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Vapor Intrusion

Will Elcoate
Product Manager Air

AWMA Nov 12th., 2008

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Vapor Intrusion

Why is vapor intrusion a problem?

- Toxic and/or carcinogenic compounds
- Exposure risk is by inhalation
  (Cancer and non-cancer risk)
- Long term, non-voluntary “constant” exposure
- Exposure pathway that needs to be addressed

VI exposure risk via inhalation.
Typical adult non-voluntarily inhales 20,000 liters per day.
- *Voluntarily drinks 2 liters per day of water.*
On average people spend 90% of their time in-doors

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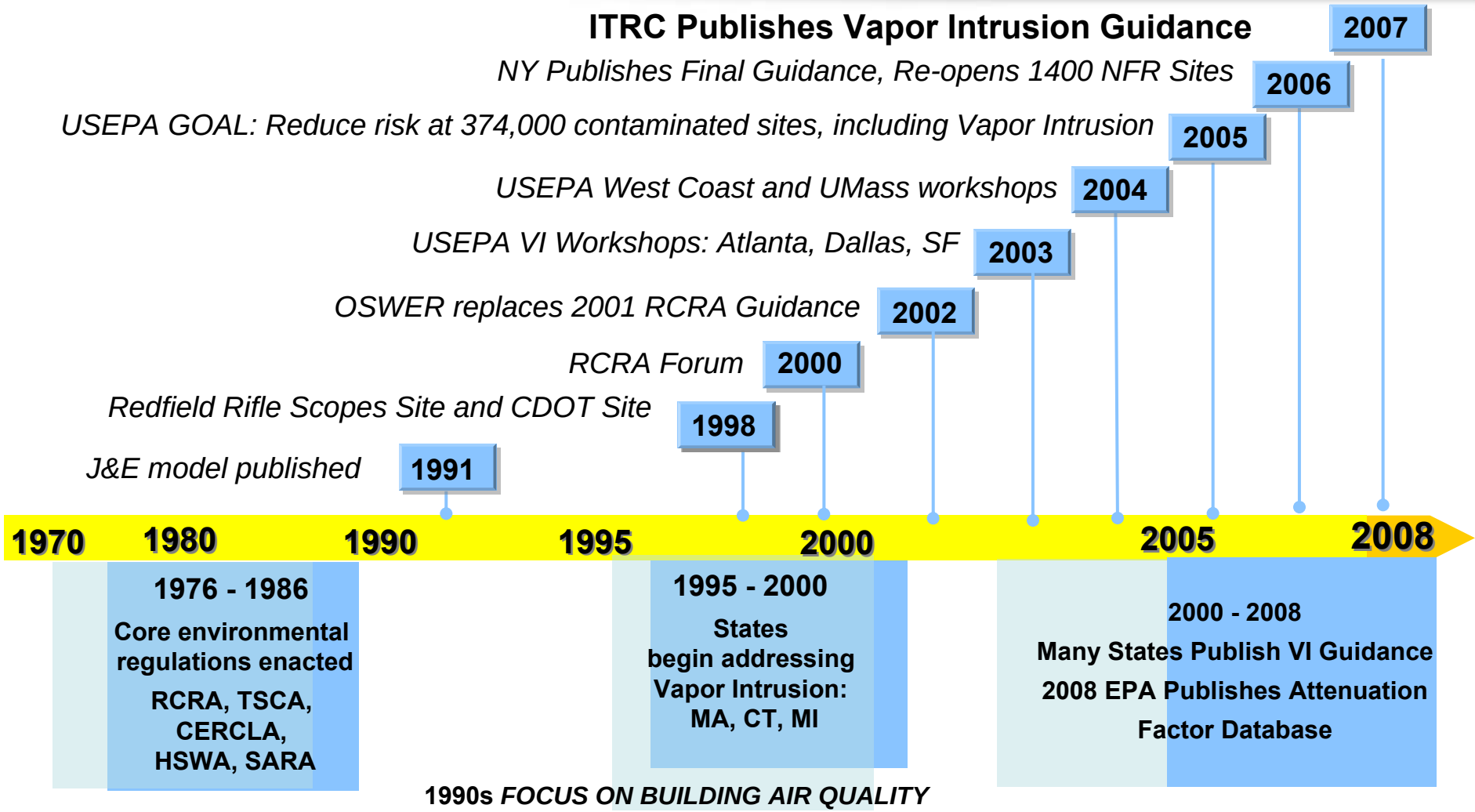
Vapor Intrusion Timeline



