


Weiss Associates
Environmental and Geologic Services

6500 Shellmound Street, Emeryville, CA 94608-2411

FAX: 510-547-6043 Phone: 510-450-6000

TRANSMITTAL

DATE: May 7, 1996

PROJECT #: 4-1129-70

TO: Amy Leeb

COMPANY: Alameda County Health Care Services Agency

FAX #: (510) 337-9335

FROM: Tim Utterback, (510) 450-6193

ENCLOSED PLEASE FIND: Soil Vapor Sampling Information for Former Chevron Service Station, 9-5607,
5269 Crow Canyon Road, Castro Valley, California

VIA:

- Fax
 1st Class Mail
 Overnight Delivery
 UPS (Surface)
 Courier

FAX:

of pages: 20
 (including this cover)
 Hard Copy to follow

AS:

- Per our phone call
 You requested
 Is required
 We believe you may
 be interested

FOR:

- Your information
 Return to you
 Your action
 Your review &
 comments

Please call (510) 450-6000 if there are any problems with transmission.

COMMENTS:

Dear Amy,

Attached are the materials you requested to clarify our approach to collecting soil vapor samples at the above referenced site. Included are a FAX copy of the Gregg Drilling soil vapor sampling tools, a soil vapor sampling report prepared by Stephen Vander Harr PHD, Weiss Associates, for Lawrence Livermore National Laboratory Site 300 and a sketch of soil vapor sampling configuration options (Figure 1). I intend to use the soil vapor sampling tools as shown in the fax from Gregg Drilling except for using a syringe (shown on page 3.4) to collect the vapor. I prefer to use a TEE to simplify sample collection and avoid possible needle sticks (Figure 1). I also want to make this change because accidental injection (via syringe) of a gas into the bloodstream can cause heart failure and death.

Please review the soil vapor sampling report prepared by Stephen Vander Harr PHD. Stephen has offered to help me with this project. Please call Stephen at (510) 450-6167 or myself at (510) 450-6193 if you have any additional questions about our vapor sampling technique.

FAX CONFIDENTIALITY NOTICE

The information contained in this transmission is confidential and only intended for the addressee. If you are not the intended recipient, you are hereby notified that any disclosure, copying, distribution or action taken in reliance on the contents of this facsimile transmittal is strictly prohibited. If you have received this facsimile in error, please call us immediately to arrange for the return of these documents.

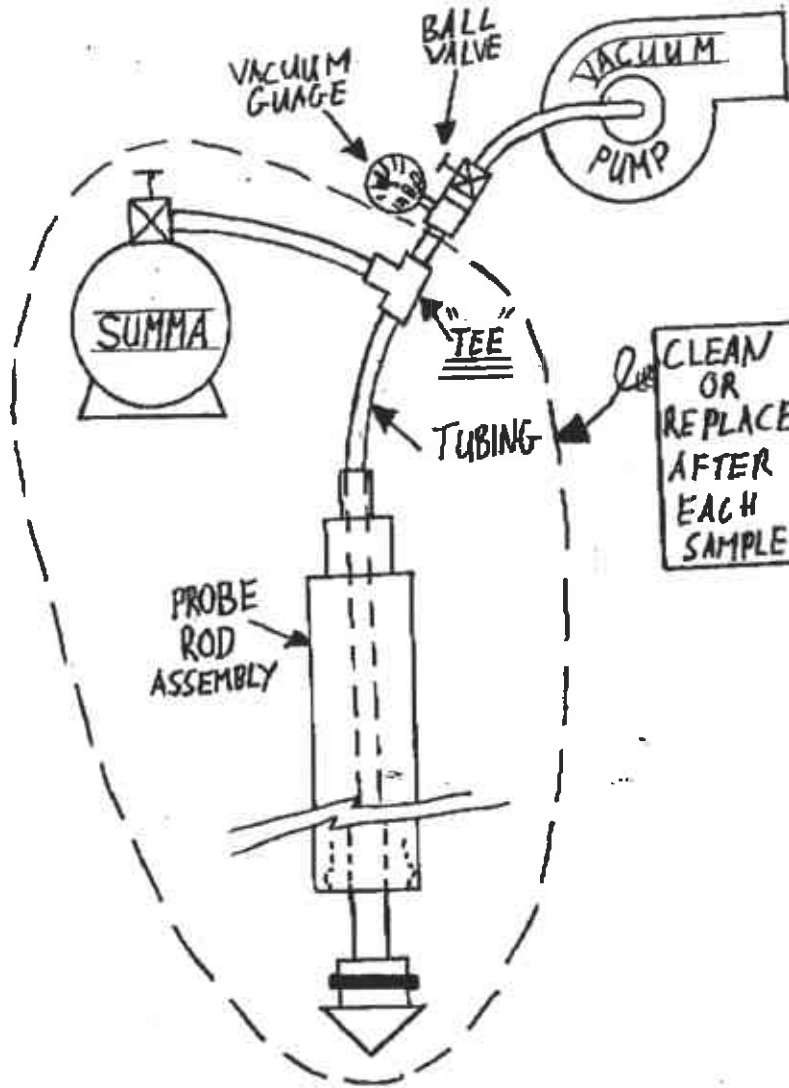
1:CGREND0111FAC20WEP0.DWG 05/07/96 13:06

