Data Collection: Vapor Intrusion Assessments

Soil vapor and indoor sampling

Catherine Regan, P.E. – Haley & Aldrich

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Agenda

1. What is vapor intrusion (VI)
2. VI conceptual site models
3. VI evaluations
4. Common sampling approaches
5. Common mistakes
6. Where to find more information

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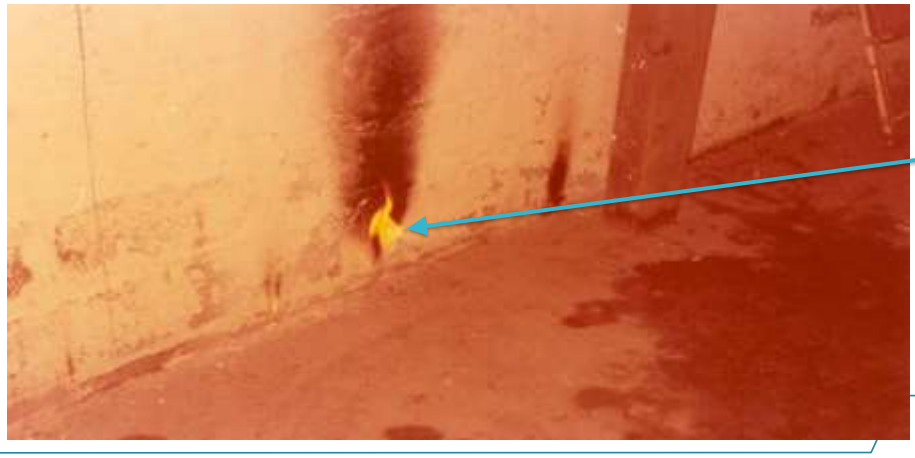
What is vapor intrusion (VI)

VI refers to movement of vapors from subsurface contamination into buildings and other structures



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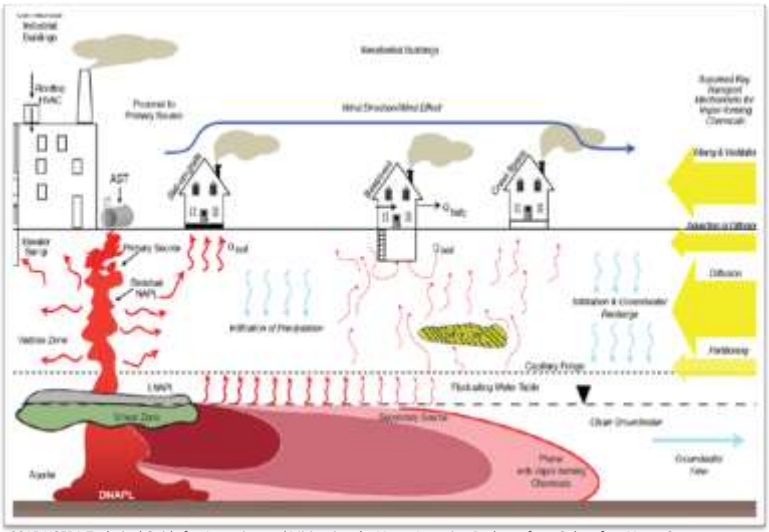
Conceptual site model (CSM) of VI



2015 USEPA Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air

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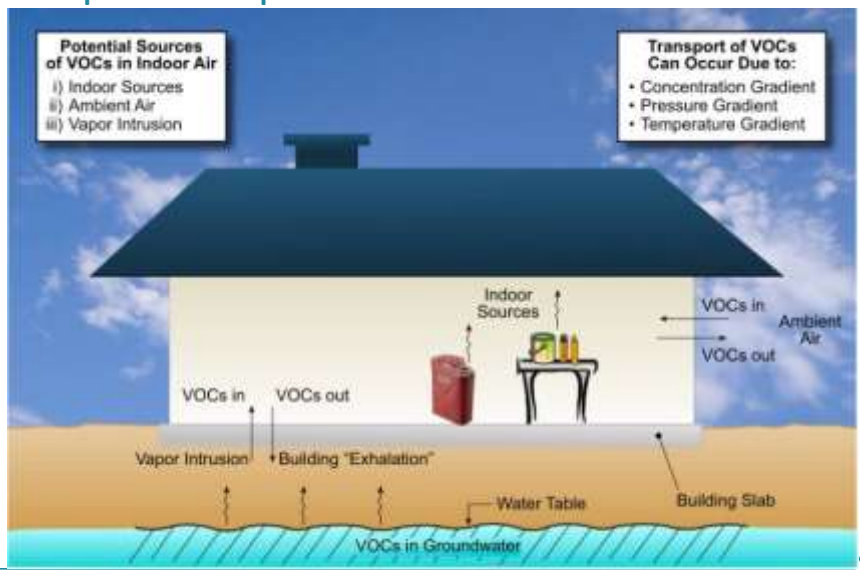
CSM of vapor transport