Modified from: M. Traister, O'Brien & Gere

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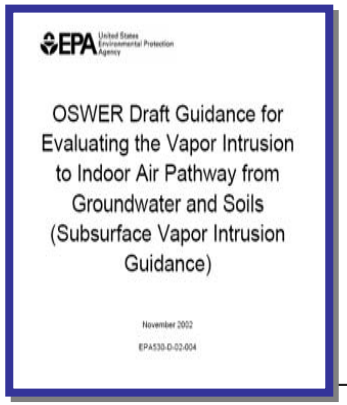
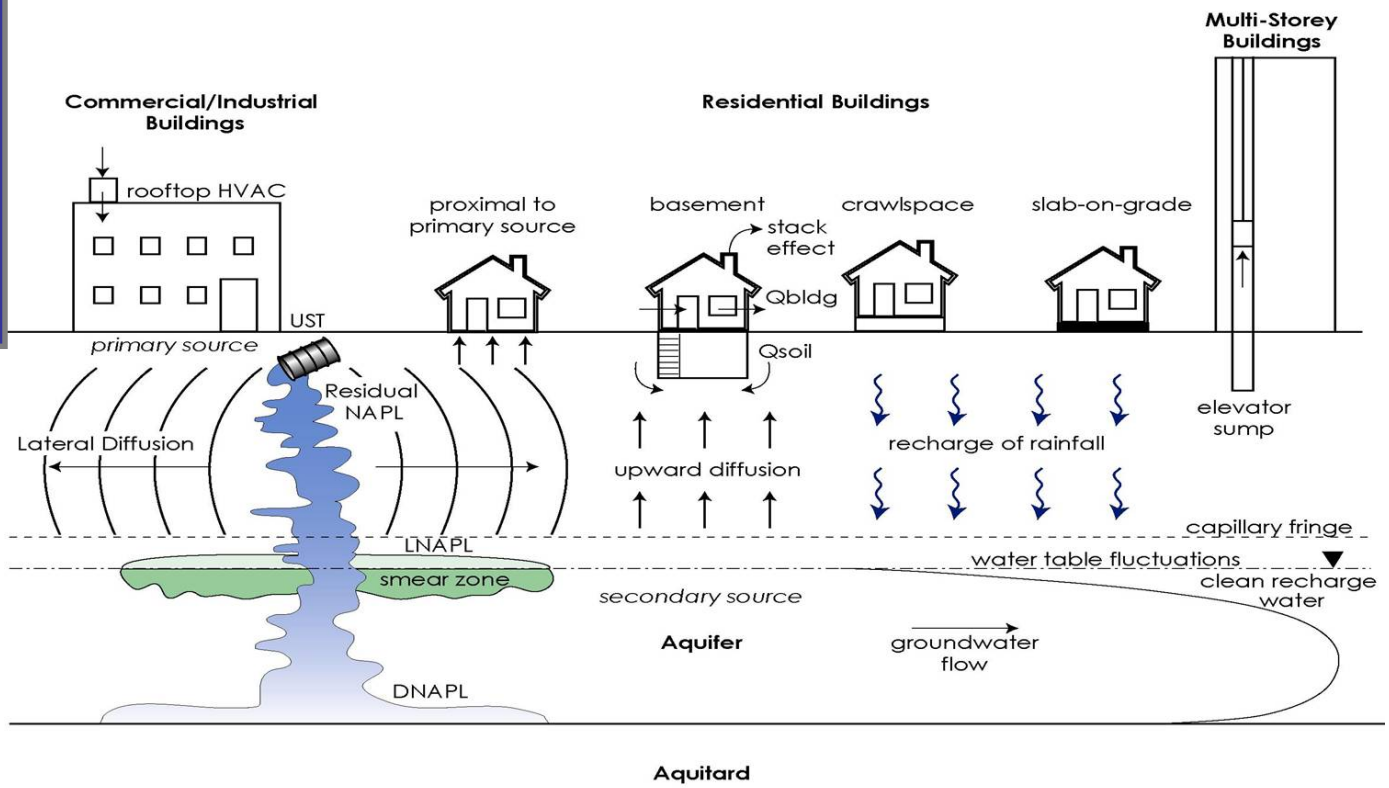
Vapor Intrusion is the migration of volatile chemicals from the subsurface into overlying or adjacent buildings.



Conceptual Model of Vapor Intrusion

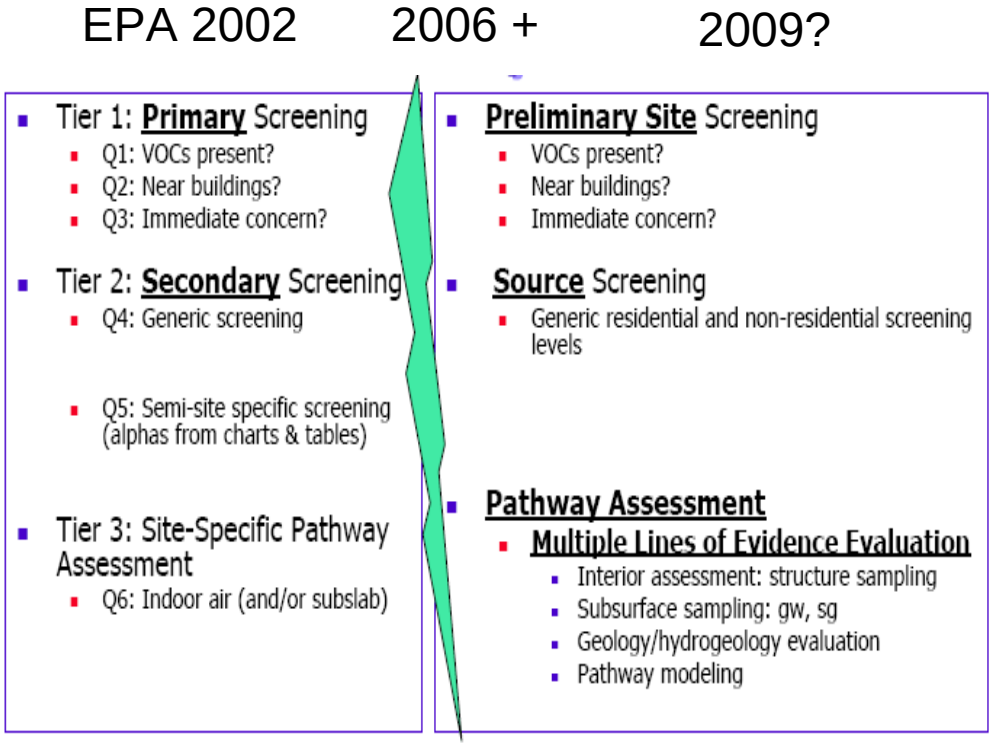


www.epa.gov/correctiveaction/eis/vapor.html

Vapor Intrusion Evolution

EPA (2002)
Focused on the appropriateness of exits; Single line of evidence can be used to screen out sites
(i.e., make a reliable VI determination)

ITRC (2007)
Focused on collection of appropriate data
Directs to State/Regulatory guidance and policies for exits



March 4th. 2008 U.S. EPA's Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors
Office of Solid Waste U.S. Environmental Protection Agency Washington, DC 20460

http://iavi.rti.org/resources.cfm?pageID=document

Update & Status of USEPA's Vapor Intrusion Guidance
AEHS West Coast Conference
San Diego, Calf.
March 13, 2008
Presented by:
Henry Schuver, DrPH, US EPA – OSW