FIGURE 1

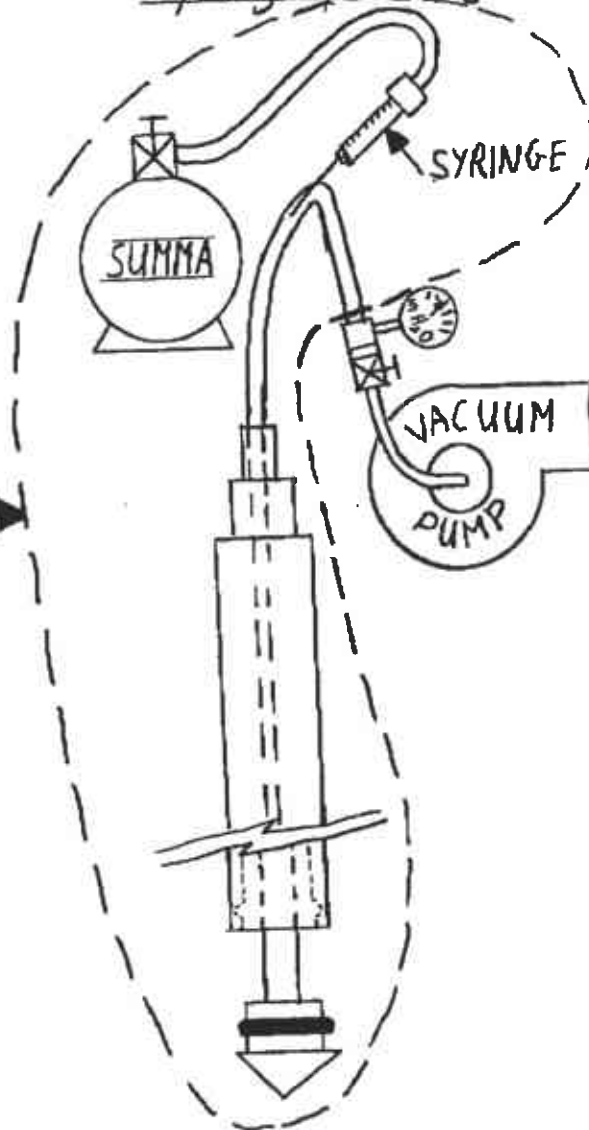
SOIL VAPOR SAMPLING CONFIGURATIONS



Preferred Configuration



Syringe Configuration





GREGG DRILLING & TESTING, INC.

SPECIALIZING IN CONTAMINANT SAMPLING AND MONITORING WELL INSTALLATIONS

Transmittal Form

FAX # 547-5043

of pages
Including cover page: 6

DATE: MARCH 29, 1996

TO: MIKE COOK

FROM: CHRIS CHRISTENSEN

COMMENTS:

WE USE THE PRT SYSTEM WITH A
RETRACTABLE PRINT SHOWN ON
PAGE 3.6.

Mail

Fax

Federal Express

SOUTHERN CALIFORNIA: 2475 CERRITOS AVENUE • SIGNAL HILL, CA 90808 • (310) 427-8888 • FAX (310) 427-3314
NORTHERN CALIFORNIA: 850 HOWE ROAD • MARTINEZ, CA 94553 • (510) 313-5800 • FAX (510) 313-0302

VAPOR SAMPLING TOOLS - PRT System - Introduction

The Post-Run Tubing System

An Inner Tubing System inserted AFTER the probe rods have been driven to depth...

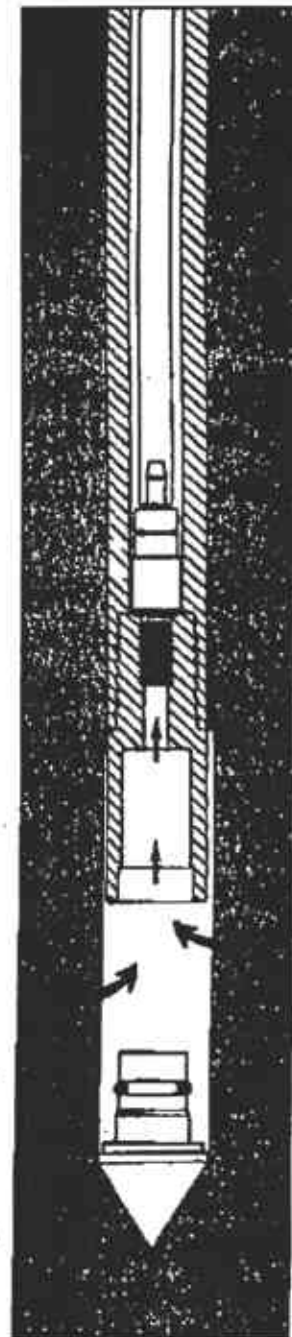
- Increases speed and accuracy of soil gas sampling.
- Eliminates problems associated with rod leakage and sample carryover.
- Reduces probe rod decontamination time.
- Utilizes simple design for ease of use and vacuum-tight sealing.
- Requires no management of inner tubing during probing.

The Post-Run Tubing System (PRT) allows the user to collect soil vapor samples quickly and easily at the desired sampling depth WITHOUT the usual time-consuming complications associated with rod leakage and contamination. O-ring connections enable the PRT system to deliver a vacuum-tight seal that prevents sample contamination from UP hole and assures that the sample is taken from the desired depth at the BOTTOM of the hole. The sample is drawn through the point holder, through the adapter, and into the sample tubing. The tubing can be replaced after each sample, thus eliminating sample carryover problems and the need to decontaminate the probe rods. The resulting time-savings translates into a higher productivity rate for you and your client.



◀ The PRT system inserted into the probe rods and connected to Geoprobe's Vacuum/Volume System.

