

PERMIT ATTACHMENT 3: SOIL-GAS SAMPLING AND ANALYSIS PLAN

3.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) provides requirements that shall be adhered to for collecting and analyzing volatile organic compound (VOC) soil-gas samples from soil-gas monitoring wells located at the Chemical Waste Landfill (CWL) during the post-closure care period.

Soil-gas monitoring is designed to provide spatial and temporal soil-gas concentration data for the approximately 500-foot-thick vadose zone beneath the former liquid organic disposal areas (southern portion of the inactive CWL) and to utilize existing vapor extraction/injection wells.

3.1. PURPOSE

The post-closure care soil-gas monitoring program is designed to provide data to determine if soil vapor has the potential to contaminate groundwater. Soil-gas monitoring shall be conducted in conjunction with groundwater monitoring to accomplish this objective. In addition to establishing data quality objectives (DQOs), this SAP presents requirements for field sampling, laboratory analysis, data validation and evaluation, and reporting. The VOC soil-gas trigger level is described in Section 1.8.2 of Attachment 1 to this Permit.

3.2. HISTORICAL SOIL-GAS MONITORING

Historical soil-gas sampling involved the pneumatic extraction of discrete volumes of soil gas resident within pore spaces of the vadose zone immediately surrounding in situ sampling devices at specified locations and depths. After sample collection, the soil gas was analyzed using on-site (field) and off-site (fixed-base) laboratories to determine the presence and magnitude of VOC contaminants. Specific field and laboratory procedures were followed in an effort to produce representative, defensible, and comparable results. These results were used to delineate concentration trends over time for each sampling location and to delineate overall soil-gas plume trends. This SAP is designed to ensure that post-closure care soil-gas monitoring procedures are consistent with past practices and to ensure that soil-gas monitoring data obtained pursuant to the requirements of this Permit are of high quality. Soil-gas data will be used to evaluate whether the VOC soil-gas plume has a significant potential to contaminate groundwater.

3.3. POST-CLOSURE CARE SOIL-GAS MONITORING OBJECTIVES

Soil-gas monitoring is required to detect whether there has been any significant expansion and/or increase in concentration of the soil-gas plume to the extent that human health and the environment will be adversely impacted. The main concern is that trichloroethene (TCE) could exceed the regulatory standard for groundwater (5 micrograms per liter) as a result of the transfer of TCE mass from the soil-gas phase to groundwater. Therefore, the primary focus of soil-gas monitoring is to determine the concentration trends of TCE vapor in the vadose zone capillary fringe (approximately 10 to 20 feet above the water table based upon the deepest soil-gas sampling ports). The soil-gas monitoring program shall also provide VOC data from various depth intervals that will be used to track the concentrations of constituent contaminants in the VOC plume.

3.4. DATA QUALITY OBJECTIVES

Appropriate sampling locations, depths, number of samples collected per event, and sampling frequency are required to ensure that the data are representative of site conditions and meet the objectives of this SAP. The main Data Quality Objective (DQO) is to produce representative, accurate, defensible, and comparable soil-gas analytical results. This SAP is designed to ensure that post-closure care soil-gas monitoring procedures meet the DQO. The DQO shall be accomplished by implementing standard field methods, analytical procedures/methods, and data validation and evaluation protocols consistent with the historic soil-gas monitoring program.

3.5. SAMPLING LOCATIONS AND FREQUENCY

3.5.1. Sample Locations

Soil-gas data shall be collected from within the plume core and at various distances laterally and vertically from the core. Figure 4 shows the configuration of the plume based upon the data set collected in September 2004. The monitoring network shall include five wells equipped with a total of 21 depth-specific sampling ports specifically designed for soil-gas monitoring. Well completion diagrams are presented in Section 3 of this Permit Attachment. The five wells and associated depth-specific sampling ports are listed in Table 3-1 and shown in Figure 10. Well construction diagrams are provided in Appendix 3-1 of Attachment 3. The five soil-gas monitoring wells are spatially located to monitor the area of the vadose zone most affected by past disposal of organic liquid waste. The deepest sampling ports from wells CWL-D1 through D3 (Port 1 in each of these wells) are located in the vadose zone immediately above the capillary fringe zone and water table.

3.5.2. Frequency

Soil-gas sampling shall be conducted annually during the post-closure care period. All sampling locations shown in Table 3-1 and Figure 10 shall be sampled.

3.6. DATA ACCURACY

The Permittees shall follow proper sampling procedures, including purging, preparation of sampling containers, and use of quality assurance/quality control (QA/QC) samples. Accurate estimates of contaminant concentrations shall be obtained through use of qualified laboratories, appropriate analytical methods, and effective QA/QC procedures.