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Interstate Technology Regulatory Council

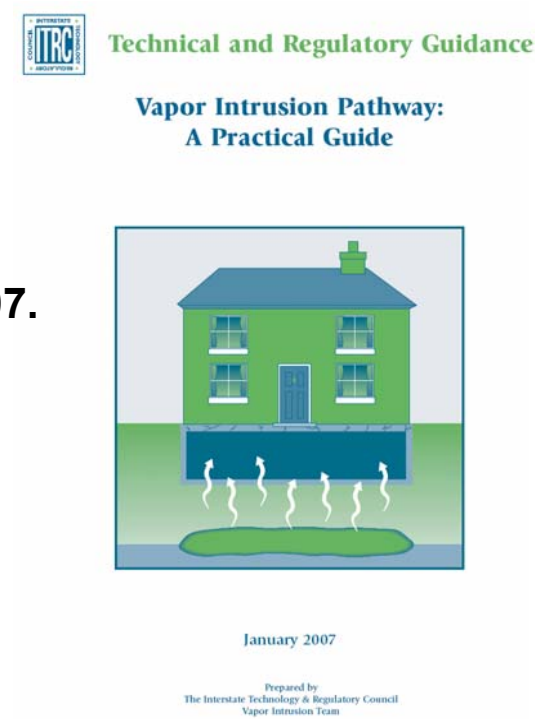
ITRC is a state-led coalition includes industry, stakeholders to achieve regulatory acceptance of environmental technologies

Vapor intrusion Team
19 of 46 States participated with API, ASTM, EPA and industry Participants publish two documents in January 2007.

Uses the concepts of:
Conceptual Site Model, Multiple lines of evidence & Weight of evidence

Provides a Vapor Intrusion (VI) "Tool Box"
Presents an iterative Stepwise (13) process VI evaluations from Investigation through Mitigation.

Does not address: Compounds, Screening or Risk levels



www.itrcweb.org/vaporintrusion

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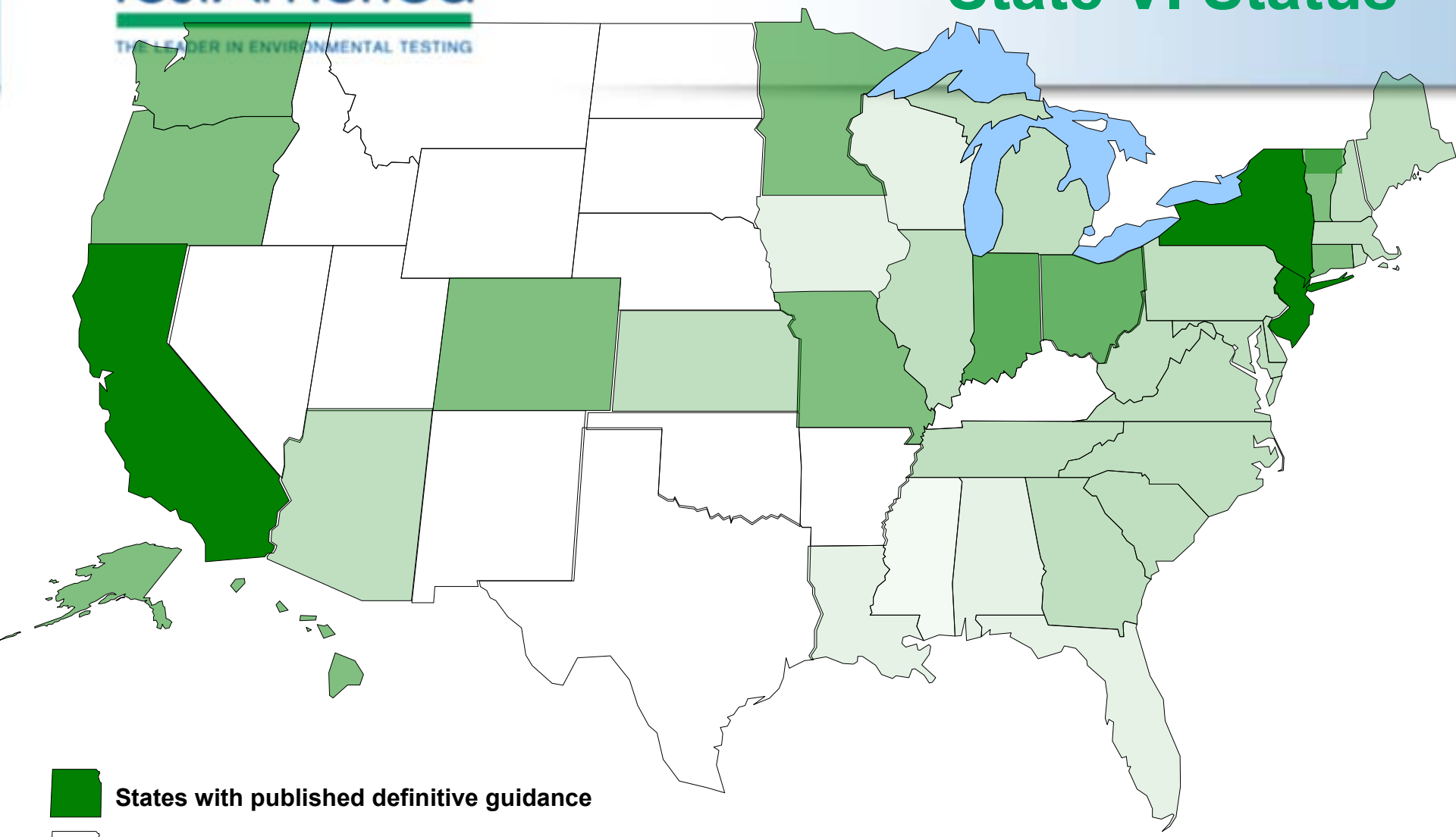
State VI Status



States with published definitive guidance

States with less than that…..

