APPENDIX A

Sampling and Analysis Plan for Soil Gas Volatile Organic Compounds, Tritium, and Radon at the Mixed Waste Landfill

SANDIA NATIONAL LABORATORIES/NEW MEXICO

DECEMBER 2006

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Acronyms and Abbreviations

AOP	Administrative Operating Procedure
bgs	below ground surface
DQO	data quality objective
EB	equipment blank
FOP	field operating procedure
GC/MS	gas chromatograph/mass spectrometer
MWL	Mixed Waste Landfill
NMED	New Mexico Environment Department
pCi/m2/s	picocuries per meter squared per second
PID	photoionization detector
ppm	part(s) per million
QA/QC	quality assurance/quality control
SAP	sampling and analysis plan
SMO	Sample Management Office
SNL/NM	Sandia National Laboratories/New Mexico
SOW	Statement of work
TBD	to be determined
VOCs	volatile organic compounds

1.0 *Executive Summary*

The Mixed Waste Landfill (MWL) is located in the north-central part of Sandia National Laboratories/New Mexico (SNL/NM) Technical Area III. Soil gas volatile organic compound (VOC) and tritium sampling was conducted at the MWL in 1993 and 1994 during a Phase 2 RCRA Investigation, but no recent data regarding VOC concentrations in soil gas and tritium in soils has been collected. This Sampling and Analysis Plan was developed in response to a request by the New Mexico Environment Department (NMED) to obtain more current soil gas VOC and tritium data for the MWL. NMED has also requested that sampling for potential radon emissions from the MWL be completed. The NMED request was submitted in a letter dated November 20, 2006 and entitled "Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005, and Requirement for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories".

This sampling and analysis plan (SAP) has been prepared to meet the NMED request. SNL/NM proposes to collect soil gas VOC and tritium soil samples from six previous 1994 locations within the MWL, and from two background locations southwest of the landfill. SNL/NM also proposes to monitor for potential radon emissions by placing radon detectors at ten locations around the MWL perimeter after the final landfill cover is installed, and at two additional background locations southwest of the landfill.

It is anticipated that the soil gas VOC and tritium soil sampling will be completed in early 2007. Radon measurements will be conducted after the permanent perimeter fence around the MWL has been constructed. Analytical results for the soil gas VOC, tritium, and radon sampling will be summarized in two separate investigation reports that will be submitted to the NMED for review.

