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REPORTS

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MAR 1995

Bio-Air Sparging Remediation Project for Shepard and Kelsey #1

CONOCO INC.
Midland Division
Farmington, New Mexico

Designed by

BioRem Environmental Consultants

March, 1995

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Bio-Air Sparging

Introduction

When designed and operated properly "Bio-Air Sparging" is a cost-effective in situ remediation process. The bio-air sparging process is best suited for the remediation of volatile and semi-volatile organic compounds in groundwater and soil environments. The design of bio-air sparging can take many forms depending on the required application. The basic system includes a surface air injection system, properly placed injection wells, bacterial nutrient stimulation when required, and a reliable monitoring program.

However, it should be noted, site evaluation and analysis, system design, insulation, operation, and monitoring are not trivial processes. In fact, soil is the most complex component of the ecosystem. Soil is hard to evaluate, analyze, and remediate. From a remediation point we are dealing with sand, silt, clay, and water which are physically, chemically, and biologically interactive.

Bio-air sparging is a remediation technology which is relatively inexpensive to implement, operate, and maintain. The technology is best applied to contaminants in relatively permeable soil. In addition, the water phase should not contain large amounts of non-aqueous phase liquids (NAPL). Free hydrocarbons must be recovered before bio-air sparging is applied. The application of bio-air sparging must be evaluated on a case-by-case basis.

The major advantage of bio-air sparging over other more costly remediation processes is that contaminants can be removed from both the soil and water phases. The remediation is accomplished by physical, chemical, and biological processes. The bio-air sparging process removes both dissolved and adsorbed phases. Mass transfer in bio-air sparging employs several advantageous mechanisms to remove contaminants from the saturated and interface zones. Therefore, bio-air sparging exhibits a "lower" asymptotic behavior as compared to vapor extraction and pump-and- treat methods. Remediation goals with bio-air sparging are obtained in less time and with reduced costs when compared to current available remediation technology. Bio-air sparging is an environmentally safe remediation process.

The bio-air sparging process does not produce a secondary waste stream which would require additional treatment or disposal. The secondary waste stream may have a major environmental impact as well as additional handling, permitting, and cost. When required, bio-air sparging can be combined with other remediation technology.

Contaminant biodegradation is a very important part of the bio-air sparging technology. The hydrocarbon biodegradation must be balanced with the physical and chemical processes. All three processes operate simultaneously although they are controlled by different parameters. An understanding of soil science, hydrology, chemistry, and microbiology is necessary for a successful remediation project.

Past experience has shown that the unsaturated and saturated zones contain a variety of indigenous microorganisms capable of biodegrading organic carbon contaminants. Air sparging increases the oxygen content of the groundwater and soil. In many environments, the oxygen content is the primary limiting parameter for the biodegradation of an overbalance of hydrocarbon contamination. The groundwater and soil above the groundwater are now large chemostats for the biodegradation of the contaminants. The chemostat area is astronomically larger in volume and surface area as compared to the contaminant. This bioreaction area rapidly and efficiently biodegrades the organic contaminant to CO_2, H_2O, and cell mass. In cases of large volumes of organic contaminants, other nutrients (nitrogen and phosphorous) may be required. Oxygen concentrations of 0.3 mg/l are considered sufficient to biodegrade petroleum constituents. The rate of biodegradation can be significantly enhanced by optimizing the nutrient requirements of the microorganism ecosystem.

As in all remediation projects, accurate site characterization is essential for the success of the remediation. The site investigation must utilize delineation applicable to the design of bio-air sparging technology. Although there are key design parameters which can be utilized, a majority of the case studies do not include many design parameters. Therefore professional judgment and experience based on site characterization (soil type, soil layering, hydrology, and biodegradation) are a major part of a successful bio-air sparging system.

Sampling and Analysis

All sampling was conducted using state-of-the-art scientific protocol for soil and groundwater environments. When required, samples were stored in a cooled, insulated container (~4°C) and/or analyzed within 24 hours. On-site samples were also conducted for benzene, toluene, ethylbenzene and xylene (BTEX), temperature and pH.

On-site soil samples were screened for volatile organic compounds (VOC) using an Organic Vapor Meter (OVM). Corrections for benzene were calculated from the OVM readings by using a 0.47 correction constant. In addition, laboratory analyses were conducted for volatile organic compounds and polynuclear aromatic hydrocarbons (PAHs). It should be noted PAHs were not detected in any of the samples obtained from the Shepard & Kelsey site designated as samples SK-DG-1. Results are reported in both parts per million (ppm) and parts per billion (ppb). Total xylene is the sum of the concentrations of o- m- and p-xylene.

Laboratory analytical methods for samples from the Salmon site employed the following Environmental Protection Agency (EPA) methods:

BTEX - Method 5030 and Method 8020

PAHs - Method 3520 and Method 8270

TDS - Method 160.1

In addition, during soil boring procedures, visual notations of the soil structure, texture, and moisture were recorded by experienced personnel. On-site visual observations are an important part of the total remediation design process.

Evaluation of the Contaminated Site

The Shepard and Kelsey #1 was contaminated with BTEX from the operation of a dehydrator unit drip pit. BTEX is the primary petroleum product contaminant identified at the site. Polynuclear aromatic hydrocarbons (PAHs) were not detected at the Shepard and Kelsey #1 site.

The site measures 260 feet by 180 feet at the longest and widest points with approximately 44,000 square feet of area. The site is somewhat rectangular-shaped (see attached drawing). The contaminated thickness ranges from 0.5 feet to 6.0 feet, with an average of 3.02 feet. Approximately 130,000 cubic feet are contaminated with BTEX. It should be noted the area of contamination is conservatively determined.

The average BTEX concentration of the 15 highest soil borings was 457.1 ppm as measured with the OVM. The BTEX distribution ranges from a high of 670 ppm to a low of 18 ppm in the 15 highest soil boring wells. The highest BTEX concentration was found in SB9 (670 ppm). Three other SB wells showed BTEX levels over 600 ppm (see attached table).

Analysis of the pH of both soil and water samples indicates alkaline pHs. The average soil pH was 8.37 and 8.67 for the water phase. The high alkaline pH environment wells require special precaution when adding nutrients.

Although the contamination is primarily associated with the capillary fringe area, clay lenses and clay ribbons will make bio-air sparging more difficult. The clay lenses and ribbons associated with the soil profile tends to absorb the BTEX contamination beyond the definition of the capillary zone. The capillary zone is defined in this application as the intermediate area between the unsaturated and saturated areas. The majority of the soil profile in the area is a medium, coarse sand, however clay ribbons are present. The presence of clay ribbons in the sand profile will smear the BTEX contamination outside the capillary fringe. The BTEX contamination is associated with a variety of soil profile types, clays, coarse, medium, and fine sands, and silts. The soil types display a wide distribution in a relatively small area. SB16, 18, and 19 show a high clay content with a plastic texture. Fortunately, the plastic clay is relatively shallow, approximately 12" in thickness.

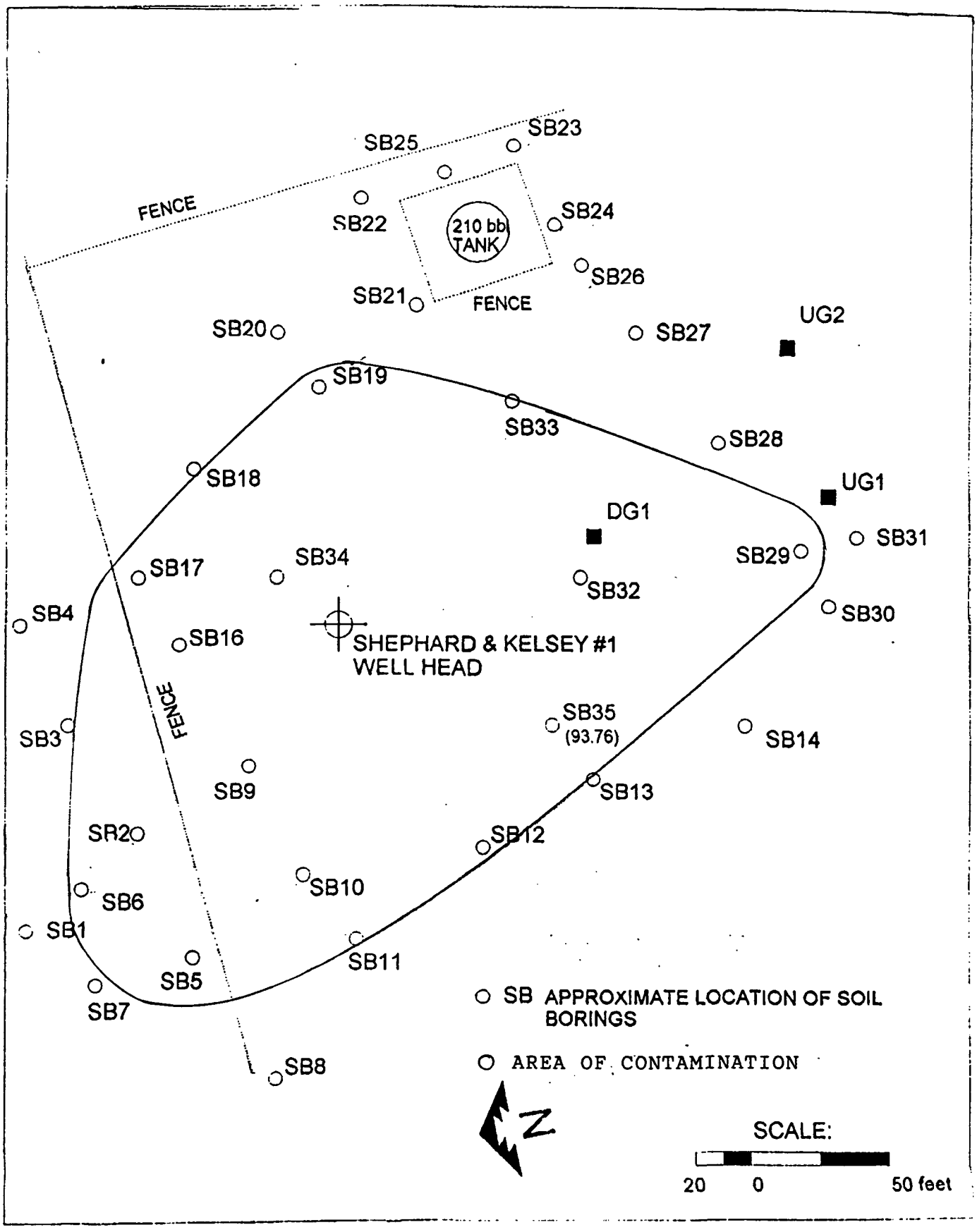
The vertical BTEX distribution ranges from 6.0 feet to 0.5 feet, averaging 3.02 feet. Although the vertical distribution is outside the capillary zone in some areas, the contamination is confined to the outlined site (see attached drawing). The movement of the BTEX contamination is relatively slow due to the type of soil profile present at the site..

The aquifer in the contaminated zone is an unconfined aquifer. The water table is determined to be approximately 6 feet (see attached relative groundwater levels). The aquifer dips slightly to the north (4 feet), the contamination is confined to the site map. The San Juan River is just over 0.5 miles to the north and is not impacted by the contaminated site.

The groundwater flow direction has been calculated and plotted from data obtained in late 1994 evaluations. Groundwater flow is to the north and contains a hydraulic gradient of 0.0133 ft/ft.

It can be estimated that the groundwater velocity in the plastic clays found in various areas of the aquifer sands is small due to the low hydraulic conductivity associated with the fine-grained material. The hydraulic conductivity in the majority of the coarse-grained aquifer is estimated to be 13.4 feet/year (4.2 meters/year).

The aquifer hydraulics and soil profile indicate the Shepard & Kelsey #1 site can be successfully remediated using modified Bio-Air Sparging technology.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FENCE
SB22
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SB24
SB26
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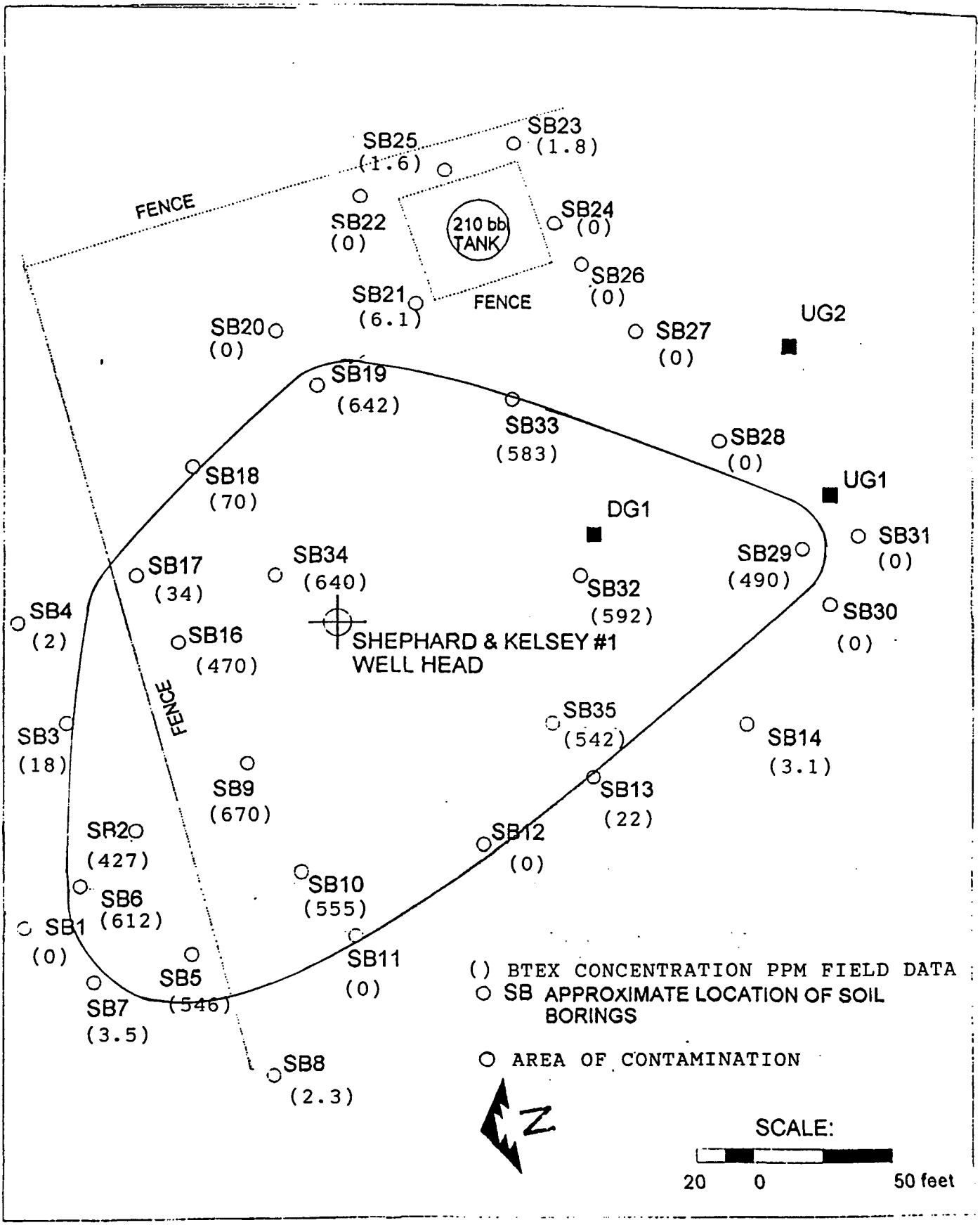
SB27
UG2
SB19
SB33
SB28
SB18
UG1
DG1
SB31
SB17
SB34
SB29
SB32
SB4
SB30
SB16
SHEPHARD & KELSEY #1 WELL HEAD
FENCE
SB35 (93.76)
SB14
SB3
SB9
SB13
SB12
SB10
SB6
SB1
SB11
SB5
SB7
SB8
SB APPROXIMATE LOCATION OF SOIL BORINGS
AREA OF CONTAMINATION
N
SCALE:
20 0 50 feet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SB23
(1.8)
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SB22
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TANK
SB24
(0)
SB26
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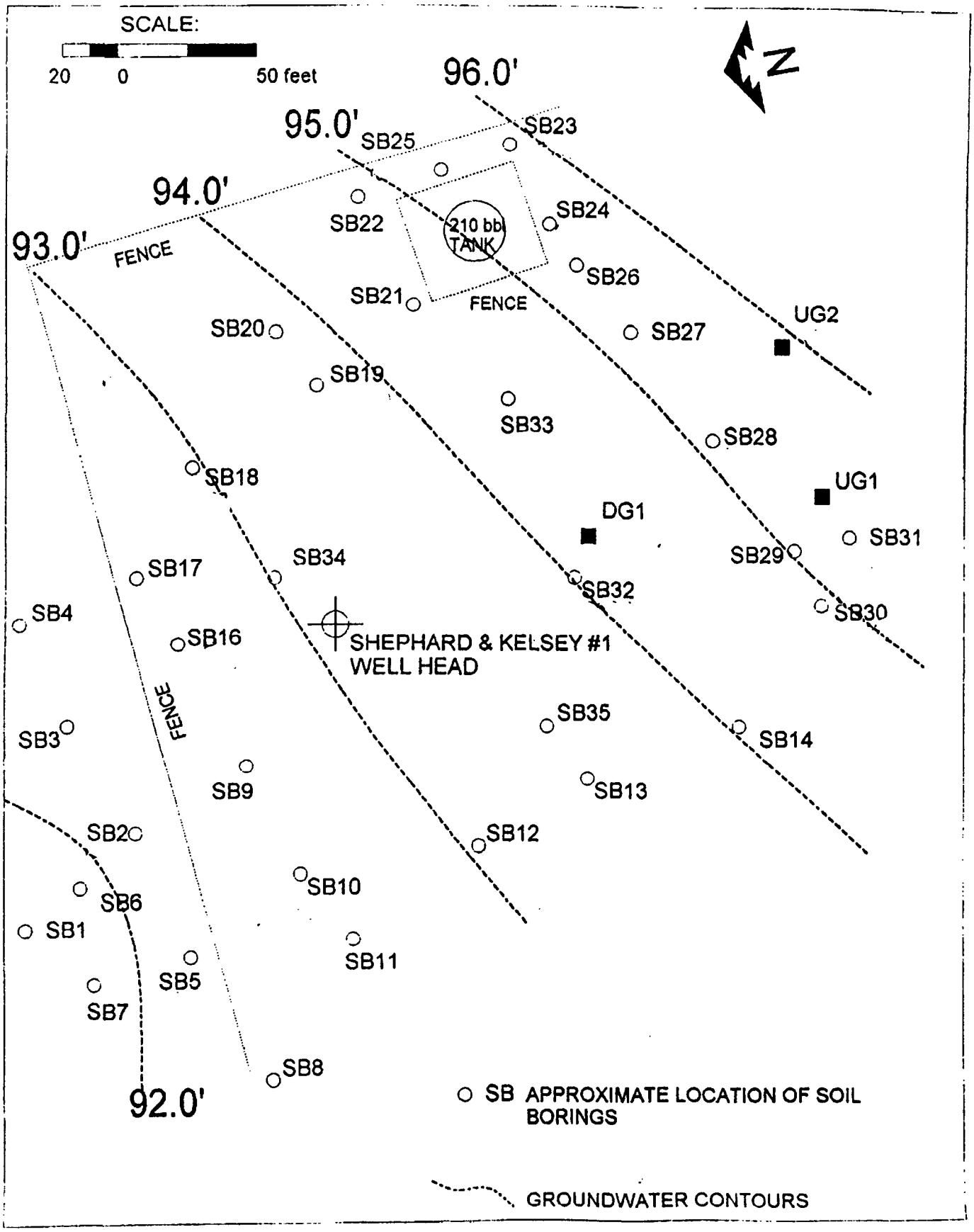
SB21
(6.1)
FENCE
SB20
(0)
SB27
(0)
UG2
SB19
(642)
SB33
(583)
SB28
(0)
SB18
(70)
UG1
DG1
SB31
(0)
SB29
(490)
SB17
(34)
SB34
(640)
SB32
(592)
SB30
(0)
SB4
(2)
SB16
(470)
SHEPHARD & KELSEY #1
WELL HEAD
FENCE
SB35
(542)
SB14
(3.1)
SB3
(18)
SB9
(670)
SB13
(22)
SB2
(427)
SB12
(0)
SB10
(555)
SB6
(612)
SB1
(0)
SB11
(0)
SB5
(546)
SB7
(3.5)
SB8
(2.3)
() BTEX CONCENTRATION PPM FIELD DATA
SB APPROXIMATE LOCATION OF SOIL BORINGS
AREA OF CONTAMINATION
N
SCALE:
20
0
50 feet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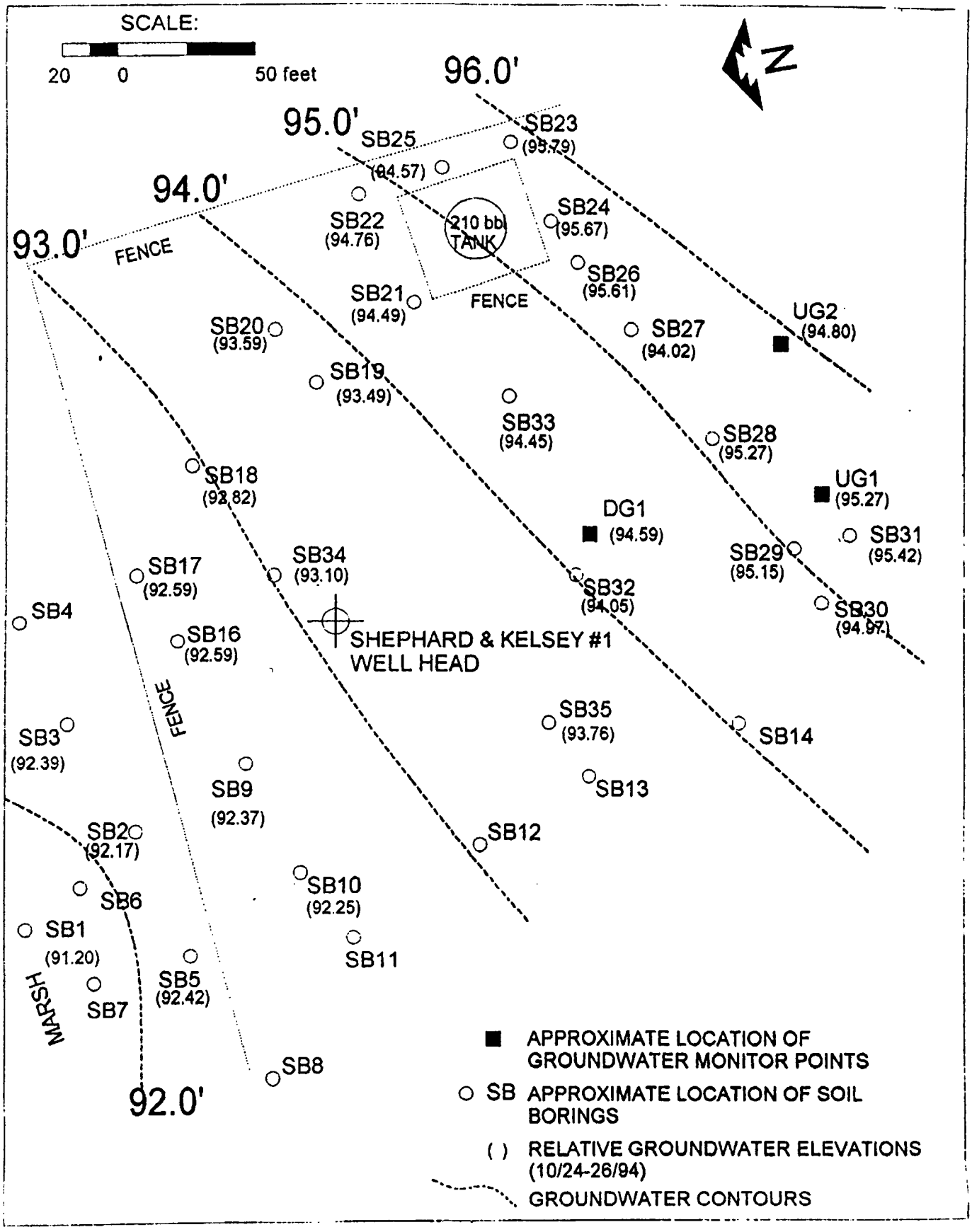
SB26
SB21
FENCE
FENCE
SB20
SB27
UG2
SB19
SB33
SB28
SB18
UG1
DG1
SB31
SB17
SB34
SB29
SB32
SB4
SB30
SB16
SHEPHARD & KELSEY #1 WELL HEAD
FENCE
SB35
SB3
SB14
SB9
SB13
SB2
SB12
SB10
SB6
SB1
SB11
SB5
SB7
SB8
SB APPROXIMATE LOCATION OF SOIL BORINGS
GROUNDWATER CONTOURS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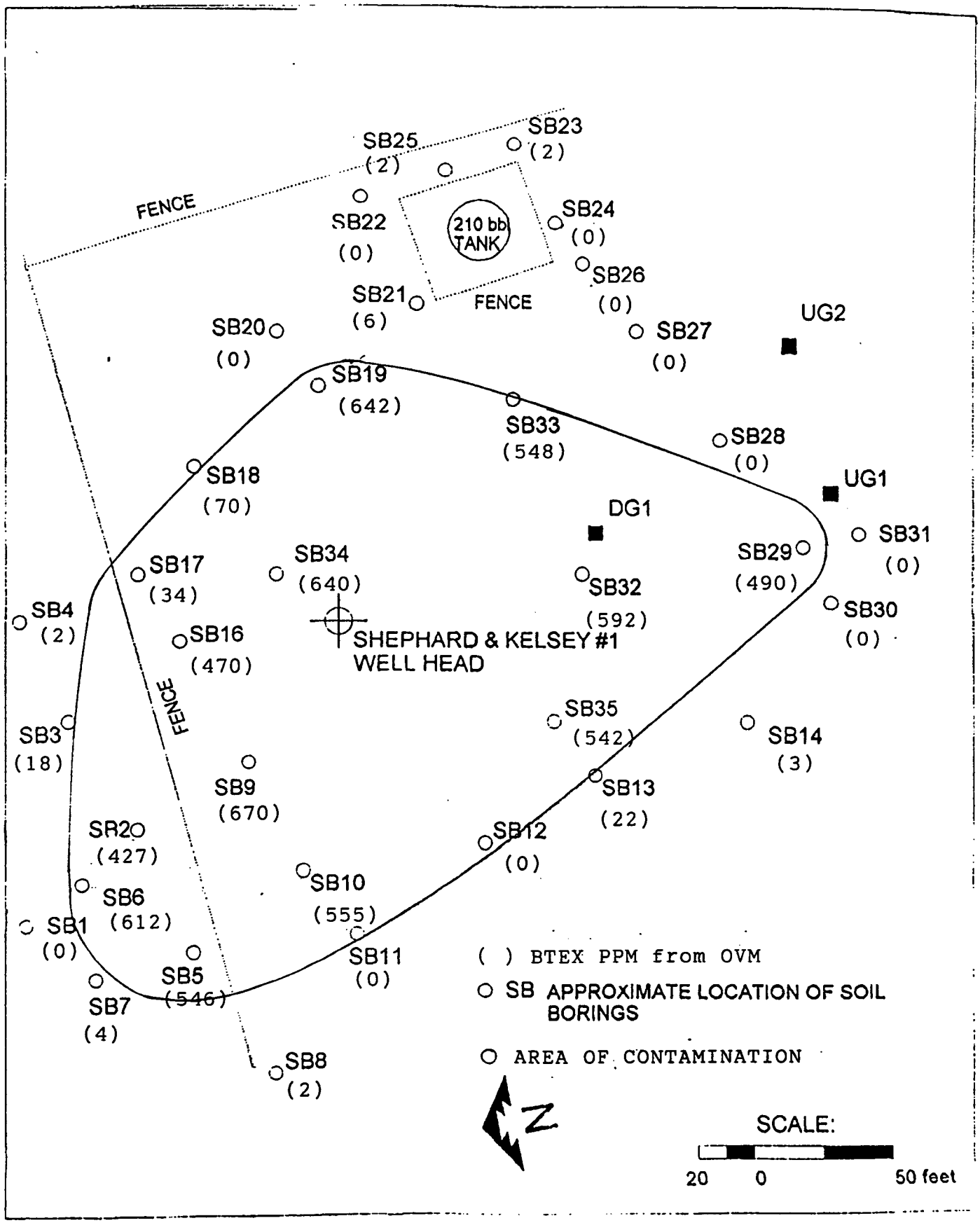
SB23 (95.79)
SB22 (94.76)
210 bbl TANK
SB24 (95.67)
SB26 (95.61)
FENCE
SB21 (94.49)
SB20 (93.59)
SB27 (94.02)
UG2 (94.80)
SB19 (93.49)
SB33 (94.45)
SB28 (95.27)
SB18 (93.82)
UG1 (95.27)
DG1 (94.59)
SB31 (95.42)
SB17 (92.59)
SB34 (93.10)
SB29 (95.15)
SB32 (94.05)
SB30 (94.97)
SB4
SB16 (92.59)
SHEPHARD & KELSEY #1 WELL HEAD
SB35 (93.76)
SB3 (92.39)
SB14
SB9 (92.37)
SB13
SB2 (92.17)
SB12
SB10 (92.25)
SB6
SB1 (91.20)
SB11
SB5 (92.42)
SB7
MARSH
SB8
APPROXIMATE LOCATION OF GROUNDWATER MONITOR POINTS
SB APPROXIMATE LOCATION OF SOIL BORINGS
( ) RELATIVE GROUNDWATER ELEVATIONS (10/24-26/94)
GROUNDWATER CONTOURS

