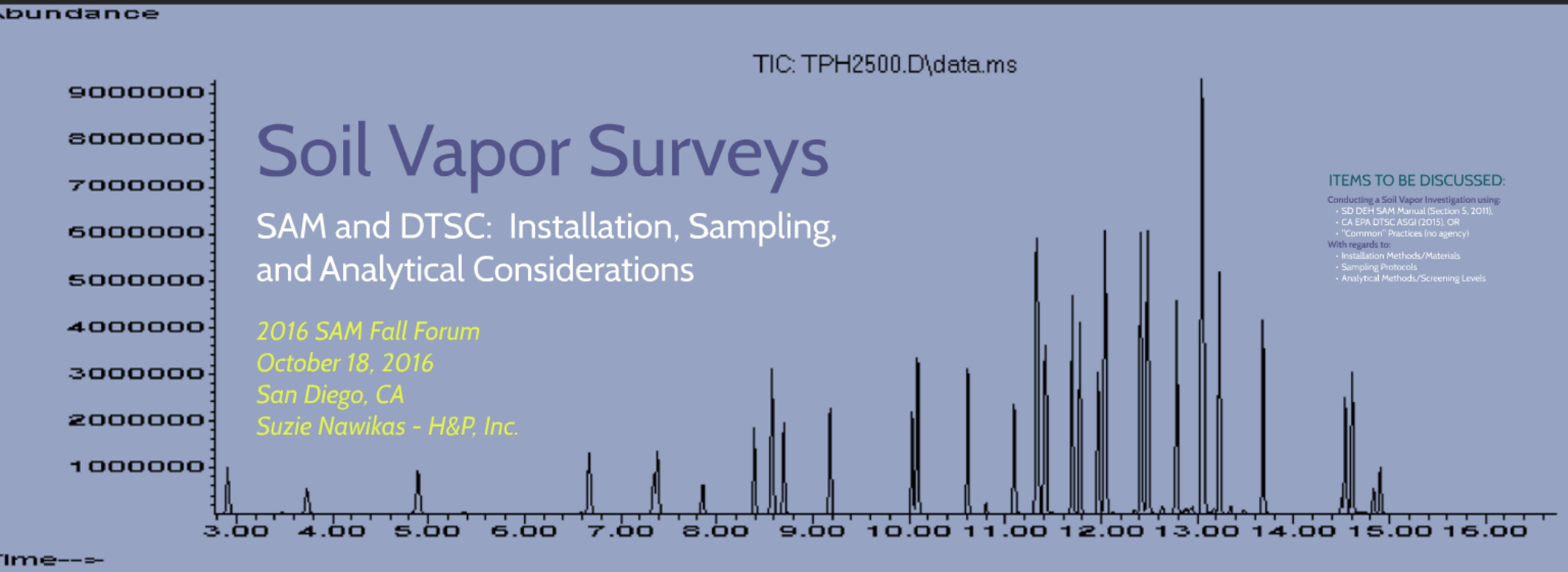


Soil Vapor Surveys

SAM and DTSC: Installation, Sampling, and Analytical Considerations

2016 SAM Fall Forum
October 18, 2016
San Diego, CA
Suzie Nawikas - H&P, Inc.

ITEMS TO BE DISCUSSED:

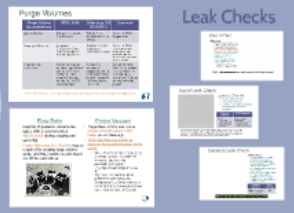
Conducting a Soil Vapor Investigation using:
- SD DEH SAM Manual (Section 5, 2011),
- CA EPA DTSC ASGI (2015), OR
- "Common" Practices (no agency)

With regards to:
- Installation Methods/Materials
- Sampling Protocols
- Analytical Methods/Screening Levels

Installation Methods: DPT & Auger

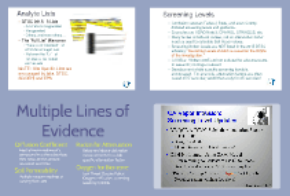
Installation Materials

Soil Vapor Sampling Protocols



Soil Vapor Sampling Containers

Analytical Considerations



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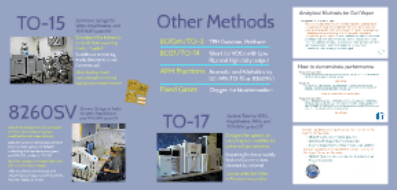

IN SUMMARY

- *It is important to know what your project objectives are, and how to best accomplish them with regards to the regulatory agency you are collaborating with, whether it be SD DEH, DTSC, or another agency (or no agency).*
- *Soil vapor is an evolving science, with changes and advancements happening all of the time. Thinking outside of the box is encouraged!*

QUESTIONS?