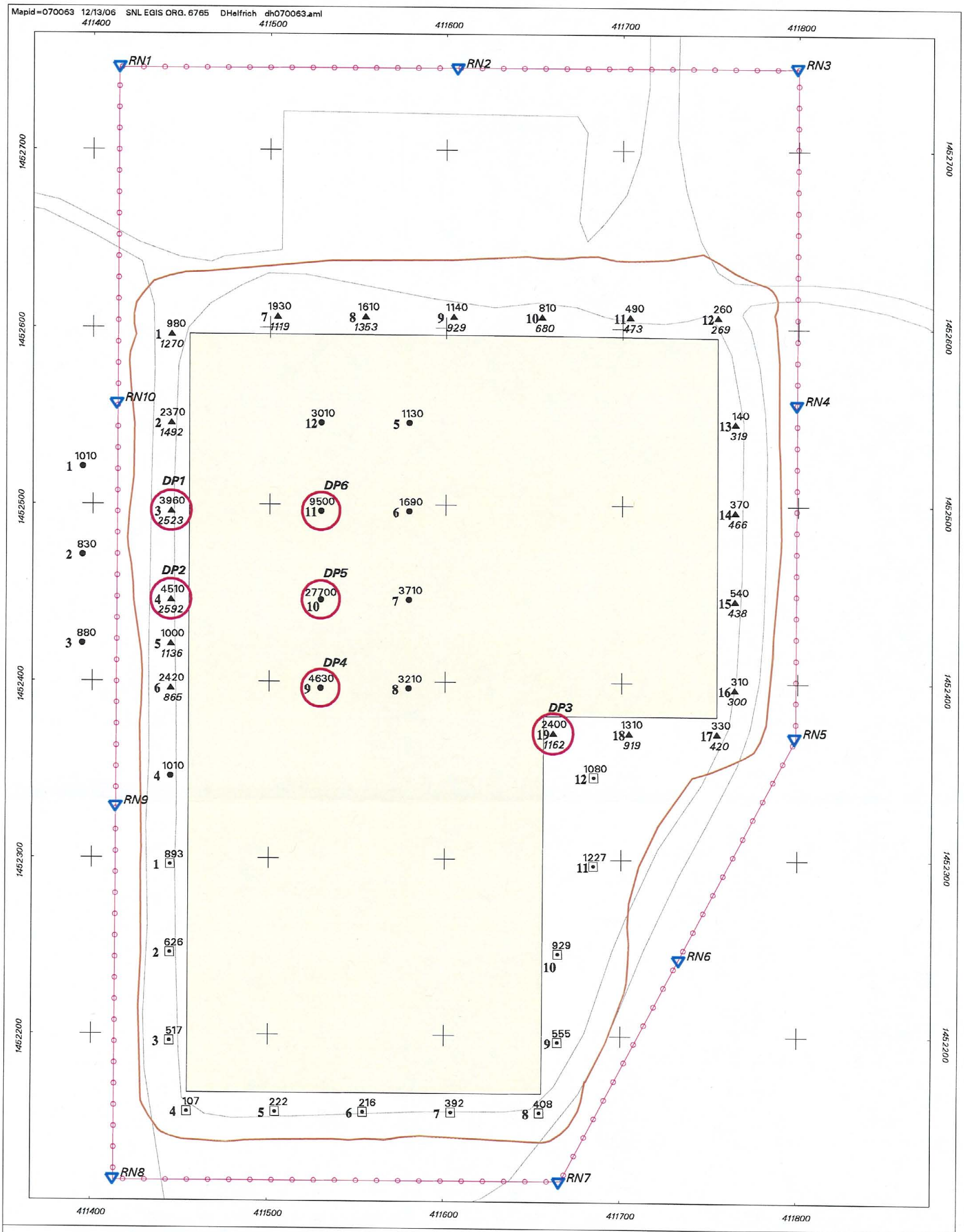
2.0 *Introduction and Background Information*

Active soil gas samples were collected from 43 locations in and around the MWL in June-October 1994, as shown on Figure 2-1. Soil gas samples were retrieved from target depths of 10 and 30 feet below ground surface (bgs) at each location with GeoProbe ™ soil gas collection equipment, and were collected in both 500 ml glass bulbs and SUMMA canisters. The glass bulb samples were analyzed with an on-site gas chromatograph/mass spectrometer (GC/MS), and the SUMMA canister samples were analyzed by an off-site commercial laboratory for VOCs by EPA Method TO-14.

Analytical results for the 1994 soil gas samples are presented and discussed in the "Report of the Mixed Waste Landfill Phase 2 RCRA Facility Investigation, Sandia National Laboratories, New Mexico" (SNL/NM September 1996). Eight individual VOCs were detected in the 10 and 30-ft samples, with total VOC concentrations ranging from 0.03 to 30.7 parts per million (ppm) in the 10-ft bgs samples, and from 0.107 to 27.7 ppm in the 30-ft bgs samples (Figure 2-1).