BTEX and Benzene Soil Field Analysis
Shepard and Kelsey #1

Well #	BTEX ppm [1]	Benzene ppm [2]
SB 1	0	0
SB 2	427	201
SB 3	18	8
SB 4	2	1
SB 5	546	257
SB 6	612	288
SB 7	4	2
SB 8	2	1
SB 9	670	315
SB 10	555	261
SB 11	0	0
SB 12	0	0
SB 13	22	10
SB 14	3	1.5
SB 15	-	-
SB 16	470	221
SB 17	34	16
SB 18	70	33
SB 19	642	302
SB 20	0	0
SB 21	6	3
SB 22	0	0
SB 23	2	1
SB 24	0	0
SB 25	2	1
SB 26	0	0
SB 27	0	0
SB 28	0	0
SB 29	490	230
SB 30	0	0
SB 31	0	0
SB 32	592	278
SB 33	548	258
SB 34	640	301
SB 35	542	255
SB 36	0	0

(1) Total soil BTEX measured in the field using an OVM.
(2) Benzene calculated using a 0.47 factor from total BTEX.


FENCE
SB25
(2)
SB23
(2)
SB22
(0)
210 bbl
TANK
SB24
(0)
SB26
(0)
SB21
(6)
FENCE
SB20
(0)
SB27
(0)
UG2
SB19
(642)
SB33
(548)
SB28
(0)
SB18
(70)
UG1
DG1
SB31
(0)
SB17
(34)
SB34
(640)
SB29
(490)
SB32
(592)
SB4
(2)
SB30
(0)
SB16
(470)
SHEPHARD & KELSEY #1
WELL HEAD
FENCE
SB35
(542)
SB14
(3)
SB3
(18)
SB9
(670)
SB13
(22)
SR2
(427)
SB12
(0)
SB10
(555)
SB6
(612)
SB1
(0)
SB11
(0)
SB5
(546)
SB7
(4)
SB8
(2)
( ) BTEX PPM from OVM
SB APPROXIMATE LOCATION OF SOIL BORINGS
AREA OF CONTAMINATION
N
SCALE:
20 0 50 feet

Analysis of the pH from Soil and Water Samples
Shepard and Kelsey #1

Well #	Soil	Water
SB 9	8.72	
SB 31	8.29	
SB 32	8.15	
SB 33	8.34	
SB 9		8.80
SB 19		8.88
SB 20		8.32
SB 33		8.70
SB 34		8.68

BTEX Distribution in the Capillary Fringe Area
Shepard and Kelsey #1

Well #	Feet of Contamination
SB 1	-
SB 2	1.0
SB 3	1.75
SB 4	-
SB 5	2.5
SB 6	1.5
SB 7	-
SB 8	-
SB 9	4.5
SB 10	2.5
SB 11	-
SB 12	-
SB 13	-
SB 14	-
SB 15	-
SB 16	4.0
SB 17	0.5
SB 18	2.5
SB 19	2.0
SB 20	-
SB 21	-
SB 22	-
SB 23	-
SB 24	-
SB 25	-
SB 26	-
SB 27	-
SB 28	-
SB 29	4.0
SB 30	-
SB 31	-
SB 32	6.0
SB 33	2.5
SB 34	5.0
SB 35	5.0
SB 36	-

TPH Analysis of Soil Samples
Shepard and Kelsey #1

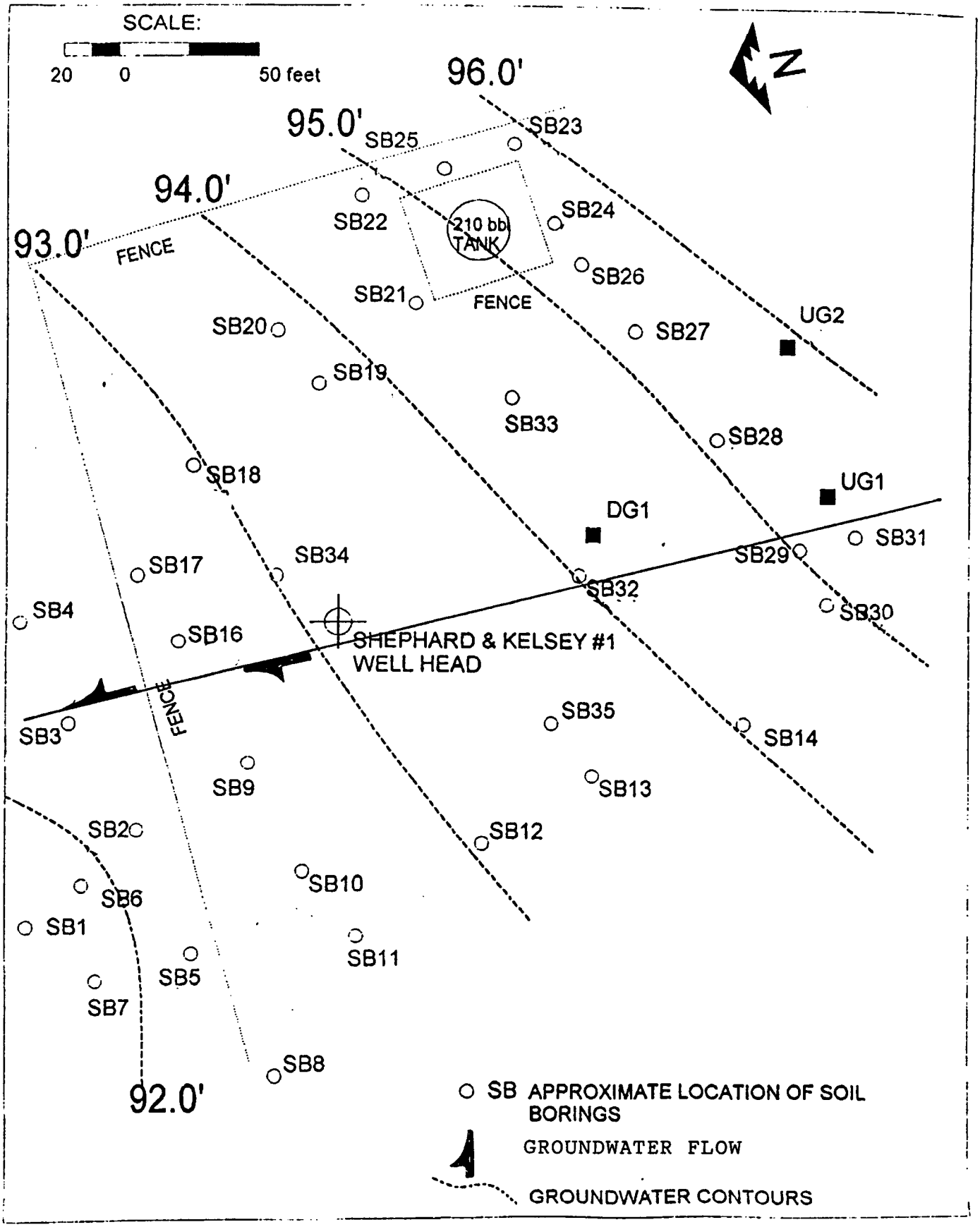
Well #	TPH ppm (1)
SB 9	5612
SB 9 @ 6.5'	2970
SB 9 @ 7.0'	235
SB 9 @ 9.0'	0
SB 31 @ 5.5'	25
SB 32 @ 6.5'	1835
SB 33 @ 5.0'	3214
SB 34 @ 6.0'	2150

(1) Laboratory analysis

BTEX and Benzene Analysis of Water Samples
Shepard and Kelsey #1

Well #	BTEX ppb (1)	Benzene ppb (1)
SB 1	14.4	ND
SB 2	720.0	44.3
SB 3	61,575	471
SB 9	29,111	7,233
SB 19	567.9	20.3
SB 32	34,977	3,434
SB 33	13,331	33.8
SB 34	5,792	71.0
SB 35	40,522	1,964
DG 1	7,524	156
UG 1	17.2	1.2
UG 2	13.0	0.7

(1) Laboratory analysis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UG2
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SB16
SHEPHARD & KELSEY #1 WELL HEAD
FENCE
SB3
SB35
SB14
SB9
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SB8
SB APPROXIMATE LOCATION OF SOIL BORINGS
GROUNDWATER FLOW
GROUNDWATER CONTOURS

The following table lists the results of the laboratory analyses of Polynuclear Aromatic Hydrocarbons (PAHs).

Table 9 Laboratory Results - Polynuclear Aromatic Hydrocarbons (PAHs)

Analyte mg/l	NC-DG1	SAL-DG1	SK-DG1
2-Methylnapthalene	<.020	<0.010	<0.010
3-Methylcholanthrene	<.020	<0.010	<0.010
7,12-Dimethlybenz(a)anthracene	<.020	<0.010	<0.010
Acenaphthene	<.020	<0.010	<0.010
Acenaphthylene	<.020	<0.010	<0.010
Anthracene	<.020	<0.010	<0.010
Benzo(a)anthracene	<.020	<0.010	<0.010
Benzo(a)pyrene	<.020	<0.010	<0.010
Benzo(b)fluoranthene	<.020	<0.010	<0.010
Benzo(g,h,i)perylene	<.020	<0.010	<0.010
Benzo(k)fluoranthene	<.020	<0.010	<0.010
Chrysene	<.020	<0.010	<0.010
Dibenz(a,h)anthracene	<.020	<0.010	<0.010
Dibenz(a,j)acridine	<.020	<0.010	<0.010
Fluoranthene	<.020	<0.010	<0.010
Fluorene	<.020	<0.010	<0.010
Indeno (1,2,3-cd) pyrene	<.020	<0.010	<0.010
Naphthalene	<.020	<0.010	<0.010
Phenanthrene	<.020	<0.010	<0.010
Pyrene	<.020	<0.010	<0.010

Note: Samples were extracted using EPA method 3520 and analyzed using Method 8270.

Please note that terphenyl-d14 surrogate recoveries for the samples from wells SAL-DG1 and SK-DG1 were low. The samples were re-extracted and re-analyzed with no changes noted for the re-analysis. This indicates that a matrix interference is present. Please refer to the Analytical Results Appendix for detailed analysis data.

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To LEN GAWEL	From JOHN COY
Co. BIOREM CONSULTANTS	Co. CONOCO INC.
Dept.	Phone #
Fax #	Fax #

Monitoring and Closure

In order to monitor progress of the bio-air sparging remediation and to apply the closure standards, the sampling and analytical procedures will utilize the methods identified in sampling and analytical protocol. Any modification to these protocols will be noted in the reporting of the data.

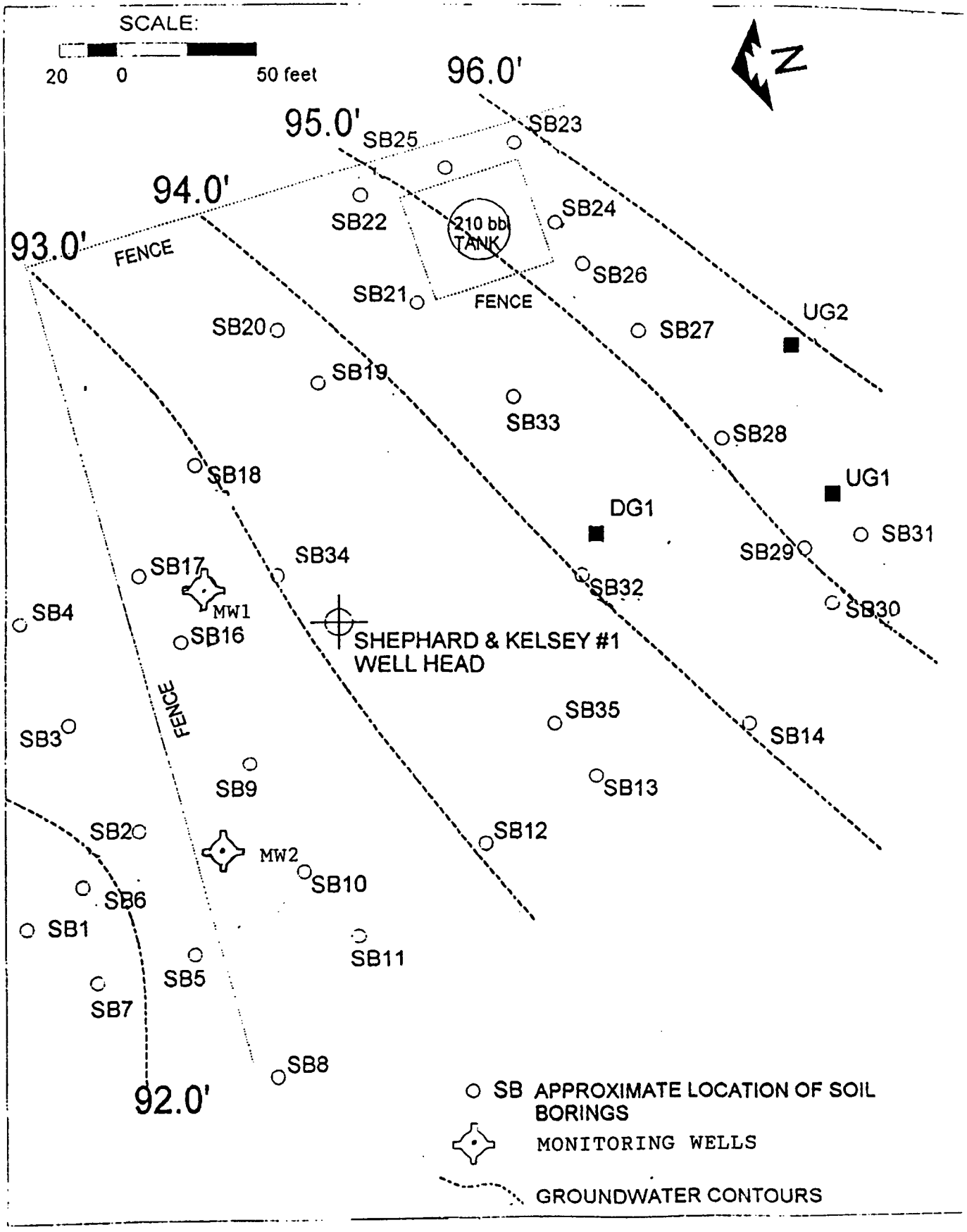
Two new monitoring wells (MW1 and MW2) will be installed in the area near SB9 and SB16 to monitor remediation progress and insure site cleanup. Installation procedures are described in the section "Monitor Well Design." In addition, presently installed wells S & K-DG1 and S & K-UG1 may be utilized as required for monitoring cleanup.

Remediation progress will be monitored by sampling water in the two new monitoring wells MW1 and MW2 and the existing monitoring wells for total BTEX. The monitoring schedule will be flexible and depend somewhat on the rate of cleanup. Baseline contamination levels will be established by monitoring 24 hours prior to bio-air sparging start up. Water samples will be analyzed for total BTEX. Before an individual water sample is obtained for analysis, a volume of water equal to the stagnant volume of the well must be removed from the well and the well allowed to recharge. Water samples will be obtained and analyzed using the below-listed schedule.

Initial monitoring	MW1, MW2, S & K-DG1 and S & K-UG1 (control)
One-month monitoring	MW1, MW2, and S & K-DG1
Additional monitoring[1]	MW1, MW2, and S & K-DG1 at 2-week intervals

[1] The monitoring time interval may be adjusted depending on the remediation rate of the bio-air sparging process and the air sparging cycles.

