Vapor Sampling Framework

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W-F2

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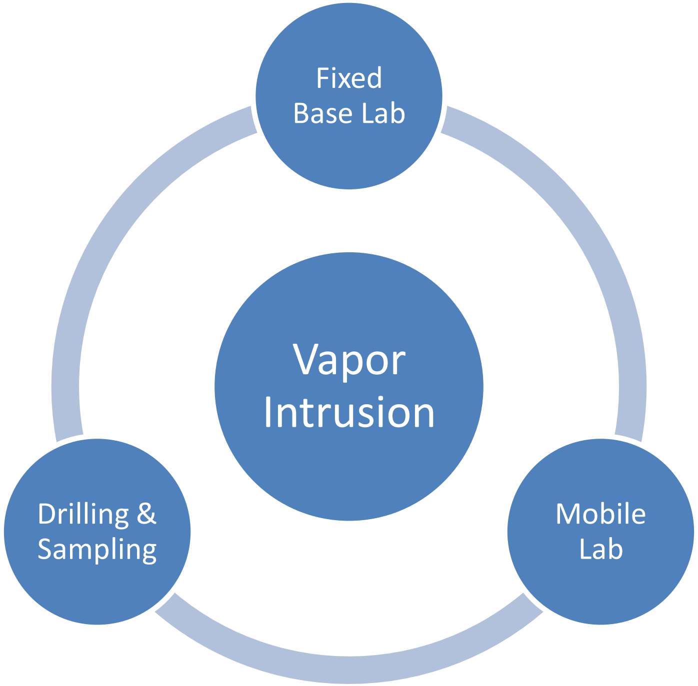
Vapor Sampling Data - GIGO to VIVO

- Garbage in = Garbage out

- Change that Garbage into VALUE

Background in Vapor Intrusion Sampling

- **Facets of H&P Mobile Geochemistry, Inc.**
- **High quality, unbiased, defensible data for vapor intrusion investigations**



Behind the Scenes at H&P

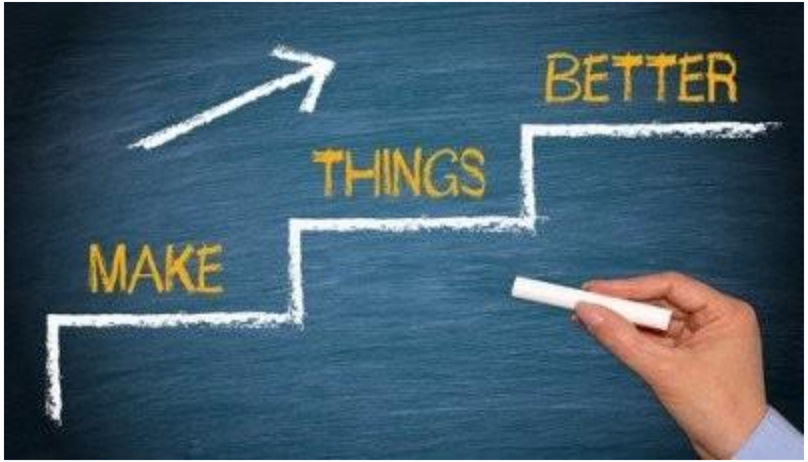
- Sampling Techs + Chemists discuss how site conditions are reflected in results

- Data objectives and processes have evolved over the past 20 years

Evolution of Vapor Intrusion Sampling

- Significant increase in volume and importance of active soil vapor data
- Lower screening levels
- Higher attenuation factors
- Greater cost of investigations

Framework for Active Soil Vapor Sampling



- Primary sampling techniques
- Parameters for evaluation
- Time to expect more

Installation Parameters

- ❑ Materials
- ❑ Subslab/Interslab
- ❑ Probe Placement
- ❑ Measurements

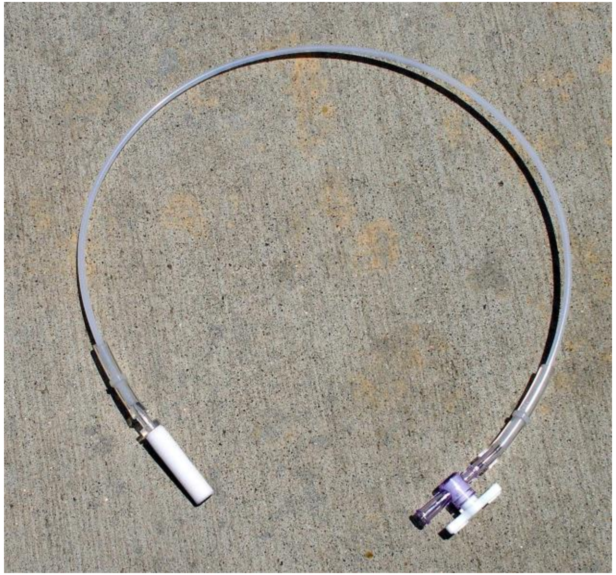
Vapor Probe Materials

2015 ASGI discusses several tubing types and annular seal methods.

H&P recommendations are:

- **Nylaflow has many advantages over Teflon tubing (kinking = leaks/no flow)**
- **Granular bentonite preferred over chips**
- **Hydration of bentonite granules in lifts provides a superior seal in small diameter borings**
  - ***Nebraska grout study (Lackey 2009) unapplicable to this application – conclusion states that the results were inconclusive and indicates further studies are underway.***

