SOIL VAPOR EXTRACTION/AIR SPARGING DOCUMENTATION REPORT AND CONCEPTUAL DESIGN

PREPARED FOR:

THE TORRINGTON COMPANY
FORMER TORRINGTON COMPANY HEAVY BEARINGS FACILITY
3702 WEST SAMPLE STREET
SOUTH BEND, INDIANA 46601

PREPARED BY:

CAPSULE ENVIRONMENTAL ENGINEERING, INC.
1970 OAKCREST AVENUE, SUITE 215
ST. PAUL, MINNESOTA 55113

AND

WENCK ASSOCIATES, INC.

P.O. BOX 428
MAPLE PLAIN, MINNESOTA 55359
(612) 479-4200

24 WESTON SOUTHWEST
GRAND RAPIDS, MICHIGAN 49503
(616) 776-9066

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GLOSSARY OF ACRONYMS

(bgl)	below ground level
(cfm)	cubic feet per minute
(EPA)	United States Environmental Protection Agency
(DO)	dissolved oxygen
(IDEM)	Indiana Department of Environmental Management
(OVM)	Organic Vapor Meter
(ppm)	parts per million
(psi)	pounds per square inch
(scfm)	standard cubic feet per minute
(VOC)	volatile organic compound
(VOCs)	volatile organic compounds
(Wenck)	Wenck Associates, Inc.

EXECUTIVE SUMMARY

Three areas of contamination have been identified at the Torrington facility. These are the S-3 area, located on the west side of the site, and two areas beneath the building, labeled Area A and Area B (see Figure 13).

In order to evaluate the technical feasibility of soil vapor extraction and air sparging to remediate soils and ground water at the former Torrington Heavy Bearings Facility, two pilot studies were performed. These tests were conducted in the S-3 area of the Torrington facility during the week of February 14, 1994. This area was selected due to the presence of pre-existing wells, its accessibility, and the fact that oil had been identified in this area. As part of the pilot study, one extraction vent, one sparge point, and three monitoring points were installed. Existing wells S3-A and S3-B were also monitored during the testing.

Results of the soil vapor extraction pilot test indicates that this technology is a desirable method of soil remediation. The data indicate that a typical soil extraction vent will generate an approximate radius of influence of 50 feet at an extraction vent vacuum of approximately 5 inches of mercury. Organic contaminant discharge during the extraction testing was approximately 0.2 pounds per day.

While the presence of clay and silt lenses within the saturated zone and an oil layer at the surface of the saturated zone does not make for ideal conditions, the air sparging pilot study indicates that air sparging is feasible. The data indicates that these constraints may inhibit the migration of the sparge air into the unsaturated zone in a uniform manner. However, air sparging is considered to be a desirable remedial alternative for this site.

1.0 INTRODUCTION

This report describes the pilot studies conducted during the week of February 14 to 18, 1994, by Wenck Associates, Inc. (Wenck), to evaluate soil vapor extraction and air sparging as potential remedial actions at the former Torrington Company Heavy Bearings Facility in South Bend, Indiana. The pilot studies were completed in the S-3 area of the site (see Figure 1) which has been contaminated with organic solvents and fuel oil (from hereon referred to as oil).

Past studies at the site have documented soil and ground water contamination resulting from surface spills. A layer of oil is floating on the water table in the S-3 Area, with a measured maximum thickness at the time of the pilot test of 0.48 feet. The smear zone associated with this oil layer is evident in many of the soil borings at this site as a zone of black colored soils at/or near the water table. Volatile organic compounds (VOCs) observed in the S-3 area in either the ground water or soil include chloroethane, 1,1,1-trichloroethane, trichloroethene, 1,1-dichloroethene, 1,1-dichloroethane, methylene chloride, benzene, ethylbenzene, toluene, and xylenes. Contaminant concentrations in soil have been observed up to 55 parts per million (ppm) 1,1,1-trichloroethane and in the ground water up to 6 ppm 1,1,1-trichloroethane.

Soils in the S-3 area are sands and gravels of high permeability extending downward approximately 55 to 60 feet to a lower clay unit. However, intermittent clay and silt lenses were noted during the construction of the monitoring and extraction vents and are also present at well S3-B. Clay layers were also identified at depth in wells W-1 and Torrington Production Well No. 3. Ground water is observed to vary at the site from 5 to 7 feet below ground level (bgl). During the pilot studies, ground water was observed at 7 feet bgl.

The soil vapor extraction pilot study was performed by extracting soil gas from an extraction vent and monitoring vacuums in monitoring vents and wells at increasing radial distances from the extraction vent. The extraction test was conducted at four different flow rates to supply the required data on flow rate versus radius of influence.

The air sparging pilot study was performed by injecting air at the base of the surficial aquifer in order to remove organic contaminants from the ground water. Air pressures in the unsaturated and saturated zones, organic vapor concentration in the unsaturated zone, and dissolved oxygen (DO) levels in the saturated zone were monitored in vents and wells at increasing radial distance from the sparge point to determine radius of influence at different flow rates.

The data obtained was evaluated to determine the feasibility of a full-scale remediation system and, if shown to be feasible, to prepare the conceptual design for the system.

2.0 PROJECT DISCUSSION

2.1 TECHNOLOGY DESCRIPTION

Soil vapor extraction is a method of remediating unsaturated zone soils containing VOCs. Soil vapor extraction vents (or "soil vents") are installed with the screened area exposed to areas of contamination in the unsaturated zone. A source of vacuum is applied to the soil vapor extraction vent to draw air through the void spaces in unsaturated soils, thereby enhancing volatilization of contaminants into these induced subsurface air streams. Contaminants are thus removed in vapor phase in the air stream drawn out of the soil vapor extraction vent. In a full-scale system, air streams from several vents are combined, treated if necessary, and discharged to the atmosphere.

Air sparging is a technology for the remediation of contaminated ground water. Air sparging points are installed with short screens, typically 2 to 5 feet long. The screened interval is placed in the saturated zone below the area of ground water contamination. Air is then forced into the sparging point where it flows out of the screen, flows through the saturated zone as small transient air pockets or "bubbles," and eventually flows into the unsaturated zone. As air passes through the saturated zone, volatile contaminants are transferred from the ground water into the air and eventually reach the unsaturated zone. Conceptually, air sparging creates a subsurface, in situ "air stripper." Air sparging must be performed in conjunction with soil vapor extraction to provide for the removal of contaminants transferred to the unsaturated zone and to prevent uncontrolled migration of vapor-phase contaminants in the unsaturated zone. Generally homogeneous aquifers are required for air sparging in order to promote uniform controlled air flow from the aquifer to the unsaturated zone.

2.2 FIELD INSTALLATION

Prior to conducting the pilot studies, three monitoring vents (MV-1, MV-2A, MV-2B), one extraction vent (EV-1), and one sparge point (SP-1) were constructed by Stearns Drilling Company of Dutton, Michigan, between January 24 to 26, 1994. Wenck was on site to oversee the drilling and log the geology of the borings. A Capsule hydrogeologist was also on site. Boring logs and construction diagrams are presented in Appendix B.

The sparge point and vents were constructed using the hollow-stem auger drilling technique. All equipment was thoroughly decontaminated prior to use to wash off road grime and between each borehole to prevent cross contamination between boreholes. Split spoon samplers were decontaminated prior to each use. All wash water and rinse water were disposed of in the same city sanitary sewer manhole where the ground water depression system is currently discharged under a city permit.

The layout of the pilot study area is shown on Figure 2. A cross-sectional view of the pilot study area is provided as Figure 3. The studies consisted of extracting air from the extraction vent EV-1 in one series of tests and injecting air into the sparge point SP-1 in another series of tests. During each of the tests, the radius of influence was observed by monitoring vacuum or pressures changes in monitoring points MV-1, MV-2A, MV-2B, S3-B, and S3-A which are located at increasing distances from EV-1 and SP-1 (see Figure 3).

2.2.1 Extraction Vent Installation

Extraction vent EV-1 was constructed of 4-inch diameter Schedule 40 PVC 10-slot (0.010-inch) screen and casing. The vent was screened from 2 to 7 bgl. Global #5 sand filter pack was used from 1 foot below the bottom of the screen to the top of the screen. BenSeal, a bentonite slurry, was used to seal the vent from 2 feet bgl to 0.5 feet bgl. A flush-mount cover was placed in 0.5 feet of concrete from 0.5 feet bgl to ground level. A threaded female coupler was fixed to the top of the casing for attachment of the extraction test riser piping.

Split spoon samples were collected continuously during the advancement of the extraction vent boring. The boring log and construction diagram for EV-1 are presented in Appendix B. Headspace readings were obtained using a Thermo Environmental Instruments, Inc., Model OVM IIB Organic Vapor Meter (OVM). The OVM was calibrated each morning using 98.5 ppm isobutylene calibration gas. The headspace readings obtained are listed on the boring log. A maximum reading of 20 ppm total VOCs was observed in the 6 to 8 feet bgl sample from EV-1.

2.2.2 Monitoring Vent Installation

Monitoring vents MV-1, MV-2A, and MV-2B were constructed using 2-inch diameter schedule 40 PVC 10-slot well screen and casing. MV-1 was screened from 4 to 14 feet bgl. MV-2A was screened from 3 to 5 feet bgl and MV-2B from 9 to 14 feet bgl. All of the vents were completed with Global #5 sand filter pack from the bottom of the boring to 0.5 feet above the top of the screen. Bentonite slurry was used to seal the vents to 0.5 feet bgl. The top 0.5 feet bgl was filled with concrete to set the flush-mount cap. Threaded female couplers were attached to the top of the casing for adapting to a riser. All vents have bolted flush-mount covers and locking casing caps.

Split spoon samples were collected continuously in the monitoring vent borings. Appendix B contains all boring and construction logs. The headspace readings for each split spoon were obtained and are also listed on the boring logs. The highest OVM readings were observed in MV-1 and MV-2B where 45 ppm total VOCs was observed in the 8 to 10 feet bgl split spoon sample from MV-1 and 50 ppm total VOCs was observed in the 6 to 8 feet bgl split spoon sample from MV-2B.

2.2.3 Sparge Point Installation

Sparge point SP-1, located 5 feet east of EV-1, was constructed of 2-inch diameter stainless steel screen and 2-inch galvanized steel riser. The sparge point is screened from 50 to 55 feet bgl with a 5-foot section of 7-slot (0.007 inch) stainless steel screen. Global #5 sand filter packing was used from 57.5 feet to 48 feet bgl. A mixture of Aquagel brand bentonite slurry and cement mixed at a ratio of 4 to 1 was placed from 48 feet to 3 feet bgl. This mixture was allowed to set overnight and the well was finished with concrete and a flush-mount cover. A threaded female coupler was attached to the top of the casing for attachment of the sparge test piping.

One split spoon sample was obtained at 55.5 feet to 57.5 feet to verify the location of the clay layer defined by previous borings in the area. The sample verified the location of the top of the clay layer, and the screen was placed immediately above this layer. The boring log and construction diagram are presented in Appendix B. The OVM headspace reading for this split spoon sample was 1 ppm total VOCs.

2.3 SOIL VAPOR EXTRACTION PILOT TEST EQUIPMENT AND PROCEDURES

The source of vacuum for the soil vapor extraction pilot test was a trailer-mounted Soil Vac Model SV4000, 10-horsepower vacuum pump. The pump is operated with a 230-volt, three-phase power source provided by the facility and is rated at a maximum flow rate of 420 cubic feet per minute (cfm) and a maximum vacuum of 190 inches of water (14 inches mercury). The vacuum inlet of the unit was piped to the extraction vent through a section of 2-inch diameter flexible hose connected to a section of rigid 2-inch PVC pipe necked up to the 4-inch extraction vent. Extraction flow rate was controlled by the ball valve and bleed air valve located on the Soil Vac Unit and a gate valve located in the section of 2-inch PVC pipe. Flow rate was measured with a Dwyer Instruments pitot tube Model 167-6 installed in the 2-inch PVC pipe. The pitot tube, when connected to a differential pressure gauge (Dwyer Instruments model 2001 magnehelic gauge), indicated air velocity which was converted to flow rate using the known cross-sectional area of the pipe. Vacuum at the extraction vent was measured using a PDM 205 oil-filled manometer through a sample port which was tapped into the extraction vent cap.

Radius of influence at the vacuum extraction vent was determined to define the required number and spacing of full-scale system extraction vents. Radius of influence was monitored by observing unsaturated zone vacuum levels in monitoring vents installed at varying distances from the operating extraction vent. The new monitoring vents, MV-1, MV-2A, and MV-2B were coupled to a 2-inch riser pipe. The riser pipe was sealed at the top with a cap that included a ball valve and sample port. The ball valve and sample port allowed connection of a magnehelic gauge or oil-filled manometer for vacuum monitoring without releasing the vacuum or pressure in the monitoring vent. Existing wells S3-A and S3-B were also used for monitoring vacuum and pressure. These 4-inch wells were sealed with a rubber 4-inch to 2-inch screw clamp coupler and 2-inch PVC riser pipe and cap with a ball valve and sample port.

The slip-fitting caps on the 2-inch riser pipes for all vents were temporarily taped in place to ensure a proper seal. The caps were removable to allow access to the ground water for sampling purposes.

The pilot study consisted of extracting soil gas from EV-1 at four different airflow rates: 38, 24, 34, and 17 standard cubic feet per minute (scfm), in order of execution. For a given flow rate, vacuum levels in the monitoring vents versus time were monitored for 1 to 2 hours. Radius of influence for a given flow rate was then defined as the distance at which measurable vacuum is observed in monitoring vents after stabilization of vacuum levels.

During the extraction vent pilot test, discharge from the vacuum pump was directed to the atmosphere through a stack with a height of approximately 12-feet above the ground surface. Per the air pollution permit exemption granted by the Indiana Department of Environmental Management (IDEM), up to 15 pounds of VOCs may be discharged directly to the atmosphere daily without treatment at a maximum flow rate of 200 cfm. During the extraction tests, emissions were periodically monitored through an access port in the discharge stack using an OVM. Emissions were measured at 0.2 pounds per day (see Appendix D) which is well below the 15 pounds per day allowed by the permit.

2.4 AIR SPARGING PILOT TEST EQUIPMENT AND PROCEDURES

The source of compressed air for the air sparging pilot test was a trailer-mounted compressor capable of delivering up to 125 cfm at 40 pounds per square inch (psi). The compressed air was delivered through a flexible hose and then through a 1.5-inch diameter PVC pipe necked up to connect to the 2-inch diameter air sparging point. The air sparging flow rate was controlled by a ball valve located on the compressor. The flow rate was monitored with a differential pressure gauge and pitot tube tapped into the 1.5-inch diameter PVC pipe.

The air sparging test was conducted as a step-test at three different flow rates to provide the relationship between flow rate and radius of influence. Increased pressure at a monitoring vent indicates that the vent is within the sparge point's radius of influence since this increase is caused by flow of air from the saturated zone into the unsaturated zone. During each of the step flow rates, unsaturated and saturated zone pressures were measured in the monitoring points using either a magnehelic gauge or the oil-filled manometer. The tests were run for 1 to 1.5 hours.

The unsaturated zone soil gas organic vapor content was measured in the monitoring points periodically during each test. Measurements were made by connecting the OVM to the access port in the capped monitoring vents. Measured increases in organic vapor in monitoring vents are an indication of the removal of organic compounds from the ground water and allows for determining the radius of air sparging influence.

The third parameter, ground water DO content, was measured in the monitoring points that extended into the water table between air sparging tests, but prior to operating the extraction vent for sparge air recovery. DO was measured with a YSI Model 50 DO meter. For the measurement, monitoring points were uncapped and the DO meter probe was lowered into the well. DO measurements were made between tests and not during each test as uncapping the monitoring vents would be disruptive to unsaturated zone pressure and organic vapor measurements. Measured increases in ground water DO content are another indication of the radius of influence showing the distance sparge air bubbles have migrated (that is, air bubbles in contact with ground water will gradually increase the DO content).

In order to reduce the potential of migration of contamination, each sparge test was run for less than two hours. Immediately following each sparge test, the extraction vent was operated at approximately 38 scfm for the time required to extract at least the volume of air that was injected.

Oil thickness was also measured in vents and wells penetrating the ground water using an oil/water interface probe. Pressures were monitored in nested vents MV-2A and MV-2B to observe potential differences between the unsaturated and saturated zones.

3.0 DATA COLLECTION AND ANALYSIS

3.1 GEOLOGY

Site geology plays an important role in the movement of sparge air in the saturated zone. An aquifer which has geologic characteristics which limit or divert the movement of sparge air within the aquifer or from the aquifer into the unsaturated zone can decrease air sparging effectiveness.

Sparging air must first pass through the contaminated areas of an aquifer in order for VOCs to be transferred from the water into the air. Furthermore, it is critical that the volatile organic compound (VOC)-laden air bubbles migrate from the saturated zone at locations known to be within the influence of a soil vapor extraction system.

Two geologic cross sections have been developed to illustrate geology in the S-3 area. Cross section locations are illustrated on Figures 15a, 15b, and 15c. Boring logs used in developing the cross sections are presented in Appendix B. These logs include boring and monitoring well logs developed by others and logs of vents installed as part of this pilot study.

As illustrated by the cross sections, the site geology is generally comprised of sand varying from fine to coarse and trace gravel. Clay lenses are also present at the site, as is shown in MV-2B at 10 to 12 feet bgl, and in S3-B at 5 feet bgl. Sandy silt was also identified at EV-1 and MV-1 at approximately 7 to 8 feet bgl. Clay lenses have also been reported at depth in other areas at the site in well W-1 and Torrington Well No. 3. Although nonhomogeneous conditions have been identified in localized areas around the site, the general geologic conditions for the site would be conducive to air sparging.

3.2 SOIL VAPOR EXTRACTION TEST

Data collected during the soil vapor extraction pilot study included:

- Vacuum and flow rate from the extraction vent
- Vacuum versus time in the monitoring points
- Total organic concentrations of discharge air
- Discharge air analytical results (TO-14)

The results of the extraction test are summarized in Tables 1 and 2. The values monitored and listed include vacuum at the monitoring points (SP-1, EV-1, MV-1, MV-2A, MV-2B, S3-A, and S3-B), vacuum at the Soil Vac unit, total VOC readings at the discharge stack, and pitot tube flow readings.

3.2.1 Data Validity

All data has been evaluated and is considered valid with the following exceptions:

- Vacuum measured during the 24-scfm test at EV-1. This point is anomalous since an in-line ball valve was partially closed to reduce the flow rate during the test. The point at which vacuum was measured for this test was located between the partially closed valve and the pump. Thus, the recorded vacuum was artificially higher than what would have been observed at EV-1.

- OVM data measured at the discharge stack during Tests 3 and 4. These two datum are anomalous due to the introduction of bleed air to the vacuum pump. The OVM data was collected at the discharge stack and therefore are artificially low due to dilution by the bleed air.

3.2.2 Extraction Flow Rate

The soil vapor extraction pilot study consisted of four tests run at varying extraction flow rates. These rates, were 17, 24, 34, and 38 scfm. Figure 4 presents the relationship between vent vacuums and flow rates at the extraction vent (EV-1).

Vacuums observed during the test were much higher than anticipated. This is primarily due to three factors:

- Possibility of lower permeability material placed in this area after previous excavation activities during the removal of underground storage tanks at this site

- Reduced effective thickness of the unsaturated zone caused by the cutting oil layer and associated smear zone

- Reduced effective thickness of the unsaturated zone caused by frost

Extraction vent flow rates may increase with the absence of frost which will allow for surface leakage of air. However, this effect should be minimal as the majority of the site is already capped by asphalt, concrete, or the facility buildings.

Vacuums for the 17 and 34 scfm tests were measured at the extraction vent, whereas vacuums for the 24 and 38 scfm tests 3 and 4 were measured at the blower inlet. The line drawn on Figure 4 indicates the relationship between vacuum and flow rate. The vacuum measured during the 24-scfm test is not a valid point, as was described previously, and is, therefore, not plotted on Figure 4.

3.2.3 Vacuum Monitoring

Vacuum monitoring during the extraction testing was performed at six additional points: SP-1, MV-1, MV-2A, MV-2B, S3-B, and S3-A listed in order of increasing radial distance from EV-1 (see Table 1). Data collected from monitoring points MV-1, MV-2A, S-3B, and S3-A are plotted on Figure 5.

No appreciable changes in vacuum were measured at points SP-1 and MV-2B. This was expected, however, as both points are screened entirely below the water table.

Monitoring vent vacuums measured during each extraction test are illustrated by Figure 5. As shown, a correlation exists between extraction vent flow rates and measured monitoring point vacuums. This is evident due to the consistent relationship between higher extraction vent flow rates and higher monitoring vent vacuum levels. In addition, a relationship between monitoring point vacuums and distance is also shown by Figure 5. As the distance from the extraction vent increases, the vacuum level decreases.

The data indicate that vacuum was observed out to 82 feet (approximately 0.03 to 0.1 inches of water S3-A). However, a more conservative radius of influence is approximately 50 feet. Depending on flow rate, the vacuum level at 50 feet is between 0.22 and 0.6 inches of water. Figure 5 also indicates that increases in extraction vent flow rate (and associated vacuum) only produce minimal increases in radius of influence. Therefore, lower vacuum levels and flow rates (similar to the 17-scfm test) can be used for the design of the extraction blower or vacuum pump.

3.2.4 Air Emissions Analyses

Air emissions from the vacuum pump were monitored using an OVM at the discharge stack. In addition, Tedlar bag air samples were collected from the extraction vent following each test. Discharge stack readings are presented in Table 1. Laboratory data are summarized in Table 2. Laboratory data sheets are also presented in Appendix C.

OVM readings indicate (see Table 1) that the highest VOC levels occurred during Test 1 which was the highest flow rate test. OVM readings observed during Tests 3 and 4 (34 and 17 scfm, respectively) are artificially low due to the addition of clean bleed air (used to control extraction rate) into the vacuum pump prior to discharge (see 4.2).

Laboratory analyses were also performed on the Tedlar bag samples collected from EV-1. During the first test (38 scfm), the sample was collected from a sample port on the Soil Vac unit. After the next three tests, the samples were collected from the sample port on the EV-1 cap. A personal sampler pump was used to "pull" the air from EV-1 immediately after the Soil Vac unit was shut off. For all samples, the Tedlar air sample bag was filled and purged three times prior to final filling for analytical testing. Sample bags were shipped in a cooler by overnight courier to Enseco Air Toxics Laboratory in City of Industry, California. Results of the analytical testing are in Appendix C and are also summarized in Table 2. Air samples were analyzed for VOCs by United States Environmental Protection Agency (EPA) Method TO-14.

Highest laboratory VOC concentrations were observed during the first test (38 scfm) with a total VOC concentration of 39 ppm. The three subsequent tests had total VOC concentrations of 22 ppm (24 scfm), 19 ppm (34 scfm), and 24 ppm (17 scfm), respectively.

In all four tests, chloroethane, 1,1,1-trichloroethane, and 1,1-dichloroethane comprised the majority of air emissions (see Table 2). These three compounds were observed at similar concentration ratios in the four tests. Minor concentrations of vinyl chloride, 1,1-dichloroethene, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, and trichlorofluoromethane were also observed. Calculated air emissions for the pilot study are presented in Appendix D. The calculation shows that approximately 0.2 pounds of contaminants are discharged per day at 20 scfm.

3.2.5 Summary of Results

3.2.5.1 Radius of Influence

As illustrated by Figure 5, all four soil vapor extraction tests produced significant vacuum pressure in S3-B, located 53 feet from EV-1 (vacuum pressure levels ranged from 0.22 to 0.6 inches of water during the four tests). The test results also indicate that increases in extraction flow rates from EV-1 do not produce significant increases in radius of influence. Therefore, lower flow rates (and corresponding lower vacuum pressure levels) can be used.

Based on the EV-1 test results, vertical vents installed in formations similar to that of the S-3 area can be expected to produce a radius of influence of at least 50 feet at a flow rate of 20 scfm. The vacuum pressure level at 50 feet at this flow rate will be approximately 0.5 inches of water. Utilizing Figure 4, a vacuum pressure of approximately 5-inches mercury will be required at the extraction vent to produce a 20-scfm flow.

3.2.5.2 Air Emissions

Total VOC concentrations in EV-1 discharge (see Table 2) ranged from 19 to 39 ppm based on laboratory analytical results. Highest VOC concentrations were observed during the first test (39 ppm), with more stable concentrations observed during the remaining three tests (22, 19, and 24 ppm). Three compounds were observed in high concentrations: chloroethane, 1,1,1-trichloroethane, and 1,1-dichloroethane, listed in order of decreasing concentrations. Smaller concentrations (less than 1 ppm) of several other compounds were also observed:

cis-1,2-dichloroethene, 1,1-dichloroethene, vinyl chloride, trichlorofluoromethane, tetrachloroethene, and trichloroethene.

The average VOC mass removal rate during the pilot study was approximately 0.2 pounds per day. The current air permit exemption stipulates total emissions of 15 pounds per day at a maximum flow rate of 200 cfm.

3.2.6 Effectiveness of Technology

The following conclusions can be drawn from a review of the data:

- Soil vapor extraction is a feasible technology to remediate VOC contaminated, unsaturated zone soils.
- Vertical extraction vents, installed in soils similar to those of the S-3 area, will produce radii of influence of approximately 50 feet at an extraction flow rate of 20 scfm.
- Increased extraction rates from these vents do not produce significant increases in radius of influence.
- An extraction flow rate of approximately 20 scfm requires an extraction vent vacuum of approximately 5 inches of mercury.

The test data indicates that vertical extraction vents are capable of generating capture zones of approximately 50 feet in radius. The data also indicates that high extraction flow rates are not required and that wintertime flow rates of approximately 20 scfm at approximately 5 inches of mercury vacuum per vent will be required. As summertime operating flow rates may be higher, the vacuum pump for the final system will need to have extra capacity.

3.3 AIR SPARGING TEST

Data collected during the air sparging pilot study included:

- Pressure and flow rate to the sparge point
- Pressure versus time in the monitoring points
- Total organic vapor concentrations in monitoring points
- DO content in ground water
- Oil thickness measurements (at select points)

The results of the air sparging tests are summarized in Table 3. The values monitored and listed include pressures at the monitoring points (EV-1, MV-1, MV-2A, MV-2B, S3-A, and S3-B), pressure at the sparge point SP-1, total VOC readings at the monitoring points, pitot tube flow readings, and DO measurements before and after the test in each vent or well that intersected water.

3.3.1 Data Validity

All data has been evaluated and are considered valid with the following exceptions:

- Data collected during the first test. All data collected during the first sparge test has been rejected as a stable air injection rate was not achieved.

- Increased OVM readings in MV-2B. This vent is screened entirely beneath the water table and therefore is not directly comparable to other monitoring points screened in the unsaturated zone. Observed increases in OVM readings from this vent resulted from the flow of sparge air directly into the vent, not an increase in unsaturated zone organic vapor concentrations.