Suzie Nawikas
H&P Mobile Geochemistry, Inc.
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Office: 760.804.9678
Cell: 858.401.3032

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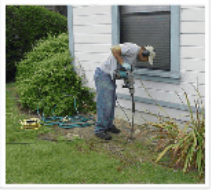
Installation Methods: DPT & Auger

Drive Point/Handprobe (through the rod)



- Benefits and Considerations
  - No introduction of foreign material
  - Tubing is connected and seal confirmed before installation
  - Sampling range 3-ft to 5-ft bgs
  - Access to 2+ locations at a time ideal
  - A lot of moving around on-site
  - Not recommend for consolidated lithologies

Drive Point Handprobe	DTSC 2015	Other (e.g. SD DEH 2011)	"Common"
Equilibration Time	Not Specified	30 minutes	20 minutes per EPA study

PRT (Post Run Tubing)

- Benefits and Considerations
  - No introduction of foreign material
  - Difficult to test tubing connection with LCC, must wait to confirm at surface
  - Multi depth sampling capabilities
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PRT Sampling	DTSC 2015	Other (e.g. SD DEH 2011)	"Common"
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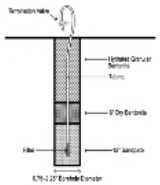
Vapor Well (Permanent or Temporary)

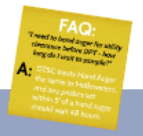


- Benefits and Considerations
  - Variety of drilling methods; direct push, auger, etc.
  - Introduction and documentation of sand and bentonite
  - Multi depth/nested sampling
  - DPT installation is quick, minimizing duration of drilling
  - Can be left in place if needed for re-sampling
  - Inefficient in loose soils (i.e. holes collapsing)

Vapor Well w/ Sand	DTSC 2015	Other (e.g. SD DEH 2011)	"Common"
Equilibration Time **for Direct Push**	120 minutes	8 hours* *(usually next day)*	30 minutes

Other Drilling Methods

- Auger Drilling
  - Equilibration time = 48 hours
    - Any auger method, including hand auger or hollow stem
  - Equilibration period applies to probes set within 5-ft of the auger zone, per DTSC 2015
  - "Common" practice is to allow for 2-ft of undisturbed soil, or having the sand and dry bentonite in undisturbed zones, at a minimum.
- Air Rotary, Sonic, Mud Rotary
  - Air/Sonic viable if equilibration can be demonstrated
  - Mud is not recommended



Analyte Lists

- DTSC 2015: 3 Lists
  - Aromatic & Oxygenated
  - Halogenated
  - Others, and even others…
- The "Full List" Misnomer

Screening Le

- Confusion between dictated screening
- Examples are HER
- Many tables provid must be used to ca

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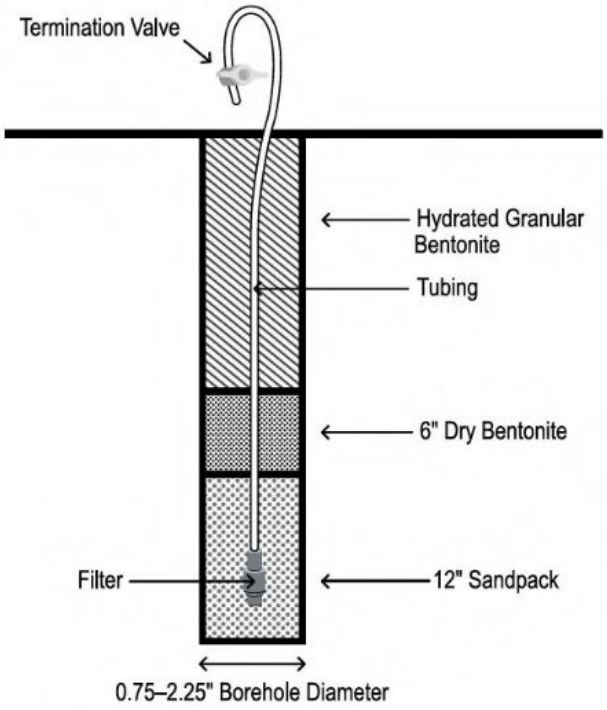

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FAQ:

"I need to hand auger for utility clearance before DPT - how long do I wait to sample?"

A: DTSC treats Hand Auger the same as Hollowstem, and any probes set within 5' of

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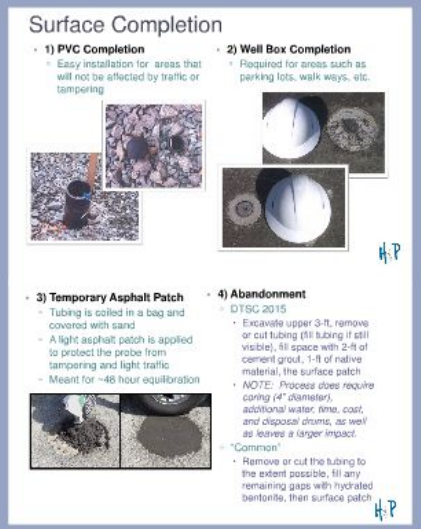