Equipment Blank

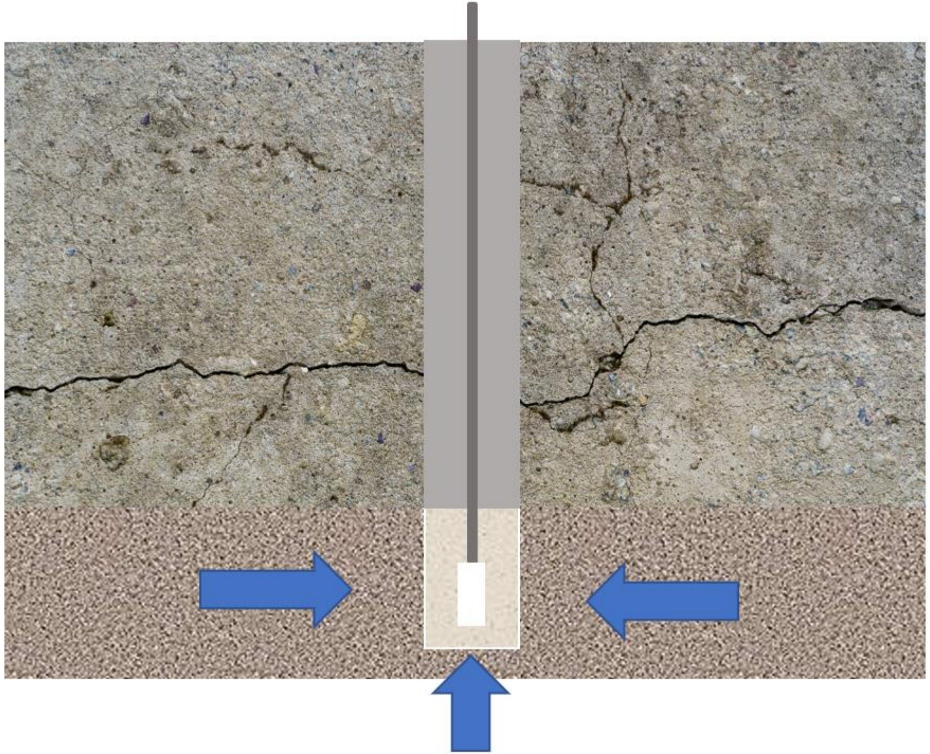


- Cal/EPA is flexible with regard to blank testing, but examples provided in 2015 ASGI are not all feasible.
- *Best method is to sample ambient air through a constructed probe at the surface, and to collect an ambient grab sample to qualify the source*
- A high quality subcontractor will also blank test all new batches of supplies

Subslab Sampling

Classic subslab probe

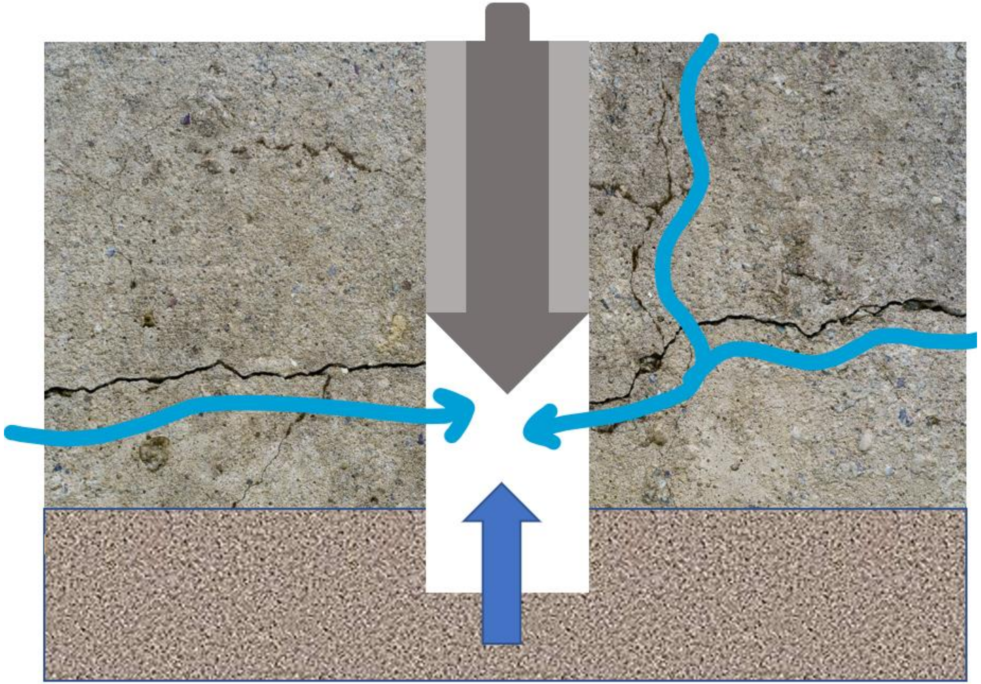
- Entire column drilled through the slab is sealed with bentonite or cement
- Vapor source is truly <u>sub</u>slab.