(Eklund, 2006)

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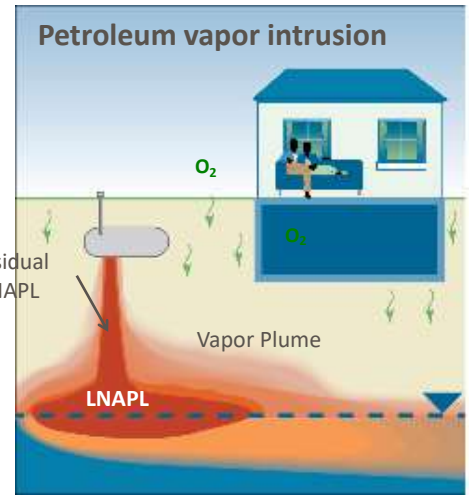
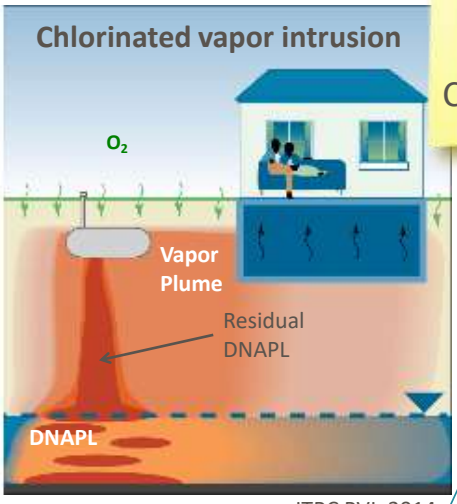
CSM consideration – type of VI

Petroleum VI ≠ Chlorinated VI





ITRC PVI, 2014

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Typical progression for evaluating VI

Step 1: Develop Site Conceptual Model

Step 2: Identify Applicable Guidance

Step 3: Perform Simple Screen

Step 4: Collect Data Outside of Building

Step 5: Collect Data Inside of Building

A VI evaluation approach:

Assessment of a vapor intrusion pathway should proceed iteratively as disposal site conditions and potential exposure concerns warrant and employ multiple lines of evidence in determining if the vapor intrusion pathway is likely to be of concern."
– 2016 MassDEP VI Guidance

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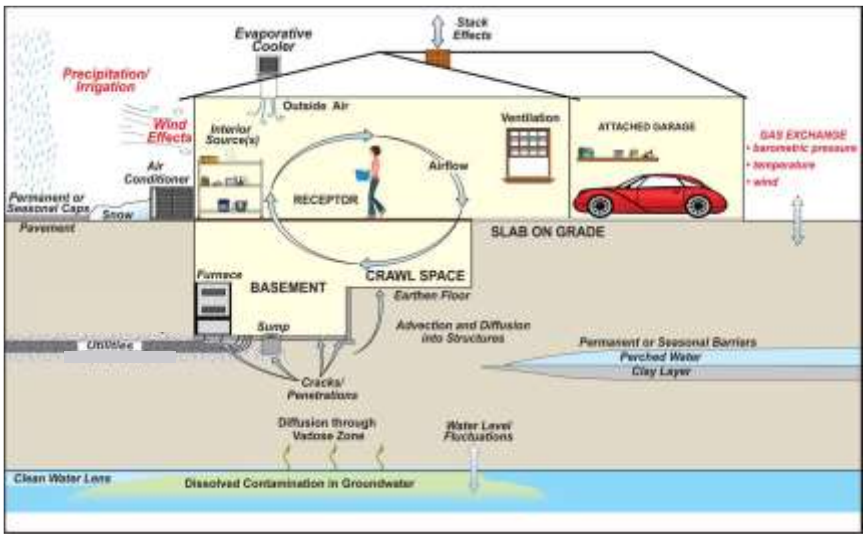
Key elements in assessing VI



