

September 22, 2024

Michael Keller, E.I.T.
Project Manager
New York State Department of Environmental Conservation
Division of Environmental Remediation
700 Delaware Avenue
Buffalo, New York 14209

**Re: Soil Vapor Intrusion Assessment Work Plan
Moog Inc. – Building 11
Site No. 915164
Elma, New York**

Dear Mr. Keller:

On behalf of Moog Inc. (Moog), Roux Environmental Engineering and Geology, D.P.C. (Roux) has prepared this Soil Vapor Intrusion (SVI) Assessment Work Plan (SVI Work Plan) to provide details of the planned SVI sampling at the Moog Inc. – Building 11 site (Site), located in Elma, Erie County, New York (see Figure 1). The Site is listed under the New York State Department of Environmental Conservation (NYSDEC) Inactive Hazardous Waste Disposal Site Program (State Superfund Program, Site No. 915164) as a Class 4 Site. Moog never formally entered into a voluntary cleanup agreement with the NYSDEC; however, they voluntarily started cleanup at the Site in October 1996. This Work Plan includes revisions requested by NYSDEC and NYSDOH in a letter dated September 16, 2024.

Background

An initial SVI investigation was conducted in the eastern portion of Building 11A in May 2008 by URS Corporation (URS) due to the presence of chlorinated volatile organic compounds (cVOCs) identified in Site groundwater. Three sub-slab vapor (SSV) samples, designated Moog-SSA, -SSB, and -SSC, were collected in the eastern portion of Building 11A. Results of this assessment were reported in an SVI sampling letter report provided to the NYSDEC in July 2008¹. Analytical results indicated the presence of 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) and cVOCs 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), tetrachloroethene (PCE), and trichloroethene (TCE) at all three sub-slab sample locations.

A sub-slab depressurization (SSD) system was installed by US Radon, Inc. in June 2009 with oversight from URS to address SVI, as documented in the Subslab Depressurization System Installation – Moog Plant 11 letter report provided to the NYSDEC in July 2009². The SSD system consists of three sub-slab extraction points (North, South, and East Suction Points) and one vapor extraction fan (see Figure 2). The suction points consist of 4-inch Schedule 40 PVC pipes that penetrate the building floor. The suction points are connected to a suction fan

¹ URS Corporation. Soil Vapor Intrusion Sampling, East Aurora, New York Facility. May 2008.

² URS Corporation. Subslab Depressurization System Installation – Moog Plant 11. July 2009.

(Radonaway Mogel No. GP501) mounted two feet below the roof on the eastern exterior wall. The fan vents to a 4-inch PVC pipe that extends vertically from the fan to a point three feet above the roof. Each suction point is outfitted with a valve to adjust air flow and a manometer to measure vacuum pressure. Initial system testing indicated the presence of a negative pressure field under the building created by the SSD system. Attachment 1 includes SSD system drawings. Vacuum measurements at the three suction points are recorded weekly and provided to the NYSDEC annually. Vacuum measurements reported in the Draft May 31, 2023 – May 31, 2024 Periodic Review Report (PRR)³ indicated the system continues to operate as designed.

A groundwater pump and treat system was installed in January 1996 to address cVOC-impacted groundwater at the Site and operated until February 2013, when it was turned off in consultation with the NYSDEC. Groundwater monitoring results collected in February 2022 indicated that no detectable concentrations of cVOCs were observed in 7 of the 8 sampled wells. However, Freon and cVOCs were detected at well MW-2B above TOGS 1.1.1 Groundwater Quality Standards (GWQS)⁴. In February 2024, Moog completed groundwater amendment injections to address remaining contamination at well MW-2B. No cVOCs were detected at concentrations exceeding GWQS during post-injection groundwater monitoring completed in May 2024. Therefore, the PRR included the following recommendation:

- Moog will submit an SVI Work Plan to NYSDEC for review and approval. The Work Plan will describe sub-slab vapor and indoor air testing in the eastern portion of Building 11A to assess whether the SSD system may be terminated.

As discussed in the 2015 Site Management Plan (SMP)⁵, the SSD system cannot be discontinued unless prior written approval is granted by the NYSDEC. The proposed scope of work includes the collection of SSV and indoor air (IA) samples from the eastern portion of Building 11A, proximate the sub-slab sample locations collected by URS in May 2008 to assess whether the SSD system is still required to protect human health or if it may be discontinued. The SSV and IA sampling will be completed in general conformance with the NYS Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York⁶.

Pre-Sample Assessment

Prior to initiation of sampling, a pre-sampling inspection will be performed to identify and minimize conditions that may interfere with the proposed testing. The inspection will evaluate the type of structure, floor layout, airflows and physical conditions of the building. This information, along with information on sources of potential indoor air contamination, will be identified on the Indoor Air Quality Questionnaire & Building Inventory form (see Attachment 2). If products are identified that may interfere with the SVI sampling, these contents may require removal at least 48-hours prior to completing the sampling.

³ Roux Environmental Engineering and Geology, D.P.C. DRAFT Periodic Review Report, Reporting Period May 31, 2023 to May 31, 2024, Moog Inc. – Building 11 Site, Site No. 915164, Elma, New York. June 2024.

⁴ New York State Department of Environmental Conservation. Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. June 1998.

⁵ Moog Inc. Moog Inc. – Building 11 Site Management Plan, NYSDEC Site Number: 915164. May 2015.

⁶ New York State Department of Health. Guidance for Evaluating Soil Vapor Intrusion in the State of New York. October 2006 and subsequent revisions.

SVI & Outdoor Air Sample Collection

Four SSV and four IA samples will be collected from the eastern portion of Building 11A, proximate the sub-slab sample locations collected by URS in May 2008. One outdoor ambient air (OA) sample will be collected concurrent with the SSV/IA samples. Figure 2 shows approximate sample locations. The ASD system will be temporarily shut down 30 days prior to SVI sampling and turned back on after completion of sampling. The NYSDEC will be notified 7 days prior to temporary system shutdown and once the system is restarted.

At each SVI sampling location, Roux personnel will drill a ¼-inch diameter hole through the concrete slab using a hand-held hammer drill. SSV samples will be collected in the following manner:

- The SSV sample tubing will be sealed to the surface with Pergamum grout, melted beeswax, putty, or other non-VOC containing and non-shrinking products for temporary installation.
- The integrity of the surface seal of the sub-slab sampling point will be assessed using tracer gas (e.g., helium) per the Soil Vapor Sample Collection Field Operative Procedure (FOP) in Attachment 3.
- Approximately one to three volumes (i.e., the volume of the sample tube) will be purged prior to collecting the samples to ensure samples collected are representative.
- The building is used for industrial manufacturing. SSV sample canisters will be equipped with an 8-hour regulator to allow the sample to be collected over an approximate 8-hour period between approximately 7 am and 4 pm, representative of a workday for first shift workers at the Site.
- Samples will be collected with laboratory provided sampling canisters and regulators (e.g., Summa® canisters) and analyzed by EPA Method TO-15.

Holes in the concrete slab will be filled and sealed after completion of the sampling event.

Concurrent with the SSV samples, IA samples will be co-located with each SSV location and one OA sample will be collected from an outdoor upwind location of the Site, as determined on the day of field activities. IA and OA samples will also be collected with laboratory provided sampling canisters equipped with 8-hour regulators to allow the samples to be collected over the same approximate 8-hour period as the SSV samples.

SVI & Outdoor Air Sample Analysis

Air samples will be collected in Summa® canisters and once filled will be transported under chain-of-custody command to a NYSDOH-approved laboratory for analysis of USEPA TCL VOCs in accordance with USEPA Method TO-15/TO-15SIM. Typically, a minimum reporting limit of 1 microgram per cubic meter (1 ug/m³) or less is sufficient for most analytes. Field documentation of sampling activities will be recorded.

The laboratory will prepare a NYSDEC Analytical Services Protocol (ASP) Category B laboratory data package for the purpose of data validation. A third-party data validator will be contracted to prepare a Data Usability Summary Report (DUSR) for the laboratory results in

accordance with NYSDEC Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation⁷.

Schedule & Reporting

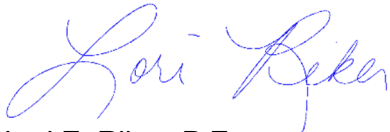
SVI sampling activities are planned for mid-November 2024. The ASD system will be temporarily shut off on October 15, 2024, to prepare for SVI sampling. Upon completion of the SVI investigation, the analytical results will be compared to the appropriate Decision Matrices associated with NYSDOH's Guidance for Evaluating Soil Vapor Intrusion in New York State to determine whether mitigation due to SVI is still needed in the eastern portion of Building 11A. An SVI Assessment Report will be prepared and submitted to NYSDEC/NYSDOH for review. The report will include:

- A summary of activities completed.
- Tables and figures summarizing the analytical results and identifying the SVI sampling locations.
- Laboratory report and sampling field forms.
- Recommendation and conclusion regarding SVI.

If the SVI investigation results indicate mitigation is no longer required, the SVI Assessment Report will include a request to terminate the SSD system.

Sincerely,

ROUX ENVIRONMENTAL ENGINEERING AND GEOLOGY, D.P.C.



Lori E. Riker, P.E.
Principal Engineer

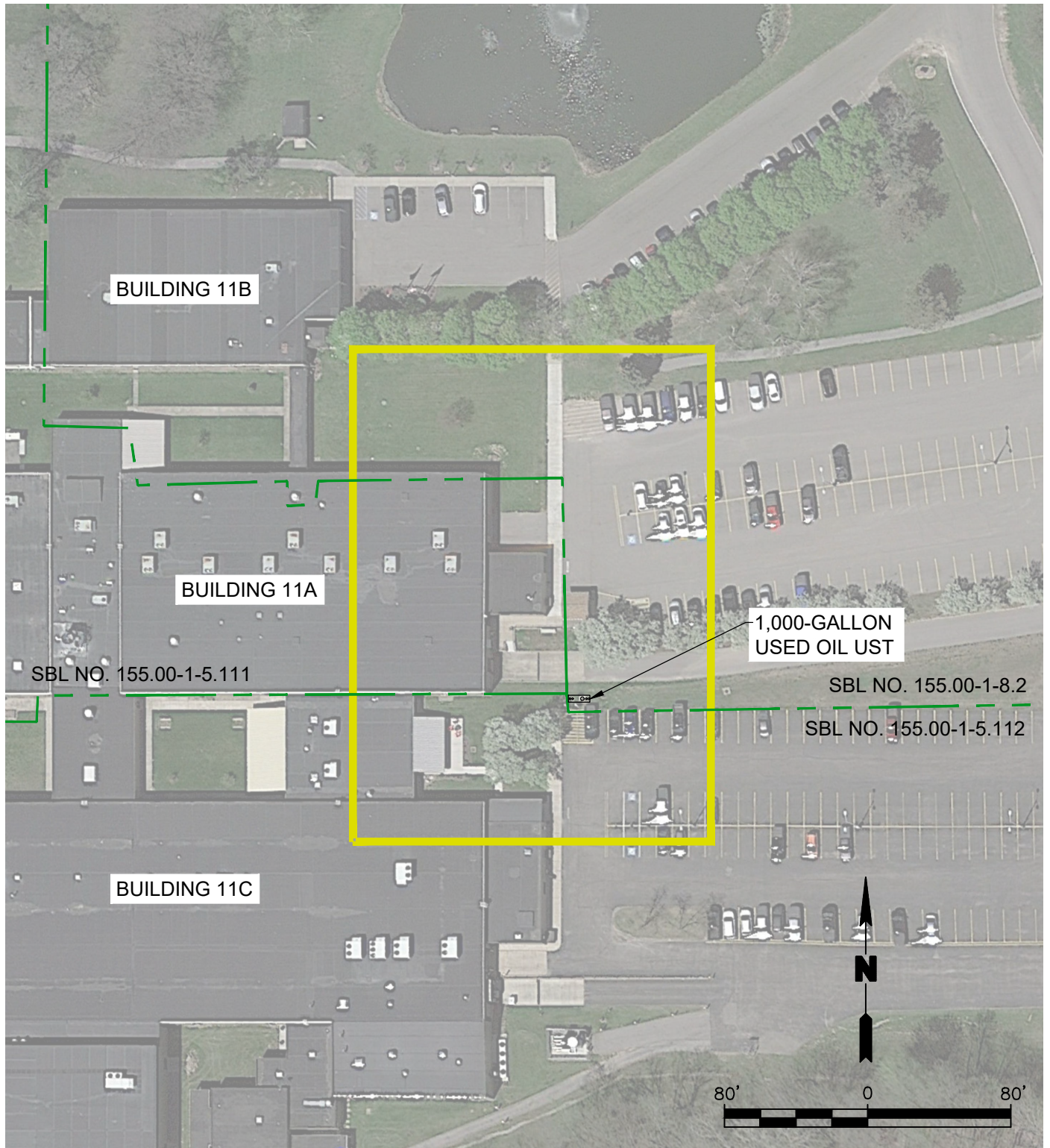
Attachments Figure 1 – Site Plan (Aerial)
 Figure 2 – SSD System Design & Proposed Sampling Locations
 Attachment 1 – SSD System Drawings
 Attachment 2 – Indoor Air Quality Questionnaire & Building Inventory Form
 Attachment 3 – Soil Vapor Sample Collection FOP

cc: Chris Russin (Moog)
 Robin Young (Moog)
 Michael Lesakowski (Roux)
 Chelsea Kanaley (Roux)

⁷ New York State Department of Environmental Conservation. NYSDEC Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation. May 2010.