The monitoring wells are placed in areas identified as the site's highest level of BTEX contamination (see Monitoring Well Placement map). In addition to using the wells for monitoring remediation progress, the well can be used for the addition of nutrients to stimulate bacterial degradation. However, at the Shepard and Kelsey site, we do not anticipate the need for nutrient addition. However, nutrient level (N and P) will be monitored in order to determine if nutrient addition may become necessary.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UG2
SB19
SB33
SB28
SB18
UG1
DG1
SB31
SB17
SB34
SB29
SB32
SB4
MW1
SB16
SB30
SHEPHARD & KELSEY #1 WELL HEAD
FENCE
SB35
SB3
SB14
SB9
SB13
SB2
SB12
MW2
SB10
SB6
SB1
SB11
SB5
SB7
SB8
SB APPROXIMATE LOCATION OF SOIL BORINGS
MONITORING WELLS
GROUNDWATER CONTOURS

Monitoring Well Design

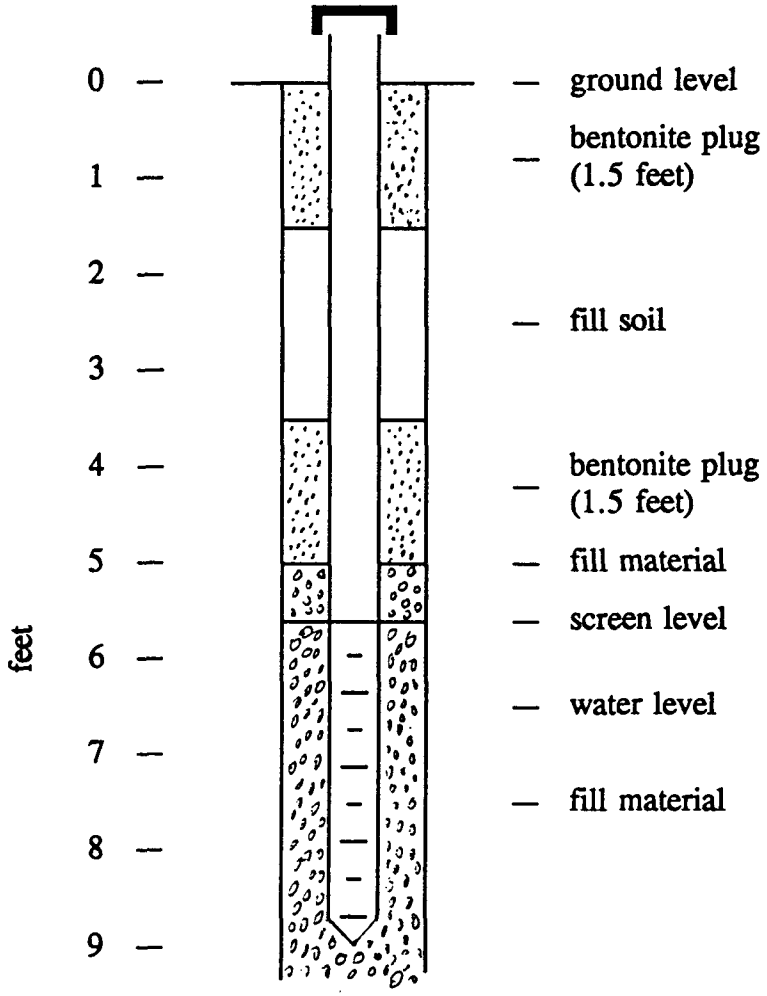
Monitoring wells 1 and 2 (MW1 and MW2) will be installed similarly to the procedure used to install monitoring wells at the Salmon Lease. The monitoring wells will be two inches in diameter. The well construction material is PVC with screened and unscreened sections. The screened PVC should use a 0.01- inch slotted screen (#10 slot screen). The screened section should be completed as to have 3 feet below the surface of the water table and 1 foot above the water table.

Monitor wells MW1 and MW2 will be completed to an identical design. In the area of both monitoring wells the water table is approximately at the 6.5 foot level. The 4 foot screen section will be used to cover 1 foot of the unsaturated zone and 3 feet of the saturated zone. The screen section should be completed with a cone point for easy installation.

The annulus screened area of the well is completed with Colorado Environmental Spec 30 fill material or similar material 6 inches above the screened section. The fill material is secured by a 1.5-foot hydrated bentonite plug. The well is backfilled with soil and sealed to the surface with a 1.5-foot hydrated bentonite plug. The bentonite plugs will prevent surface-to-groundwater communication. The well can be installed using a hand auger with a 3 1/4" bit.

The PVC well riser should be completed with a screw cap for security and easy access for sampling. (See attached detailed drawings of the monitoring wells.)

Monitor Well Design



MW1
&
MW2

Well Placement and Design

A total of 24 air sparging wells (ASW) capable of achieving a 25+-foot air distribution radius have been positioned to cover the Shepard and Kelsey contaminant site (see attached site map). The wells are numbered #1, #2, ..., #24 on the north axis. On the west side of the site (the longest interval of the site) is approximately 350 feet. Note, three wells will be placed across the fence line and may require subsurface (6") installation.

Each air sparging well is constructed from 2-inch diameter schedule 40 or 80 pvc with a 4-foot-long well screen. The screen slot size of 0.01 inches (number 10) is recommended for the ASW completion. In order to assist well construction, the screen section should be completed with a molded point. (See attached well diagram for details of ASW construction.)

The ASW screen is placed 5 feet below the water table. Some well placements may be adjusted in areas where clay sands are present. (See individual well depth table.) Complete the wellbore area with a coarse sand pack in the screen area. The placement of the sand pack is particularly important in clay sand areas. The sand pack is placed along the length of the well screen and completed 1 foot above the screened area. The well screen area and sand pack are isolated from the remainder of the borehole by a hydrated 1.5-foot bentonite plug. The bentonite plug can be placed by using 1/4 bentonite pellets 3.5 feet below the groundwater level.

The wells are installed using an 8-inch hollow-stem auger. A 1.5-foot hydrated bentonite seal must be placed over the sand pack. Over the first bentonite seal, the wellbore is backfilled with surface soil and a 5% bentonite mixture. The same backfill material (soil + bentonite) is used between the secondary bentonite seal and the surface. The surface is capped using a third bentonite seal (see well design diagram).

Due to the soil profile at the Shepard & Kelsey site, a special bio-air sparging design will be required. The remediation operates on a 3-cycle process of air sparging (off-and-on sparging). Eight wells will be sparged while the remainder of the wells come to equilibrium (will not be receiving air). The site is divided into 3 banks of 8 wells.

Bank #1 - ASW 1, 2, 3, 4, 5, 6, 7, & 13
Bank #2 - ASW 8, 9, 10, 11, 12, 16, 17, & 18
Bank #3 - ASW 14, 15, 19, 20, 21, 22, 23, & 24

Air sparging pressures and volumes will be set during the initial rotation start-up. Following the 3-day start-up period, air sparging will begin into Bank #1. Air sparging will continue for a period of 1 week (and rotate for a 1-week period in Banks 2 and 3). During the rotation, the wells not receiving air sparging will come to equilibrium.

During the next sparging rotation (rotation #2), the wells will be sparged for two weeks before beginning of the rotation period. During sparging rotation #3, the wells are sparged for a 3-week period. Following the second and third sparging rotations, the monitoring wells will be

sampled for remediation progress. Samples will be analyzed for BTEX and oxygen concentrations.

Following the three sparging rotation periods (~18 weeks) and evaluation of the monitoring program, the remediation plan may be adjusted. Detailed rotation periods are outlined in the Remediation Parameters section.

It is recommended that the 2-inch SCH 40 and SCH 80 be purchased from local suppliers. The 4-foot screen material may not be available in the Farmington area. Screen material can be purchased from:

Atlantic Screen and Manufacturing, Inc.
118 Broadball Road
Milton, DE 19968
Phone: (302) 684-3197
Fax: (302) 684-0643

2" SCH 80 4-foot screen $8.30 per unit
available in threads or flush joints
Note: o rings are required and available upon request.

The screening material is also available by the foot at $1.71 per foot for 2-inch SCH 80. Coupling units will be required ($0.85 per unit). Each of the seven wells will require a riser cap or reducer to 1 inch and a molded point ($1.87 per unit).

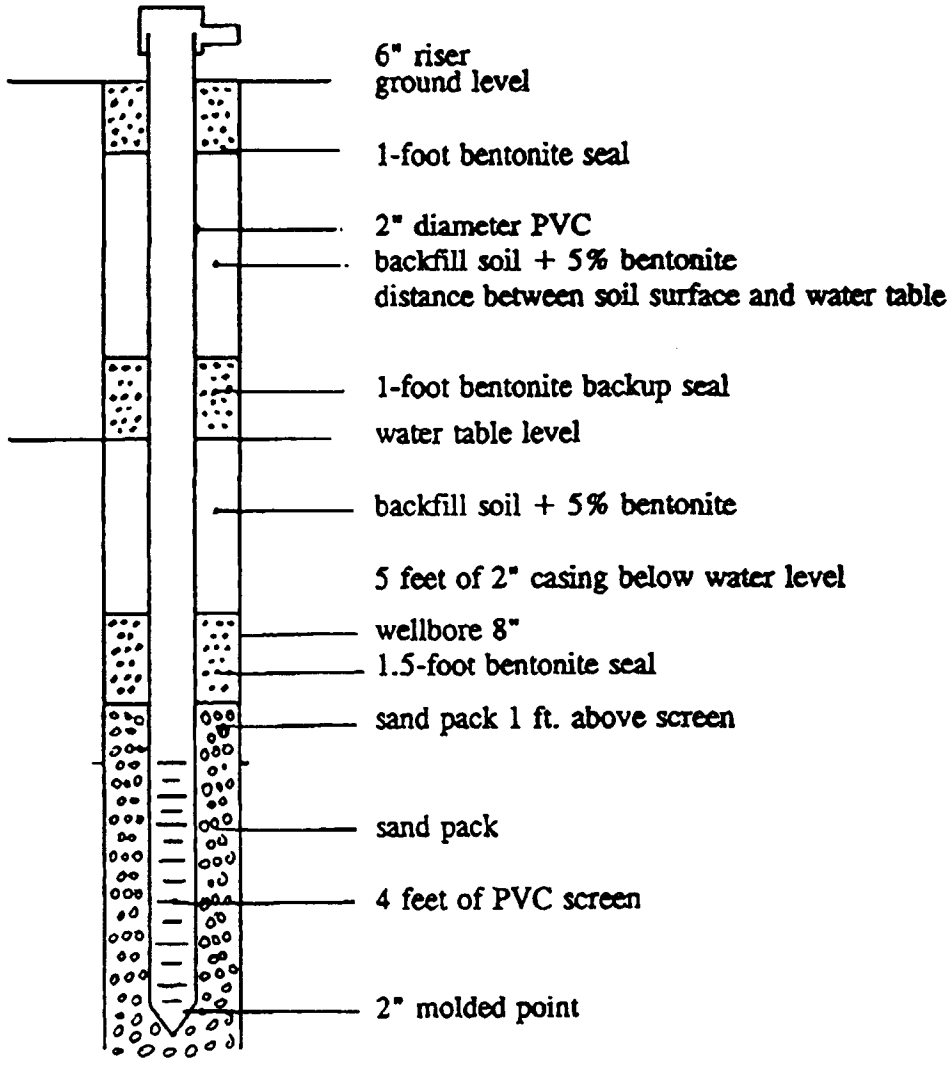
The air transfer lines from the manifold to the individual sparging wells should be equipped with easy on/off connections. The air transfer lines will be rotated 3 to 5 times during the remediation process. The connections used must have a positive and tight seal to avoid air losses.

Following completion of the remediation, the air sparging wells will be plugged in order to protect the groundwater. When possible, the PVC 2" well casing will be removed and plugged to surface with a 3-5% bentonite grout. If the 2" well casing cannot be removed, the wells will be cut at the 2-foot level and plugged back from total depth to casing surface with a 3-5% bentonite grout.

Please contact BioRem personnel for discussion of sparge well construction and installation.

It should be noted that telephone consulting is provided by BioRem during the construction phase without time charges to Conoco.

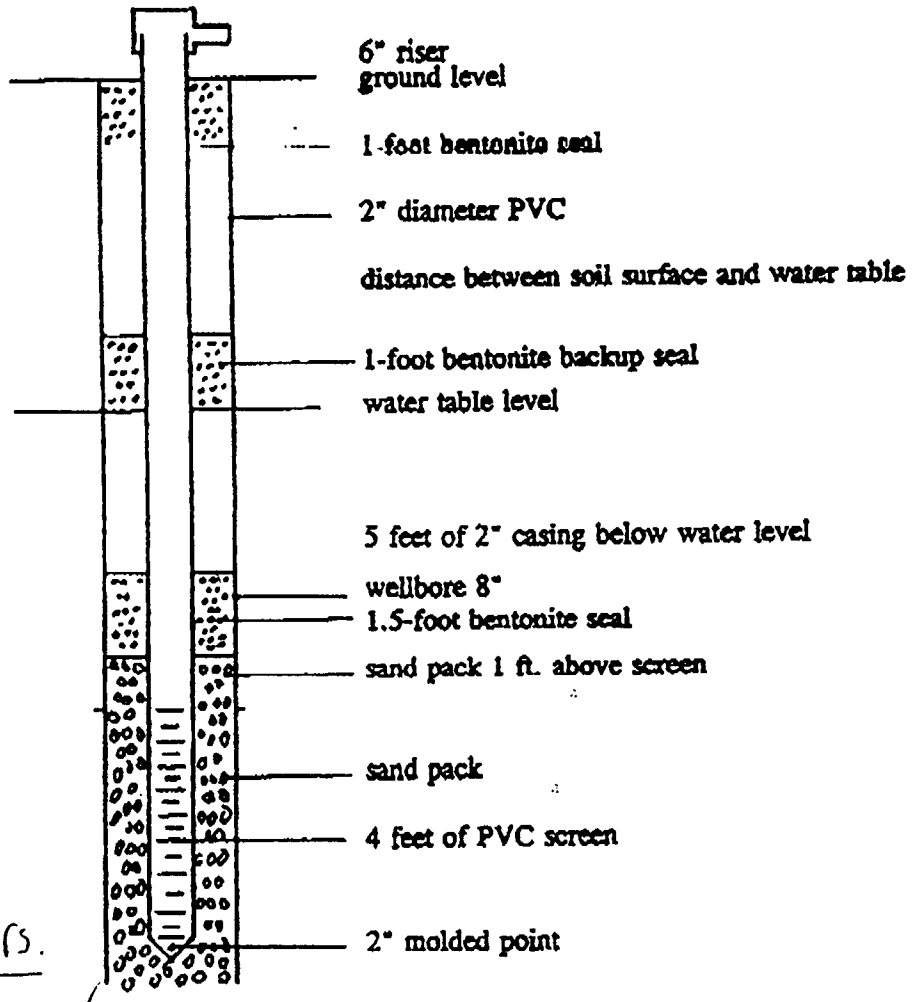
Air Sparging Well Design for HS 8" Auger, Shepard and Kelsey, April 5, 1995



2 feet

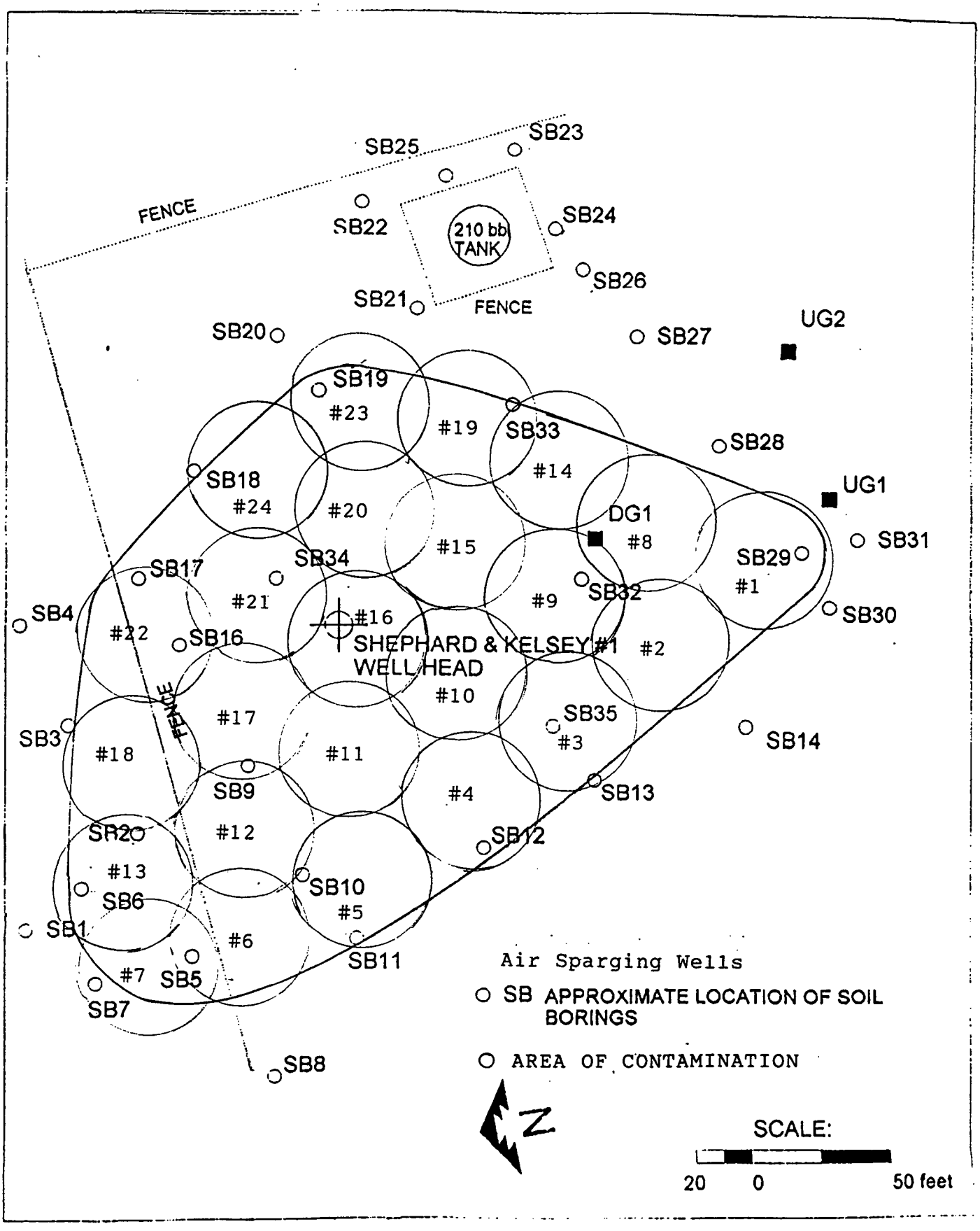
Scale #30

Air Sparging Well Design for HS 8" Augur, Shepard and Kelley, April 5, 1995

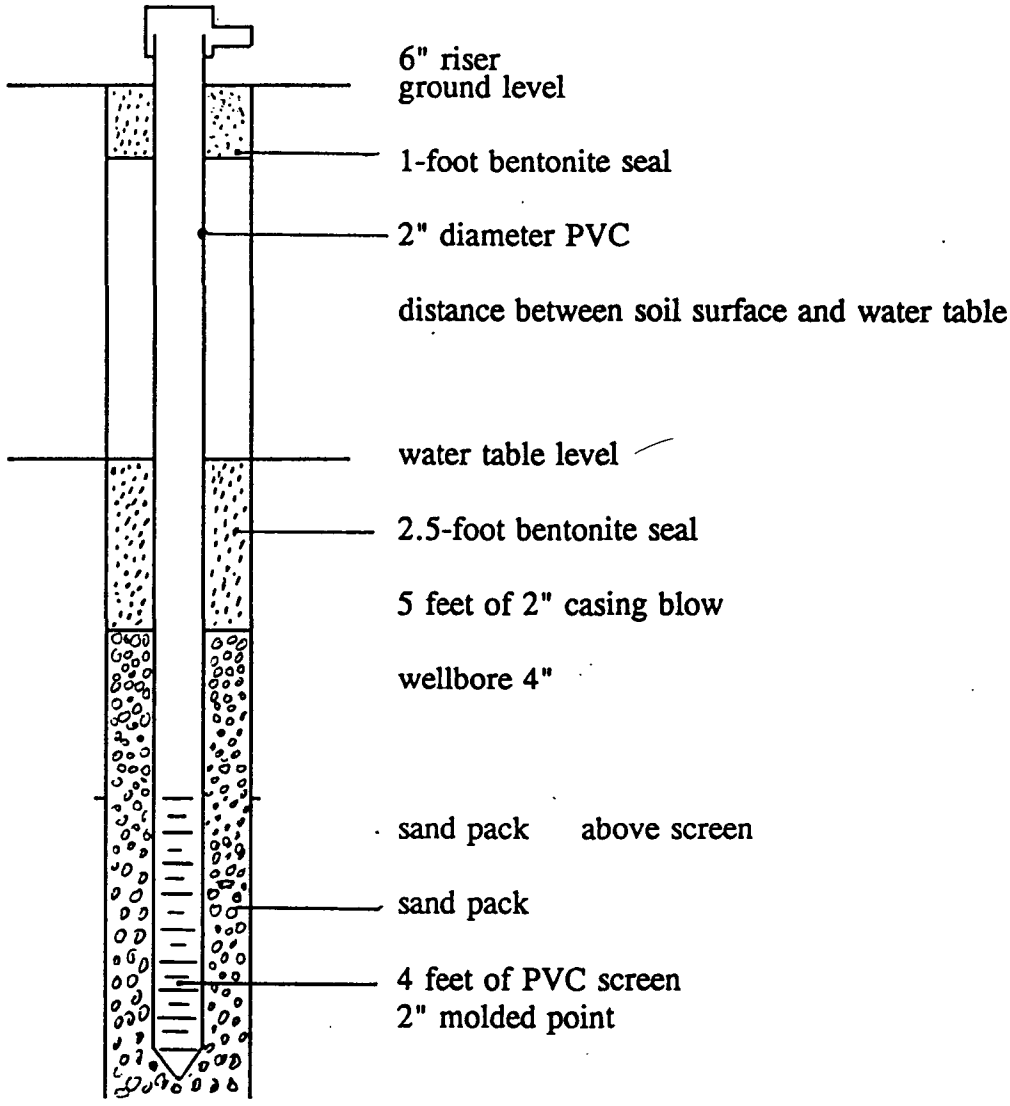


4/10/95 0900 hrs.
Verbally approved to Judy McLemore with condition that bentonite be added to the fill in the interval between the surface plug and the water table plug

Bill Olson.


SB25
SB23
FENCE
SB22
210 bbl TANK
SB24
SB26
SB21
FENCE
SB20
SB27
UG2
SB19
#23
#19
SB33
SB28
SB18
#24
#20
#14
UG1
DG1
#8
SB31
#15
SB29
#1
SB17
SB34
SB32
SB4
#21
#9
SB30
#22
SB16
#16
SHEPHARD & KELSEY #1
WELL HEAD
#2
#10
FENCE
SB35
#3
SB3
#17
SB14
#18
#11
SB9
#4
SB13
SB2
#12
SB12
#13
SB10
SB6
#5
SB1
#6
SB11
#7
SB5
SB7
SB8
Air Sparging Wells
SB APPROXIMATE LOCATION OF SOIL BORINGS
AREA OF CONTAMINATION
N
SCALE:
20
0
50 feet

Air Sparging Well Design



2 feet

Scale #30

Air Sparging Well Lengths - Shepard & Kelsey

Well #	Casing Length ft. & in. [3]	Total Well Length ft. & in. [4]
1	10' 2"	14' 8"
2	11' 0"	15' 6"
3	11' 5"	15' 11"
4	11' 5"	15' 11"
5	11' 6"	16' 0"
6	11' 3"	15' 9"
7	11' 4"	15' 10"
8	11' 5"	15' 11"
9	10' 9"	15' 3"
10	10' 9"	15' 3"
11	10' 9"	15' 3"
12	11' 10"	16' 4"
13	11' 5"	15' 9"
14	10' 2"	14' 8"
15	10' 2"	14' 8"
16	10' 2"	14' 8"
17	10' 2"	14' 8"
18	10' 9"	15' 3"
19	10' 2"	14' 8"
20	11' 5"	15' 11"
21	11' 5"	15' 11"
22	11' 4"	15' 10"
23	9' 9"	14' 5"
24	9' 9"	14' 5"

1. All screen lengths are 4 ft.
2. Riser length binders
3. Length of casing from ground level to screen (ft. & in.)
4. Total length of well includes riser, casing, and screen
5. Note: All measurements are in feet and inches to accommodate field installation.

Sparging Manifold

Sparge air from the atmosphere will be transferred through an air filter, through the blower, and into a manifold for distribution to the individual sparging wells. The air blower is connected to the manifold through a 2" galvanized pipe. Galvanized pipe is recommended to reduce possibility of corrosion. Corrosion particulates may cause blockage on valves and gauges in the manifold area. The galvanized pipe coupling the air blower and manifold is required to withstand the possibility of high temperatures generated by the blower. The 2" galvanized pipe should be 1 to 12 feet in length to dispense heat generated by the blower.