- DO measurements in EV-1. The screened interval for EV-1 is from 2 to 7 feet below grade. Water level measurement indicated a depth to water of 7 feet below grade. Therefore, the water encountered in EV-1 may be residual water from vent construction rather than ground water. Consequently, the DO measurements from this vent would not represent ground water conditions.

The data correlation between parameters (that is, OVA readings and pressure measurements) at the same monitoring locations and between different monitoring locations is not consistent (see Figures 7a to 10b). Under ideal conditions, good correlation between locations and parameters would indicate a relatively uniform transfer of air through the aquifer and from the aquifer into the unsaturated zone. Conversely, a lack of correlation between locations and parameters indicates a nonuniform transfer of air into the unsaturated zone.

3.3.2 Air Sparging Rates

The air sparging pilot study consisted of three tests at varying flow rates. These rates were 15, 26, and 35 scfm. Due to high aquifer pressures observed during tests 2 and 3, a fourth air sparge test was not performed. As stated above, a stable air injection rate was not achieved in the first test (15 scfm) and the data from this test is therefore not included in the data analysis.

Figure 6 presents air sparging flow rates versus pressure at the sparge point. The 26-scfm and 35-scfm flow rates are plotted, along with the calculated zero flow pressure (the pressure needed to depress the water column in the sparge point). The pilot study shows agreement between the measured flow rates and pressures and the theoretical zero-flow pressure. The flat slope of this line indicates that once the initial water column is pushed out of the sparge point, very little additional pressure is required for substantial airflow to take place.

3.3.3 Pressure Monitoring

Pressure monitoring during the air sparge testing was performed at points EV-1, MV-1, MV-2A, MV-2B, S3-B, and S3-A listed in order of increasing radial distance from EV-1 (see Table 3). Pressure data are plotted on Figures 7 and 8 for the 26 scfm and 35 scfm sparge tests, respectively. Figures 7 and 8 have been separated into three figures to account for consistency in screen intervals.

The effects of inhomogeneities present at the site are illustrated by the large pressure differentials observed at MV-2A and MV-2B (see Figures 7 and 8). During tests 2 and 3, minimal pressure was observed in MV-2A, measured at 0.1 and 0.8 inches of water, respectively. Contrasting to MV-2A, pressures in MV-2B, screened completely below the aquifer and a clay lens, were measured at 7.9 and 79 inches of water during tests 2 and 3. In addition to the noted clay layer, #4 fuel oil present in the S-3 area at the site may also have an influence on sparge air migration into the unsaturated zone. Oil has been measured in adjacent monitoring points MV-1, S3-B and S3-A at 0.01, 0.43, and 0.03 feet, respectively. Oil thickness could not be measured in well S3-C due to the product recovery equipment present in the well. Oil thickness could not be measured in MV-2A/MV-2B as neither vent was screened across the water table. Also reported in the S-3 area is an oil smear zone, a 1- to 2-foot thick zone of soil which has been exposed to oil and is saturated with oil. This smear zone is identified on the cross section (Figures 15b and 15c) as gray and black stained sand.

It is apparent from the correlation of the data that the inhomogeneities at this site have an impact on air sparging. These inhomogeneities confine the sparging air by lowering the effective vertical air permeability and do not readily allow the sparge air to naturally migrate up into the unsaturated zone in the area of the sparging well.

However, the data does indicate that the sparge air influenced MV-1, located 26 feet from SP-1 and that effects of sparging were observed in S3-A (the farthest monitoring point), located 82 feet from SP-1.

3.3.4 Organic Vapor Monitoring

Organic vapor concentrations were measured in monitoring points EV-1, MV-1, MV-2A, MV-2B, S3-A, and S3-B prior to and following each air sparging test. Figures 9a, 9b, 10a, and 10b present organic vapor concentrations measured in the monitoring points prior to and at the end of each test. MV-2B was not plotted as its screen was below the water table.

Figures 9 and 10 indicate that during the air sparging test VOCs were removed from the ground water, as shown by the elevated organic concentrations observed in EV-1 and MV-1, and to a lesser extent in S3-A and S3-B. The plots also indicate that airflow into the unsaturated zone near MV-2A may not be occurring as MV-2A did not show elevated organic vapor concentrations.

Lower organic vapor concentrations were observed in most monitoring points during the second test. The exception to this is EV-1 in which organic vapor concentrations were measured at greater than 750 ppm. It is possible that the OVM did not accurately measure organic vapor following the EV-1 measurement as EV-1's concentration was outside of the instrument's calibration range and may have affected the subsequent readings at points MV-1, MV-2A, S3-A, and S3-B all of which were collected within eight minutes following the EV-1 sampling.

The data does indicate that increases in organic vapor concentrations in the unsaturated zone occurred in some areas. Most notable was EV-1 where organic vapor concentrations increased from 9 ppm to 278 ppm during test 2 and from 24 ppm to greater than 750 ppm during test 3. However, organic vapor increases did not correlate well with pressure monitoring data and showed a high degree of variability.

3.3.5 DO Monitoring

DO was monitored in points EV-1, MV-1, MV-2B, S3-B, and S3-A prior to and following each test. Changes in DO versus distance are plotted on Figures 11 and 12 for the 26- and 35-scfm tests, respectively. Ground water was present at the site at approximately 7 feet below grade. Therefore, any water present in EV-1 was likely residual water from vent construction.

Inspection of the plots reveals that DO levels were elevated in vents MV-1 and MV-2B. The highest DO levels were observed in MV-2B. This is consistent with the elevated pressure data in MV-1 and MV-2B indicating that sparged air was reaching these locations and, as a result, transferring oxygen into the ground water.

No changes in DO were observed in S-3B and S-3A. The presence of cutting oil in S-3B (measured at 0.43 feet) may have caused lower readings as the DO sensor had to pass through this layer. However, DO was measured in MV-1 which had a measured oil layer of 0.01 feet. The lack of DO in S3-A may be indicative of the greater distance from the sparge point.

3.3.6 Summary of Results

3.3.6.1 Radius of Influence

Due to the effects site inhomogeneities, a reliable determination of the radius of influence cannot be made. The data shows that sparged air was reaching S3-A approximately 82 feet from the sparge point. Since monitoring points closer to the sparge point than S3-A show nonuniform air sparging influence, sparged air is likely being forced to travel a laterally greater distance than would occur if airflows were uniform. Thus, sparged air could travel distances greater than 82 feet due to site inhomogeneities and a definitive, controlled radius of influence is not achievable.

The effect of varying the air sparging flow rate on the radius of influence is difficult to assess as sparged air is not being uniformly released but rather is being forced to travel laterally greater distances due to site inhomogeneities.

3.3.6.2 Air Emissions

While air emissions were not measured in EV-1 following the sparge tests and the extraction vent was not operated in concert with air sparging, increases in organic vapor concentrations in the discharge air will occur. Figures 9 and 10 illustrate the increase in organic vapor concentrations in the unsaturated zone caused by the sparging. Organic vapor concentrations increased from 9 ppm to 278 ppm and from 24 ppm to greater than 750 ppm during tests 2 and 3. This data shows the effectiveness of an air sparging system in removing VOCs from contaminated ground water.

3.3.7 Effectiveness of Technology

The following conclusions can be drawn from a review of the data:

- Data indicates that VOC transfer from the ground water into the unsaturated zone did occur.
- Where localized inhomogeneities are present, sparge air migration and VOC transfer into the unsaturated zone was not consistent and lateral sparge air transfer could occur.

While air sparging has been shown to remove VOCs from the ground water, as observed in elevated organic vapor concentrations in some monitoring points, inhomogeneities present in the S-3 area appear to have an effect on subsurface airflow. Although site hydrogeologic conditions are complex, a system can be engineered using air sparging technology that will effectively remediate the site while accounting for the inhomogeneities.

4.0 CONCEPTUAL DESIGN OF SOIL VAPOR EXTRACTION SYSTEM

4.1 SYSTEM DESCRIPTION

Three separate areas of unsaturated zone soil contamination have been identified at this site through previous soil boring installation and soil vapor survey work. These areas of concern are shown on Figure 13 Installation of a soil vapor extraction systems would remove the VOCs present in these areas. The location of these three systems are shown on Figure 14 Using the design radius of influence of 50 feet (for an extraction flow rate of 20 scfm), vents are drawn within areas of known soil contamination such that radii of influence will overlap and thereby remediate the target areas.

As shown on Figure 14, nine vents are estimated for the S-3 area, three vents for Area A, and five vents for Area B (total of 17 vents). Due to the distance between the S-3 area and Areas A and B, two separate extraction systems appear to be the most practical. System 1 would be constructed in the S-3 area and System 2 would be constructed for Areas A and B. Thus, vents from Areas A and B would be piped to a common blower, and vents from the S-3 area would be piped to a separate blower. Conceptually, and based on the soil vapor extraction test results, System 1 will have a design flow rate of 180 scfm (20 scfm per vent) and System 2 will have a design flow rate of 160 scfm (20 scfm per vent) . Both systems will operate at a vacuum level of approximately 5 inches mercury, assuming soil conditions in Areas A and B are similar to soils in the S-3 area.

The number of vents shown in each area on Figure 14 are estimated to be the minimum number of vents required for full-scale systems. During extraction vent installation, if unsaturated zone contaminated soils are observed to extend further than currently estimated, additional vents would be installed such that contaminated soil areas are completely contained within extraction vent radii of influence. Also, if air sparging is implemented in any of these areas, the number of extraction vents required to provide capture of sparged air would change (see 5.2).

Due to the possibility of additional vents being required, soil venting blowers which have extra capacity and/or a modular design in which additional equipment can be easily added would be installed. Extraction vent construction should be 4-inch diameter PVC similar to pilot study vent EV-1. In the final design, consideration should be given to vent head completions and/or piping arrangements that would allow some (or all) vents to be utilized as extraction vents or air inlet vents in order to increase system flexibility. Piping connecting the vents to the blowers should be PVC, where possible, due to economic savings and corrosion resistance. Steel piping may, however, be necessary for sections of piping of shallow burial or other higher-strength piping requirements. Valves, vacuum gauges, and a method of flow measurement should be provided at each vent to allow for system monitoring and operational flexibility (operational flexibility improves the ability to maximize system effectiveness when operational changes are desired). Discharge from the blowers should be piped to an outdoor air emission stack. Space should be allowed for installation of off-gas treatment in the event that it is required.

4.2 AIR EMISSIONS

The calculated emission rate from EV-1 during the pilot test was 0.2 pounds per day. If this rate were the average rate from each vent at full system startup, total VOC emissions from both System 1 and System 2 would be 3.4 pounds per day (17 vents x 0.2 pounds per vent). However, since EV-1 is located in an area of lower VOC contamination (based on the soil gas survey conducted at this site), the total system emission rate at system startup would probably be greater than 3.4 pounds per day. However, emission rates for soil vapor extraction systems typically decrease 50 to 90 percent within the first year of operation. Consequently, the need for an emissions treatment system will be evaluated at the time of system startup.

5.0 CONCEPTUAL DESIGN OF AIR SPARGING SYSTEM

5.1 SYSTEM DESCRIPTION

As discussed earlier, installation of a full-scale air sparging system is recommended for this site. The conceptual design combines air sparging with relief vents installed around (and possibly within) the perimeter of the air sparging system. The relief vents would be designed to provide conduits for sparged air to move from the saturated zone into the unsaturated zone when lithology is preventing this transfer. Installing relief vents around the perimeter would prevent or minimize the lateral spread of contamination. The relief vents would be installed deep enough such that the lower, screened portion of these vents intercept sparged air that is traveling horizontally. The necessary design and spacing of these vents and the method of applying vacuum to the unsaturated zone would require further consideration.

5.2 EFFECT ON SOIL VAPOR EXTRACTION SYSTEM SIZE

The proposed vapor extraction system design only accounts for the removal of air and contaminants from the unsaturated zone. Consequently, the size of the venting system that is required to ensure the capture of sparged air will need to be designed. In general, installation of air sparging in the S-3 area, Area A, or Area B would require that additional soil vapor extraction vents be installed to address the increased air flow that would occur.

5.3 AIR EMISSIONS

Installation of an air sparging system will increase the emissions from a soil vapor extraction system. At startup of a full-scale air sparging system, VOC emissions have been observed to increase as much as an order of magnitude over emissions from a soil vapor extraction system alone. Though this can result in a very high emissions "spike" at startup, emissions will typically begin to decline shortly after startup, similar to soil vapor extraction systems. Also, this emission "spike" can potentially be "managed" at an air sparging site by starting up sparge points in a phased approach. If air sparging is implemented, the likelihood of needing to treat venting system emissions does increase and may need to be addressed through the process of obtaining an air permit.

TABLE 1

Soil Vapor Extraction Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Extraction Test 1: Date: 2/15/94
System On - 13:53 System Off - 16:14
Tedlar Bag Sample (pre-mufffler) - 16:00

Monitoring Point/ Location	Time	Monitoring Point Vacuum (inches water)	Vacuum Pump Inlet Port (inches Hg)	VOC Emissions (ppm)	Flow Rate (feet/minute)
EV-1	13:57				2400
EV-1	14:06	100+			
EV-1	14:15		10.5		
EV-1	14:19				2300
EV-1	14:34	100+			
EV-1	15.01	100+			
EV-1	15:07				2200
EV-1	15:11				2100
EV-1	15:22		10.6		
EV-1	15:24	100+			
EV-1	16:02				2000
EV-1	16:03	100+			
EV-1	16:06		11		
EV-1	14:16			15.3	
EV-1	14:36			401	
EV-1	15:04			282	
EV-1	15:26			259	
MV-1	14:07	10.2			
MV-1	14:27	10			
MV-1	14:53	10			
MV-1	15:17	9.85			
MV-1	15:59	9.6			
MV-2A	14:08	2.9			
MV-2A	14:28	2.9			
MV-2A	14:55	2.9			
MV-2A	15:18	2.85			
MV-2A	16:00	2.8			
MV-2B	14:09	0			
MV-2B	14:28	0			
MV-2B	14:54	0			
MV-2B	15:18	0			
MV-2B	16:00	0			
S3-A	14:10	0			
S3-A	14:30	0.2			
S3-A	14:57	0.15			
S3-A	15:20	0.2			
S3-A	16:01	0.2			
S3-B	14:11	0.6			
S3-B	14:32	0.7			
S3-B	14:59	0.63			
S3-B	15:20	0.7			
S3-B	16:01	0.6			
SP-1	14:04	0			
SP-1	14:33	0			
SP-1	14:52	0			
SP-1	15:24	0			
SP-1	16:02	0			
Stack Discharge	15:36			76	
Stack Discharge	16:09			79	

TABLE 1

Soil Vapor Extraction Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Extraction Test 2: Date: 2/15/94
System On - 16:45 System Failure - 17:23
System Reset - 17:27 System Off - 17:55
Tedlar Bag Sample (EV-1) - 18:00

Monitoring Point/ Location	Time	Monitoring Point Vacuum (inches water)	Vacuum Pump Inlet Port (inches Hg)	VOC Emmissions (ppm)	Flow Rate (feet/minute)
EV-1	17:03	100+			
EV-1	17:05		11.1		
EV-1	17:09				1530
EV-1	17:12			22	
EV-1	17:14				1500
EV-1	17:22		11		
EV-1	17:32				1500
EV-1	17:40		11		
EV-1	17:46			25	
EV-1	17:52				1470
EV-1	17:52		11		
MV-1	16:57	7.3			
MV-1	17:18	7.1			
MV-1	17:33	6.5			
MV-1	17:49	6.5			
MV-2A	16:58	2.1			
MV-2A	17:20	2.1			
MV-2A	17:35	1.9			
MV-2A	17:51	1.9			
MV-2B	16:58	0.2			
MV-2B	17:19	0.2			
MV-2B	17:34	0.1			
MV-2B	17:50	0.1			
S3-A	16:59	0.1			
S3-A	17:21	0.15			
S3-A	17:36	0.15			
S3-A	17:51	0.1			
S3-B	16:59	0.45			
S3-B	17:22	0.5			
S3-B	17:37	0.45			
S3-B	17:52	0.45			
SP-1	17:48	0			
Stack Discharge	17:08			20	
Stack Discharge	17:42			12	

TABLE 1

Soil Vapor Extraction Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Extraction Test 3: Date: 2/16/94
System On - 9:25 System Off - 10:50
Tedlar Bag Sample(EV-1) - 11:00

Monitoring Point/ Location	Time	Monitoring Point Vacuum (inches water)	Vacuum Pump Inlet Port (inches Hg)	VOC Emmissions (ppm)	Flow Rate (feet/minute)
EV-1	9:38	9.5 (in Hg)	9.75		2100
EV-1	9:46	9.7 (in Hg)			2100
EV-1	9:51			14.5	
EV-1	9:59		10		
EV-1	10:00	9.75 (in Hg)			2100
EV-1	10:03			14	
EV-1	10:17	9.75 (in Hg)			2100
EV-1	10:24		10		
EV-1	10:25				2070
EV-1	10:27			20	
EV-1	10:45				2050
EV-1	10:48		10		
MV-1	9:42	7.7			
MV-1	9:56	8.5			
MV-1	10:19	8.4			
MV-1	10:42	8.3			
MV-2A	9:43	2.25			
MV-2A	9:57	2.45			
MV-2A	10:20	2.4			
MV-2A	10:43	2.4			
MV-2B	9:42	0			
MV-2B	9:57	0			
MV-2B	10:19	0			
S3-A	9:44	0.2			
S3-A	9:58	0.1			
S3-A	10:21	0.1			
S3-A	10:43	0.1			
S3-B	9:45	0.5			
S3-B	9:59	0.6			
S3-B	10:22	0.6			
S3-B	10:44	0.6			
SP-1	9:41	0			
SP-1	9:55	0			
Stack Discharge	9:49			5	
Stack Discharge	10:03			14	
Stack Discharge	10:23			14	

TABLE 1

Soil Vapor Extraction Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Extraction Test 4: Date: 2/16/94
System On - 14:51 System Off - 15:57
Tedlar Bag Sample(EV-1) - 16:00

Monitoring Point/ Location	Time	Monitoring Point Vacuum (inches water)	Vacuum Pump Inlet Port (inches Hg)	VOC Emmissions (ppm)	Flow Rate (feet/minute)
EV-1	14:57	52			900
EV-1	15:03		5		
EV-1	15:08	52		4	900
EV-1	15:19	52			
EV-1	15:20		5		900
EV-1	15:21			3.5	
EV-1	15:30	52			
EV-1	15:35		5		
EV-1	15:36				900
EV-1	15:43			3.5	
EV-1	15:51	52			900
EV-1	15:56		5		
MV-1	14:59	3.2			
MV-1	15:15	3.3			
MV-1	15:32	3.22			
MV-1	15:52	3.2			
MV-2A	15:00	0.9			
MV-2A	15:17	0.95			
MV-2A	15:33	0.92			
MV-2A	15:53	0.92			
MV-2B	15:01	0			
MV-2B	15:16	0			
MV-2B	15:32	0			
MV-2B	15:53	0			
S3-A	15:02	0.07			
S3-A	15:18	0.04			
S3-A	15:34	0.03			
S3-A	15:55	0.03			
S3-B	15:03	0.24			
S3-B	15:19	0.21			
S3-B	15:35	0.22			
S3-B	15:55	0.22			
Stack Discharge	15:06			4	
Stack Discharge	15:22			3.7	
Stack Discharge	15:39			3.5	

TABLE 1

Soil Vapor Extraction Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Summary of Results:

Vacuum vs. Distance:

Monitoring Point/ Location	Distance from EV-1 (feet)	Test4 17 scfm Vacuum (inches water)	Test 2 24 scfm Vacuum (inches water)	Test3 34 scfm Vacuum (inches water)	Test 1 38 scfm Vacuum (inches water)
MV-1	26	3.2	6.5	8.3	10.2
MV-2A	47	0.92	1.9	2.4	2.9
S3-B	53	0.22	0.45	0.6	0.6
S3-A	75	0.03	0.1	0.1	0.2
EV-1 (inches Hg)		5	11	9.75	10.5

TABLE 2

Volatile Organic Compounds in Discharge Air - Modified TO-14
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Compound	Test 1 (38 scfm) (ppb, vol/vol)	Test 2 (24 scfm) (ppb, vol/vol)	Test 3 (34 scfm) (ppb, vol/vol)	Test 4 (17 scfm) (ppb, vol/vol)
Dichlorodifluoromethane	ND	ND	ND	ND
Chloromethane	ND	ND	ND	ND
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ND	ND	ND
Vinyl chloride	170	ND	ND	ND
Bromomethane	ND	ND	ND	ND
Chloroethane	21,000	11,000	9,200	11,000
Trichlorofluoromethane	ND	ND	ND	110
1,1-Dichloroethene	190	110	110	130
Carbon disulfide	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ND	ND	ND
Acetone	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND
1,1-Dichloroethane	7,100	3,900	4,000	4,800
Vinyl acetate	ND	ND	ND	ND
cis-1,2-Dichloroethene	510	200	240	210
2-Butanone	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND
1,1,1-Trichloroethane	9,700	6,700	5,900	7,600
Carbon tetrachloride	ND	ND	ND	ND
Benzene	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND
Trichlorethene	41	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND
cis-1,2-Dichloropropene	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND
Toluene	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND
Tetrachloroethene	62	ND	ND	ND
2-Hexanone	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND
1,2-Dibromoethane	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND
total Xylenes	ND	ND	ND	ND
Styrene	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND
Benyl chloride	ND	ND	ND	ND
4-Ethyl toluene	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND
Total VOC's	38,773	21,910	19,450	23,850

TABLE 3

Air Sparge Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Sparge Test 1: Date: 2/17/94 Injection Rate: 15 scfm
System on - 13:22 System off - 14:49

Monitoring/Point Location	Time	Monitoring Point Pressure (inches water)	Sparge Air Pressure (psi)	VOC (ppm)	Dissolved Oxygen (%)	Flow Rate (feet/minute)
EV-1	10:50			44		
EV-1	11:05				11.9	
EV-1	13:40	0.1				
EV-1	14:09			512		
EV-1	14:15	0.03				
EV-1	14:34			137		
EV-1	14:48	0.03				
EV-1	15:00				2.6	
MV-1	10:50			28		
MV-1	11:10	0			-2.6	
MV-1	13:40	0				
MV-1	13:51			112		
MV-1	14:15	0				
MV-1	14:37			73		
MV-1	15:00				-3	
MV-2A	10:50			13		
MV-2A	11:14	0				
MV-2A	13:40	0				
MV-2A	14:00			395		
MV-2A	14:15	0				
MV-2A	14:44			83		
MV-2A	15:00					
MV-2B	10:50			38		
MV-2B	11:15	0			-2.5	
MV-2B	13:40	0				
MV-2B	13:57			36		
MV-2B	14:15	0.4				
MV-2B	14:42			69		
MV-2B	15:00				-3	
S3-A	10:50			42		
S3-A	11:25	0			-1.8	
S3-A	13:40	0				
S3-A	14:05			482		
S3-A	14:46			401		
S3-A	15:00				-3	
S3-B	10:50			105		
S3-B	11:30	0			5	
S3-B	13:40	0				
S3-B	14:07			129		
S3-B	14:46			82		
S3-B	15:00				-3	
SP-1	10:50			-		
SP-1	11:00	0		-	-2.5	
SP-1	13:37		6			1000
SP-1	13:40	0				
SP-1	13:44		9			900
SP-1	14:30					900
SP-1	15:00				6.7	

System not stable; varied in pressure and flowrate from listed values to zero. Adjustments required. Water column likely not fully pushed out of well.