A cross-section of the PRT System showing how soil gas (arrows) is drawn through the inner tubing system. ▶



VAPOR SAMPLING TOOLS - PRT System - Operation

Basics

Using the Post-Run Tubing (PRT) System, one can drive probe rods to the desired sampling depth, then insert and seal an internal tubing for soil gas sampling. The usual Geoprobe probe rods and driving accessories with the following tools are required:

- PRT Expendable Point Holder (IMPORTANT: PR-13B replaces AT-13B)
- PRT Adapter
- Selected PRT Tubing

Preparation

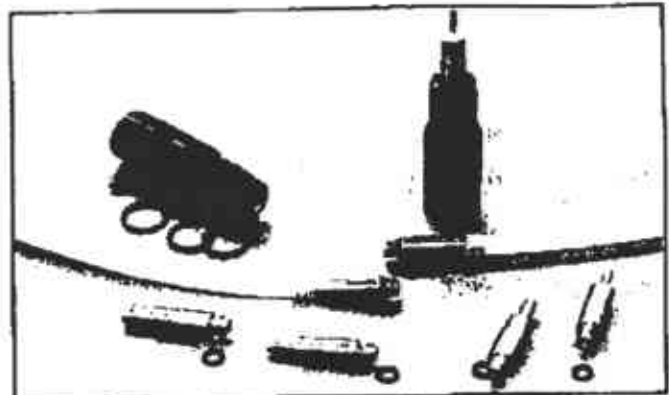
1. Clean all parts prior to use. Install O-rings on the PR-13B and the PRT adapter.
2. Inspect the probe rods and clear them of all obstructions.
3. TEST FIT the adapter with the PRT fitting on the expendable point holder to assure that the threads are compatible and fit together smoothly. NOTE: Fittings are left-hand threaded.
4. Push the adapter into the end of the selected tubing. Tape may be used on the outside of the adapter and tubing to prevent the tubing from spinning freely around the adapter during connection - especially when using teflon tubing. (Figure 1.)

Probing

Drive the PRT tip configuration into the ground. Connect probe rods as necessary to reach the desired depth. After depth has been reached, disengage the expendable point by pulling up on the probe rods. Remove the pull cap from the top probe rod, and position the Geoprobe unit to allow room to work.

Connection

1. Insert the adapter end of the tubing down the inside diameter of the probe rods. (Figure 2.)
2. Feed the tubing down the hole until it hits bottom on the expendable point holder. Allow about 2 ft. of tubing to extend out of the hole before cutting it.
3. Grasp the excess tubing and apply some downward pressure while turning it in a counter-clockwise motion to engage the adapter threads with the expendable point holder. (Figure 3.)
4. Pull up lightly on the tubing to test engagement of the threads. (Failure of adapter to thread could mean that intrusion of soil may have occurred during driving of probe rods or disengagement of drive point.)



PRT SYSTEM PARTS
PRT Expendable Point Holder, PRT Adapters, Tubing, and O-rings.



Figure 1. Securing adapter to tubing with tape. NOTE: Tape does not contact vapor sample.



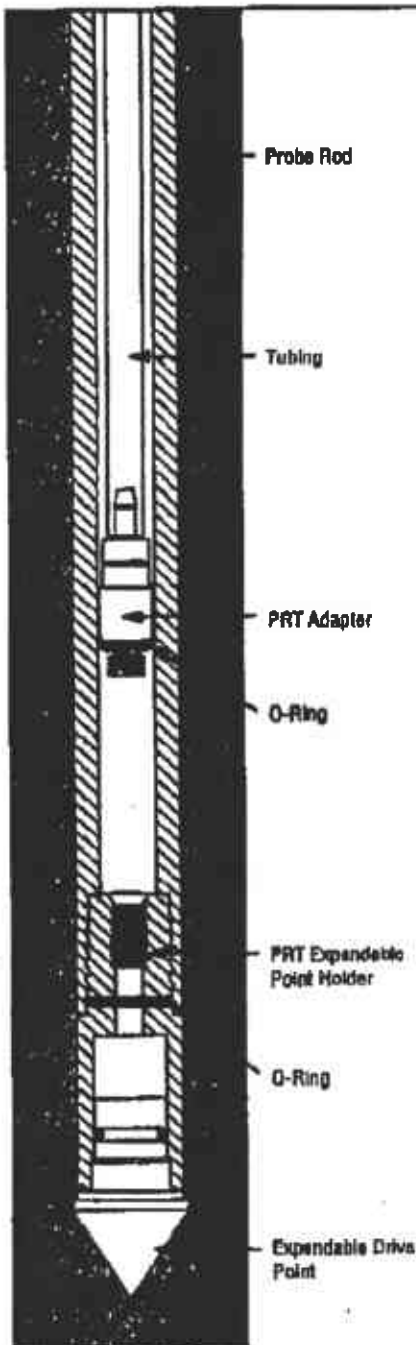
Figure 2. Insertion of tubing and PRT adapter.



Figure 3. Engaging threads by rotating tubing.

Geoprobe Systems

VAPOR SAMPLING TOOLS - PRT System - Operation



A cross-sectional view of probe rods driven to depth and then retracted to allow for soil vapor sampling. The PRT adapter and tubing are now fed through the rods and rotated to form a vacuum-tight connection at the point holder. The result is a continuous run of tubing from the sample level to the surface.



Figure 4. Taking a soil gas sample for direct injection into a GC with the PRT system.



Figure 5. Visual inspection of the PRT adapter/point holder connection. O-ring must be compressed for seal.