A range in deviation from actual (true) concentration of 50-130% (percent recovered or %REC) for each detected VOC shall be considered acceptable.

At least two duplicate samples shall be collected and analyzed during each sampling event. A relative percent difference (RPD) of 20% or less for each detected VOC is considered to be acceptable. The Permittees shall immediately repeat the sampling and analysis for any sample results where the above specified quality control targets (%REC and RPD) are not met.

**TABLE 3-1
 Soil-Gas Monitoring Ports to be Sampled During CWL Post-Closure Care**

In Situ Monitoring Port	Depth (ft bgs)
Well CWL-UI1	
Port P1	120
Port P2	80
Port P3	40
Well CWL-UI2	
Port P1	136
Port P2	76
Port P3	36
Well CWL-D1	
Port P1 ^a	470
Port P2	350
Port P3	240
Port P4	160
Port P5	100
Well CWL-D2	
Port P1 ^a	470
Port P2	440
Port P3	350
Port P4	240
Port P5	120
Well CWL-D3	
Port P1 ^a	480
Port P2	440
Port P3	350
Port P4	170
Port P5	120

^aOnly sampling ports subject to the VOC soil-gas trigger level as described in Section 1.8.2 of Permit Attachment 1.

ft = Foot (feet).
 PCCP = Post-Closure Care Permit.

3.7. DATA CONSISTENCY AND COMPARABILITY

Future soil-gas monitoring results must be comparable with historic VOC soil-gas data sets. The Permittees shall maintain consistency in methods and procedures by conducting sampling and analysis:

- Using consistent field sample collection and management methods;
- Using an off-site contract laboratory that complies with the Facility's Sample Management Office (SMO) analytical laboratory statement of work (SOW) and meeting U.S. Environmental Protection Agency (EPA) standards for quality assurance and quality control (QA/QC);
- Using soil-gas analytical method EPA Compendium Method TO-14 (EPA January 1999); and
- Using the soil-gas analytical data review and validation procedure in Administrative Operating Procedure (AOP) 00-03.

After soil-gas analytical results are received from the laboratory, the Permittees shall review the laboratory report for completeness and conformance to the performance criteria, and arrange for data validation. If problems are noted that require corrective action during these verification and validation reviews, corrective action shall be implemented. The scope of the data verification and validation process shall address field sample management and custody requirements, as well as adherence to QA/QC requirements by the off-site laboratory performing the analyses. These processes are discussed in more detail in Section 3.10 of this Permit Attachment.

3.8. MONITORING ACTIVITIES

This section describes the field and laboratory procedures that shall be followed to produce soil-gas analytical results that meet the requirements of this Permit.

3.9. FIELD SAMPLING

The methods and procedures used to obtain soil-gas samples for laboratory analysis are described below in Sections 3.9.1 through 3.9.3. Additional measurements beyond those described in this SAP may be obtained to support evaluation of the soil-gas plume.

Activities that shall be conducted by the Permittees in preparation for or during soil-gas sampling include:

- Pre-field work planning;
- Vacuum check of SUMMA[®] canisters;
- Visual inspection of all CWL soil-gas wells and sampling ports;
- Purging and field estimation of total VOC concentration;
- Sample acquisition;
- Sample container documentation and packaging; and
- Sample delivery to laboratory within the method holding time.

The Facility Operating Procedures for these activities, as well as SMO procedures, guidance, and laboratory procedures that apply to the post-closure care soil-gas monitoring program are listed in Table 3-2 and this Permit. All personnel directly involved in field activities related to soil-gas monitoring shall review and abide by these procedures.

The Permittees shall provide to the New Mexico Environment Department (the Department) within sixty (60) days of the effective date of this Permit in hard copy and electronic format the current versions of the FOPs and AOPs listed in Table 3-2. The Permittees shall provide the Department with any updated versions of the FOPs/AOPs within 30 days of their acceptance by the Permittees. If any requirement or procedure in the FOPs or AOPs is found by the Department to be unacceptable for reasons including, but not limited to, the requirement or procedure will or could prevent the acquisition of representative and reliable soil-gas sampling results, the requirement or procedure shall be replaced by the Permittees with a different requirement or procedure that is acceptable to the Department. The requirements of this SAP take precedence over those of any FOP or AOPs listed in Table 3-2.