Approx 30 states have published Guidance, Rule Making related to Vapor Intrusion

October 2007

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State Guidance's

Table 3. Residential Screening Levels for Selected VOCs

State	Benzene			TCE			PCE		
	Ground Water	Soil Gas	Indoor Air	Ground Water	Soil Gas	Indoor Air	Ground Water	Soil Gas	Indoor Air
Alaska	5	3.1	0.31	5	0.22	0.022	5	8.1	0.81
California	NA	36.2	0.084	NA	528	1.22	NA	180	0.41
Colorado	15	NA	0.23	5	NA	0.016	5	NA	0.31
Connecticut	130	2,490	3.3	27	752	1	340	3,798	5
Indiana	95-850	250 - 1400; 25 - 140[a]	2.5	4.6 - 700	120 - 2000; 2 - 200[a]	1.2 - 4.1	7.4 - 1100	320 - 5200; 32 – 520[a]	3.2 - 10
Louisiana	2,900	NA	12	10,000	NA	59	15,000	NA	110
Maine	NA	NA	10[b]	NA	NA	NA	NA	NA	NA
Massachusetts	2,000	NA	0.3	30	NA	1.37	50	NA	0.04
Michigan	5,600	150	2.9	15,000	700	14	25,000	2,100	42
Minnesota	NA	1.3-4.5	1.3-4.5	NA	NA	NA	NA	NA	20
New Hampshire	2,000	95	1.9	50	54	1.1	80	68	1.4
New Jersey	15	16	2	1	27	3	1	34	3
New York	NA	NA	NA	NA	NA	5	NA	NA	100
Ohio	14	31	3.1	--	122	12.2	11	81	8.1
Oklahoma	5	3.1	0.27	5	0.17	0.017	5	0.33	0.33
Oregon	160	NA	0.27	6.6	NA	0.018	78	NA	0.34
Pennsylvania	3,500	NA	2.7	14,000	NA	12	42,000	NA	36

Notes:
1. Units are µg/L for groundwater and µg/m^3 for soil gas and indoor air
2. See individual state guidance documents for additional information, including limitations and exceptions
3. Trigger or action levels for mitigation based on indoor air concentrations may be higher than the screening levels shown.

[a] Second range of values shown is for sub-slab soil gas.
[b] Chronic exposure value.

Eklund et al, AWMA, 2006

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Recent Request

UST site in Northern CA

	Soil Vapor Screening Levels			TO15 /TO14	
	Lowest Applicable , or CHHSL Value			Low Level	Mid -(SG) Level
Chemical	ug/m3	ppbv	ug/L	ug/m3	ug/m3
EDB	4.1	0.53	0.0041	0.4	15.37
Naphthalene*	31.9	6.09	0.03190		
Benzene*	36.2	11.33	0.0362	0.96	9.58
1,2_DCA*	49.6	12.25	0.0496		
Ethyl-Benzene	980	226	0.98	0.65	8.68
TBA	2600	857.7	2.6		
MTBE*	4000	1109	4		
TPH_G	10000	2445	10		
Xylenes	21000	4836	21	0.57	8.68
Toluene	63000	16719	63	0.65	7.54

*Designates a CHHSL Listed value, others are ESL's

CHHSL -California Human Health Screening Level

ESL EPA Region 2, Environmental Screening Levels

ASTM Standard E2600 -08

ASTM Standard E2600 – 08 March 3rd. 2008

"Standard Practice for the Assessment of Vapor Intrusion into Structures on Property Involved in Real Estate Transactions"

***Objectives*—Objectives guiding the development of this practice are:**

- **To synthesize and put into writing good commercial and customary practice for conducting a *Vapor Intrusion Assessment* on a property involved in a *real estate transaction***
- ***T*o supplement a *Phase I environmental site assessment (ESA)* conducted in accordance with Practice E 1527,**
- ***T*o ensure that the process for assessing vapor intrusion is practical and reasonable**
- **To provide an industry standard for a *VIA* on a property involved in a *real estate transaction*.**

Maybe purchased at; http://www.astm.org/Standards/E2600.htm

ASTM Standard E2600 -08

Four (4) Tier Process

Tier 1 Determine if there's a VIC or p-VIC condition

may be considered a supplement to a Practice E 1527 Phase I ESA

Tier 2 investigate/model/screening tools

Applies semi-site specific numeric screening criteria to existing or newly collected soil, soil gas and/or groundwater testing results to assess whether or not a *pVIC* still exists.

Tier 2 has two data collection components: one non-invasive and one invasive.

Tier 3 VI Pathway Assessment

Evaluations should utilize the following general process:

- **Identify the desired endpoint**
- **Identify applicable regulatory standards, requirements, and models, or other evaluation criteria to be utilized**
- **Identify and collect needed data**
- **Evaluate data to determine if a *VIC* exists.**

Tier 4 Pre-emptive remediation

VIC "Vapor Intrusion Condition"

ASTM Standard E2600 -08

Tier 4 Pre-emptive remediation

Institutional controls (ICs)

Legally enforceable conditions placed on a property;

- **Restrictive covenants, zoning and land use restrictions**

Engineering Controls

- **Vapor intrusion mitigation systems, Passive or active**
- **Barriers and venting that block the migration of vapors**
- **Pressurization of building interiors or indoor air treatment systems**

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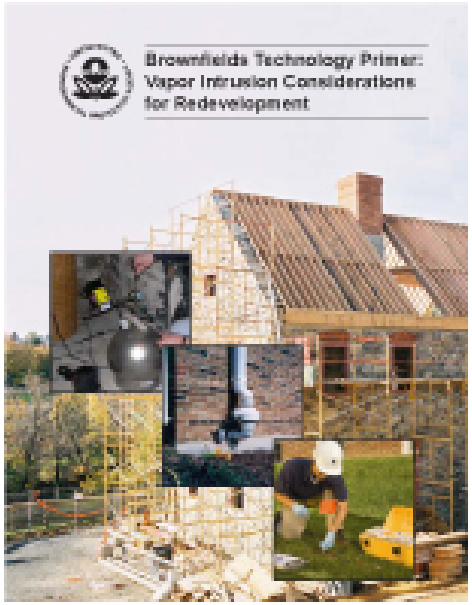
EPA Brownfield's

Brownfields Technology Primer: Vapor Intrusion Considerations for Redevelopment (EPA 542-R-08-001).