Factors

1. Nature of contamination
2. Primary pollutants of interest
3. Concentration of contamination
4. Limits of contamination
5. Subsurface characteristics
6. Type of construction
7. Exposure scenario
8. Building ventilation
9. Background sources
10. Current use scenario

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Sampling approaches

What are some of the tools in our toolbox?

- ☑ Groundwater
- ☑ Soil sampling
- ☑ Soil gas
  - ☑ Exterior
  - ☑ Sub-slab
  - ☑ Near-slab
- ☑ Passive sampling
- ☑ High volume sampling
- ☑ Compound specific isotope analysis (CSIA)
- ☑ Hydrocarbon fingerprinting
- ☑ Indoor air sampling
- ☑ Outdoor ambient air sampling
- ☑ Crawlspace sampling
- ☑ Real-time monitoring
- ☑ Building pressure control testing
- ☑ Sewer/conduit sampling

☑ and many others!

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Sampling approaches

Tool	Relative advantages	Relative disadvantages
Soil gas Shallow - <5ft Deep - >5ft	• Existing data may already be available • Less chance to short circuit (> 5ft) • Temporal variations minimized (> 5ft)	• May not be representative of soil gas close to receptors • Greater temporal variability (<5ft) • May be conservative for screening purposes
Sub-slab soil gas	• Representative data closest to receptors • Preferred approach for some regulators	• Greater spatial variability • Intrusive (access agreements) • Need to confirm tightness of port and sample train • Could be influenced by interior sources
Indoor air	• Direct measurements of indoor air quality • May be more convincing to occupants	• Background indoor air sources • Intrusive (access, surveying, chemical inventory) • Temporal variability • Poor sample control
Crawlspace air	• Direct measurement of air under main occupied areas	• Possible background air sources • Intrusive (access, surveying, chemical inventory) • Temporal variability

Adapted from ITRC VI Guide, 2007

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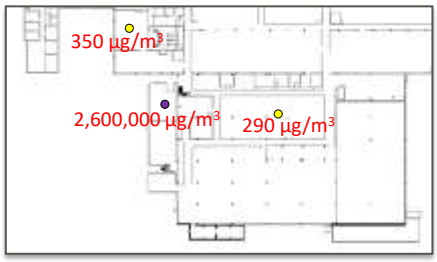
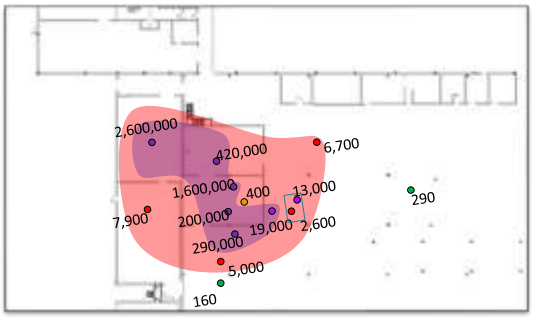
Soil gas/sub-slab sampling considerations

- ❑ Know your sampling objectives
  - ❑ Preliminary evaluation?
  - ❑ Exceedance of screening levels?
  - ❑ Delineation?
  - ❑ Risk to receptors?
  - ❑ Mitigation design?





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Soil gas/sub-slab sampling considerations

- ❑ Sample Type
  - ❑ Exterior – deep (>5 ft, shallow (<5 ft)
  - ❑ Sub-slab
  - ❑ Near-slab (if no access)
  - ❑ Passive Soil Gas Sampling
  - ❑ Permanent or temporary?