**TABLE 3-2
 Reference Documentation
 CWL Post-Closure Care Soil-Gas Monitoring^a**

FOP or AOP	Title
FOP 94-28	Health and Safety Monitoring of Organic Vapors (FID and PID)
ASSOP 01-04	Activity Specific Standard Operating Procedure For Active Soil-Gas Sampling Using Method TO-14 at the Corrective Action Management Unit and Former CWL
AOP 95-16	Sample Management and Custody
AOP 00-03	Data Validation Procedure for Chemical and Radiochemical Data
LOP 94-03	Sample Handling, Packaging, and Shipping
SMO 05-03	Procedure for Completing the Contract Verification Review
NA	SNL/NM SOW for Analytical Laboratories
NA	Quality Assurance Project Plan for the Sample Management Office

^aSandia National Lab's Documents (procedures/documents will be used as revised and updated):

- ASSOP = Activity-Specific Standard Operating Procedure.
- FID = Flame Ionization Detector.
- NA = Not applicable.
- PID = Photoionization Detector.

3.9.1. Pre-Field Sampling Preparations

Prior to initiating soil-gas sampling, field personnel shall ensure that all necessary equipment is ready and properly functioning in accordance with applicable FOPs and this Permit and that the necessary arrangements have been made with the SMO and off-site analytical laboratory for sample shipment and analysis. As appropriate, operating procedures shall be reviewed and support personnel notified.

3.9.2. Purging and Field Estimation of Total Concentration of VOCs

At the wellhead, a vacuum pump connected to the sample tubing via a Swagelok[®] or equivalent fitting shall be used to purge stagnant and/or pre-existing soil gas from the monitoring ports and sample tubing. The stream of soil gas extracted from the sampling port shall be screened with a photoionization detector (PID) containing an ultraviolet lamp with an ionization potential of 11.8 electron volts. PID measurements shall be monitored during purging and recorded in the field book

or on a sampling form. Sample collection shall commence only after at least 30 minutes of purging has taken place and after at least three PID measurements have stabilized to within plus or minus 10 percent.

3.9.3. Sample Collection

Soil-gas samples shall be collected in 6-liter SUMMA[®] canisters for off-site laboratory analysis of VOCs by EPA Compendium Method TO-14 (EPA January 1999). The SUMMA[®] canisters shall be shipped from the laboratory under vacuum and connected directly to the sampling ports by Swagelok[®] fittings or equivalents. Soil gas shall be drawn into the sample container by the pressure differential between the atmosphere and the container interior. After sample collection, the valve shall be closed, and the canister shall be shipped back to the laboratory with an analysis request/chain-of-custody form containing the sample identification number, sample location, date and time, elevation, and ambient pressure. Field sample management shall follow AOP 95-16 and the requirements of this Permit. A plug Swagelok[®] or equivalent fitting shall be fastened to the canister opening to ensure that the canister remains airtight during shipment to the laboratory. The canisters require no special preservation during transport and storage.

3.10. LABORATORY ANALYSIS AND DATA REVIEW

All samples shall be submitted to an off-site analytical laboratory. The samples shall be analyzed using EPA Compendium Method TO-14 (EPA January 1999). The Permittees shall ensure that the off-site laboratory implements the requirements of the method, including analytical method, target analytes for quantification, and internal QA/QC procedures. The target analytes are listed in Table 3-3.

3.10.1. Data Verification

After soil-gas analytical results are received from the laboratory, the Permittees shall review the laboratory report for completeness and conformance to the performance criteria of the contract according to the "Procedure for Completing the Contract Verification Review," SMO 05-03 and the requirements of this Permit. If problems are noted that require corrective action, the appropriate corrective action shall be implemented.

3.10.2. Data Validation

After the data verification review is completed, the Permittees shall arrange for the validation of the data. The data validation process shall address field sample management and custody requirements, as well as adherence to the analytical method and internal laboratory QA/QC requirements by the off-site laboratory performing the analyses. Data qualification is based upon review of field QC data, laboratory-supplied QC data, the specific QC criteria, and the DQOs identified in the EPA Compendium Method TO-14 procedure (EPA January 1999), the DQO in Section 3.4 of this Permit Attachment and the requirements of this Permit. Data validation shall be conducted according to the requirements of this Permit and AOP 00-03, "Data Validation Procedure for Chemical and Radiochemical Data." All associated data validation reports shall be submitted to the Department along with the results for each monitoring event.