TABLE 3

Air Sparge Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Sparge Test 2: Date: 2/18/94 Injection Rate: 26 scfm
System on - 8:10 System off - 9:47

Monitoring/Point Location	Time	Monitoring Point Pressure (inches water)	Sparge Air Pressure (psi)	VOC (ppm)	Dissolved Oxygen (%)	Flow Rate (feet/minute)
EV-1	7:10				-3	
EV-1	7:57			9		
EV-1	8:30	0.01		112		
EV-1	9:10	0				
EV-1	9:25			278		
EV-1	9:39	0				
EV-1	9:50				-2	
MV-1	7:15				-3	
MV-1	7:59			13		
MV-1	8:36	0.02		97		
MV-1	9:10	0				
MV-1	9:28			233		
MV-1	9:39	4				
MV-1	9:56				3.6	
MV-2A	8:00			7		
MV-2A	8:38	0		9		
MV-2A	9:11	0				
MV-2A	9:30			14		
MV-2A	9:40	0.1				
MV-2B	7:25				-3	
MV-2B	8:02			9		
MV-2B	8:40	0.01		24		
MV-2B	9:11	0.1				
MV-2B	9:32			35		
MV-2B	9:41	7.9				
MV-2B	10:03				10.1	
S3-A	7:30				-3	
S3-A	8:04			25		
S3-A	8:40	0		71		
S3-A	9:12	0.1				
S3-A	9:35			114		
S3-A	9:43	0.4				
S3-A	10:10				-3	
S3-B	7:35				-3	
S3-B	8:05			34		
S3-B	8:49	0		57		
S3-B	9:12	0.1				
S3-B	9:38			66		
S3-B	9:44	0				
S3-B	10:13				-3	
SP-1	7:05				-3	
SP-1	8:28		19.5			1500
SP-1	9:12		19.5			1550

TABLE 3

Air Sparge Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Sparge Test 3: Date: 2/18/94 Injection Rate: 35 scfm
System on - 13:15 System off - 14:17

Monitoring/Point Location	Time	Monitoring Point Pressure (inches water)	Sparge Air Pressure (psi)	VOC (ppm)	Dissolved Oxygen (%)	Flow Rate (feet/minute)
EV-1	11:10				-3	
EV-1	11:25			24		
EV-1	13:11	0				
EV-1	13:27	0				
EV-1	13:40			155		
EV-1	13:54	0				
EV-1	14:06	0.2		750+		
EV-1	14:20				-3	
MV-1	11:15				9.6	
MV-1	11:29			28		
MV-1	13:13	0.6				
MV-1	13:29	0.2				
MV-1	13:41			140		
MV-1	13:55	3.7				
MV-1	14:08	16		79		
MV-1	14:24				11.5	
MV-2A	11:33			8		
MV-2A	13:14	0.2				
MV-2A	13:30	0				
MV-2A	13:43			18		
MV-2A	13:56	0.2				
MV-2A	14:09	0.8		18		
MV-2B	11:17				13.4	
MV-2B	11:32			12		
MV-2B	13:15	0.8				
MV-2B	13:31	0.35				
MV-2B	13:45			270		
MV-2B	13:57	24				
MV-2B	14:10	76		31		
MV-2B	14:28				25	
S3-A	11:22				-3	
S3-A	11:38			9		
S3-A	13:17	4.3				
S3-A	13:33	3.8				
S3-A	13:46			20		
S3-A	13:58	5				
S3-A	14:12	18		12		
S3-A	14:32				-3	
S3-B	11:24				-3	
S3-B	11:40			30		
S3-B	13:18	0				
S3-B	13:35	0				
S3-B	13:49			28		
S3-B	13:59	0				
S3-B	14:14	0.7		24		
S3-B	14:36				-3	
SP-1	13:36		20			2000
SP-1	14:01		20			2000

TABLE 3

Air Sparge Pilot Study Data
Former Torrington Heavy Bearing Facility, South Bend, Indiana

Summary of Results:

Pressure vs. Distance:

Monitoring Point/ Location	Distance from SP-1 (feet)	Test 2 Pressure (in. water)	Test 3 Pressure (in. water)
EV-1	5	0	0.2
MV-1	27	4	16
MV-2B	47	7.9	76
MV-2A	48	0.1	0.8
S3-B	63	0	0.7
S3-A	78	0.4	18

OVM vs. Distance:

Monitoring Point/ Location	Distance from SP-1 (feet)	Pre-Test 2 VOCs (ppm)	Test 2 VOCs (ppm)	Pre-Test 3 VOCs (ppm)	Test 3 VOCs (ppm)
EV-1	5	9	278	24	750 +
MV-1	27	13	233	28	79 (140 interim)
MV-2A	48	7	14	8	18
S3-B	63	34	66	30	24
S3-A	78	25	114	9	12

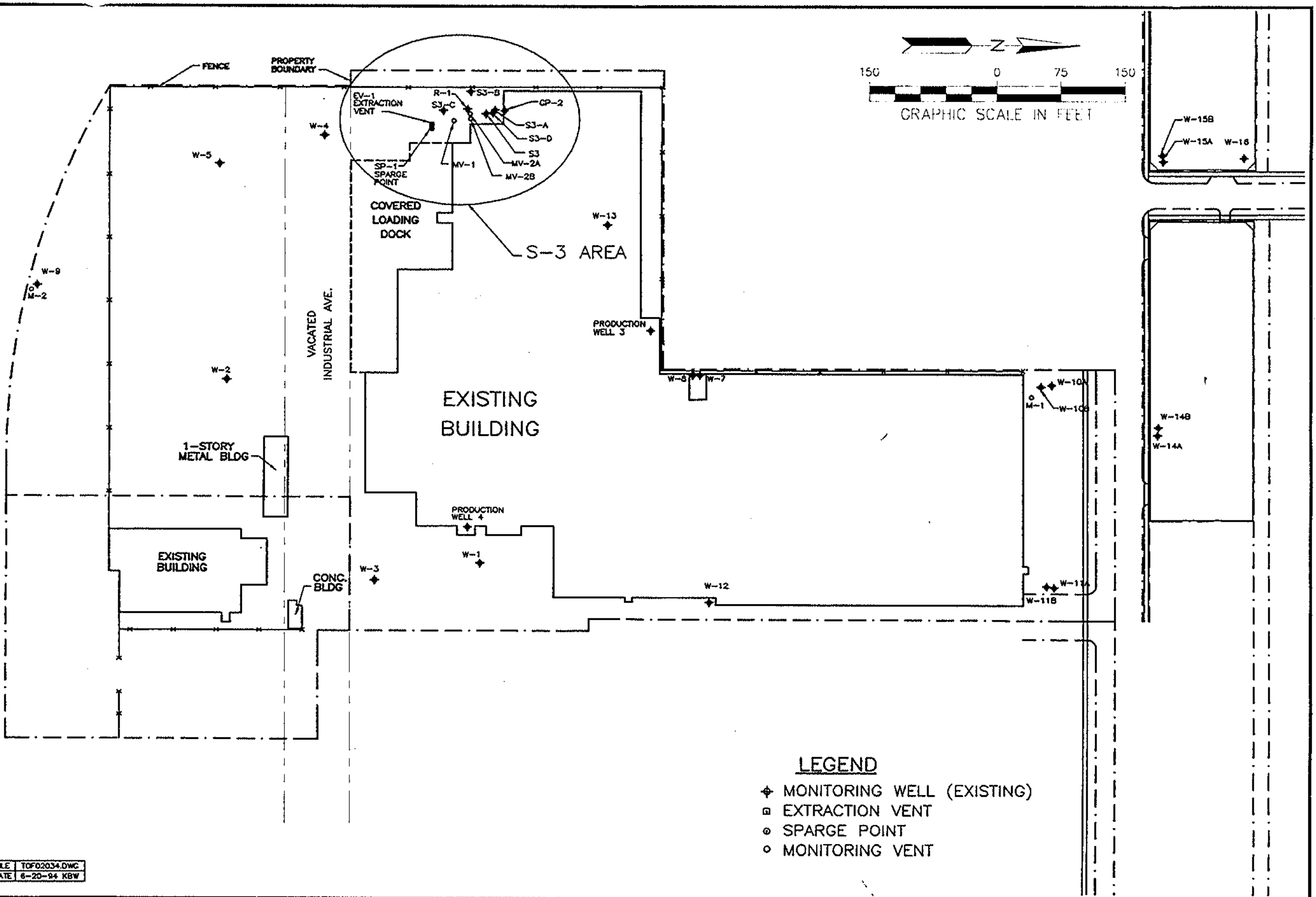
Dissolved Oxygen vs. Distance:

Monitoring Point/ Location	Distance from SP-1 (feet)	Test 2 Dissolved Oxygen (% Saturation)	Test 3 Dissolved Oxygen (% Saturation)
EV-1	5	0	0
MV-1	27	3.6	11.5
MV-2B	47	10.1	25
S3-B	63	0	0
S3-A	78	0	0

Pressure vs. Sparge Flowrate:

Flow Rate (scfm)	Pressure (psi)	
0	18.6	(Static water head over sparge point)
26	19.5	
35	20	

FIGURES



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Site Map

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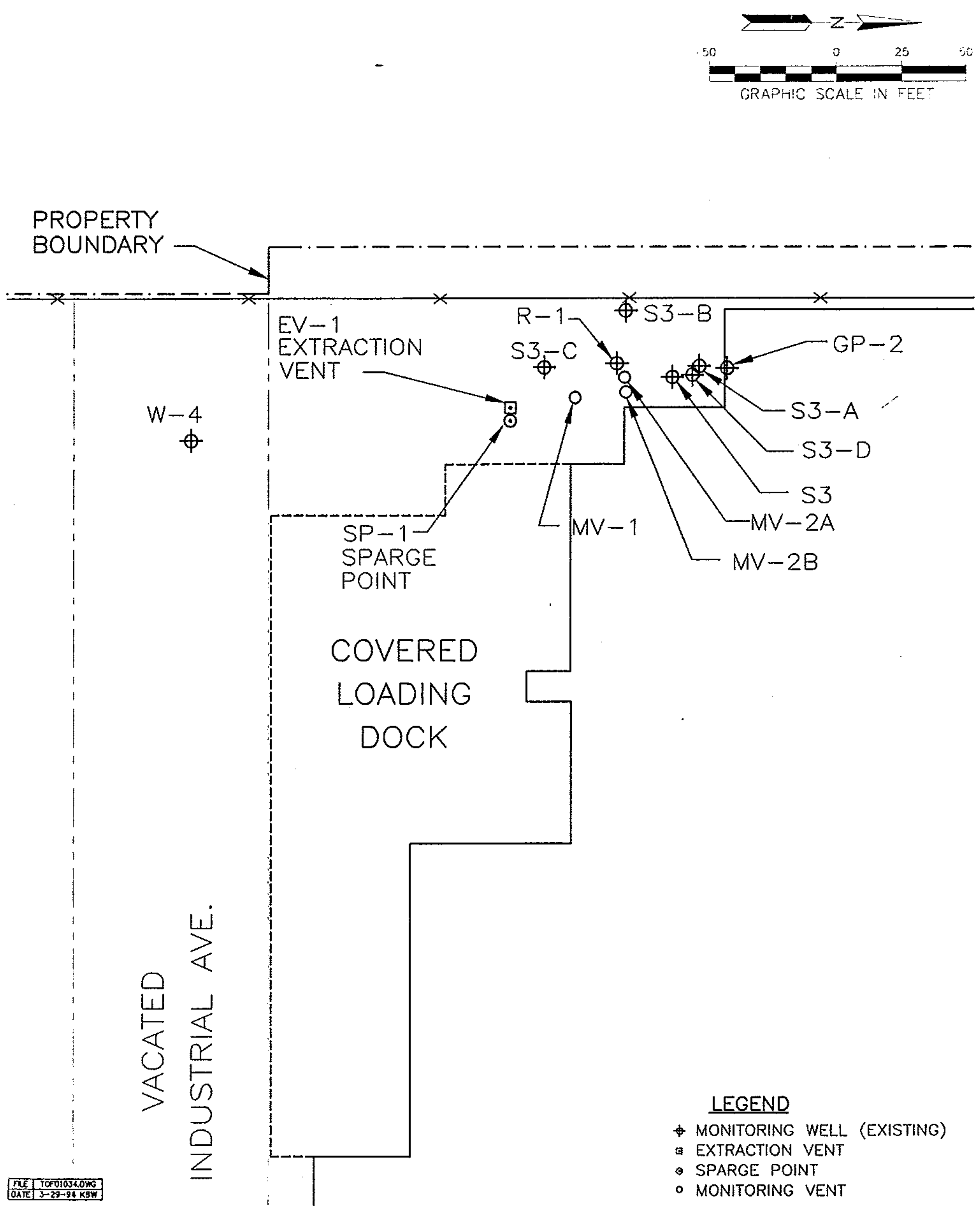
FIGURE 1



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Pilot Study Layout

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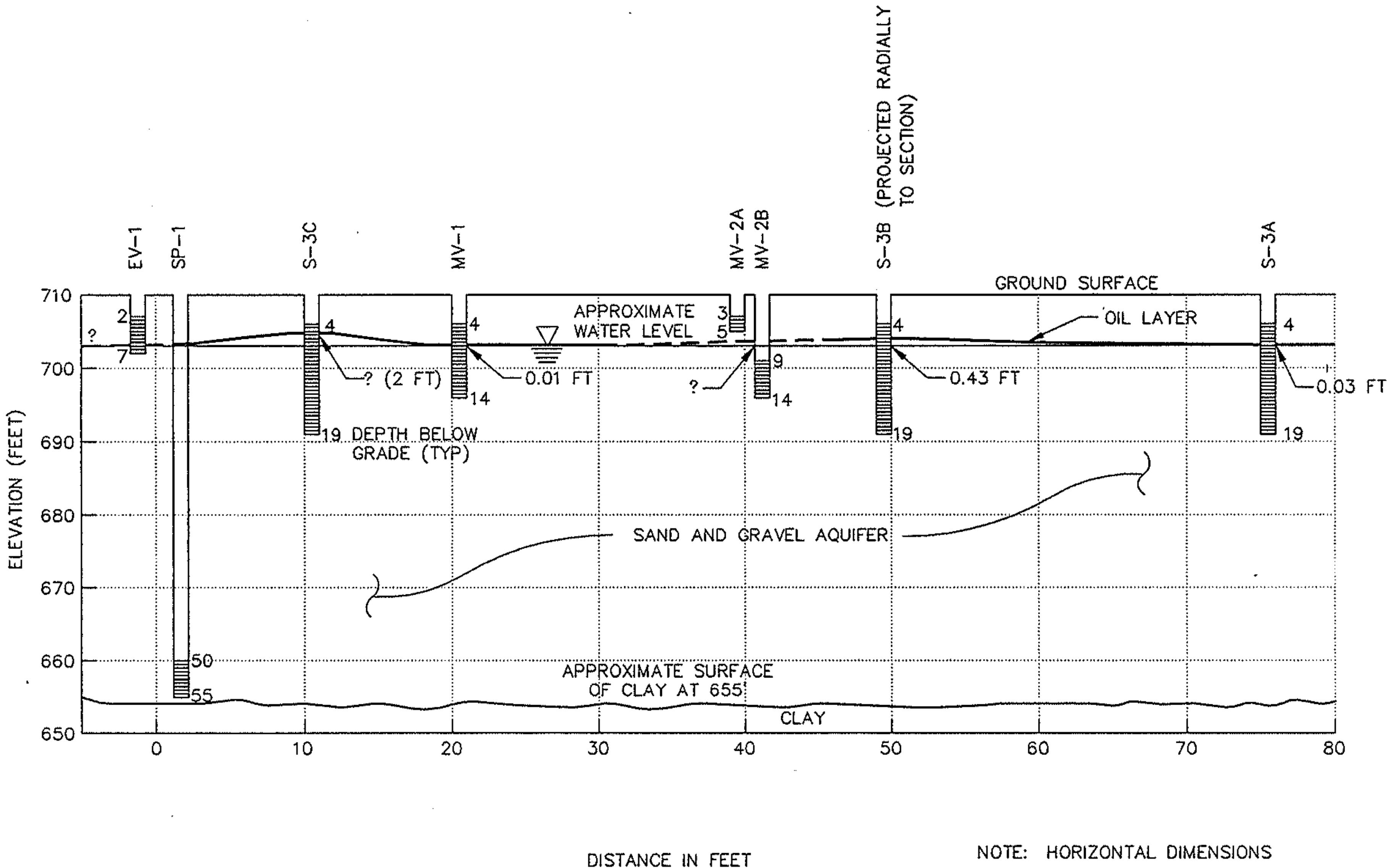
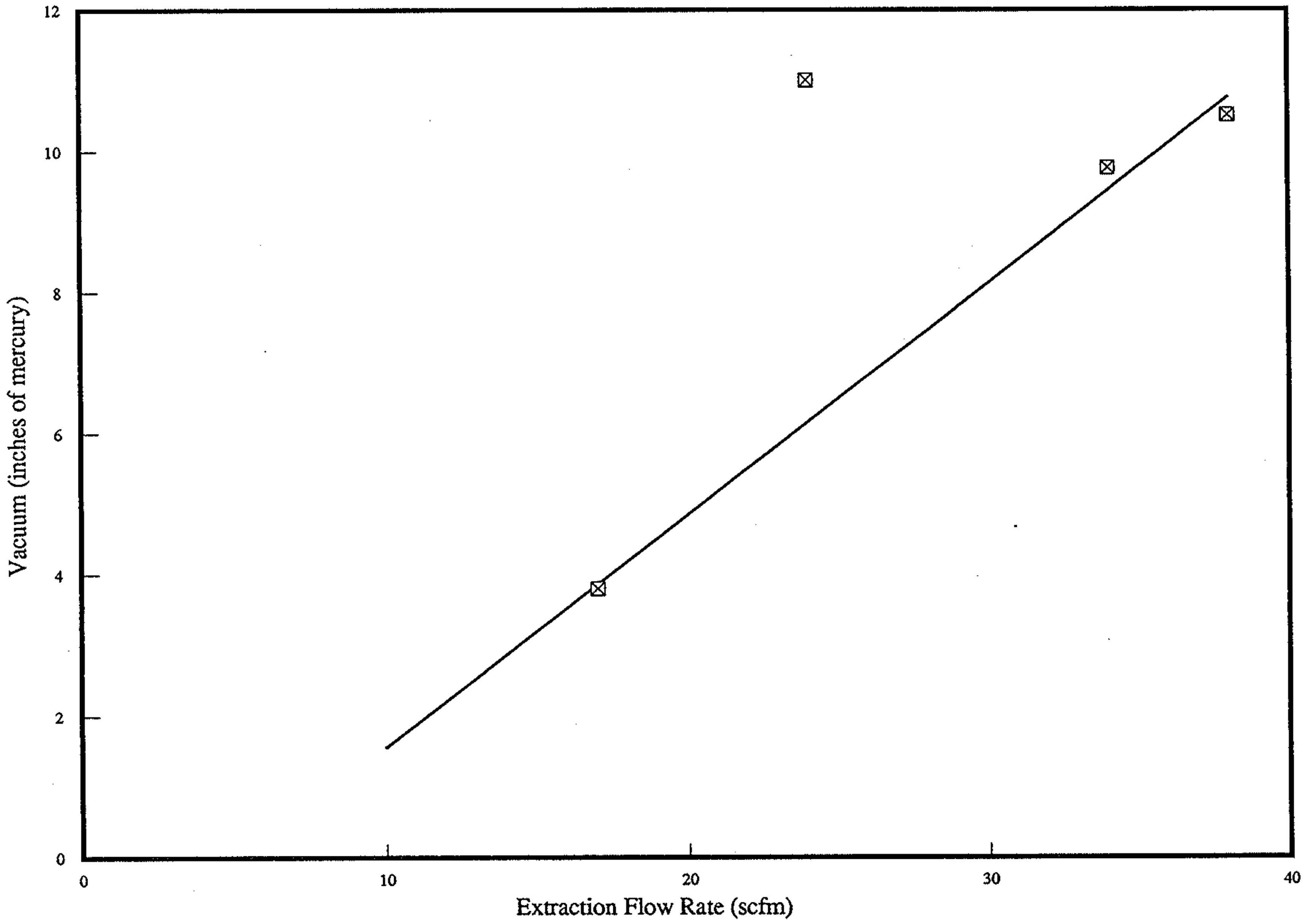
Figure 2



NOTE: HORIZONTAL DIMENSIONS OF WELLS AND VENTS EXAGGERATED

FILE TOX01034.DWG
DATE 3-29-94 KBW

THE TORRINGTON COMPANY	**Wenck** Wenck Associates, Inc. 1800 Pioneer Creek Ctr. Environmental Engineers Maple Plain, MN 55359	June 1994
Cross-Section of Pilot Study Area		Figure 3



Note: The 24 scfm data point was an invalid vacuum measurement and is therefore not included in the linear regression.

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Soil Vapor Extraction - Vacuum vs. Flow Rate

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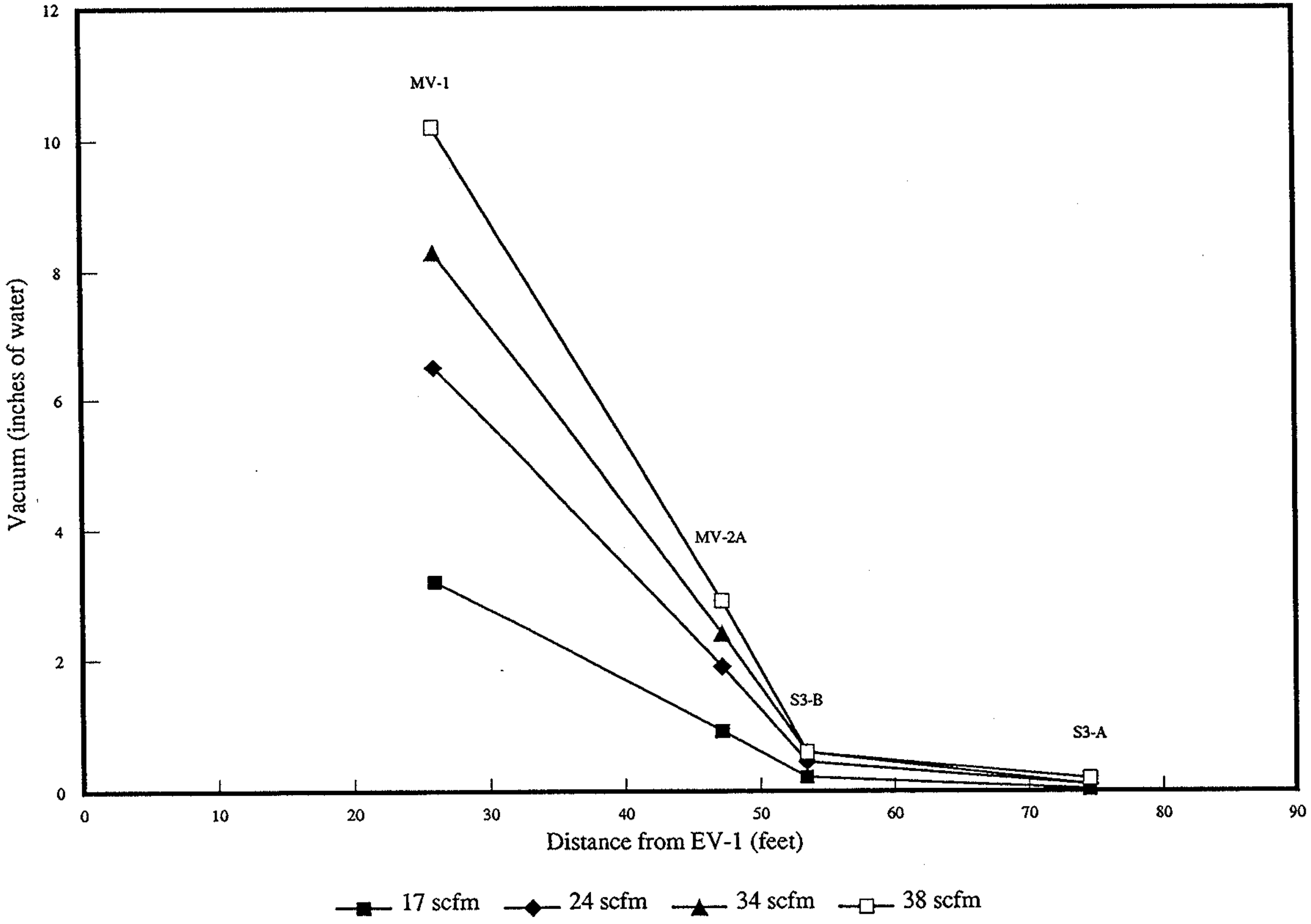
Figure 4



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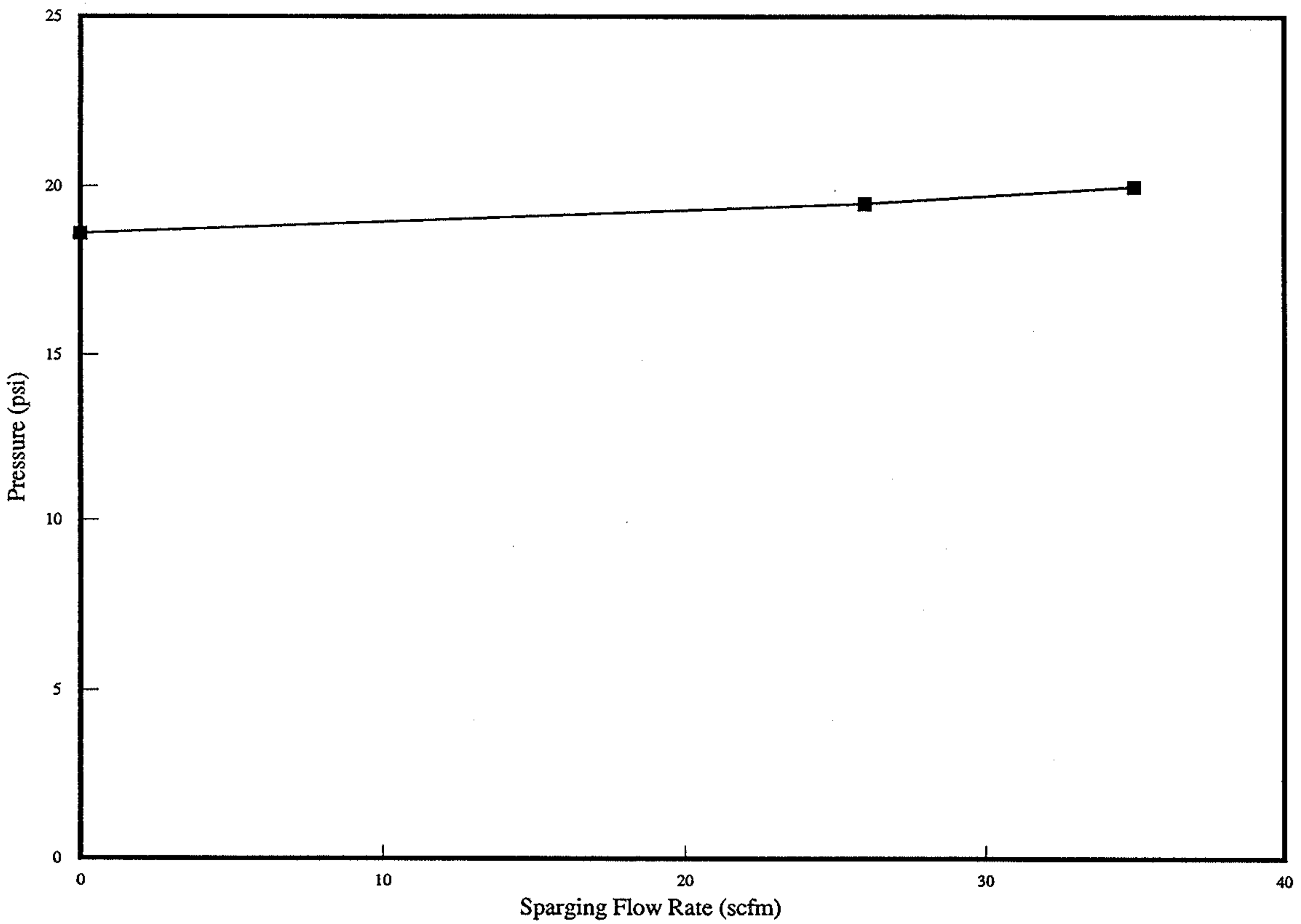
Soil Vapor Extraction - Soil Vacuums vs. Distance		Figure 5



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Air Sparging - Pressure vs. Flow Rate

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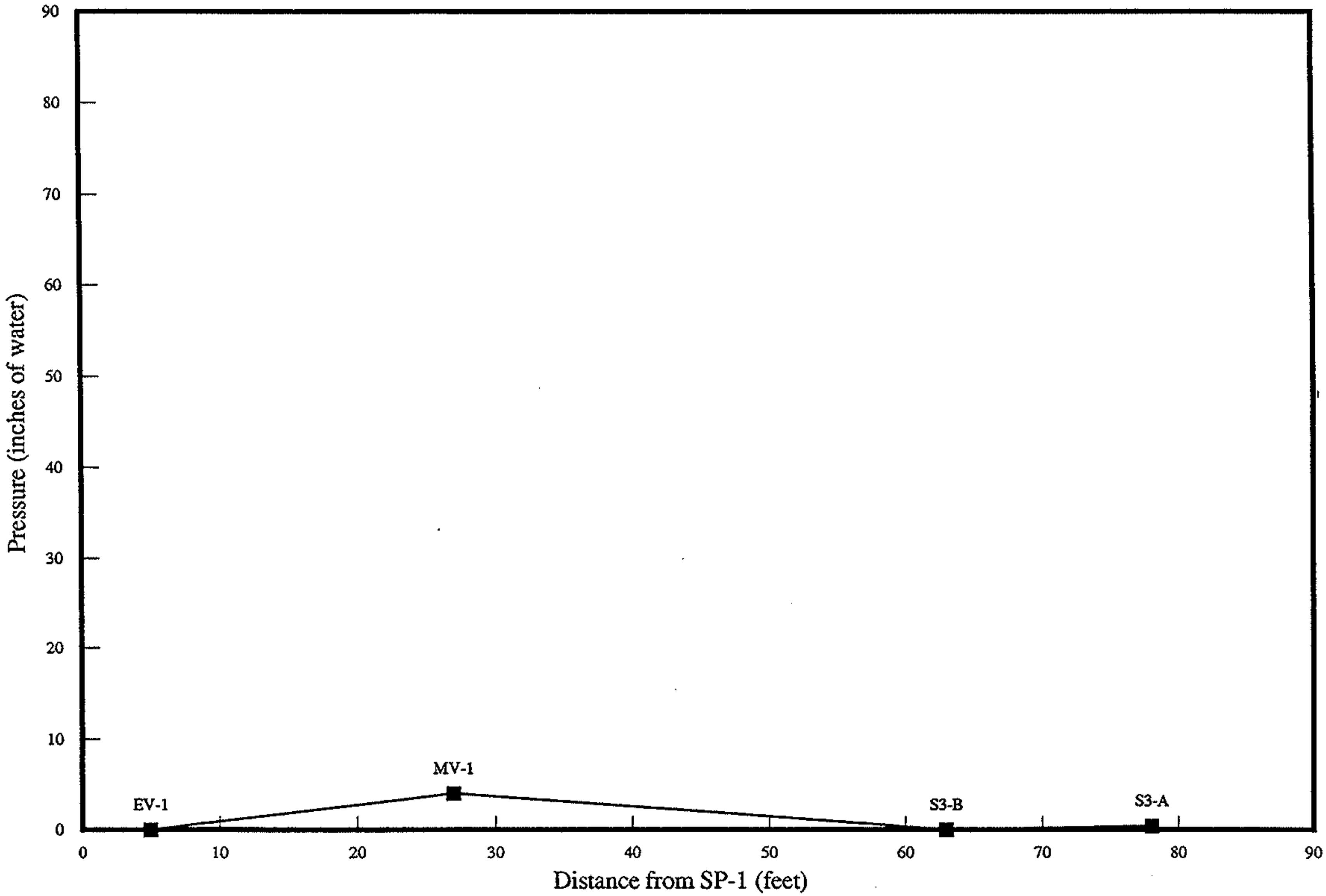
Figure 6



Note: Data nearest the end of each test is plotted.
EV-1 does not extend into the water table. Other monitoring points on this graph extend into the water table.