The Mixed Waste Landfill Corrective Measures Implementation Work Plan was written and submitted to the NMED Hazardous Waste Bureau in November 2005 (SNL/NM November 2005). NMED reviewed the document, and responded with a "Notice of Disapproval" letter dated November 20, 2006 (NMED November 2006). This letter described a number of deficiencies related to both the MWL cover, construction plans, performance and fate and transport modeling, and monitoring triggers. The letter also included a requirement for additional soil gas sampling at the landfill, as follows:

"As the Permittees are aware, most site characterization data for the MWL (other than groundwater data) dates before the mid 1990's. Because the rupturing of containers and leaking of their contents could have occurred since the mid 1990's, the NMED requires more current soil-gas data to help resolve this issue. The Permittees shall therefore collect and analyze active soil-gas samples taken at depths of 10 and 30 feet at a minimum of three locations within the landfill where previous sampling has detected the highest soil-gas concentrations in the past. The soil-gas samples shall be analyzed for volatile organic compounds, tritium, and radon. Pursuant to Section VI.A of the Order on Consent (April 29, 2004), the Permittees shall provide for approval to the NMED within 30 days of receipt of this letter a work plan to conduct the active soil-vapor sampling described above. The work plan shall be prepared in accordance with Section X.B of the Consent Order." (NMED November 2006).



Legend

6 ▲450 — 1994 First-round sample location, borehole number, and total soil gas VOC concentration at 30 feet(ppb)

4 ●720 — 1994 Second-round sample location, borehole number, and total soil gas VOC concentration at 30 feet(ppb)

1 ⊡47 — 1994 Third-round sample location, borehole number, and total soil gas VOC concentration at 30 feet(ppb)

RN1 — 2007 Radon Track Etch sampling locations and name

DP1 — 2007 Re-sample location and new borehole name

Current Unpaved Road

Proposed Final Fence

Proposed Toe of Landfill Cover

SWMU 76, Former MWL Extent

Figure 2-1
1994 Soil Gas VOC Sampling Locations, Soil Gas VOC Concentrations at 30 Feet, and Proposed 2007 Soil Gas VOC, Tritium, and Radon Sampling Locations, Mixed Waste Landfill

0 60 120
Scale in Feet

0 14 28
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

3.0 Scope of Activities

This SAP has been prepared to address the NMED requirement for additional sampling at the MWL. This document provides guidance and instructions for collecting and analyzing for VOCs in soil gas, tritium in soil moisture, and Radon flux at locations in and around the landfill. This SAP also presents specifications for field sampling, laboratory analysis, data validation and evaluation, and reporting. It is also designed to ensure that future soil gas VOC and tritium sampling procedures are consistent with past practices and produce defensible analytical results that can be compared to historical results. Analytical results for the new soil gas VOC samples will be compared to those results obtained from the 1994 samples to determine if significant changes in soil gas VOC concentrations have occurred in MWL subsurface soils since the 1994 samples were collected. Tritium activities in soil moisture that are detected in the new samples will also be compared to tritium activities detected in soil samples collected in 1994, and that were presented in the 1996 Phase 2 RFI report (SNL/NM September 1996). Ambient radon concentrations measured by Track-Etch radon detectors will be compared to the proposed trigger value of 4 pCi/L, presented in the "Probabilistic Fate and Transport Modeling of the Mixed Waste Landfill at Sandia National Laboratories" (Ho, C.H., et al February 2006).

3.1 Soil Gas VOC and Tritium Sampling Locations, Depths, and Frequency

One round of soil gas VOC and tritium soil moisture samples will be collected at depths of 10 and 30 feet below the original surface of the landfill. Since boreholes will be drilled through the recently-completed subgrade, the added thickness of the subgrade at each boring location will have to be accounted for, in order that the samples are collected from the same depths that were sampled in 1994. Samples will be collected from six MWL sampling locations where the highest soil gas VOC concentrations were detected at the 30-ft depth samples in 1994. It is anticipated that these samples will be collected in early 2007. As shown in Figure 2-1, the six highest total VOC concentrations in the 30-ft deep soil gas samples collected in 1994 were detected at the first round locations 3, 4, and 19, and second round locations 9, 10, and 11. For comparison purposes, background soil gas VOC and tritium soil samples will also be collected from two additional locations in an area approximately 600 feet southwest of the southwest corner of the landfill that is not believed to be impacted by anthropogenic activities. Actual background sampling locations will be selected during the sampling event.