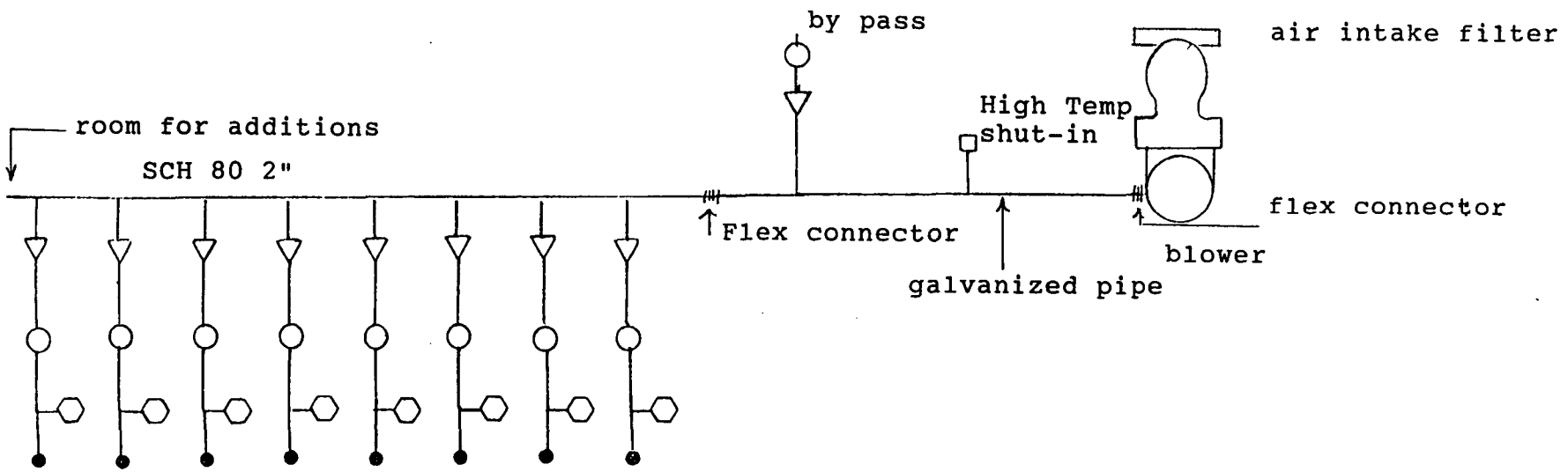
The 10- to 12-foot length of pipe may be in the form of a U or loop reducing equipment space. It is recommended that some type of safety protection around the air blower and particularly the galvanized piping be provided.

A high-temperature shut-down switch mounted on the 2" galvanized pipe on the exit side of the air blower is recommended. The high-temperature shut-down switch is required to protect the blower from potentially overheating.

In addition to the high-temperature shut-down switch, a bypass air flow meter and ball valve should be installed. The meter and valve are placed immediately prior to the manifold. The purpose of the bypass valve is to regulate excess air to the atmosphere during sparging operations. The valve unit is required and the air flow meter is optional. A Dwyer RM-123 with 3 to 30 scfm or equivalent is recommended for this service.

The sparging manifold is constructed of SCH 80 material. We recommend the use of a flex connector between the galvanized pipe and the manifold. On the manifold, each ASW flow line consists of a ball valve, a 1-20 scfm flow meter and a 0-15 psi pressure gauge. In order to reduce cost of purchasing numerous flow meters and pressure gauges, the manifold can be constructed with tees and plugs. It is recommended at least 2 flow meters and 2 pressure gauges be purchased. A pressure gauge and flow meter can be used on each individual well to set and check the well parameters. Once the individual wells are set, only periodical checks and adjustments are necessary. The sparged air travels from the manifold to each individual well in a 1" diameter pipe. PVC or black polyethylene pipe can be used for the transfer line. (See attached air sparging manifold diagram for details.)

Sparging Manifold Diagram



▽ ball valve

○ flow meter

⬡ pressure gauge

□ vacuum gauge

● connection to individual ASW

Blowers

The air sparge blower has been designed for this application to deliver at least 40 standard cubic feet per minute (scfm) while maintaining up to 12 psi of wellhead pressure. Motors will range from 3 to 5 HP to turn the blower shaft (most are direct drive). A single-phase or three-phase motor is available depending on available power supply. The blower has been oversized to allow for variable use at future sites. Additional options include air filter, silencer, high-temperature shut-in and relief valve.

We recommend the Roots URAI 32-2-2 blower with a 5 HP motor for this remediation (see attached specification sheet).

Initial remediation will start with approximately 2 cfm. This relatively low sparging rate will minimize hydrocarbon stripping while maximizing biodegradation of the BTEX. Although not necessary, field monitoring of oxygen content in the monitoring well can assist in determining remediation progress and zone of influence.

Blower maintenance may include a change of oil and greasing the rotating shaft and air intake filter, depending on the type of unit and maintenance manual specifications.

It may be difficult to obtain the blower size recommended in areas where a power supply is not available and will require a portable power supply. Please discuss blow options with BioRem before making a final selection.

Blower unit cost is in the $3,500 to $4,500 range, depending on the additional equipment placed on the unit (motor controls, gauges, etc.).

Detroit Air Compressor & Pump Co.
(Roots/Dresser)
3205 Bermuda
Ferndale, MI 48220
(810) 544-2982
(810) 544-2027 (Fax)
Contact: Dennis Wise

Invincible Airflow Systems
700 North Ray
P.O. Box 380
Baltic, OH 43804
(216) 897-3200
(216) 897-3400 (Fax)

GAST Manufacturing
P.O. Box 97
Benton Harbor, MI 49023
(616) 926-6171
(616) 927-0808 (Fax)

EG&G Rotron
Saugerties, NY 12477
(914) 246-3401
(914) 246-3802

ROOTS (DRESSER)

DRESSER INDUSTRIES, INC
ROOTS DIVISION
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331

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1-505- 327- 5821-

COMPANY : CONOCO SW PHN. : 327- 5813

ATTN. : JOHN COX FAX :

REFERENCE : PO 7981- 619159

PERFORMANCE

BAROMETER (PSIA)

INLET PRESSURE (PSIA) 14.5

INLET TEMPERATURE (°F) 100 °F

INLET FLOW (ACFM) 50

DISCHARGE PRESSURE (PSIA) 6-10 PSIG

DISCHARGE TEMP. (°F) 265 °F

BLOWER SPEED (RPM) 2000

BLOWER BRAKE HP 9.1

BILL OF MATERIALS - 2F PACKAGE

■ ITEMS SUPPLIED IN PACKAGE

■ BLOWER 32 RAI-U

■ MOTOR: FRAME 184 HP 5 RPM 1800

MFG. VOLT 1-60-230

~~☐ INLET FILTER~~ ■ INLET FILTER/SILENCER 2"

~~☐ INLET SILENCER~~ ■ DISCHARGE SILENCER 2"

~~☐ CHECK VALVE: Technic Check 5002 class A~~

~~☐ BUTTERFLY VALVE: PDC~~

~~☐ TEMP. GAUGE: Ashcroft, 50-550° RANGE~~

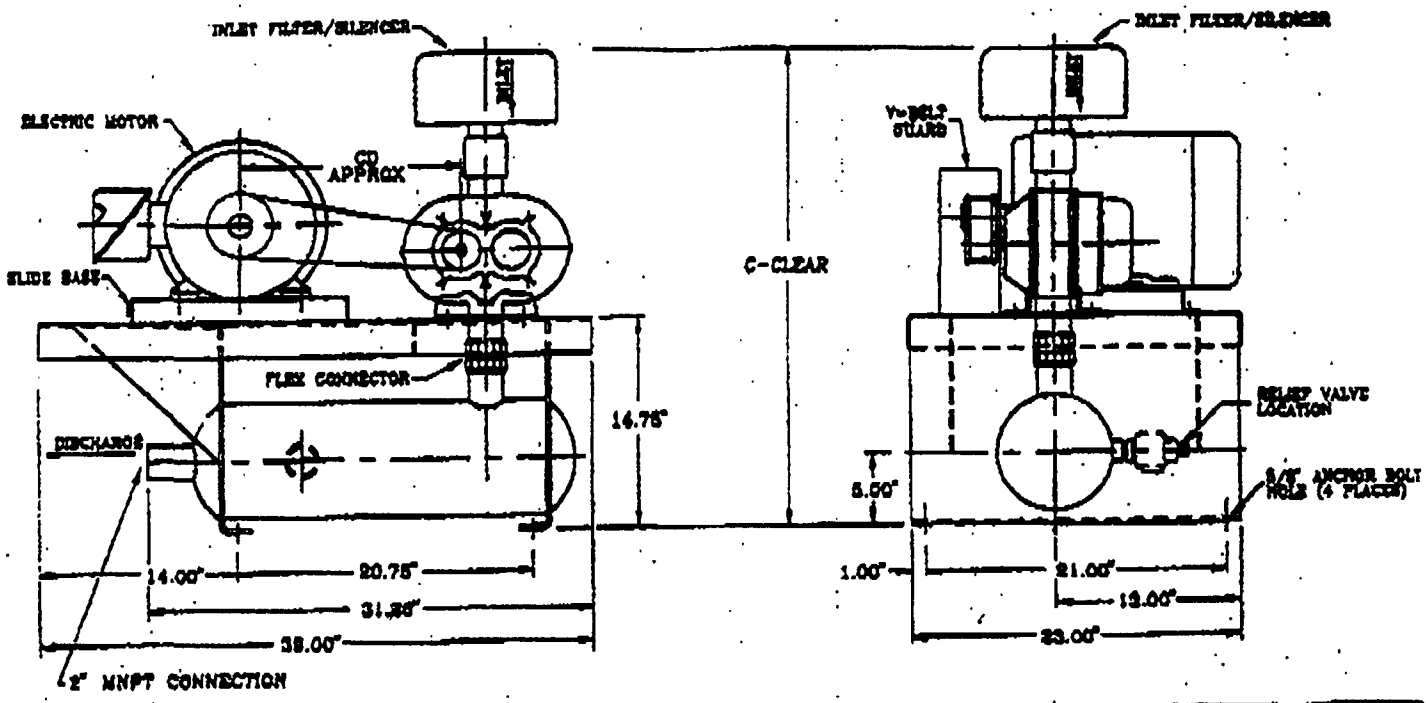
~~☐ TEMP. SWITCH: 0-125°F RANGE NEMA 4 ( ) NEMA 7 ( )~~

~~☐ PRESS. GAUGE: WIKA, 0-15 PSI RANGE~~

~~☐ PRES. SWITCH: 2-20 PSI RANGE NEMA 4 ( ) NEMA 7 ( )~~

■ RELIEF VALVE: 2-337 @ 10 PSIG

ROOTSPAK STANDARD ARRANGEMENT



MODEL	BLOWER	C	CD	APPROX NET WT. (LBS.)
22-1.5-2	22 URAI	34.38	15.50	240
24-2-2	24 URAI	32.38	15.50	250
32-1.5-2	32 URAI	36.38	15.50	270
32-2-2	32 URAI	36.38	15.50	275
33-2-2	33 URAI	35.88	15.50	280
42-2-2	42 URAI	32.63	15.50	295

NOTES:
1. ALL DIMENSIONS ARE IN INCHES
2. PACKAGES MAY NOT BE EXACTLY AS SHOWN.
3. APPROX. WEIGHTS DO NOT INCLUDE MOTOR.
4. ALL INSTRUMENTS MOUNTED IN DISCH. SILENCER.

FPAK-S

PROPOSAL

PACKAGE PRICE AS SHOWN: 4375 EA. QTY: 1

F.O.B. FERNDALE ME FREIGHT COLLECT

DELIVERY: 4-6 WEEKS A R O

TERMS OF PAYMENT : NET 30 DAYS

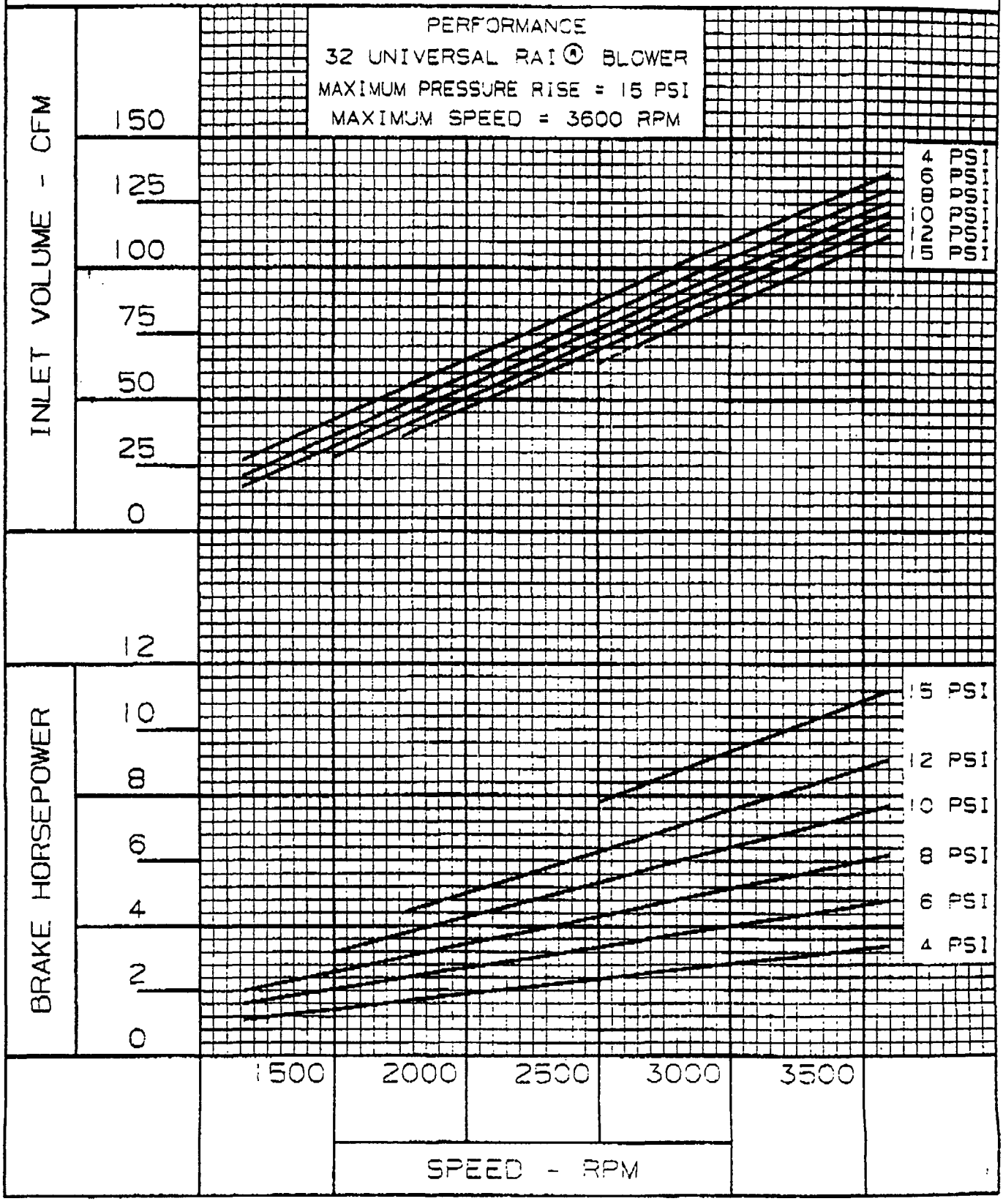
OPTIONAL PRICING : INCLUDES MOUNTED STARTER, CRATING FOR SHIPMENT HI TEMP SWITCH, INLET FILTER GAGE,

PRICES ARE FIRM THRU DELIVERY & ARE SUBJECT TO ROOTS STANDARD TERMS AND CONDITIONS

ROOTS DIVISION
DRESSER INDUSTRIES, INC.
CONNERSVILLE, IN. 47331
PRINTED IN U.S.A.

PERFORMANCE BASED ON INLET AIR AT 14.7 PSIA & 68°F

AUGUST 1990



PC-12-32

Remediation Parameters

The BioAir Sparging remediation will be operated in special rotation sequence due to the soil profile at the Shepard and Kelsey lease. Following the monitoring results of the second and third rotations, adjustment in rotations and air volumes may be necessary. The remediation is designed to be completed in six months. There is an initial start-up time of three to four days.

Week	Duration (weeks)	Bank	Flow Rate scfm
1	1	1	3
2	1	2	3
3	1	3	3
4	2	1	4
6	2	2	4
8	2	3	4
10	3	1	6
13	3	2	6
16	3	3	6
20	2	1	5
22	2	2	5
24	2	3	5

Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2

Boring Well No. SB1

Ground Elev.

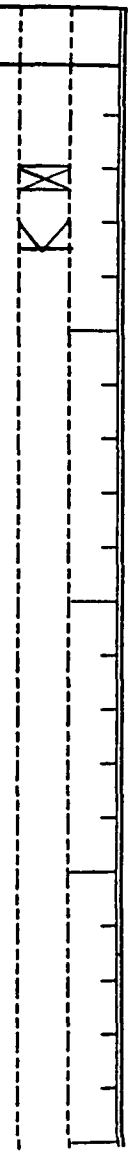
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Clay
2			2'3"
3	ND	OVM	Free Water 3'Gng Sand-Fine - Silt
4	57°		
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Ground Water Level

Total depth of well

Sample area

Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB2

Ground Elev.

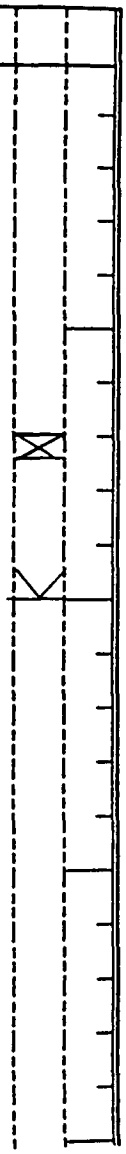
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Drill easy 3'
3			
4			
5			Stiff Drilling
6			
7			Drilling Eased
8			Water
9	427	OVM	Dark Gr. Med. Sand, Silt, HC Smell.
	67°	Soil Sample BTEX	
10			Course Sand & Gravels - 8½
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB3

Ground Elev.

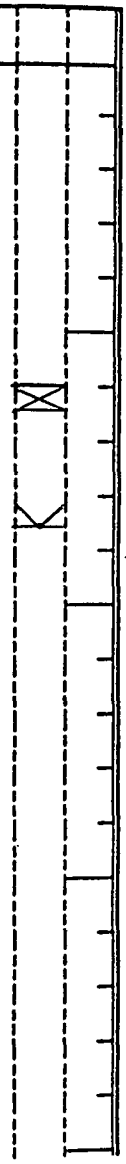
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			
6	6ppm 65°	Cuttings o vm	Water - 6' Gray Med Sand
7	18ppm	Hand Aug.	Clay Sand Lense, Some Gravel Dk. Gry.
8	60°	ovm	Gravel / Sand
9	2ppm 61°	Hand Aug. ovm	Sand, Heavy Gravel
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Hand Auger

Bore Diameter 2 3/4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB4

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3	2PPM T-59°	OVM	Water 2.5'FT.
4			Fine Med. Sand, Gray Brown, Little Clay
5			Swampy smell
6			
7			
8			
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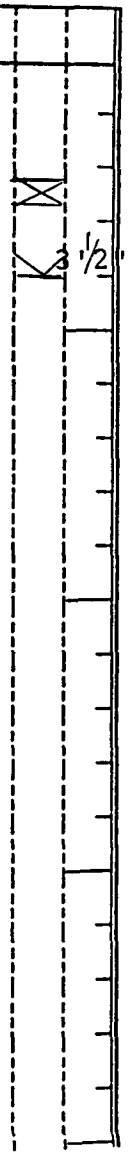
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB5

Ground Elev.

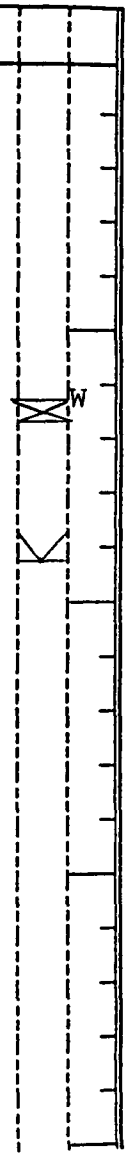
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			
6	546PPM 65°	Cuttings OVM	Med Gray, Med. Sand, HC Smell 6' Brown 6.5' Darker Gry. courser Sand 7" Clay Lense Sand with gravel 7½'
7			
8	15 64° ppm	Hand Aug OVM	
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Hand Auger

Bore Diameter 2 3/4"

Casing

Screen

Plugging Method Benonite 2'

Boring Well No. SB6

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification	
1 feet				
2				
3	612ppm 57°	OVM	Black med. sand & clay HC smell	3'
4			Sand med, lt. gray, clean smell 3½'	
5				
6				
7				
8				
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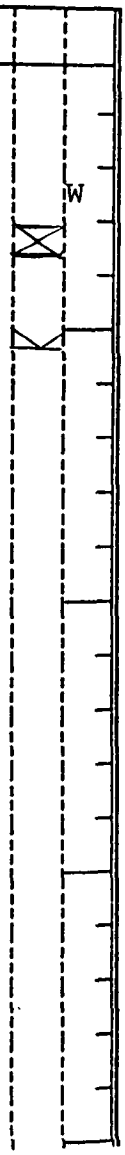
18				
19				
20				



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Hand Auger

Bore Diameter 2 3/4"

Casing

Screen

Plugging Method Bentonite 2' Sand

Boring Well No. SB7

Ground Elev.

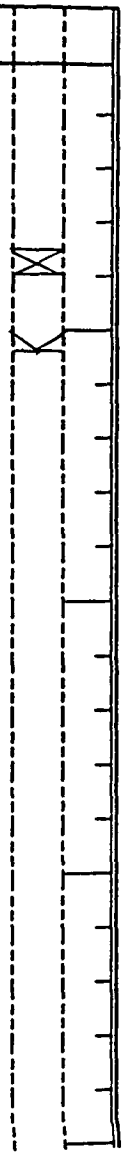
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3	3.5ppm		Course sand, Brown
4	57°	ovm	Med, Gray sand, No HC smell 3'5"
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94 1:50 pm

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method

Boring Well No. SB8

Ground Elev.

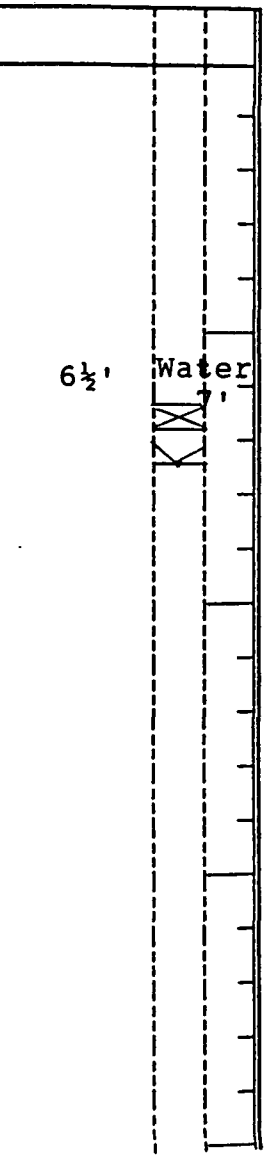
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			
6			Clay lense
7	2.3ppm	Hand Auger	
8	61°	OVM	Lt Gray Med Sand. Med Clay
9			Clay Lease
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB9

Ground Elev.