Sampling

1. Connect the outer end of the tubing to silicone tubing and vacuum hose (or other sampling apparatus).
2. Follow the appropriate sampling procedure for collecting a soil gas sample. (Figure 4.)

Removal

1. After collecting a sample, disconnect the tubing from the vacuum hose or sampling system.
2. Pull up firmly on the tubing until it releases from the adapter at the bottom of the hole. (Taped tubing requires a stronger pull.)
3. Remove the tubing from the probe rods. Dispose of polyethylene tubing or decontaminate teflon tubing as protocol dictates.
4. Retrieve the probe rods from the ground and recover the expendable point holder with the attached PRT adapter.
5. Inspect the o-ring at the base of the PRT adapter to verify that proper sealing was achieved during sampling. The o-ring should be compressed. (Figure 5.) This seal can be tested by capping the open end of the point holder applying vacuum to the PRT adapter.
6. Prepare for the next sample.

VAPOR SAMPLING TOOLS - PRT System - Parts

POST-RUN TUBING SYSTEM PARTS LIST					
TUBING SIZE			PART NUMBER	INTERNAL VOLUME mL/FT	ADAPTER
LD POLYETHYLENE*					
O.D.	I.D.	WALL			
1/4	.170	.040	TB-17L	4.48	PR-17S
3/8	1/4	.080	TB-25L	9.65	PR-25S

*Available in 500 ft. length only

TEFLON (TPE)*			NUMBER	VOLUME	ADAPTER
O.D.	I.D.	WALL			
1/4	1/8	.060	TB-12T	2.41	PR-12B
1/4	3/16	.030	TB-17T	5.43	PR-17S
3/8	5/16	.030	TB-30T	16.06	PR-30S

*Available in 50 ft. length only.

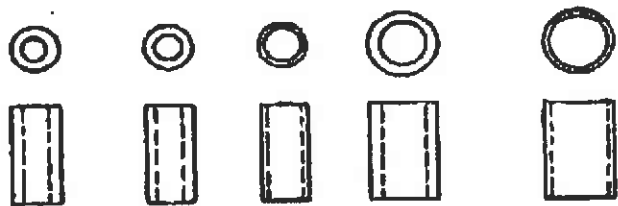
PRT EXPENDABLE POINT HOLDER	PR-13B
PRT POINT HOLDER O-RINGS (package of 25)	PR-13R
PRT RETRACTABLE POINT HOLDER*	PR-21B
PRT ADAPTER O-RINGS (package of 25)	PR-25R

Important: PR-12B replaces AT-13B

*Retractable Point Holder Only, Retractable Point (AT-21B) is sold separately.

Note: The sorption characteristics of certain tubings may not permit their applications in all circumstances.

Tubing



TB-12T

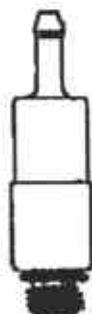
TB-17L

TB-17T

TB-25L

TB-30T

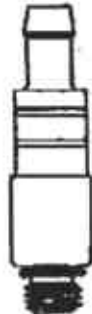
Adapters



PR-12B



PR-17S



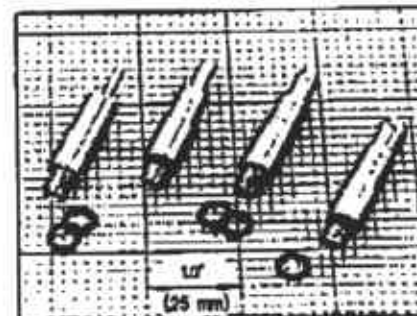
PR-25S



PR-30S



500 Foot Roll of TB-17L.



PRT Adapters, O-rings.

Geoprobe Systems

03/29/96 12:14 (REPRINTED) INSTANTI 510 547 5043
 03/29/96 12:13 GREGORILLING-INSTIU 510 547 5043
 NO. 822 005

Final Site-Wide Remedial Investigation Report Lawrence Livermore National Laboratory Site 300

Chapter 9 Building 833 Study Area

C. P. Webster-Scholten
Editor

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April 1994

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Environmental Restoration Division

1994

UCRL-AR-108131

*Site-Wide Remedial Investigation***9-2.4.6. Well Abandonment**

To date, no wells have been sealed or abandoned in the Building 833 study area. No former water-supply wells exist in the study area. Methods of well abandonment at Site 300 are described in Appendix A.

9-2.5. Geophysical Investigations

Geophysical investigations have been conducted in portions of the study area. These surface and borehole investigations are described below.

9-2.5.1. Borehole Geophysics

In the study area, electromagnetic induction, natural gamma, spontaneous potential, caliper, single point resistance, normal resistivity, and neutron logging have been conducted on selected boreholes and monitor wells. A borehole video camera was also used at monitor well W-833-30. The methodologies and techniques used for borehole geophysics are described in Appendix A and listed in Table 9-4.

9-2.5.2. Surface Geophysics

In April 1991, Underground Location Services conducted a survey at Site 300 to locate buried metal objects at three earthen pits south of Building 833 (Fig. 9-6). Numerous passes were made of each pit using metal and cable locators and other equipment (Webster-Scholten *et al.*, 1991). The equipment is designed to detect very small metal objects buried near the surface, medium-sized metal objects buried within a few feet of the surface, and larger objects (such as 55-gal drums) buried less than 10 ft from the surface (Bradley, 1991). Other techniques for surface geophysics investigations are described in Appendix A.