Sand and Bentonite

- **Annular Bentonite Seal**
  - Options for bentonite hydration
    - **Common:**
      - Hydrate in lifts (i.e for every ½ cup of bentonite, add ½ cup water; 12" in a 1.5" boring)
    - **DTSC Temporary <365 days**
      - Hydrate bentonite grout at the surface, then pour or pump into boring (tremie >15-ft)
    - **DTSC Permanent >365 days**
      - Neat cement with >5% bentonite, hydrate at the surface then pour or pump into boring (tremie >15 ft)
- **Dry Bentonite**
  - 6-in of dry granular bentonite above the sand pack (and below, for nested probes)
- **Sand**
  - Typically #3 kiln dried sand
  - Note that for soil vapor probes, **the sand is the actual filter** for the sampling zone*
    - *The probe filter is meant to keep debris out of the tubing

Consider your project time and cost constraints when selecting an annular seal option

d even County

TO-15 *Summa or Syringe for*


Tubing Types
Nylaflow - 1/8" or 1/4"
Teflon - 1/4"
Stainless Steel - 1/4"
FAQ:
"What type of termination should I use?"
A: There are a lot of good choices. However, any sampling that will be done should require an on/off valve, such as a one-way valve or a way to attach a one-way valve.
Filter Options
Airstone Filter (Temporary <4 weeks)
Stainless Steel Implant (Permanent)
Stainless Steel Screen - 6' (Permanent)

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Surface Completion

- **1) PVC Completion**
  - Easy installation for areas that will not be affected by traffic or tampering

- **2) Well Box Completion**
  - Required for areas such as parking lots, walk ways, etc.

- **3) Temporary Asphalt Patch**
  - Tubing is coiled in a bag and covered with sand
  - A light asphalt patch is applied to protect the probe from tampering and light traffic
  - Meant for ~48 hour equilibration

- **4) Abandonment**
  - DTSC 2015
    - Excavate upper 3-ft, remove or cut tubing (fill tubing if still visible), fill space with 2-ft of cement grout, 1-ft of native material, the surface patch
    - *NOTE: Process does require coring (4" diameter), additional water, time, cost, and disposal drums, as well as leaves a larger impact.*
  - "Common"
    - Remove or cut the tubing to the extent possible, fill any remaining gaps with hydrated bentonite, then surface patch

Soil Vapor Sampling Protocols

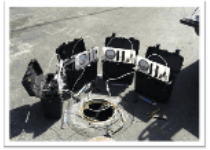
Purge Volumes

Purge Volume Considerations	DTSC 2015	Other (e.g. SD DEH 2011)	"Common"
System Volume	Tubing, Filter, Sand, Dry Bentonite	Tubing, Filter, Sand (or default to DTSC)	Default to DTSC Suggestions
Porosity of Materials	Sand 40% Dry Bentonite 50% *H&P concurs with the porosities via lab tests*	No specifications for porosity *H&P defaults to DTSC*	Default to DTSC *Note however that before 2012, dry bentonite was not included and sand was purged at 30%*
Purge Volume Calculation	Always use 3 purge volumes, regardless of equilibration time or number of times sampled. A purge volume test is NOT recommended	1-3 system volumes is suggested, and the sand need only be purged if sampled the same day as installation	3 purge volumes. Note that for probes that are subject to re-sampling, at minimum of 1 tubing volume should be purged

Note: For sites that are sampled regularly, consistency often overrules updated suggestions.

Flow Rate

- Majority of guidance documents agree with a recommended ≤200mL/min during purging and sampling
- Faster flow rates (i.e. 5L/min) may be required for purging large volume wells, and this practice is acceptable per DTSC and others



Probe Vacuum

- Regardless of flow rate, probe vacuum should remain <100" Water (or <8" Mercury)
- Flow rate does not matter as much as the applied vacuum to the probe:
  - Vacuum conditions during purging or sampling may indicate that "there is likely too little permeability to get an uncompromised sample" SD DEH 2011
  - High vacuum leads to leaks, preferential pathways, etc. Samplers should take note and a consultant should always consider vacuum when evaluating data

Leak Checks

Shut In Test

This is a leak prevention step, not a replacement for a leak check compound

Liquid Leak Check

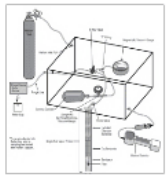
Liquid: 1,1-DFA or IPA

- Saturated cloth method
- Full strength chemical
- Excellent for mobile lab sampling and acceptable for summa sampling

"Common" Threshold	DTSC Threshold
10 ug/L • ~1.0% leak* • Other states, SD DEH, DTSC pre 2012, etc	10x the analytical reporting limit • TO-15 = 0.05 ug/L • 8260/5V = 1 ug/L • ~0.1%-0.005% leak*

*Pure 1,1-DFA is 1,580,300 ug/L when it equilibrates to its vapor pressure. However, Solid sets show concentrations at the sampling point of 1,580-19,300 ug/L after 5 minutes of exposure. Even with the conservative 1,300 ug/L surface concentration, a detection of 10 ug/L in the sample would represent a leak of approximately 1% or less.