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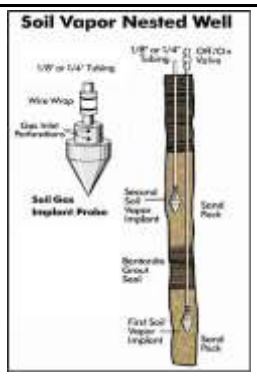

ITRC PVI-1, Figure G-7
Source: H&P Mobile Geochemistry

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Soil gas/sub-slab sampling considerations

Number and Location – more than "dots on a map"

- ❑ Sampling locations for exterior soil gas
  - ❑ Depth
  - ❑ Single or nested
  - ❑ Locations relative to building
  - ❑ Utilities
- ❑ Sampling locations for sub-slab:
  - ❑ Building square footage
    - ❑ Building/room use
    - ❑ Foundation information
    - ❑ Utility conduits
    - ❑ Openings for preferential soil gas entry

Source: MI EGLE

TIP: *Use video chat with your PM if you're unsure of sample locations.*

EPA Guidance Reference:

"…recommends site planning and data review teams consider collecting multiple samples per building when sub-slab soil gas sampling is conducted. Three sub-slab samples have been collected in a number of EPA investigations of a typical size residential building or commercial building less than 1,500 square feet in area." – Section 6.4.3 OSWER VI Guidance

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Soil gas/sub-slab sampling QA/QC

Consider and check for two types of leaks

- Leaks in the sample point,
  - Around the surface seal for sub-slab points
  - Probe construction (bentonite) for soil gas points
- Leaks in the sample train
  - Often where the tubing connects to the flow controller
- Leak checks may include
  - Water dam leak test
  - Helium leak test
  - Tracer gas leak test
  - Shut-in or vacuum test

Helium Shroud

Water Dam Test

Shut-in Test

TIP: *Use Nylon or Teflon® tubing (not poly, which may absorb VOCs).*

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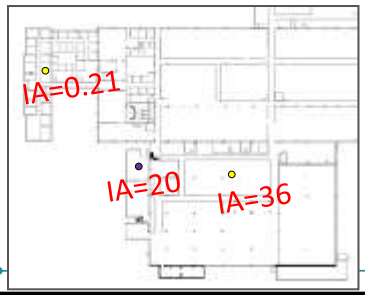
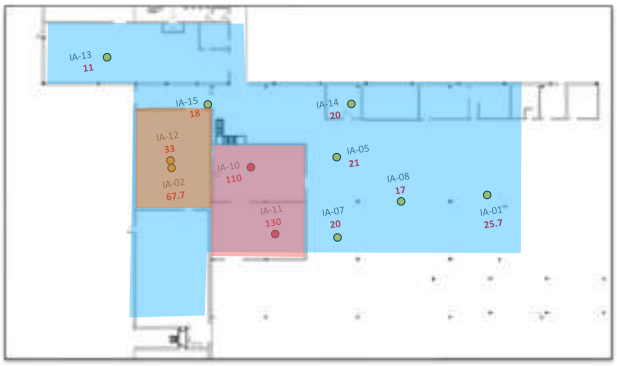
Indoor air sampling considerations

- ❑ What are your sampling objectives?
  - ❑ Initial evaluation
  - ❑ Identify/delineate exceedances
  - ❑ Evaluate risk to receptors
  - ❑ Identify background indoor air sources
  - ❑ Mitigation design
  - ❑ Current use versus future use





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Building Survey

- Completed prior to indoor air investigations
- Collect information on occupants
- Record general building characteristics
- Document HVAC system configuration, air flow
- Identify construction and potential migration pathways
- Chemical inventory
- Identify other factors that could influence results

INDOOR AIR BUILDING SURVEY
& SAMPLING FORM

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Building Survey

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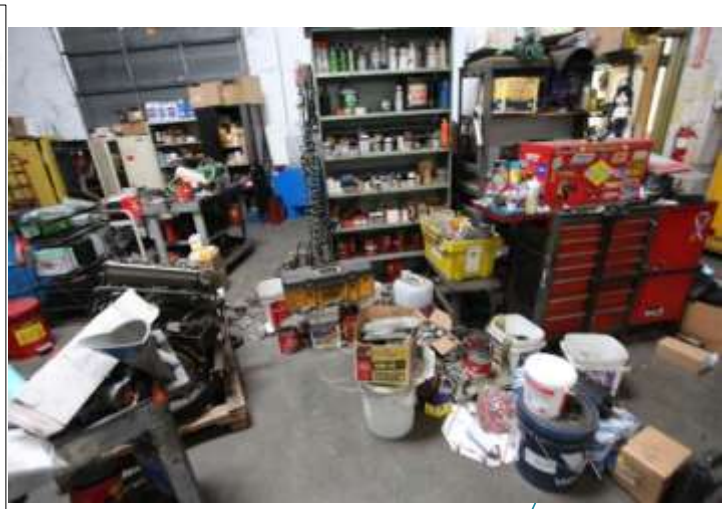
Chemical Inventory

