

Sampling Subsurface Vapor

Effective Date: 4/20/16

Next Review Date: 4/20/19

Hazard Class: Low Moderate High/Complex
Usage Mode: Reference UET Both UET & Reference

The Responsible Manager has determined that the following organizations' review is required for initial procedure release as well as subsequent major revisions. Review documentation is contained in the Document History File.

Technical Lead	Engineering
Subject Matter Expert	Safety Basis
Subcontractor Technical Rep	Environmental Protection
Quality Assurance	Waste Management
Safety IH	

Classification Review: Unclassified UCNI Classified

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REVISION HISTORY

Document No./Revision No.	Issue date	Action	Description
EP-ERSS-SOP-5074, R0.0	02/09/07	New Procedure	New document number, reformatted and renumbered. Supersedes SOP-06.31
EP-ERSS-SOP-5074, IPC 1	TBD	IPC	Adds one item to the equipment and tools list. Adds more detail to the weight measurement steps in Section 4.7.
EP-ERSS-SOP-5074, IPC-2	July 2009	IPC	Standardized drying silica gel prior to use. Recording initial mass of silica gel, prior to adding to sampling cartridge. Calculation of corrected tritium pore gas concentrations. Superseding EP-ERSS-SOP-5074, R 0 IPC-1.
EP-ERSS-SOP-5074, R1	6/22/2010	Major Revision	Add routine testing of silica gel bound water. Standardize purging requirements for VOC sampling. Standardize use of CO ₂ and O ₂ screening steps for VOC sampling. Superseding EP-ERSS-SOP-5074, R 0 IPC-2
EP-ERSS-SOP-5074, IPC-1	7/23/2010	IPC	Change sample line purge to 10 minutes prior to CO ₂ screening in Section 4.10, Step 4.
EP-ERSS-SOP-5074, R2	9/17/2010	Major Revision	Formalized changes documented in IPC-1 into the procedure as Revision 2.
EP-ERSS-SOP-5074, R2	3/15/2012	Minor Revision	Additional changes to Revision 2.
ER-SOP-20294, R0	4/20/16	Major Revision	Update procedure for subsurface vapor sampling. Procedure will remove references to B&K instrument which is no longer used. Procedure needs to be updated to the new format. New number - supersedes EP-ERSS-SOP-5074.

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1. PURPOSE AND SCOPE

The purpose of this procedure is to describe the process of sampling subsurface air for vapor phase contaminants at the Los Alamos National Laboratory (Laboratory).

2. BACKGROUND AND PRECAUTIONS**2.1 Background**

Sampling systems and sampling equipment vary between sampling projects; therefore, all portions of this procedure are not required for every port that is sampled. All sections of the procedure applicable to a single type of sampling system or equipment are required and are followed in the order presented. The individual work plan will specify the sampling systems and the samples to be collected using this procedure.

This procedure is to be used in conjunction with an approved Environmental, Safety, and Health (ES&H) Plan or an Integrated Work Document (IWD).

The sample train, sample containers, and sampling systems are the primary components of the sub-atmospheric air-sampling system. The Laboratory uses two types of sampling systems:

- Down-hole packer(s) – removable devices that isolate the sample depth interval within the borehole or casing.
- Stainless steel tubing system with sampling ports permanently installed at specific depths. Sampling ports are surrounded by a sand filter pack. Bentonite seals are placed above and below the sand pack to prevent soil air flow between ports.

The sample train may be fitted with or adapted to various field screening instruments, such as an air-flow gauge, vacuum gage, a photo-ionization detector (PID), a LANDTEC gas extraction meter, MultiRAE IR Multigas Monitor, or gas chromatograph/mass spectrometer (GC/MS). Field screening of oxygen and carbon dioxide is required to assure representative samples are collected. Other field screening instruments may be used for other sampling objectives. The sample train will be fitted to a SUMMA canister for volatile organic compound (VOC) sample collection and to a silica gel cartridge for tritium sample collection.

2.2 Precautions

- If both VOCs and tritium are sampled at a single sampling port, the order in which the tritium cartridge sample and the VOC SUMMA canister sample are collected must be consistent between each sampling period at a given monitoring site. See discussion in Attachment 1, Sampling Considerations.