Each soil gas and soil sample will be identified with a unique location identification number, as specified in Table 3-1. Duplicate soil gas and tritium samples will be collected from the 30-ft depths at second round locations 10 and 11 (Figure 2-1) where the highest soil gas VOC concentrations were detected in 1994. In addition, one aqueous tritium equipment blank (EB) sample will be collected on each day that drilling and sampling occur. All data will be reviewed and validated according to "Data Validation Procedure for Chemical and Radiochemical Data," - Administrative Operating Procedure (AOP) 00-03, Rev. 01 (SNL/NM December 2003).

Table 3-1 also correlates original sample locations from the Phase 2 RFI Active Soil Gas sampling events with the proposed locations for the current samples. Sample location coordinates shown in the table utilize the same MWL coordinate system that was used back in 1994, and are based on distance and relative direction from the northwest corner of the landfill.

3.2 Radon Track Etch Sampling

As shown on Figure 2-1, radon levels around the perimeter of the MWL will be measured using Track Etch radon detectors. A total of 10 detectors will be placed at corners and midpoints of the future perimeter fence that will be constructed once the final MWL cover has been constructed. For comparison purposes, two additional detectors will also be placed in the area at which the soil gas VOC and tritium background samples will be collected. These detectors will remain in place for one quarter (three months), and at the end of that period will be returned to the manufacturer for analysis.

Table 3-1

Summary of Soil Gas VOC and Tritium Soil Sample IDs and Sample Depths

Phase 2 RFI Active Soil Gas Sampling Location (Figure 2-1)	MWL Coordinate Locations	Borehole ID	VOC Soil Gas Sample ID	Tritium Soil Sample ID	Sample Depths (ft below original landfill surface)	VOC Soil Gas Duplicate Sample ID	Tritium Duplicate Soil Sample ID
First Round, Location #3	100S, 10W	MWL-DP1	MWL-DP1-10-SG MWL-DP1-30-SG	MWL-DP1-10-S MWL-DP1-30-S	10 ft 30 ft	NA	NA
First Round, Location #4	150S, 10W	MWL-DP2	MWL-DP2-10-SG MWL-DP2-30-SG	MWL-DP2-10-S MWL-DP2-30-S	10 ft 30 ft	NA	NA
First Round, Location #19	225S, 207E	MWL-DP3	MWL-DP3-10-SG MWL-DP3-30-SG	MWL-DP3-10-S MWL-DP3-30-S	10 ft 30 ft	NA	NA
Second Round, Location #9	200S, 75E	MWL-DP4	MWL-DP4-10-SG MWL-DP4-30-SG	MWL-DP4-10-S MWL-DP4-30-S	10 ft 30 ft	NA	NA
Second Round, Location #10	150S, 75E	MWL-DP5	MWL-DP5-10-SG MWL-DP5-30-SG	MWL-DP5-10-S MWL-DP5-30-S	10 ft 30 ft	MWL-DP5-30-SG-DUP	MWL-DP5-30-S-DUP
Second Round, Location #11	100S, 75E	MWL-DP6	MWL-DP6-10-SG MWL-DP6-30-SG	MWL-DP6-10-S MWL-DP6-30-S	10 ft 30 ft	MWL-DP6-30-SG-DUP	MWL-DP6-30-S-DUP
NA	Background location #1 approximately 600 ft SW of MWL[1]	MWL-DP7	MWL-DP7-10-SG MWL-DP7-30-SG	MWL-DP7-10-S MWL-DP7-30-S	10 ft 30 ft	NA	NA
NA	Background location #2 approximately 600 ft SW of MWL[1]	MWL-DP8	MWL-DP8-10-SG MWL-DP8-30-SG	MWL-DP8-10-S MWL-DP8-30-S	10 ft 30 ft	NA	NA
Equipment Blank	NA	NA	NA	MWL-EB1 MWL-EB2	NA	NA	NA

Table 3-1 (concluded)
Summary of Soil Gas VOC and Tritium Soil Sample IDs and Sample Depths

[1]Actual location to be determined in the field.