TIP: *Photograph products if you can't physically write everything down (make sure you get relevant label information in picture).*

Part IV – Indoor Contaminant Sources

Identify all potential indoor sources observed in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. List items separately. To the extent possible, product labeling information should be examined and documented for items known or suspected to contain target compounds. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Source	Location	Removed (Yes/No/NA)
Gasoline storage cans		
Gas-powered equipment		
Kerosene storage cans		
Paints / thinners / strippers		
Automotive Aerosol Products		
Cleaning solvents		
Oven cleaners		
Carpet / upholstery cleaners		
Other house cleaning products		
Moth balls		
Dry-cleaned items		
Polishes / waxes		
Insecticides		
Furniture / floor polish		
Nail polish / polish remover		
Hairspray		
Cologne / perfume		
Air fresheners		
Fuel tank (inside building)		
Wood stove or fireplace		
New furniture / upholstery		
New carpeting / flooring		
Hobbies: glues, paints, etc.		
Other:		



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Examples of VOC Sources

- PCE > 95% by weight
- Can also include:
  - TCE
  - Toluene
  - Acetone

- Can include:
  - Toluene
  - Xylene
  - Ethylbenzene
  - Petroleum distillates

- Plastics can include:
  - 1,2 dichloroethane

- Can include:
  - TCE
  - Toluene
  - Acetone

- Can include:
  - Aromatic petrol. dist.
  - 1,2,4-TMB
  - 1,3,5-TMB
  - Xylene
  - Cumene

- Can include:
  - 1,4-Dioxane
  - Ethanol
  - Naphthalene
  - Benzene

Source: modified from H&P Analytical

Photo source: Lila Beckley, GS

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Indoor air sampling considerations

- ❑ Sample Type
  - ❑ Active or passive
  - ❑ Residential (active samples typically 24 hours)
  - ❑ Commercial (active samples typically 8-10 hours)

	Relative Advantages	Relative Disadvantages
Summa Canisters	Generally accepted by regulatory agencies	Can be perceived as dangerous looking
	Generally reliable for most compounds of interest	Limitation to about 24 hours per canister
	Generally can meet lower RLs	Larger volumes, high shipping costs
		More expensive
Passive Samplers	Smaller, innocuous-looking	Not yet widely accepted
	Smaller volume, lower shipping costs	Need some prior site knowledge
	Can be deployed 1-21 days	Regulator may require split sampling

Adapted from ITRC VI Guide, 2007

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Indoor air sampling considerations

- ❑ Sampling locations – more than "dots on a map"
  - ❑ Results of building survey/chemical inventory
  - ❑ Building footprint (ft^2)
  - ❑ Source location
  - ❑ Location of sub-slab samples
  - ❑ Preferential pathways
- ❑ During Sampling
  - ❑ Observe building use before and during sampling
  - ❑ Monitor vacuum through sampling period (close canister early or late as needed)

C. Regan, H&A

W. McKercher, MS DEQ

EPA Guidance Reference:

"For a typical-size residential building or a commercial building less than 1,500 square feet, EPA recommends….one time-integrated sample in the area directly above the foundation floor (basement or crawl space) and one from the first floor living or occupied area, at least for the initial sampling round." - Section 6.4.1 OSWER VI Guidance

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Outdoor ambient air sampling considerations

- ❑ **Sampling Locations**
  - ❑ Collected concurrent with indoor air sampling
  - ❑ Wind direction *may change
  - ❑ HVAC air intake locations
  - ❑ Security issues
- ❑ **During Sampling**
  - ❑ May need to set flow controllers for a longer sampling time than indoor air (i.e., open prior to indoor air samples and close around same time as indoor air)
  - ❑ Check and record vacuum drop during the day (may change speed in very cold weather)