Interslab Sampling

Interslab Device

- Column is left open below the device
- Vapor source includes cracks and pathways within the slab (if present)

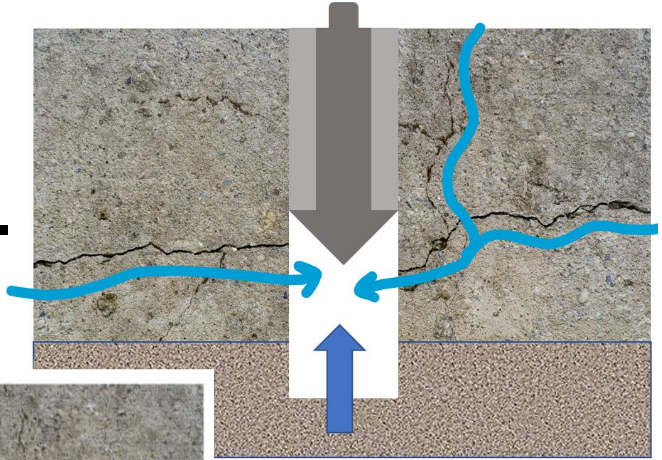


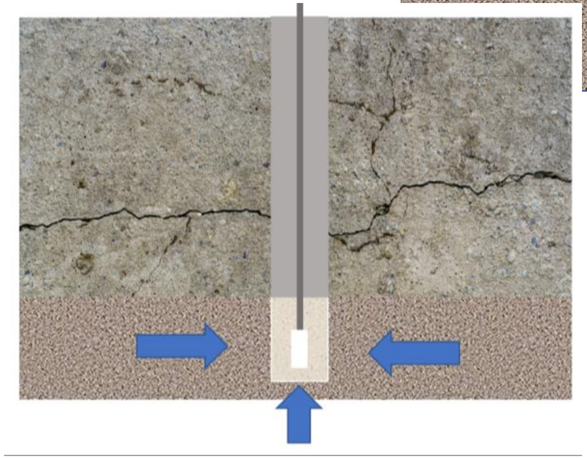
Subslab or Interslab

Valuable tools, but not synonymous.

Like any tool, consider appropriate use:

- **Slab thickness**
- **Slab condition**
- **Contaminant spills (slab is off gassing)**





Subslab Considerations

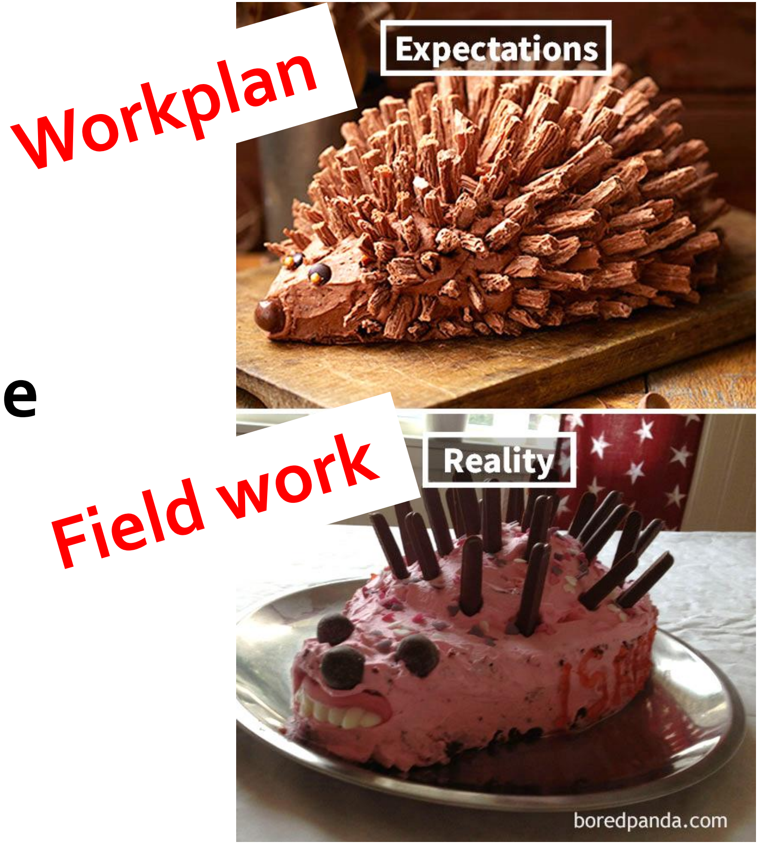
- Greater chance for communication (intake inches below the surface)
- Document all visible cracks and condition of concrete

Concrete degradation along rebar could create a preferential pathway

Probe Placement

Workplan vs. Field Work

Empower geologists onsite to make adjustments based on site conditions



Probe Placement

Adjust in the field laterally or vertically based on:

- **Lithology**
- **Surface condition**
- **Irrigation in planters**
- **Utilities**

Installation Field Records & Measurements

Accurate and detailed installation records are the first step toward proper sampling and avoiding a GIGO situation

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Installation Field Records & Measurements

- Installation of soil vapor or subslab probes
  - Drilling type(s) used
  - Type of sand, thickness, and diameter
  - Type of DRY bentonite, thickness, and diameter above and below sand
  - Type of annular seal
  - Subsurface filter type
  - Type of tubing, diameter, and depth
  - Surface termination
  - Specs of any installed support rods (which would minimize purge volume)
  - Record variable boring diameters (e.g. due to hand augering at surface, which could increase purge volume)