2.2 Precautions (continued)

- Properly documented field procedures must be followed to ensure wells and boreholes do not become damaged or contaminated during sampling activities.
- Ports should be labeled with metal tags, and any tags that are not stamped metal should be documented and replaced with metal tags.
- Because of the harsh conditions in the field, the plastic tubing of the sampling lines and vapor ports may degrade over time, depth tags on the tubing or ports may become unreadable, or plugs may be lost. Any unusual conditions of the sampling lines (tubing) or vapor ports must be documented in the field logbook and the information relayed to the subcontractor technical representative (STR). Repairs to these components should be undertaken according to the manufacturer's specifications as soon as they are discovered.
- Field screening and monitoring equipment shall have factory calibration certification as prescribed in the equipment's manufacturer's manual. These certifications are required for Appendix B, "Field Methods" of Consent Order reports.
- Naturally occurring radon may be present on some of the sampling lines or vapor ports. Radon can collect on the sampling lines or vapor ports because the plastic has a slightly negative static charge. The human body has a slight positive charge, and the hands may attract minute amounts of radon when they come in contact with the vapor ports or plastic tubing. Clapping the hands to eliminate any built-up static charge may alleviate this problem. Nitrile gloves should be worn for protection, and they may also alleviate the problem of static charge.
- Preparation of field screening equipment, packer systems, silica gel, and silica gel cartridges require preparation and maintenance activities described in this procedure prior to sampling; be aware of these timelines prior to sampling.
- If a vehicle or generator is used to supply power to purge pumps, ensure that exhaust is directed away (downwind) from the borehole sampling operation to prevent contamination of samples.
- Special care should be taken during the installation of the silica gel cartridges into the sample train to minimize exposure to ambient air. When installed into the sampling train, the cartridge must be oriented so that air flow passes through the silica gel and then the filter, so that silica gel is not pulled out of the sample cartridge and into the pump.
- Silica gel water vapor collection efficiency is significantly reduced during hot weather. For sampling efficiencies during the warm spring/summer months, it is recommended that the silica gel cartridge connected to the sample train be placed in a cooler with ice during sampling to reduce the time required to collect 5 grams of water.
- Water vapor may condense and freeze in sampling lines during cold weather, restricting flow. Sample lines may be heated using a heat gun to re-vaporize condensed water and restore air flow.

2.2 Precautions (continued)

- When collecting a SUMMA canister field blank from a gas cylinder of pure nitrogen, close the SUMMA canister valve and the nitrogen cylinder valve when the SUMMA pressure valve equals zero, to avoid over pressurizing the SUMMA canister.
- Packer systems can become contaminated when used in multiple boreholes. Precautions to prevent cross contamination should be identified prior to the sampling campaign. Different strategies can be taken: packers can be decontaminated between uses, packers can be assigned for use at only one borehole, etc.
- Clear handwriting of data in field collection logs and logbooks is essential to assure data quality.
- Waste generated from sampling activities must be handled in accordance with EP-DIR-SOP-10021, Characterization and Management of Environmental Programs Wastes.

3. EQUIPMENT AND TOOLS

3.1 All Sampling Systems

- Gas flow meter.
- Differential pressure gauge or manometer for measuring static subsurface pressure.
- Hand tools – adjustable wrench, screwdrivers, pliers, utility knife.
- Nitrile gloves for skin protection and minimizing contamination, in accordance with the approved ES&H plan or Integrated Work Document (IWD).
- Teflon tubing that delivers pore gas from the vapor sampling port to the sample or field screening instruments/containers
- Heat gun in cold weather to ensure the ports do not clog from freezing condensate
- Vacuum pump(s) capable of flow rates between 2 – 15 liters/min.
- Pure (99.99%) nitrogen gas for field blank samples
- SUMMA Canisters - The SUMMA canister captures and contains the air sample for transport to the analytical laboratory for analysis of VOCs.
- Field screening instruments such as a LANDTEC gas extraction meter or MultiRAE IR Multigas Monitor for monitoring oxygen and carbon dioxide.