DP = Direct push
DUP = Duplicate
E = East
EB = Epuipment blank
ft = foot, feet
ID = Identification
MWL = Mixed Waste Landfill
NA = Not applicable
RFI = RCRA Facility Investigation
RCRA = Resource Conservation and Recovery Act
S = Soil, south
SG = Soil gas
SW = Southwest
VOC = Volatile organic compounds
W = West

4.0 Data Quality Objectives

The main data quality objective (DQO) is to produce representative, accurate, and defensible soil gas VOC, tritium, and radon analytical results to support the monitoring objectives. This SAP is designed to ensure that soil-gas and soil sampling procedures are consistent with past practices and produce defensible analytical results that can be compared to historical results. This DQO will be accomplished through the implementation of standard field methods, analytical procedures/methods, and data validation and evaluation protocol consistent with procedures that have been utilized for the collection of soil gas samples at other SNL/NM sites.

4.1 Data Accuracy

Proper sampling procedures such as purging, preparation of sampling containers, and use of quality assurance/quality control (QA/QC) samples such as blanks will help to reduce random and systematic sampling error or bias. Accurate estimates of contaminant concentration can be reliably obtained through use of qualified laboratories, appropriate analytical methodologies, and effective QA/QC procedures. These measures along with consistent implementation of this SAP should satisfy the DQO for accuracy.

4.2 Data Consistency and Compatability

To produce comparable analytical data, QA/QC procedures used to collect future soil gas VOC and tritium soil samples must be comparable with procedures used to collect historic soil gas VOC and tritium in soil moisture samples. Data consistency and comparability will be achieved through implementation of this SAP, which defines field and laboratory procedures designed for this purpose. Consistency in methods and procedures will be maintained in the following areas to ensure that future soil gas VOC and soil tritium sample data are consistent and comparable to historic data sets:

- Field sample collection and management
- Use of an off-site contract laboratory selected by the SNL/NM Sample Management Office (SMO) that complies with the SMO analytical laboratory statement of work (SOW)
- Analyzing soil gas VOC samples by EPA Method TO-14 (EPA January 1999) and soil tritium samples by EPA Method 906.0 (EPA August 1980). Radon measurements around the MWL perimeter will be completed with Track Etch radon samplers.

- Utilizing soil gas VOC and tritium soil moisture analytical data review and validation procedure "Data Validation Procedure for Chemical and Radiochemical Data," Administrative Operating Procedure (AOP) 00-03, Rev. 01 (SNL/NM December 2003)

4.3 Data Verification and Validation

After soil gas VOC and tritium analytical results are received from the laboratory, the SNL/NM SMO will 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 will be implemented as defined in the analytical laboratory SOW. The scope of the data verification and validation process addresses 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 5.0.

5.0 *Investigation Methods, and Monitoring and Sampling Program*

This section describes the field and laboratory measures to be taken in producing soil gas VOC, tritium, and radon analytical results that meet the DQOs presented in Section 2.0. Prior to initiating soil gas and soil sampling, field personnel will make sure that all necessary equipment is functioning properly in accordance with applicable FOPs 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 will be reviewed and support personnel will be notified.

5.1 Soil Gas VOC Sampling

Soil gas VOC sampling will generally be conducted in accordance with procedures specified in SNL/NM Field Operations Procedure (FOP) 94-21 (SNL/NM March 1994). Soil gas VOC samples will be collected by using truck mounted direct push sampling equipment provided by a commercial drilling company. This equipment will initially be decontaminated at the SNL/NM decontamination pad in Technical Area III prior to commencement of sampling activities at the MWL. The decontaminated equipment will then be taken to the first sampling location at the landfill and sampling activities will commence. At each sample location, a reusable drive-point fitted with a polyethylene tube will be attached to steel drive pipe, and the tip and drive pipe will be driven to the desired sampling using a hydraulic hammer. Once the sampling depth has been reached, the drive pipe will be retracted approximately 3 to 6 inches to create a void between the tip and pipe, and expose the sampling equipment to a short section of open borehole. The vacuum pump will be activated to extract soil gas from the sampling port. The stream of extracted soil gas will be screened with a photoionization detector (PID) instrument containing an ultraviolet lamp with an ionization potential of 11.8 electron volts. PID readings will be monitored during purging and recorded in the fieldbook or on a sampling form once they have stabilized to within plus or minus 10 percent.