Installation Field Records & Measurements

- Extra considerations for installation of interslab probes
  - Total thickness of the slab (for void space purge calculations)
- Equilibration Time *(not discussed today, but important to document)*
- Equipment Blank
  - Description of the process
  - Documentation of subcontractor verification of materials
- Probe Placement
  - Proximity of scheduled irrigation
  - Lithology of sampling depth
  - Proximity of vapor exit points (cracks/cuts in pavement or slab, deteriorating conditions, etc)

Sampling Techniques and Parameters

- ❑ Purging
- ❑ Low flow
- ❑ Leak check
- ❑ Sample size
- ❑ Documentation

Purging Prior to Sampling

- Remove ambient air entrained during installation
- Remove stagnant air settled between events
- Calculate purge volume with porosity and volume of the materials (sand, dry bentonite, tubing).
- System volume x 3 purge volumes
  - Over-purging may increase zone of influence and introduce uncertainty of the sample source or invite leaks
  - Under-purging may bias results due to stagnant or ambient air being collected

Purging

Two 10 foot probes, two construction approaches, two very different volumes – Consider this when installation probes!

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CALC0003
Revision: 6
Revised: 8/8/2016
Effective: 8/9/2016
Page 1 of 1

Purge Volume Calculation Worksheet (Standard)

H&P Project #: Sample for QA/QC
Date: 7/15/05
Page: 1 of 1

Tubing Diameter:
1/4" OD = 0.177" ID
1/8" OD = 0.078" ID

*Reviewed:*_______
*Scanned:*_______

	Probe Specs							Volume Calculations					Purge Rate & Time	
	Point ID or Probe Type (i.e. all 5' probes, all 15' probes, etc)	Tubing Length (ft)	Tubing ID (in.)	Sand Ht (in.)	Sand Dia (in.)	Dry Bent. Ht (in.)	Dry Bent. Dia (in.)	*Volume of Tubing (1PV, cc)*	*Volume of Sand (1PV, cc)*	*Volume of Dry Bent (1PV, cc)*	*One System Volume (1PV, cc)*	**Three Purge Volumes (3PV, cc)**	Purge Flow Rate (mL/min)	**Purge Time for 3PV (hh:mm:ss)**
1	Direct Push, Stnd Sand	12	0.078	12	1	6	1	*11*	*62*	*39*	*112*	**335**	200	**0:01:40**
2	Hand Auger, Large Sand	12	0.177	18	5	12	5	*58*	*2317*	*1931*	*4305*	**12916**	200	**1:04:35**

Vacuum and Flow

- 100-200mL/min = flow rate assigned to active soil vapor sampling
- 100" or water or less = vacuum threshold assigned to active soil vapor sampling (aka milkshake effect)
- Faster purge rates can be utilized to decrease purge time and improve efficiency as well as sample quality

Low Flow Probes

Lithology does not have enough vapor to give at an active flow level, therefore vacuum exceeds 100" water

The most COMMON and the most DIFFICULT probe condition encountered

Low Flow Probes

DTSC ASGI 2015 suggests:
If low flow conditions are encountered, go slower… but how slow??

> ***Industry challenge – determine a minimum flow rate at which active soil gas sampling is no longer applicable**

Low Flow Probes

DTSC ASGI 2015 also suggests:
If low flow conditions are encountered, build a bigger probe.

BUT, this increases the purge volume, which increases the amount of air that needs to come out of the ground, which increases the zone of influence…and increases the problem

Low Flow Probes

The next suggestion is to only purge one volume of the tubing. In that case, why not just go back to the original probe and purge one volume of the tubing…without introducing a wider drilling technology and unnecessary materials into the ground?

Resistance would seem to indicate that the ambient air entrained or settled in the system has been exhausted.

Low Flow Probes

Low/No flow probes can also indicate:

- **Tubing is kinked**
- **Water or bentonite has clogged the probe**
- ***At least 1 volume of tubing should be achievable… if not, that is an indicator that the probe may have in installation problem***

Low Flow Probes

"Just get the sample!"
"I NEED a sample here."
"Do whatever you need to do!"

This mentality is toxic to morals in our industry

Leak Testing Methods

- Leak Prevention Steps
- Leak Check Compound Procedures
- Evaluation and Tolerance of Leaks

Leak Prevention: Shut-in Test

By applying vacuum to a closed sampling train, demonstrate that the sampling train from the probe valve to the sample container is free of leaks

Avoid preventable leaks and detect/correct before sampling

Leak Prevention: Reinforcing the Seal

Reinforce the probe seal at the surface:

- Mound of hydrated bentonite
- Water dam

Block leaking from occurring at the probe seal

Leak Prevention ≠ Leak Checking

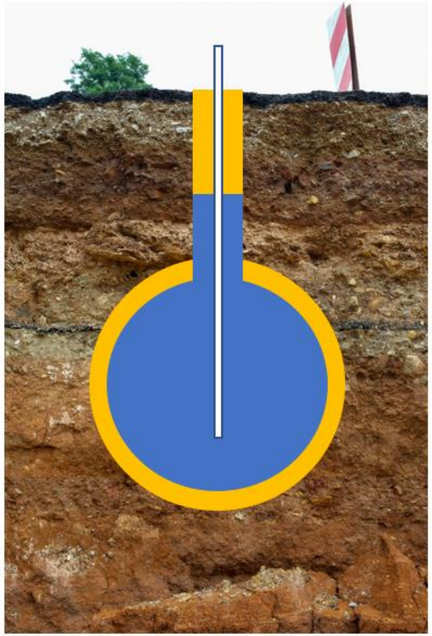
Checking for Leaks

1. Application of a tracer compound (liquid or gaseous)
2. Test the sample for the tracer to reveal leaks below the probe valve, leaks within or along the annular seal, and surface communication

Checking for Leaks during Purge & Sample

Application of the compound during purging AND sampling (not just one or the other) is important in order to test the cumulative impact of the air removal from the system.