3.2 Sampling Tritium

- Sampling manifold if sampling from multiple ports simultaneously
- Silica gel cartridges for tritium analysis. Cartridges must hold 135 grams of silica gel. Cartridges must have end plugs, to isolate the silica gel before and after sampling.
- Digital scale capable of reading 1000 +/- 0.01 g
- Silica gel, 6–12 mesh, 135 grams per sample
- Laboratory oven capable of maintaining 110° C for 48 hours
- 2 crucibles for each lot of silica gel to be tested for bound water percentage. Crucibles shall be able to hold 50 - 100 grams of silica gel.
- Laboratory grade oven capable of maintaining 1000° C for 2 hours
- Tongs, gloves, eye protection for removing silica gel from oven
- High-temp marker or etched markings to mark crucibles prior to denaturing silica gel
- 5 grams distilled water for each field blank sample
- “T” connection for sampling train for collecting duplicate tritium sample

3.3 Equipment and Tools for the Packer Sampling System

- Dedicated packers
- Pulling rig or sampling tripod for lowering and raising packer systems into the borehole.
- Teflon tubing with an outer diameter of approximately one quarter inch. This tubing is attached at the surface to stainless steel tubing and fittings that must be air tight. Fittings along the stainless steel tubing that will accommodate attachments for the sample containers.
- Pure nitrogen gas (99.99%) for decontaminating re-usable sample tubing
- Calibrated depth measuring device to ensure that packer is deployed at the correct depth

4. PERFORMANCE – SAMPLING SUBSURFACE VAPOR

4.1 Develop Field Data Collection Forms

NOTE *Each sampling campaign includes different sampling equipment and different numbers of boreholes and ports to be sampled. Example forms for field data collection are provided in Attachments 2 to 4. Each sampling campaign should develop field data collection forms, containing the data specified in the attachments, appropriate to the specific sampling campaign. Sufficient space should be allowed on each data collection form to allow for legible handwriting.*

Field Team Leader

[1] **RECORD** the time to purge the sample train prior to screening for CO₂ on Attachment 4, Purge/Screening Using Landtec or MultiRAE IR Multigas Monitor, calculated as follows:

- For boreholes constructed using stainless steel sampling tubes in sand pack filters, the purge time is a minimum of 10 minutes.
- For open boreholes to be sampled using a down-hole packer, the sample train should be purged for either 10 minutes or the time required to purge the entire volume of the sample lines/port volumes, whichever is greater.
- For open boreholes, calculate the time required for purging one volume of sample line/borehole volume for each port to be sampled. The time to purge one volume is calculated as (the total volume of sample lines and port volumes)/pump flow rate.
- The volume of sample line is calculated as $L * \pi * D^2/4$, where L is the sample line length to the sampling port, and D is the inner diameter of the sample line.
- If the borehole is open and sampling intervals are designated with inflatable packers, the volume of the borehole between the packers is added to the volume of the sample line, to obtain the entire volume that requires purging prior to screening. The volume of space between the packers is calculated as $P * \pi * DB^2/4$, where P is the distance between the packers and DB is the diameter of the borehole.

4.2 **Periodic Evaluation of Silica Gel Bound Water Percentage for Tritium Sampling**

Field Team Member

- [1] **TEST** silica gel periodically to measure bound water percentage, as this value can change over time or with different manufacturers.
- [2] **TEST** silica gel when procured from a new manufacturer.
- [3] **IF** silica gel is purchased more than once per year,
THEN TEST silica gel once every six months.
- [4] **IF** silica gel is purchased less than once per year,
THEN TEST silica gel when new silica gel is purchased.

NOTE *Silica gel is purchased in containers of varying sizes. Newly procured silica gel containers are called "lots" in this procedure.*

- [5] **SELECT** a minimum of 2% of newly procured silica gel lots to be used in testing prior to its use in field sampling.
- [6] **DRY** the silica gel in a drying oven at 110° C for at least 48 hours.
- [7] **DRY** the silica gel in a tray or in the original metal can with the lid removed.
- [8] **PLACE** the dried silica gel into a container that can be closed immediately after removal from the oven to minimize the exposure of silica gel to ambient air.
- [9] **ALLOW** the silica gel to cool before proceeding to the next steps.
- [10] **WEIGH** each crucible with lid while empty (CE).
- [11] **MARK** each crucible with a number using a high-temp marker or etched markings.
- [12] **RECORD** the weight of each crucible with lid on Attachment 2, Silica Gel Bound Water Percentage Worksheet.