9-2.6. Soil Vapor Survey (SVS) Techniques

Two types of SVSs have been used in the Building 833 study area to characterize the extent of contaminants in soil vapor: active vacuum induced (AVI) SVS and passive SVS (Appendix I). The purpose of these studies has been to:

- Screen and define areas for further investigation,
- Provide information on the possible source(s) of TCE and similar VOCs previously detected in the soil and ground water, and
- Help determine the extent of contaminants in the soil and ground water.

9-2.6.1. Active Vacuum Induced (AVI) SVS

Three phases of AVI SVSs have been conducted in the study area. Details of these investigations are described below and in Appendix A.

1989—AVI Phases 1 and 2

In the first phase, 24 AVI SVS points were drilled and sampled in the vicinity of Building 833; the second phase consisted of 13 additional AVI SVS points at Building 833

(Taffet *et al.*, 1989; Lamarre, 1989). A trailer-mounted, auger drill rig was used to drill the 2-in.-diam AVI SVS boreholes.

Details of the methodology used for sampling, analytical techniques, and results and interpretations are described in Vonder Haar *et al.* (1989, 1991), Lamarre (1989), and Appendix A.

1991—AVI Phase 3

During the third phase, a portable Photovac GC/PID was used. A total of 105 AVI SVS points were installed in the vicinity of Building 833. The equipment was operated in a field laboratory set up in Building 833. The field laboratory provided more stable operating conditions for the Photovac GC/PID and allowed for vapor samples to be analyzed shortly after sample collection. A hand-held electric hammer drill was used to drill the soil-vapor boreholes.

The sampling methodology, analytical techniques, and results and interpretations are described in detail in Vonder Haar *et al.* (1989, 1991), Lamarre (1989), and Appendix A.

9-2.6.2. Passive SVS

During May 1990, a total of 51 passive SVS collectors were installed in the vicinity of Buildings 833, 835, and 836. At Building 833 proper, the suspected source area, additional SVS collectors were installed for greater resolution. During early 1991, 56 passive SVS collectors were installed in the vicinity of Buildings 833, 835, and 836 as part of an RI at Building 833 (Webster-Scholten *et al.*, 1991). The integration period for the 1991 SVS averaged 18 days for the passive SVS survey at Building 833.

The passive SVS method is well established and has been used primarily for petroleum exploration, but it is being used increasingly at sites having hazardous VOCs (Vonder Haar *et al.*, 1991). In addition, the passive SVS collectors provided easy access to steep slopes where the AVI SVS equipment could not be operated. The methodology used for sampling and analytical techniques for passive SVSs in the study area are described in detail in Vonder Haar *et al.* (1989, 1991), Lamarre (1989), and Appendix A.

For the Building 833 study area, mapping of the relative ion count data from the passive SVS was accomplished after determining appropriate contour intervals for each compound or component class. To establish the contour intervals, factors such as ion count distribution, physicochemical considerations, and compound-source material relationships, if known, were considered for each compound or class in a study area (Vonder Haar *et al.*, 1991). A computer was used to determine the ion counts of indicator peaks for the specified compounds of interest. The techniques for relative ion count determination and mapping are described in Vonder Haar *et al.* (1991) and Appendix A.