Gaseous Leak Check



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*NOTE: SD DEH allows up to a 15% leak in a sample

IN SUMMARY

- *It is important to know what your project*

er Methods

Analytical Methods for Soil Vapor

Per Appendix F of DTSC 2015, Page 1:

"There are no approved USEPA methods specifically designed to analyze volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in soil gas samples. Consequently, modified versions of existing USEPA methods are used to analyze soil gas samples…These modified methods can be used provided they have been validated and it can be demonstrated

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Shut-In Test

- Based on H&P's experience and certified sampling protocols, this is **the single most important step in the sampling process**
- Suggested in the DTSC Advisory as well as many others, but the importance is often not emphasized
- Connect sampling train, then apply a minimum 100" water vacuum for 60 seconds*

**H&P recommends longer for larger sample containers (i.e. half the RP time)*

This is a *leak prevention step*, not a replacement for a leak check compound

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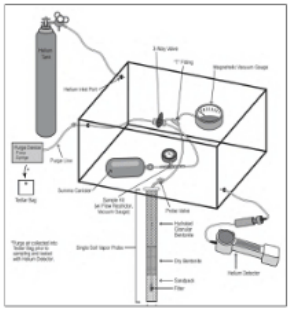

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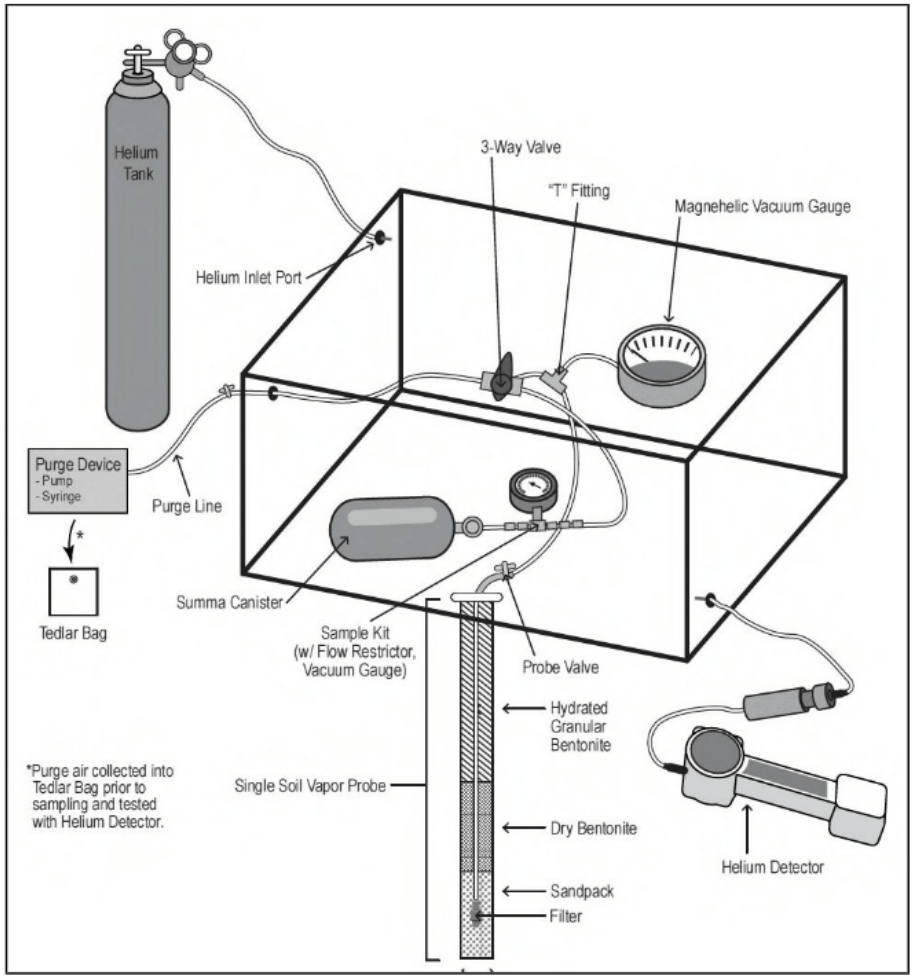

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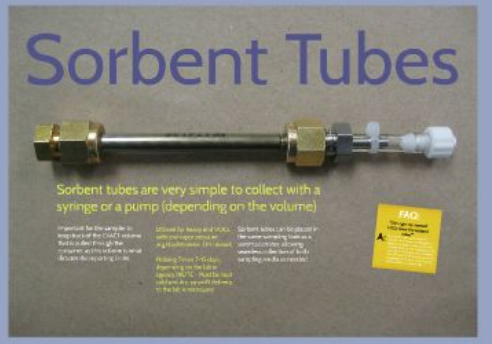
Soil Vapor Sampling Containers

Tedlar Bags



QUESTIONS?

Summa Canisters

Holding Time 30 days

NOTE: SD DEH suggests 14 days for some COCs (not identified).

6 Liter

Designed for 8-24 hour ambient air sampling, but not recommended for soil vapor sampling.
Larger sample volume allows the laboratory to reach indoor air screening values.

1 Liter

Versitile size can be used for soil vapor, subslab, and even ambient air sampling.