This primer is designed for land revitalization stakeholders concerned about vapor intrusion, including property owners, municipalities, and real estate developers. It provides an overview of the vapor intrusion issue and how it can affect redevelopment. It also summarizes techniques for quickly and cost effectively assessing the potential for vapor intrusion, as well as techniques for mitigating it. The topics covered will familiarize stakeholders with options for addressing vapor intrusion to help them communicate with their project contractors and consultants (March 2008, 48 pages).

View or download at

http://brownfieldstsc.org/vaporintrusion
http://brownfieldstsc.org/newpublications.cfm?tabS=2

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LEED Leadership in Energy and Environmental Design

U.S. Green Building Council (www.usgbc.org) founded in 1993 (501(c)(3)non-profit)

- **Leadership in Energy and Environmental Design (LEED) rating system launched in 1998**
- **LEED-APs (~40,000)**

"Green Building" Rating system
Level of Green Standard
Level 1 – Certified Level 2 – Silver Level 3 – Gold Level 4 – Platinum

Air Testing after construction and before occupancy, conduct baseline IAQ tests

- **Formaldehyde 0.05 ppm**
- **Particulates (PM10) 50 µg/m3**
- **Total VOC 500 µg/m3**
- **4-Phenylcyclohexene (4-PCH) 6.5 µg/m3**
- *(only required is styrene butadiene rubber (SBR) latex)*
- **Carbon Monoxide 9 ppm**

Molasky Building – LEED Gold
AIHce

May 2007 AIHA "The Synergist" magazine article titled *LEED and the Industrial Hygienist: Another Approach to Protect Worker Health*

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Vapor Intrusion Analytical Overview

The 2002 OSWER Draft Guidance in Table II lists 114 compounds Identified as Compounds of Potential Concern (COPC's)

Compound of Concern (potential Concern) are determined by:

EPA, State Guidance, or other Agency Guidance, & State PM's and/or from developing a Conceptual Site Model for the site, use history & impacts.

Sample Collection Methodology comes from Compounds of Concern:

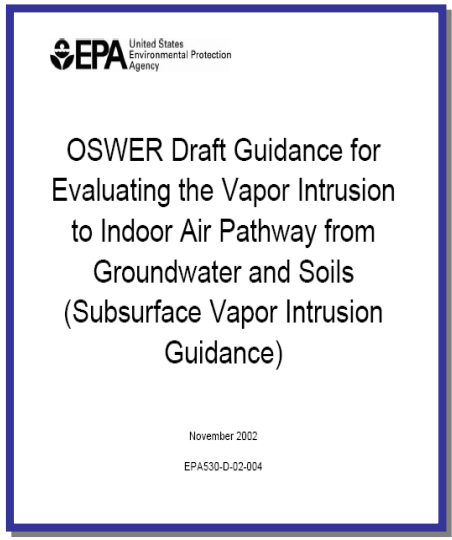
- **Data Use: Screening data or definitive data**
- **Screening methods: Mobile labs / Passive Monitors**
- **Definitive Data: NELAC Approved Laboratory / Certified Media**

Reporting Limits come from:

Guidance, screening tables by Federal, EPA or State agencies

- **Soil Gas, Residential / Commercial Screening levels, MRL's & RBCs**

For definitive Data then NELAC Certified laboratories with Certfication in Air Methods and demonstrated experience in supporting these Investigations is Highly recommended.

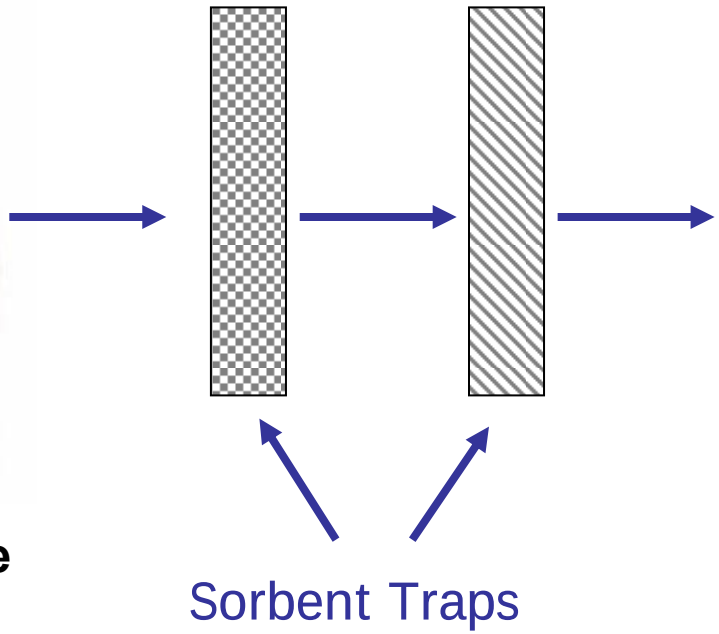


Update February 22 2004:
USER'S GUIDE FOR EVALUATING SUBSURFACE VAPOR INTRUSION INTO BUILDINGS

TO-15 Analytical Overview

Whole Gas sample

For Definitive Data, TO15 is Typical Method



TCE @ 0.017 µg/m3 RBC
8 pg TCE for 500 mL sample
(EPA current screening level 1ug/M3)