Purging invites the initial airflow through the system, and the zone of influence increases as more air is removed for sampling.



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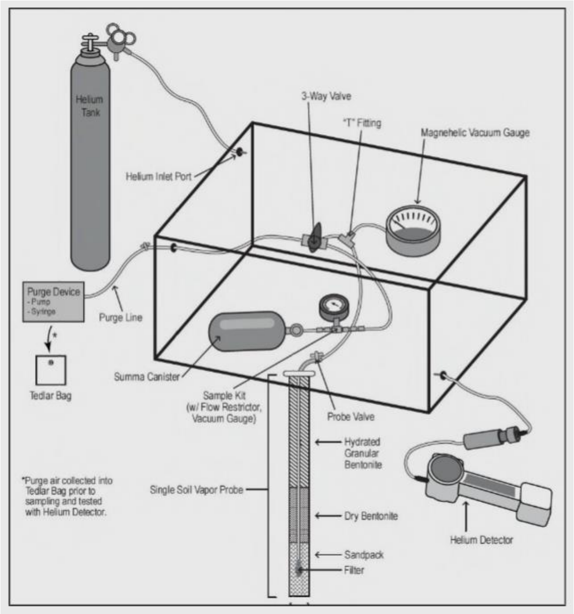
Liquid Tracer Method

- Compounds
  - 1,1-Difluoroethane
  - Isopropyl Alcohol
  - Other compound mixes
- Pros
  - Easy SOP to learn
  - Cost effective
- Cons
  - Qualitative
  - Zero tolerance threshold
  - Reapplication 5 minute intervals

Gaseous Shroud Tracer Method



- **Helium Shroud**
- **Pros**
  - **Quantitative PREVIEW**
  - **Higher tolerance threshold***
    - ***A pro to some, con to others**
- **Cons**
  - **Extra supplies needed**
  - **More cost and more time to train and perform the test**

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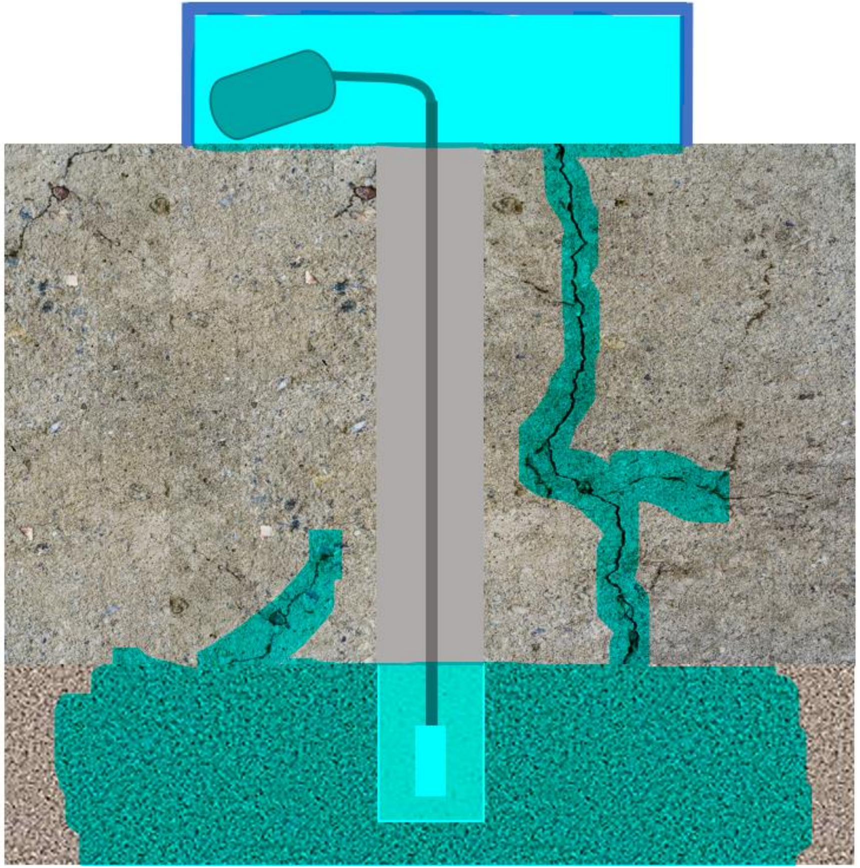
Gaseous Shroud Tracer Method

- **A bag style shroud does not perform the same test as a box shroud (or even as a liquid)**
- **Surface area surrounding the probe should be exposed to the tracer compound**