TABLE 3-3
EPA Compendium Method TO-14 Analyte List^a
CWL Post-Closure Care

Compound	Compound
Acetone	Dichloropropane, 1,2-
Benzene	Dichloropropene, cis-1,3-
Benzyl chloride	Dichloropropene, trans-1,3-
Bromodichloromethane	Ethyl benzene
Bromoform	Ethyltoluene, 4-
Bromomethane	Hexachlorobutadiene
Butanone, 2-	Hexanone, 2-
Carbon disulfide	Methylene chloride
Carbon tetrachloride	Pentanone, 4-methyl-, 2-
Chlorobenzene	Styrene
Chloroethane	Tetrachloroethane, 1,1,2,2-
Chloroform	Tetrachloroethene
Chloromethane	Toluene
Dibromochloromethane	Trichloro-1,2,2-trifluoroethane, 1,1,2-
Dibromoethane, 1,2-	Trichlorobenzene, 1,2,4-
Dichloro-1,1,2,2-tetrafluoroethane, 1,2-	Trichloroethane, 1,1,1-
Dichlorobenzene, 1,2-	Trichloroethane, 1,1,2-
Dichlorobenzene, 1,3-	Trichloroethene
Dichlorobenzene, 1,4-	Trichlorofluoromethane
Dichlorodifluoromethane	Trimethylbenzene, 1,2,4-
Dichloroethane, 1,1-	Trimethylbenzene, 1,3,5-
Dichloroethane, 1,2-	Vinyl acetate
Dichloroethene, 1,1-	Vinyl chloride
Dichloroethene, cis-1,2-	Xylene, m-, p-
Dichloroethene, trans-1,2-	Xylene, o-

^aEPA, January 1999.

3.11. DATA MANAGEMENT AND REPORTING

The following activities comprise data management and reporting tasks, and shall be conducted by the Permittees:

- Program-side QA/QC;
- Technical evaluation; and
- Reporting

Program-side QA/QC involves ensuring QA/QC measures are being implemented across the soil-gas monitoring program according to this SAP and this Permit, including field and laboratory methods, protocol, and procedures. Technical evaluation and reporting activities shall be initiated after data validation is completed.

The following specific data evaluation and reporting steps shall be followed and documented as part of the annual post-closure care report for soil-gas monitoring. Data interpretation and evaluation shall follow the procedures outlined below.

1. Add results (VOC soil-gas concentrations) to existing tabulated summaries in EXCEL and WORD (or equivalent) file formats;
2. Perform an assessment of each data point for reasonableness and comparability against historical data and trends;
3. Add the data to the appropriate graphical charts in EXCEL (or equivalent) format to illustrate concentration versus time trends for specified monitoring ports;
4. Compare detected VOC concentrations for the deepest sampling ports (Port 1) of CWL-D1 through D3 to the trigger level of 20 ppmv using the procedure discussed in Section 1.8.2.2 of Permit Attachment 1;
5. Provide a brief summary discussion of the soil-gas plume trend(s);
6. Provide a summary of the groundwater sampling results as they may relate to the soil-gas results; and
7. Plot selected soil-gas concentrations (e.g., TCE) on a site map and/or profiles to show spatial relationships both laterally and vertically.

3.12. RECORDS MANAGEMENT

Records associated with soil-gas monitoring include this Permit and SAP, personnel training, field documentation, laboratory analytical results, data validation reports, and post-closure care reports and technical data evaluations. These records shall be maintained at the Facility's Environmental Safety & Health and Security Records Center and comply with the record-keeping provisions of 40 C.F.R. § 264.74, concerning the availability, retention, and disposition of records.

3.13. REFERENCES

Kieling, J.E. (New Mexico Environment Department), December 2003. Letter to K.L. Boardman (U.S. Department of Energy) and P.B. Davies (Sandia Corporation), "Chemical Waste Landfill, Corrective Measures Study, May 2003, Sandia National Laboratories NM5890110518, HWB SNL-03-013." December 12, 2003.

- Sandia National Laboratories/New Mexico (SNL/NM), December 2004. "Chemical Waste Landfill Corrective Measures Study Report," Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), December 2003. "Administrative Operating Procedure for Sample Management and Custody," AOP 95-16, Revision 01, Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), March 2003. "SNL/NM Statement of Work for Analytical Laboratories, Revision 2," Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), December 2003. "Data Validation Procedure for Chemical and Radiochemical Data," AOP 00-03, Revision 01, Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM) December 2003. "Quality Assurance Project Plan (QAPP) for the Sample Management Office," Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM) December 2003. "Procedure for Completing the Contract Verification Review," SMO 05-03, Sample Management Office, Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), December 2003. "Sample Handling, Packaging, and Shipping," Sample Management Office (SMO) LOP 94-03, Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), November 2001. "Activity-Specific Standard Operating Procedure for Active Soil-Gas Sampling Using Method TO-14 at the Corrective Action Management Unit (CAMU)," SNL/NM ASSOP 01-04, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.
- Sandia National Laboratories/New Mexico (SNL/NM), May 2000. "Chemical Waste Landfill Vapor Extraction Voluntary Corrective Measures Final Report," Sandia National Laboratories, Albuquerque, New Mexico.
- U. S. Environmental Protection Agency (EPA) January 1999. "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-14A," Center for Environmental Research Information, Office of Research and Development, US EPA, Cincinnati, Ohio.