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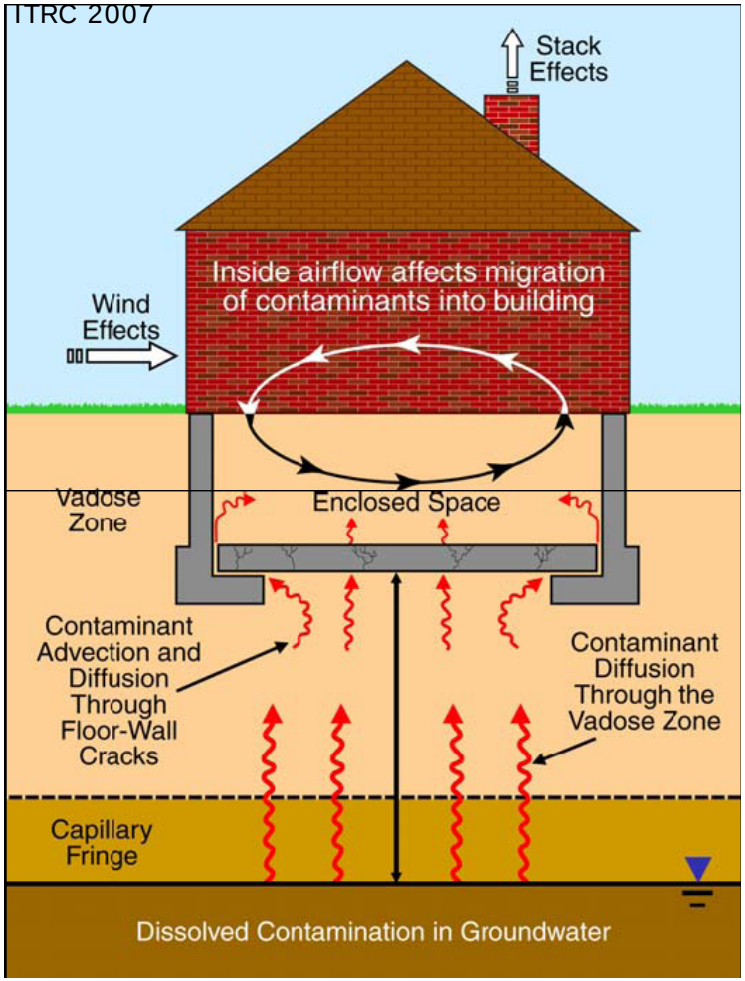
Factors affecting VI Data

http://www.itrcweb.org/gd_VI.asp



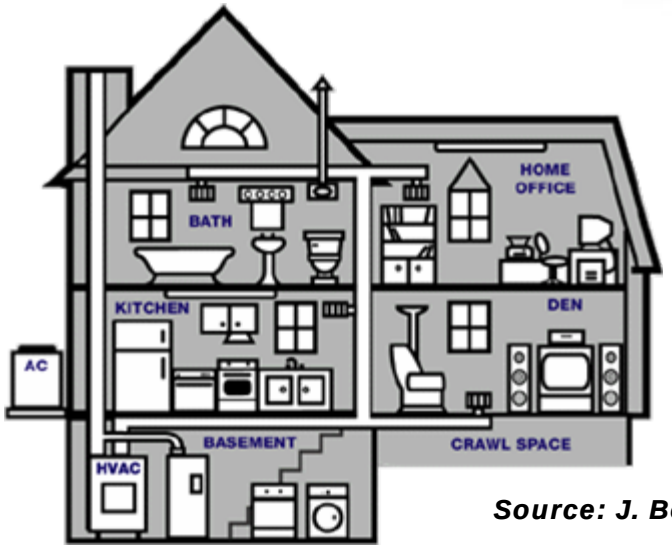
Sources of Variability

- **Barometric pressure fluctuations**
- **Surface cover**
- **Preferential pathways**
- **Soil moisture content & permeability**
- **Building depressurization**

Seasonal effects: Advection

- **Biodegradation**
- **Geologic heterogeneity**
- **Indoor Background**
- **Ambient Background**

Sources of Background Indoor Air Contamination



Source: J. Boyer, NJDEP

- **Consumer Activities**
- **Household Products**
- **Building Materials & Furnishings**
- **Ambient (outside) Air**

Common Household Sources of Background Indoor Air Contamination

Acetone	Formaldehyde
Benzene	n-Heptane
Bromomethane	n- Hexane
2-Butanone (MEK)	Methylene chloride
Chlorobenzene	Methyl isobutyl ketone
Chloroethane	Methyl tert butyl ether
Chloroform	Styrene
Cyclohexane	1,1,2,2-Tetrachloroethane
1,4-Dichlorobenzene	Tetrachloroethene (PCE)
Dichlorodifluoromethane	Toluene
1,1-Dichloroethane	1,1,1-Trichloroethane
1,3-Dichloropropene	Trichloroethene (TCE)
Ethylbenzene	Xylenes, total

http://www.state.nj.us/dep/srp/guidance/vaporintrusion/

Important:

Conduct a Building survey before Sampling

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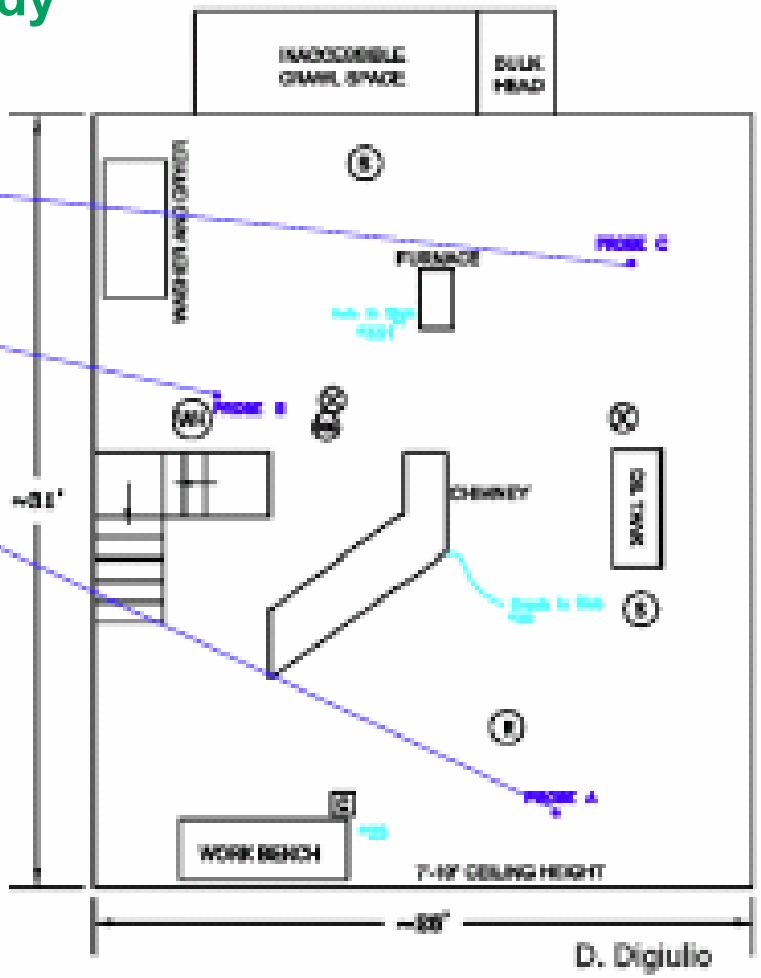
Spatial Variability