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Air Sparging - Pressure vs. Distance at 26 scfm

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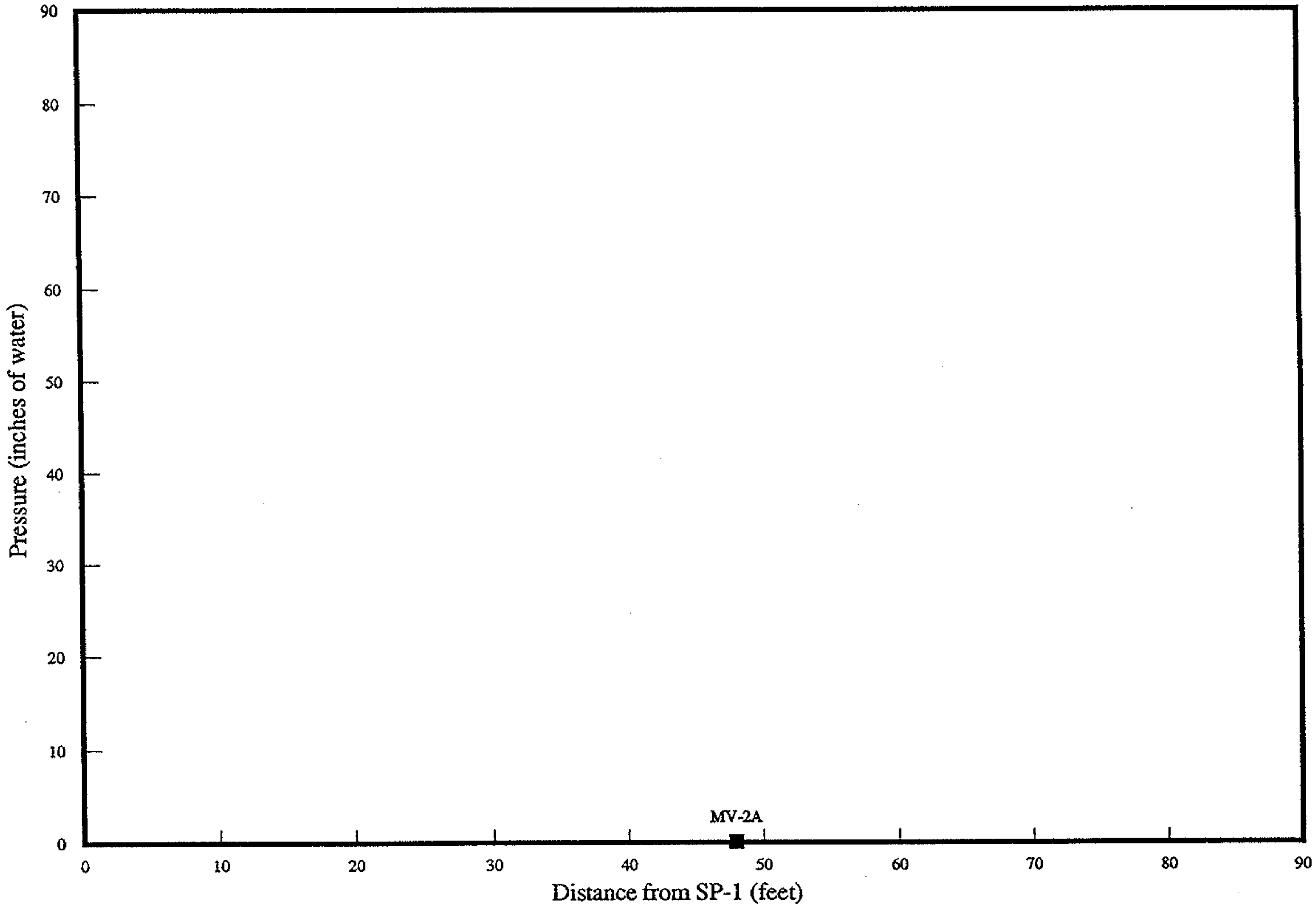
Figure 7a



Note: Data nearest the end of each test is plotted.

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Air Sparging - Pressure vs. Distance at 26 scfm

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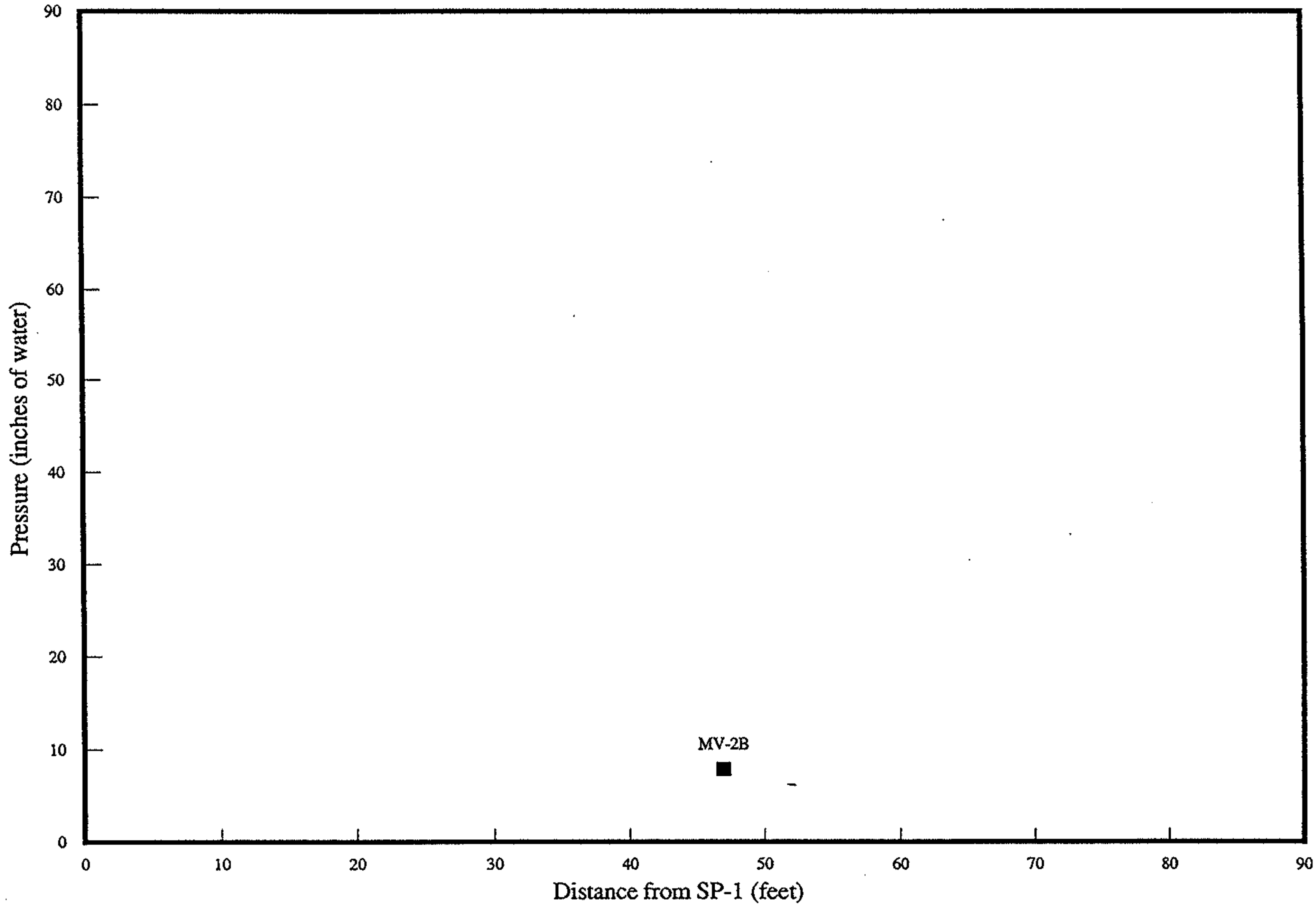
Figure 7b



Note: Data nearest the end of each test is plotted.

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Air Sparging - Pressure vs. Distance at 26 scfm

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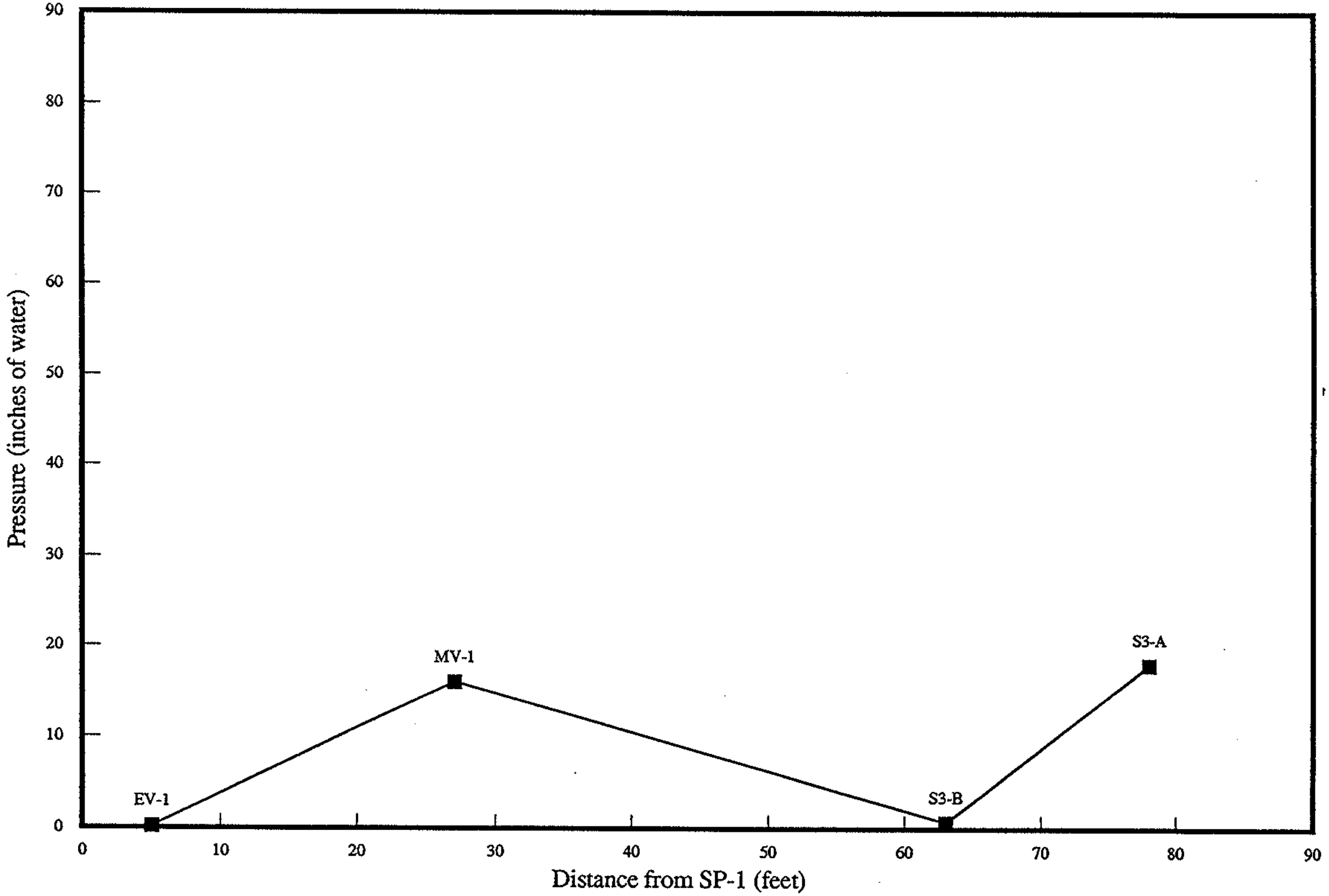
Figure 7c



Note: Data nearest the end of each test is plotted.
EV-1 does not extend into the water table. Other monitoring points on this graph extend into the water table.

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Air Sparging - Pressure vs. Distance at 35 scfm

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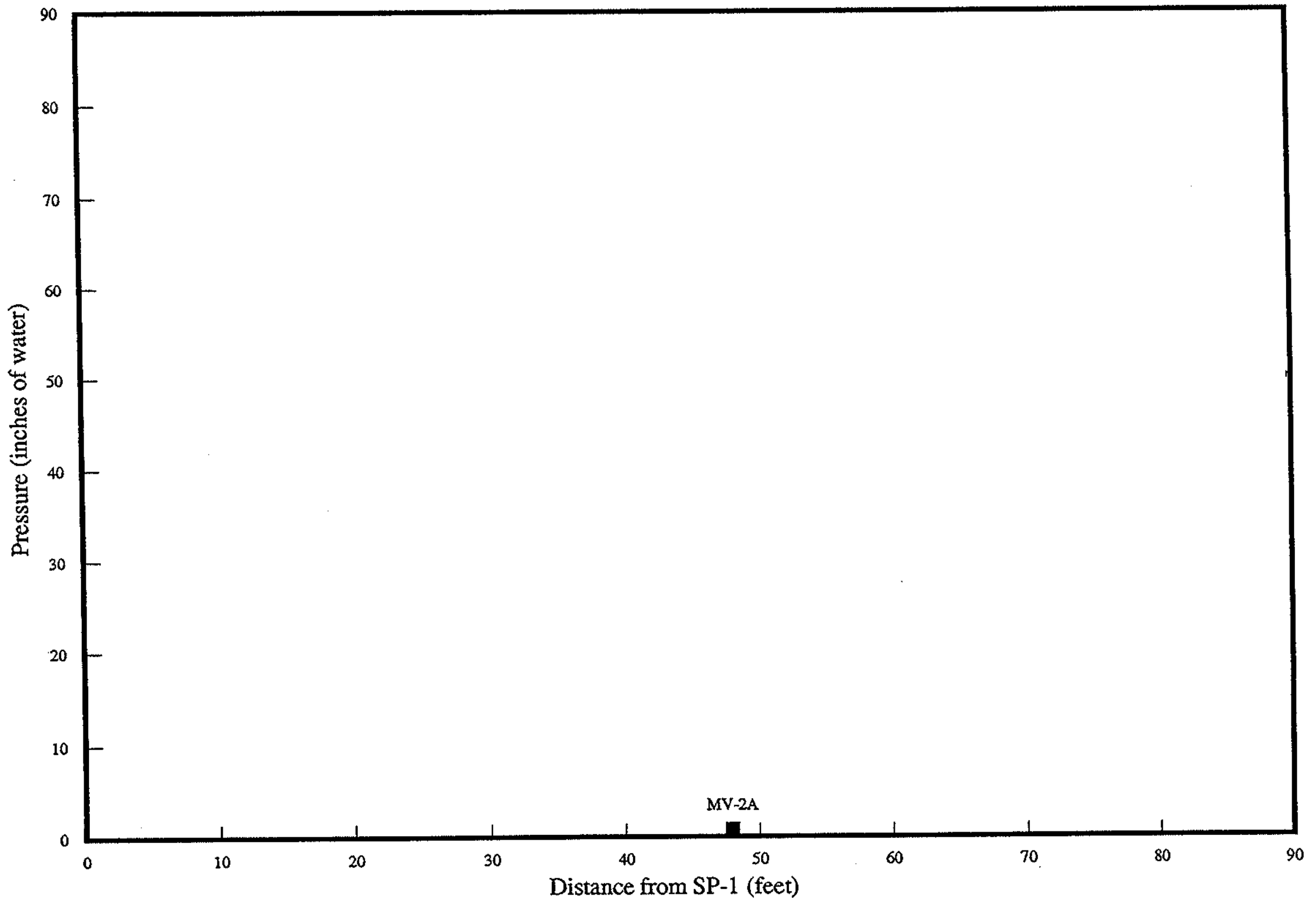
Figure 8a



Note: Data nearest the end of each test is plotted.

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Air Sparging - Pressure vs. Distance at 35 scfm

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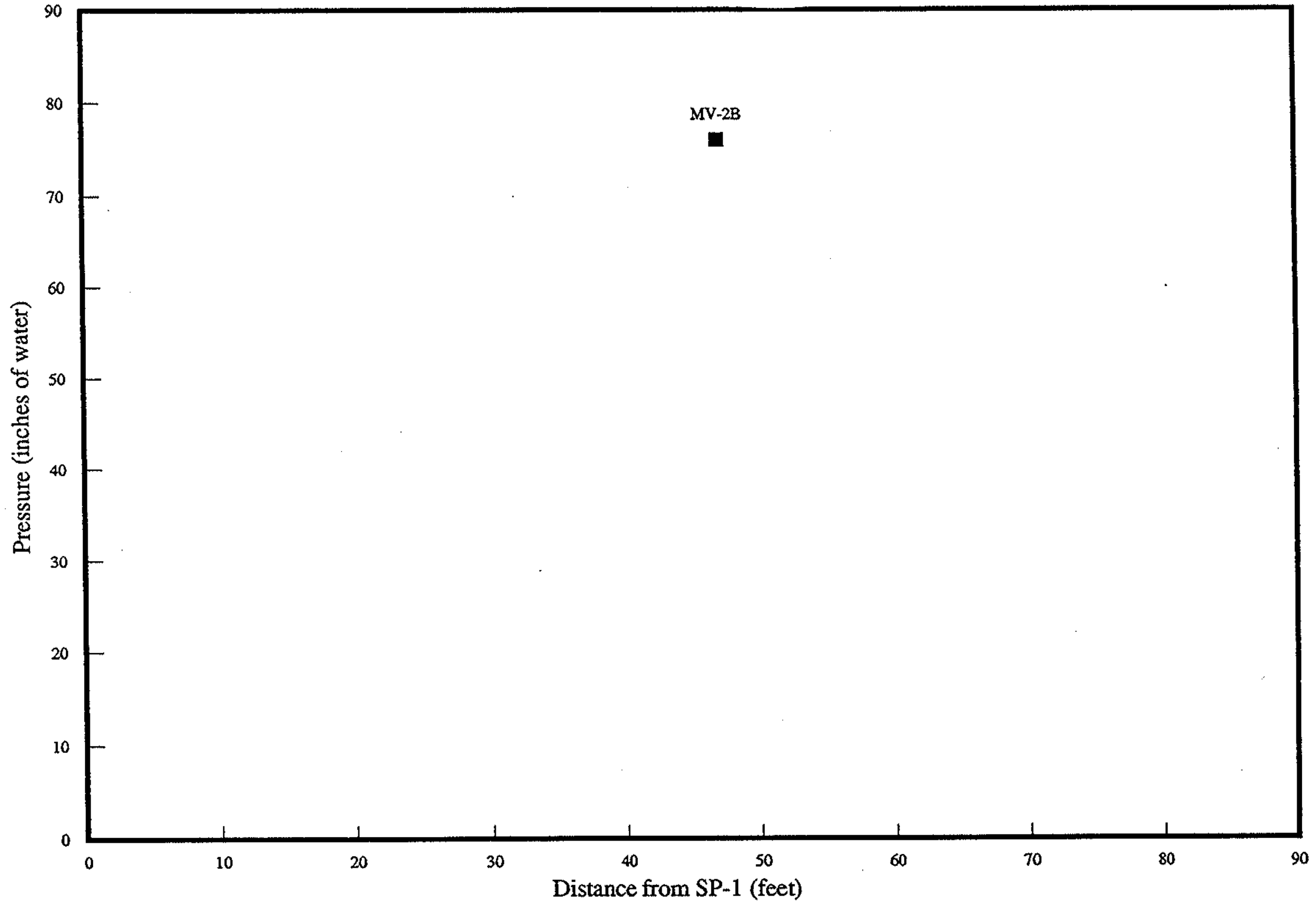
Figure 8b



Note: Data nearest the end of each test is plotted.

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Air Sparging - Pressure vs. Distance at 35 scfm

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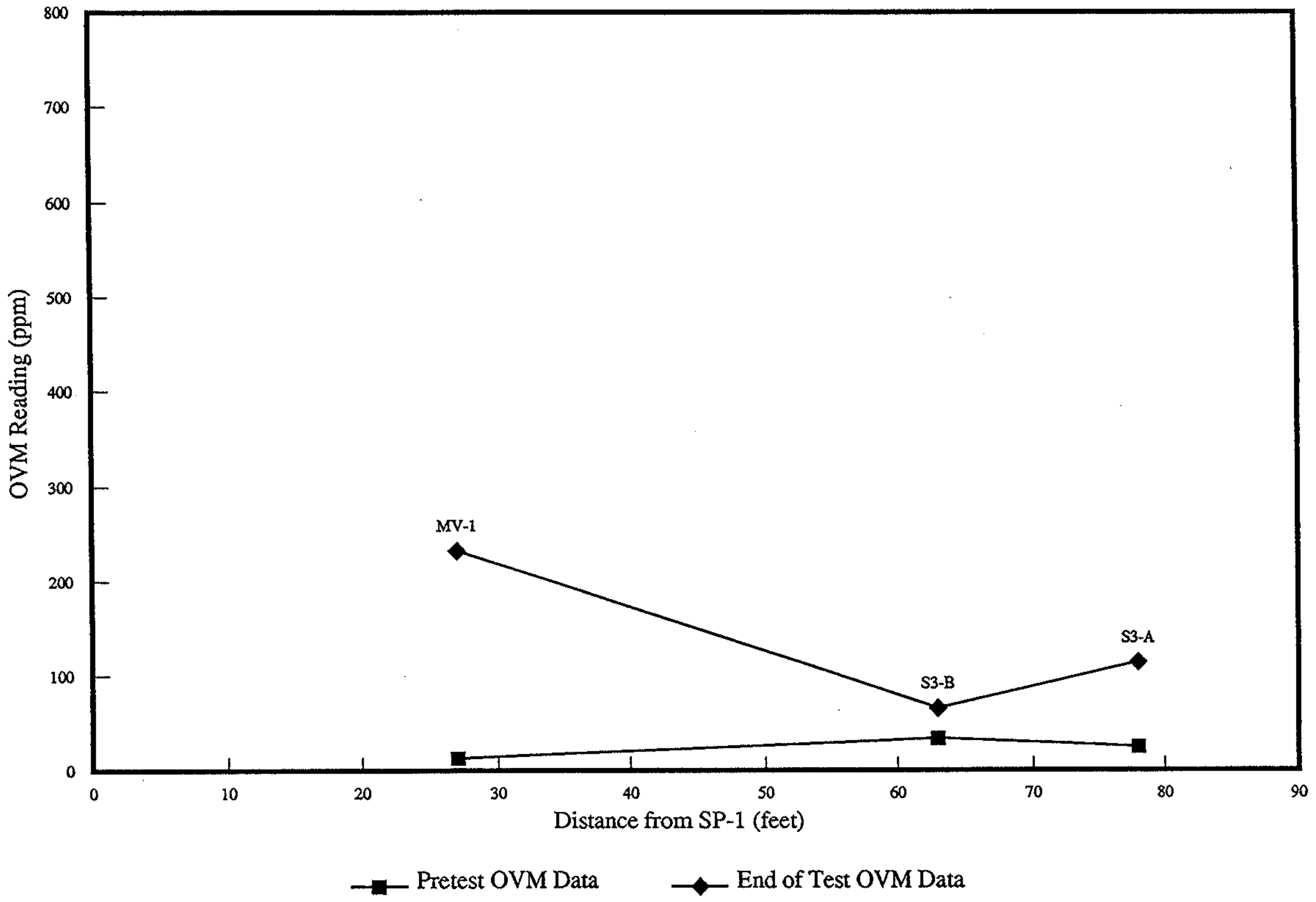
Figure 8c



Note: Data nearest the end of each test is plotted.

