75	7/30/99 0:30	1.95286	1.87952	999.08
7/27/99 19:30	-0.51000	-0.41698	1002.73	7/30/99 1:30	2.08619	2.00134	998.87
7/27/99 20:30	-1.07246	-0.93583	1003.06	7/30/99 2:30	1.98351	1.90358	998.66
7/27/99 21:30	-1.57668	-1.40356	1003.51	7/30/99 3:30	2.04022	1.96524	998.63
7/27/99 22:30	-1.79277	-1.61711	1004.02	7/30/99 4:30	1.89309	1.82839	998.50
7/27/99 23:30	-1.62879	-1.48026	1004.11	7/30/99 5:30	1.19883	1.22531	998.57
7/28/99 0:30	-1.32687	-1.21406	1004.00	7/30/99 6:30	0.42487	0.51094	999.13
7/28/99 1:30	-1.11077	-1.02156	1003.79	7/30/99 7:30	0.11989	0.24174	999.79
7/28/99 2:30	-0.89621	-0.82906	1003.53	7/30/99 8:30	-0.39506	-0.19891	999.98
7/28/99 3:30	-1.04947	-0.98246	1003.45	7/30/99 9:30	-0.90234	-0.63505	1000.43
7/28/99 4:30	-1.06173	-0.98546	1003.53	7/30/99 10:30	-0.82725	-0.53729	1000.86
7/28/99 5:30	-1.42189	-1.31332	1003.59	7/30/99 11:30	-0.57130	-0.29366	1000.74
7/28/99 6:30	-1.90465	-1.75247	1003.94	7/30/99 12:30	-0.38586	-0.11319	1000.53
7/28/99 7:30	-2.33377	-2.13146	1004.44	7/30/99 13:30	0.35284	0.55155	1000.30
7/28/99 8:30	-2.61117	-2.38412	1004.88	7/30/99 14:30	0.83407	0.99070	999.50
7/28/99 9:30	-2.69393	-2.48638	1005.19	7/30/99 15:30	1.27546	1.37270	998.96
7/28/99 10:30	-2.84412	-2.64580	1005.48	7/30/99 16:30	1.62795	1.69754	998.54
7/28/99 11:30	-2.44872	-2.30291	1005.75	7/30/99 17:30	1.89002	1.97276	998.15
7/28/99 12:30	-1.85101	-1.74645	1005.44	7/30/99 18:30	2.07240	2.12767	997.85

Table A-3 Continued

Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)
7/30/99 19:30	1.59424	1.64491	997.65	8/2/99 1:30	-2.22343	-1.86225	1001.74
7/30/99 20:30	0.65476	0.80872	998.05	8/2/99 2:30	-2.12841	-1.77954	1001.42
7/30/99 21:30	-0.09314	0.09135	998.84	8/2/99 3:30	-2.17898	-1.84421	1001.40
7/30/99 22:30	-0.02724	0.16203	999.42	8/2/99 4:30	-2.37975	-2.02468	1001.46
7/30/99 23:30	-0.02264	0.14850	999.29	8/2/99 5:30	-2.91156	-2.48939	1001.75
7/31/99 0:30	0.13675	0.28536	999.26	8/2/99 6:30	-3.33915	-2.88041	1002.29
7/31/99 1:30	0.27008	0.39965	998.95	8/2/99 7:30	-3.86176	-3.34964	1002.73
7/31/99 2:30	0.46166	0.56659	998.79	8/2/99 8:30	-4.26483	-3.70457	1003.39
7/31/99 3:30	0.45093	0.55606	998.51	8/2/99 9:30	-4.37824	-3.81135	1003.68
7/31/99 4:30	0.05246	0.19362	998.52	8/2/99 10:30	-4.63725	-4.01889	1003.87
7/31/99 5:30	-0.14218	0.01465	998.84	8/2/99 11:30	-4.36445	-3.78728	1004.20
7/31/99 6:30	-1.30388	-1.03359	999.13	8/2/99 12:30	-3.82191	-3.30001	1003.90
7/31/99 7:30	-1.64105	-1.32686	1000.13	8/2/99 13:30	-3.43877	-2.95411	1003.52
7/31/99 8:30	-2.13147	-1.75247	1000.30	8/2/99 14:30	-2.92382	-2.47887	1003.25
7/31/99 9:30	-2.52535	-2.09386	1000.90	8/2/99 15:30	-2.43033	-2.05777	1002.78
7/31/99 10:30	-2.99585	-2.51797	1001.34	8/2/99 16:30	-1.99507	-1.64268	1002.37
7/31/99 11:30	-2.65715	-2.19613	1001.71	8/2/99 17:30	-1.70235	-1.39152	1002.03
7/31/99 12:30	-2.29086	-1.84270	1001.32	8/2/99 18:30	-1.86174	-1.51034	1001.82