FIGURES

1. Site Plan (Aerial)
2. SSD System Design & Proposed Sampling Locations



LEGEND

- SITE BOUNDARY
- PARCEL BOUNDARY

NOTES:

1. IMAGE TAKEN FROM GOOGLE EARTH 2022.
2. SITE BOUNDARY FROM FRONTIER TECHNICAL ASSOCIATES, INC. PERIODIC REVIEW REPORT AT MOOG – PLANT 11 (MAY 23, 2022, REVISED SEPTEMBER 27, 2022).

Title:

SITE PLAN (AERIAL) SVI ASSESSMENT WORK PLAN MOOG INC. - BUILDING 11

SITE NO. 915164
ELMA, NEW YORK

Prepared for:

MOOG INC.

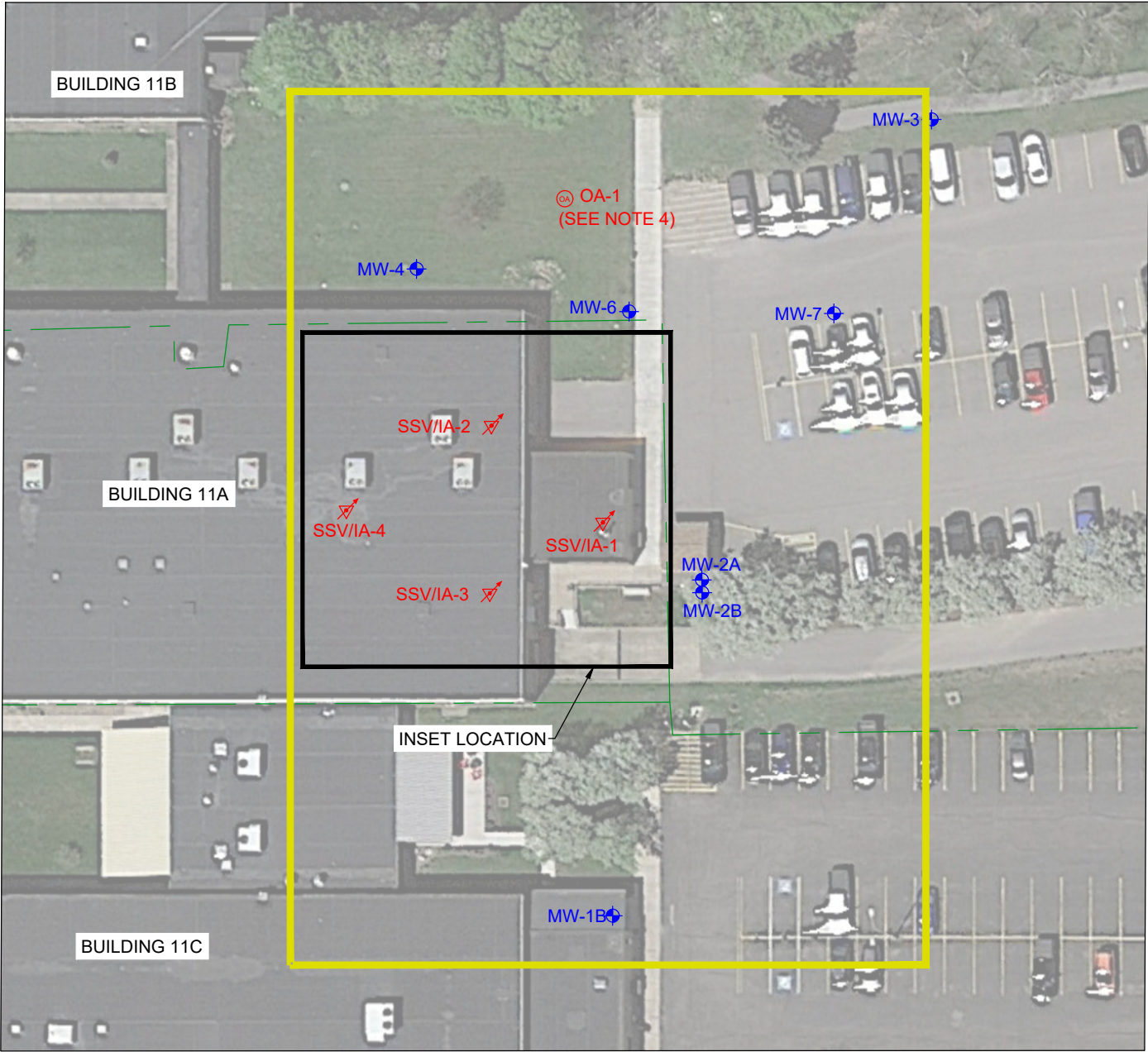


Compiled by: CNK	Date: JULY 2024
Prepared by: CNK	Scale: AS SHOWN
Project Mgr: LER	Project: 4366.0008B000
File: FIGURE 1: SITE PLAN (AERIAL).DWG	

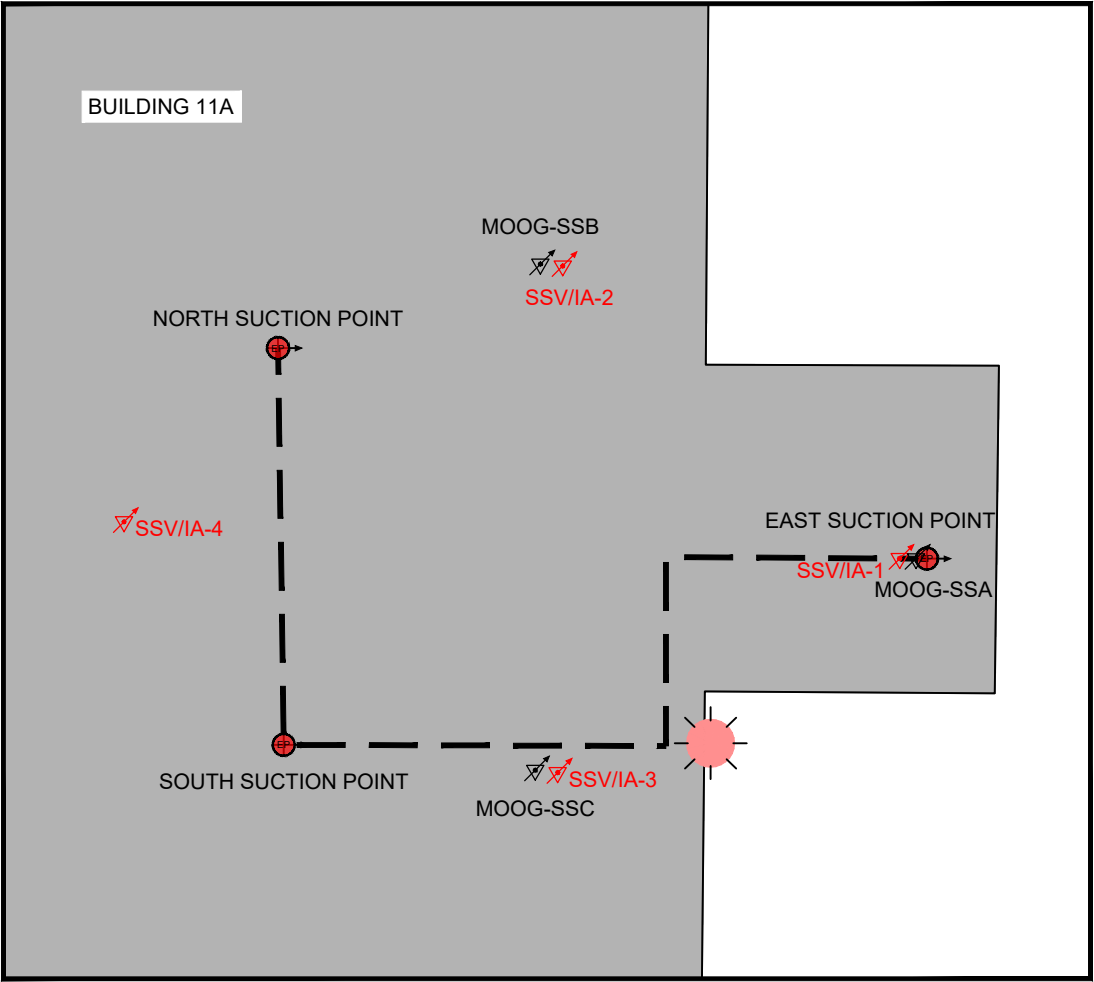
FIGURE

1

F:\CAD\BENCHMARK\MOOG\PLANT 11\SVI WORK PLAN\FIGURE 2: SSD SYSTEM DESIGN & PROPOSED SAMPLING LOCATIONS.DWG



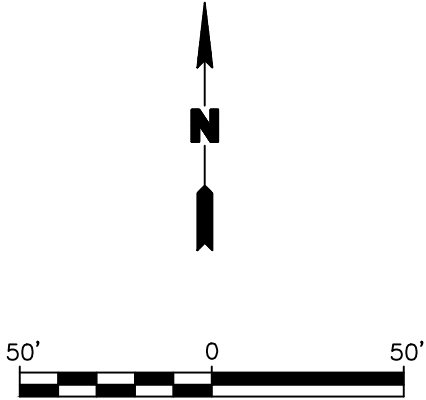
INSET: EASTERN PORTION OF BUILDING 11
SSD SYSTEM LAYOUT & SVI LOCATIONS
SCALE 1" = 20'



LEGEND

- SITE BOUNDARY
- PARCEL BOUNDARY
- MW-2B MONITORING WELL LOCATION
- MOOG-SSA URS SUBSLAB VAPOR LOCATION (2008)
- SUCTION POINT SSD SYSTEM SUCTION POINT LOCATION
- SSD SYSTEM FAN LOCATION
- OVERHEAD SSD SYSTEM PIPING
- SSV/IA-1 ROUX PROPOSED SUBSLAB VAPOR/INDOOR AIR LOCATION
- OA-1 ROUX PROPOSED OUTDOOR AIR LOCATION (SEE NOTE 4)

- NOTES:
1. IMAGE TAKEN FROM GOOGLE EARTH 2022.
 2. SITE BOUNDARY AND MONITORING WELL LOCATIONS FROM FRONTIER TECHNICAL ASSOCIATES, INC. PERIODIC REVIEW REPORT AT MOOG – PLANT 11 (MAY 23, 2022, REVISED SEPTEMBER 27, 2022).
 3. SUB-SLAB VAPOR SAMPLE LOCATIONS, SUCTION PIT LOCATIONS, AND OVERHEAD PIPING LOCATIONS FROM URS CORPORATION SUBSLAB DEPRESSURIZATION SYSTEM INSTALLATION – MOOG PLANT 11 LETTER REPORT (JULY 2009).
 4. ACTUAL LOCATION OF OUTDOOR AIR SAMPLE TO BE DETERMINED BY FIELD CONDITIONS (WIND DIRECTION) ON THE DAY OF SAMPLE COLLECTION.



Title:

SSD SYSTEM DESIGN & PROPOSED SAMPLING LOCATIONS

SVI ASSESSMENT WORK PLAN

MOOG INC. - BUILDING 11

SITE NO. 915164

ELMA, NEW YORK

Prepared for:

MOOG INC.