The reporting limits that can be achieved will depend on the laboratory capabilities.

400 mL

Ideal size for discrete soil vapor sampling, especially in areas with high moisture and/or tight lithologies where sample volume is difficult to obtain.
Plenty of sample volume to obtain soil vapor and subslab screening values, with multiple analyses for dilutions/reruns.

...and smaller

Many labs even have smaller 200mL canisters for VOC analysis by TO-15!
It is no longer necessary to use bulky 6L canisters for every project, saving time and transportation costs.

FAQ:

"What is the difference between batch and individual certification?"

A: All canisters are cleaned the same way. In a batch of 10-20 canisters, to batch certify, the canister that had the densest sample is tested to check the batch for cleanliness. Individual means that each canister is tested to verify cleanliness. Hence more cost.

FAQ:

"What size canister do I put in my work plan?"

A: Ask your lab, or leave room for flexibility if it is going out to bid. The lab will determine the most appropriate size based on the DQOs and their own instrument capabilities.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Tedlar Bags

Helpful for sites with moisture or SVE checks

Holding Times:
SD DEH Fuels: 2-3 days
SD DEH Solvents: 3+ days
DTSC: 6 Hours
EPA: 3 days
Missouri DNR: 5 days

Option to down fill into a summa canister to obtain longer holding times

Syringes

For use with a mobile laboratory laboratory, due to short holding times:

- SAM: 30 minutes
- DTSC: 30 minutes
- H&P Certifications: 15 minutes

Gas tight, cleaned and tracked between samples, simple to collect, and small sample volumes

VOCs, TPH, Fixed Gases, etc.

Sorbent Tubes

Sorbent tubes are very simple to collect with a syringe or a pump (depending on the volume)

Important for the sampler to keep track of the EXACT volume that is pulled through the container, as this volume is what dictates the reporting limits.

Utilized for heavy end VOCs with low vapor pressure (e.g.Naphthalene, TPH diesel)

Holding Times 7-15 days, depending on the lab or agency (NOTE - Must be kept cold and dry, so swift delivery to the lab is necessary)

Sorbent tubes can be placed in the same sampling train as a summa canister, allowing seamless collection of both sampling media as needed.

FAQ:

"Can I get my normal VOCs from the sorbent tube?"

A: Yes (for the most part). Just like summa canisters are not designed to capture the heavier end compounds, sorbent tubes are not designed for the very light end compounds. However, most of the VOC list that you are used to getting from a summa can also be reported from a sorbent tube.

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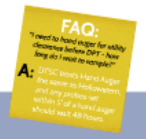
holes collapsing)

Vapor Well w/ Sand	DTSC 2015	Other (e.g. SD DEH 2011)	"Common"
Equilibration Time **for Direct Push**	120 minutes	8 hours* *(usually next day)*	30 minutes

bentonite in undisturbed zones, at a minimum.



Analytical Considerations

Analyte Lists

- DTSC 2015: 3 Lists
  - Aromatic & Oxygenated
  - Halogenated
  - Others, and even others…
- The "Full List" Misnomer
  - There is no "standard" list of VOCs amongst labs
  - Not even the "full" list includes all calibrated compounds

NOTE: Site Specific Lists are encouraged by labs, DTSC, SD DEH, and EPA

Screening Levels

- Confusion between Federal, State, and even County dictated screening levels and guidance.
- Examples are HERO Note 3, EPA RSL, SFRWQCB, etc.
- Many tables provide Air values, but *an attenuation factor* must be used to calculate Soil Vapor values.
- Screening/Action Levels are NOT listed in the 2015 DTSC advisory: "Reporting Levels should be based on the DQOs of the investigation."
- CHHSLs: Written 2005 and not updated for advancements in research; no longer relevant
- Development of site specific screening levels is encouraged. For example, attenuation factors are often based on 5' samples; would that apply for 25' samples?

Multiple Lines of Evidence

Diffusion Coefficient
Inject a known volume of a compound into the subsurface, then measure the amount recovered over time

Soil Permeability
Multiple vacuum readings at varying flow rates

Radon for Attenuation
Below and above slab radon measurements for a slab specific attenuation factor

Oxygen for Bio-zone
Low Threat Closure Policy: Oxygen >4% raises screening levels by 1,000x

CA Vapor Intrusion: Screening Level Updates

- RWQCB & DTSC Subslab Attenuation Factors
  - DTSC: 0.05
  - RWQCB: 0.002
  - Major Disconnect! 25x difference!
- DEH No Longer Using SAM Model
  - Now referring consultants to use DTSC model
  - Result: 25x decrease in 5' SG screening levels
- EPA R9 Coming Out with Urgent SG Levels
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(slide courtesy of FBH)