APPENDIX 3-1 of PERMIT ATTACHMENT 3

CWL SOIL-GAS MONITORING WELL NETWORK

WELL CONSTRUCTION DIAGRAMS

Boring ID: UI-1

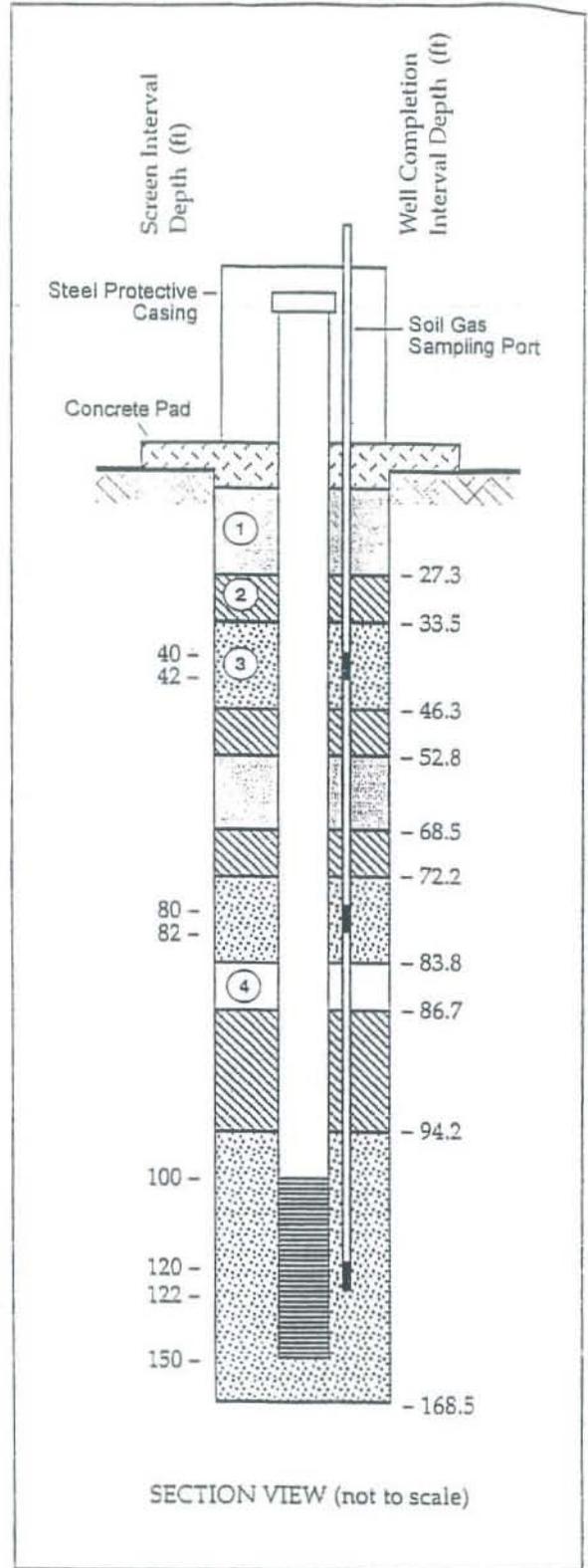
Installation Date: January 23, 1997

Dimensions:

Total Boring Depth	168.5 ft
Well Casing Diameter	5 in
Total Well Length	150 ft
Well Screen Length	50 ft
Upper Annular Seal Thickness	27.3 ft

Materials Data:

Well Casing	8"-diameter Schedule 80 PVC
Sanitary Seal	① Bentonite grout
Annular Seal	② Granular bentonite
Sand Pack	③ 10/20 Sand; 40/60 sand at top of each filter pack
	④ Formation Material
	Soil Gas Sampling Port