7/31/99 13:30	-1.82189	-1.44115	1001.08	8/2/99 19:30	-2.42573	-2.03821	1002.00
7/31/99 14:30	-1.20120	-0.85161	1000.59	8/2/99 20:30	-3.01118	-2.56760	1002.66
7/31/99 15:30	-0.83797	-0.52526	1000.08	8/2/99 21:30	-3.39892	-2.94659	1003.15
7/31/99 16:30	-0.60655	-0.29215	999.68	8/2/99 22:30	-3.56291	-3.09848	1003.54
7/31/99 17:30	-0.47169	-0.18989	999.46	8/2/99 23:30	-3.65946	-3.17970	1003.79
7/31/99 18:30	-0.32456	-0.07559	999.37	8/3/99 0:30	-3.44949	-3.01126	1003.87
7/31/99 19:30	-0.89468	-0.59595	999.27	8/3/99 1:30	-2.98512	-2.57812	1003.63
7/31/99 20:30	-1.88319	-1.51334	999.85	8/3/99 2:30	-2.74144	-2.37209	1003.21
7/31/99 21:30	-2.49929	-2.06980	1000.70	8/3/99 3:30	-3.38972	-2.96313	1003.17
7/31/99 22:30	-2.66481	-2.23072	1001.18	8/3/99 4:30	-3.94605	-3.46394	1003.90
7/31/99 23:30	-2.59431	-2.17507	1001.40	8/3/99 5:30	-4.28782	-3.77976	1004.37
8/1/99 0:30	-2.20964	-1.83970	1001.30	8/3/99 6:30	-4.70315	-4.17981	1004.82
8/1/99 1:30	-1.74679	-1.41108	1000.92	8/3/99 7:30	-4.88093	-4.43848	1005.30
8/1/99 2:30	-1.21959	-0.96892	1000.46	8/3/99 8:30	-5.18744	-4.71220	1005.92
8/1/99 3:30	-1.17054	-0.91929	999.93	8/3/99 9:30	-5.07250	-4.62347	1006.35
8/1/99 4:30	-1.32993	-1.06818	999.97	8/3/99 10:30	-4.75679	-4.30614	1006.43
8/1/99 5:30	-1.80810	-1.49981	1000.18	8/3/99 11:30	-4.17747	-3.78728	1006.29
8/1/99 6:30	-2.36749	-2.01415	1000.66	8/3/99 12:30	-3.52459	-3.20977	1005.93
8/1/99 7:30	-2.92842	-2.50443	1001.19	8/3/99 13:30	-2.57286	-2.34201	1005.36
8/1/99 8:30	-3.34068	-2.87289	1001.75	8/3/99 14:30	-1.87400	-1.72389	1004.59
8/1/99 9:30	-3.58130	-3.08194	1002.11	8/3/99 15:30	-1.46020	-1.32535	1004.00
8/1/99 10:30	-3.71463	-3.16014	1002.44	8/3/99 16:30	-1.15982	-1.10578	1003.57
8/1/99 11:30	-3.65333	-3.10300	1002.66	8/3/99 17:30	-1.03108	-0.94185	1003.33
8/1/99 12:30	-3.21348	-2.67438	1002.63	8/3/99 18:30	-1.00349	-0.91478	1003.32
8/1/99 13:30	-2.85025	-2.39916	1002.24	8/3/99 19:30	-1.27169	-1.18699	1003.39
8/1/99 14:30	-2.30312	-1.90888	1001.99	8/3/99 20:30	-1.70388	-1.59456	1003.72
8/1/99 15:30	-1.71308	-1.35092	1001.47	8/3/99 21:30	-1.96902	-1.82466	1004.17
8/1/99 16:30	-1.02342	-0.72829	1001.00	8/3/99 22:30	-1.66863	-1.58102	1004.35
8/1/99 17:30	-0.59429	-0.31170	1000.38	8/3/99 23:30	-1.51997	-1.44717	1004.11
8/1/99 18:30	-0.99276	-0.66964	999.96	8/4/99 0:30	-1.06480	-1.05765	1003.95
8/1/99 19:30	-1.80810	-1.41258	1000.38	8/4/99 1:30	-0.78127	-0.77491	1003.57
8/1/99 20:30	-2.17898	-1.80661	1001.09	8/4/99 2:30	-0.47015	-0.57489	1003.30
8/1/99 21:30	-2.63723	-2.21718	1001.45	8/4/99 3:30	-0.34908	-0.43954	1003.07
8/1/99 22:30	-2.73991	-2.32998	1001.96	8/4/99 4:30	-0.35674	-0.42450	1002.98
8/1/99 23:30	-2.69087	-2.29087	1001.93	8/4/99 5:30	-0.86403	-0.88320	1003.07
8/2/99 0:30	-2.56673	-2.17357	1002.01	8/4/99 6:15	-1.48604	-1.42654	1003.44

Table A-4. Vadose Zone Differential Pressures and Barometric Pressure Recorded During SVE Testing on MSB 68D.

Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)	Date/Time	MSB 47D (mb)	MSB 67D (mb)	Barometric Pressure (mb)
8/16/99 7:30	-	-6.54850	1009.50	8/18/99 13:30	3.64943	3.64964	1001.45
8/16/99 8:30	-	-6.96809	1010.18	8/18/99 14:30	4.56438	4.46929	1000.67
8/16/99 9:30	-	-7.19218	1010.86	8/18/99 15:30	5.09772	4.98664	999.69
8/16/99 10:30	-	-7.12751	1011.39	8/18/99 16:30	5.04255	4.94603	999.08
8/16/99 11:30	-	-5.99655	1011.51	8/18/99 17:30	4.71917	4.65878	999.05
8/16/99 12:30	-	-3.25188	1011.06	8/18/99 18:30	4.34369	4.34145	999.23
8/16/99 13:30	-	-5.39198	1010.37	8/18/99 19:30	3.75978	3.78801	999.38
8/16/99 14:30	-	-4.72573	1010.02	8/18/99 20:30	2.79118	2.89166	999.84
8/16/99 15:30	-	-4.87613	1010.10	8/18/99 21:30	1.85171	2.00886	1000.62
8/16/99 16:30	-	-4.29411	1010.13	8/18/99 22:30	1.72757	1.90659	1001.29
8/16/99 17:30	-	-3.99332	1009.40	8/18/99 23:30	1.77202	1.95472	1001.29
8/16/99 18:30	-	-3.58425	1009.27	8/19/99 0:30	1.84405	2.01187	1001.11
8/16/99 19:30	-	-3.67148	1008.85	8/19/99 1:30	1.81799	1.97577	1000.90
8/16/99 20:30	-	-4.24899	1009.35	8/19/99 2:30	1.71991	1.89606	1000.80
8/16/99 21:30	-	-4.53323	1010.01	8/19/99 3:30	1.61876	1.79530	1000.62
8/16/99 22:30	-	-4.36329	1010.31	8/19/99 4:30	1.26780	1.46744	1000.83
8/16/99 23:30	-	-4.23395	1010.32	8/19/99 5:30	0.86166	1.08845	1000.98
8/17/99 0:30	-	-3.93768	1010.28	8/19/99 6:20	0.23075	0.52999	1001.38
8/17/99 1:30	-	-3.39325	1010.07				
8/17/99 2:30	-	-3.26993	1009.65				
8/17/99 3:30	-	-3.06540	1009.61				
8/17/99 4:30	-	-2.88944	1009.50				
8/17/99 5:30	-	-2.86838	1009.42				
8/17/99 6:30	-	-2.98569	1009.54				
8/17/99 7:30	-	-2.88342	1009.67				
8/17/99 8:30	-	-2.99471	1009.70				
8/17/99 9:30	-	-2.85184	1009.93				
8/17/99 10:30	-2.53608	-2.31945	1009.80				
8/17/99 11:30	-1.81576	-1.58854	1009.43				
8/17/99 12:30	-1.10311	-0.83056	1008.79				
8/17/99 13:30	-0.24946	-0.01242	1007.90				
8/17/99 14:30	0.83867	0.99220	1006.80				
8/17/99 15:30	1.60037	1.70206	1005.71				
8/17/99 16:30	2.00957	2.09759	1004.90				
8/17/99 17:30	2.29003	2.35326	1004.42				
8/17/99 18:30	1.90382	1.99833	1004.24				
8/17/99 19:30	1.49922	1.61784	1004.41				
8/17/99 20:30	1.32757	1.46143	1004.71				
8/17/99 21:30	0.67622	0.86136	1004.74				
8/17/99 22:30	0.77277	0.93806	1005.16				
8/17/99 23:30	0.99193	1.13056	1005.14				
8/18/99 0:30	1.28006	1.39225	1004.79				
8/18/99 1:30	1.64941	1.73815	1004.40				
8/18/99 2:30	1.83179	1.90358	1003.94				
8/18/99 3:30	1.97432	2.02540	1003.67				
8/18/99 4:30	2.07853	2.11113	1003.41				
8/18/99 5:30	1.76742	1.83741	1003.24				
8/18/99 6:30	1.36282	1.46895	1003.46				
8/18/99 7:30	1.39347	1.47948	1003.77				
8/18/99 8:30	1.48389	1.57573	1003.59				
8/18/99 9:30	1.60496	1.70356	1003.40				
8/18/99 10:30	1.73370	1.83591	1003.19				
8/18/99 11:30	2.41110	2.47658	1002.97				
8/18/99 12:30	3.04559	3.04356	1002.24				