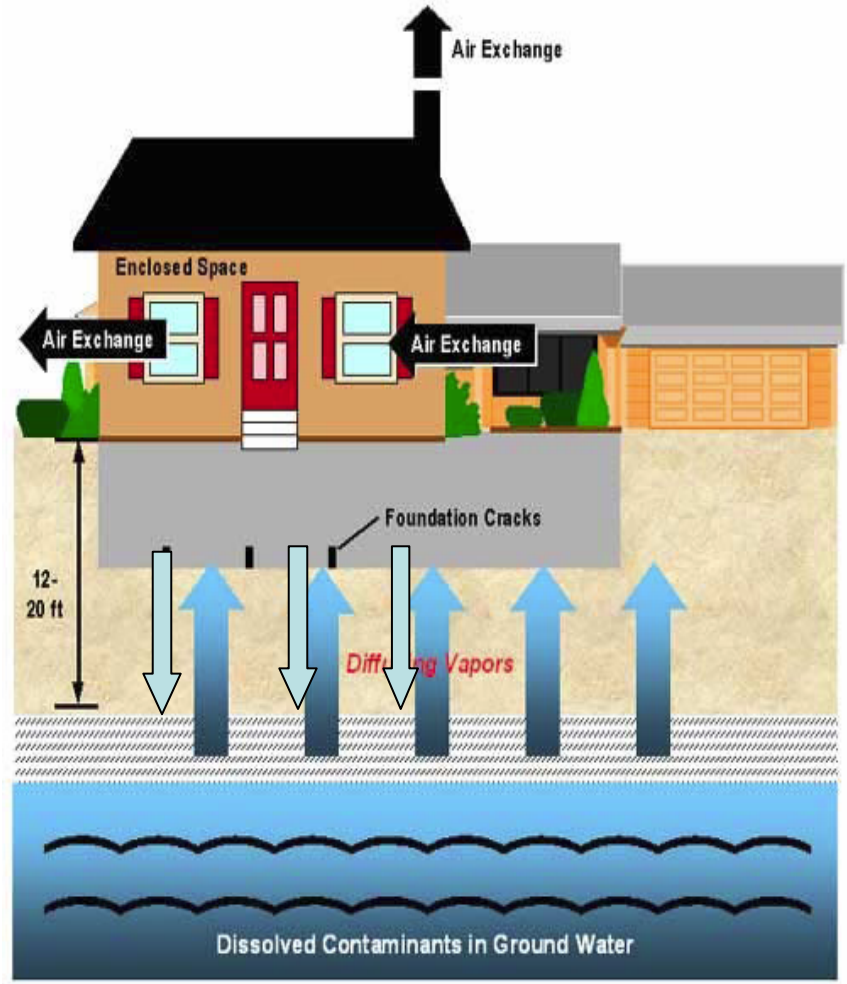
EPA Study

Sub-Slab Concentrations

1,1,1-TCA	1,1-DCE	TCE	c-1,2-DCE
70	64	17	1.4
1,1,1-TCA	1,1-DCE	TCE	c-1,2-DCE
542	480	189	46
1,1,1-TCA	1,1-DCE	TCE	c-1,2-DCE
52	31	31	8.5



Temporal Variability



Variation in pressure differential between Building and sub-slab can cause vapors to travel in both directions over time.

Test sub-Slab and Indoor air concurrently to assess if transfer from indoor to sub-slab is occurring

Differential pressure monitoring can also be done

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Chemical Information Sources

National Institutes of Health
National Library of Medicine
Specialized Information Services

http://householdproducts.nlm.nih.gov/
http://webbook.nist.gov/chemistry/name-ser.html
http://chem.sis.nlm.nih.gov/chemidplus/chemidheavy.jsp
http://www.atsdr.cdc.gov/

ATSDR Department of Health and Human Services
Agency for Toxic Substances & Disease Registry

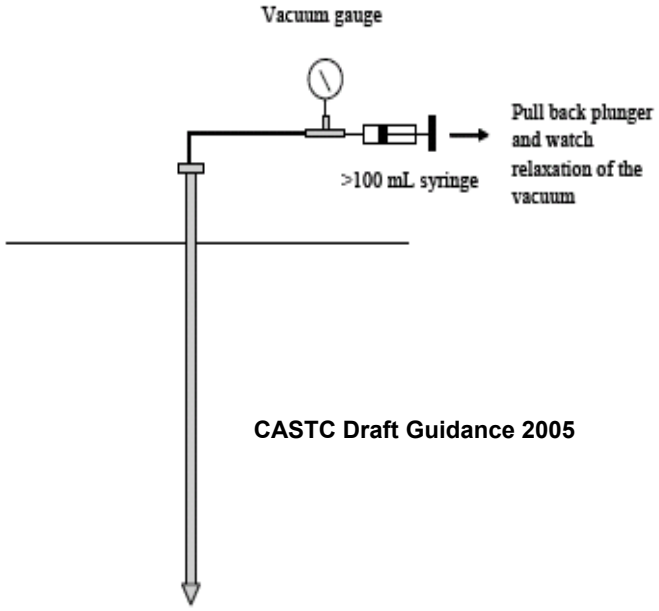
NYDOH CEH BEEI Soil Vapor Guidance October 2006