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Air Sparging - Organic Vapor vs. Distance at 26 scfm

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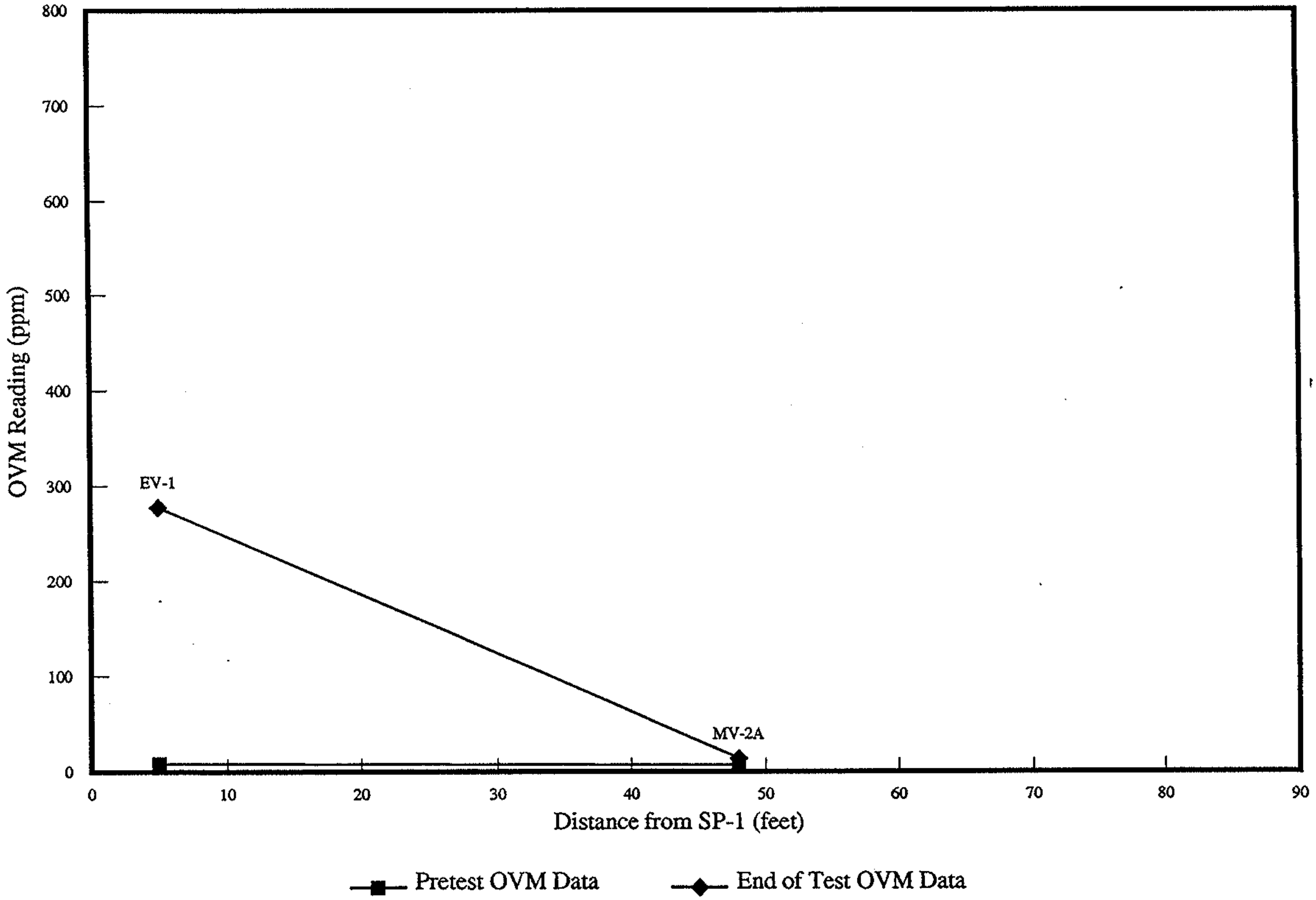
Figure 9a



Note: Data nearest the end of each test is plotted.

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Air Sparging - Organic Vapor vs. Distance at 26 scfm

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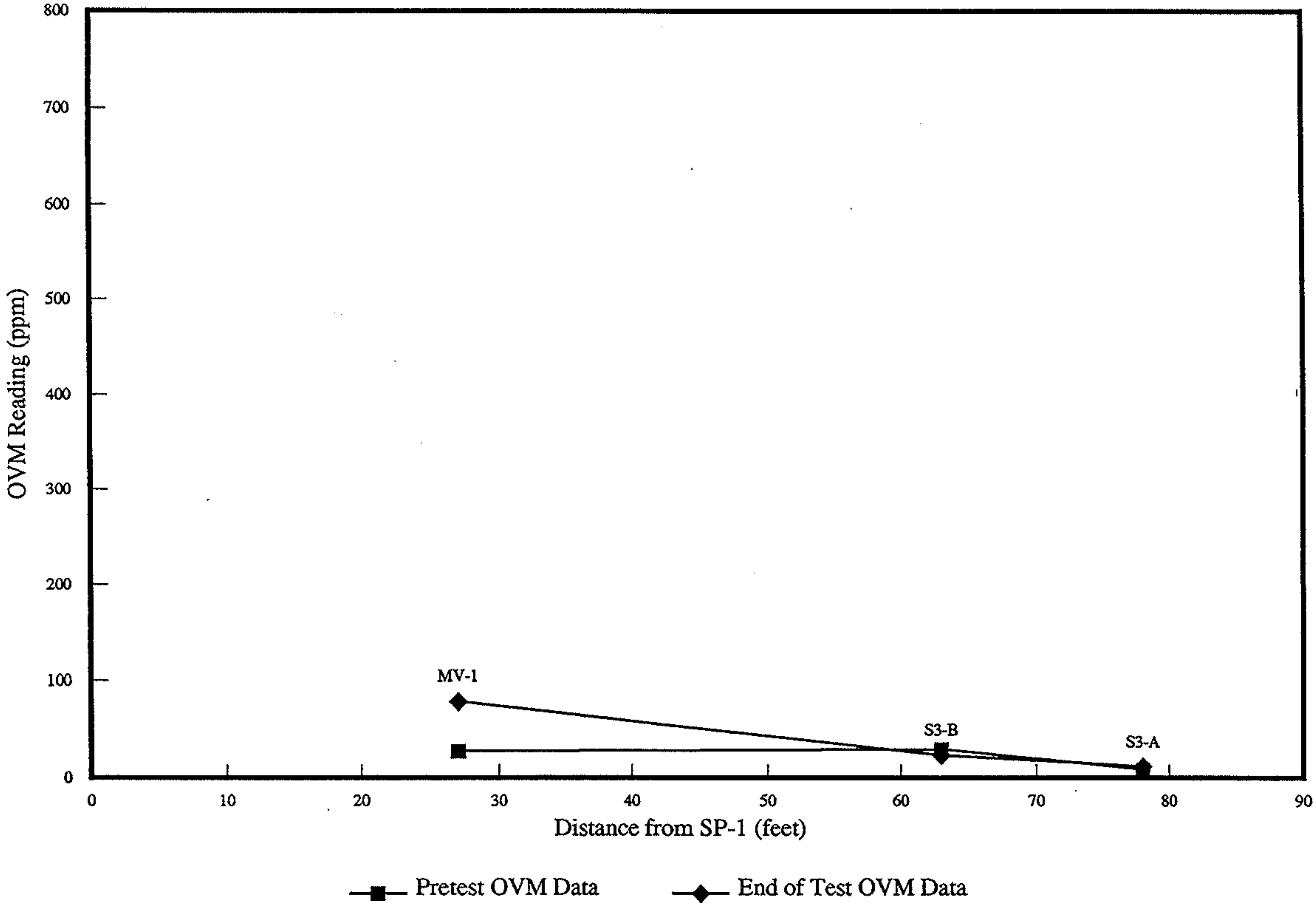
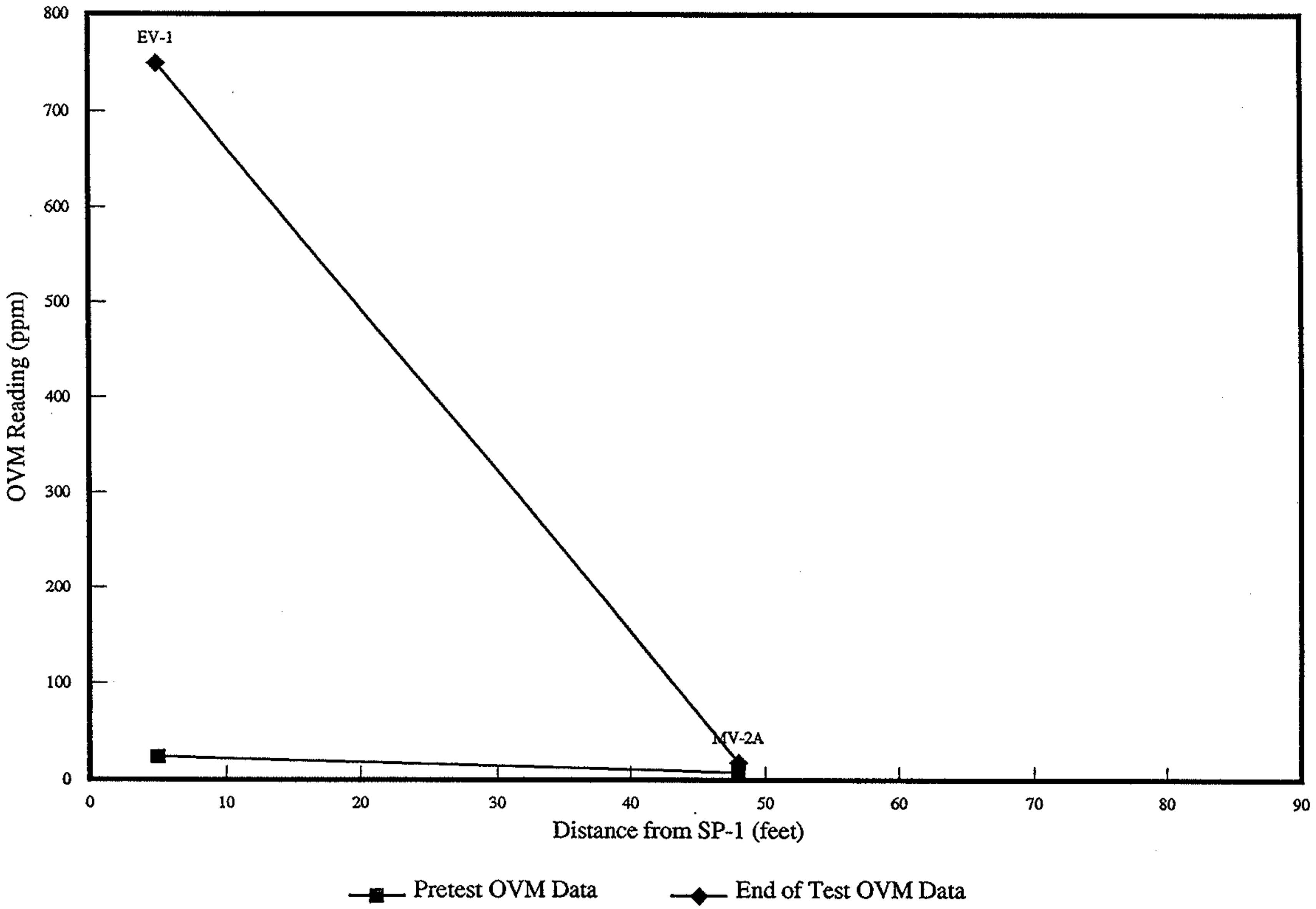
Figure 9b



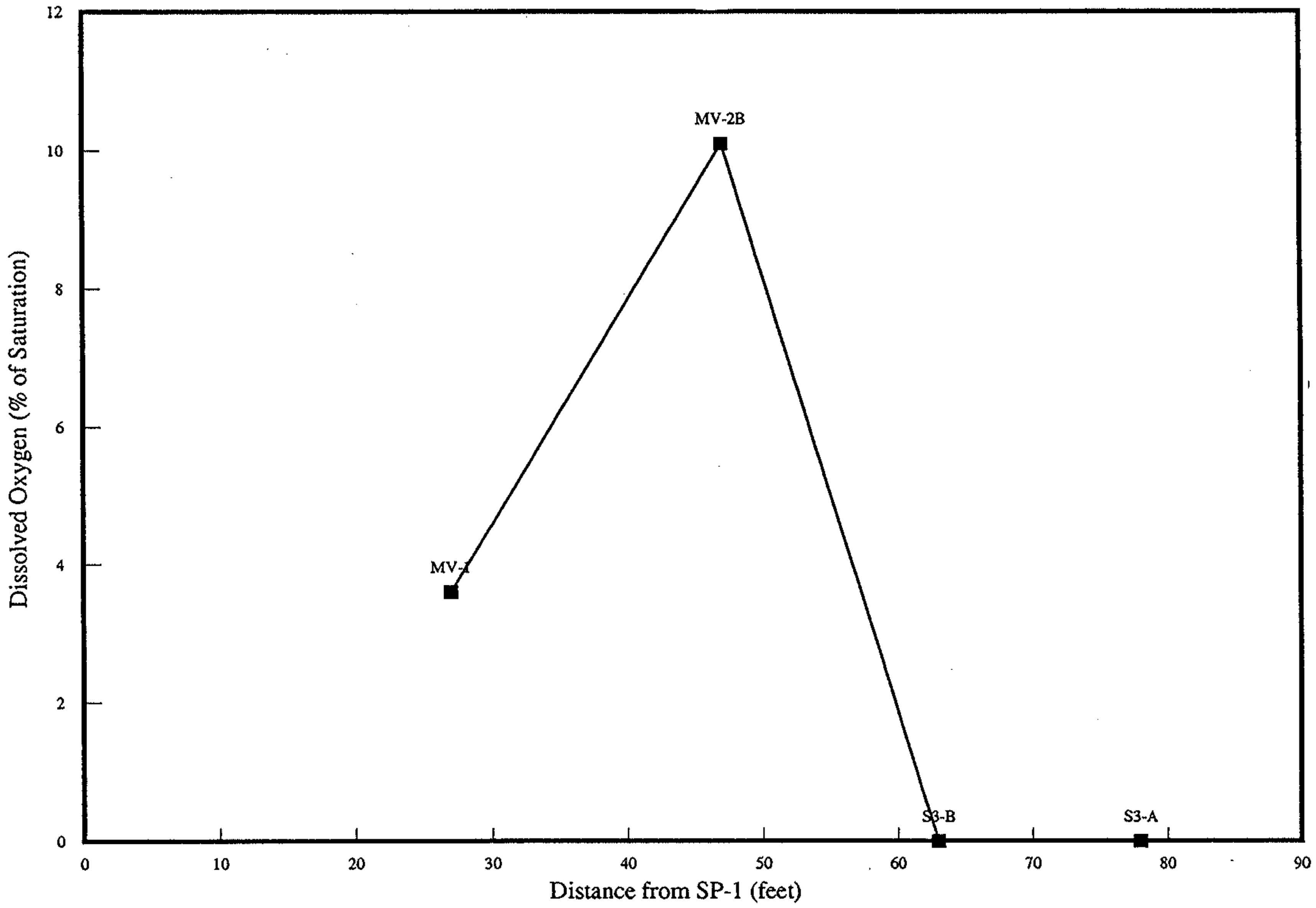
Note: Data nearest the end of each test is plotted.

THE TORRINGTON COMPANY	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Ctr. Environmental Engineers Maple Plain, MN 55359	June 1994
Air Sparging - Organic Vapor vs. Distance at 35 scfm		Figure 10a



Note: Data nearest the end of each test is plotted.

THE TORRINGTON COMPANY	Wenck Associates, Inc. 1800 Pioneer Creek Ctr. Environmental Engineers Maple Plain, MN 55359	June 1994
Air Sparging - Organic Vapor vs. Distance at 35 scfm		Figure 10b



Note: Data collected immediately after the air sparging test was stopped is plotted.

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Air Sparging - Dissolved Oxygen vs. Distance at 26 scfm

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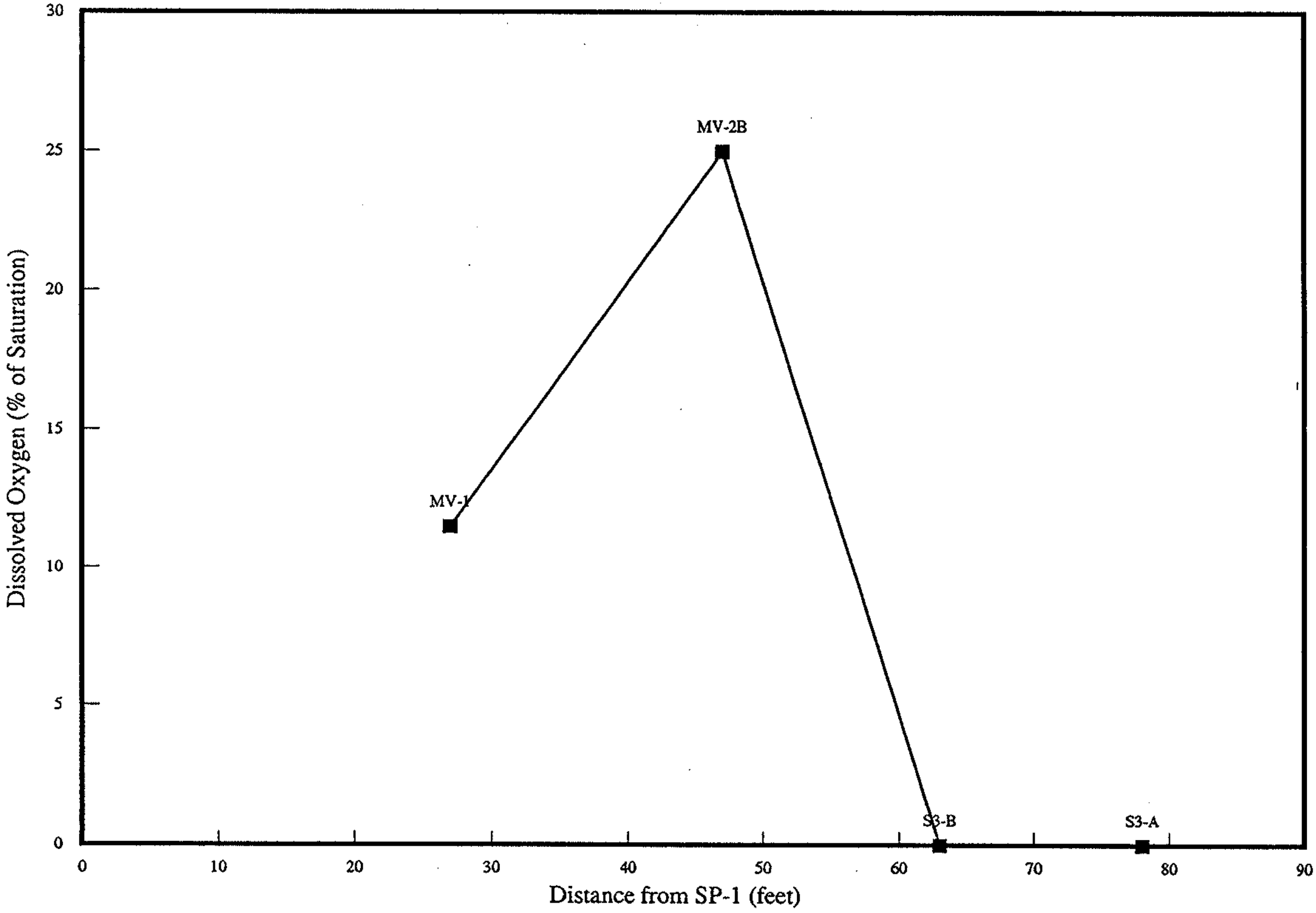
Figure 11



Note: Data collected immediately after the air sparging test was stopped is plotted.

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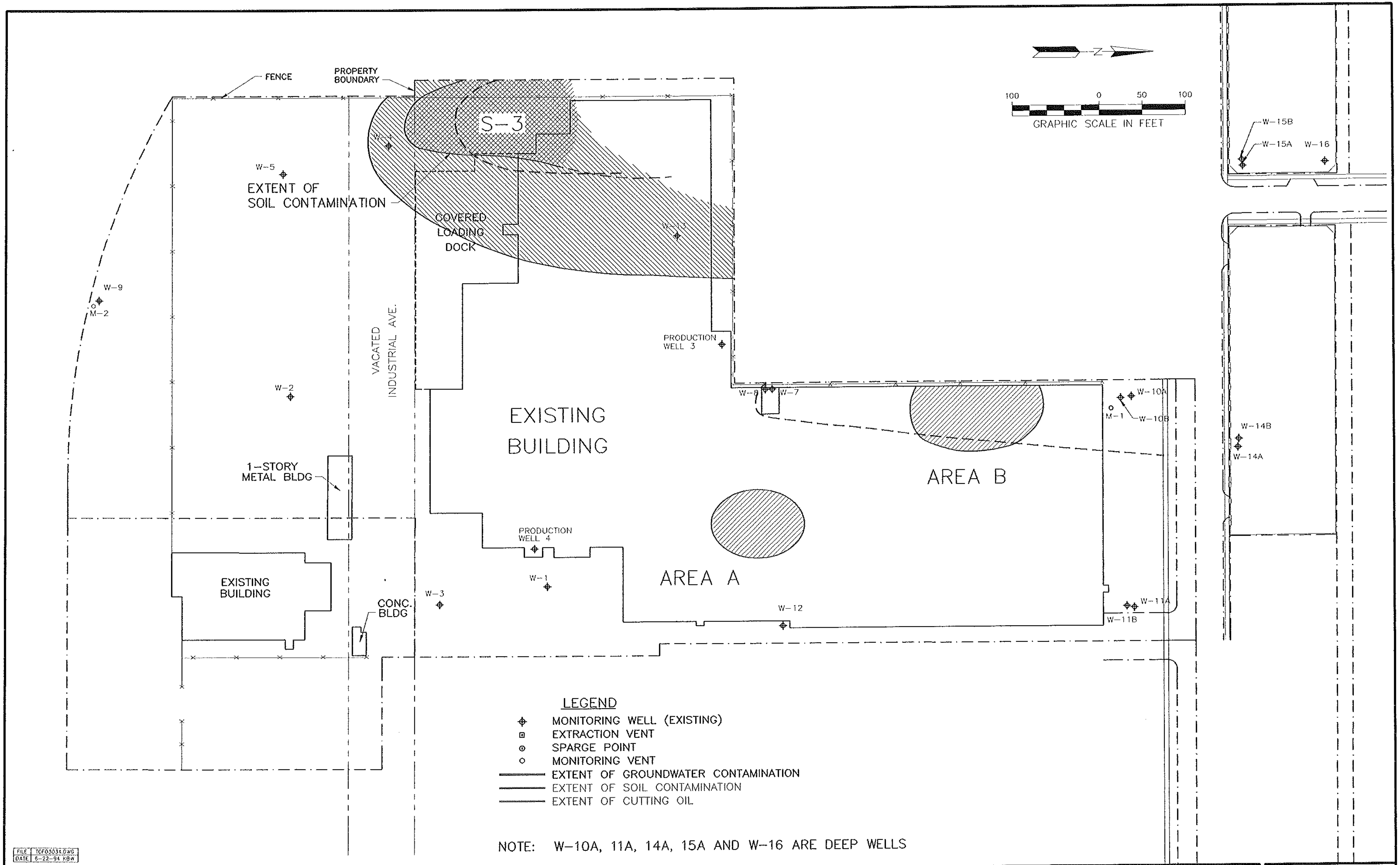
Air Sparging - Dissolved Oxygen vs. Distance at 35 scfm		Figure 12



NOTE: W-10A, 11A, 14A, 15A AND W-16 ARE DEEP WELLS

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DATE	6-22-94 KBW

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Areas of Contamination

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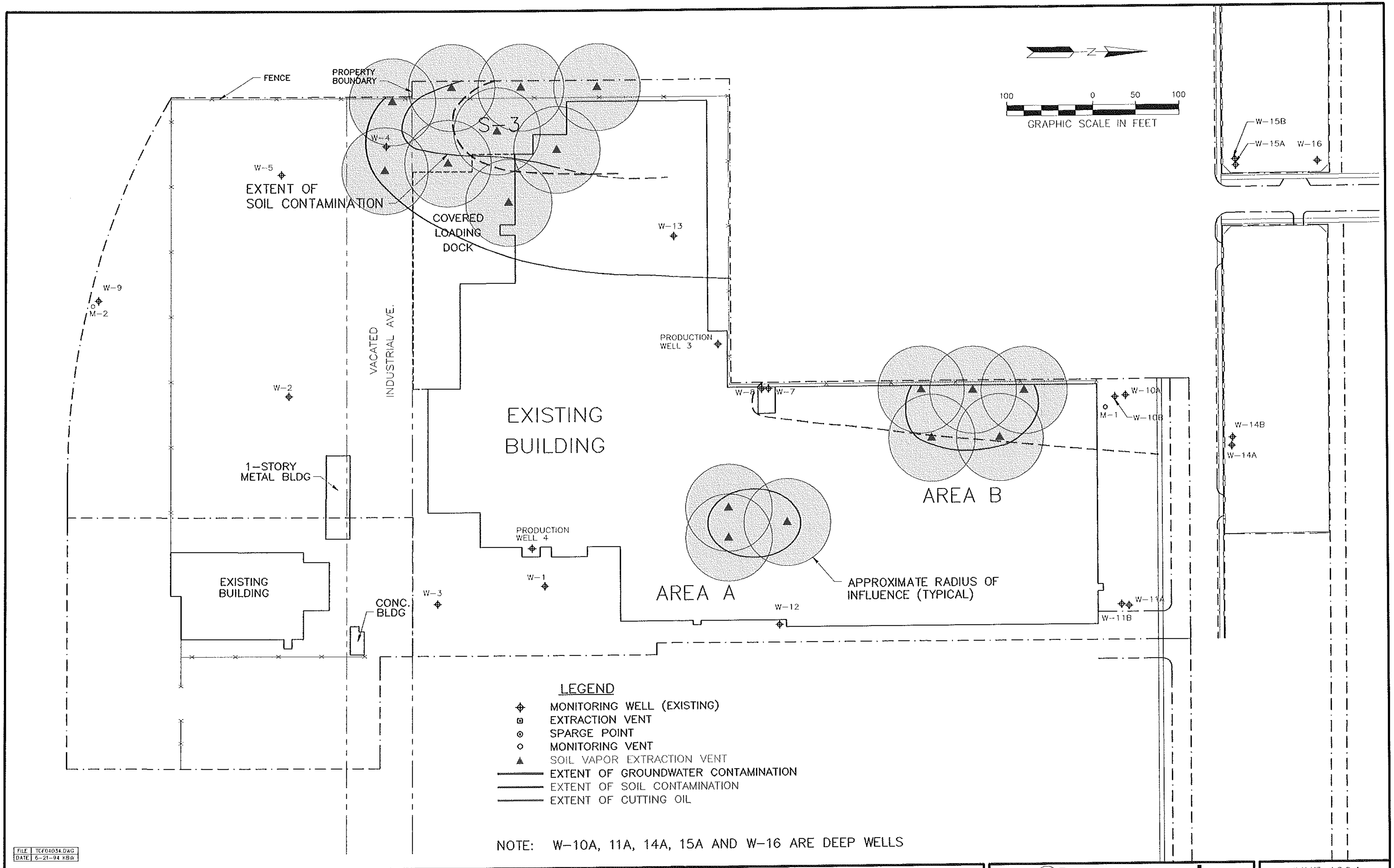
Figure No. 13



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Conceptual Design Layout of the Soil Vapor Extraction System