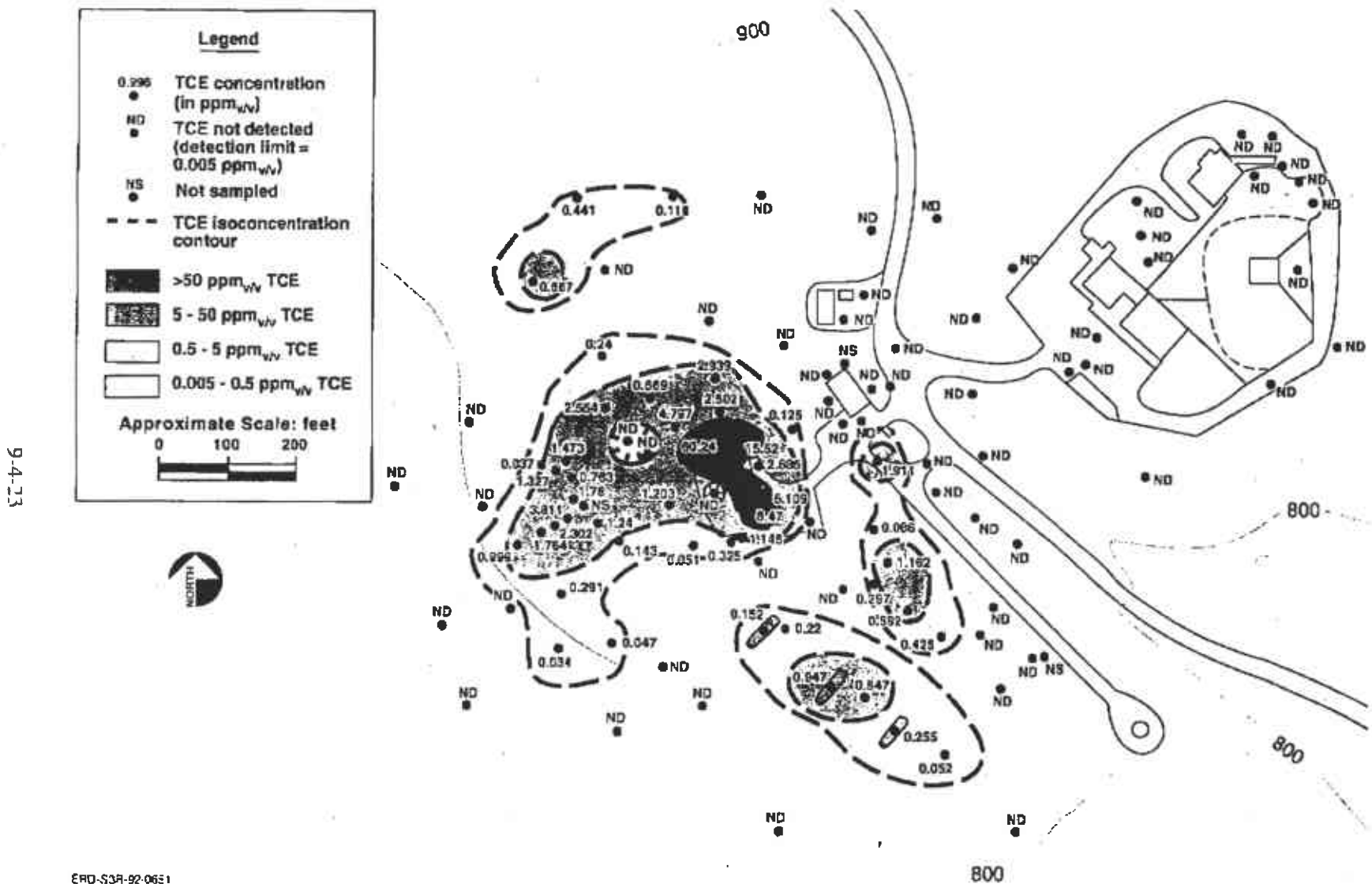
9-2.7. Excavations

No exploratory trenches or excavations were performed in the Building 833 study area. However, southeast of Building 833, three nearly identical earthen pits were identified. The three pits were constructed prior to July 1961 and are oriented southwest to northeast (Fig. 9-6) (Webster-Scholten *et al.*, 1991). No records exist that define the purpose of the excavations. All

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9-4-23

ERD-S3A-92-0631

Figure 9-35. Concentrations of TCE using AVI SVS (in ppm_{v/v}) in the Building 833 study area.

Final Site-Wide Remedial Investigation Report Lawrence Livermore National Laboratory Site 300

Appendices A-F

C. P. Webster-Scholten
Editor

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April 1994

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Environmental Restoration Division

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A-1.2.2.5. Dipole-Dipole Resistivity Survey

The main consideration in designing a dipole-dipole resistivity survey is that detectable differences in electrical properties exist between contaminants and ground water or between different geologic units. Prior to surveying, additional considerations include locating artificial electrical sources such as buried utilities or pipelines in the area.

Dipole-dipole resistivity surveys consist of current and voltage dipoles that can be used to measure variations in subsurface electrical properties with depth. An electrical current is conducted through the ground between two current electrodes separated by a fixed distance x . The subsurface distribution of this current is measured by voltage electrodes that are placed at multiple distances of x away from the current electrodes. Data are presented in the form of a pseudosection as shown in Figure A-35. The pseudosection is a representation of the subsurface distribution of electrical properties along a vertical plane beneath the area surveyed.

A-1.2.2.5.1. Application. Dipole-dipole resistivity surveys are designed to measure variations in subsurface electrical properties with depth. The pseudosections produced from the dipole-dipole resistivity survey were integrated with data on geology and terrain conductivity to evaluate the hydrologic conditions beneath the landfill pits.

A-1.2.2.5.2. Objectives. The main objective of the dipole-dipole resistivity survey was to evaluate the subsurface geology and determine the depth and geometry of the saturated zone beneath landfill pits 2 and 7. An additional objective was to check for evidence of possible ground water contamination beneath the pits.

A-1.2.2.5.3. Instrumentation. A Scintrex IPC-7 2.5-kW transmitter and IPR-8 receiver were used with steel electrodes separated by 66 ft.

A-1.2.2.5.4. Survey Design. Dipole-dipole resistivity data were obtained along two perpendicular lines at pits 2 and 7. At each pit, a 1,200-ft line was oriented parallel to the strike of bedding (i.e., N55W), and measurements were obtained every 55 ft. A second line was oriented parallel to the dip direction, and measurements were also obtained every 55 ft. These surveys were designed to investigate to an approximate depth of 40 ft in the subsurface.

A-1.2.2.5.5. Interpretation. The interpretation of dipole-dipole electrical surveys as an iterative process involves computing electrical resistivity models such as the one shown in Figure A-36 and comparing these models to measured resistivity pseudosections until a reasonable match is achieved. The models are computed assuming that the survey line is perpendicular to structure and that the surface of the survey is flat. Because these solutions are not unique, it was necessary to constrain each model with available geologic data. Additional information about the interpretation of surface electrical surveys conducted at Site 300 is presented in Raber and Carpenter (1983).

A-1.3. Soil Vapor Survey (SVS) Techniques for VOCs

From October 1988 to October 1991, we conducted SVSs at various locations at Site 300, on adjacent portions of the Connolly and Gallo Ranches, and the downstream Corral Hollow Creek Area. Two SVS methods were used: (1) active vacuum induced (AVI), and (2) passive Petrex. The purpose of these studies was two-fold:

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- To provide information on the possible source(s) of TCE and similar VOCs detected in the soil and ground water at or near these areas; and
- To help determine the extent of VOCs in the soil and ground water.

Discussions of the methodology and theory, sampling and analytical techniques, and results of some of these investigations are presented in Vonder Haar *et al.* (1989, 1991) and Lamarre (1989c).

A-1.3.1. AVI SVS Technique

In this section, we describe the procedures associated with the AVI SVS method.