Compiled by: CNK

Date: SEPTEMBER 2024

Prepared by: CNK

Scale: AS SHOWN

Project Mgr: LER

Project: 4366.0008B000

File:

FIGURE 2: SSD SYSTEM DESIGN & PROPOSED SAMPLING LOCATIONS.DWG

FIGURE

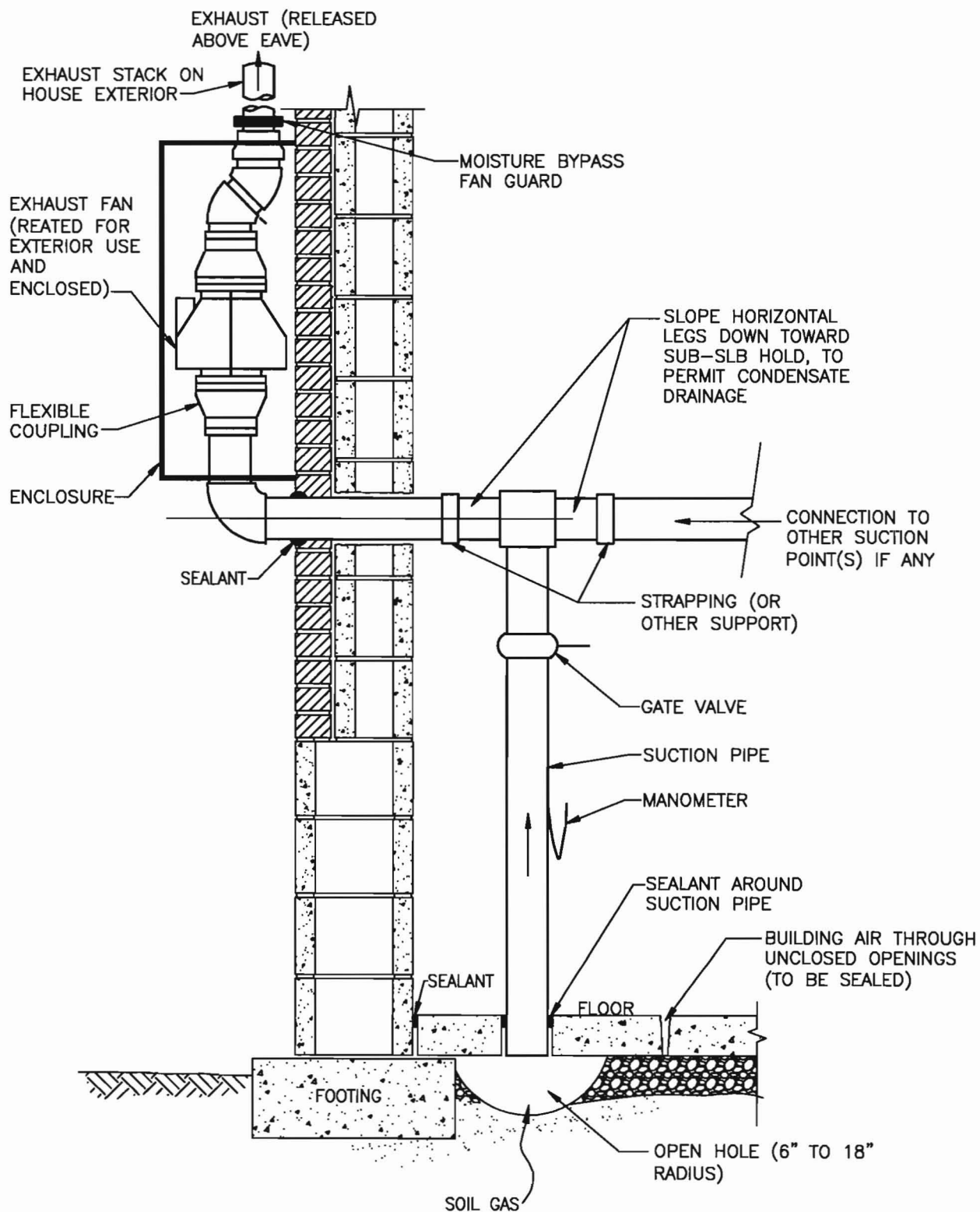
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SVI Assessment Work Plan
Moog Inc. – Building 11

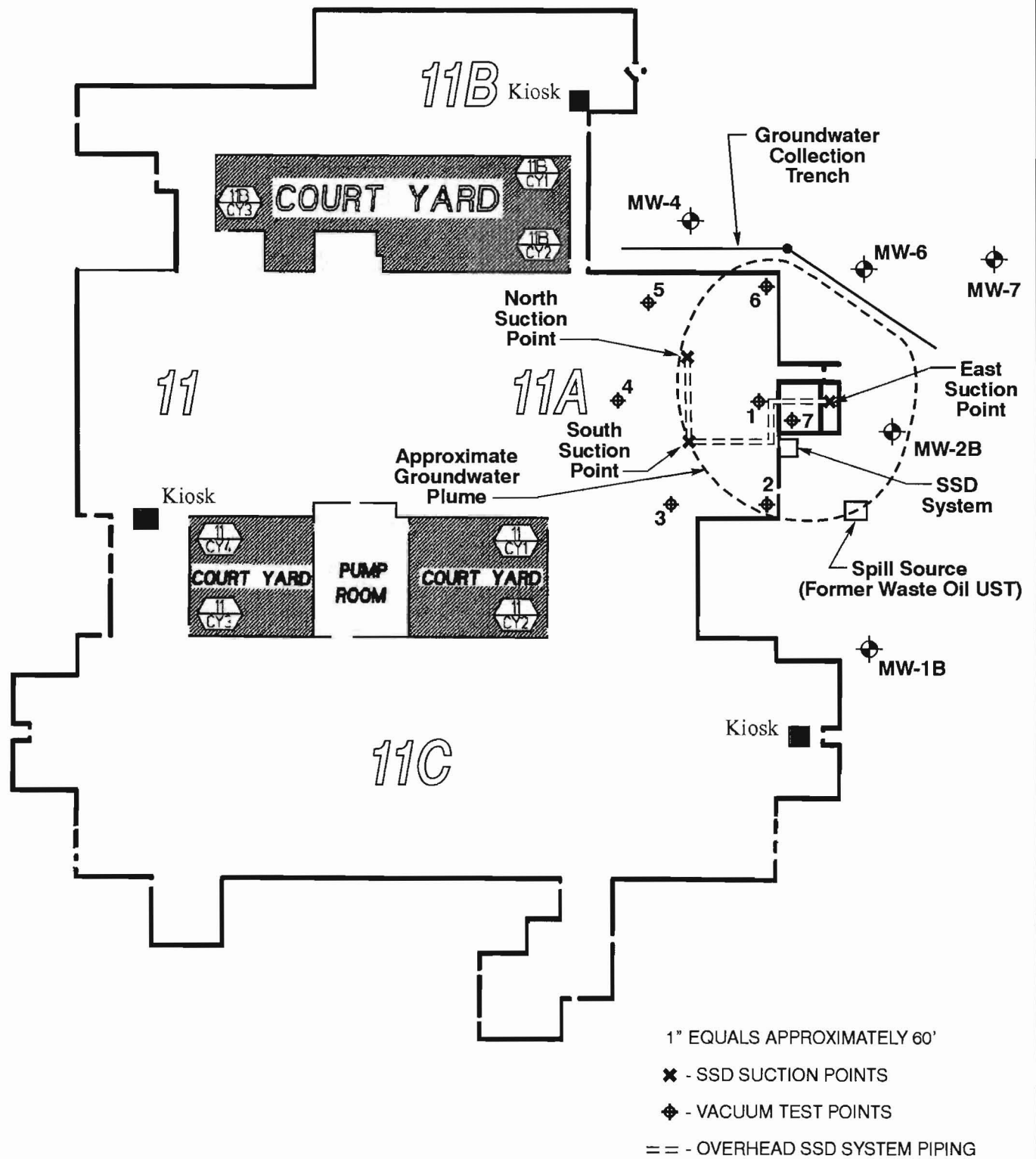
ATTACHMENTS

ATTACHMENT 1

SSD System Drawings



NOT TO SCALE



ATTACHMENT 2

Indoor Air Quality Questionnaire & Building Inventory Form



INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

Project Name:	Moog Inc. - Building 11	Project No.	4366.0008B000
Project Location:	Elma, New York	Client:	Moog Inc.
Preparer's Name:	Date/Time:		
Preparer's Affiliation:	Phone No:		
Purpose of Investigation:			

1. OCCUPANT:

Interviewed: **yes** **no**

Last Name: First Name:

Address:

County:

Home Phone: Office Phone:

Number of Occupants/persons at this location: Age of Occupants:

2. OWNER OR LANDLORD: (check if same as occupant_____)

Interviewed: **yes** **no**

Last Name: First Name:

Address:

County:

Home Phone: Office Phone:

3. BUILDING CHARACTERISTICS

Type of Building: check appropriate response)

- | | | |
|--------------------------------------|---------------------------------|---|
| <input type="checkbox"/> Residential | <input type="checkbox"/> School | <input type="checkbox"/> Commercial/Multi-use |
| <input type="checkbox"/> Industrial | <input type="checkbox"/> Church | <input type="checkbox"/> Other: |

If the property is residential, type? (check appropriate response)

- | | | |
|---------------------------------------|--|--|
| <input type="checkbox"/> Ranch | <input type="checkbox"/> 2-Family | <input type="checkbox"/> 3-Family |
| <input type="checkbox"/> Raised Ranch | <input type="checkbox"/> Split Level | <input type="checkbox"/> Colonial |
| <input type="checkbox"/> Cape Cod | <input type="checkbox"/> Contemporary | <input type="checkbox"/> Mobile Home |
| <input type="checkbox"/> Duplex | <input type="checkbox"/> Apartment House | <input type="checkbox"/> Townhouse/Condo |
| <input type="checkbox"/> Modular | <input type="checkbox"/> Log Home | <input type="checkbox"/> Other: |

If multiple units, how many?

If the property is commercial, type?

Business Type(s):

Does it include residences (i.e., multi-use)? **yes** **no** If yes, how many?

Other Characteristics:

Number of floors	Building age
Is the building insulated? yes no	How air tight? tight average not tight



INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

4. AIR FLOW

Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:

Airflow between floors

Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (check all that apply)

- | | | | |
|------------------------------|-------------------------------------|-------------------------------------|---|
| a. Above grade construction: | <input type="checkbox"/> wood frame | <input type="checkbox"/> concrete | <input type="checkbox"/> stone |
| b. Basement type: | <input type="checkbox"/> full | <input type="checkbox"/> crawlspace | <input type="checkbox"/> slab |
| c. Basement floor: | <input type="checkbox"/> concrete | <input type="checkbox"/> dirt | <input type="checkbox"/> stone |
| d. Basement floor: | <input type="checkbox"/> uncovered | <input type="checkbox"/> covered | <input type="checkbox"/> covered with _____ |
| e. Concrete floor: | <input type="checkbox"/> unsealed | <input type="checkbox"/> sealed | <input type="checkbox"/> sealed with _____ |
| f. Foundation walls: | <input type="checkbox"/> poured | <input type="checkbox"/> block | <input type="checkbox"/> stone |
| g. Foundation walls: | <input type="checkbox"/> unsealed | <input type="checkbox"/> sealed | <input type="checkbox"/> sealed with _____ |
| h. The basement is: | <input type="checkbox"/> wet | <input type="checkbox"/> damp | <input type="checkbox"/> dry |
| i. The basement is: | <input type="checkbox"/> finished | <input type="checkbox"/> unfinished | <input type="checkbox"/> partially finished |
| j. Sump present? | <input type="checkbox"/> yes | <input type="checkbox"/> no | |
| k. Water in Sump? | <input type="checkbox"/> yes | <input type="checkbox"/> no | <input type="checkbox"/> not applicable |

Basement/Lowest level depth below grade:

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)



INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

6. HEATING, VENTING, and AIR CONDITIONING (check all that apply)

Type of heating system(s) used in this building: (check all that apply - note primary)

- | | | |
|--|--|--|
| <input type="checkbox"/> Hot air circulation | <input type="checkbox"/> Heat pump | <input type="checkbox"/> Hot water baseboard |
| <input type="checkbox"/> Space Heaters | <input type="checkbox"/> Steam radiation | <input type="checkbox"/> Radiant floor |
| <input type="checkbox"/> Electric baseboard | <input type="checkbox"/> Wood stove | <input type="checkbox"/> Outdoor wood boiler |
| | <input type="checkbox"/> Other | _____ |