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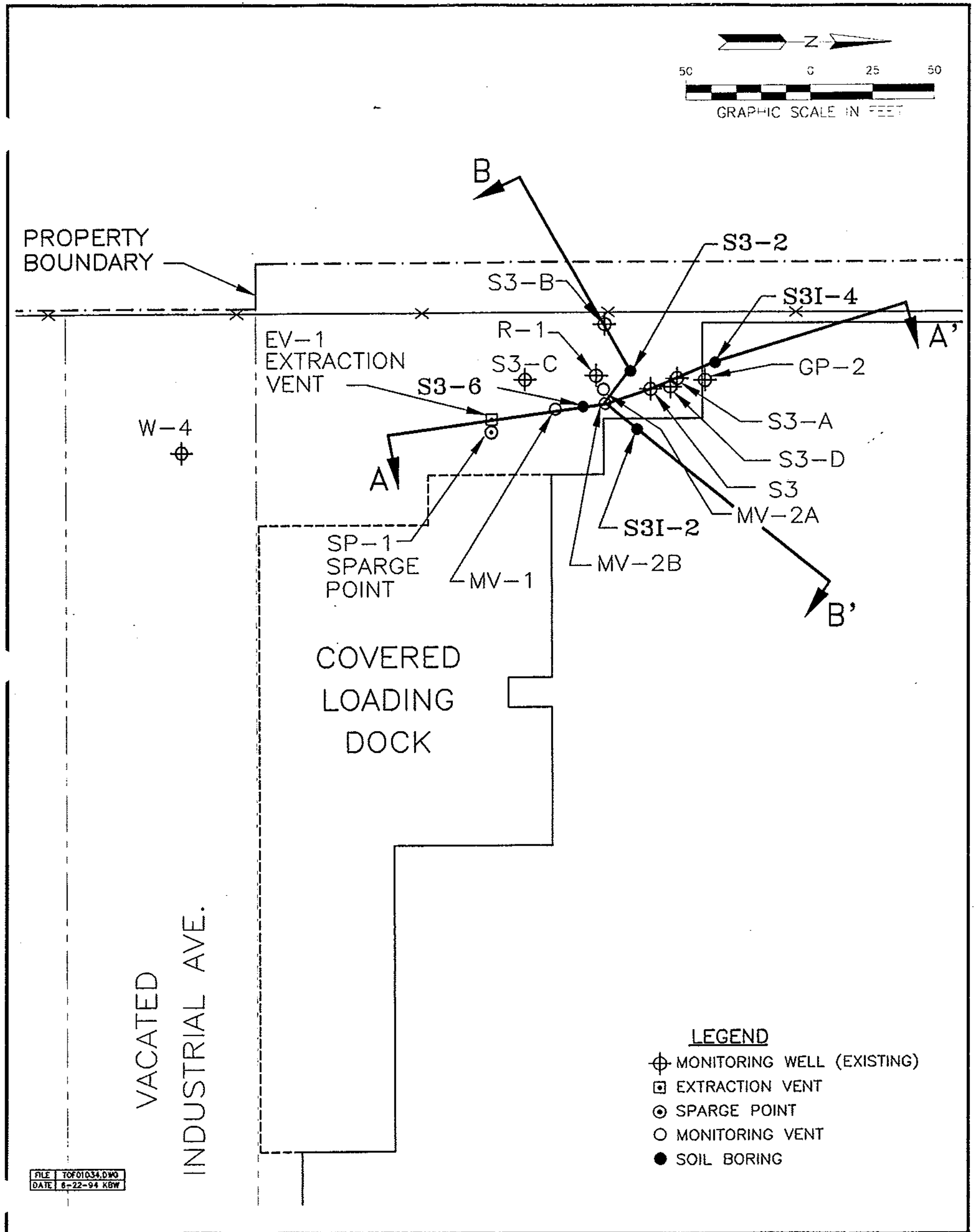
Figure No. 14



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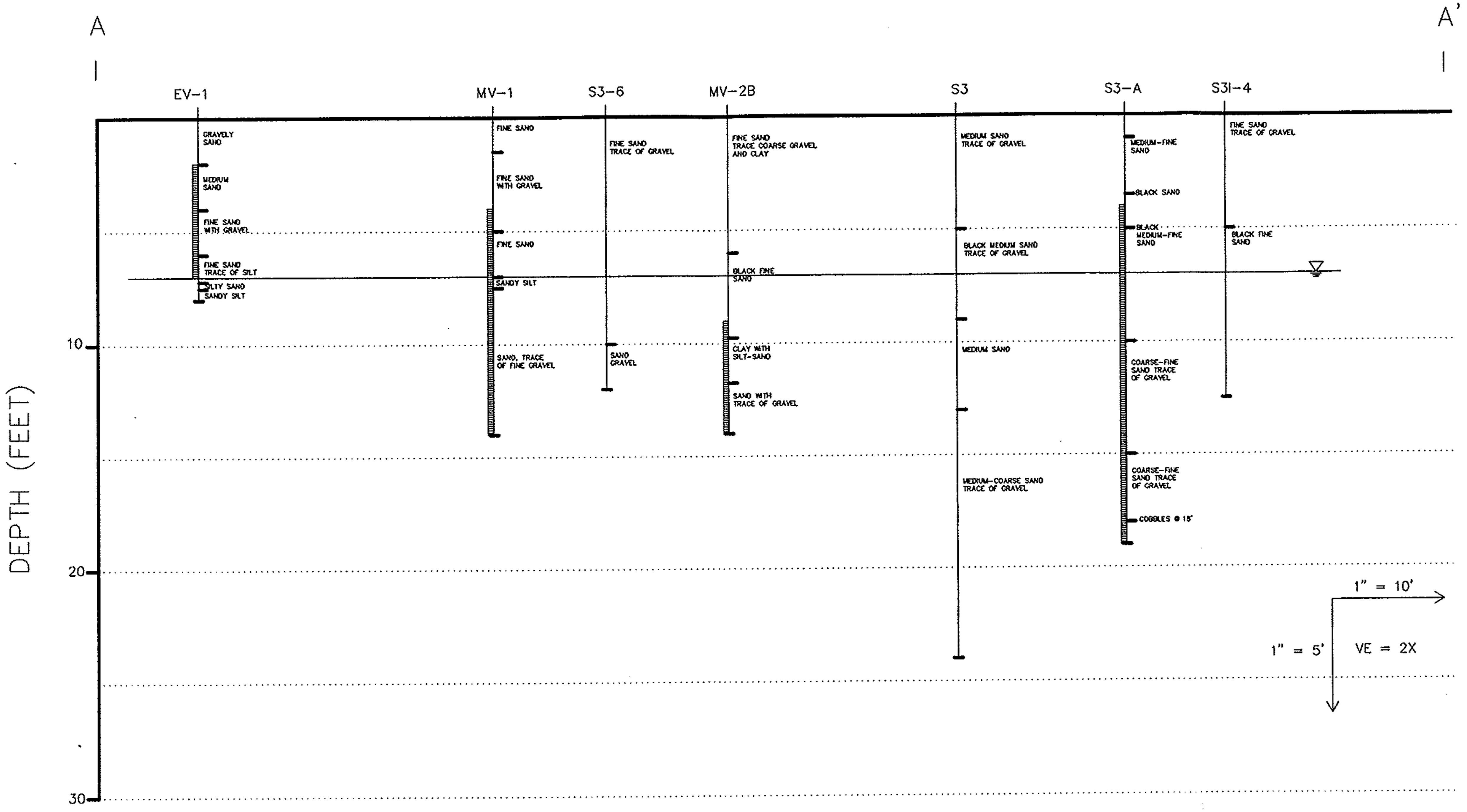
Cross-Section Location Map		Figure 15a



FILE TORXS254.DWG
DATE 6-22-94 KBW

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Geologic Cross-Section A-A'

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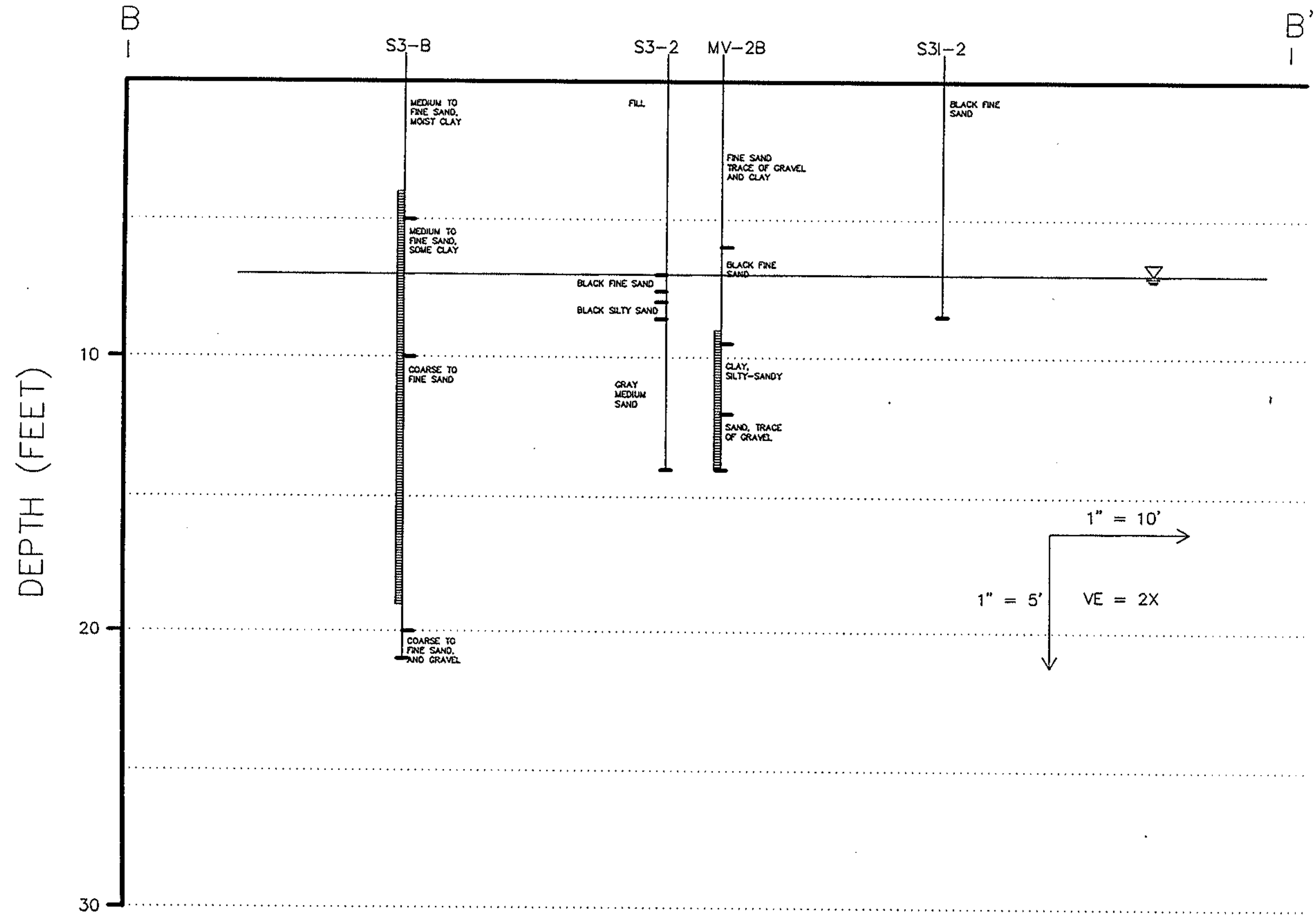
Figure 15b



FILE TORXS154.DWG
DATE 6-22-94 KBW

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Geologic Cross-Section B-B'

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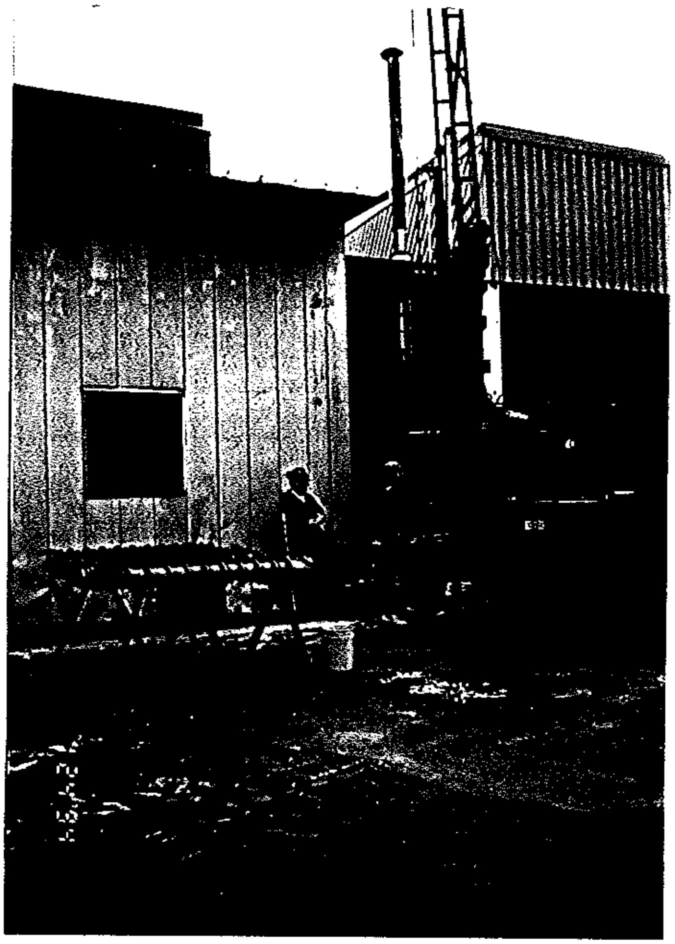
June 1994

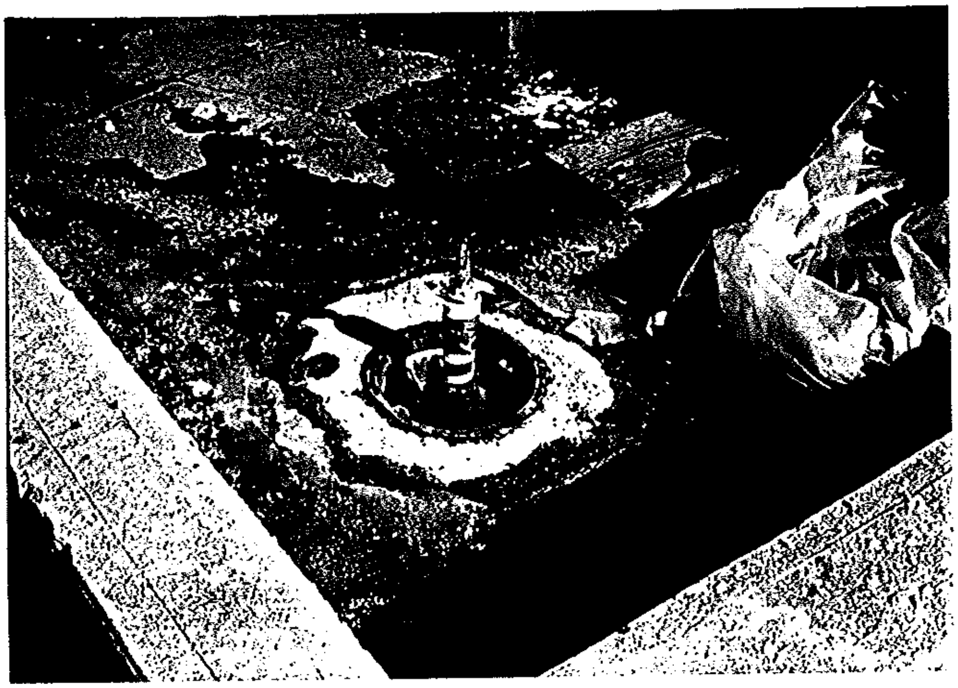
Figure 15c

Appendix A

Photographic Portfolio



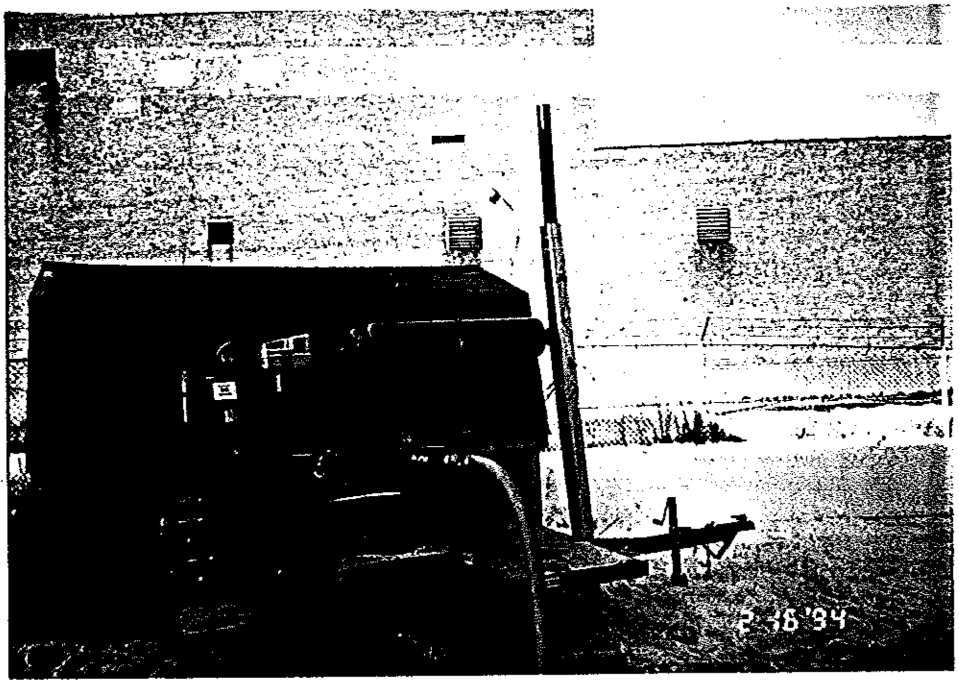
Hollow stem auger drilling
at MV-2B.

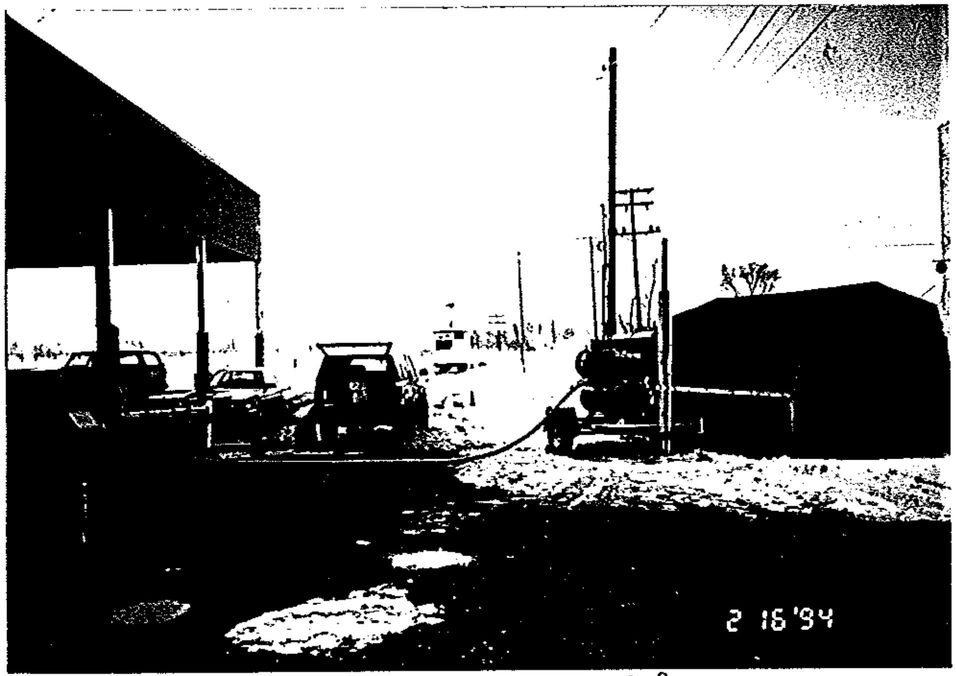


Monitoring point S-3A
riser - typical.

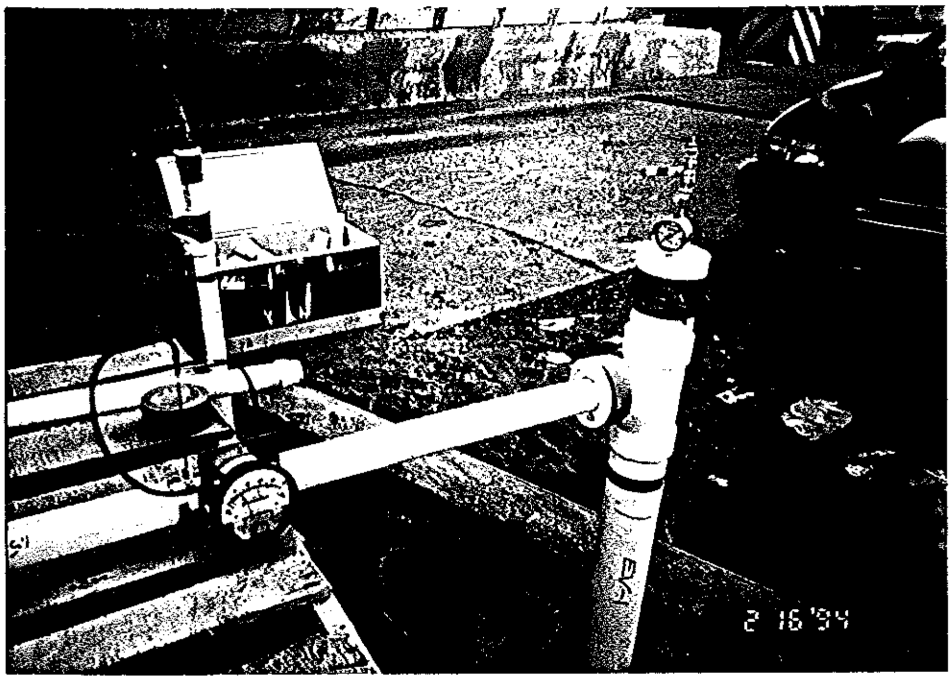
Monitoring vent risers MV-1, 2A, and 2B (loading dock on left) - typical.

SoilVac™ in front of shed containing the oil skimmer equipment.



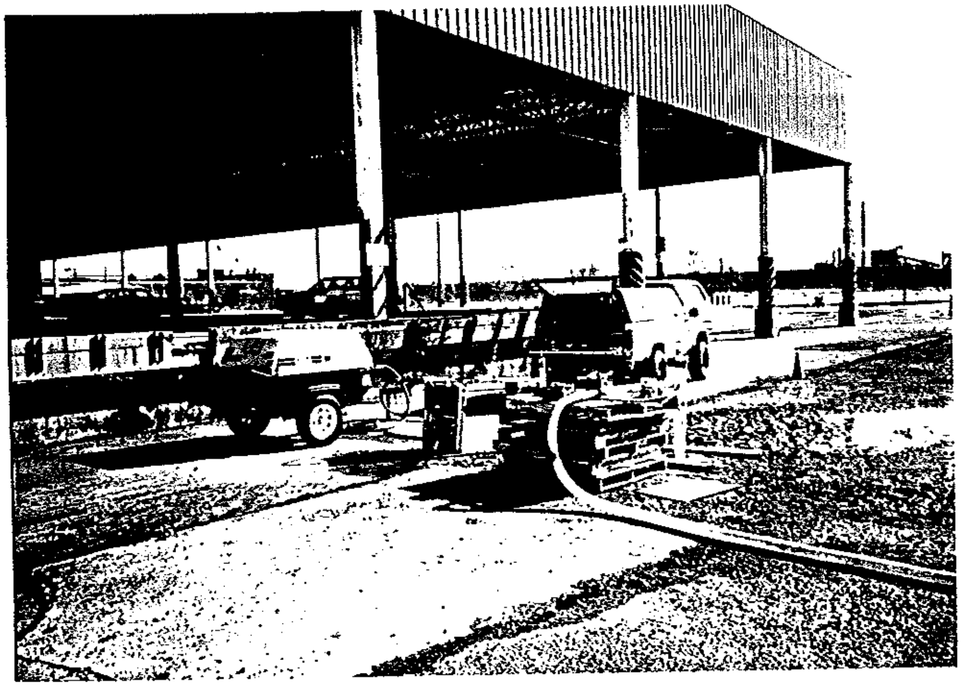


SoilVac™ connected to extraction vent, EV-1.



Extraction vent EV-1 magnehelic gauge connected to pitot tube on left.

Compressor connected to sparge point SP-1.



Sparge point SP-1 with magnehelic gauge connected to pitot tube in foreground. Also note pressure gauge to left of pitot tube.

Appendix B

Soil Boring Logs and Diagrams

WENCK ASSOCIATES, INCORPORATED

LOG OF TEST BORING NO: MV-1

PROJECT NAME: TORRINGTON
PROJECT LOCATION: TORRINGTON-SOUTH BEND, ID

WAI PROJ. NO: 0112-03
CHECKED BY: MJO

SUBSURFACE PROFILE

ELEV. (FT)	USCS GROUP	GROUND SURFACE ELEV: FT	DEPTH (FT)
	SP	medium dense dark brown FINE SAND	00.0
	SP-GW	loose brown GRAVELLY FINE SAND	2.0 4.0
	SP	loose gray FINE SAND	6.0
	SM	soft black fine SANDY SILT and SILT ▼	
	SW	loose dark gray SAND trace fine gravel	8.0 10.0 12.0
			14.0 16.0 18.0 20.0 22.0 24.0 26.0 28.0 30.0 32.0 34.0

SOIL SAMPLE DATA

SAMPLE TYPE	BLOW COUNT	STD. PEN RES. (N)	PERCENT RECOVERY	JAR SPACE SCREENING
S-1	27-20-7-3	27	64	3 ppm
S-2	4-1-1-2	2	64	3 ppm
S-3	1-1-1-1	2	92	38 ppm
S-4	1-1-1-1	2	66	39 ppm
S-5	2-6-6-9	?	64	45 ppm
S-6	5-5-10-20	15	58	14 ppm
S-7	2-6-10-10	16	33	

TOTAL DEPTH: 14 FT
DRILLING DATE: 1-26-94
INSPECTOR: MIKE OEZER
DRILLER: STEARNS

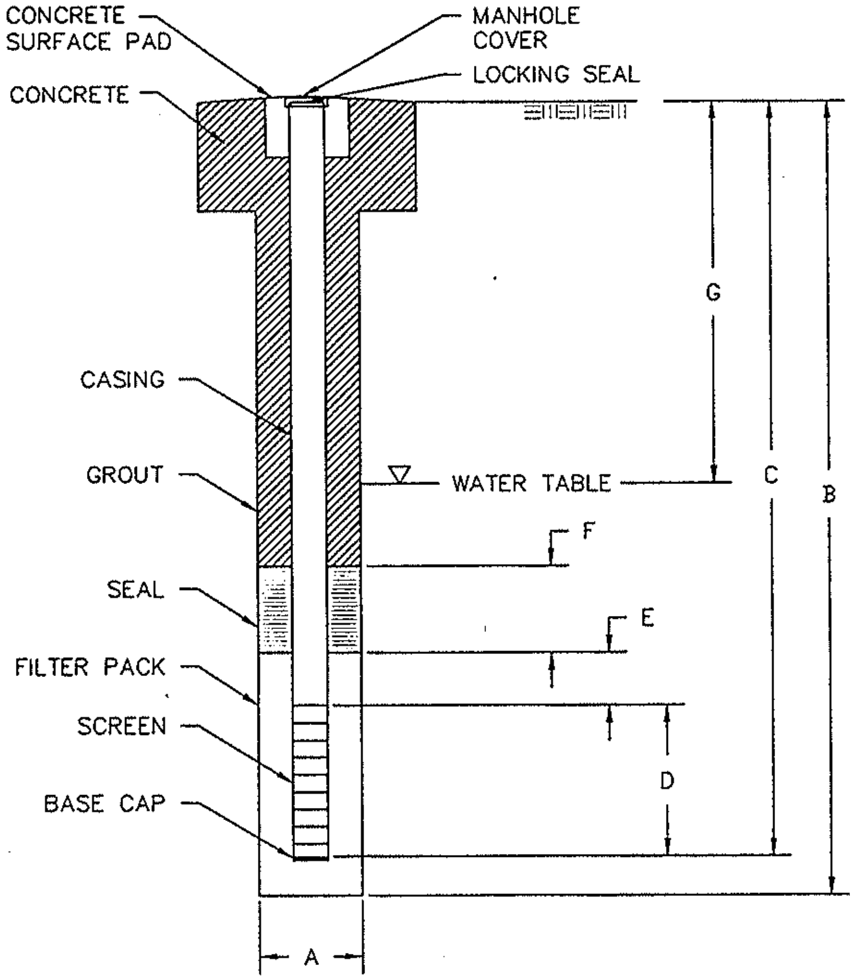
DRILLING METHOD:
4 1/4 ID H.S.A.