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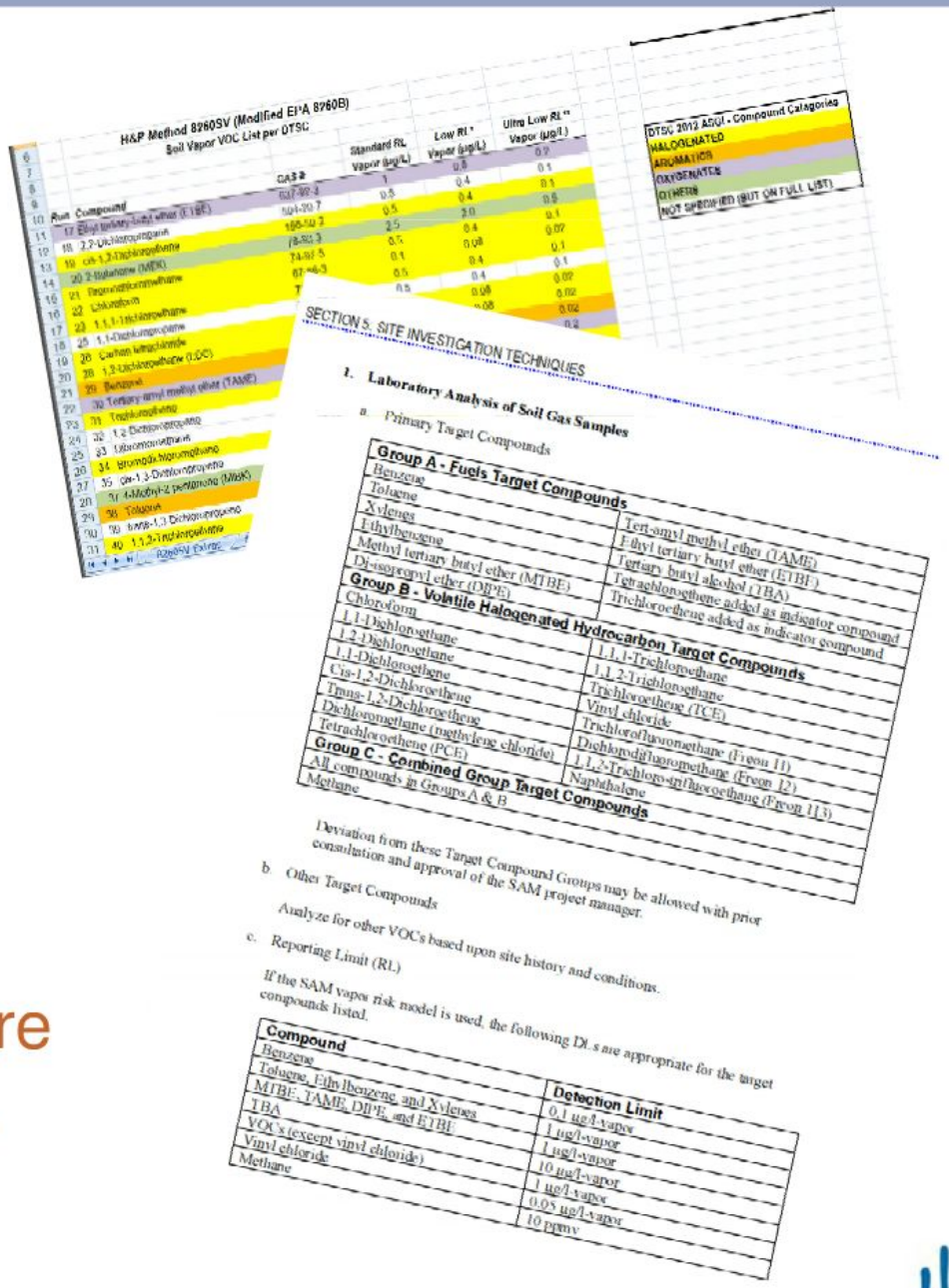

H&P Method 8260SV (Modified EPA 8260B)
Soil Vapor VOC List per DTSC

Run	Compound	CAS #	Standard RL Vapor (ug/L)	Low RL * Vapor (ug/L)	Ultra Low RL ** Vapor (ug/L)
17	Ethyl tertiary-butyl ether (ETBE)	637-92-3	1	0.4	0.1
18	2,2-Dichloropropane	594-20-7	0.5	0.4	0.05
19	cis-1,2-Dichloroethene	156-59-2	2.5	0.4	0.1
20	2-Butanone (MEK)	78-93-3	0.5	0.08	0.02
21	Bromochloromethane	74-97-5	0.1	0.4	0.1
22	Chloroform	67-66-3	0.5	0.4	0.05
23	1,1,1-Trichloroethane		0.5	0.08	0.02
24	1,1-Dichloropropene			0.08	0.02
25	Carbon tetrachloride				0.2
26	1,2-Dichloroethane (1,2DC)				
27	Benzene				
28	Tertiary-amyl methyl ether (TAME)				
29	Trichloroethene				
30	1,2-Dichloropropane				
31	Dibromomethane				
32	Bromodichloromethane				
33	cis-1,3-Dichloropropene				
34	4-Methyl-2-pentanone (MIBK)				
35	Toluene				
36	trans-1,3-Dichloropropene				
37	1,1,2-Trichloroethane				