A-1.3.1.1. Pre-1991 AVI SVS Field Procedures

To collect soil-vapor samples, we drilled boreholes (2-in. diam) using a trailer-mounted Giddings Probe auger drilling rig. First, the boreholes were drilled to within 1.5 to 2 ft of the desired sampling depth (typically 5 to 10 ft). We then tipped a 5/8-in. diameter, hollow, stainless steel rod with a 2-in. slotted aluminum drive point and threaded an appropriate length of Teflon tubing into the drive point. The tubing exited the rod at the top. Then the rod was hydraulically driven 1.5 to 2 ft beyond the depth of the drilled hole. The drilled and sampling depths were then recorded in field notes. When we encountered hard subsurface materials, the sampling rod was driven as far as possible. The annular space was then backfilled with cuttings to seal the borehole prior to obtaining a vapor sample. We then lifted the rod 2 in. to expose the slots in the drive point to the soil. The Teflon tubing was sealed at the top of the rod using a threaded shaft and Teflon tape to prevent intrusion of surface air into the sampling system.

We connected a constant-flow sample pump to the Teflon sampling tube. We operated the pump for approximately 5 min to purge the tubing and draw soil vapor into the system. When hard subsurface materials were encountered, the sampling period was reduced to 1 to 2 min, long enough to purge the tubing and draw a soil-vapor sample. This procedure prevented us from drawing surface air into the system in the event a proper subsurface seal had not been obtained.

Then, using a clean, gas-tight, glass syringe, a 0.5 mL sample of the soil-vapor was collected through a silicone tubing segment of the pumping system and injected directly into a Photovac GC mounted in a van. We collected the sample between the rod exit port and the pump to eliminate possible residual contamination in the pump.

A-1.3.1.2. Dedicated AVI SVS Monitoring Points

In 1989 and 1990, during the SVSs at the GSA and Building 834, we installed several dedicated AVI SVS monitoring points. They were designed to enable *in situ* monitoring of long-term trends in soil-vapor concentrations near suspected release sites during pilot vapor extraction studies.

To install the dedicated points, we placed the Teflon vapor sampling tube at the proper depth. The surface end was cleaned, plugged with a Luer-lock locking plug, and covered with a plastic bag to keep debris from falling into the tubing. We filled the bottom 6 in. of the borehole with #0 Monterey fine sand. Then, we placed 6 in. of bentonite pellets on top of the sand.

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Subsequently, we used a 5% bentonite and 95% Portland cement grout mixture to fill the remainder of the borehole to within 1 ft of the surface (Fig. A-37).

We removed soil around the borehole to approximately 1 ft below grade to allow for the placement of a short length of threaded, 5-in. o.d. PVC casing with threaded cap, and a protective Christy box. When the casing was cemented in place, soil between it and the Christy box was left uncovered to allow for drainage from inside the box. After we installed the Christy box, the Luer-lock plugs on the end of the Teflon sampling tubes were replaced with Luer-lock gas valves. The threaded PVC caps were installed on the protective casings to prevent water from entering the enclosed Teflon sampling tube.

A-1.3.1.3. 1991 AVI Drilling and Vapor Sampling

A hand-held electric hammer drill was used to drill the soil-vapor boreholes. Vacuum extraction was conducted by driving a 6-ft, tapered hollow rod approximately 5 ft below grade. We tipped each rod with a 2-in. slotted aluminum drive point and threaded an 8- to 9-ft length of Teflon tubing into the drive point, which exited the rod at the top. After driving the rod 5 ft into the ground, we raised the rod 2 in. to release the drive point and to expose the slotted shaft to the soil. The Teflon tubing was sealed at the top of the rod, using a threaded shaft and Teflon tape to prevent intrusion of surface air into the sample. The end of the Teflon tubing was connected to a desiccator, which was connected to a vacuum pump set at 5 in. of Hg (low vacuum). Prior to sample collection, the line was purged for 5 min to remove air from the tubing and the rod. Once the system was purged, we placed a Tedlar bag in the desiccator with the sample line inserted into the bag using a syringe needle (Yale hypodermic 26G1-LNR, regular bevel). The maximum flow rate through the needle was approximately 200 mL/min. The resultant vacuum in the desiccator pulled the soil-vapor sample into the Tedlar bag by creating a pressure gradient.

A-1.3.1.4. AVI SVS Analytical Procedures

We used two procedures to analyze the AVI vapor samples: (1) samples analyzed solely for TCE were run on a Photovac portable GC, and (2) samples analyzed for the full suite of EPA Method 8010 compounds were analyzed using a mobile laboratory. The results of the soil-vapor analyses are listed in Appendix I.

A-1.3.1.4.1. Pre-1991 Photovac Portable GC Analyses. The Photovac portable GC was equipped with a capillary column and photoionization detector (PID). Prior to field work, we conducted trial analyses to estimate a detection limit of TCE at about 0.005 ppm_{v/v}.¹ To calibrate the GC at the start of each day, we used a commercially prepared and certified standard ($\pm 2\%$ traceable to National Bureau of Standards) of TCE at 9.970 ppm_{v/v} in nitrogen. This standard was also used at intervals during the day if ambient temperature changed significantly. To correct for possible system drift and provide consistent results, this concentration was used for the initial GC/PID daily calibration and again after 3 or 4 hr, or more frequently under variable temperature conditions.