The primary type of fuel used is:

- | | | |
|--------------------------------------|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> Natural Gas | <input type="checkbox"/> Fuel oil | <input type="checkbox"/> Kerosene |
| <input type="checkbox"/> Electric | <input type="checkbox"/> Propane | <input type="checkbox"/> Solar |
| <input type="checkbox"/> Wood | <input type="checkbox"/> Coal | <input type="checkbox"/> Other |
- _____

Domestic hot water tank fueled by: _____

Boiler/furnace located in:

- | | | | |
|-----------------------------------|-----------------------------------|-------------------------------------|--------------------------------|
| <input type="checkbox"/> Basement | <input type="checkbox"/> Outdoors | <input type="checkbox"/> Main Floor | <input type="checkbox"/> Other |
|-----------------------------------|-----------------------------------|-------------------------------------|--------------------------------|
- _____

Air Conditioning:

- | | | | |
|--------------------------------------|---------------------------------------|---------------------------------------|-------------------------------|
| <input type="checkbox"/> Central Air | <input type="checkbox"/> Window units | <input type="checkbox"/> Open Windows | <input type="checkbox"/> None |
|--------------------------------------|---------------------------------------|---------------------------------------|-------------------------------|
- _____

Are there air distribution ducts present? ☐ yes ☐ no

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY

Is basement/lowest level occupied? ☐ Full-time ☐ Occasionally ☐ Seldom ☐ Almost Never

Level **General Use of Each Floor** (e.g., family room, bedroom, laundry, workshop, storage)

Basement

First Floor

Second Floor

Third Floor

Fourth Floor

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

- a. Is there an attached garage? ☐ yes ☐ no
- b. Does the garage have a separate heating unit? ☐ yes ☐ no ☐ NA
- c. Are petroleum-powered machines or vehicles stored in the garage? ☐ yes ☐ no ☐ NA
(e.g., lawnmower, atv, car) If yes, please specify: _____
- d. Has the building ever had a fire? ☐ yes ☐ no
If yes, when? _____
- e. Is a kerosene or unvented gas space heater present? ☐ yes ☐ no
If yes, where? _____
- f. Is there a workshop or hobby/craft area? ☐ yes ☐ no
If yes, where and type? _____
- g. Is there smoking in the building? ☐ yes ☐ no
If yes, how frequently? _____
- h. Have cleaning products been used recently? ☐ yes ☐ no
If yes, when & type? _____
- i. Have cosmetic products been used recently? ☐ yes ☐ no
If yes, when & type? _____
- j. Has painting/staining been done in the last 6 months? ☐ yes ☐ no
If yes, where & when? _____
- k. Is there new carpet, drapes, or other textiles? ☐ yes ☐ no
If yes, where & when? _____
- l. Have air fresheners been used recently? ☐ yes ☐ no
If yes, when & type? _____
- m. Is there a kitchen exhaust fan? ☐ yes ☐ no
If yes, where vented? _____
- n. Is there a bathroom exhaust fan? ☐ yes ☐ no
If yes, where vented? _____



INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY (continued)

- o. Is there a clothes dryer? ☐ yes ☐ no
If yes, is it vented outside? yes no
- p. Has there been a pesticide application? ☐ yes ☐ no
If yes, when & type? _____
- q. Are there odors in the building? ☐ yes ☐ no
If yes, please describe? _____

- r. Do any of the building occupants use solvents at work? ☐ yes ☐ no
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)
If yes, what types of solvents are used? _____
If yes, are their clothes washed at work? ☐ yes ☐ no
- s. Do any of the building occupants regularly use or work at a dry-cleaning service?
(check appropriate response)
☐ yes, use dry-cleaning regularly (weekly) ☐ no
☐ yes, use dry-cleaning infrequently (monthly or less) ☐ unknown
☐ yes, work at a dry-cleaning service
- t. Is there a radon mitigation system for the building/structure? ☐ yes ☐ no
If yes, date of installation? _____
Is the system active or passive? _____

9. WATER AND SEWAGE

- Water Supply: ☐ Public Water ☐ Drilled Well ☐ Driven Well ☐ Dug Well
☐ Other: _____
- Sewage Disposal: ☐ Public Sewer ☐ Septic Tank ☐ Leach Field ☐ Dry Well
☐ Other: _____

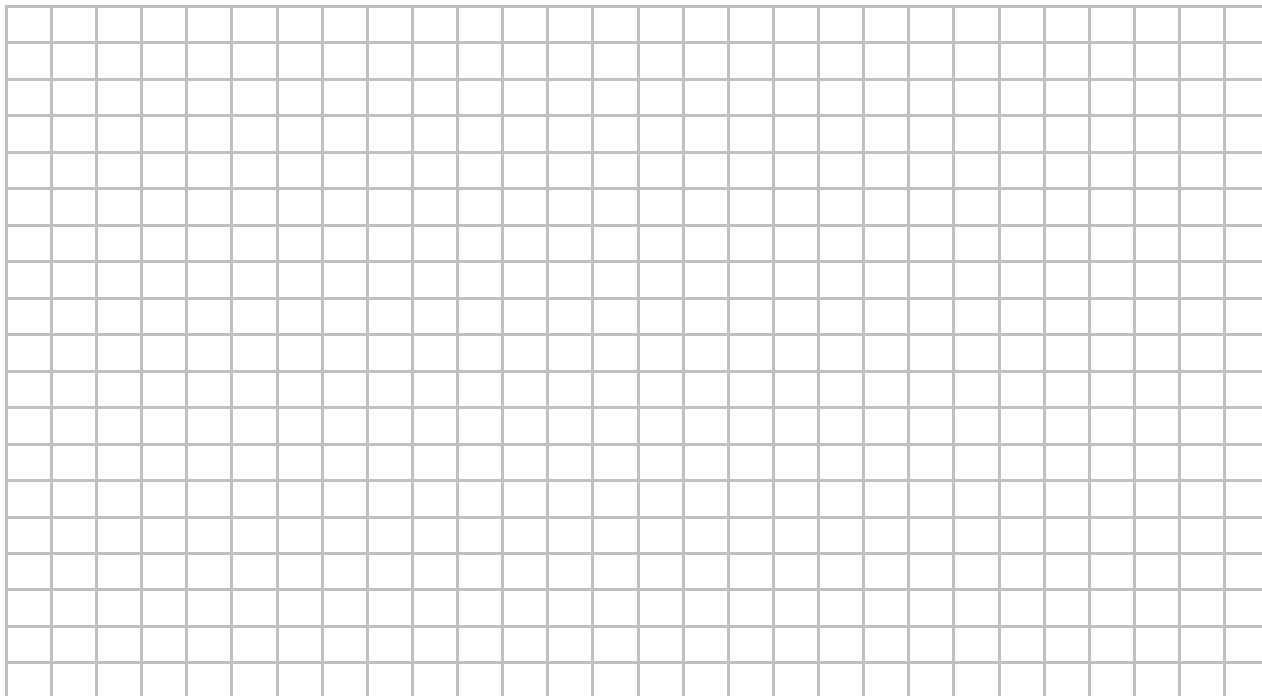
10. RELOCATION INFORMATION (for oil spill residential emergency)

- a. Provide reasons why relocation is recommended: _____
- b. Residents choose to: ☐ remain in home ☐ relocate to friends/family ☐ relocate to hotel/motel
- c. Responsibility for costs associated with reimbursement explained? ☐ yes ☐ no
- d. Relocation package provided and explained to residents? ☐ yes ☐ no

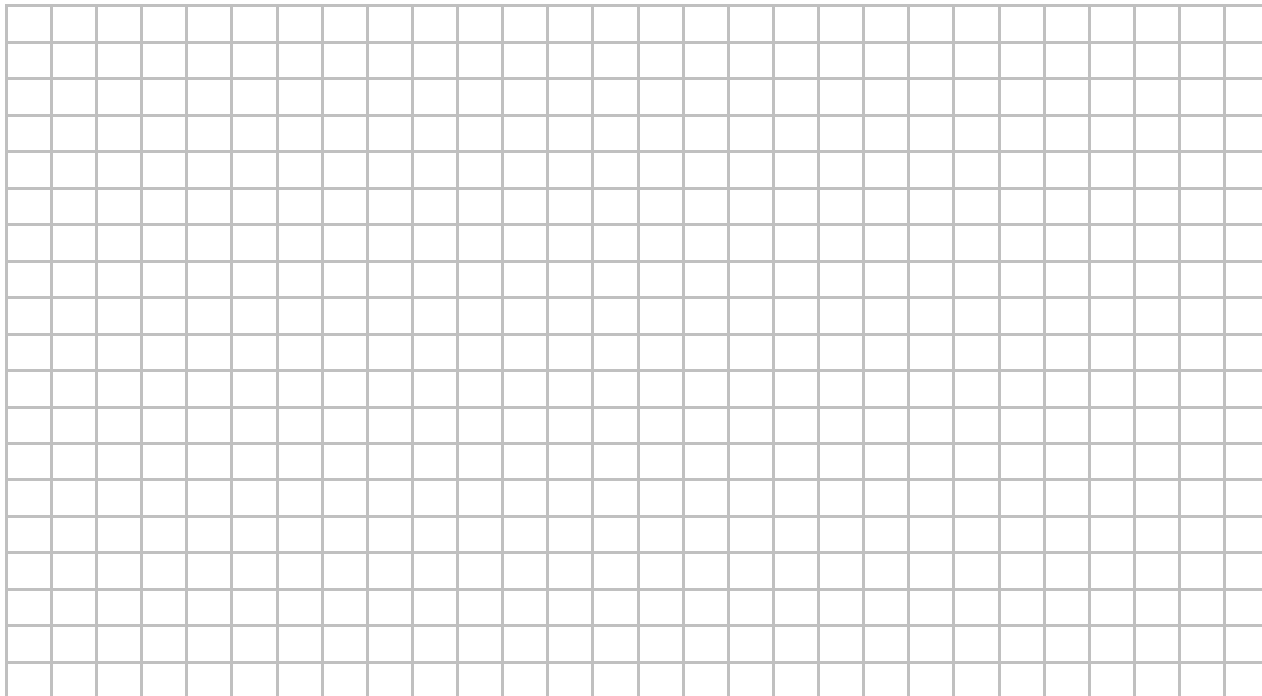
11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:



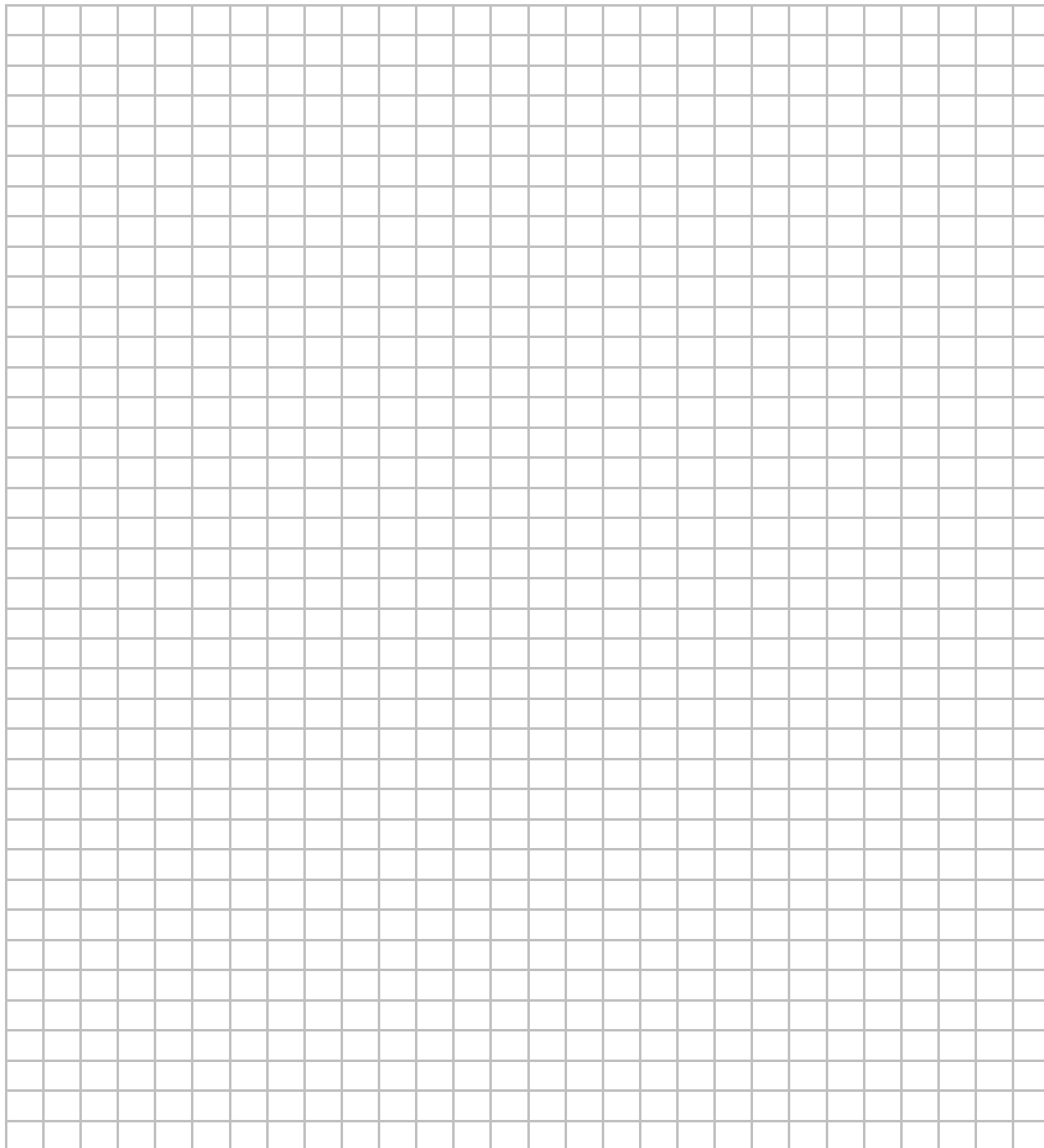
First Floor:



12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and spetic system, if applicable, and a qualifying statement to help locate the site on a topographic map.





Make & Model of field instrument used:

List specific products found in the structure that have the potential to affect indoor air quality.

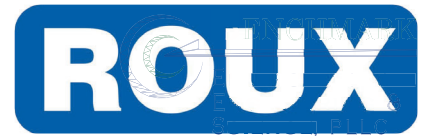
[illegible]

1. Describe the condition of the product containers as **Unopened (UO)**, **Used (U)**, or **Deteriorated (D)**.

2. Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

ATTACHMENT 3

Soil Vapor Sample Collection FOP

A thick, dark blue vertical bar runs down the left side of the page, starting from the top and extending past the bottom of the text area.

FIELD OPERATING PROCEDURES

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Soil Vapor Sample Collection Procedures

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

BACKGROUND

In October 2006, the New York State Department of Health (NYSDOH) finalized their vapor intrusion guidance document entitled “Guidance for Evaluating Soil Vapor Intrusion in the State of New York.” (www.health.state.ny.us/nysdoh/gas/svi_guidance/), which has been guiding NYSDOH and New York State Department of Environmental Conservation (NYSDEC) decisions concerning the need for subslab vapor mitigation at sites undergoing investigation, cleanup and monitoring under formal NY State remedial programs (e.g., Brownfield Cleanup Program sites, Inactive Hazardous Waste Site Remediation Program sites, etc.). Per the most recent update, February 2024, guidance presents six (6) soil vapor/indoor air matrices to assist in interpreting the comparison of subslab and ambient air data. As of February 2024, 20 compounds have been assigned to these six (6) current matrices (i.e., “Matrix A”, “Matrix B”, “Matrix C”, “Matrix D”, “Matrix E”, and “Matrix F”) as follows:

Soil Vapor / Indoor Air Matrix	Volatile Chemical
Matrix A	Carbon tetrachloride
	1,1-Dichloroethene
	cis-1,2-Dichloroethene
	Trichloroethene
Matrix B	Methylene Chloride
	Tetrachlorethene
	1,1,1-Trichloroethane
Matrix C	Vinyl chloride
Matrix D	Benzene
	Ethylbenzene
	Naphthalene

FOP 004.7

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

	Cyclohexane
	Isooctane (2,2,4-Trimethylpentane)
	1,2,4-Trimethylbenzene
	1,3,5-Trimethylbenzene
	o-Xylene
Matrix E	m,p-Xylene
	Heptane
	Hexane
Matrix F	Toluene

The matrices are attached as Figures 1 through 6.

PURPOSE

The procedures presented herein delineate the scope of additional investigation at a building on the project site to determine if volatile organic compounds (VOCs) detected in groundwater and/or soil near the building are intruding into the building airspace or have the potential, in sufficient concentrations, to adversely impact indoor air quality. The soil vapor, subslab vapor, and ambient air monitoring procedures follow the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006) as well as USEPA Methods TO-14 and TO-15, for volatile organic compounds (VOCs) using Summa passive canisters.

SURVEYS AND PRE-SAMPLING BUILDING PREPARATION (IF REQUIRED)

If required, a pre-sampling inspection should be performed prior to each sampling event to identify and minimize conditions that may interfere with the proposed testing. The

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

inspection should evaluate the type of structure, floor layout, airflows, and physical conditions of the building(s) being studied. This information, along with information on sources of potential indoor air contamination, should be identified on a building inventory form. An example of the building inventory form is attached. Items to be included in the building inventory include the following:

- Construction characteristics, including foundation cracks and utility penetrations or other openings that may serve as preferential pathways for vapor intrusion;
- Presence of an attached garage;
- Recent renovations or maintenance to the building (e.g., fresh paint, new carpet or furniture);
- Mechanical equipment that can affect pressure gradients (e.g., heating systems, clothes dryers or exhaust fans);
- Use or storage of petroleum products (e.g., fuel containers, gasoline operated equipment and unvented kerosene heaters); and
- Recent use of petroleum-based finishes or products containing volatile chemicals.

Each room on the floor of the building being tested and on lower floors, if possible, should be inspected. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

Potential interference from products or activities releasing volatile chemicals may need to be controlled. Removing the source from the indoor environment prior to testing is the most effective means of reducing interference. Ensuring that containers are tightly sealed may be acceptable. When testing for volatile organic compounds, containers should be tested with portable vapor monitoring equipment to determine whether compounds are leaking. The inability to eliminate potential interference may be justification for not testing, especially when testing for similar compounds at low levels. The investigator should consider the possibility that chemicals may adsorb onto porous materials and may take time to dissipate.

In some cases, the goal of the testing is to evaluate the impact from products used or stored in the building (e.g., pesticide misapplications, school renovation projects). If the goal of the testing is to determine whether products are an indoor volatile chemical contaminant source, the removing these sources does not apply.

Once interfering conditions are corrected (if applicable), ventilation may be needed prior to sampling to eliminate residual contamination in the indoor air. If ventilation is appropriate, it should be completed 24 hours or more prior to the scheduled sampling time. Where applicable, ventilation can be accomplished by operating the building's HVAC system to maximize outside air intake. Opening windows and doors, and operating exhaust fans may also help or may be needed if the building has no HVAC system.

Air samples are sometimes designed to represent typical exposure in a mechanically ventilated building and the operation of HVAC systems during sampling should be noted on the building inventory form (see attached sample). In general, the building's HVAC system should be operating under normal conditions. Unnecessary building ventilation should be avoided within 24 hours prior to and during sampling. During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

Depending upon the goal of the indoor air sampling, some situations may warrant deviation from the above protocol regarding building ventilation. In such cases, building conditions and sampling efforts should be understood and noted within the framework and scope of the investigation.

To avoid potential interferences and dilution effects, every effort should be made to avoid the following for 24 hours prior to sampling:

- Opening any windows, fireplace dampers, openings or vents;
- Operating ventilation fans unless special arrangements are made;
- Smoking in the building;
- Painting;
- Using a wood stove, fireplace or other auxiliary heating equipment (e.g., kerosene heater);
- Operating or storing automobile in an attached garage;
- Allowing containers of gasoline or oil to remain within the house or garage area, except for fuel oil tanks;
- Cleaning, waxing or polishing furniture, floors or other woodwork with petroleum- or oil-based products;
- Using air fresheners, scented candles or odor eliminators;
- Engaging in any hobbies that use materials containing volatile chemicals;
- Using cosmetics including hairspray, nail polish, nail polish removers, perfume/cologne, etc.;
- Lawn mowing, paving with asphalt, or snow blowing;
- Applying pesticides; and
- Using building repair or maintenance products, such as caulk or roofing tar.

PRODUCT INVENTORY (IF REQUIRED)

If required, the primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building, keeping in mind the goal of the investigation and site-specific

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

contaminants of concern. For example, it is not necessary to provide detailed information for each individual container of like items. However, it is necessary to indicate that "20 bottles of perfume" or "12 cans of latex paint" were present with containers in good condition. This information is used to help formulate an indoor environment profile.

An inventory should be provided for each room on the floor of the building being tested and on lower floors, if possible. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Products in buildings should be inventoried every time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, Material Safety Data Sheets (MSDS) may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

SAMPLE LOCATIONS

The following are types of samples that are collected to investigate the soil vapor intrusion pathway:

- Subsurface vapor samples:

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- *Soil vapor* samples (i.e., soil vapor samples not beneath the foundation or slab of a building) and
- *Sub-slab vapor* samples (i.e., soil vapor samples immediately beneath the foundation or slab of a building);
- Indoor air samples; and
- Outdoor air samples.

The types of samples that should be collected depend upon the specific objective(s) of the sampling, as described below.

- Soil vapor
Soil vapor samples are collected to determine whether this environmental medium is contaminated, characterize the nature and extent of contamination, and identify possible sources of the contamination. Soil vapor sampling results are used when evaluating the following:
 - The potential for *current* human exposures;
 - The potential for *future* human exposures (e.g., should a building be constructed); and
 - The effectiveness of measures implemented to remediate contaminated subsurface vapors.

- Sub-slab vapor
Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used when evaluating the following:
 - *Current* human exposures;
 - The potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
 - Site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

Sub-slab vapor samples are collected after soil vapor characterization and/or other environmental sampling (e.g., soil and groundwater characterization) indicate a need. Subslab samples are typically collected concurrently with indoor and outdoor air samples. However, outside of the heating season, sub-slab vapor samples may be collected independently depending on the sampling objective

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

(e.g., characterize the extent of subsurface vapor contamination outside of the heating season to develop a more comprehensive, focused investigation plan for the heating season).

■ Indoor air

Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors and crawlspaces. Indoor air sampling results are used when evaluating the following:

- *Current* human exposures;
- The potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
- Site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

Indoor air samples are collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate a need. When indoor air samples are collected, concurrent sub-slab vapor and outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system.

In addition, site-specific situations may warrant collecting indoor air samples prior to characterizing subsurface vapors and/or without concurrent sub-slab sampling due to a need to examine immediate inhalation hazards. Examples of such situations may include, but are not limited to, the following:

- In response to a spill event when there is a need to qualitatively and/or quantitatively characterize the contamination;
- If high readings are obtained in a building when screening with field equipment (e.g., a photoionization detector (PID), an organic vapor analyzer, or an explosimeter) and the source is unknown;
- If significant odors are present and the source needs to be characterized; or
- If groundwater beneath the building is contaminated, the building is prone to groundwater intrusion or flooding (e.g., sump pit overflows), and subsurface vapor sampling is not feasible.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- Outdoor air

Outdoor air samples are collected to characterize site-specific background outdoor air conditions. These samples must be collected simultaneously with indoor air samples. They may also be collected concurrently with soil vapor samples. Outdoor air sampling results are primarily used when evaluating the extent to which outdoor sources may be influencing indoor air quality. They may also be used in the evaluation of soil vapor results (i.e., to identify potential outdoor air interferences associated with the infiltration of outdoor air into the sampling apparatus while the soil vapor sample was collected).