Gaseous Shroud Type

A box style shroud, with an open bottom, exposes the surface area surrounding the probes to nearby preferential pathways



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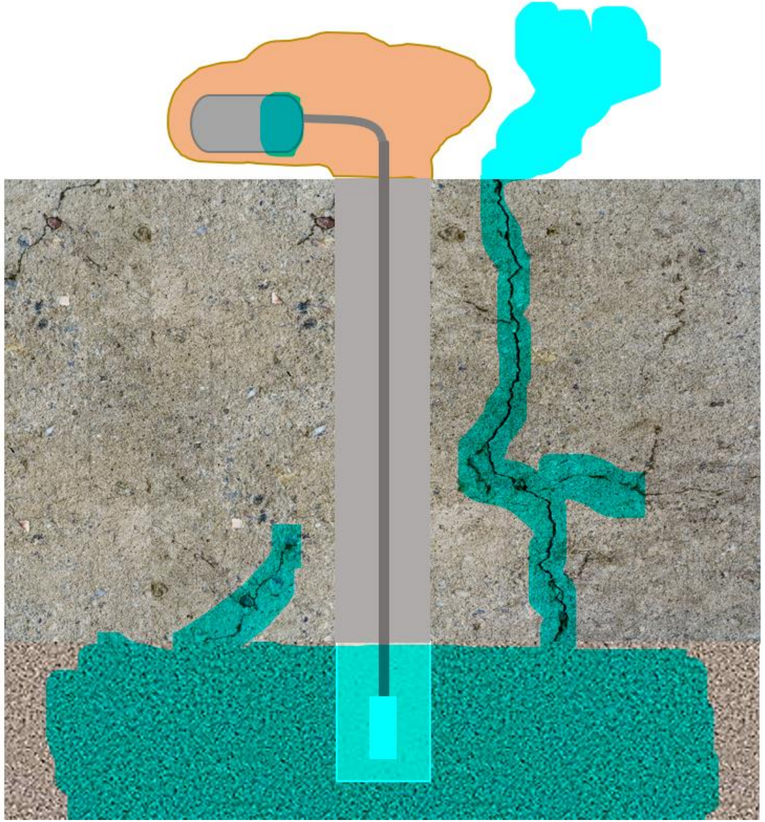
Gaseous Shroud Type

A bag style shroud that is designed to cover a small surface area (i.e. probe seal), will miss these leaks.

They are still occurring; you're just not catching them.



Leak Tolerance – DTSC Thresholds

The 2015 ASGI introduced a sliding scale for leak check tolerance that is inconsistently applied across labs and methods

Surface Concentration	500,000 ug/m3	Based on research by H&P, Inc. presented at AEHS in San Diego March 2013 and DTSC 2020
0.0108% Threshold	54 ug/m3	Current ASGI derived threshold using EPA TO-15 with a 1,1-DFA reporting limit of 5.4 ug/m3
1% Threshold	5,000 ug/m3	Current ASGI derived threshold using H&P 8260SV with a 1,1-DFA reporting limit of 500 ug/m3
2% Threshold	10,000 ug/m3	Pre 2015 DTSC ASGI recommended threshold
5% Threshold	25,000 ug/m3	Current ASGI suggested threshold for gaseous leak check methods (compared to what 5% of DFA would be)

Leak Tolerance and Evaluation

Statistically valid data points are being discarded or resampled (liquid tracers less than 1% leak)

Samples with larger leaks are being accepted (gaseous tracers with 5% leak)

Checking for Leaks vs Avoiding Leaks

<u>**We need to change the culture of leak evaluation**</u>

A detection of a leak check compound:

Tells you that communication is occurring with the ambient air.

Tells you that the sample results may be diluted with ambient air.

Tells you valuable information about a probe location.

Tells you to try to correct and resample, if possible.