DTSC 2012 ASV - Compound Categories
HALOGENATED
AROMATICS
OXYGENATES
OTHERS
NOT SPECIFIED (BUT ON FULL LIST)

SECTION 5: SITE INVESTIGATION TECHNIQUES

1. **Laboratory Analysis of Soil Gas Samples**

a. Primary Target Compounds

Group A - Fuels Target Compounds	
Benzene	Tert-amyl methyl ether (TAME)
Toluene	Ethyl tertiary butyl ether (ETBE)
Xylenes	Tertiary butyl alcohol (TBA)
Ethylbenzene	Tetrachloroethene added as indicator compound
Methyl tertiary butyl ether (MTBE)	Trichloroethene added as indicator compound
Di-isopropyl ether (DIPE)	
Group B - Volatile Halogenated Hydrocarbon Target Compounds	
Chloroform	1,1,1-Trichloroethane
1,1-Dichloroethane	1,1,2-Trichloroethane
1,2-Dichloroethane	Trichloroethene (TCE)
Cis-1,2-Dichloroethene	Vinyl chloride
Trans-1,2-Dichloroethene	Trichlorofluoromethane (Freon 11)
Dichloromethane (methylene chloride)	Dichlorodifluoromethane (Freon 12)
Tetrachloroethene (PCE)	1,1,2-Trichlorotrifluoroethane (Freon 113)
Group C - Combined Group Target Compounds	Naphthalene
All compounds in Groups A & B	
Methane	

Deviation from these Target Compound Groups may be allowed with prior consultation and approval of the SAM project manager.

b. Other Target Compounds

Analyze for other VOCs based upon site history and conditions.

c. Reporting Limit (RL)

If the SAM vapor risk model is used, the following DLs are appropriate for the target compounds listed.

Compound	Detection Limit
Benzene	0.1 ug/l-vapor
Toluene, Ethylbenzene, and Xylenes	1 ug/l-vapor
MTBE, TAME, DIPE, and ETBE	1 ug/l-vapor
TBA	10 ug/l-vapor
VOCs (except vinyl chloride)	1 ug/l-vapor
Vinyl chloride	0.05 ug/l-vapor
Methane	10 ppmv

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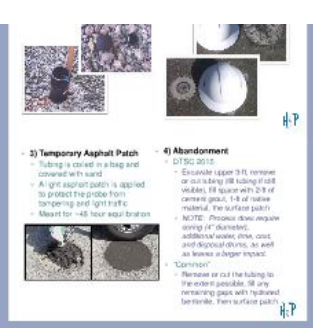


- 6-in of dry granular bentonite above the sand pack (and below, for nested probes)
- **Sand**
  - Typically #3 kiln dried sand
  - Note that for soil vapor probes, the sand is the actual filter for the sampling zone!
    - The areas filter is meant to keep debris out of the tubing

Consider your project time and cost constraints when selecting an annular seal option

Protocols

- Major
- Faste

Analytical Methods

TO-15

Summa or Syringe for VOCs, Naphthalene, and TPH/APH up to C12

Developed for indoor air analysis (low reporting limits, <1 ppbv)

Satisfies air screening levels (Residential and Commercial)

Ideal for low level samples with minimal background interference

8260SV

Summa, Syringe, or Tedlar for VOCs, Naphthalene, and TPH/APH up to C12

8260B developed for soil and water, but the method has long been modified for soil vapor analysis

8260SV is the certified equivalent of the modified version of 8260B (including strict performance goals and QA/QC similar to TO-15)

Ideal for samples with both high and low contamination ranges

Able to achieve commercial and residential soil vapor screening levels, but not indoor air levels

Other Methods

8015m/TO-3	TPH Gasoline, Methane
8021/TO-14	Short list VOCs with Low RLs and high daily output
APH Fractions	Aromatic and Aliphatics by GC/MS (TO-15 or 8260SV)
Fixed Gases	Oxygen for bioattenuation

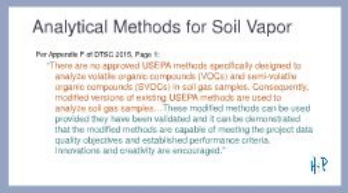
TO-17

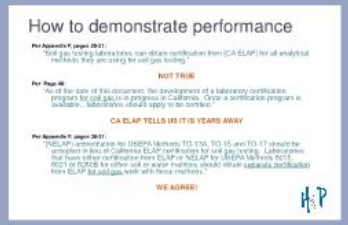
Sorbent Tube for VOCs, Naphthalene, PAHs, and TPH/APH up to C21

Designed for passive air sampling, but modified for active soil gas sampling

Reporting limits can satisfy Resi and Comm values (dictated by volume)