**Extraction Well UI-1 Construction Diagram
Chemical Waste Landfill, Sandia National Laboratories/New Mexico**

Boring ID: UI-2

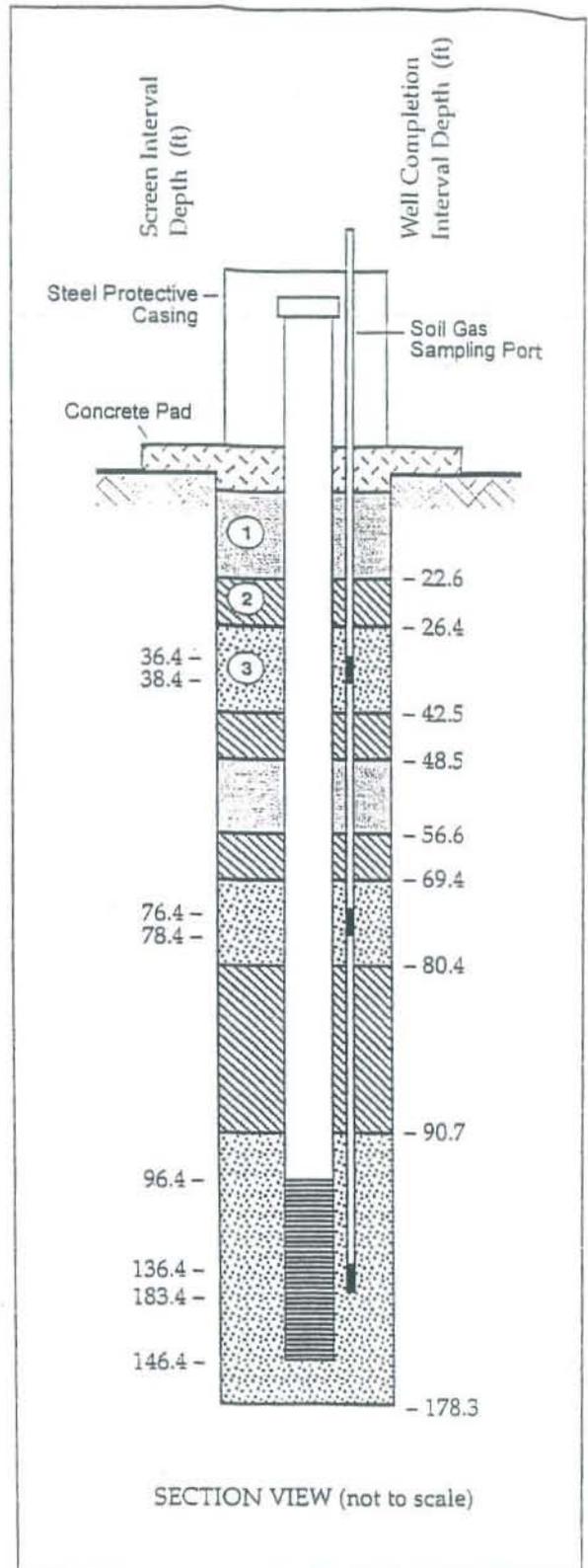
Installation Date: December 18, 1996

Dimensions:

Total Boring Depth	178.3 ft
Well Casing Diameter	5 in
Total Well Length	146.4 ft
Well Screen Length	50 ft
Upper Annular Seal Thickness	22.6 ft

Materials Data:

Well Casing	5 in. I.D. Schedule 80 PVC
Sanitary Seal	① Bentonite pellets
Annular Seal	② Granular bentonite
Sand Pack	③ 10/20 Sand; 40/60 sand at top of each filter pack
	┃ Soil Gas Sampling Port



Extraction Well UI-2 Construction Diagram
Chemical Waste Landfill, Sandia National Laboratories/New Mexico