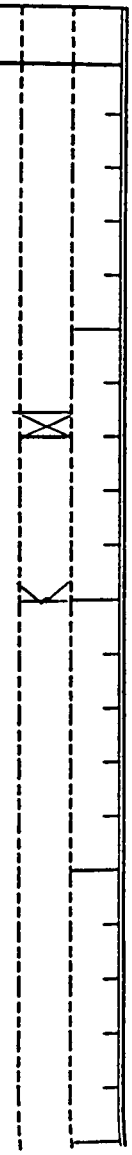
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			Clay Lease, HC Smell
6	516ppm	67° ovm	Dk. Gray, Med course sand, No clay
7			
8	533ppm	62° ovm	Lt. Gray Med Sand, Silt and clay ribbons 1.5'
9	349ppm	64° ovm	Gravel
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method

Boring Well No. SB9

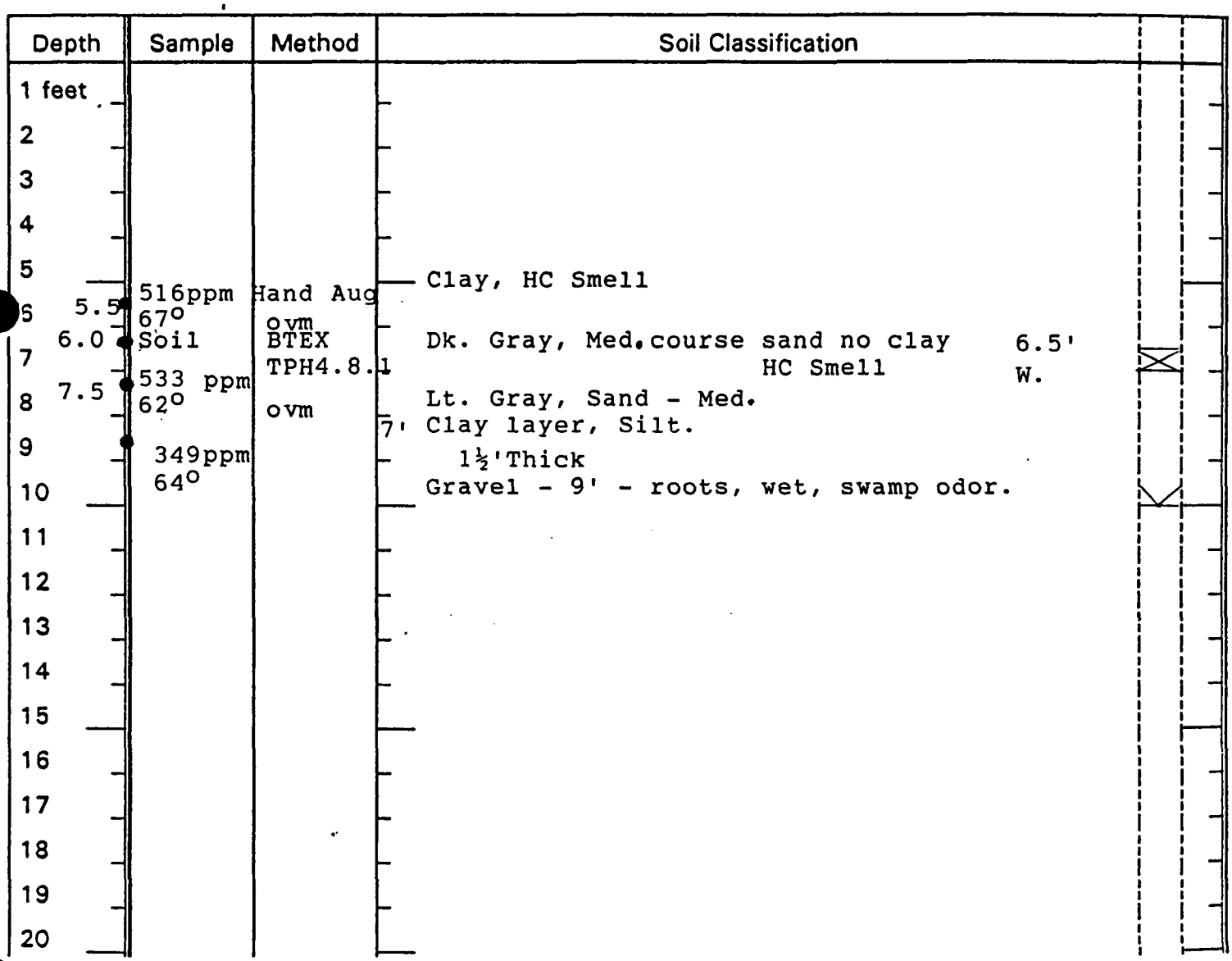
Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB10

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			Clay content begins 4½' (Small clay amounts) Tan med-fine sand.
6	555ppm	Hand aug.	Lt. Gray sand-med.
7		ovm 78°	Black med. sand 6'10" W
8	34 ppm	ovm 62°	Clay
9	48ppm	ovm 62°	Clay
10			
11			
12			
13			
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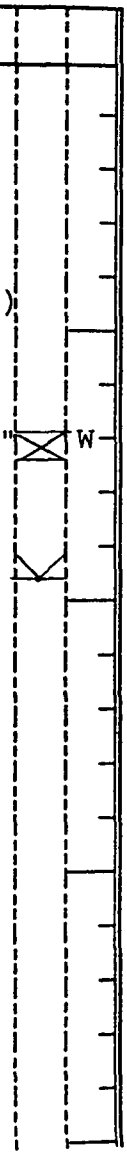
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB11

Ground Elev.

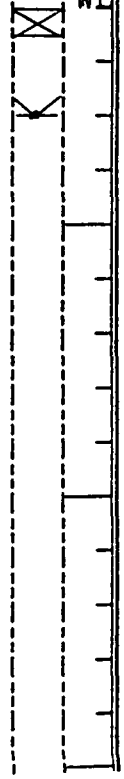
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			
5			
6	ND	ovm 61	Lt. Brown Med. Sand. Start WL.
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method

Boring Well No. SB12

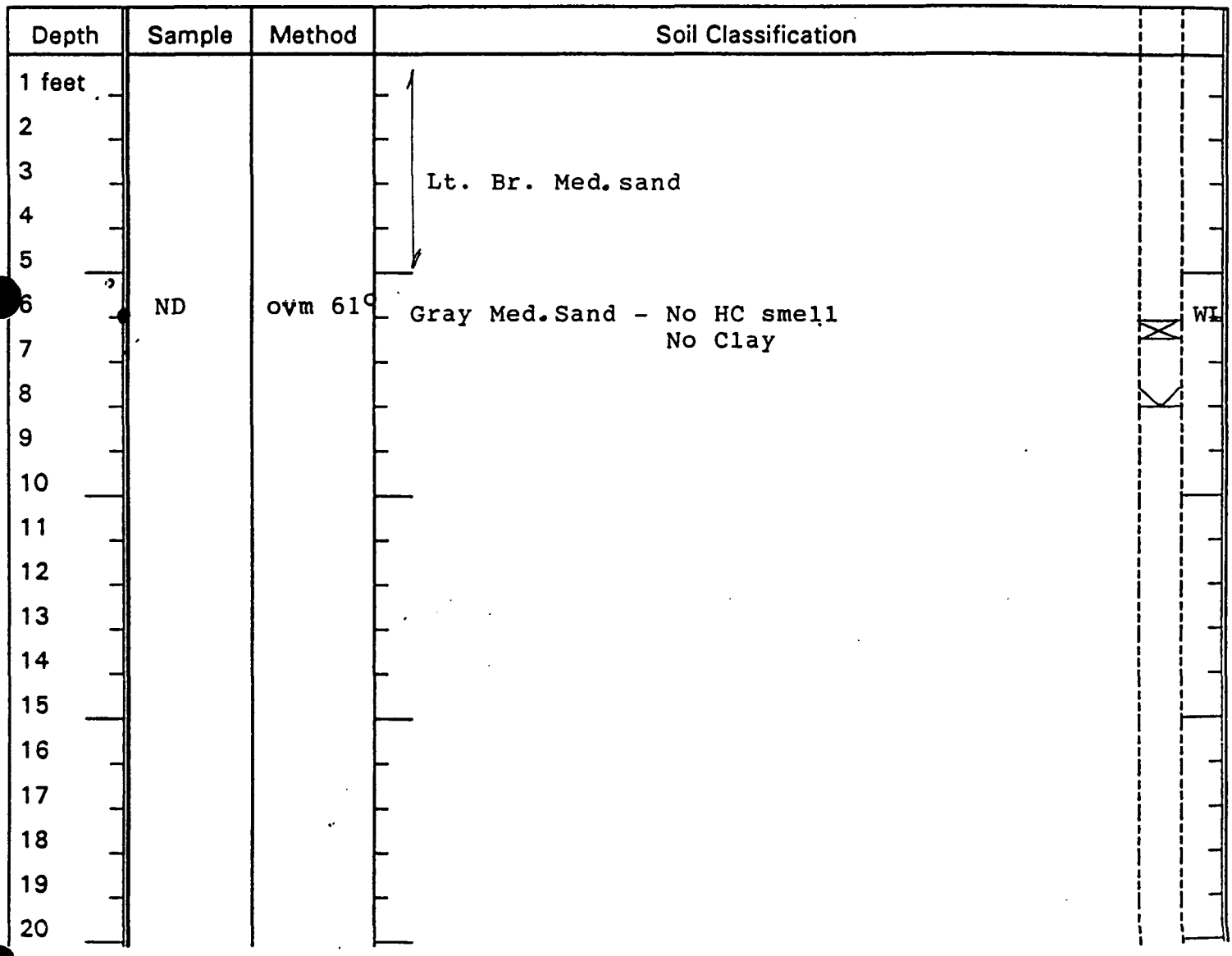
Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB13

Ground Elev.

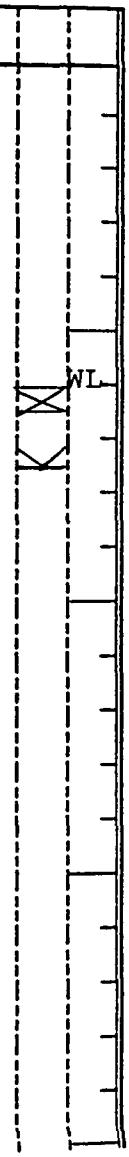
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			Lt. Brown Med. Sand
5			
6	22ppm	ovm 60	Gray Med. Sand
7	ND	ovm 60	Gray Med. Sand
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB14

Ground Elev.

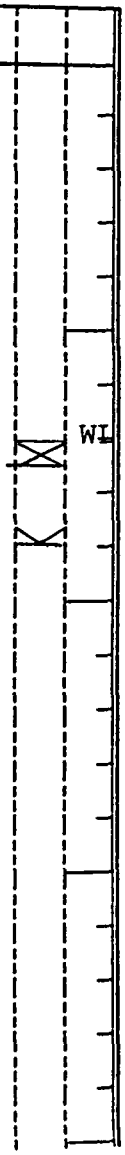
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Lt. Br. Med. Sand
3			
4			
5			
6			Lt. Br. Sand & Clay 50/50 No smell
7	3.1ppm	ovm 60	Lt. Br. Sand - No clay, No HC smell
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger

Bore Diameter 4'

Casing -

Screen -

Plugging Method Bentonite 2'

Boring Well No. SB16

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification		
1 feet					
2					
3					
4			Brown Sand		
5					
6	34ppm	ovm 62	Clay Lease 6' Black	First H20	6.5
7	470ppm	ovm 61	Sand Med. Dk. Gray some clay	Water Level 7'	
8	38ppm	ovm 61	Clay Drk. Gray Very Plastic		
9	136ppm	ovm 61	Ltr Gray Clay Very Plastic		
10	22 ppm	ovm 61			
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Project S & K

Location Farmington NM

Date 10-24-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB17

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification	Water
1 feet				
2				
3			Clay	
4				
5				
6	2 ppm	Hand Auger		
7		ovm 61	Dr. Sand/Clay 50/50. Swamp Odor	W.L. 6.5
8	34ppm	ovm 61	Sand Drk. Strong H_2S, Swamp odor. No Hc	
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4" , 2 3/4

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB18

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			Clay
4			
5			
6	70ppm	ovm 61	Clay layer and Fine sand
			Clay small amounts of fine sand
7			Plastic
	40ppm	ovm 61	Grey sand & slight clay - WL
8	5.1ppm	ovm 61	Clay - Plastic
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB19

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification		
1 feet					
2					
3			Med. to Fine Sand		
4					
5					
			Lt. Brown Sand - 5% Clay		
7	642ppm	ovm 63	Clay Plastic 15% Sand 6.5'	7.'2	WL
	259ppm	ovm 60	Light Br. Sand & Clay.		
8	18ppm	ovm 61	Clay & 15% Sand		
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB20

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Sand & Clay
3			
4			
5			Clay, Lt. Med. Sand.
6	No HC	ovm	Lt. Med. Br. Sand - No Clay - Water
7	No HC	ovm	Clay & 15% sand -
8			
9			
10			
11			
12			
13			
14			
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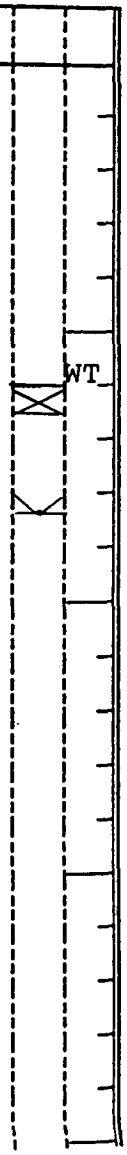
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentinote - 1.5 to 2'

Boring Well No. SB21

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2	2.3ppm	ovm 60	Sand - Drk. Br. Sand - No HC smell 20-25% Clay
3			
4			
5	1.9ppm	ovm 550	Br. Med. Sand - 1% Clay & O
6	2.1ppm	ovm 630	Clay Ribbon
7			Sand
8	6.1ppm	ovm 620	Clay Ribbon
9			
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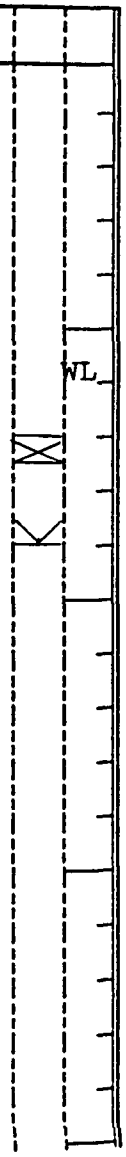
20			

7' WL



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB22

Ground Elev.

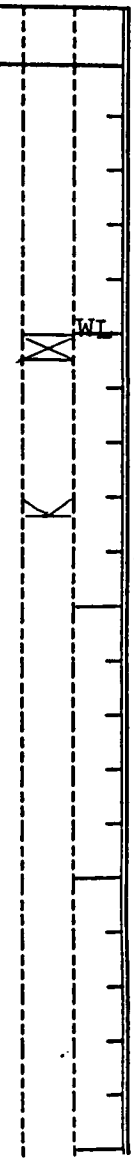
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Br. Med Sand
2			
3			
4			Clay & Sand
5			Br. Med Sand
6	ND	OvM 62°	
7		OVM 62°	
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB23

Ground Elev.

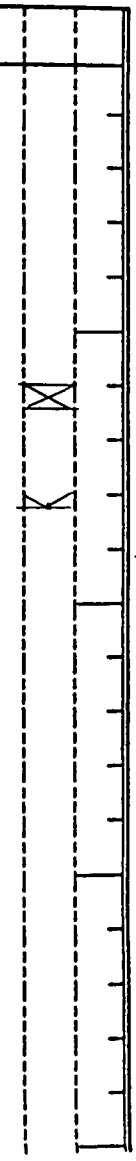
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Br. Med. Sand with Clay 20°
2			
3			
4			
5			Sand - Wet Br. Med Sand. 10% Clay.
	1.8ppm	OVM 59°	Med. Sand
7	1.4ppm	OVM 60°	Med, Sand
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB24

Ground Elev.

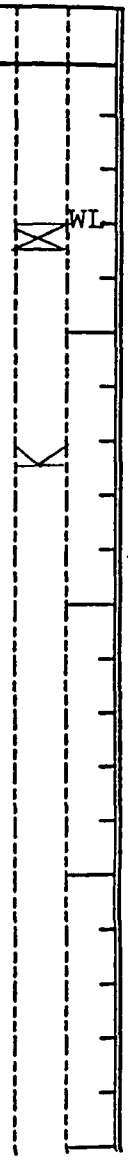
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			Sand
4			
5	ND		
	ND		Br. Med. Sand
	3PPM	OVM	Br. Med. Sand & Clay (5 to 10%)
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB25

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Br. Med Sand
2			
3			Br. Fine Sand
4	ND	(smell)	Br. Med. Sand & Clay 2%
5	1.6ppm	OVM 590	
6	1.9ppm	OVM 590	Br. Med. Sand & Silt & Clay 2-3%
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB26

Ground Elev.

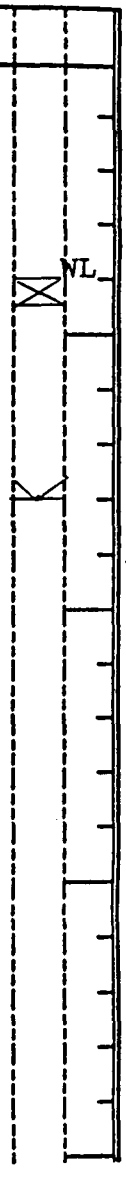
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Br. Med. Sand
3			Br. Fine Sand
4	ND	smell	Br. Fine Sand
5	0.8	OVM 65°	
6			
7	ND	OVM	Fine Sand
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB27

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Br. Med. Sand & Clay
2			
3			
4			
5	ND		Br. Med. Sand & Clay
	2ppm	ovm 65°	Br. Med. Sand & Clay - 5-10%
7	6ppm	ovm 65°	Lt. Med. Sand, Silt, Clay 2-3% No Free H2°
8		ovm 65°	Lt. Med. Sand & Clay 80% Clay
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB28

Ground Elev.

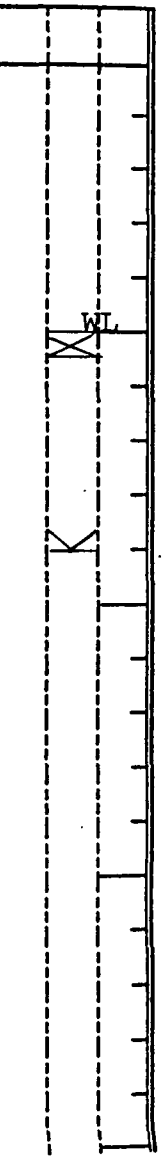
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			Br. Med. Sand
4			
5	0.8ppm	ovm 65°	Br. Med. Sand, Silt, Clay 5%
7	0.6ppm	ovm 65°	Br. Med. Sand, Silt, Clay 5 to 10%
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite 1.5 2'

Boring Well No. SB29

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			Br. Med. Sand Clay 2-3%
4			
5	490ppm	ovm 73°	Bl. Med, Sand, Clay 2-3%
			WL
7	240ppm	ovm 64°	Lt. Br. Med sand
8	8.2ppm	ovm 62°	Lt. Br. Med Sand
9			
10			
11			
12			
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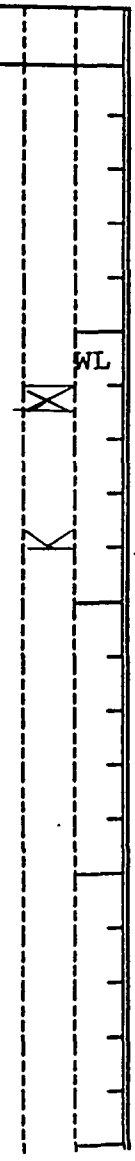
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB30

Ground Elev.

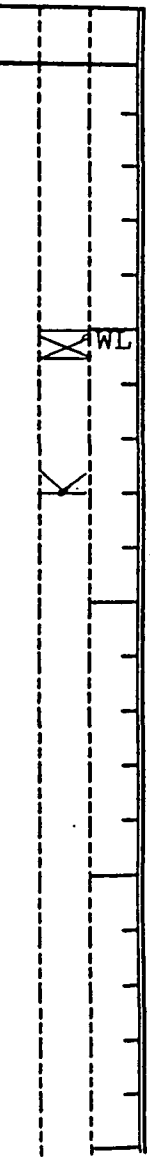
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Lt. Br. Med. Sand
2			
3			
4			
5	1.0ppm	ovm 62°	Lt. Br. Med. Sand
7	0.6ppm	ovm 59°	Lt. Br. Med. Sand No Clay
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger

Bore Diameter 4'

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB31

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Br. Med. Sand
3			
4			
5	ND		Br. Med. Sand
			Br. Med. Sand
7	0.6ppm	ovm 620	Br. Med. Sand
8			
9			
10			
11			
12			
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14			
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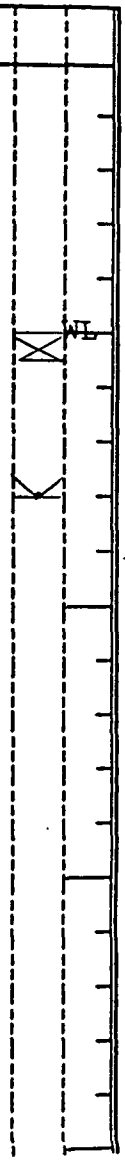
19			
20			



Project S & K

Location Farmington NM

Date 10-24-94 4:05

Drilling Method Power & Hand Auger

Bore Diameter 4" , 2 3/8

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB32

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Br. Med. Sand
3			
4			
5	57 ppm	ovm65°	
	592ppm	ovm64°	Moist sticky Bl. Med. Sand Wet 1.2% Clay
7			Med Sand & Bl. Clay
8	258ppm	ovm 63°	Gr. Clay Fine Sand (50/50) Strong H.C. Odor
9			Med Sand
	128ppm	ovm 70°	Gr. Clay Plastic
10	235ppm	ovm 68°	Bl. Med. Sand & Clay, Plastic (Silt)
11	66 ppm	ovm 66°	Gr. Clay
12			
13			
14			
15			
16			
17			
18			
19			
20			

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB 33

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			Lt. Br. Sand
3			Dark Br. Med Sand
4			
5	548ppm	ovm 66	Dark Br. Med Sand, Clay 1% Clay
			Bl/Br. Sand, 2% Clay
	139ppm	ovm 66	Gr. Fine Sand Silt and Clay 10% (Clay Ribbon)
7	92ppm	ovm 65	Med. Sand
8			
9			
10			
11			
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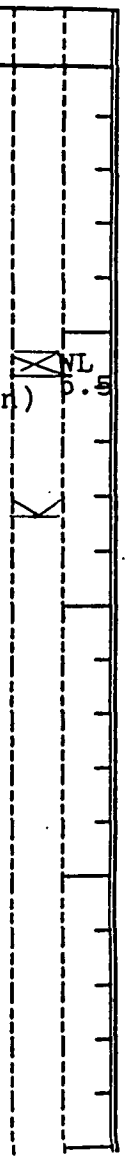


Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger & Hand

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite 2'

Boring Well No. SB34

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			
4			Br. Med. Sand
5	640ppm	ovm 65	5'3" Start of Black Fine Sand / Clay
7	623ppm	ovm 66	Lt. Gray Clay & Fine Sand. WL
8	324ppm	ovm 65	Sand Clay Plastic
9	326ppm	ovm 63	Clay / Sand / Silt
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Power Auger

Bore Diameter 4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB35

Ground Elev.