4.2 Periodic Evaluation of Silica Gel Bound Water Percentage for Tritium Sampling (continued)

- [13] **FILL** 2 crucibles partially, using the dried silica gel selected for testing.
- [14] **WEIGH** each setup of crucible, lid, and silica gel (CSGI) and **RECORD** the data on Attachment 2.
- [15] **PLACE** the crucibles in furnace and heat at 1000° C for two hours.

WARNING

Use tongs to remove crucibles from oven, and wear proper PPE, including gloves and eye protection. Stand back when opening the furnace.

- [16] **REMOVE** crucibles after oven has cooled.
- [17] **WEIGH** and **RECORD** final crucible + silica gel weight (CSGF) on Attachment 2 when crucibles are cool enough to handle.
- [18] **CALCULATE** the percent moisture of silica gel from each crucible:
$$\frac{(CSGI - CSGF) \times 100}{CSGI - CE}$$
- [19] **RECORD** this value on Attachment 2 for each crucible of silica gel tested (e.g. 5.54%).
- [20] **CALCULATE** the percent moisture value of the silica gel lot as the average of the individual crucibles tested.
- [21] **RECORD** this value on Attachment 2 (e.g. 6.35%).
- [22] **RECORD** this value in sampling logbooks and **RETAIN** this value with the lot of silica gel.

4.3 Preparation of Tritium Cartridges Prior to Field Deployment

Field Team Member

- [1] **ENSURE** that all materials and equipment that will come into contact with the silica gel are clean and dry before proceeding.
- [2] **DRY** the silica gel to be used for field sampling in a drying oven at 110° C for at least 48 hours.
 - [A] **DRY** the silica gel in a tray or in the original metal can with the lid removed.
 - [B] **PLACE** the dried silica gel in a container and **CLOSE** the container after removal from the oven to minimize the exposure of silica gel to ambient air.
 - [C] **ALLOW** the silica gel to cool before proceeding to the next steps.
- [3] **RECORD** the percent moisture value for the lot of silica gel in the logbook (see Section 4.2).
- [4] **CHECK** the cartridge to assure that a filter is in place in one of the end caps and **MARK** the direction of sample air flow on the cartridge. (Sample air moves towards the filter.)
- [5] **WEIGH** each empty cartridge with end plugs to the nearest 0.01 g and **RECORD** the weight of each cartridge in the logbook.
- [6] **ADD** approximately 135 grams of silica gel to each canister and close both openings.
- [7] **WEIGH** each cartridge containing silica gel to the nearest 0.01 g.
- [8] **RECORD** the weight of the cartridge with silica gel in the logbook.
- [9] **CALCULATE** the amount of dry silica gel added to the cartridge (this value is the weight of the cartridge containing silica gel minus the weight of the empty cartridge).
- [10] **RECORD** the weight of the dry silica gel (which will be approximately 135 grams) in the logbook.

4.4 Preparation of Packer System Prior to Field Deployment

Field Team Member

- [1] **IF** re-usable sample lines are used with the packer systems, **THEN DECONTAMINATE** sample line prior to use.
- [2] **PURGE** line with nitrogen for a minimum of three sample line volumes.
- [3] **IF** re-usable packers are used, **THEN DECONTAMINATE** packers prior to use following EP-ERSS-SOP-5061, Field Decontamination of Equipment.
- [4] **TEST** the inflatable packers and air line fittings for leaks before the packer system is sent down-hole.

4.5 Planning for QA/QC Samples

Field Team Member

- [1] **COLLECT** QA/QC samples at a frequency greater than or equal to 10% (1 for every 10 samples collected).
- [2] **COLLECT** two (2) QA/QC samples for VOCs using SUMMA canisters: a field duplicate (FD) sample, and a field blank of pure nitrogen (99.99%).
- [3] **COLLECT** two (2) QA/QC samples for tritium: a field duplicate (FD) sample and a field blank sample of distilled water.