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Data considerations

- Know which analytical method to use (e.g., TO-15, TO-15 Low Level, TO-15 SIM, TO-15 SIM/SCAN)
- Check can size dilution
- Check against your screening levels
- Check canister availability
- Check minimum sample volume needed
- Can you limit the list of reported analytes

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Common mistakes

- Sample locations
  - Soil gas sampling in water
  - Sub-slab samples from damaged soil vapor points
  - Sub-slab samples from points near floor cracks
  - Forgetting to label depths for nested soil gas probes

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Common mistakes

- Indoor environments
  - Sampling near high background sources
- Sampling errors
  - Forgetting to turn on sample canisters
  - Faulty flow controllers (going too fast or going too slow)

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Slide Source: ITRC PVI Training, 2018
Source: MI EGLE

Common mistakes

Project Manager
Collected by: (Print and Sign)
Company Email
Address City State Zip
Phone Fax

Project Info:
P.O. #
Project #
Project Name

Turn Around Time: ☐ Normal ☒ Flush 1 week
Lab Use Only: Pressurized by: Date: 9/17/09 Pressurization Gas: N_2 He

Lab I.D.	Field Sample I.D. (Location)	Can #	Date of Collection	Time of Collection	Analyses Requested	Canister Pressure/Vacuum Initial	Final	Receipt	Final
11A	01A SGW-138	7167	8/14	9:30am	TO15+NAPH+TPH+TICS	26.5	23.5	21.2 "Hg	15
12A	02A SGW-137	97108	8/14	9:45Am	"	28.5	23	22.4 "Hg	
13A	03A SGW-135	36459	8/14	9:50 Am	"	30.0	25	22.4 "Hg	
14A	04A SGW-114	34601	8/14	10:30Am	"	30	24	21 "Hg	
15A	05A SGW-117	9383AT	8/14	11:00 Am	"	28	18	18 "Hg	
16A	06A SGW-136	1445	8/14	4:55am	"	26	11.5	11.6 "Hg	
17A	07A Duplicate(ext)*	33396	8/14	—	"	27	11.5	12 "Hg	
18A	08A SGW-134	25603	8/14	11:25Am	"	25.5	20	20 "Hg	
19A	09A SGW-101	35554	8/14	12:20Pm	"	30	12	3.8 "Hg	
20A	10A SGW-132	12367	8/14	1:25 Pm	"	30	12	9.6 "Hg	

Relinquished by: (signature) Date/Time | Received by: (signature) Date/Time
Relinquished by: (signature) Date/Time | Received by: (signature) Date/Time
Relinquished by: (signature) Date/Time | Received by: (signature) Date/Time

Notes: * LEAK IN SAMPLING train on Intial vacuum Check

Lab Shipper Name Air Bill # Temp (°C) 0° Condition Custody Seals Intact? ✓ Work Order #

Common mistakes

- Data errors – units (µg/m3 ≠ ppb)
  - Units of ppm and ppb in gas systems are commonly calculated on a volume-per-volume basis, more accurately termed ppmV and ppbV

$$ppbV = \frac{24.45 \times ug/m^3}{MW}$$

MW = molecular weight in g/mole

Or…

$$\mu g/m^3 = \frac{MW \times ppbV}{24.45}$$

  - Example TCE (MW=131.4 g/mole)

1 µg/m^3 TCE converts to → 0.19 ppbV TCE

1 ppbV TCE converts to → 5.4 µg/m^3 TCE

***24.45 = volume in liters that a mole of a gas occupies when the pressure is at standard temperature and pressure

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Where to find more information

- www.itrcweb.org
  - VI guidance documents, 2007, 2014 (PVI) and 2022 (Mitigation)
  - New comprehensive document coming out in 2026
  - Free webinars (and archives of recordings)
- State regulatory guidance
  - See your local state guidance or EPA
  - Refer to other states guidance such as New Jersey, Wisconsin, Georgia, and others
- Keep up to date with ongoing studies/research

Open Access paper to Summary of all VI state guidance documents (as of 2022):

Groundwater Monitoring & Remediation

Open Access paper to recent background indoor air study in residential homes (2025)

Groundwater Monitoring & Remediation

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Questions?

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