SOIL VAPOR SAMPLE COLLECTION PROCEDURES

Soil vapor probe installations (see Figure 4 attached) may be permanent, semi-permanent, or temporary. In general, permanent installations are preferred for data consistency reasons. Soil implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Soil vapor probes should be installed using direct push technology or, if necessary to attain the desired depth, using an auger;
- Porous backfill material (e.g., glass beads or coarse sand) should be used to create a sampling zone 1 to 2 feet in length;
- Soil vapor probes should be fitted with inert tubing (e.g., polyethylene, stainless steel, or Teflon®) of the appropriate size (typically 1/8 inch to 1/4 inch diameter) and of laboratory or food grade quality to the surface;
- Soil vapor probes should be sealed above the sampling zone with a bentonite slurry for a minimum distance of 3 feet to prevent outdoor air infiltration and the remainder of the borehole backfilled with clean material;

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- For multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones; and
- For permanent installations, a protective casing should be set around the top of the probe tubing and grouted in place to the top of bentonite to minimize infiltration of water or outdoor air, as well as to prevent accidental damage.

Soil vapor samples should be collected in the same manner at all locations to minimize possible discrepancies. The following procedures should be included in any sampling protocol:

- At least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;
- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;
- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements; and

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) (discussed later in this procedure). Once verified, continued use of the tracer gas may be reconsidered.

When soil vapor samples are collected, the following actions should be taken to document local conditions during sampling that may influence interpretation of the results:

- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified;
- Outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north);
- Weather conditions (e.g., precipitation, outdoor temperature, barometric pressure, wind speed and direction) should be noted for the past 24 to 48 hours; and
- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

SUB-SLAB VAPOR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor should be inspected and any penetrations (cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Sub-slab vapor probe installations (see Figure 5 attached) may be permanent, semi-permanent, or temporary. Sub-slab implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Permanent recessed probes must be constructed with brass or stainless steel tubing and fittings;
- Temporary probes must be constructed with polyethylene or Teflon® tubing of laboratory or food grade quality;
- Tubing should not extend further than 2 inches into the sub-slab material;
- Coarse sand or glass beads should be added to cover about 1 inch of the probe tip for permanent installations; and
- The soil vapor probe should be sealed to the surface with permagum grout, melted beeswax, putty or other non-VOC-containing and non-shrinking products for temporary installations or cement for permanent installations.

Sub-slab vapor samples should be collected in the following manner:

- After installation of the probes, one to three volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;
- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury,

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;
- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements [Section 2.9 of the Guidance], the flow rate, and the sampling duration; and
- Ideally, samples should be collected over the same period of time as concurrent indoor and outdoor air samples.

When sub-slab vapor samples are collected, the following actions should be taken to document conditions during sampling and ultimately to aid in the interpretation of the sampling results:

- If sampling within a commercial or industrial building, uses of volatile chemicals in commercial or industrial processes and/or during building maintenance, should be identified;
- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and
- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Soil vapor purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the subslab air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.
4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample (discussed in

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

the next section). Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure section in this procedure.
6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.
7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.
8. At each location, drill an approximately 3/4-inch diameter hole through the concrete slab (typically 6-8 inches thick) using a hand-held hammer drill.
9. Measure and record the concrete thickness in the Project Field Book.
10. Insert polyethylene or Teflon® tubing of laboratory or food grade quality into the drilled hole and no further than 2 inches into the subslab material.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

11. Seal the tubing with an appropriately sized volatile organic compound-free stopper (i.e., permagum grout, melted beeswax, putty, or other non-VOC-containing and non-shrinking product) into the concrete core hole and secure in-place making sure the fit is very snug. Supplement any visible gaps between the stopper and concrete slab with a VOC-free sealant, such as beeswax or bentonite slurry.
12. Run the tubing assembly through a shroud (plastic pail, cardboard box, or garbage bag) creating a tight seal with the surface making sure not to disturb the seal around the tubing penetration.
13. Enrich the atmosphere of the shroud with helium. Measure and record the helium concentration within the shroud.
14. Purge approximately 1 to 3 tubing volumes (i.e., the volume of the sample probe and tube) using a hand pump (or similar approved device) to ensure the collection of a representative sample.
15. Flow rates for both purging and sample collection must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling.
16. Use a portable monitoring device to analyze a sample of soil vapor for the tracer **prior to and after** sampling for the compounds of concern. Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.
17. If concentrations greater than 10% of tracer gas are observed either prior to and/or after sampling, the probe seal should be enhanced to reduce the infiltration of outdoor air. Following enhancement of the seal, repeat steps 14 through 17 above until purged concentrations are less than 10% of the tracer gas within the shroud.
18. Following tubing purge and adequate seal integrity testing via helium tracer gas, immediately attach a 6-liter Summa Canister fitted with a 24-hour regulator (or approved other duration) to the opposite end of the tubing.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.

19. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.
20. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.
21. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
22. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
23. Repair all concrete openings with a cement patch.
24. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

INDOOR AIR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. If possible, prior to collecting indoor samples, a pre-sampling inspection, discussed earlier in this procedure, should be performed to evaluate the physical layout and conditions of the building being investigated, to identify conditions that may affect or interfere with the proposed sampling, and to prepare the building for sampling.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

In general, indoor air samples should be collected in the following manner:

- Sampling duration should reflect the exposure scenario being evaluated without compromising the detection limit or sample collection flow rate (e.g., an 8 hour sample from a workplace with a single shift versus a 24 hour sample from a workplace with multiple shifts). To ensure that air is representative of the locations sampled and to avoid undue influence from sampling personnel, samples should be collected for at least 1 hour. If the goal of the sampling is to represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;
- Personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;
- Sample flow rates must conform to the specifications in the sample collection method and, if possible, should be consistent with the flow rates for concurrent outdoor air and sub-slab samples;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved); and
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory.

At sites with tetrachloroethene contamination, passive air monitors that are specifically analyzed for tetrachloroethene (i.e., "perc badges") are commonly used to collect indoor and outdoor air samples. If site characterization activities indicate that degradation products of

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

tetrachloroethene also represent a vapor intrusion concern, perc badges may be used to indicate the likelihood of vapor intrusion (i.e., by using tetrachloroethene as a surrogate) followed, as needed, by more comprehensive sampling and laboratory analyses to quantify both tetrachloroethene and its degradation products. Perc badge samples ideally should be collected over a twenty-four hour period, but for no less than eight hours.

The following actions should be taken to document conditions during indoor air sampling and ultimately to aid in the interpretation of the sampling results:

- A product inventory survey must be completed (discussed earlier);
- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;
- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling height,
- Identity of samplers,
- Sampling methods and devices,
- Depending upon the method, volume of air sampled,
- If canisters used, the vacuum before and after samples collected,
- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the indoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan. Indoor air sampling typically requires the continuous collection of samples over a 24-hour period.
4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample. Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e.,

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure presented in this procedure.
6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.
7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.
8. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.
9. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.
10. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

11. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
12. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
13. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

OUTDOOR AIR SAMPLE COLLECTION PROCEDURES

Outdoor air samples must be collected simultaneously with indoor air samples and may be collected concurrently with subsurface vapor samples. Outdoor air samples must be collected in the same manner as indoor samples.

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the sampling results:

- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and
- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

The following describes the outdoor air sampling procedure:

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.
4. Sample locations typically are collected upwind of the facility.
5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. Place canisters on the ground or step ladder, with a clear plastic sheet beneath to prevent contamination. Locate the sampling inlet approximately 18-inches above the ground surface.
6. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results.
7. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.
8. All Summa Canister valves should remain closed until all subslab borings are complete and all of the indoor and outdoor canisters in their respective positions.
9. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

10. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
11. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
12. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-14 or TO-15.
13. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).

TRACER GAS

When collecting soil vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control device to verify the integrity of the soil vapor probe seal. Without the use of a tracer, there is no way to verify that a soil vapor sample has not been diluted by surface air.

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF₆) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

There are two basic approaches to testing for the tracer gas:

- Include the tracer gas in the list of target analytes reported by the laboratory; or
- Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to and after sampling for the compounds of concern. (Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.)

The advantage of the second approach is that the real time tracer sampling results can be used to confirm the integrity of the probe seals prior to formal sample collection. Figure 6 (attached) depicts common methods for using tracer gas. In each of the examples, a, b and c, the tracer gas is released in the enclosure prior to initially purging the sample point. Care should be taken to avoid excessive purging prior to sample collection. Care should also be taken to prevent pressure build-up in the enclosure during introduction of the tracer gas. Inspection of the installed sample probe, specifically noting the integrity of the surface seal and the porosity of the soil in which the probe is installed, will help to determine the tracer gas setup. Figure 6(a) may be most effective at preventing tracer gas infiltration; however, it may not be required in some situations depending on site-specific conditions. Figures 6(b) and 6(c) may be sufficient for probes installed in tight soils with well-constructed surface seals. In all cases, the same tracer gas application should be used for all probes at any given site.

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations ($> 10\%$) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of ambient air.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

During the initial stages of a soil vapor sampling program, tracer gas samples should be collected at each of the sampling probes. If the results of the initial samples indicate that the probe seals are adequate, the project manager can consider reducing the number of locations at which tracer gas samples are employed. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor probes as part of a long-term monitoring program, annual testing of the probe integrity is recommended.

QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Extreme care should be taken during all aspects of sample collection to ensure that sampling error is minimized and high quality data are obtained. The sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, and wearing freshly dry-cleaned clothing or personal fragrances), which can cause sample interference in the field. Appropriate QA/QC protocols must be followed for sample collection and laboratory analysis, such as use of certified clean sample devices, meeting sample holding times and temperatures, sample accession, chain of custody, etc. Samples should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures must be followed including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates, and laboratory duplicates, as appropriate.

Some methods require collecting samples in duplicate (e.g., indoor air sampling using passive sampling devices for tetrachloroethene) to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

For certain regulatory programs, a Data Usability Summary Report (DUSR) may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing a DUSR is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with detection limits similar to background (e.g., tetrachloroethene via EPA Method TO-15).

The work plan must state that all samples that will be used to make decisions on appropriate actions to address exposures and environmental contamination will be analyzed by an ELAP-certified laboratory. If known, the name of the laboratory should also be provided. Similarly, the name of the laboratory that was used must be included in the report of the sampling results. For samples collected and tested in the field for screening purposes by using field testing technology, the qualifications of the field technician must be documented in the work plan.

The target final field vacuum of any sample canister after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

DECISION MATRICES (FIGURES 1 THROUGH 6)

The considerations in assigning a chemical to a matrix include the following:

- Human health risks, including such factors as a chemical's ability to cause cancer, reproductive, developmental, liver, kidney, nervous system, immune system or other effects, in animals and humans and the doses that may cause those effects;
- The data gaps in its toxicological database;
- Background concentrations of volatile chemicals in indoor air [Section 3.2.4]; and
- Analytical capabilities currently available.

To use the matrices accurately as a tool in the decision-making process, the following must be noted:

- The matrices are generic. As such, it may be necessary to modify recommended actions to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or site-specific conditions (e.g., proximity of building to identified subsurface contamination) for the protection of public health. Additionally, actions more conservative than those specified within the matrix may be implemented at any time. For example, the decision to implement more conservative actions may be based on a comparison of the costs associated with resampling or monitoring to the costs associated with installation and monitoring of a mitigation system.
- Indoor air concentrations detected in samples collected from the building's basement or, if the building has a slab-on-grade foundation, from the building's lowest occupied living space should be used.
- Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude the need to investigate possible sources of vapor contamination, nor does it preclude the need to remediate contaminated soil vapors or the source of soil vapor contamination.

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- When current exposures are attributed to sources other than vapor intrusion, the agencies must be provided documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix and to support assessment and follow-up by the agencies.

RECOMMENDED ACTIONS

Actions recommended in the matrix are based on the relationship between sub-slab vapor concentrations and corresponding indoor air concentrations. They are intended to address both potential and current human exposures and include the following:

- *No further action*
When the volatile chemical is not detected in the indoor air sample and the concentration detected in the corresponding sub-slab vapor sample is not expected to substantially affect indoor air quality.
- *Identify source(s) and resample or mitigate*
Reasonable and practical actions are recommended to identify the source(s) affecting indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Resampling may be required in the event indoor and/or outdoor sources are not readily identified or confirmed to demonstrate SVI mitigation actions are not needed. Steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile chemical-containing products in places where people do not spend much time, such as a garage or shed). Mitigation may be required if soil vapor intrusion cannot be ruled out.
- *Monitor*
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure HVAC systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building specific basis, taking into account applicable environmental data and building operating conditions.

- *Mitigate*

Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4 of the Guidance.