When the PID readings have stabilized, the soil gas sample will then be collected in a 6-liter SUMMA canister. The canister will be filled with soil gas, the valve will be closed, and the canister will be shipped back to the laboratory with an analysis request/chain-of-custody form containing the sample identification number, sample location, date and time, depth, and ambient pressure. The canisters require no special preservation during transport and storage. The soil gas samples will be analyzed for VOCs by EPA Method TO-14.

After each soil gas sample is collected, all field equipment used in the process will be removed from the borehole and decontaminated by washing with Alconox and distilled water. The polyethylene sample tubing will be completely purged with nitrogen gas after each soil gas sample is collected. After purging, the tube will be checked with the PID to ensure that it has been completely evacuated of VOCs.

5.2 Tritium Soil Sampling

Following completion of collection of the soil gas VOC sample in a particular interval, the direct push drive pipe and drive point used for collection of the soil gas sample will be withdrawn from the borehole. The sampling equipment will again be decontaminated, and a 2-inch outside diameter (OD) by 2-ft long stainless steel split spoon sampler will be attached to the end of the drive pipe. The sampler and drive pipe will then be inserted back into the borehole and pushed down to the designated sampling depth at the bottom of the borehole. The split spoon sampler will then be hydraulically driven downward two feet into the undisturbed soil to fill the sampler. The drive pipe and sampler will be retrieved to the surface, and the soil will be transferred to the appropriate sample container. Approximately two liters of soil are required by the laboratory for a soil moisture tritium analysis. A 2-inch OD by 2-ft. long sampler will retrieve approximately 1 liter of soil, so at a minimum a second two-foot long run will be required to retrieve additional soil. If the split spoon sampler is not completely filled during each two-foot sampling run, additional runs will be made until the required volume of soil is obtained. The filled sample containers will be immediately placed in a sampling cooler and shipped to the offsite commercial laboratory for analysis by EPA Method 906.0.

The tritium EBs will be collected by pouring deionized water through a decontaminated split spoon sampler, collecting the rinsate in sample containers, and analyzing the water for tritium by EPA Method 906.0.

Soil gas VOC and tritium soil sample requirements are summarized in Table 5.1. If the borehole remains open following removal of the drilling equipment, it will be backfilled with bentonite chips. A small amount of water will be added to the borehole to hydrate the chips, if they are used.

Table 5.1
Soil Gas VOC and Tritium Soil Sample Requirements

Quantity	Container	Matrix	Parameter	Preservative
18	6-Liter SUMMA canister	Soil Gas	VOCs (EPA Method TO-14)	None
18	(2) 1-liter wide mouth poly	Soil	Tritium (EPA Method 906.0)	None
2 or 3 (depends on number of days in the field)	(1) 250 ml. amber glass	Water	Tritium (EPA Method 906.0)	None

EPA = U.S. Environmental Protection Agency
ml. = Milliliter
VOCs = Volatile organic compounds

5.3 Radon Sampling

Track Etch radon detectors will be used to monitor potential Radon flux that may be emanating from the MWL once the final cover has been installed. These detectors consist of a piece of plastic material which can register alpha particles that hit it. This alpha radiation, which comes from radon and its progeny does microscopic damage to the surface of the plastic. At the end of the monitoring period, the exposed detectors are returned to the laboratory from which they were obtained for analysis. The damaged area is then chemically etched, and the damaged area is enlarged and seen as tracks. The tracks can be counted and related to the radon concentration in the air in which the detector was exposed.