4.6 Pre-Sampling Activities

Field Team Members

- [1] **DOCUMENT**, at a minimum, the following pre-sampling activities into the field logbook:
 - Date, time, location
 - Sample train inspection
 - Current calibration of all instruments
 - Port conditions
 - Tubing problems/solutions
 - Field screening instrumentation operational check
- [2] **REPLACE** any handwritten port labels with metal tags and **REPLACE** any degraded metal tags.
- [3] **INSPECT** all tubing, fittings, and valves on the sample train for degradation.
- [4] **INSPECT** Swagelok fittings for degradation.
- [5] **TIGHTEN**, as necessary, all fittings and valves that make up the assembly.
- [6] **ENSURE** the power supply is functional.

4.7 Daily Field Operational Check of Screening Instruments

NOTE *Screening instruments include Landtec Gas Extraction Meter, MultiRAE IR Multigas Monitor, etc.*

Field Team Member

- [1] **ENSURE** that the monitor is charged before taken out in the field and that the external power supply is functional.
- [2] **PERFORM** daily operational checks of field screening instrumentation according to manufacturer's procedure. (Field screening is required for oxygen and carbon dioxide.)
- [3] **CHECK** O₂ and CO₂ for Landtec or MultiRAE IR Multigas Monitor meter. (Oxygen values should be +/- 1% of 20.9%. Carbon dioxide should read 0 %.)

4.7 Daily Field Operational Check of Screening Instruments (continued)

- [4] **RECORD** results on Attachment 3, Daily QA/QC Operational Checks for Landtec or MultiRAE IR Multigas Monitor Instruments.
- [5] **IF** readings are not within manufacturer's specifications,
THEN FOLLOW repair instructions or **CONTACT** the manufacturer.

4.8 Preparation and Installation of Packer Systems

Field Team Members

- [1] **IF** re-usable sample lines are used with the packer systems,
THEN DECONTAMINATE sample line prior to each use.
- [2] **PURGE** line with nitrogen for a minimum of 3 sample line volumes.
- [3] **TEST** the inflatable packers and air line fittings for leaks before they are sent down-hole.
- [4] **ENSURE** packer(s) are the appropriate diameter for the borehole.
- [5] **ENSURE** the borehole is free of any irregularities (before the packer system is lowered into an open borehole), such as sloughing or the state wherein the borehole is curved due to incorrect auger tracking.
- [6] **DEPLOY** the packer(s) to the desired depth using the appropriate equipment (pull rig or sampling tripod).
- [7] **POSITION** the packer at the correct depth using a calibrated depth measurement device.
- [8] **INFLATE** the packer to the desired inflation pressure according to the manufacturer's specification.

NOTE *If the pressure drops following inflation, it may indicate a packer-inflation leak.*

- [9] **IF** a packer-inflation leak is detected,
THEN REMOVE the packer from the borehole and either **FIX** or **REPLACE** the leaking component prior to sampling.

4.9 Sampling Activities at a Borehole: Purging and Screening

NOTE *Screening instruments include Landtec Gas Extraction Meter, MultiRAE IR Multigas Monitor, etc.*

Field Team Members

- [1] **CONFIRM** the borehole number and location and **DOCUMENT** on sample collection log and field logbook.
- [2] **OPEN** borehole cover and **DOCUMENT** any finding that may impede sampling of the borehole.
- [3] **MEASURE** the static pressure of the formation at the sample interval using the differential pressure gauge and **DOCUMENT** the static pressure of the formation at the sample interval on Attachment 4.
- [4] **CONNECT** the purge pump to the top of the vapor port system using a length of Teflon™ tubing.
- [5] **PURGE** the sample train for a minimum of 10 minutes or the time calculated in section 4.1 with the purge pump to remove all stagnant air within the tubing and valves.
- [6] **DOCUMENT** purge flow rate and start/stop times on Attachment 4.
- [7] **IF** you suspect that the port is blocked, **DISCONTINUE** sampling at this port, **DOCUMENT** in logbook and sample collection log and **CONTACT** STR for further instructions at the time of this discovery.
- [8] **CONNECT** the screening instrument to the vapor port and monitor CO₂/O₂ values following purging (steps 4-6).