SOIL SAMPLING METHOD: 2'x2" SPLIT SPOON

*SUBMITTED TO LABORATORY FOR ANALYSIS

WATER LEVEL OBSERVATION:
WATER TABLE OBSERVED AT 8 FEET

FILE T0B01034.DWG
DATE 3-29-94 KBW



MONITORING VENT MV–1 SCHEMATIC
NOT TO SCALE

BOREHOLE INFORMATION

A	BOREHOLE DIAMETER	–
B	BOREHOLE DEPTH	14 FEET
C	WELL DEPTH	15 FEET

SCREEN INFORMATION

D	SCREEN LENGTH	10 FEET
–	SCREEN DIAMETER	2 INCHES
–	SLOT SIZE	10 SLOT
–	MATERIAL	PVC
–	SCREENED INTERVAL	–

INNER CASING INFORMATION

–	CASING DIAMETER	2 INCHES
–	CASING MATERIAL	PVC

FILTER PACK INFORMATION

E	DIST. ABOVE SCREEN	1/2 FOOT
–	FILTER PACK MATERIAL	GLOBAL #5

SEAL INFORMATION

F	SEAL THICKNESS	3 1/2 FEET
–	SEAL MATERIAL	BENTONITE SLURRY

OTHER INFORMATION

–	GROUT MATERIAL	REDIMIX
–	SURFACE SEAL	–
–	DRILLING METHOD	4 1/4 ID H.S.A.
–	DRILLER	STEARNS
–	INNER CASING ELEVATION	–
G	DEPTH TO WATER	8 FEET
–	DATE DRILLED	1–26–94
–	–	–
–	–	–
–	PROJECT NAME	TORRINGTON
–	PROJECT LOCATION	TORRINGTON–SOUTH BEND, IN

FILE	TOD01034.DWG
DATE	3-29-94 KBW

WENCK ASSOCIATES, INCORPORATED

LOG OF TEST BORING NO: MV-2A

PROJECT NAME: TORRINGTON
PROJECT LOCATION: TORRINGTON-SOUTH BEND, ID

WAI PROJ. NO: 0112-03
CHECKED BY: MJO

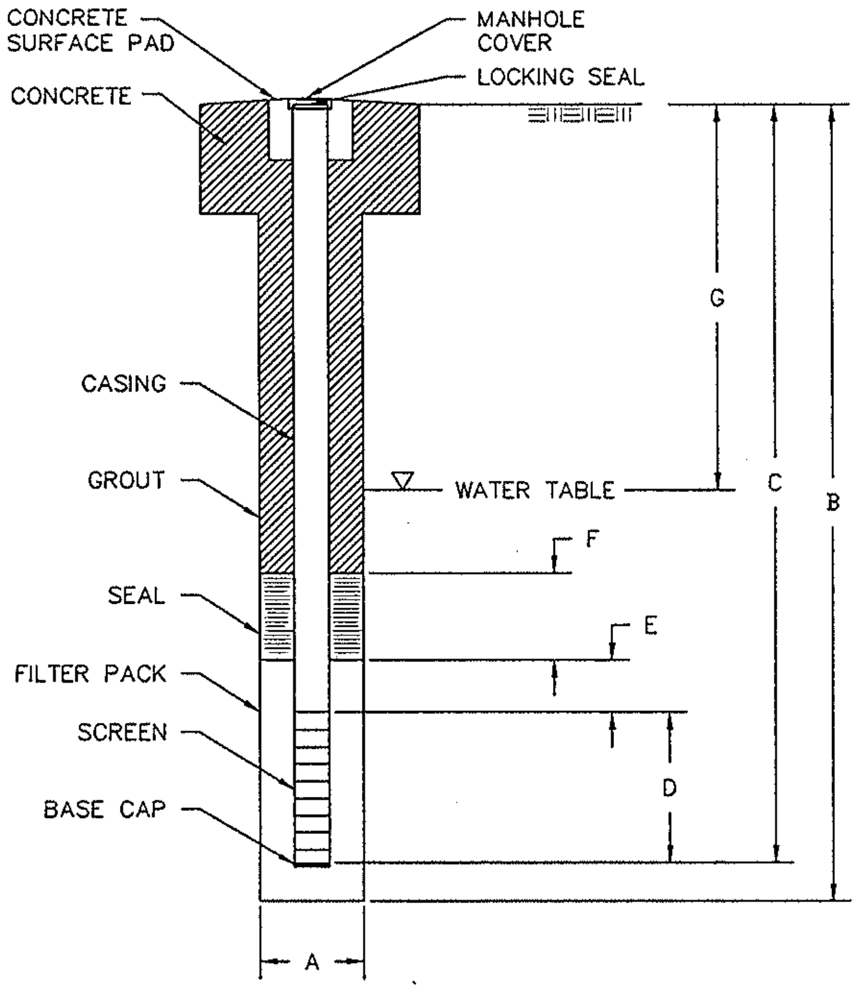
SUBSURFACE PROFILE				SOIL SAMPLE DATA				
ELEV. (FT)	USCS GROUP	GROUND SURFACE ELEV: FT	DEPTH (FT)	SAMPLE TYPE	BLOW COUNT	STD. PEN RES. (N)	PERCENT RECOVERY	JAR SPACE SCREENING
	SC-GC	dense gray GRAVELLY SAND with some clay	00.0	S-1			83	10ppm
	SP	loose brown FINE SAND trace coarse sand, gravel	2.0	S-2			58	27ppm
			4.0	S-3			58	6ppm
			6.0					
			8.0					
			10.0					
			12.0					
			14.0					
			16.0					
			18.0					
			20.0					
			22.0					
			24.0					
			26.0					
			28.0					
			30.0					
			32.0					
			34.0					

TOTAL DEPTH: 6 FT
DRILLING DATE: 1-24-94
INSPECTOR: MIKE OEZER
DRILLER: STEARNS
DRILLING METHOD:
4 1/4 ID H.S.A.
SOIL SAMPLING METHOD: 2'x2" SPLIT SPOON

*SUBMITTED TO LABORATORY FOR ANALYSIS

WATER LEVEL OBSERVATION:

FILE	T0B02034.DWG
DATE	3-29-94 KBW



MONITORING VENT MV-2A SCHEMATIC

NOT TO SCALE

BOREHOLE INFORMATION

A	BOREHOLE DIAMETER	–
B	BOREHOLE DEPTH	5 FEET
C	WELL DEPTH	6 FEET

SCREEN INFORMATION

D	SCREEN LENGTH	2 FEET
–	SCREEN DIAMETER	2 INCHES
–	SLOT SIZE	10 SLOT
–	MATERIAL	PVC
–	SCREENED INTERVAL	–

INNER CASING INFORMATION

–	CASING DIAMETER	2 INCHES
–	CASING MATERIAL	PVC

FILTER PACK INFORMATION

E	DIST. ABOVE SCREEN	1/2 FOOT
–	FILTER PACK MATERIAL	GLOBAL #5

SEAL INFORMATION

F	SEAL THICKNESS	2 1/2 FEET
–	SEAL MATERIAL	BENTONITE SLURRY

OTHER INFORMATION

–	GROUT MATERIAL	1/2 FOOT REDIMIX
–	SURFACE SEAL	–
–	DRILLING METHOD	4 1/4 ID H.S.A.
–	DRILLER	STEARNS
–	INNER CASING ELEVATION	–
G	DEPTH TO WATER	–
–	DATE DRILLED	1–24–94
–	–	–
–	–	–
–	PROJECT NAME	TORRINGTON
–	PROJECT LOCATION	TORRINGTON–SOUTH BEND, ID

FILE	10002034.DWG
DATE	5-29-94 KBW

WENCK ASSOCIATES, INCORPORATED

LOG OF TEST BORING NO: MV-2B

PROJECT NAME: TORRINGTON
PROJECT LOCATION: TORRINGTON-SOUTH BEND, ID
WAI PROJ. NO: 0112-03
CHECKED BY: MJO

SUBSURFACE PROFILE

ELEV. (FT)	USCS GROUP	GROUND SURFACE ELEV: FT
	SP-SC	medium dense to loose brown/orange FINE SAND trace coarse sand, trace clay
	SP	very loose black/gray FINE SAND
	CL-SC	very soft black SILTY CLAY with SAND
	CL-SC	very soft black SANDY CLAY with some silt
	CL	very soft gray CLAY
	SW	loose gray SAND trace fine gravel

DEPTH (FT): 00.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0

SOIL SAMPLE DATA

SAMPLE TYPE	BLOW COUNT	STD. PEN RES. (N)	PERCENT RECOVERY	JAR SPACE SCREENING
S-1	25-13-5-8	18	92	0.3 ppm
S-2	1-1-1-1	2	75	2 ppm
S-3	2-1-1-1	2	42	16 ppm
S-4	2-1-1-1	2	50	50 ppm
S-5	1-0-0-0	0	58	23 ppm
S-6	1-1-1-1	2	100	14 ppm
S-7	3-3-5-8	8	67	

TOTAL DEPTH: 14 FT
DRILLING DATE: 1-24-94
INSPECTOR: MIKE OEZER
DRILLER: STEARNS

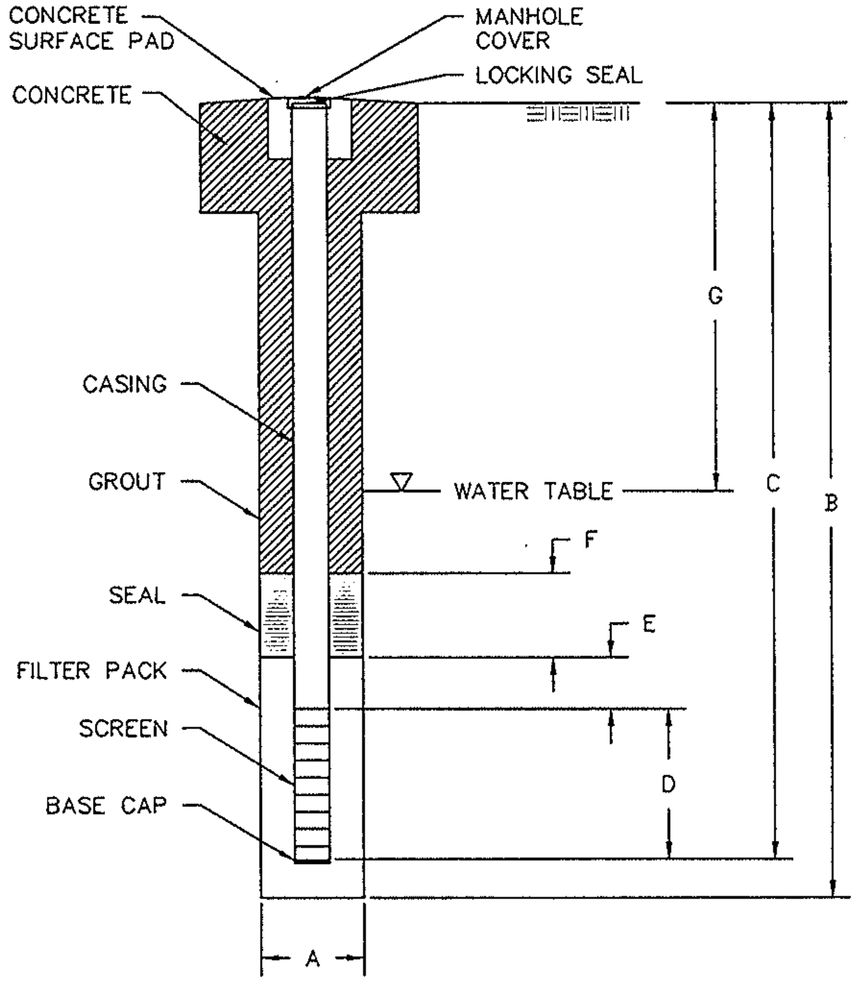
DRILLING METHOD:
4 1/4 ID H.S.A.

SOIL SAMPLING METHOD: 2'x2" SPLIT SPOON

*SUBMITTED TO LABORATORY FOR ANALYSIS

WATER LEVEL OBSERVATION:
WATER TABLE OBSERVED AT 7 FEET

FILE	T0B03034.DWG
DATE	3-29-94 KBW



MONITORING VENT MV–2B SCHEMATIC

NOT TO SCALE

BOREHOLE INFORMATION

A	BOREHOLE DIAMETER	–
B	BOREHOLE DEPTH	14 FEET
C	WELL DEPTH	14 FEET

SCREEN INFORMATION

D	SCREEN LENGTH	5 FEET
–	SCREEN DIAMETER	2 INCHES
–	SLOT SIZE	10 SLOT
–	MATERIAL	PVC
–	SCREENED INTERVAL	–

INNER CASING INFORMATION

–	CASING DIAMETER	2 INCHES
–	CASING MATERIAL	PVC

FILTER PACK INFORMATION

E	DIST. ABOVE SCREEN	1/2 FOOT
–	FILTER PACK MATERIAL	GLOBAL #5

SEAL INFORMATION

F	SEAL THICKNESS	8 1/2 FEET
–	SEAL MATERIAL	BENTONITE SLURRY

OTHER INFORMATION

–	GROUT MATERIAL	1/2 FOOT REDIMIX
–	SURFACE SEAL	–
–	DRILLING METHOD	4 1/4 ID H.S.A.
–	DRILLER	STEARNS
–	INNER CASING ELEVATION	–
G	DEPTH TO WATER	7 FEET
–	DATE DRILLED	1–24–94
–	–	–
–	–	–
–	PROJECT NAME	TORRINGTON
–	PROJECT LOCATION	TORRINGTON–SOUTH BEND, ID

FILE	TOD03034.DWG
DATE	3-29-94 KBW

WENCK ASSOCIATES, INCORPORATED

LOG OF TEST BORING NO: EV-1

PROJECT NAME: TORRINGTON
PROJECT LOCATION: TORRINGTON-SOUTH BEND, ID
WAI PROJ. NO: 0112-03
CHECKED BY: MJO

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
ELEV. (FT)	USCS GROUP	GROUND SURFACE ELEV: FT	DEPTH (FT)	SAMPLE TYPE	BLOW COUNT	STD. PEN RES. (N)	PERCENT RECOVERY	JAR SPACE SCREENING
	SW	medium dense brown GRAVELLY SAND	00.0	S-1	35-15-13-11	28	100	0.6 ppm
	SP	loose brown fine and medium SAND	2.0	S-2	6-4-3-3	7	75	3 ppm
	SP-GW	loose gray GRAVELLY FINE SAND MOIST	4.0	S-3	2-1-1-1	2	100	17 ppm
	SP	very loose gray fine SAND trace silt	6.0	S-4	1-1-1-1	2	100	20 ppm
	SM	3" very loose gray SILTY SAND						
	ML	very soft SANDY SILT	8.0					
			10.0					
			12.0					
			14.0					
			16.0					
			18.0					
			20.0					
	SW	loose dark gray SAND trace fine gravel						
			22.0					
			24.0					
			26.0					
			28.0					
			30.0					
			32.0					
			34.0					

TOTAL DEPTH: 8 FT
DRILLING DATE: 1-26-94
INSPECTOR: MIKE OEZER
DRILLER: STEARNS

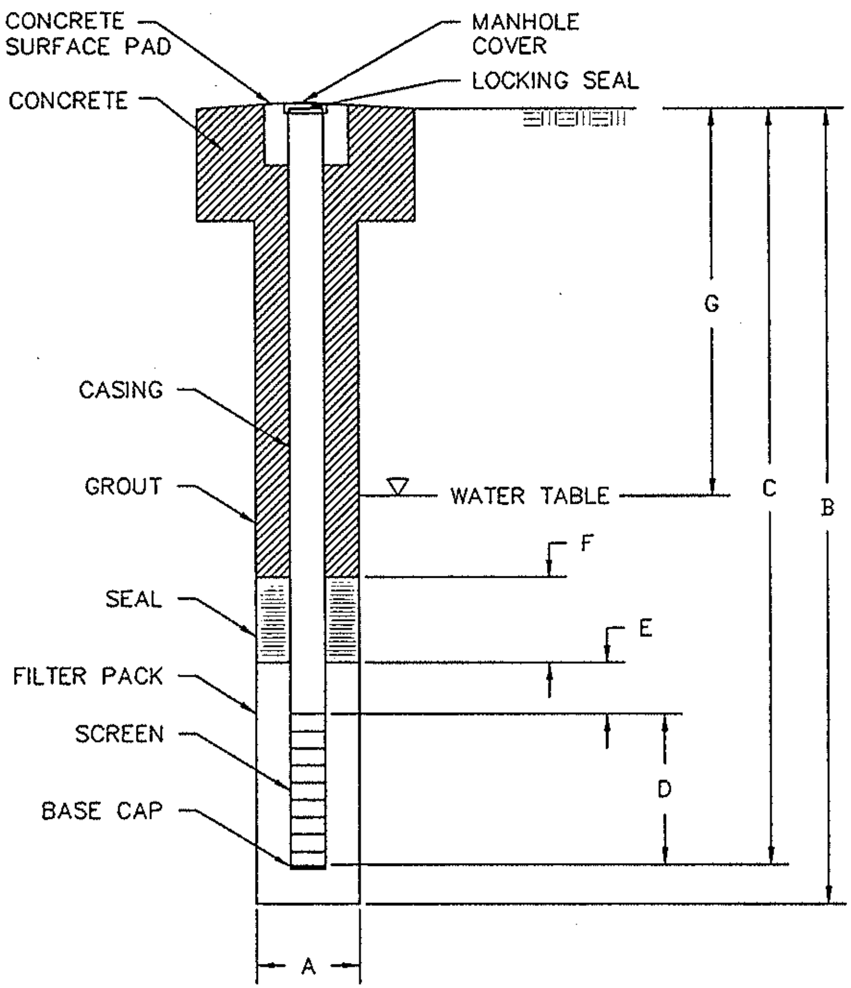
DRILLING METHOD:
8 1/4 ID H.S.A.

SOIL SAMPLING METHOD: 2'x2" SPLIT SPOON

*SUBMITTED TO LABORATORY FOR ANALYSIS

WATER LEVEL OBSERVATION:
MOISTURE OBSERVED AT 5.8 FEET

FILE	TCB04034.DWG
DATE	3-29-94 KBW



EXTRACTION VENT EV-1 SCHEMATIC

NOT TO SCALE

BOREHOLE INFORMATION

A	BOREHOLE DIAMETER	–
B	BOREHOLE DEPTH	8 FEET
C	WELL DEPTH	7 FEET

SCREEN INFORMATION

D	SCREEN LENGTH	5 FEET
–	SCREEN DIAMETER	4 INCH
–	SLOT SIZE	10 SLOT
–	MATERIAL	PVC
–	SCREENED INTERVAL	–

INNER CASING INFORMATION

–	CASING DIAMETER	4 INCHES
–	CASING MATERIAL	PVC

FILTER PACK INFORMATION

E	DIST. ABOVE SCREEN	0 FEET
–	FILTER PACK MATERIAL	GLOBAL #5

SEAL INFORMATION

F	SEAL THICKNESS	1 1/2 FEET
–	SEAL MATERIAL	BENSEAL

OTHER INFORMATION

–	GROUT MATERIAL	1/2 FOOT REDIMIX
–	SURFACE SEAL	–
–	DRILLING METHOD	8 1/4 ID H.S.A.
–	DRILLER	STEARNS
–	INNER CASING ELEVATION	–
G	DEPTH TO WATER	7 FEET
–	DATE DRILLED	1-26-94
–	–	–
–	–	–
–	PROJECT NAME	TORRINGTON
–	PROJECT LOCATION	TORRINGTON-SOUTH BEND, ID

FILE	T0004034.DWG
DATE	3-29-94 KBW

WENCK ASSOCIATES, INCORPORATED

LOG OF TEST BORING NO: SP-1

PROJECT NAME: TORRINGTON
PROJECT LOCATION: TORRINGTON-SOUTH BEND, ID

WAI PROJ. NO: 0112-03
CHECKED BY: MJO

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
ELEV. (FT)	USCS GROUP	GROUND SURFACE ELEV: FT	DEPTH (FT)	SAMPLE TYPE	BLOW COUNT	STD. PEN RES. (N)	PERCENT RECOVERY	JAR SPACE SCREENING
		NOTE: No samples collected from 0 to 55.5 feet.	30.0					
			32.0					
			34.0					
			36.0					
			38.0					
			40.0					
			42.0					
			44.0					
			46.0					
			48.0					
			50.0					
			52.0					
			54.0					
	CL	1" stiff gray SANDY CLAY with some silt						
	GM-GW	3" medium dense brown SANDY GRAVEL with trace silt	56.0					
	CL	3" SANDY CLAY S.A.A.		S-1	13-10-18-19	28	67	1 ppm
	GM-GW	2" SANDY GRAVEL S.A.A.						
	CL	6" SANDY CLAY S.A.A.	58.0					
			60.0					
			62.0					
			64.0					

TOTAL DEPTH: 28 FT
DRILLING DATE: 1-25-94
INSPECTOR: MIKE OEZER
DRILLER: STEARNS

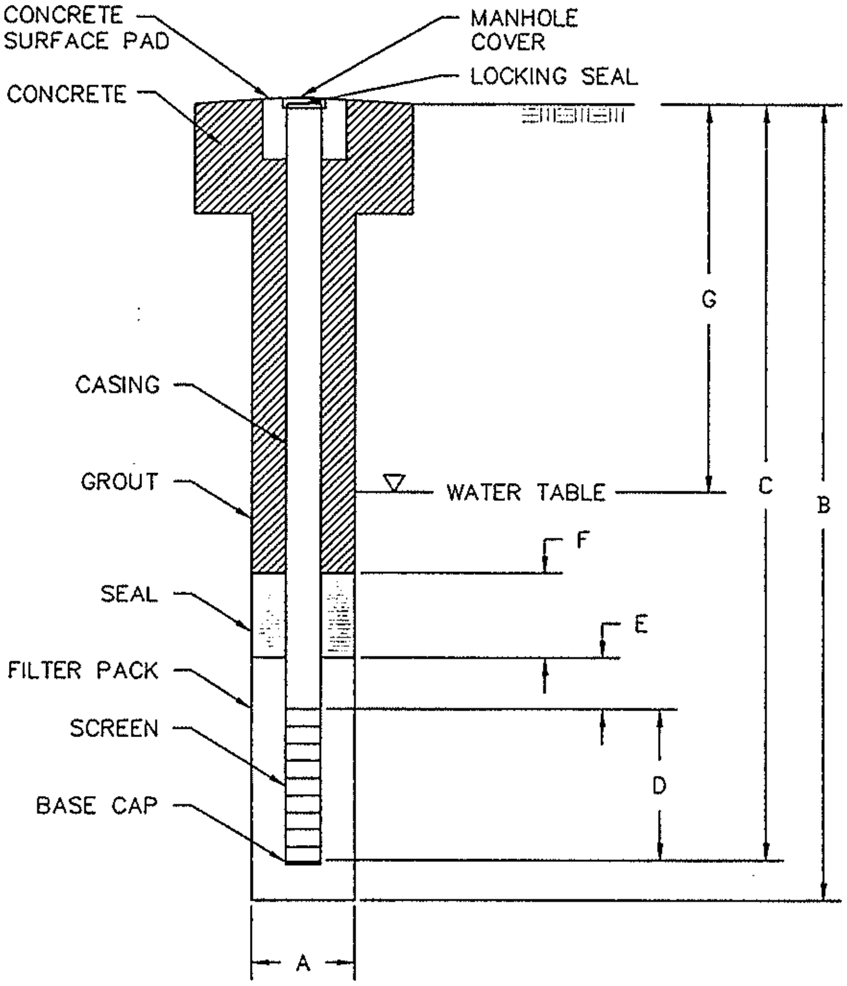
DRILLING METHOD:
4 1/4 ID H.S.A.

SOIL SAMPLING METHOD: 2'x2" SPLIT SPOON

*SUBMITTED TO LABORATORY FOR ANALYSIS

WATER LEVEL OBSERVATION:
WATER TABLE OBSERVED AT 6 FEET

FILE	TOB05034.DWG
DATE	3-29-94 KBW



BOREHOLE INFORMATION

A	BOREHOLE DIAMETER	–
B	BOREHOLE DEPTH	57.5 FEET
C	WELL DEPTH	55 FEET

SCREEN INFORMATION

D	SCREEN LENGTH	5 FEET
–	SCREEN DIAMETER	2 INCHES
–	SLOT SIZE	7 SLOT
–	MATERIAL	STAINLESS STEEL
–	SCREENED INTERVAL	ELEV.