As shown on Figure 2-1, the detectors will be placed at 10 locations around the the MWL perimeter fence. The detectors will be placed on MWL perimeter fence posts at a breathing level height of approximately six feet above the ground surface. In addition, for comparison purposes two additional detectors will also be placed in the area at which the soil gas VOC and tritium background samples will be collected. These detectors will remain in place for one quarter (three months) to collect the initial round of baseline data, and at the end of that period will be returned to the manufacturer for analysis. A report summarizing results of the analyses of the detectors will be prepared and transmitted to the NMED for review.

5.4 Laboratory Analysis and Data Review

Laboratory analysis and data review includes the methods and procedures used to obtain the soil gas VOC and tritium results and confirm the quality of the information. All soil gas and tritium samples will be submitted to an off-site analytical laboratory that was selected by the SMO and follows the SMO SOW. The soil gas VOC and tritium samples will be analyzed using EPA Methods TO-14 and 906.0, respectively. The off-site laboratory is responsible for implementing the requirements of the method, including analytical methodology, target analytes for quantification, and internal QA/QC procedures. After the analytical results are received from the laboratory, the SMO will review the laboratory report for completeness and conformance to the current off-site commercial laboratory performance criteria. If problems are noted that require corrective action, corrective action will be implemented as defined in the analytical laboratory SOW.

5.5 Data Validation

After the data verification review is completed, the SMO will arrange for the validation of the data by an outside contractor. The scope of the data validation process addresses 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. The purpose of data validation is to determine the usability and establish the defensibility of the numerical results. Data qualification is based upon review of laboratory-supplied QC data, the specific QC criteria, and the DQOs identified in the procedures for EPA Methods TO-14 and 906.0. Data validation will be conducted according to the requirements of Administrative Operating Procedure (AOP) 00-03, Rev. 01, "Data Validation Procedure for Chemical and Radiochemical Data." (SNL/NM December 2003) All associated data validation reports will be provided along with the results for each sampling event.

5.6 Data Management and Reporting

Technical evaluation and reporting activities will be initiated after data validation is completed. Analytical results of the future soil gas VOC and tritium soil samples, and results of the radon Track Etch measurements will be summarized and reported in investigation report that includes the elements specified in Section X.C of the NMED Compliance Order on Consent (NMED April 2004).

5.7 Records Management

Records associated with the soil gas VOC, tritium, and radon sampling effort include this SAP, field documentation, laboratory analytical results, data validation reports, and technical data evaluations. These records will be maintained at the SNL/NM Customer Funded Records Center.

6.0 Schedule

6.1 Soil Gas VOC and Tritium Sampling, Analysis, and Reporting

It is anticipated that the soil gas VOC and tritium soil samples will be collected in early 2007. Preparations for field work and sample collection activities are expected to take approximately one week. Approximately two months will be required for sample analysis (assumes normal [21 working day] laboratory turnaround), SNL/NM SMO contract verification and data validation, and data entry into an electronic database. Once the validated results are entered into the database, a report summarizing the results of the sampling will be prepared and submitted to the NMED for review. The report production, peer review, and transmittal process will require approximately six weeks. The total time from start of field work preparations through transmittal of the final report to NMED is anticipated to be approximately 3.5 months.

6.2 Radon Track Etch Sampling, Analysis, and Reporting

Radon track etch samplers will be placed at ten locations on the perimeter fence that will be installed once the MWL final cover has been completed, and at two background location southwest of the landfill. These samplers will remain in place for three months to obtain one full quarter's worth of data, and will be returned to the manufacturer for analysis at the end of this period. Approximately one month is required for detector analyses and reporting by the manufacturer. A report summarizing the results of the radon track etch sampling will then be prepared and submitted to the NMED. The report production process and transmittal is also anticipated to take approximately six weeks. Therefore, total time from deployment of the track etch samplers in the field to submittal of the final summary report to NMED is anticipated to be approximately 5.5 months.

7.0 References

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