NOTE *When 2 consecutive readings of CO₂ have changed by less than 10%, the values have stabilized and a representative sample can be collected.*

- [9] **RECORD** screening values of CO₂ and O₂ readings in 1 minute intervals on Attachment 4.

4.10 SUMMA Canister Sampling

Field Team Members

- [1] **CONNECT** pressure valve with the vacuum gauge to the vapor port.
- [2] **ENSURE** all the valves are closed.
- [3] **ATTACH** the SUMMA canister to the pressure valve.
- [4] **OPEN** the valve on the SUMMA canister and check the vacuum gauge for proper vacuum.
- [5] **DOCUMENT** the starting pressure on the sample collection log, and the date/time of sample collection.
- [6] **OPEN** the pressure valve.
- [7] **CLOSE** the valve on the canister when the gauge indicates the pressures in the canister and atmospheric pressure have equilibrated (i.e. reading on pressure gauge = 0 psig).
- [8] **DOCUMENT** the final pressure on the sample collection log.
- [9] **COMPLETE** the identification tag of the canister.
- [10] **DOCUMENT** SUMMA canister sampling in the field logbook, in the sample collection log, and on the chain-of-custody forms.
- [11] **DISCONNECT** pressure valve from vapor port.
- [12] **STORE** the SUMMA canister in the shipping container and **SHIP** to the Laboratory Sample Management Office (SMO) in accordance with ER-SOP-20236, Handling, Packaging, and Transporting Field Samples.

4.11 Collect SUMMA Canister QA/QC Samples

Field Team Members

- [1] To collect the field duplicate sample, **CONNECT** a second SUMMA canister to the sample train immediately following the collection of the original sample.
- [2] **COMPLETE** steps in 4.10, SUMMA Canister Sampling.
- [3] To collect the field blank sample, **CONNECT** the regulator to the nitrogen tank, with the tank and regulator valves closed.
- [4] **CONNECT** the sample train to the nitrogen tank regulator and **OPEN** the nitrogen tank valve.
- [5] **PURGE** the sample train with nitrogen by slowly opening the regulator valve for a few seconds.
- [6] **CLOSE** the regulator valve.
- [7] **ATTACH** SUMMA canister to the pressure valve and to the sample train and **CLOSE** all valves on sample train.
- [8] **OPEN** valve on SUMMA canister and **DOCUMENT** the starting pressure and the date/time of sample collection on the sample collection log.
- [9] **OPEN** the valve on the sample train leading to the nitrogen tank.
- [10] **OPEN** the regulator valve on the nitrogen tank slightly, allowing nitrogen to flow through sample train into the SUMMA canister until SUMMA pressure is zero.
- [11] **RECORD** the final pressure on the sample collection log.
- [12] **CLOSE** the SUMMA valve and the regulator valve when SUMMA canister pressure valve equals zero. (Do not over pressurize the SUMMA canister.)
- [13] **OPEN** the regulator valve slowly to release any gas remaining in the regulator.
- [14] **STORE** the SUMMA canister in the shipping container and **SHIP** to the Laboratory SMO in accordance with ER-SOP-20236, Handling, Packaging, and Transporting Field Samples.

4.12 Tritium Sampling

NOTE *Tritium samples are only collected after the system has been purged with a field screening instrument. Tritium sampling may take several hours.*

Field Team Members

- [1] **CONNECT** the tritium cartridge to the purge fittings of the sample manifold and **ORIENT** the cartridge so the filtered end cap is on the pump side of the sample train.
- [2] **ACTIVATE** pump(s) to pull subsurface pore gas through the tritium cartridge.
- [3] Periodically **DISCONNECT** the tritium cartridge from the sample train, **INSTALL** both end plugs, and **WEIGH** cartridge.