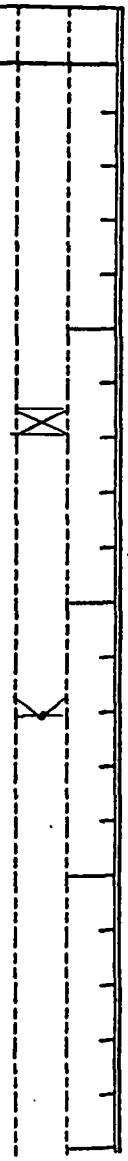
Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			
2			
3			Br. Med. Sand (fill sand)
4			
5			
6	282ppm	ovm 61°	Bl. Clay, Silt, Plastic
7			
8	543ppm	ovm 61°	Gr. Med Sand - Very Little Clay
9	161ppm	ovm 59°	Dk. Gray Fine Sand & Silt
10			Gray Fine Sand, Silt/Clay
11	439ppm	ovm 60°	Gr. Fine Sand
12			
13			
14			
15			
16			
17			
18			
19			
20			



Project S & K

Location Farmington NM

Date 10-25-94

Drilling Method Hand Auger

Bore Diameter 2 3/4"

Casing

Screen

Plugging Method Bentonite

Boring Well No. SB36

Ground Elev.

Top of Casing Elev.

Static Water Level

Method

Personnel

Depth	Sample	Method	Soil Classification
1 feet			Lt. Br. Med. Sand
2	ND		
3			Lt. Br. Med. Sand Clay 1%
4	ND		Fine Sand, Br. Clay Cont 40/60
5			Med Sand, Clay 2%
6	ND		Dk. Gr. Fine Sand, Clay 10-15%
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

ON SITE
TECHNOLOGIES, LTD.

November 4, 1994

Dr. Len J. Gawel
BioRem Consultants, Inc.
1601 Meadowbrook Drive
Ponca City, OK 74604

RE: Conoco Site Assessments
Shephard & Kelsey #1

Project No: 4-1140

Enclosed is the field survey and lab data collected for the Shephard & Kelsey #1 site.

Please note that the survey is relative to the bottom flange of the well head (assumed relative elevation: 100.00'). Water levels were measured by surveying a ground elevation using a stick over each soil boring and measuring the depth to water present in each boring with a steel tape from the stick. It should be noted the not all water levels were measure on the same date, holes were open to an extended time, and the measuring points were not well fixed.

The following table summarizes the field and lab data for the soil and water samples collected as part of this assessment:

SOIL SAMPLE RESULTS

SAMPLE	SOIL TYPE	pH	TPH (ppm)	BENZENE (ppm)	BTEX (ppm)
SB2				0.092	20.1
SB9			5612	1.83	104.2
SB9@6.5'	CL	8.72	2970		
SB9@7'	CL	8.84	235		
SB9@9'	CL	8.29			
SB31@5.5'			25		
SB32@6.5'	CL/SC	8.15	1835		
SB33@5'	CL	8.34	3214		
SB34@6.5'			2150		

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LEN GAWEL: SHEPHARD & KELSY #1
ON SITE TECHNOLOGIES

NOV 4, 1994
PROJECT: 4-1140

WATER SAMPLE RESULTS

SAMPLE	FIELD pH	BENZENE (ppb)	BTEX (ppb)
SB1		ND	14.4
SB2		44.3	720.0
SB3		471	61,575
SB9	8.80	7,233	29,111
SB19	8.88	20.3	567.9
SB20	8.32		
SB32	9.14	3,434	34,977
SB33	8.70	33.8	13,331
SB34	8.68	71.0	5,792
SB35		1,964	40,522
DG1		156	7,524
UG1		1.2	17.2
UG2		0.7	13.0

It was a pleasure working with you and Conoco on this project. Please contact me if you have any questions or need further information.

Respectfully submitted,
ON SITE TECHNOLOGIES, LTD.

Michael K. Lane, P.E.
Senior Geological Engineer

Encl: Survey Notes
Lab Reports: Soil Profiles (5)
TPH: EPA 418.1(7)
BTEX: EPA 8020 (14)
Soil pH (5)

CC: C. John Coy, Farmington, NM
Judy McLemore, Midland, TX

SURVEY NOTES FOR: SHEPHARD & KELSEY #1
PROJECT NO: 4-1140 SURVEY BY: MKL
DATE: 10/24-25-26/94 (FILE:41140SVY)

LOCATION	WATER LEVEL	RELATIVE ELEV	CORRECTED COORD X	Y	WATER ELEV
WH		100	0	0	
DG1	6.31	100.895	34.433252	-96.18255	94.585
UG1	6.44	101.71	47.370564	-178.1681	95.27
UG2	6.43	101.23	101.00507	-162.6652	94.8
SB5	6.33	98.75	-122.156	46.941092	92.42
SB2	7.104	99.275	-78.56927	72.511662	92.171
SB3	5.74	98.13	-36.23796	96.75077	92.39
SB1	2.042	93.24	-107.7869	114.17399	91.198
SB8		98.5	-166.2684	20.039886	
SB10	7.104	99.35	-93.06596	5.6832387	92.246
SB9	6.75	99.12	-49.01194	29.907877	92.37
SB11		104.08	25.149855	-37.91747	
SB12		99.01	-81.32058	-56.02953	
SB13		99.73	-56.34906	-97.57422	
SB14		100.81	-36.49562	-151.2349	
SB16	6.49	99.075	-3.804443	56.753793	92.585
SB17	6.33	98.915	18.792931	68.893525	92.585
E FNC		99.535	41.495897	82.982514	
W FNC		98.96	-73.73254	52.516327	
10/26/94 survey					
SB9	6.75	99.12	-48.70184	29.506017	92.37
SB34	6.44	99.54	20.68252	19.408724	93.1
SB18	6.8	99.62	60.552937	48.620794	92.82
SB20	6.08	99.67	111.41953	20.16474	93.59
SB19	5.85	99.335	91.026114	5.686637	93.485
SB22	5.29	100.05	158.74463	-7.562313	94.76
SB21	5.14	99.63	119.97251	-32.11546	94.49
SB25	5.5	100.07	171.10942	-41.3533	94.57
SB23	4.74	100.532	179.03009	-66.43281	95.792
SB24	4.47	100.14	151.85073	-81.53957	95.67
SB26	4.28	99.89	134.66417	-91.68192	95.61
SB27	6.13	100.145	112.4782	-111.9716	94.015
SB28	4.6	99.865	70.125205	-139.3976	95.265
SB33	4.92	99.365	80.344016	-66.15937	94.445
SB29	5.16	100.31	30.223906	-169.8199	95.15
SB31	6.06	101.475	39.268031	-172.1772	95.415
SB30	5.92	100.89	11.925375	-183.3173	94.97
SB32	5.75	99.8	21.796963	-89.80927	94.05
SB35	6.56	100.315	-33.79031	-82.66182	93.755

OFF: (505) 325-8786

ON SITE
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LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael Lane*	Date:	10/25/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample ID:*	*3721*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1127*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #1***				
Sampled by:	MKL/LG	Date:	10/24/94	Time:	12:00
Analyzed by:	DLA	Date:	10/25/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	ND	*0.2*
Toluene	3.3	*0.2*
Ethylbenzene	0.8	*0.2*
m,p-Xylene	8.1	*0.2*
o-Xylene	2.3	*0.2*
	TOTAL *14.4 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: DA
Date: 10/25/94

OFF: (505) 325-8786

ON SITE TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael Lane*	Date:	10/25/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample ID:*	*3722*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1127*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #2***				
Sampled by:	MKL/LG	Date:	10/24/94	Time:	12:10
Analyzed by:	DLA	Date:	10/25/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	44.3	*0.2*
Toluene	6.6	*0.2*
Ethylbenzene	45.1	*0.2*
m,p-Xylene	457.2	*0.2*
o-Xylene	166.9	*0.2*
	TOTAL 720.0 ug/L	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by:

Date: 10/25/94

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LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael Lane*	Date:	10/26/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample ID:*	*3719*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1127*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #2***				
Sampled by:	MKL/LG	Date:	10/24/94	Time:	11:25
Analyzed by:	DLA	Date:	10/25/94		
Sample Matrix:	*Soil*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/kg*	*Detection Limit Concentration ug/kg*
Benzene	*92*	*0.2*
Toluene	*2,070*	*0.2*
Ethylbenzene	*1,247*	*0.2*
m,p-Xylene	*13,227*	*0.2*
o-Xylene	*3,489*	*0.2*
	TOTAL 20,124 ug/kg	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by:
Date: 10/26/94

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LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael Lane*	Date:	10/25/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample ID:*	*3723*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1127*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #3***				
Sampled by:	MKL/LG	Date:	10/24/94	Time:	12:25
Analyzed by:	DLA	Date:	10/25/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	471	*0.2*
Toluene	9,632	*0.2*
Ethylbenzene	1,816	*0.2*
m,p-Xylene	38,178	*0.2*
o-Xylene	11,478	*0.2*
	TOTAL 61,575 *ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: DLG
Date: 10/26/94

OFF: (505) 325-8786

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LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/27/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3757*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***SB 9***				
Sampled by:	MKL	Date:	10/26/94	Time:	14:10
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	***Measured Concentration ug/L***	***Detection Limit Concentration ug/L***
Benzene	7,233	*0.2*
Toluene	3,183	*0.2*
Ethylbenzene	1,378	*0.2*
m,p-Xylene	13,708	*0.2*
o-Xylene	3,610	*0.2*
	TOTAL 29,111 ug/L	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by:
Date: 10/29/94

OFF: (505) 325-8786

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TECHNOLOGIES, LTD.

LAB: (505) 325-5667

TOTAL PETROLEUM HYDROCARBONS

Attn:	*Michael Lane*	Date:	10/25/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample No.*	*3720*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #9***				
Sampled by:	MKL/LG	Date:	10/24/94	Time:	14:20
Analyzed by:'	DLA	Date:	10/25/94		
Type of Sample:	*Soil*				

Laboratory Analysis

Laboratory Identification	*Sample Identification*	*Total Petroleum Hydrocarbons*
3720-2236	*Conoco, Inc. / Shephard & Kelsey Assessment* ***Shephard & Kelsey #1; SB #9***	5,612 *mg/kg*

Method - *EPA Method 418.1 Total Petroleum Hydrocarbons*

Approved by:
Date: 10/25/94

OFF: (505) 325-8786

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LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael Lane*	Date:	10/26/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2236*
Address:	*657 W. Maple*	*Sample ID:*	*3720*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1127*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB #9***				
Sampled by:,	MKL/LG	Date:	10/24/94	Time:	14:20
Analyzed by:	DLA	Date:	10/25/94		
Sample Matrix:	*Soil*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/kg*	*Detection Limit Concentration ug/kg*
Benzene	*1,827*	*0.2*
Toluene	*24,555*	*0.2*
Ethylbenzene	*7,720*	*0.2*
m,p-Xylene	*54,776*	*0.2*
o-Xylene	*15,280*	*0.2*
	TOTAL 104,157 ug/kg	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by:
Date: 10/26/94

ON SITE TECHNOLOGIES, LTD.

SOIL PROFILE ANALYSIS

Attn:	*c/o Len Gawel*	Date:	10/24/94
Company:	*Conoco, Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite100W*	*Sample No.*	*3770*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey #1***				
Project Location:	***SB9 @ 6.5***				
Sampled by:		Date:	10/24/89	Time:	0:00
Analyzed by:	*MKL*	Date:	10/31/94		
Type of Sample:	*Soil sample from sandy clay at water table.*				

Moisture Content:

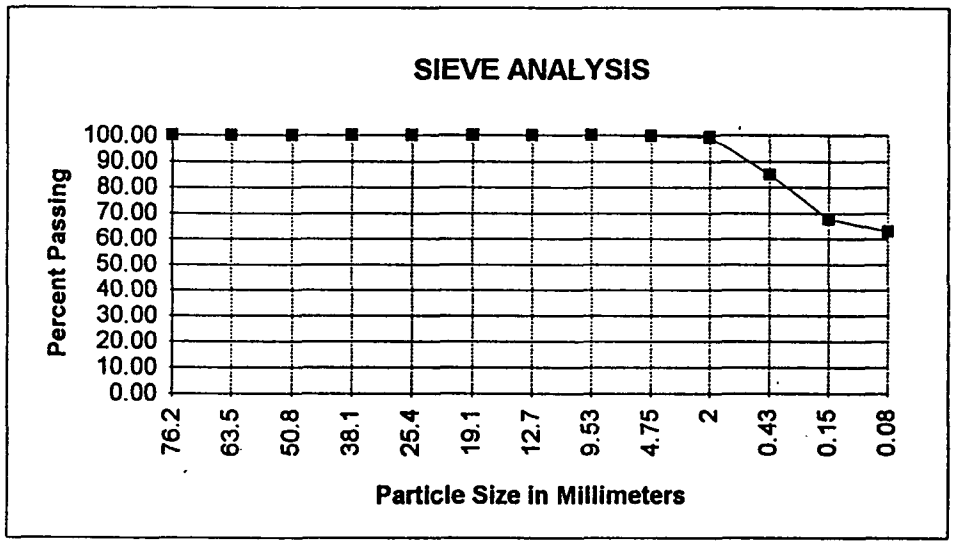
	oven-dry (ASTM D-4959)	9.70 %	speedy (ASTM D-4944)	%

Grain Size Distribution:

Gravel	Coarse:	0.00 %
	Fine:	0.22 %
Sand	Coarse	0.42 %
	Medium	14.44 %
	Fine	22.07 %
minus #200		62.85 %

Soil Constants:

PL:	
LL:	
PI:	
Cc:	
Cu:	



Soil Classification (USCS): Sandy Clay to Silty Clay (CL): grey-brown, plastic, moist, with medium to fine sand.

Remarks: No atterberg limits tested on fine fraction. Assumed similar to sample SB9@7'.

Approved by:

Date: 11/3/94

FILE: SOIL3770.XLS

MICHAEL K. LANE NEW MEXICO 11340 REGISTERED PROFESSIONAL ENGINEER

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LAB: (505) 325-5667

TOTAL PETROLEUM HYDROCARBONS

Attn:	*Michael Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2265*
Address:	*657 W. Maple*	*Sample No.*	*3770*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB 9 @ 6.5'***				
Sampled by:	LG	Date:	10/24/94	Time:	14:15
Analyzed by:	DLA	Date:	10/28/94		
Type of Sample:	*Soil*				

Laboratory Analysis

Laboratory Identification	***Sample Identification***	***Total Petroleum Hydrocarbons***
3770-2265	*Conoco, Inc. / Shephard & Kelsey Assessment* ***Shephard & Kelsey #1; SB 9 @ 6.5'***	2,970 *mg/kg*

Note: Samples recieved in zip-lock bags.

Method - *EPA Method 418.1 Total Petroleum Hydrocarbons*

Approved by:
Date: 10/28/94

ON SITE TECHNOLOGIES, LTD.

SOIL PROFILE ANALYSIS

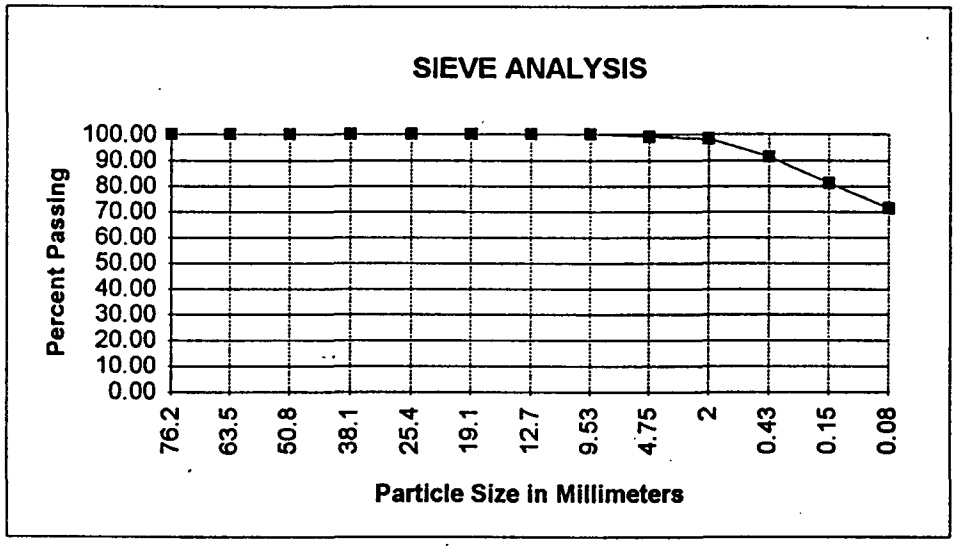
Attn:	*c/o Len Gawel*	Date:	10/24/94
Company:	*Conoco, Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite100W*	*Sample No.*	*3771*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey #1***				
Project Location:	***SB9 @ 7'***				
Sampled by:		Date:	10/24/89	Time:	0:00
Analyzed by:	*MKL*	Date:	10/31/94		
Type of Sample:	*Sandy clay to silty clay, moist to wet, black to dark gray*				

Moisture Content:

	oven-dry (ASTM D-4959)	28.40 %	speedy (ASTM D-4944)	%

Grain Size Distribution:			**Soil Constants:**	
Gravel	Coarse:	0.00 %	PL:	21
	Fine:	0.89 %	LL:	45
Sand	Coarse	0.63 %	PI:	24
	Medium	6.98 %		
	Fine	20.05 %	Cc:	
minus #200		71.45 %	Cu:	



Soil Classification (USCS): Sandy Lean Clay (CL): black to dark grey, plastic, with fine to very fine sand.

Remarks: Sample heavily contaminated with hydrocarbons.

Approved by: *Michael K. Lane*

Date: *11/3/94*

MICHAEL K. LANE NEW MEXICO 11340 REGISTERED PROFESSIONAL ENGINEER

FILE: soilrpt

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ON SITE TECHNOLOGIES, LTD.

SOIL PROFILE ANALYSIS

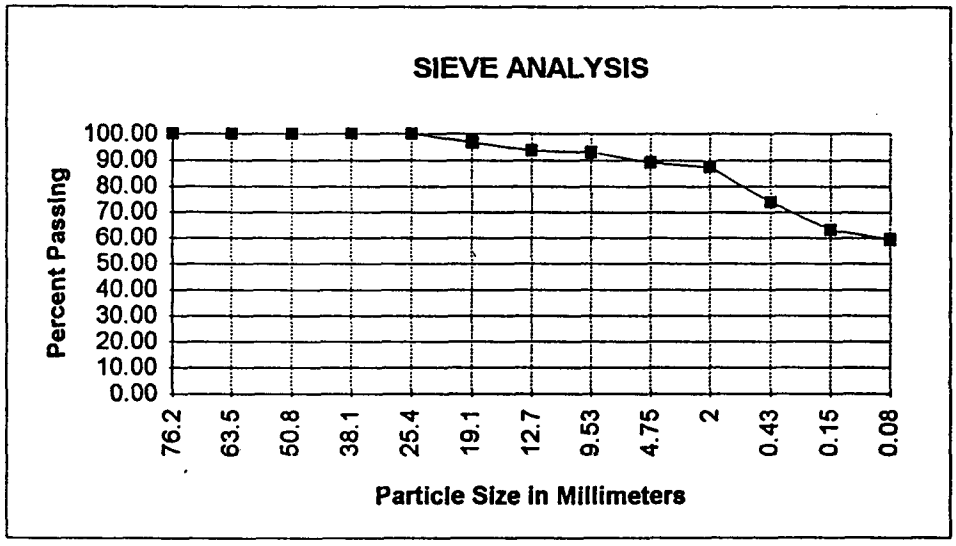
Attn:	*c/o Len Gawel*	Date:	10/24/94
Company:	*Conoco, Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite100W*	*Sample No.*	*3775*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey #1***				
Project Location:	***SB9 @ 9***				
Sampled by:		Date:	10/24/89	Time:	0:00
Analyzed by:	*MKL*	Date:	10/31/94		
Type of Sample:	*Sample form soils below water table.*				

Moisture Content:

	oven-dry (ASTM D-4959)	13.53 %	speedy (ASTM D-4944)	%

Grain Size Distribution:			**Soil Constants:**	
Gravel	Coarse:	3.16 %	PL:	
	Fine:	7.78 %	LL:	
Sand	Coarse	1.69 %	PI:	
	Medium	13.77 %		
	Fine	14.18 %	Cc:	
minus #200		59.42 %	Cu:	



Soil Classification (USCS): Sandy Lean Clay to Silty Clay (CL): Grey Brown to Lt Brown, sl. plastic fines, with fine gravels.

Remarks: Sample not of recommended volume for maximum particle diameter. No analysis of fines, assumed similar to SB9 @ 7'.

Approved by:

FILE: SOIL3775.XLS Date: 11/3/94

MICHAEL K. LANE NEW MEXICO 11340 REGISTERED PROFESSIONAL ENGINEER

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OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3760*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***SB 19***				
Sampled by:	MKL	Date:	10/26/94	Time:	12:55
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	***Measured Concentration ug/L***	***Detection Limit Concentration ug/L***
Benzene	20.3	*0.2*
Toluene	56.1	*0.2*
Ethylbenzene	57.1	*0.2*
m,p-Xylene	411.4	*0.2*
o-Xylene	23.1	*0.2*
	TOTAL *567.9 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: JAK
Date: 10/28/94

OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

TOTAL PETROLEUM HYDROCARBONS

Attn:	*Michael K. Lane*	Date:	11/2/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2273*
Address:	*657 W. Maple*	*Sample No.*	*3818*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***S & K #1 : SB #31 R***				
Sampled by:	MKL	Date:	11/1/94	Time:	12:45
Analyzed by:	DLA	Date:	11/2/94		
Type of Sample:	*Soil*				

Laboratory Analysis

Laboratory Identification	*Sample Identification*	*Total Petroleum Hydrocarbons*
3818-2273	*Conoco, Inc. / Shephard & Kelsey Assessment* ***S & K #1 : SB #31 R***	25 *mg/kg*

Method - *EPA Method 418.1 Total Petroleum Hydrocarbons*

Approved by:
Date: 11/2/94

ON SITE TECHNOLOGIES, LTD.