Can be collected inline with a summa canister





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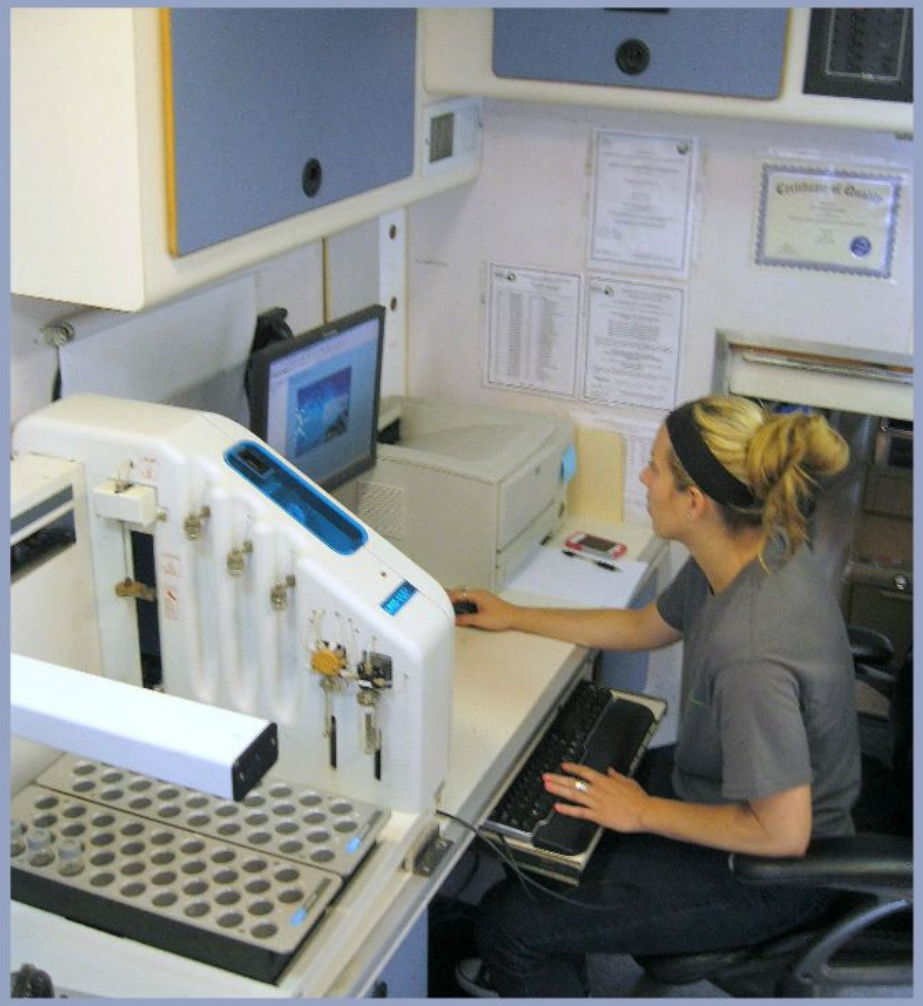

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8021/TO-14	Short list VOCs with Low RLs and high daily output
APH Fractions	Aromatic and Aliphatics by GC/MS (TO-15 or 8260SV)
Fixed Gases	Oxygen for bioattenuation

Analytical Methods for Soil Vapor

Per Appendix F of DTSC 2015, Page 1:

"There are no approved USEPA methods specifically designed to analyze volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in soil gas samples. Consequently, modified versions of existing USEPA methods are used to analyze soil gas samples…These modified methods can be used provided they have been validated and it can be demonstrated that the modified methods are capable of meeting the project data quality objectives and established performance criteria. Innovations and creativity are encouraged."

How to demonstrate performance

How to demonstrate performance

Per Appendix F, pages 20-21:

"Soil gas testing laboratories can obtain certification from [CA ELAP] for all analytical methods they are using for soil gas testing."

NOT TRUE

Per Page 40:

"As of the date of this document, the development of a laboratory certification program for soil gas is in progress in California. Once a certification program is available…laboratories should apply to be certified."

CA ELAP TELLS US IT IS YEARS AWAY

Per Appendix F, pages 20-21:

"(NELAP) accreditation for USEPA Methods TO-13A, TO-15 and TO-17 should be accepted in lieu of California ELAP certification for soil gas testing. Laboratories that have either certification from ELAP or NELAP for USEPA Methods 8015, 8021 or 8260B for either soil or water matrices should obtain separate certification from ELAP for soil gas work with those methods."

WE AGREE!

Accrediting Bodies offering Analytical Certification for Soil Vapor VOC Methods:

- NELAP Certification (state specific)
- DOD ELAP (Department of Defense)
- Arizona Department of Health Services (ADHS)

Accrediting Bodies offering SAMPLING Certification for Soil Vapor Collection Methods:

- NEFAP (National Environmental Field Activities Program of DOD)

PJLA Testing /Accreditation #69070
ISO/IEC 17025:2005 &
DoD-ELAP Accredited

IN SUMMARY

- *It is important to know what your project objectives are, and how to best accomplish them with regards to the regulatory agency you are collaborating with, whether it be SD DEH, DTSC, or another agency (or no agency).*

- *Soil vapor is an evolving science, with changes and advancements happening all of the time. Thinking outside of the box is encouraged!*

QUESTIONS?

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Cell: 858.401.3032