Boring ID: D-1

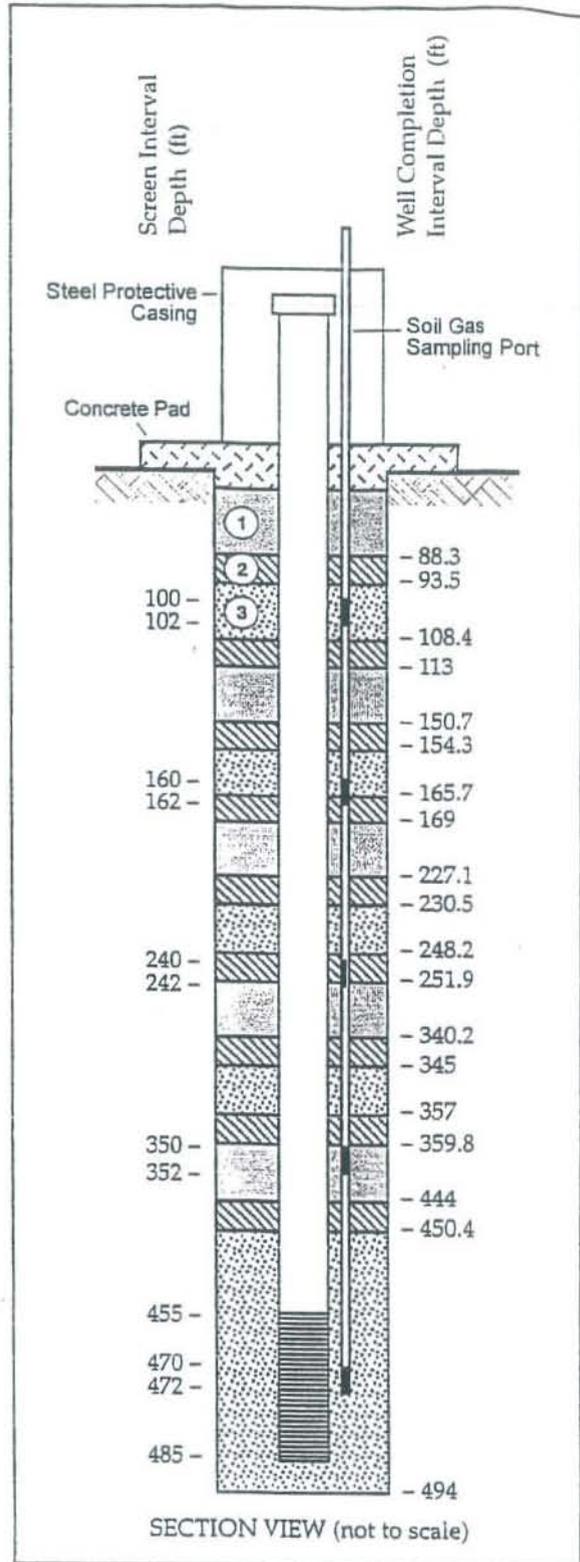
Installation Date: January 16, 1997

Dimensions:

Total Boring Depth	494 ft
Well Casing Diameter	5 in
Total Well Length	485 ft
Well Screen Length	30 ft
Upper Annular Seal Thickness	88.3 ft

Materials Data:

Well Casing	5 in. I.D. Schedule 80 PVC
Sanitary Seal	① Bentonite grout
Annular Seal	② Granular bentonite
Sand Pack	③ 10/20 Sand; 30/70 sand at top of each filter pack
	▮ Soil Gas Sampling Port



Extraction Well D-1 Construction Diagram
Chemical Waste Landfill, Sandia National Laboratories/New Mexico

Boring ID: D-2

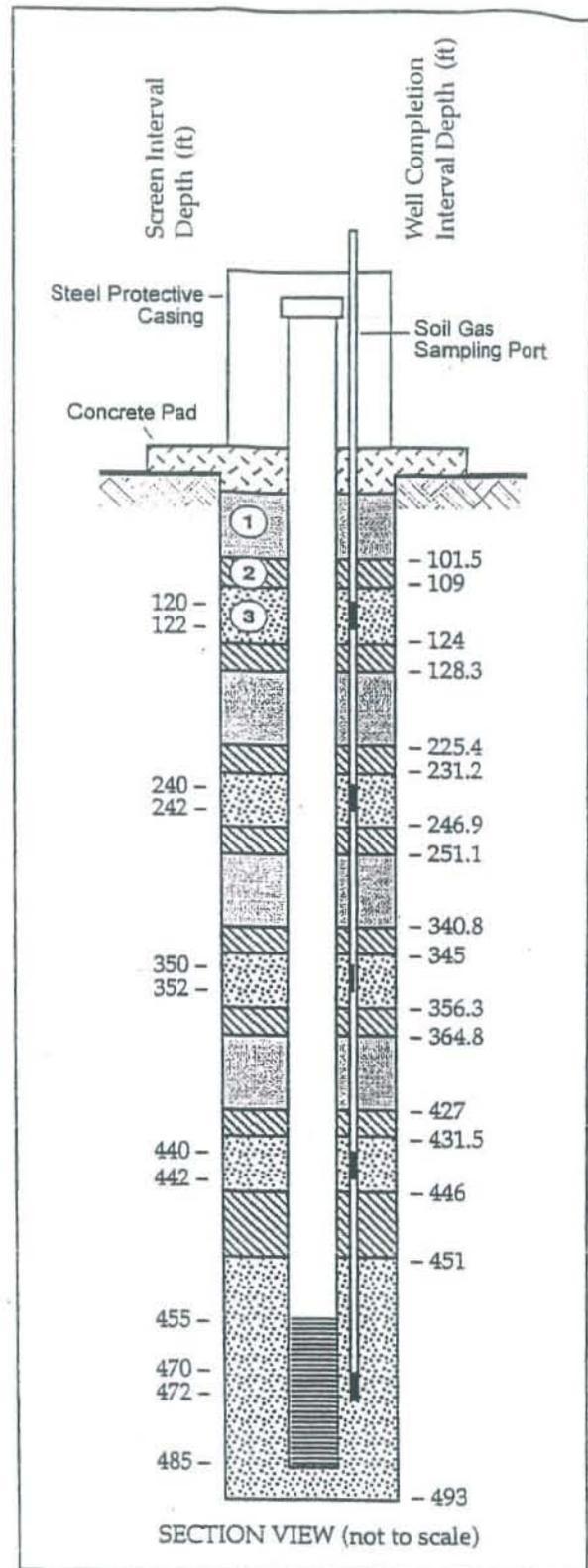
Installation Date: December 10, 1996

Dimensions:

Total Boring Depth	493 ft
Well Casing Diameter	5 in
Total Well Length	485 ft
Well Screen Length	30 ft
Upper Annular Seal Thickness	101.5 ft

Materials Data:

Well Casing	5 in. I.D. Schedule 80 PVC
Sanitary Seal	① Bentonite grout
Annular Seal	② Granular bentonite
Sand Pack	③ 10/20 Sand; 30/60 sand at top of each filter pack
	┃ Soil Gas Sampling Port



Extraction Well D-2 Construction Diagram
Chemical Waste Landfill, Sandia National Laboratories/New Mexico

Boring ID: D-3

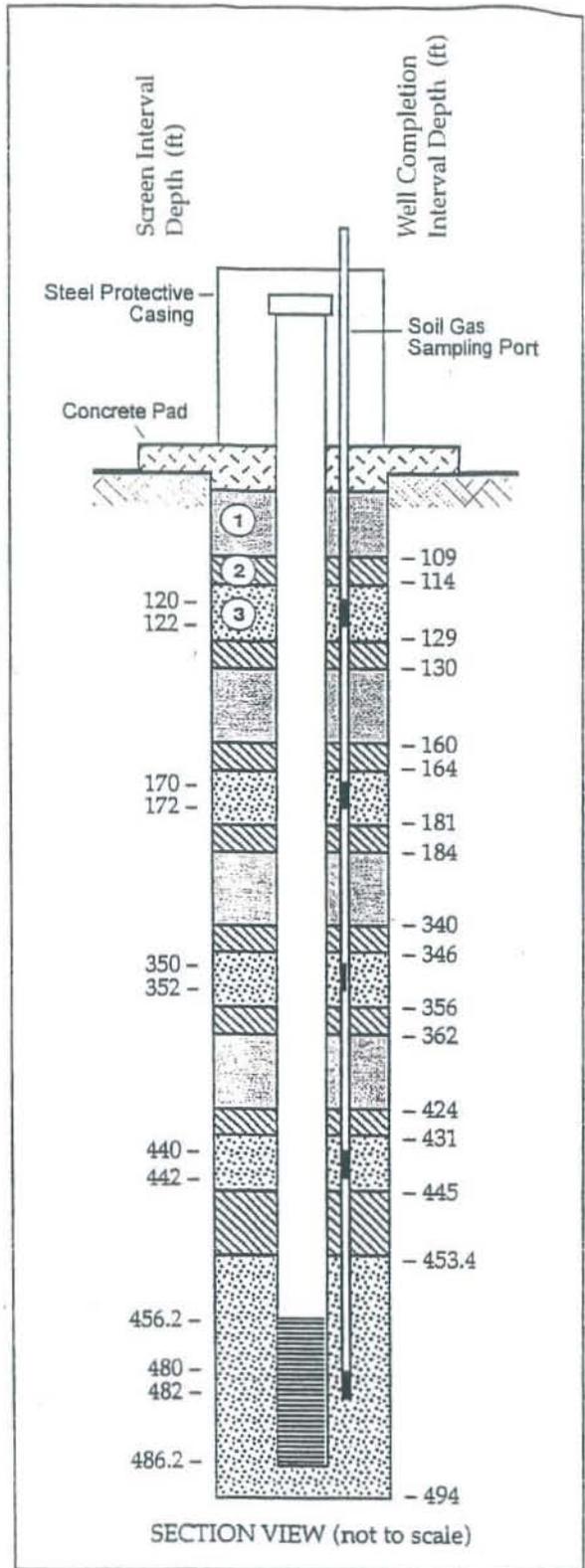
Installation Date: November 12, 1996

Dimensions:

Total Boring Depth	494 ft
Well Casing Diameter	5 in
Total Well Length	486.2 ft
Well Screen Length	30 ft
Upper Annular Seal Thickness	109 ft

Materials Data:

Well Casing	5 in. I.D. Schedule 80 PVC
Sanitary Seal	① Bentonite grout
Annular Seal	② Granular bentonite
Sand Pack	③ 10/20 Sand; 30/60 sand at top of each filter pack
	┃ Soil Gas Sampling Port



Extraction Well D-3 Construction Diagram
Chemical Waste Landfill, Sandia National Laboratories/New Mexico