SOIL PROFILE ANALYSIS

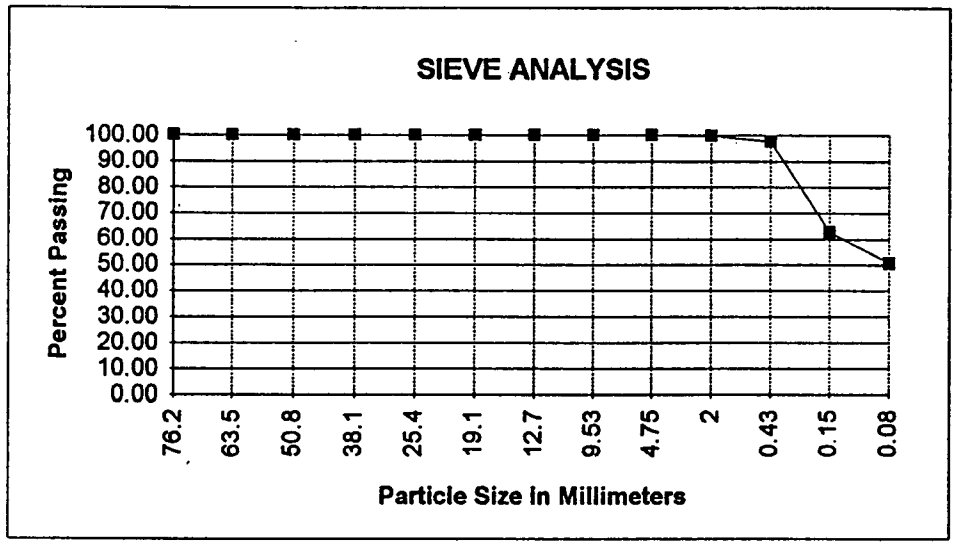
Attn:	*c/o Len Gawel*	Date:	10/24/94
Company:	*Conoco, Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite100W*	*Sample No.*	*3772*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey #1***				
Project Location:	***SB32 @ 6.5'***				
Sampled by:		Date:	10/24/89	Time:	0:00
Analyzed by:	*MKL*	Date:	10/31/94		
Type of Sample:	*Contaminated soil at water table.*				

Moisture Content:

oven-dry (ASTM D-4959)	17.86 %	speedy (ASTM D-4944)	%

Grain Size Distribution:		**Soil Constants:**	
Gravel Coarse:	0.00 %	PL:	
Fine:	0.00 %	LL:	
Sand Coarse	0.24 %	PI:	
Medium	2.23 %		
Fine	46.95 %	Cc:	
minus #200	50.59 %	Cu:	



Soil Classification (USCS): Sandy Lean Clay to Clayey Sand (CL/SC): Grey black, sl. plastic, fine to very fine sand.

Remarks: Sample contaminated with hydrocarbons.
No analyses of fines done, assumed to be similar to SB9@7'.

Approved by:

FILE: SOIL3772.XLS Date: 11/3/94

MICHAEL K. LANE NEW MEXICO 11340 REGISTERED PROFESSIONAL ENGINEER

FAX: (505) 327-1496 • 24 HR. – (505) 327-7105 • OFF: (505) 325-8786
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OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3758*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***SB 33***				
Sampled by:	MKL	Date:	10/26/94	Time:	13:30
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	33.8	*0.2*
Toluene	1,476	*0.2*
Ethylbenzene	707	*0.2*
m,p-Xylene	9,463	*0.2*
o-Xylene	1,651	*0.2*
	TOTAL *13,331 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: DA
Date: 10/28/94

ON SITE TECHNOLOGIES, LTD.

SOIL PROFILE ANALYSIS

Attn:	*c/o Len Gainel*	Date:	10/24/94
Company:	*Conoco, Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite100W*	*Sample No.*	*3773*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey #1***				
Project Location:	***SB33 @ 5'***				
Sampled by:		Date:	10/24/89	Time:	0:00
Analyzed by:	*MKL*	Date:	10/31/94		
Type of Sample:	*Sample of soils at water table.*				

Moisture Content:

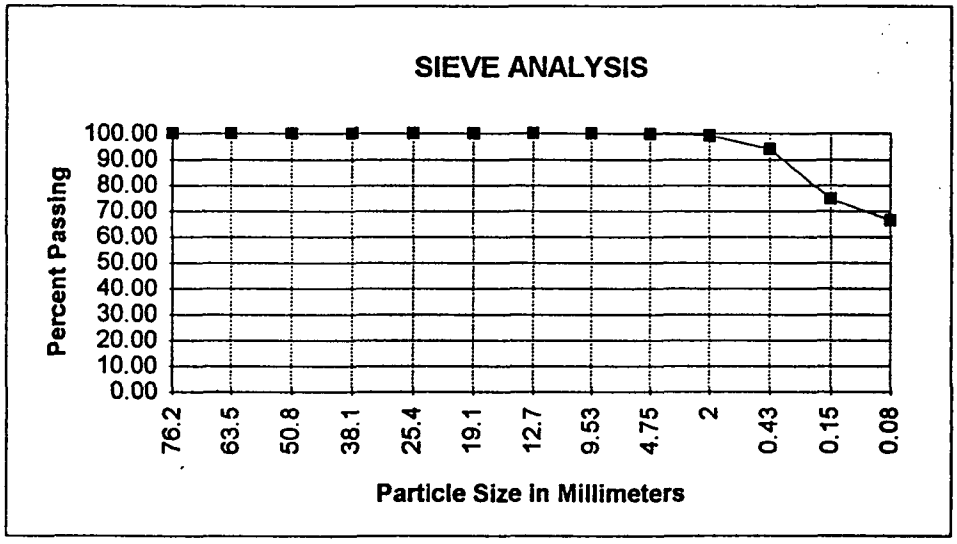
	oven-dry (ASTM D-4959)	19.11 %	speedy (ASTM D-4944)	%

Grain Size Distribution:

Gravel	Coarse:	0.00 %
	Fine:	0.12 %
Sand	Coarse	0.41 %
	Medium	5.39 %
	Fine	27.61 %
minus #200		66.47 %

Soil Constants:

PL:	
LL:	
PI:	
Cc:	
Cu:	



Soil Classification (USCS): Sandy Lean Clay to Silty Clay (CL): Grey brown to meduim yellow orange, slightly plastic, with fine to very fine sand. Larger sand particles consisted of calcified fine sand clusters.

Remarks: Sample not of recommended volume for particle analysis.

Approved by:

Date: 11/3/94

FILE: SOIL3773.XLS

MICHAEL K. LANE NEW MEXICO 11340 REGISTERED PROFESSIONAL ENGINEER

FAX: (505) 327-1496 • 24 HR. – (505) 327-7105 • PAGER: (505) 325-8786

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ON SITE
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AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3759*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***SB 34***				
Sampled by:	MKL	Date:	10/26/94	Time:	13:12
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	71	*0.2*
Toluene	228	*0.2*
Ethylbenzene	784	*0.2*
m,p-Xylene	2,997	*0.2*
o-Xylene	1,711	*0.2*
	TOTAL 5,792 *ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: DLA
Date: 10/28/94

OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

TOTAL PETROLEUM HYDROCARBONS

Attn:	*Michael Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2265*
Address:	*657 W. Maple*	*Sample No.*	*3774*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***Shephard & Kelsey #1; SB 34 @ 6.5'***				
Sampled by:	LG	Date:	10/25/94	Time:	17:00
Analyzed by:	DLA	Date:	10/28/94		
Type of Sample:	*Soil*				

Laboratory Analysis

Laboratory Identification	*Sample Identification*	*Total Petroleum Hydrocarbons*
3774-2265	*Conoco, Inc. / Shephard & Kelsey Assessment* ***Shephard & Kelsey #1; SB 34 @ 6.5'***	2,150 *mg/kg*

Note: Samples recieved in zip-lock bags.

Method - *EPA Method 418.1 Total Petroleum Hydrocarbons*

Approved by: Dale
Date: 10/28/94

OFF: (505) 325-8786

ON SITE TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/27/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3755*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***SB 35***				
Sampled by:	MKL	Date:	10/26/94	Time:	14:45
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	1,964	*0.2*
Toluene	11,406	*0.2*
Ethylbenzene	1,128	*0.2*
m,p-Xylene	20,550	*0.2*
o-Xylene	5,474	*0.2*
	TOTAL 40,522 *ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: JAL

Date: 10/20/94

OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/27/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3761*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***UG 1***				
Sampled by:	MKL	Date:	10/26/94	Time:	14:40
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	***Measured Concentration ug/L***	***Detection Limit Concentration ug/L***
Benzene	1.2	*0.2*
Toluene	1.5	*0.2*
Ethylbenzene	1.4	*0.2*
m,p-Xylene	9.5	*0.2*
o-Xylene	3.6	*0.2*
	TOTAL *17.2 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: JA-L
Date: 10/28/94

OFF: (505) 325-8786

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TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3762*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***UG 2***				
Sampled by:	MKL	Date:	10/26/94	Time:	14:53
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	0.7	*0.2*
Toluene	0.2	*0.2*
Ethylbenzene	3.7	*0.2*
m,p-Xylene	7.3	*0.2*
o-Xylene	1.1	*0.2*
	TOTAL *13.0 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: JA
Date: 10/28/94

OFF: (505) 325-8786

ON SITE
TECHNOLOGIES, LTD.

LAB: (505) 325-5667

AROMATIC VOLATILE ORGANICS

Attn:	*Michael K. Lane*	Date:	10/28/94
Company:	*On Site Technologies, Ltd.*	*Lab ID:*	*2264*
Address:	*657 W. maple*	*Sample ID:*	*3763*
City, State:	*Farmington, NM 87401*	*Job No.*	*4-1140*

Project Name:	***Conoco, Inc. / Shephard & Kelsey Assessment***				
Project Location:	***DG 1***				
Sampled by:	MKL	Date:	10/26/94	Time:	15:03
Analyzed by:	DLA	Date:	10/27/94		
Sample Matrix:	*Water*				

Aromatic Volatile Organics

Component	*Measured Concentration ug/L*	*Detection Limit Concentration ug/L*
Benzene	156	*0.2*
Toluene	596	*0.2*
Ethylbenzene	833	*0.2*
m,p-Xylene	4,621	*0.2*
o-Xylene	1,318	*0.2*
	TOTAL *7,524 ug/L*	

ND - Not Detectable

Method *- SW-846 EPA Method 8020 Aromatic Volatile Organics by Gas Chromatography*

Approved by: DA-4
Date: 10/28/94

ON SITE
TECHNOLOGIES, LTD.

SOIL pH ANALYSIS

Attn:	*c/o Len Gawel*	Date:	11/3/94
Company:	*Conoco Inc.*	*Lab ID:*	*2265*
Address:	*10 Desta Drive, Suite 100W*	*Sample No.*	*listed*
City, State:	*Midland, TX 79705*	*Job No.*	*4-1140*

Project Name:	***Site Characterization***				
Project Location:	***Shephard & Kelsey #1***				
Sampled by:	LG	Date:	10/24-25/94	Time:	0:00
Analyzed by:	*MKL*	Date:	11/3/94		
Type of Sample:	*Impacted Soils*				

Sample No.		Sample	pH
3770-2265		SB9@6.5'	8.72
3771-2265		SB9@7'	8.84
3772-2265		SB32@6.5'	8.15
3773-2265		SB33@5'	8.34
3775-2265		SB9@9'	8.29

Note: Samples received in zip-lock bags.

Method: EPA Method 9045 Soil pH

Approved by:

FILE: SOILpH.XLS Date: 11/4/94

FAX: (505) 327-1496 • 24 HR. – (505) 327-7105 • OFF.: (505) 325-8786
3005 NORTHRIDGE DRIVE • SUITE F • P. O. BOX 2606 • FARMINGTON, NEW MEXICO 87499

OFF: (505) 325-8786

ON SITE TECHNOLOGIES, LTD.

LAB: (505) 325-5667

QUALITY ASSURANCE REPORT

for EPA Method 8020

Date Analyzed: 10/25/94

Internal QC No.: 0222-STD
Surrogate QC No.: 0223-STD
Reference Standard QC No.: 0300-STD

Method Blank

Analytes in Blank	*Amount*
Average Amount of All Analytes In Blank	<0.1 ppb

Calibration Check

Calibration Standards	*Units of Measure*	**True Value*	*Analyzed Value*	*% Diff*	*Limit*
Benzene	ppb	20	19	5	15%
Toluene	ppb	20	18	10	15%
Ethylbenzene	ppb	20	17	13	15%
m,p-Xylene	ppb	40	36	11	15%
o-Xylene	ppb	20	18	12	15%

Spike Results

Analyte	*1- Percent Recovered*	*2 - Percent Recovered*	*Limit*	*%RSD*	*Limit*
Benzene	105	104	(39-150)	1	20%
Toluene	98	98	(46-148)	0	20%
Ethylbenzene	100	99	(32-160)	1	20%
m,p-Xylene	98	97	(35-145)	1	20%
o-Xylene	96	95	(35-145)	1	20%

Surrogate Recoveries

Laboratory Identification	*S1 Percent Recovered*	*S2 Percent Recovered*	*S3 Percent Recovered*
Limits	(70-130)		
3721-2236	102		

S1: Flourobenzene

CHAIN OF CUSTODY RECORD

2236

ON SITE TECHNOLOGIES, LTD.

657 W. Maple • P. O. Box 2606 • Farmington NM 87499
LAB: (505) 325-5667 • FAX: (505) 325-6256

Date: 10/25/94

Page 1 of 1

Purchase Order No.:	Reference No.:		
SEND INVOICE TO: Name	c/o Michael Lane	REPORT RESULTS TO: Name	Michael Lane / Title
Company	Conoco / Dept.	Company	On Site Tech.
Address		Mailing Address	
City, State, Zip		City, State, Zip	
		Telephone No.	Telefax No.

Special Instructions:

Shephard / Kelsey #1

Sampler:

Michael K. Lane / Len Gawlik

SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	COMPOSITE/ GRAB	PRESERVATIVES	Number of Containers	602	BTEX	418.1 TPH						Remarks (matrix)
					ANALYSIS REQUESTED								
SB#2	10/24 1125	G	N	1	✓			3719	-	2236			Soil
SB#9	" 1420	G	N	1	✓	✓		3720	-	2236			Soil
SB#1	" 1200	G	H_2SO_4	2	✓			3721	-	2236			WTR
SB#2	" 1210	G	"	2	✓			3722	-	2236			"
SB#3	" 1225	G	"	2	✓			3723	-	2236			"

Relinquished by:	Date/Time 10/25 1230	Received by:	Date/Time 10/25/94 1230
Relinquished by:	Date/Time	Received by:	Date/Time
Relinquished by:	Date/Time	Received by:	Date/Time

Method of Shipment:

Authorized by: _____ Date 10/25/94

(Client Signature Must Accompany Request)

Rush	5 Working Days	10 Working Days	Sampling Location:

Distribution: White – On Site Yellow – LAB Pink – Sampler Goldenrod – Client

GROUNDWATER ASSESSMENT FOR THREE PRODUCTION TANK BATTERIES
SAN JUAN BASIN PRODUCTION AREA
MIDLAND DIVISION
CONOCO, INC.

Submitted to:

William C. Olson
Hydrogeologist
Environmental Bureau
New Mexico Oil Conservation Division

Prepared for:

Judy McLemore
Environmental Coordinator
Midland Division
Conoco, Inc.
10 Desta Drive, Suite 100W
Midland, TX 79705

Prepared by:

John P. Hancock
Senior Environmental Engineer
Environmental Services Division
Conoco, Inc.
Ponca City, OK

September 30, 1993

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A. Introduction

In closing impoundments on state and fee lands identified in Conoco's San Juan Basin Pit Closure Plan using procedures described in guidelines issued by the New Mexico Energy, Minerals and Resources Oil Conservation Division Environmental Bureau (NMOCD), preliminary site assessments were performed. When using the ranking criteria of the guidelines, three impoundments required further assessment of oil and gas production operation impact upon localized groundwater. These further assessments were conducted by Conoco's Environmental Services Division (EvSD) with laboratory analysis performed by EvSD's compliance laboratory using EPA protocol analysis. Assessments were performed on impoundments at the following sites located in San Juan County New Mexico.

- Nye Com #1E Tank Drip Pit
- Salmon #1 Line Drip Pit
- Shepard and Kelsey #1 Dehydrator Pit

These assessments were performed on August 24, 25 and 26, 1993 by Conoco EvSD personnel Joel Wilson and Michael Boor.

B. Assessment Plan

The assessment for each site was to be performed by installing three small diameter monitoring wells at each site. One well was to be installed hydrologically downgradient from the surface impoundment with two wells installed upgradient. Each well was to be sampled using appropriate sampling methods and protocols for the following parameters.

- BTEX
- PAH (semivolatiles)
- Specific Conductance
- pH
- Temperature
- TDS

All samples were to be field screened for volatile organic compounds (field headspace analysis) using an Organic Vapor Meter (OVM). If the reading for any well was greater than 100 ppm, another well would be installed approximately 100 feet downgradient and sampled.

Following well installation a survey of the site was to be performed to horizontally locate the wells and to determine the hydraulic gradient.

Please refer to Appendix A for the complete workplan.

C. Well Installation and Sampling

All wells were installed to a depth of about three feet below the water table using a power auger or hand auger as needed. A 0.010" slotted screened PVC pipe was installed at a depth of about three feet below the water table to about three feet above the water table. Unscreened PVC casing was installed to the surface above the screened pipe. A one foot bentonite seal was placed at the surface to prevent surface water from entering the well bore. Colorado Environmental Spec 30 sand was used as the completion material to fill the annulus from the well total depth to the surface bentonite seal. After all materials were installed in each well, each bentonite seal was hydrated. All augering equipment was cleaned after the installation of each well. Construction logs for each well are detailed in Appendix B. Photographs of each well installation are included in Appendix C.

C.1. Nye Com #1E

Three wells were installed at the Nye Com #1E.

Please refer to Figure 1 and Appendices B and D for the site plot-plan, hydraulic gradient calculations and well construction logs.

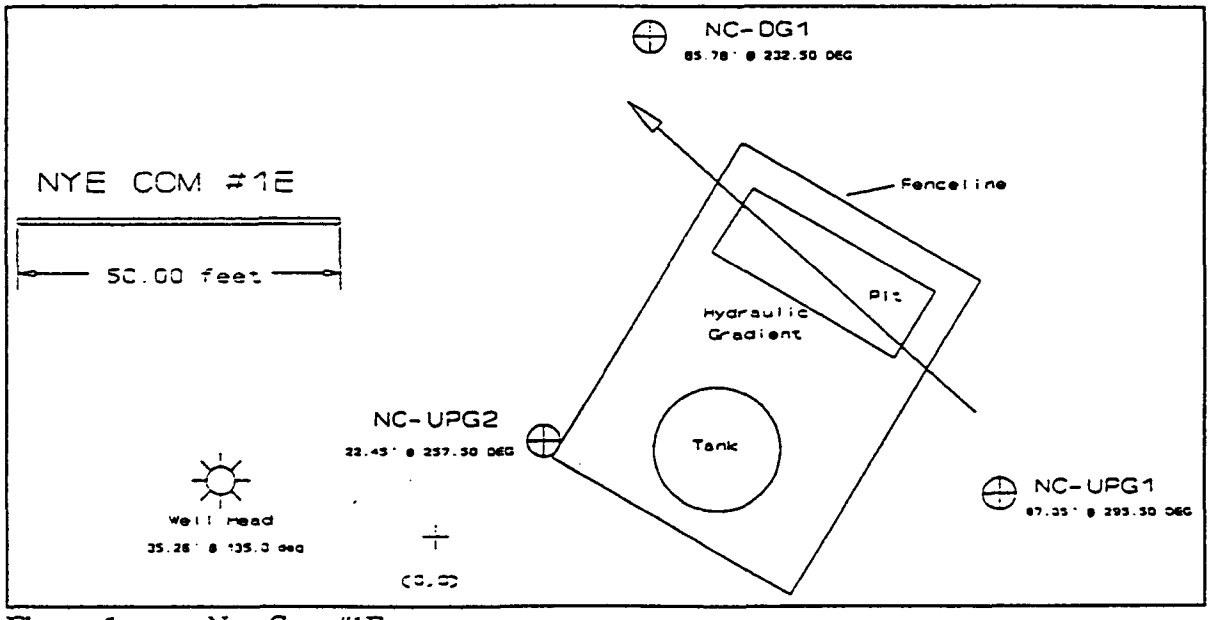


Figure 1 Nye Com #1E

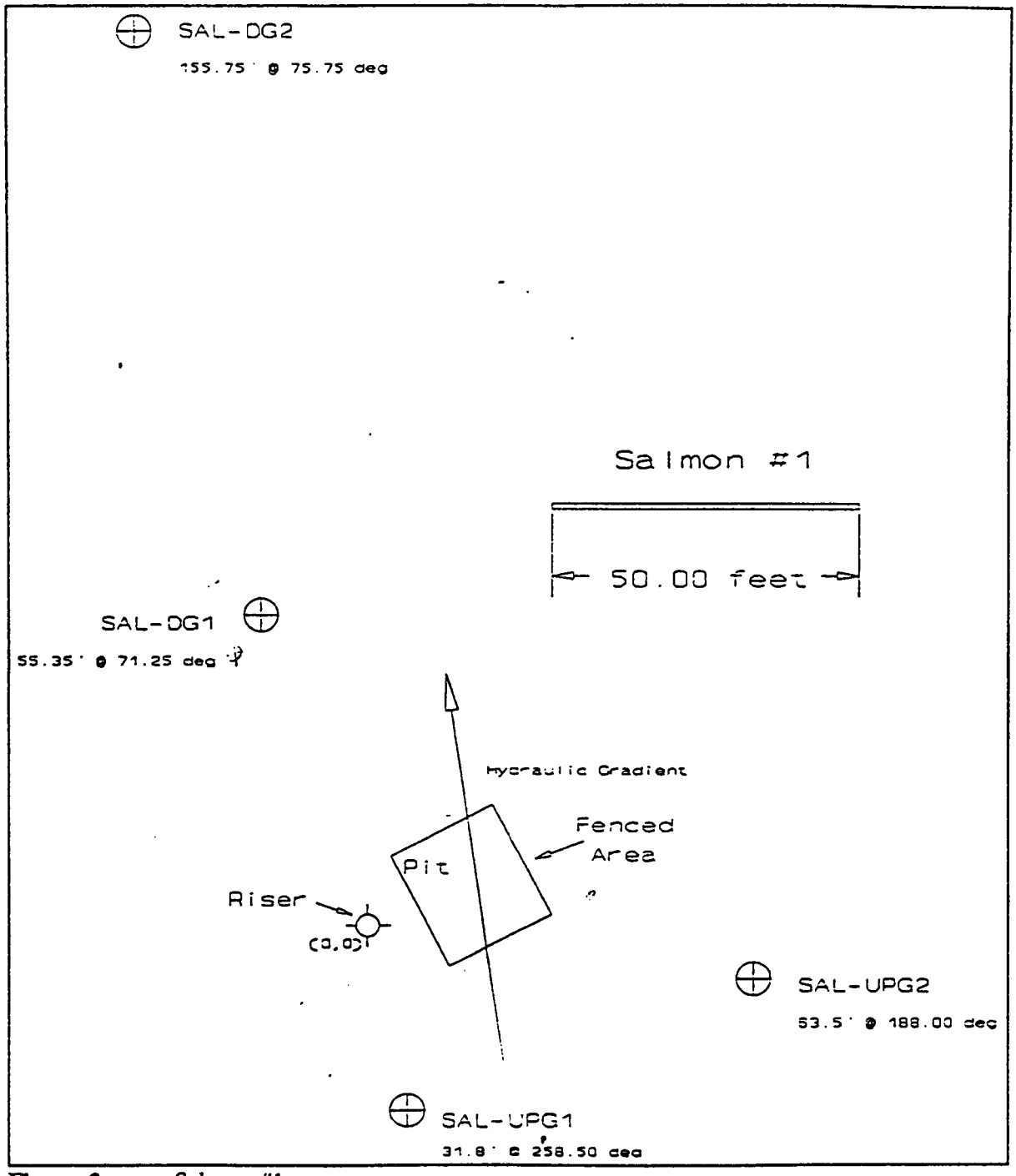


Figure 2 Salmon #1

The OVM reading for well SAL-DG1 was above 100 ppm indicating that another well should be installed farther downgradient. Well SAL-DG2 was installed approximately 100 feet

downgradient from well SAL-DG1. The OVM reading for well SAL-DG2 was less than 100 ppm and an additional downgradient well was not installed.