NOTE *The sample is complete when the weight of the cartridge has increased by at least 5 g above the original cartridge weight determined in Section 4.3.*

- [4] **IF** the weight has not increased by at least 5 g,
THEN RE-INSTALL the cartridge in the sample train and **CONTINUE** pulling pore gas through the sample cartridge until the weight of the cartridge has increased by at least 5 g.
- [5] **RECORD** the final weight of the cartridge and **SAMPLE** to the nearest 0.01 g.
- [6] **REMOVE** cartridge quickly and **SEAL** the ends.
- [7] **DOCUMENT** the tritium cartridge sample in the field logbook and in the sample collection log and the chain-of-custody forms.
- [8] **RECORD** the following on the sample collection log:
 - Initial weight of dry silica gel used in the sample
 - The weight of the cartridge plus dry silica gel before sampling
 - The weight of the silica gel cartridge and silica gel after sampling
- [9] **RECORD** the silica gel bound water percentage for this lot of silica gel (from the field logbook or Attachment 2) on the sample collection log or chain-of-custody form.
- [10] **SUBMIT** samples to the Laboratory's SMO in accordance with ER-SOP-20236, Handling, Packaging, and Transporting Field Samples.

4.13 Collect Tritium QA/QC Samples

Field Team Members

- [1] To collect field duplicate samples, **CONNECT** a second tritium cartridge to the sample train using a “T” connection into the two columns, so that air is pulled through both samples simultaneously.
- [2] **FOLLOW** steps in 4.12 for sample collection, data recording, and submission.
- [3] To collect a field blank sample, **ADD** 5 grams of distilled water to a tritium cartridge.
- [4] **ADD** end plugs to the cartridge and **WEIGH** the cartridge with silica gel and distilled water.

4.14 Complete Sampling through the Packer System

Field Team Members

- [1] **DEFLATE** the packer(s) before pulling them out of the borehole and **PULL** the packers.
- [2] **CLOSE** borehole.
- [3] **DISPOSE** of any tubing that is visibly damaged or contaminated.
- [4] **DOCUMENT** date/time of completion of packer system removal in field logbook and **NOTE** any abnormal condition of the packer system.

4.15 Post-sampling Activities

Field Team Members

- [1] **ENSURE** that the packer system is contaminant-free by scanning it with field screening instruments following sampling to prevent cross-contamination from other boreholes.
- [2] Alternately, **DECONTAMINATE** sampling equipment following EP-ERSS-SOP-5061, Field Decontamination of Equipment and **DOCUMENT** results in sample logbook.

4.16 Records Processing

Field Team Members

- [1] **SUBMIT** the following records generated by this procedure to the Records Processing Facility:
- Completed chain-of-custody/request for analysis forms
 - Closed-out field logbooks
 - Attachments from this procedure
 - Completed sample collection logs

5. REFERENCES

EP-ERSS-SOP-5061, Field Decontamination of Equipment

ER-SOP-20236, Handling, Packaging, and Transporting Field Samples

EP-DIR-SOP-10021, Characterization and Management of Environmental Programs Wastes

6. ATTACHMENTS

Attachment 1, Sampling Considerations

Attachment 2, Silica Gel Bound Water Percentage Worksheet

Attachment 3, Daily QA/QC Operational Checks for Landtec or MultiRAE IR Multigas Monitor Instruments

Attachment 4, Purge/Screening Using Landtec or MultiRAE IR Multigas Monitor

ATTACHMENT 1

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Sampling Considerations**General**

There is not one standard method for collecting subsurface vapor contaminants, due to the lack of equilibrium in subsurface contaminant vapor plumes and due to the variability of vadose zone geology from site to site. The lack of equilibrium in subsurface contaminant vapor plumes is a function of the source of vapor phase contaminants, methods of disposal, rate of degradation in the soil, and the time since disposal.

The ASTM standard recommends that sampling in a consistent manner, from time period to time period, is of greatest importance to obtain a credible data set over time. This procedure calls for the consistent use of sampling equipment and methods from time period to time period, but does not require that each site use the exact same methods due to the variability in site geology and the variability in contaminant vapor plumes from site to site.

Each site (primarily Material Disposal Areas at LANL) is governed by an individual sampling plan approved by the NMED. And so, there is variability from site to site in sampling requirements (frequencies, depths, VOCs, tritium, etc.). The NMED approved sampling plan will specify the locations, port depths, and contaminants to be monitored. This procedure covers all aspects of subsurface vapor monitoring, to implement the NMED approved sampling plan.

Sample Pump Flow Rates

Consistent use of pumps for sample line/borehole purging and sampling tritium is required. A minimum sample pump flow rate is 300 ml/min. Typical sample pump flow rates are 3-15 liters/minute due to the variability of port depths to be sampled and the porosity of the vadose zone soils at Los Alamos.