The area of the GC peak for the TCE standard was recorded in volt-seconds and was stored in the memory of the microprocessor in the Photovac GC/PID. This value was used to calculate subsequent sample concentrations until the next calibration. The TCE value for each sample was

¹ Note: One ppm_{v/v} = one ppm mole/mole.

automatically calculated and printed out on the chromatogram by the GC/PID. Other compounds detected by the GC/PID translated as peaks on the chromatograms, and were reported as unknowns. The volt-second response of the TCE identified in any sample was also used to manually calculate the TCE concentration as an additional check. Any concentration of TCE measured in the syringe blank prior to sampling was subtracted from the sample concentration before reporting.

A-1.3.1.4.2. 1991 AVI GC Analysis. During 1991, we conducted an additional phase of AVI SVS at the Building 833 Area and HE Process Area using a portable Photovac GC/PID. This equipment was operated in a field laboratory set up in a building. The field laboratory provided more stable operating conditions for the Photovac GC/PID and allowed for vapor samples to be analyzed within 10–50 min after sample collection.

After collection, each sample was immediately transported to a nearby building and analyzed using the Photovac GC (Model 10S70) equipped with a capillary column and a PID. Samples were manually injected using a Hamilton 0.5-mL gas-tight syringe. The detection limit of the GC/PID was estimated for TCE to be approximately 0.005 ppm_{v/v} (Vonder Haar *et al.*, 1989).

Table A-10 lists the QA/QC analytical procedures used to produce consistent system performance and to ensure no cross contamination between samples or sites.

Through a series of tests, we determined that a soil-vapor sample could remain in the 1-L Tedlar Bag for approximately 6 to 7 hr before affecting its concentration by 1% (using TCE Calibration Standard at 10.8 ppm). We also determined that a low vacuum (5 in. of Hg) produced a more representative sample than a high vacuum (20 in. of Hg). In addition, we conducted a test for optimizing the vacuum extraction technique. Initially, a battery-operated personal air-sampling pump was used to draw samples. However, we found residual TCE in a zero air sample run through the sampler; the presence of this residual indicated that the pump was not suitable because TCE was probably adhering to the diaphragm.

A-1.3.1.4.3. Mobile Laboratory GC Analyses. During a portion of the SVS, we used a mobile laboratory equipped with a Hewlett-Packard GC and a Hall electroconductivity detector. This equipment permitted the identification of a spectrum of VOCs by a modified EPA Method 8010. We also used commercially available Supelco EPA Method 601 standards. The sample volume, collected in the syringe and injected into the GC, ranged from 0.5 to 30 mL depending on the vapor concentrations present.

While operating the mobile laboratory GC, we used standardized procedures to quantify the concentration of chemicals in the soil vapor. Using a single point external calibration, we compared the detector response to the sample with the response measured for the calibration standard. In general, equipment calibrations have shown that a detector response for each compound analyzed is linear and passes through the origin.

For the mobile laboratory GC process, the QA/QC procedures were similar to those performed for the GC Photovac system. Table A-10 summarizes these procedures.

A-1.3.2. Passive Petrex Soil Vapor Technique

In this section, we describe the procedures associated with the passive Petrex SVS method.

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Table A-10. AVI soil vapor field analytic procedures.

Field laboratory procedures for 1991	Mobile laboratory GC procedures
1. The Photovac GC/PID was operated by the same technician for every analysis.	1. The analytical system was calibrated each day with a gas standard prepared in a Tedlar bag.
2. Baselines were established and checked daily on the Photovac GC/PID.	2. A calibration check was conducted at the end of each day to evaluate system precision and detector response drift.
3. Zero air was used to analyze for the potential presence of residual TCE in the syringes. The syringes were used throughout the day for calibration and periodic sample runs.	3. Blanks were run through the chromatographic system each morning to ensure that the system was clean.
4. The Photovac GC/PID was calibrated using a high-quality calibration gas standard.	4. Syringes were checked for contamination by injecting analyte-free air into the chromatographic system.
5. Calibration was set and checked four to five times daily.	5. Prior to sampling each day, a sampling system blank was run by sampling ambient air drawn through a soil-vapor point, Teflon tubing, and metal probe.
6. Each sample analysis consisted of two to four replicates, using the appropriate sensitivity that would provide a sufficient peak on the chromatogram.	
7. Syringe tightness was checked daily using TCE calibration standards and comparison with other syringes.	
8. Tedlar bags were re-used only if testing yielded reproducible ND results after being flushed three to six times with zero air.	
9. The air flow was set at approximately 10 mL/min and was continuously monitored.	
10. Oven temperatures within the GC were maintained at 40°C.	
11. The septum of the manual injection port was replaced daily, and all flow lines were checked for leakage.	
12. All data values were determined by the size of the peak, the sensitivity of the GC/PID, and the consistency of the replicates per sample.	
13. Data were recorded on data sheets, with each sheet corresponding to an entry in the log book (designated PA) for soil-vapor sampling at Site 300. Chromatographs were affixed into the log book to provide a documented hardcopy of real-time results.	

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Table A-10. (Continued)

Field laboratory procedures for 1991	Mobile laboratory GC procedures
14. All points (with one exception) were sampled at a depth of 5 ft below grade to normalize the analytical results.	
15. The steel sampling rods were cleaned between sites with hot water and detergent.	
16. New aluminum tips, Teflon tubing, and silicone tubing were used at each sampling point.	
17. Fresh, clean sampling syringes were used for each soil-vapor sample.	
18. Syringe blanks were run on each syringe prior to sampling.	
19. Daily system blanks were used to check for possible TCE carry-over between samples.	
20. The GC system was calibrated according to the TCE standard discussed earlier.	
21. A PID was used to screen for high concentrations that required dilution.	
22. A duplicate sample was used if the first result was questionable.	