INNER CASING INFORMATION

–	CASING DIAMETER	2 INCHES
–	CASING MATERIAL	GALVANIZED STEEL

FILTER PACK INFORMATION

E	DIST. ABOVE SCREEN	2 FEET
–	FILTER PACK MATERIAL	GLOBAL #5

SEAL INFORMATION

F	SEAL THICKNESS	52 FEET
–	SEAL MATERIAL	AQUAGEL

OTHER INFORMATION

–	GROUT MATERIAL	AQUAGEL
–	SURFACE SEAL	1 FOOT REDIMIX
–	DRILLING METHOD	4 1/4 ID H.S.A.
–	DRILLER	STEARNS
–	INNER CASING ELEVATION	–
G	DEPTH TO WATER	–
–	DATE DRILLED	1–25–94
–	–	–
–	–	–
–	PROJECT NAME	TORRINGTON
–	PROJECT LOCATION	TORRINGTON–SOUTH BEND, ID

SPARGE POINT SP–1 SCHEMATIC

NOT TO SCALE

FILE	10D05034.DWG
DATE	3–29–94 KBW

Appendix C

Air Emissions Laboratory Data - TO-14

Enseco
A Corning Company

Enseco - Air Toxics Laboratory
18501 East Gale Avenue, Suite 130
City of Industry, CA 91748-1321
(818) 965-1006 • FAX (818) 965-1003

March 3, 1994

WENCK ASSOCIATES, INC.
1800 Pioneer Creek Ctr.
Maple Plain, MN 55359
ATTN: MR. CHRIS MOSENTINE

ANALYSIS NO.: 104496-0001/0004-SA
ANALYSES: Volatile Organics by GCMS - Modified EPA TO14
DATE SAMPLED: 02/15/94, 02/16/94
DATE SAMPLE REC'D: 02/17/94

PROJECT: TORRINGTON PILOT TEST

PROJECT NO.: 0112-03

Enclosed with this letter is the report on the chemical and physical analyses for the samples from ANALYSIS NO.: 104496-0001/0004-SA as shown above.

The samples were received by Enseco-Air Toxics Laboratory, intact and with the chain-of-custody record attached.

Please note that ND means not detected at the reporting limits expressed.

The preliminary results were faxed to Mr. Chris Mosentine at 7:54 a.m. on March 1, 1994.

EPA Method TO-14 describes the use of SUMMA canisters for sampling and analysis. Use of Tedlar sample bags constitutes a modification to the method and is noted in the analysis description above.

Report Narrative:

Please note that sample EV-1 (104496-0004) was transfered to another Tedlar bag prior to analysis due to a possible leak.

APPROVED

3-3-94
DATE

SAMPLE DESCRIPTION INFORMATION
for
Wenck Associates, Inc.

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
104496-0001-SA	SOIL VAC SAMPLE PORT	AIR	15 FEB 94	15:58	17 FEB 94
104496-0002-SA	EV-1	AIR	15 FEB 94	18:00	17 FEB 94
104496-0003-SA	EV-1	AIR	16 FEB 94	10:50	17 FEB 94
104496-0004-SA	EV-1	AIR	16 FEB 94	16:00	17 FEB 94

Volatile Organics by GCMS - EPA TO14

Client Name: Wenck Associates, Inc.			
Client ID: EV-1			
Lab ID: 104496-0002-SA			
Matrix: AIR	Sampled: 15 FEB 94	Received: 17 FEB 94	
Authorized: 17 FEB 94	Prepared: NA	Analyzed: 18 FEB 94	

Parameter	Result	Units	Reporting Limit
Dichlorodifluoromethane	ND	ppb (v/v)	100
Chloromethane	ND	ppb (v/v)	200
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ppb (v/v)	100
Vinyl chloride	ND	ppb (v/v)	100
Bromomethane	ND	ppb (v/v)	100
Chloroethane	11000	ppb (v/v)	200
Trichlorofluoromethane	ND	ppb (v/v)	100
1,1-Dichloroethene	110	ppb (v/v)	100
Carbon disulfide	ND	ppb (v/v)	500
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ppb (v/v)	100
Acetone	ND	ppb (v/v)	500
Methylene chloride	ND	ppb (v/v)	100
trans-1,2-Dichloroethene	ND	ppb (v/v)	100
1,1-Dichloroethane	3900	ppb (v/v)	100
Vinyl acetate	ND	ppb (v/v)	500
cis-1,2-Dichloroethene	200	ppb (v/v)	100
2-Butanone	ND	ppb (v/v)	500
Chloroform	ND	ppb (v/v)	100
1,1,1-Trichloroethane	6700	ppb (v/v)	100
Carbon tetrachloride	ND	ppb (v/v)	100
Benzene	ND	ppb (v/v)	100
1,2-Dichloroethane	ND	ppb (v/v)	100
Trichloroethene	ND	ppb (v/v)	100
1,2-Dichloropropane	ND	ppb (v/v)	100
Bromodichloromethane	ND	ppb (v/v)	100
cis-1,3-Dichloropropene	ND	ppb (v/v)	100
4-Methyl-2-pentanone	ND	ppb (v/v)	200
Toluene	ND	ppb (v/v)	100
trans-1,3-Dichloropropene	ND	ppb (v/v)	100
1,1,2-Trichloroethane	ND	ppb (v/v)	100
Tetrachloroethene	ND	ppb (v/v)	100
2-Hexanone	ND	ppb (v/v)	200
Dibromochloromethane	ND	ppb (v/v)	100
1,2-Dibromoethane (EDB)	ND	ppb (v/v)	100
Chlorobenzene	ND	ppb (v/v)	100
Ethylbenzene	ND	ppb (v/v)	100
Xylenes (total)	ND	ppb (v/v)	100
Styrene	ND	ppb (v/v)	100
Bromoform	ND	ppb (v/v)	100

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14

Client Name:	Wenck Associates, Inc.		
Client ID:	SOIL VAC SAMPLE PORT		
Lab ID:	104496-0001-SA		
Matrix:	AIR	Sampled: 15 FEB 94	Received: 17 FEB 94
Authorized:	17 FEB 94	Prepared: NA	Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit	
Dichlorodifluoromethane	ND	ppb (v/v)	100	
Chloromethane	ND	ppb (v/v)	200	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ppb (v/v)	100	
Vinyl chloride	170	ppb (v/v)	100	
Bromomethane	ND	ppb (v/v)	100	
Chloroethane	21000	ppb (v/v)	200	
Trichlorofluoromethane	ND	ppb (v/v)	100	
1,1-Dichloroethene	190	ppb (v/v)	100	
Carbon disulfide	ND	ppb (v/v)	500	
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ppb (v/v)	100	
Acetone	ND	ppb (v/v)	500	
Methylene chloride	ND	ppb (v/v)	100	
trans-1,2-Dichloroethene	ND	ppb (v/v)	100	
1,1-Dichloroethane	7100	ppb (v/v)	100	
Vinyl acetate	ND	ppb (v/v)	500	
cis-1,2-Dichloroethene	510	ppb (v/v)	100	
2-Butanone	ND	ppb (v/v)	500	
Chloroform	ND	ppb (v/v)	100	
1,1,1-Trichloroethane	9700	ppb (v/v)	100	
Carbon tetrachloride	ND	ppb (v/v)	100	
Benzene	ND	ppb (v/v)	100	
1,2-Dichloroethane	ND	ppb (v/v)	100	
Trichloroethene	41	ppb (v/v)	10	D
1,2-Dichloropropane	ND	ppb (v/v)	100	
Bromodichloromethane	ND	ppb (v/v)	100	
cis-1,3-Dichloropropene	ND	ppb (v/v)	100	
4-Methyl-2-pentanone	ND	ppb (v/v)	200	
Toluene	ND	ppb (v/v)	100	
trans-1,3-Dichloropropene	ND	ppb (v/v)	100	
1,1,2-Trichloroethane	ND	ppb (v/v)	100	
Tetrachloroethene	62	ppb (v/v)	10	D
2-Hexanone	ND	ppb (v/v)	200	
Dibromochloromethane	ND	ppb (v/v)	100	
1,2-Dibromoethane (EDB)	ND	ppb (v/v)	100	
Chlorobenzene	ND	ppb (v/v)	100	
Ethylbenzene	ND	ppb (v/v)	100	
Xylenes (total)	ND	ppb (v/v)	100	
Styrene	ND	ppb (v/v)	100	
Bromoform	ND	ppb (v/v)	100	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14 (CONT.)

Client Name: Wenck Associates, Inc.
Client ID: SOIL VAC SAMPLE PORT
Lab ID: 104496-0001-SA
Matrix: AIR
Authorized: 17 FEB 94

Sampled: 15 FEB 94
Prepared: NA

Received: 17 FEB 94
Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit
1,1,2,2-Tetrachloroethane	ND	ppb (v/v)	100
Benzyl chloride	ND	ppb (v/v)	100
4-Ethyl toluene	ND	ppb (v/v)	100
1,3,5-Trimethylbenzene	ND	ppb (v/v)	100
1,2,4-Trimethylbenzene	ND	ppb (v/v)	100
1,3-Dichlorobenzene	ND	ppb (v/v)	100
1,4-Dichlorobenzene	ND	ppb (v/v)	100
1,2-Dichlorobenzene	ND	ppb (v/v)	100
1,2,4-Trichlorobenzene	ND	ppb (v/v)	200
Hexachlorobutadiene	ND	ppb (v/v)	200

Note D : Compound quantitated at a secondary dilution.

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14 (CONT.)

Client Name:	Wenck Associates, Inc.			
Client ID:	EV-1			
Lab ID:	104496-0002-SA			
Matrix:	AIR	Sampled: 15 FEB 94	Received:	17 FEB 94
Authorized:	17 FEB 94	Prepared: NA	Analyzed:	18 FEB 94

Parameter	Result	Units	Reporting Limit
1,1,2,2-Tetrachloroethane	ND	ppb (v/v)	100
Benzyl chloride	ND	ppb (v/v)	100
4-Ethyl toluene	ND	ppb (v/v)	100
1,3,5-Trimethylbenzene	ND	ppb (v/v)	100
1,2,4-Trimethylbenzene	ND	ppb (v/v)	100
1,3-Dichlorobenzene	ND	ppb (v/v)	100
1,4-Dichlorobenzene	ND	ppb (v/v)	100
1,2-Dichlorobenzene	ND	ppb (v/v)	100
1,2,4-Trichlorobenzene	ND	ppb (v/v)	200
Hexachlorobutadiene	ND	ppb (v/v)	200

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14

Client Name: Wenck Associates, Inc.
Client ID: EV-1
Lab ID: 104496-0003-SA
Matrix: AIR
Authorized: 17 FEB 94
Sampled: 16 FEB 94
Prepared: NA
Received: 17 FEB 94
Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit
Dichlorodifluoromethane	ND	ppb (v/v)	100
Chloromethane	ND	ppb (v/v)	200
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ppb (v/v)	100
Vinyl chloride	ND	ppb (v/v)	100
Bromomethane	ND	ppb (v/v)	100
Chloroethane	9200	ppb (v/v)	200
Trichlorofluoromethane	ND	ppb (v/v)	100
1,1-Dichloroethene	110	ppb (v/v)	100
Carbon disulfide	ND	ppb (v/v)	500
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ppb (v/v)	100
Acetone	ND	ppb (v/v)	500
Methylene chloride	ND	ppb (v/v)	100
trans-1,2-Dichloroethene	ND	ppb (v/v)	100
1,1-Dichloroethane	4000	ppb (v/v)	100
Vinyl acetate	ND	ppb (v/v)	500
cis-1,2-Dichloroethene	240	ppb (v/v)	100
2-Butanone	ND	ppb (v/v)	500
Chloroform	ND	ppb (v/v)	100
1,1,1-Trichloroethane	5900	ppb (v/v)	100
Carbon tetrachloride	ND	ppb (v/v)	100
Benzene	ND	ppb (v/v)	100
1,2-Dichloroethane	ND	ppb (v/v)	100
Trichloroethene	ND	ppb (v/v)	100
1,2-Dichloropropane	ND	ppb (v/v)	100
Bromodichloromethane	ND	ppb (v/v)	100
cis-1,3-Dichloropropene	ND	ppb (v/v)	100
4-Methyl-2-pentanone	ND	ppb (v/v)	200
Toluene	ND	ppb (v/v)	100
trans-1,3-Dichloropropene	ND	ppb (v/v)	100
1,1,2-Trichloroethane	ND	ppb (v/v)	100
Tetrachloroethene	ND	ppb (v/v)	100
2-Hexanone	ND	ppb (v/v)	200
Dibromochloromethane	ND	ppb (v/v)	100
1,2-Dibromoethane (EDB)	ND	ppb (v/v)	100
Chlorobenzene	ND	ppb (v/v)	100
Ethylbenzene	ND	ppb (v/v)	100
Xylenes (total)	ND	ppb (v/v)	100
Styrene	ND	ppb (v/v)	100
Bromoform	ND	ppb (v/v)	100

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14 (CONT.)

Client Name: Wenck Associates, Inc.
Client ID: EV-1
Lab ID: 104496-0003-SA
Matrix: AIR
Authorized: 17 FEB 94

Sampled: 16 FEB 94
Prepared: NA

Received: 17 FEB 94
Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit
1,1,2,2-Tetrachloroethane	ND	ppb (v/v)	100
Benzyl chloride	ND	ppb (v/v)	100
4-Ethyl toluene	ND	ppb (v/v)	100
1,3,5-Trimethylbenzene	ND	ppb (v/v)	100
1,2,4-Trimethylbenzene	ND	ppb (v/v)	100
1,3-Dichlorobenzene	ND	ppb (v/v)	100
1,4-Dichlorobenzene	ND	ppb (v/v)	100
1,2-Dichlorobenzene	ND	ppb (v/v)	100
1,2,4-Trichlorobenzene	ND	ppb (v/v)	200
Hexachlorobutadiene	ND	ppb (v/v)	200

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14

Client Name:	Wenck Associates, Inc.		
Client ID:	EV-1		
Lab ID:	104496-0004-SA		
Matrix:	AIR	Sampled: 16 FEB 94	Received: 17 FEB 94
Authorized:	17 FEB 94	Prepared: NA	Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit
Dichlorodifluoromethane	ND	ppb (v/v)	100
Chloromethane	ND	ppb (v/v)	200
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ppb (v/v)	100
Vinyl chloride	ND	ppb (v/v)	100
Bromomethane	ND	ppb (v/v)	100
Chloroethane	11000	ppb (v/v)	200
Trichlorofluoromethane	110	ppb (v/v)	100
1,1-Dichloroethene	130	ppb (v/v)	100
Carbon disulfide	ND	ppb (v/v)	500
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ppb (v/v)	100
Acetone	ND	ppb (v/v)	500
Methylene chloride	ND	ppb (v/v)	100
trans-1,2-Dichloroethene	ND	ppb (v/v)	100
1,1-Dichloroethane	4800	ppb (v/v)	100
Vinyl acetate	ND	ppb (v/v)	500
cis-1,2-Dichloroethene	210	ppb (v/v)	100
2-Butanone	ND	ppb (v/v)	500
Chloroform	ND	ppb (v/v)	100
1,1,1-Trichloroethane	7600	ppb (v/v)	100
Carbon tetrachloride	ND	ppb (v/v)	100
Benzene	ND	ppb (v/v)	100
1,2-Dichloroethane	ND	ppb (v/v)	100
Trichloroethene	ND	ppb (v/v)	100
1,2-Dichloropropane	ND	ppb (v/v)	100
Bromodichloromethane	ND	ppb (v/v)	100
cis-1,3-Dichloropropene	ND	ppb (v/v)	100
4-Methyl-2-pentanone	ND	ppb (v/v)	200
Toluene	ND	ppb (v/v)	100
trans-1,3-Dichloropropene	ND	ppb (v/v)	100
1,1,2-Trichloroethane	ND	ppb (v/v)	100
Tetrachloroethene	ND	ppb (v/v)	100
2-Hexanone	ND	ppb (v/v)	200
Dibromochloromethane	ND	ppb (v/v)	100
1,2-Dibromoethane (EDB)	ND	ppb (v/v)	100
Chlorobenzene	ND	ppb (v/v)	100
Ethylbenzene	ND	ppb (v/v)	100
Xylenes (total)	ND	ppb (v/v)	100
Styrene	ND	ppb (v/v)	100
Bromoform	ND	ppb (v/v)	100

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Dave Olson

Approved By: Val Mallari

Volatile Organics by GCMS - EPA TO14 (CONT.)

Client Name: Wenck Associates, Inc.
Client ID: EV-1
Lab ID: 104496-0004-SA
Matrix: AIR Sampled: 16 FEB 94 Received: 17 FEB 94
Authorized: 17 FEB 94 Prepared: NA Analyzed: 18 FEB 94

Parameter	Result	Units	Reporting Limit
1,1,2,2-Tetrachloroethane	ND	ppb (v/v)	100
Benzyl chloride	ND	ppb (v/v)	100
4-Ethyl toluene	ND	ppb (v/v)	100
1,3,5-Trimethylbenzene	ND	ppb (v/v)	100
1,2,4-Trimethylbenzene	ND	ppb (v/v)	100
1,3-Dichlorobenzene	ND	ppb (v/v)	100
1,4-Dichlorobenzene	ND	ppb (v/v)	100
1,2-Dichlorobenzene	ND	ppb (v/v)	100
1,2,4-Trichlorobenzene	ND	ppb (v/v)	200
Hexachlorobutadiene	ND	ppb (v/v)	200

ND = Not detected
NA = Not applicable

Reported By: Dave Olson Approved By: Val Mallari

QC LOT ASSIGNMENT REPORT - MS QC
Air Toxics

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK/LCS)	MS QC Run Number (SA,MS,SD,DU)
104496-0001-SA	AIR	TO-14	18 FEB 94-A1	18 FEB 94-A1	
104496-0002-SA	AIR	TO-14	18 FEB 94-A1	18 FEB 94-A1	
104496-0003-SA	AIR	TO-14	18 FEB 94-A1	18 FEB 94-A1	
104496-0004-SA	AIR	TO-14	18 FEB 94-A1	18 FEB 94-A1	

DUPLICATE CONTROL SAMPLE REPORT
Air Toxics
Project: 104496

Category: TO-14 Method TO-14 - Volatile Organics
Matrix: AIR
QC Lot: 18 FEB 94-A1
Concentration Units: ppb (v/v)

Date Analyzed: 18 FEB 94

	Concentration				Accuracy Average(%)		Precision (RPD)	
Analyte	Spiked	Measured DCS1	Measured DCS2	AVG	DCS	Limits	DCS	Limit
Methylene chloride	48.4	49.9	49.1	49.5	102	86-116	1.6	10
1,1-Dichloroethene	48.4	51.1	49.8	50.4	104	90-115	2.6	10
Trichloroethene	36.7	37.7	36.0	36.8	100	85-114	4.6	10
Toluene	48.4	52.7	51.0	51.8	107	92-114	3.3	10
1,1,2,2-Tetrachloroethane	55.5	60.1	60.5	60.3	109	76-124	0.66	10

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Air Toxics
Project: 104496

Volatile Organics by GCMS - Modified EPA TO-14

Test: TO-14-MOD-G
Matrix: AIR
QC Run: 18 FEB 94-A1

Date Analyzed: 18 FEB 94

Analyte	Result	Units	Reporting Limit
Dichlorodifluoromethane	ND	ppb (v/v)	2.0
Chloromethane	ND	ppb (v/v)	4.0
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	ppb (v/v)	2.0
Vinyl chloride	ND	ppb (v/v)	2.0
Bromomethane	ND	ppb (v/v)	2.0
Chloroethane	ND	ppb (v/v)	4.0
Trichlorofluoromethane	ND	ppb (v/v)	2.0
1,1-Dichloroethene	ND	ppb (v/v)	2.0
Carbon disulfide	ND	ppb (v/v)	10
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ppb (v/v)	2.0
Acetone	ND	ppb (v/v)	10
Methylene chloride	ND	ppb (v/v)	2.0
trans-1,2-Dichloroethene	ND	ppb (v/v)	2.0
1,1-Dichloroethane	ND	ppb (v/v)	2.0
Vinyl acetate	ND	ppb (v/v)	10
cis-1,2-Dichloroethene	ND	ppb (v/v)	2.0
2-Butanone	ND	ppb (v/v)	10
Chloroform	ND	ppb (v/v)	2.0
1,1,1-Trichloroethane	ND	ppb (v/v)	2.0
Carbon tetrachloride	ND	ppb (v/v)	2.0
Benzene	ND	ppb (v/v)	2.0
1,2-Dichloroethane	ND	ppb (v/v)	2.0
Trichloroethene	ND	ppb (v/v)	2.0
1,2-Dichloropropane	ND	ppb (v/v)	2.0
Bromodichloromethane	ND	ppb (v/v)	2.0
cis-1,3-Dichloropropene	ND	ppb (v/v)	2.0
4-Methyl-2-pentanone	ND	ppb (v/v)	4.0
Toluene	ND	ppb (v/v)	2.0
trans-1,3-Dichloropropene	ND	ppb (v/v)	2.0
1,1,2-Trichloroethane	ND	ppb (v/v)	2.0
Tetrachloroethene	ND	ppb (v/v)	2.0
2-Hexanone	ND	ppb (v/v)	4.0
Dibromochloromethane	ND	ppb (v/v)	2.0
1,2-Dibromoethane (EDB)	ND	ppb (v/v)	2.0
Chlorobenzene	ND	ppb (v/v)	2.0
Ethylbenzene	ND	ppb (v/v)	2.0
Xylenes (total)	ND	ppb (v/v)	2.0
Styrene	ND	ppb (v/v)	2.0
Bromoform	ND	ppb (v/v)	2.0
1,1,2,2-Tetrachloroethane	ND	ppb (v/v)	2.0
Benzyl chloride	ND	ppb (v/v)	2.0
4-Ethyl toluene	ND	ppb (v/v)	2.0
1,3,5-Trimethylbenzene	ND	ppb (v/v)	2.0
1,2,4-Trimethylbenzene	ND	ppb (v/v)	2.0
1,3-Dichlorobenzene	ND	ppb (v/v)	2.0

ND = Not Detected

Enseco
A Corning Company

CHAIN OF CUSTODY RECORD

E i5-A

☐ 2544 Industrial Ave., West Sacramento, CA. 95691-3435 (916) 372-1393
☐ 7440 Lincoln Way, Garden Grove, CA. 92641-1432 (714) 898-6370
☐ 18501 East Gale Ave., City of Industry, CA. 91748-1321 (818) 965-1006
☐ Mobile Labs, 1 (800) ENSECO-8

DATE: 2-16-94
CHAIN OF CUSTODY NUMBER: 13436
LAB NUMBER: 104496
Page 1 of 1

CLIENT: Terrington
ADDRESS: 3702 W. Samplex St
CITY: South Bend
STATE: IN
ZIP CODE: 46619
PROJECT NAME: Terrington Pilot Test
CONTRACT/PURCHASE ORDER/QUOTE NO.:
PROJECT MANAGER: Chris Mosentine
TELEPHONE NUMBER (AREA CODE): 612 479 4200
SITE CONTACT: Mike Ozer
TELEPHONE NUMBER (AREA CODE): 616 776-9066

ANALYSES

SAMPLE NO./IDENTIFICATION	DATE	TIME	LAB/SAMPLE NUMBER	SAMPLE TYPE LIQ.	SAMPLE TYPE AIR	SAMPLE TYPE SOLID	NO. OF CON-TAINERS	Call Chris Mosentine (Project Manager)	EPA TO-14 mod						Sample Condition/ REMARKS
Soil Vac Sample Port	2/15	3:58			X		1	✓	X						
EV-1	2/15	6pm			X		1	✓	X						
EV-1	2/16	10:50 AM			X		1	✓	X						
EV-1	2/16	4pm			X		1	✓	X						

DO THE SAMPLE(S) POSE ANY POTENTIAL HAZARD(S)? IF YES, PLEASE EXPLAIN

SAMPLERS (SIGNATURE)	RELINQUISHED BY (SIGNATURE)	RELINQUISHED BY (SIGNATURE)	DATE 2/16/94	TIME 4:26
RECEIVED BY (SIGNATURE)	DATE / TIME	RECEIVED BY (SIGNATURE)	DATE	TIME
RECEIVED FOR LABORATORY BY	RECEIVED DATE 2/17/94 TIME 0930	ACCEPTED	DATE	TIME

METHOD OF SHIPMENT

SPECIAL INSTRUCTIONS: Method confirmed by Chris Mosentine 2-17-94 per 10:00am

The delivery of samples and the signature on this chain of custody form constitutes authorization to perform the analyses specified above under the **Enseco** Terms and Conditions, unless a contract or purchase order has been executed and is sited above.

SAMPLE DESPOSITION:
1. Storage time requested: ________ days (Samples will be stored for thirty (30) days without additional charge; thereafter storage charges will be billed at the published rates.)
2. Sample to be returned to client: ☐ Yes ☐ No (**Enseco** will dispose of unreturned samples for a charge of $15.00. Disposal will be by incineration wherever possible; otherwise, as appropriate, according to legal requirements.)

DISTRIBUTION: WHITE - With Report; CANARY - To ENSECO; PINK - To Courier; GOLDENROD - To Sample Control

1105

Appendix D

Air Emissions Calculation

Air emissions for the extraction system were calculated to insure the Air Permit Exemption discharge rate was not being exceeded. This calculation was based on the following assumptions:

- The extraction system operated continuously
- The extraction flow rate is 20 scfm
- The off-gas VOC concentration is 24 ppm (approximately the same concentration as measured during the 17 scfm test)
- The weighted average VOC molecular weight is

Compound	Molecular Weight	Off-gas Concentration	Percent Off-gas Calculation *	Relative Molecular Weight in Off-gas
1,1,1-trichloroethane	133.4	7.6 ppm	32%	43
1,1-dichloroethane	99.0	4.8 ppm	20%	20
Chloroethane	64.5	11.0 ppm	46%	30
Others (not included in calculation)		0.4 ppm	2%	
			Weighted Average =	93 grams/molecular

* Total Off-gas concentration is 24 ppm

The mass discharge concentration of the air stream is calculated from the following:

$$\text{Cair} \bullet \text{Dair} \bullet M_c \div \text{Mair} \qquad (1)$$

Where:

Cair = Concentration of contaminants in air in parts per million (24 ppm)

Dair = Density of air (1.19 kg/m^3)

M_c = Molecular weight of contaminants (93 grams/mole)

Mair = Molecular weight of air (29 grams/mole)

Substituting into equation 1 yields the following:

$$24 \text{ mg/kg} \bullet 1.19 \text{ kg/m}^3 \bullet 93 \text{ g/mole} \div 29 \text{ g/mole} = 92 \text{ mg/m}^3$$

This discharge rate is computed with the following formula:

$$\text{Discharge Rate} = \text{Cm} \bullet \text{F} \qquad (2)$$

Where:

Cm = Mass discharge concentration (from equation 1) = 92 mg/m^3

F = Flow rate = 20 scfm = 0.57 $\text{m}^3\text{/min}$

Substituting into equation (2) and converting units yields

$$92\ \text{mg/m}^3 \bullet 0.57\ \text{m}^3\text{/min} \bullet 1\ \text{lb/454g} \bullet 1\text{g/1000mg} \bullet 1440\text{min/day} = 0.167\ \text{lbs/day}$$