Sampling VOCs and Tritium

The order of sample collection for VOC SUMMA canisters and tritium cartridges for a given site must be the same from one sampling period to the next. In all cases, the sample lines/borehole volumes are purged and then screening sampling is done prior to the collection of a VOC SUMMA canister sample or a tritium sample.

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Sampling Considerations

At locations where there are higher concentrations of VOCs in subsurface vapor plumes (e.g. MDA L), it is recommended that VOC SUMMA canisters samples are collected before tritium samples, following the purge of the sample line/borehole volumes and documentation/verification of stabilized subsurface air measurements. This order of sampling (VOCs first, then tritium) reduces the chance of impacting the equilibrium concentration of VOCs collected by the SUMMA canister that might happen following a long sampling period required (12+ hours) for collecting the tritium sample.

At locations with lower concentrations of VOCs in subsurface vapor plumes (e.g. MDA T), the tritium sample can be collected before or after the VOC SUMMA canister sample. Whichever sample is collected first (VOC or tritium), this same order of sampling must be followed each time at that particular site.

Screening for Identifying Sample Representativeness

Following purging of the sample lines/borehole, screening is required to demonstrate a representative sample of the vapor contaminant plume is being collected, as opposed to atmospheric air. Typically, solvent contaminant plumes include carbon dioxide produced as a byproduct of bacteria breaking down solvents. The goal of screening is to identify when carbon dioxide concentrations representative of the contaminant plume are identified rather than carbon dioxide naturally occurring in atmospheric air.

The carbon dioxide screening measurement becomes more complicated at sites where boreholes are in direct connection with the atmosphere (basalt, near the edge of a mesa, etc.) or where there is a low level of organic material. In these cases, the subsurface vapor sampling may pull in atmospheric air from adjacent canyons, or there may be very little CO₂ produced by degradation of organics. Screening sampling instruments must be able to differentiate between subsurface air and ambient air. For sampling at these more challenging sites, a more CO₂ sensitive screening instrument is required. A MultiRAE IR Multigas Monitor is recommended.

Reference Procedures for Sampling Subsurface Air

ASTM D5314-92(2006), Standard Guide for Soil Gas Monitoring in the Vadose Zone (Withdrawn 2015), ASTM International, West Conshohocken, PA, 2006.

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Silica Gel Bound Water Percentage Worksheet

Date of Silica Gel Bound Water Percentage Tests: _____ Sampler: _____

Dates of use of average silica gel bound water percentage (typically 6 months): _____ Reviewed by: _____

Sampling locations of use of average silica gel bound water percentage: _____ Review date: _____

Crucible number	Silica gel can number	Position of gel in can (relative to top, e.g. 1/3 down)	Weight of empty crucible plus lid, grams (CE)	Initial weight of silica gel plus crucible plus lid, grams (CSGI)	Final weight of silica gel plus crucible plus lid (after denaturing), grams (CSGF)	Calculated silica gel bound water percentage: $\frac{(CSGI - CSGF)}{CSGI - CE} \times 100$	Comments
Average of all crucible silica gel bound water percentages for the batch of silica gel cans							

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Daily QA/QC Operational Checks for Landtec or MultiRAE IR Multigas Monitor Instruments

Sampling Date _____ Landtec Instrument Name/Number _____ Sampler _____

Instrument is checked against ambient air Reviewed by: _____ Date _____

Standard	Time	Reading 1	Reading 2	Reading 3	Expected Value	Calibration Verified?
Methane					0%	
CO2					0%	
Oxygen					20.9% +/- 1%	

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Purge/Screening Using Landtec or MultiRAE IR Multigas Monitor

Borehole number: _____ Landtec No: _____ Sampler: _____

Sampling Date: _____ Static Pressure of Port: _____ Reviewed by: _____ Date: _____

Purge Flow Rate: _____ Time required to purge sample train at nominal flow rate (Section 4.1, Step 1): _____

Purge Start time: _____ Purge Complete Time: _____

Depth (ft)	Date	Screening Time	CH4 %	CO2 %	O2 %	

Example