The following table lists the survey data of this site.

Table 3 Survey Data - Salmon #1

Well	Water Level BTOC (feet)	Well Total Depth (feet)	Riser Height above ground (inches)	Elevation of TOC (feet)	Elevation of water table (feet)
SAL-UPG1	-8.65	10.88	9	-3.98	-12.63
SAL-UPG2	-9.11	11.95	14	-3.63	-12.74
SAL-DG1	-2.62	7.67	6	-10.73	-13.35
SAL-DG2	-5.21	9.34	10	-9.45	-14.66

Note: Elevation datum is height of surveying instrument.
BTOC = Below top of casing.

The hydraulic gradient at this site is 0.009 $^{feet}/_{foot}$.

The following table lists the field gathered data for this site.

Table 4 Field Data - Salmon #1

		SA-UPG1	SA-UPG2	SA-DG1	SA-DG2
Temperature	(°C)	20.1	19.2	20.9	20.4
pH		7.48	7.63	7.84	7.56
Specific Conductance	(mmhos/cm)	1490	1620	1440	1860
Total Dissolved Solids	(mg/l)	770	824	723	932
OVM Reading	(ppm)	77	ND	172	ND

Note: Total Dissolved Solids is calculated from the Specific Conductance Measurement.
ND- Not detected.

C.3. Shepard and Kelsey #1

Three wells were installed at this site. Please refer to the following figure and Appendices B and D for the site plot-plan, hydraulic gradient calculations and well construction logs.

The following table lists the survey data for this site.

Table 5 Survey Data - Shepard and Kelsey #1

Well	Water Level BTOC (feet)	Well Total Depth (feet)	Riser Height above Ground (inches)	Elevation of TOC (feet)	Elevation of water table (feet)
SK-UPG1	-6.20	10.10	5.5	-3.58	-9.78
SK-UPG2	-5.41	10.10	7.5	-4.05	-9.46
SK-DG1	-6.35	9.05	15.0	-4.38	-10.73

Note: Elevation datum is height of surveying instrument.
BTOC = Below top of casing.

The hydraulic gradient at this site is 0.013 $^{feet}/_{foot}$.

The following table lists the field gathered data for this site.

Table 6 Field Data - Shepard and Kelsey #1

		SK-UPG1	SK-UPG2	SK-DG1
Temperature	(°C)	18.0	23.3	20.7
pH		7.46	7.53	7.53
Specific Conductance	(mmhos/cm)	2110	2290	1960
Total Dissolved Solids	(mg/l)	1098	1162	978
OVM Reading	(ppm)	ND	ND	16.5

Note: Total Dissolved Solids is calculated from the Specific Conductance Measurement.
ND- Not detected.

D. Sample Protocol

All samples were taken after at least ten well volumes of water were purged from each well. The Polynuclear Aromatic Hydrocarbon (PAH or Semi-volatile) samples were taken using a peristaltic pump. All other samples were taken using a stainless steel bailer. All samples were collected, labeled, preserved, and shipped according to EPA guidelines and accompanied by a Chain-of-Custody form. Sampling equipment was washed and triple-rinsed with deionized water between samples. Chain-of-Custody forms are included in Appendix E.

The following table lists the laboratory results for BTEX and TDS.

Table 8 Laboratory Results - BTEX and TDS

Sample #	Benzene mg/l	Toluene mg/l	Eth-Benzene mg/l	p-Xylene mg/l	m-Xylene mg/l	o-Xylene mg/l	Total Xylenes mg/l	TDS mg/l
NC-UPG1	<.003	<.003	<.003	<.003	<.003	<.003	<.009	6496
NC-UPG2	<.003	<.003	<.003	<.003	<.003	<.003	<.009	1330
NC-DG1	<.003	<.003	<.003	<.003	<.003	<.003	<.009	2915
SK-UPG1	.084	.048	.023	.012	.067	.065	.252	1500
SK-UPG2	<.003	.045	.076	<.003	<.003	<.003	<.009	1828
SK-DG1	.160	1.600	.530	1.300	3.600	1.300	6.200	1288
SAL-UPG1	.098	.052	.097	.024	.061	.025	.110	1044
SAL-UPG2	<.003	<.003	<.003	<.003	<.003	<.003	<.009	1340
SAL-DG1	8.300	12.000	<.300	.610	1.700	.660	2.970	1116
SAL-DG2	.100	<.003	<.003	<.003	<.003	<.003	<.009	1344
TRIP BLANK	<.003	<.003	<.003	<.003	<.003	<.003	<.009	<3

Notes:
"UPG" designates an upgradient well.
"DG" designates a downgradient well.
BTEX by EPA Method 8020 with preparation Method 5030.
TDS by EPA Method 160.1.
mg/l is equivalent to parts per million.
Total Xylenes is the sum of the concentrations of o-, m- and p-xylene.

All QA/QC analyte spikes and surrogate recoveries were within method specifications for the above analyses.

F. Summary

F.1. Nye Com #1E

Well NC-UPG1 was placed upgradient of the surface impoundment and well NC-DG1 was placed downgradient. No impact upon the groundwater by BTEX or PAHs was found at this location.

F.2. Salmon #1

Wells SAL-UPG1 and SAL-DG1 were about 20° from the hydraulic gradient line running directly through the surface impoundment. Well SAL-DG2 was placed downgradient. SAL-UPG2 showed no evidence of groundwater impact. Groundwater samples from well SAL-DG1 contained 8.300 and 12.000 mg/l of benzene and toluene respectively and contained 2.970 mg/l of total xylene. SAL-DG2 samples contained 0.100 mg/l of benzene. This indicates that the extent of the benzene plume is beyond the extreme downgradient well, but at a very low level.

No PAHs were found to be present at this site.

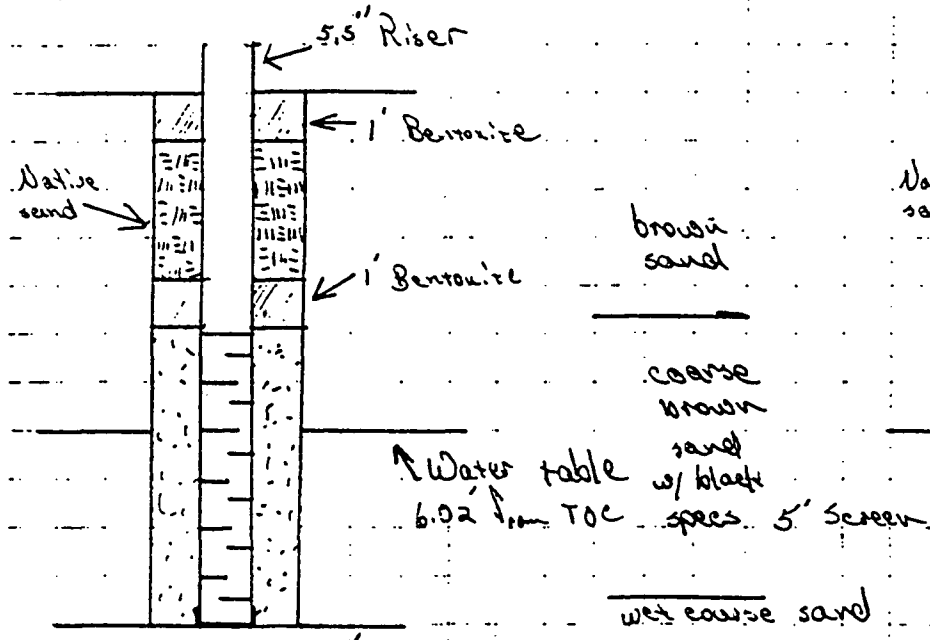
F.3. Shepard and Kelsey #1

Well SK-UPG2 was placed upgradient of the surface impoundment and well SK-DG1 was placed downgradient. SK-DG1 samples contained 0.160 and 1.600 mg/l benzene and toluene, respectively. Total xylenes for samples from well SK-DG1 at this site were 6.200 mg/l.

No PAHs were found to be present at this site.

Appendix B
Well Construction Logs
Site Plot Plans

SK-UPG1

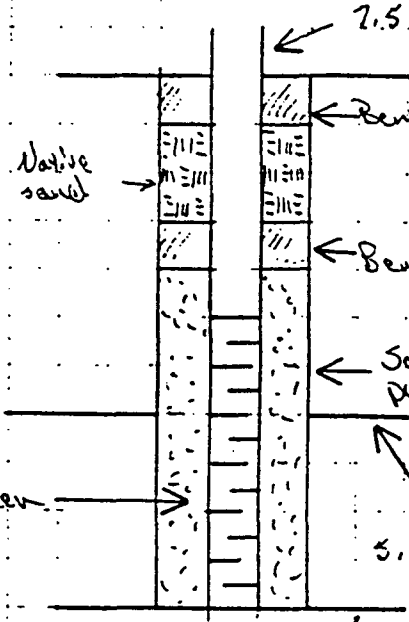


T.D. = 10.10' BTC

Material = 1" PVC w/ .010" slotted screen

Sand pack = Colorado Env. Spec 30 sand

SK-UPG2

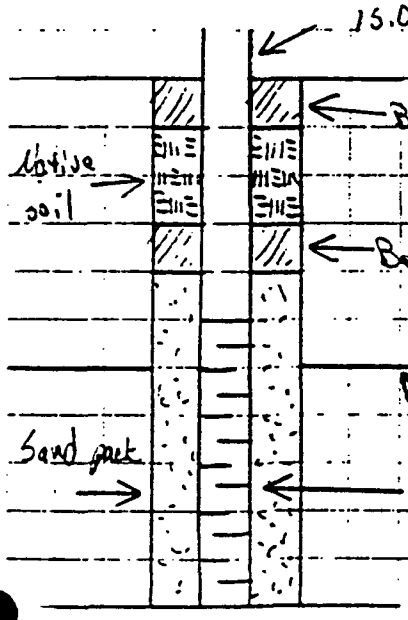


TD = 10.10' BTC

Screen length = 5'

Material = 1" PVC w/ .010" slotted screen

SK-DG1



TD = 9.05' BTC

Field data

	SK-UPG1	SK-UPG2	SK-DG1	Units
Temp	19.0	23.3	20.2	°C
pH	7.46	7.53	7.53	
S.C.	2110	2290	1960	mS/cm
TDS	1098	1,162	978	g/L
DVM	ND	ND	16.6	ppm

Made By J. P. Hancock

Checked By

Date 9-10-93

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Conoco Inc.
Calculation Sheet

Title San Juan GW
Shepard & Kelsey #1

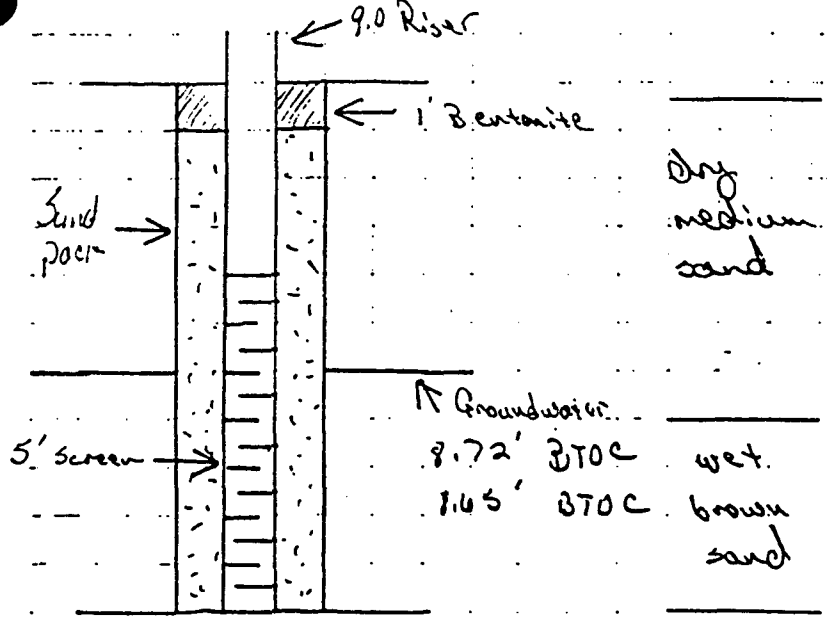
Job No.

Field San Juan

State N.M.

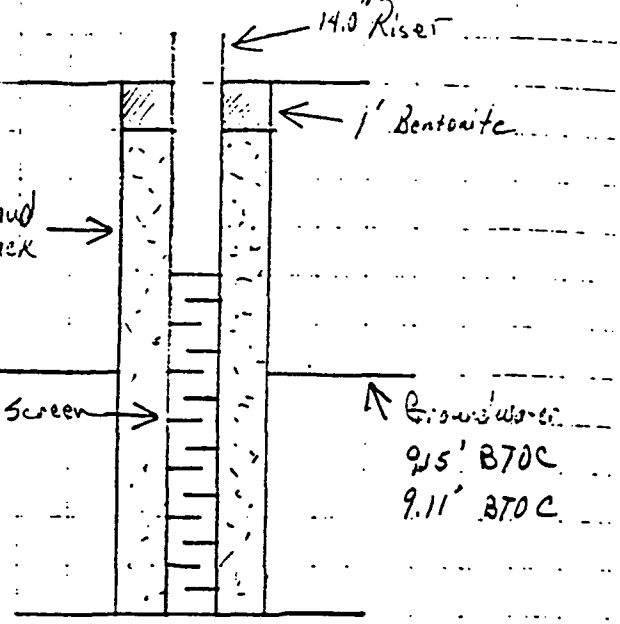
13-231-PB

SAL-UPG1



TD = 10.88'

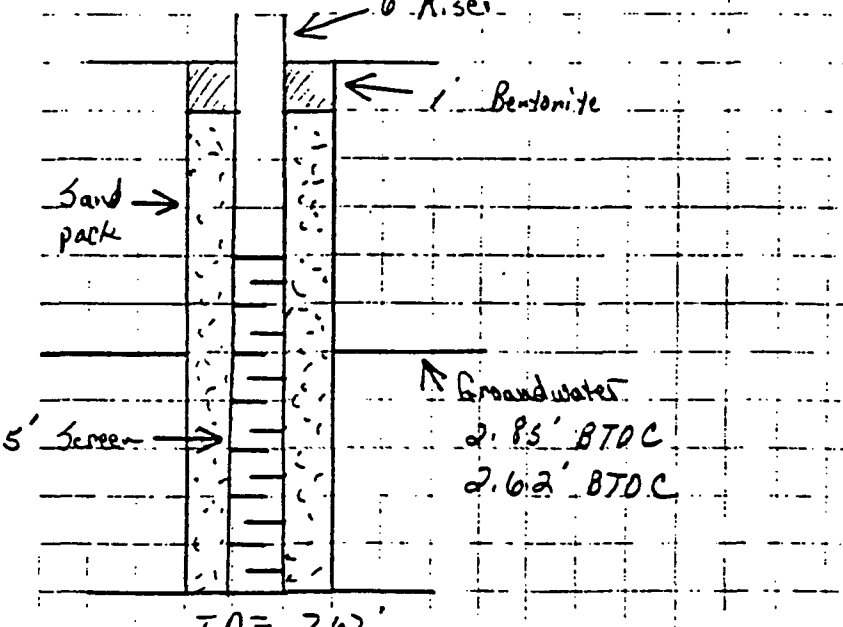
SAL-UPG2



TD = 11.95'

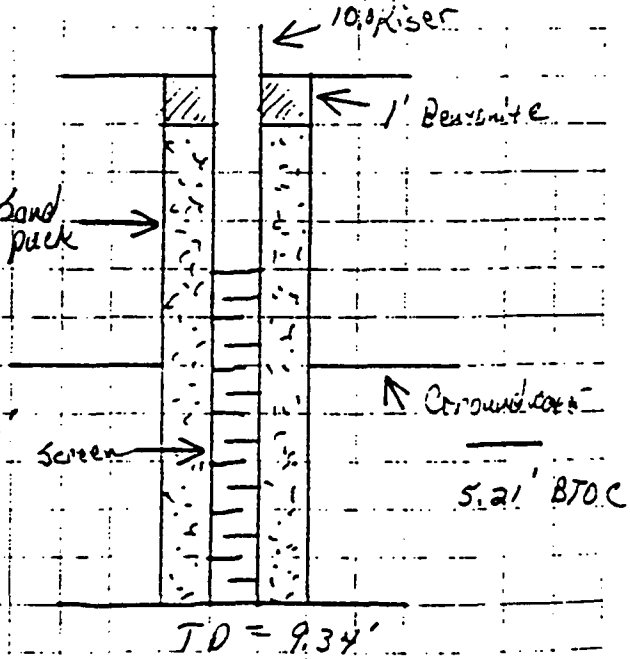
Material = 1" PVC w/ .010" slotted screen
Sand pack = C. Fnd. Sqe. 30 sand

SAL - DG1



TD = 7.67'

SAL-DG2



TD = 9.34'

13-231-PB

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Date 9-10-93
Page 2 of 4

Conoco Inc.
Calculation Sheet

Title San Juan 6'10
Salmon #1

Job No.
Field San Juan
State NM

Salmon # 1

Field Data

	SAL-UPG1	SAL-UPG2	SAL-DG1	SAL-DG-2	Units
Temp	20.1	19.2	20.9	20.4	°C
pH	7.48	7.63	7.84	7.56	
S.C.	1490	1620	1440	1860	mS/cm
TDS	0.770	0.824	0.723	0.932	g/L
OVM	77	ND	172	ND	ppm

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Date 9-10-93
Page 3 of 4

Conoco Inc.
Calculation Sheet

Title San Juan GW
Salmon #1

Job No.
Field San Juan
State NM

El -9.45' TOC
WL -5.21'
-14.66' FTOC

SAL-DG2
155.75' @ 75.75 deg

	Length	Elev. @ 100			
A =	77	72	7/72 · 77 = 7.5	43/72 · 77 = 28.9	67/72 · 77 = 61.0
			17/72 · 77 = 18.2	33/72 · 77 = 39.6	61/72 · 77 = 71.7
B =	89	61	9/61 · 89 = 8.8	26/61 · 89 = 37.9	46/61 · 89 = 67.1
			16/61 · 89 = 23.3	36/61 · 89 = 52.5	56/61 · 89 = 81.7
C =	54	11	7/11 · 54 = 34.4	50/72 · 77 = 50.13	

31/30 = 44.2/50'

30'/35.07' = .009 ft/ft

X = 35.07'

El -10.73' TOC
WL -2.62' FTOC
-13.35

SAL-DG1
55.35' @ 71.25 deg

Salmon #1

50.00 feet

A

B

C

Fenceline

Pit

Elev. 0

Riser

(0,0)

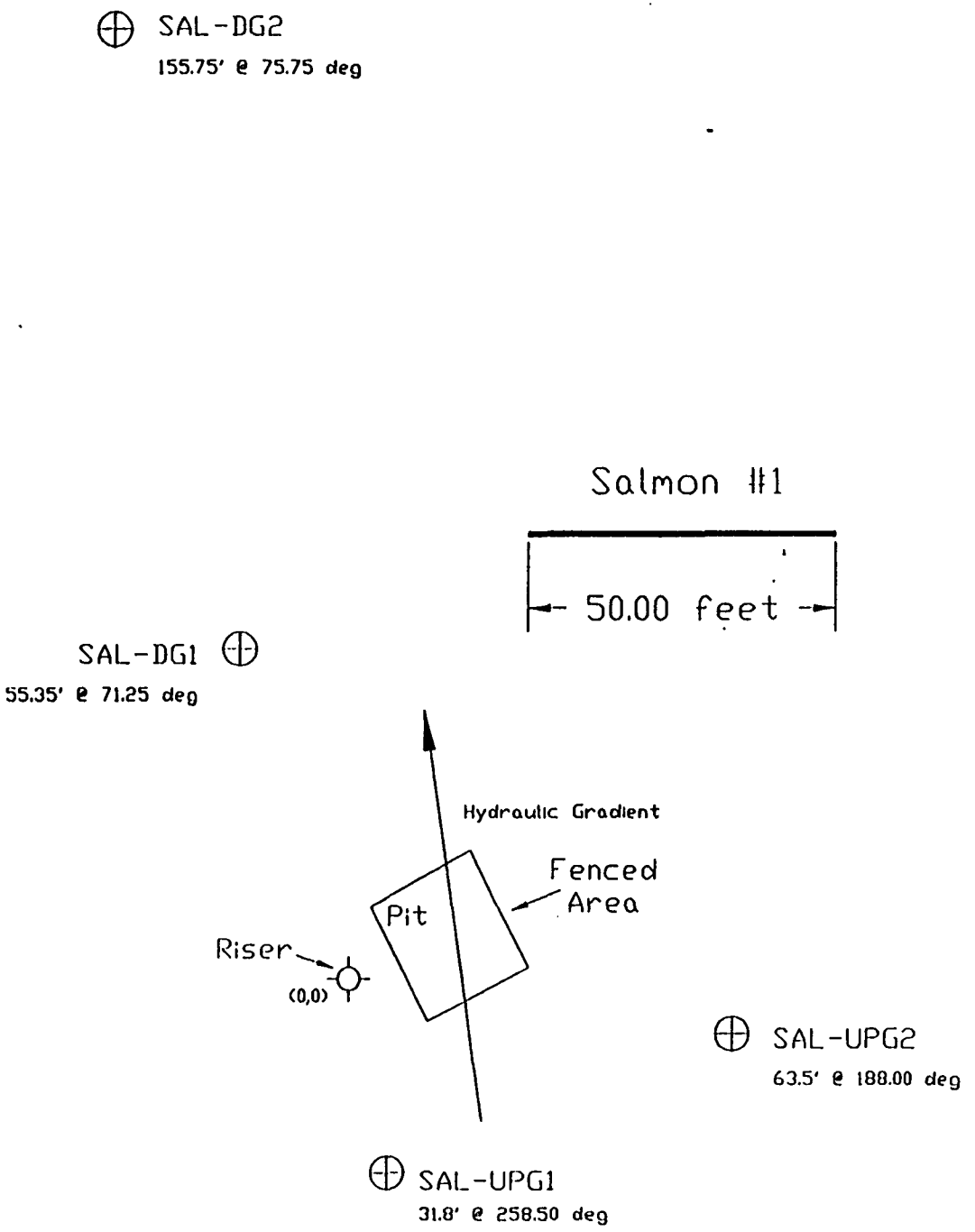
SAL-UPG2
63.5' @ 188.00 deg

El. -3.625' TOC
WL -8.11' FTOC
-12.74

El -3.975' TOC
WL -8.65' FTOC
-12.63

SAL-UPG1
31.8' @ 258.50 deg

SALMON.DWG


SAL-DG2
155.75' @ 75.75 deg
Salmon #1
50.00 feet
SAL-DG1
55.35' @ 71.25 deg
Hydraulic Gradient
Fenced
Area
Pit
Riser
(0,0)
SAL-UPG2
63.5' @ 188.00 deg
SAL-UPG1
31.8' @ 258.50 deg