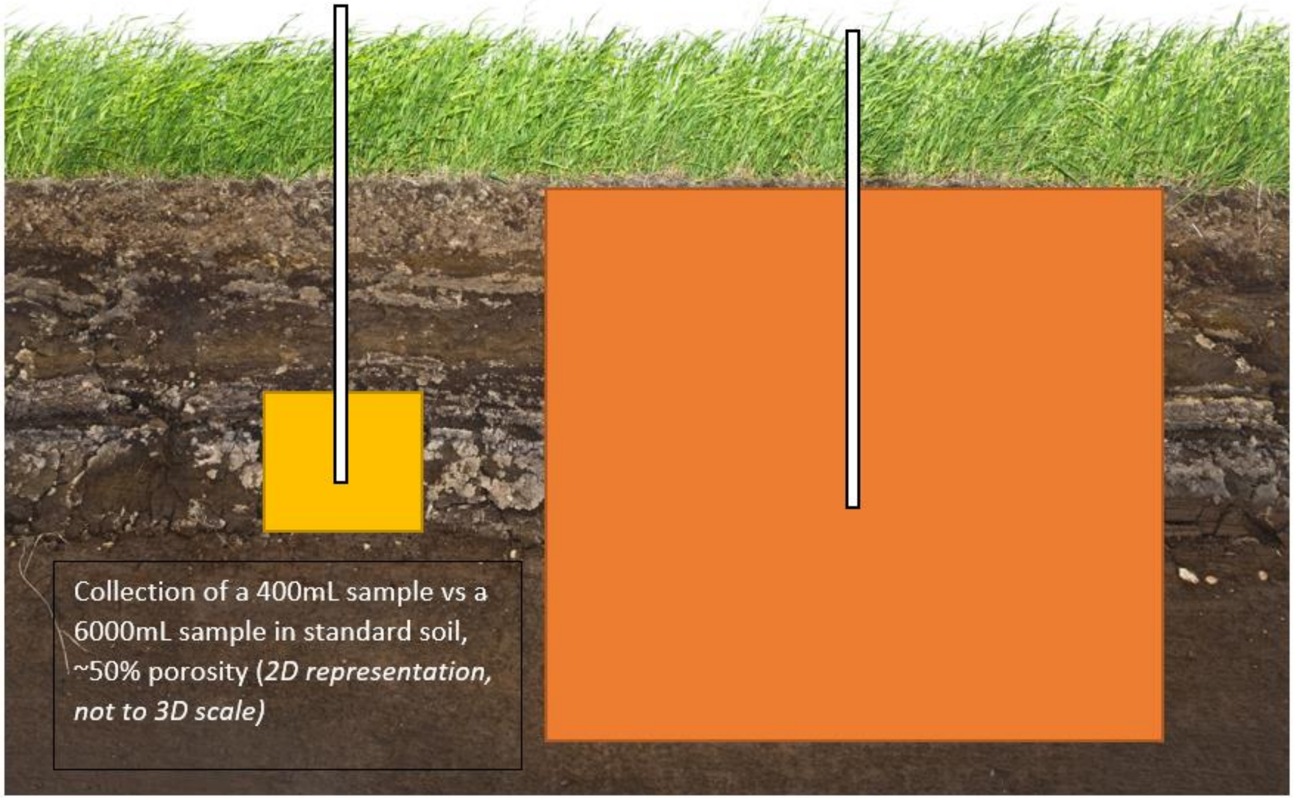
Does NOT tell you to throw the sample results away.

Soil Vapor or Subslab Sample Size

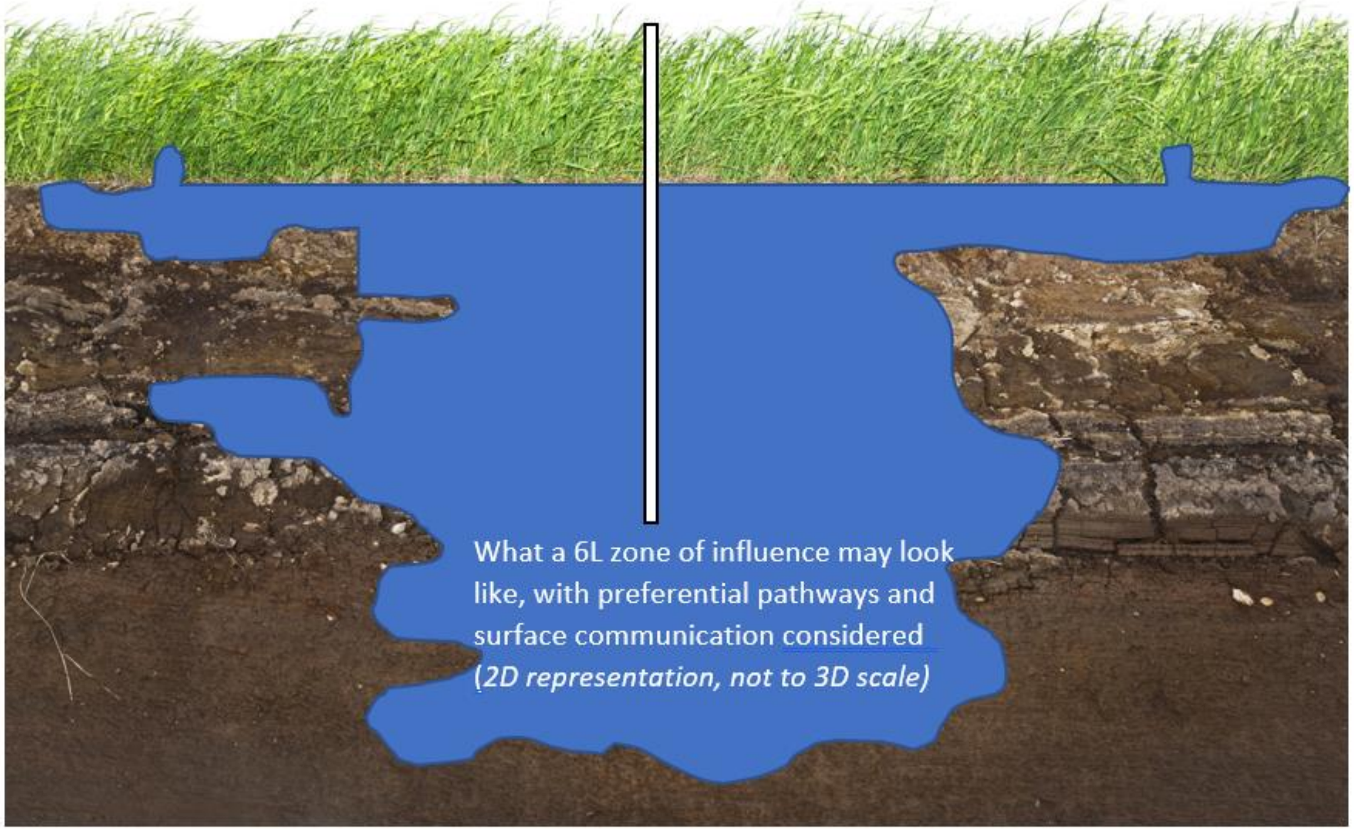
Max size recommended is 1 Liter
(photo of 6L compared to 400mL)

However, 6 Liter canisters are still being used every day for active soil gas sampling either due to canister demand or to achieve lower analytical reporting limits.