TIME OF YEAR

Sub-slab vapor samples and, unless there is an immediate need for sampling, indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and air is being drawn into the building. In general, heating systems are expected to be operating routinely from November 15th to March 31st throughout the state. However, this timeframe may vary depending on factors, such as the location of the site (e.g., upstate versus downstate) and the weather conditions for a particular year.

A vapor intrusion investigation may also be conducted outside of the heating season. However, the results may not be used to rule out exposures. For example, results indicating "no further action" or "monitoring required" must be verified during the heating season to ensure these actions are protective during the heating season as well.

SAMPLING ROUNDS

Investigating a soil vapor intrusion pathway usually requires more than one round of subsurface vapor, indoor air, and/or outdoor air sampling, for reasons such as the following:

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

- To characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;
- To evaluate fluctuations in concentrations due to
 - Different weather conditions (e.g., seasonal effects),
 - Changes in building conditions (e.g., various operating conditions of a building's HVAC system),
 - Changes in source strength, or
 - Vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or
- To confirm sampling results or the effectiveness of mitigation or remedial systems.

Overall, successive rounds of sampling are conducted until the following questions can be answered:

- Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?
- What are the current and potential exposures to contaminated subsurface vapors?
- What actions, if any, are needed to prevent or mitigate exposures and to remediate subsurface vapor contamination?

Toward this end, multiple rounds of sampling may be required to characterize the nature and extent of subsurface vapor contamination such that

- Both potential and current exposures are adequately addressed;
- Measures can be designed to remediate subsurface vapor contamination, either directly (e.g., SVE system) or indirectly (e.g., soil excavation or groundwater remediation), given that monitoring and mitigation are considered temporary measures implemented to address exposures related to vapor intrusion until contaminated environmental media are remediated; and
- The effectiveness of remedial measures can be monitored and confirmed (e.g., endpoint sampling).

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

ATTACHMENTS

- Figure 1** *Soil Vapor/Indoor Air Matrix A*
Figure 2 *Soil Vapor/Indoor Air Matrix B*
Figure 3 *Soil Vapor/Indoor Air Matrix C*
Figure 4 *Soil Vapor/Indoor Air Matrix D*
Figure 5 *Soil Vapor/Indoor Air Matrix E*
Figure 6 *Soil Vapor/Indoor Air Matrix F*
Figure 7 *Schematics of a permanent soil vapor probe and permanent nested soil vapor probes*
Figure 8 *Schematic of a sub-slab vapor probe*
Figure 9 *Schematics of tracer gas applications*

Air Canister Field Record

Indoor Air Quality Questionnaire and Building Inventory

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

REFERENCES

New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, October 2006.

New York State Department of Health, *Indoor Air Sampling & Analysis Guidance*. (February 1, 2005).

Office of Solid Waste and Emergency Response (OSWER). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. November 2002.

United States Environmental Protection Agency. *EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. 1988

- Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). Pp. 15-1 through 15-62.
- Method TO-17, Determination of Volatile Organic Compounds in Ambient Air using Active Sampling on Sorbent Tubes. Pp. 17-1 through 17-49.
- Compendium of Methods for the Determination of Air Pollutants in Indoor Air, EPA/600/4-90-010.

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 1

Soil Vapor/Indoor Air Matrix A

May 2017

Analytes Assigned:

Trichloroethene (TCE), *cis*-1,2-Dichloroethene (c12-DCE), 1,1-Dichloroethene (11-DCE), Carbon Tetrachloride

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)		
	< 0.2	0.2 to < 1	1 and above
< 6	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
6 to < 60	4. No further action	5. MONITOR	6. MITIGATE
60 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) and Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX A Page 1 of 2

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

ADDITIONAL NOTES FOR MATRIX A

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.20 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 2

Soil Vapor/Indoor Air Matrix B

May 2017

Analytes Assigned:

Tetrachloroethene (PCE), 1,1,1-Trichloroethane (111-TCA), Methylene Chloride

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)		
	< 3	3 to < 10	10 and above
< 100	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
100 to < 1,000	4. No further action	5. MONITOR	6. MITIGATE
1,000 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) and Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX B Page 1 of 2

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

ADDITIONAL NOTES FOR MATRIX B

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 3

Soil Vapor/Indoor Air Matrix C

May 2017

Analytes Assigned:
Vinyl Chloride

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)	
	< 0.2	0.2 and above
< 6	1. No further action	2. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
6 to < 60	3. MONITOR	4. MITIGATE
60 and above	5. MITIGATE	6. MITIGATE

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) and Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX C Page 1 of 2

**SOIL VAPOR SAMPLE
COLLECTION PROCEDURE**

ADDITIONAL NOTES FOR MATRIX C

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.20 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 4

Soil Vapor/Indoor Air Matrix D

February 2024

Analytes Assigned:

Benzene, ethylbenzene, naphthalene, cyclohexane, isooctane (2,2,4-trimethylpentane), 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, o-xylene

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)		
	< 2	2 to < 10	10 and above
< 60	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) or RESAMPLE or MITIGATE
60 to < 600	4. No further action	5. MONITOR	6. MITIGATE
600 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

mcg/m³ = micrograms per cubic meter

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) or Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation, and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building -specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX D Page 1 of 2

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

ADDITIONAL NOTES FOR MATRIX D

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu of* sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

MATRIX D Page 2 of 2

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 5

Soil Vapor/Indoor Air Matrix E

February 2024

Analytes Assigned:
m,p-xylene, heptane, hexane

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)		
	< 6	6 to < 20	20 and above
< 200	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) or RESAMPLE or MITIGATE
200 to < 2,000	4. No further action	5. MONITOR	6. MITIGATE
2,000 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

mcg/m³ = micrograms per cubic meter

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) or Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation, and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building -specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX E Page 1 of 2

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

ADDITIONAL NOTES FOR MATRIX E

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

MATRIX E Page 2 of 2

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 6

Soil Vapor/Indoor Air Matrix F

February 2024

Analytes Assigned:
Toluene

SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m ³)	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m ³)		
	< 10	10 to < 50	50 and above
< 300	1. No Further Action	2. No Further Action	3. IDENTIFY SOURCE(S) or RESAMPLE or MITIGATE
300 to < 3,000	4. No Further Action	5. MONITOR	6. MITIGATE
3,000 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

mcg/m³ = micrograms per cubic meter

No further action: No additional actions are recommended to address human exposures.

Identify Source(s) or Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation, and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building -specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX F Page 1 of 2

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

ADDITIONAL NOTES FOR MATRIX F

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

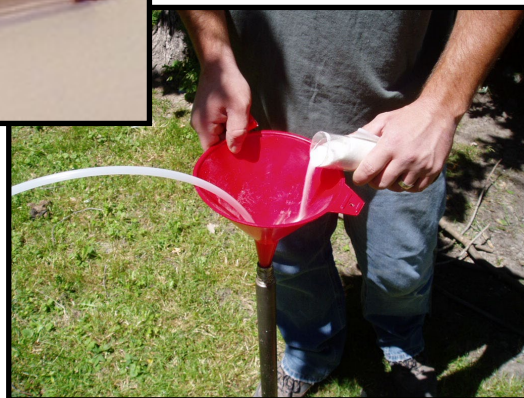
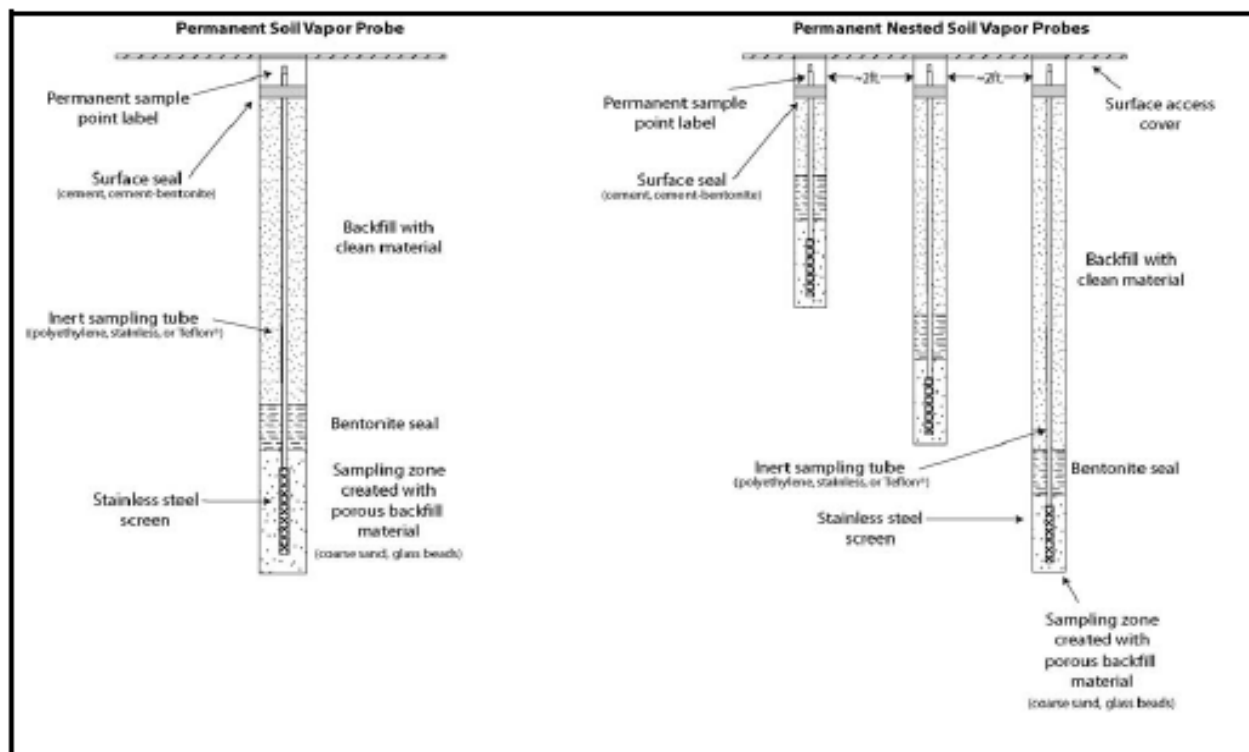
- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion to occur is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

MATRIX F Page 2 of 2

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 7

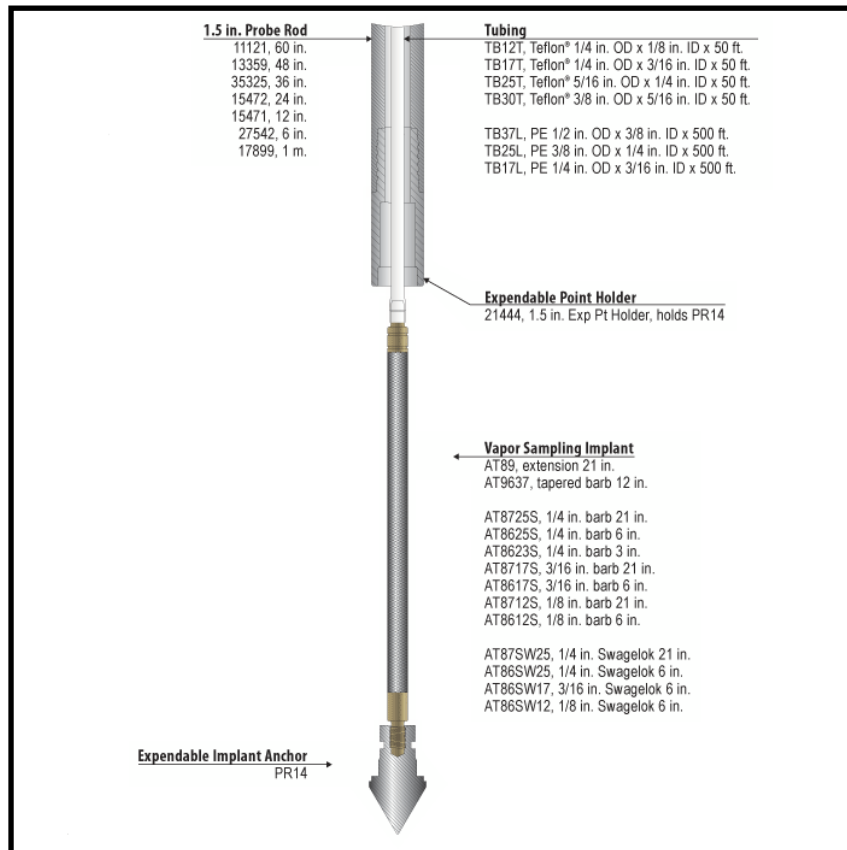
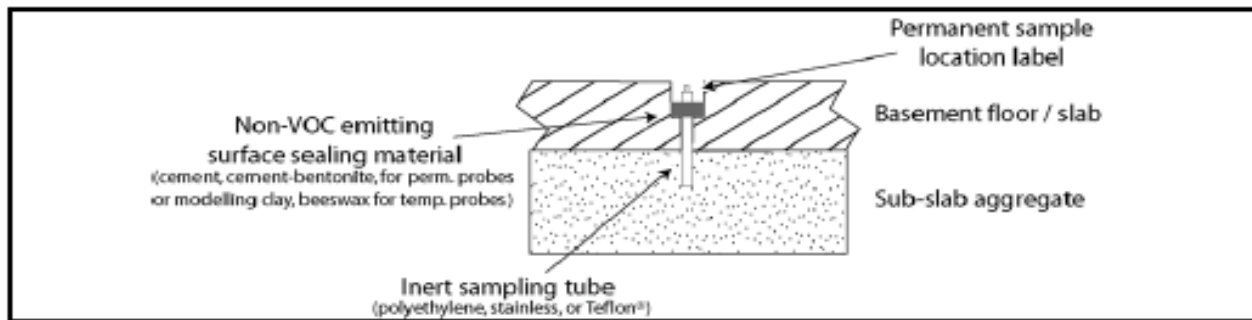
Schematics of a permanent soil vapor probe and permanent nested soil vapor probes



SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 8

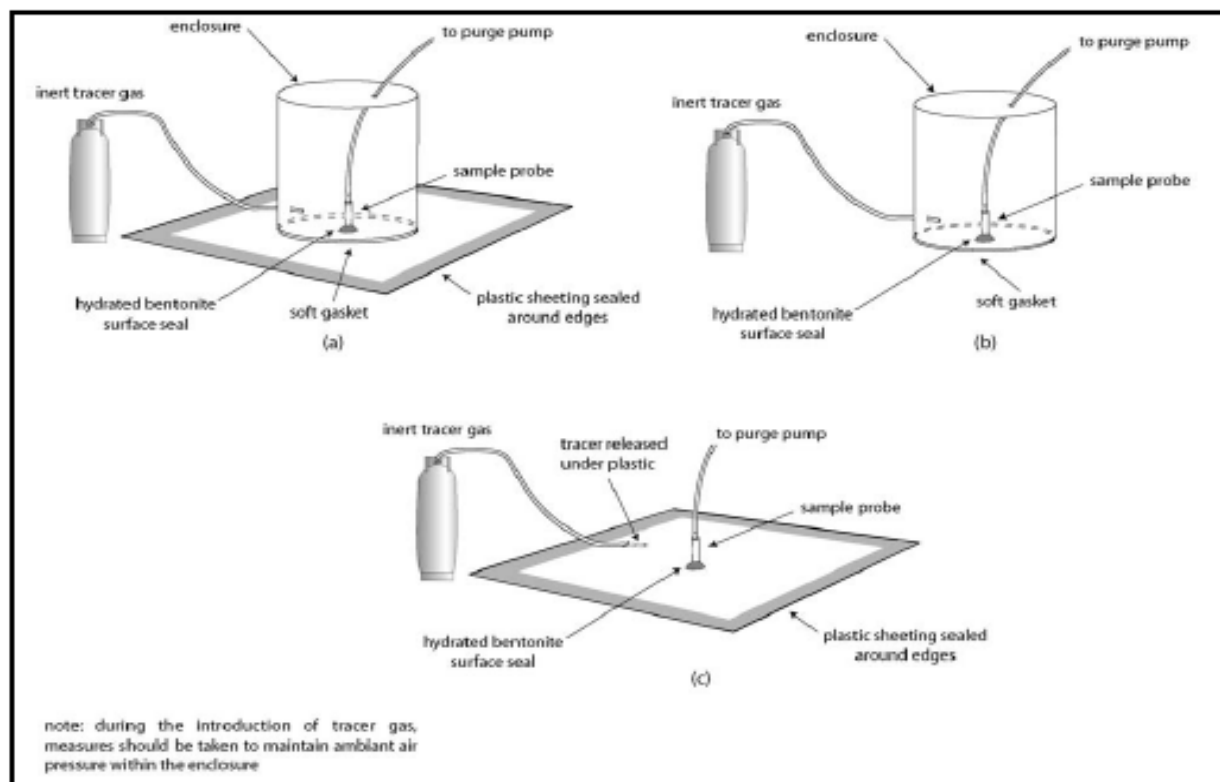
Schematic of a sub-slab vapor probe



SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 9

Schematics of tracer gas applications



SOIL VAPOR SAMPLE COLLECTION PROCEDURE



AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project: _____

Job No: _____

Location: _____

Field Staff: _____

Client: _____

SAMPLE I.D.: _____

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.: _____

Ambient Air Temp. - P.M.: _____

Wind Direction: _____

Wind Speed: _____

Precipitation: _____

Size of Canister: _____

Canister Serial No.: _____

Flow Controller No.: _____

Sample Date(s): _____

Shipping Date: _____

Sample Type: ☐ _____☐ _____

Soil Gas Probe Depth: _____

FIELD SAMPLING INFORMATION:

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check ¹				
Initial Field Vacuum ²				
Final Field Vacuum ³				
Duration of Sample Collection				

LABORATORY CANISTER PRESSURIZATION:

Initial Vacuum (inches Hg and psia)	
Final Pressure (psia)	
Pressurization Gas	

SUBSLAB SHROUD:

Shroud Helium Concentration: _____

Calculated tubing volume _____ x 3 = _____

Purged Tubing Volume Concentration: _____

Is the purged volume concentration less than or equal to 10% in shroud?

☐☐

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

1 Vacuum measured using portable vacuum gauge (provided by Lab)

2 Vacuum measured by canister gauge upon opening valve

3 Vacuum measured by canister gauge prior to closing valve

Signed: _____

SOIL VAPOR SAMPLE COLLECTION PROCEDURE

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

Project Name: _____ Project No. _____
 Project Location: _____ Client: _____
 Preparer's Name: _____ Date/Time: _____
 Preparer's Affiliation: _____ Phone No: _____

Purpose of Investigation: _____

1. OCCUPANT:
 Interviewed: ☐ yes ☐ no
 Last Name: _____ First Name: _____
 Address: _____
 County: _____
 Home Phone: _____ Office Phone: _____
 Number of Occupants/persons at this location: _____ Age of Occupants: _____

2. OWNER OR LANDLORD: (check if same as occupant)
 Interviewed: ☐ yes ☐ no
 Last Name: _____ First Name: _____
 Address: _____
 County: _____
 Home Phone: _____ Office Phone: _____

3. BUILDING CHARACTERISTICS:
 Type of Building: (check appropriate response)
☐ Residential ☐ School ☐ Commercial/Multi-use
☐ Industrial ☐ Church ☐ Other: _____
 If the property is residential, type (check appropriate response)
☐ Single Family ☐ 3-Family
☐ Raised Ranch ☐ Split Level ☐ Colonial
☐ Cape Cod ☐ Contemporary ☐ Mobile Home
☐ Duplex ☐ Apartment House ☐ Townhouse/Condo
☐ Modular ☐ Log Home ☐ Other: _____

If multiple units, how many? _____
 If the property is commercial, type?
 Business Type(s): _____
 Does it include residences (i.e., multi-use)? ☐ yes ☐ no If yes, how many? _____

Other Characteristics:
 Number of floors: _____ Building age: _____
 Is the building insulated? ☐ yes ☐ no How air tight? ☐ tight ☐ average ☐ not tight

Page 1 of 8

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

4. AIR FLOW
 Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:

Airflow between floors: _____

Airflow near source: _____

Outdoor air infiltration: _____

Infiltration into air ducts: _____

5. BASEMENT AND CONSTRUCTION DETAILS/REPAIRS (check all that apply)
 a. Above grade construction: ☐ wood frame ☐ masonry ☐ stone
 b. Basement type construction: ☐ full ☐ crawlspace ☐ slab
 c. Basement floor: ☐ concrete ☐ dirt ☐ stone
 d. Basement floor: ☐ finished ☐ covered ☐ covered with
 e. Concrete floor: ☐ unsealed ☐ sealed ☐ sealed with
 f. Foundation walls: ☐ poured ☐ block ☐ stone
 g. Foundation walls: ☐ unsealed ☐ sealed ☐ sealed with
 h. The basement is: ☐ wet ☐ damp ☐ dry
 i. The basement is: ☐ finished ☐ unfinished ☐ partially finished
 j. Sump present? ☐ yes ☐ no
 k. Water in Sump? ☐ yes ☐ no ☐ not applicable

Basement/Lowest level depth below grade: _____
 Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Page 2 of 8

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

6. HEATING, VENTING, AND AIR CONDITIONING (check all that apply)
 Type of heating system(s) used in this building: (check all that apply - note primary)
☐ Hot air circulation ☐ Heat pump ☐ Hot water baseboard
☐ Space Heaters ☐ Steam radiation ☐ Radiant floor
☐ Electric baseboard ☐ Wood stove ☐ Outdoor wood boiler
☐ Other: _____

The primary type of fuel used is:
☐ Natural Gas ☐ Fuel oil ☐ Kerosene
☐ Electric ☐ Propane ☐ Coal
☐ Wood ☐ Other: _____

Domestic hot water tank fueled by: _____
 Boiler/furnace located in:
☐ Basement ☐ Outdoor ☐ Attic ☐ Other: _____

Air Conditioning:
☐ Central Air ☐ Window units ☐ Open windows ☐ None

Are there air distribution ducts present? ☐ yes ☐ no

Describe the supply and cold air return openings, noting location where visible, including whether there is a cold air return and the tightness of each panel. Indicate the locations on the floor plan diagram.

7. OCCUPANCY
 Is basement/lowest level occupied? ☐ Full-time ☐ Occasionally ☐ Seldom ☐ Almost Never
 Level General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage)
 Basement _____
 First Floor _____
 Second Floor _____
 Third Floor _____
 Fourth Floor _____

Page 3 of 8


BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? ☐ yes ☐ no
 b. Does the garage have a separate heating unit? ☐ yes ☐ no ☐ NA
 c. Are petroleum-powered machines or vehicles stored in the garage? ☐ yes ☐ no ☐ NA
 (e.g., lawnmower, etc., etc) If yes, please specify: _____
 d. Has the building ever had a fire? ☐ yes ☐ no
 If yes, when? _____
 e. Is a kerosene or unvented gas space heater present? ☐ yes ☐ no
 If yes, when? _____
 f. Is there a workshop or hobby/craft area? ☐ yes ☐ no
 If yes, when? _____
 g. Is there smoking in the building? ☐ yes ☐ no
 If yes, when? _____
 h. Have cleaning products been used recently? ☐ yes ☐ no
 If yes, when? _____
 i. Have cosmetics or perfumes been used recently? ☐ yes ☐ no
 If yes, when? _____
 j. Has paint been standing in the last 6 months? ☐ yes ☐ no
 If yes, when? _____
 k. Is there new carpet, drapes, or other textiles? ☐ yes ☐ no
 If yes, when? _____
 l. Have air fresheners been used recently? ☐ yes ☐ no
 If yes, when? _____
 m. Is there a kitchen exhaust fan? ☐ yes ☐ no
 If yes, when? _____
 n. Is there a bathroom exhaust fan? ☐ yes ☐ no
 If yes, when? _____

Page 4 of 8



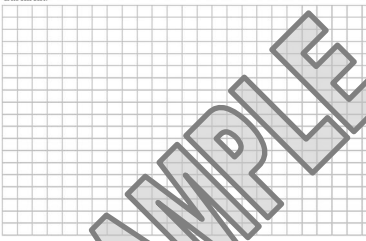
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INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

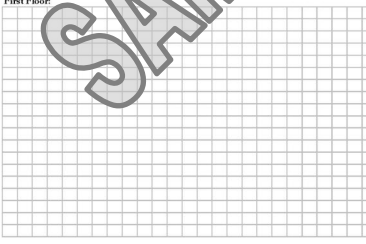
II. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement



First Floor



[illegible]