What does a sample size look like?



What a large sample size more likely looks like:



Sampling Field Records & Measurements

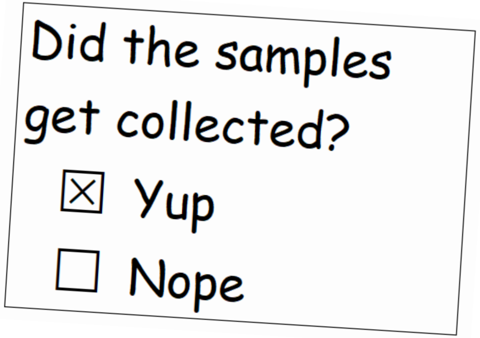
- ❑ Weather (including rain events in past 40 hours)
- ❑ Purging
  - ❑ Volume (show your work)
  - ❑ Flow rate(s)
  - ❑ Observations (fluctuating vacuum, moisture, smell, etc)
- ❑ Low Flow and Vacuum
  - ❑ You can never document too much here – all details may be important at the time of data evaluation
  - ❑ If a majority of a site has vacuum, except for a few probes, document it!

Sampling Field Records & Measurements

- ❑ Leak Prevention and Leak Check Procedures
  - ❑ Visual surface check, document conditions, cracks, etc
  - ❑ Condition of tubing
  - ❑ Condition of seal at the surface
  - ❑ Nearby irrigation should be noted
  - ❑ Shut-In test (vacuum and duration)
  - ❑ Was the probe seal reinforced with water or bentonite
  - ❑ Leak check compound used and frequency of reapplication
  - ❑ Leak check application type (cloth, box shroud, bag shroud, etc)
- ❑ Sample Size

Equal Importance

Process to Evaluate Installation & Sampling



Process to Evaluate Laboratory Data

Compliance Screening ***Also referred to as:*** • CCS (EPA) • QA-1 (PSDDA/PSEP) • Cursory • Verification	♦ Holding Times ♦ Method Blank ♦ Accuracy (LCS, MS/MSD, Surrogate) ♦ Precision (MS/MSD, Lab Dup)	♦ Chains of Custody ♦ Sample Result Summaries ♦ Method Blank Summaries ♦ LCS, MS/MSD and Surrogate %R Summaries ♦ Lab Dup, MS/MSD RPD Summaries
Summary Validation ***Also referred to as:*** • Level 3 (EPA CLP) • Level C (Navy) • Screening (AFCEE) • M-2 (organics EPA Region 3) • IM-2 (inorganics EPA Region 3) • CLP summary form review	***Compliance Screening plus:*** ♦ Initial Calibration (ICAL) ♦ Continuing Calibration (CCAL) ♦ Instrument Blanks ♦ Internal Standards ♦ Additional QC (Serial Dilutions, Post Spike Recoveries)	***Screening Summaries plus:*** ♦ ICAL and CCAL Summaries ♦ Instrument Blank Summaries ♦ Internal Standard Summaries ♦ Additional QC Summaries ♦ Raw Data is not required but is highly recommended
Full Validation ***Also referred to as:*** • Levels 4 and 5 (EPA CLP) • Levels D and E (Navy) • QA-2 (PSDDA/PSEP) • Definitive (AFCEE) • M-3 (organics EPA Region 3) • IM-3 (inorganics EPA Region 3)	***Summary Validation plus:*** ♦ Compound Identification ♦ Compound Quantitation ♦ Transcription Checks	***All of the above plus:*** ♦ All Raw Data (this includes all calibration and associated QC samples) ♦ Instrument Run Logs ♦ Sample Prep Logs ♦ Percent Solids Bench Sheets

OK – I get it – but how to expect more?

H&P holds NEFAP accreditation for our active soil vapor sampling services. Our team goes through a specific and continued training program with the goal of providing unbiased, consistent, and defensible sampling techniques to this industry.

Per DTSC 2012 ASGI (Evaluate sampling in the same manner):

"Certification ensures that the laboratories have the requisite facilities, equipment and personnel to perform the testing, and have demonstrated competence and compliance with the methods being certified. In addition, certification entails the validation of the analytical method as well as periodic checks with performance evaluation or blind samples (where available) to assess laboratory continued competence with the method."

Vapor Intrusion - GIGO VIGO VIVO

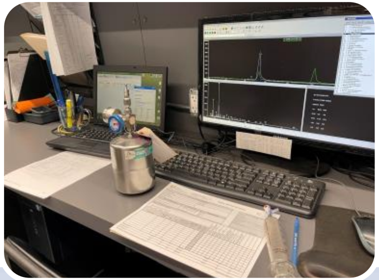
Data quality

+

Report quality

=

Quality of the result



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Quality
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Any Questions?

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