Soil Gas/Sub Slab Sampling Protocols:

- After installation of probes (>24 hrs. permanent), purge one to three volumes
- Flow rates for both purging and collecting must not exceed 0.2 liters per minute
- Samples must be collected, using conventional sampling methods in certified clean containers (e.g., Summa® canisters if analyzing by using EPA Method TO-15)
- A sample size depends upon the volume of sample required to achieve minimum reporting limit requirements
- A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples

Other States have included, Isobutylene, Iso-Propyl Alcohol IPA

Soil Gas Sampling



CASTC Draft Guidance 2005

Figure A–1. Example test apparatus to determine if soil gas sampling is practicable.

Check Soil Porosity

Use a flow restrictors/ flow controllers maximum flow rate of 200 mls per minute

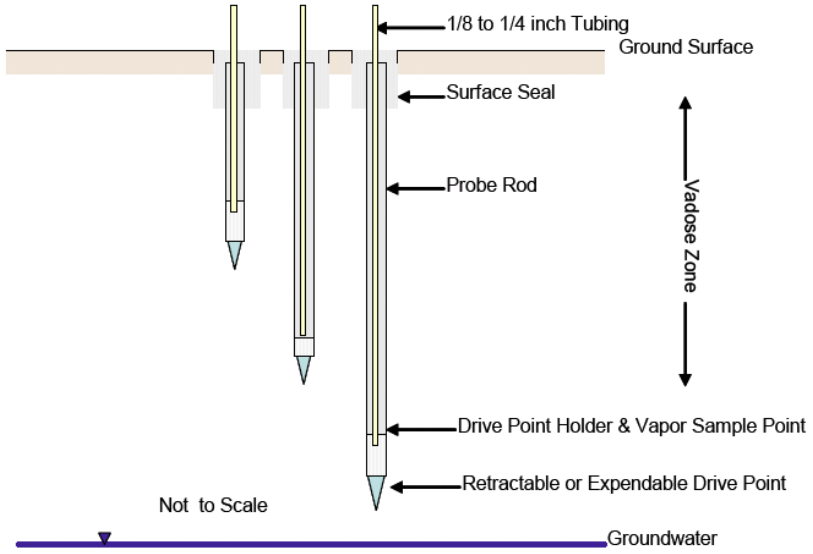
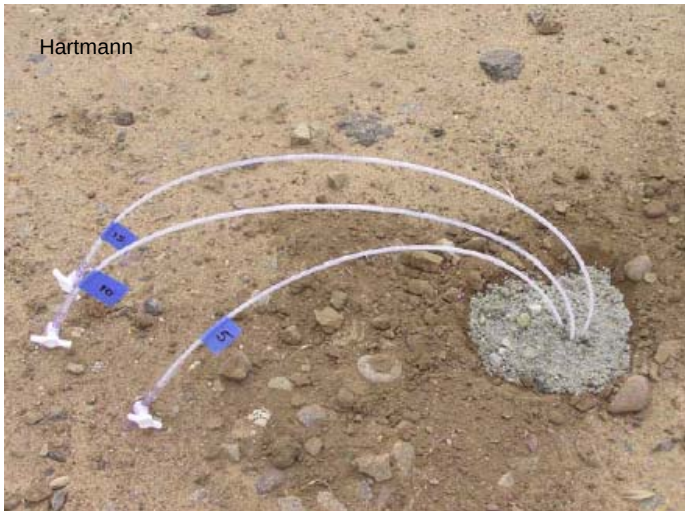


Figure C–7. Direct push temporary soil gas probe (developed based on illustration provided at www.geoprobe.com).

http://www.geoprobe.com/literature/pdfdownload.htm

Sampling – Leak Check

Ambient / Indoor Air entering the probe
Through seal leakage during sampling may represent a significant dilution of the sample.



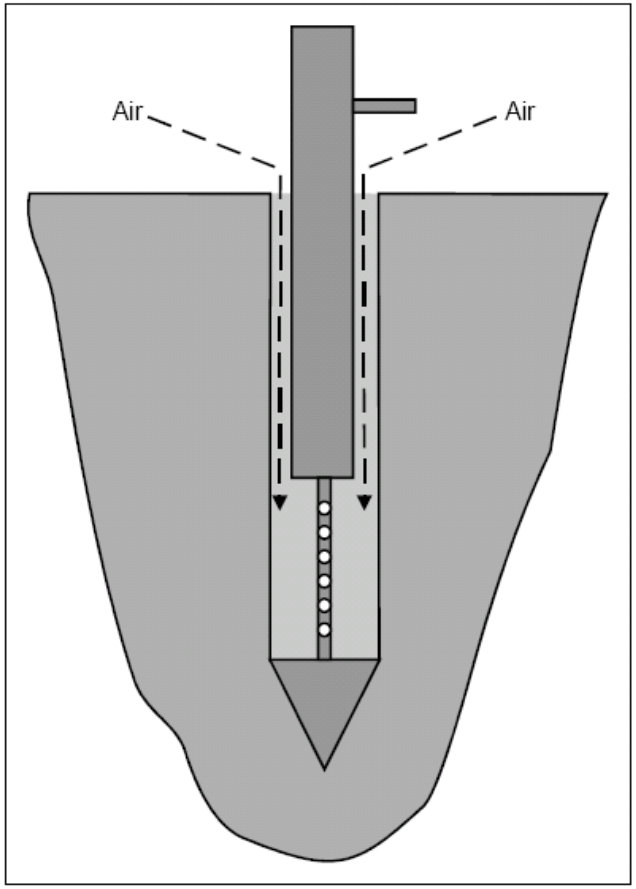


Figure 9.8 Ground Probes Ambient Air Short Circuiting

Sub-Slab Probe installation

Draft

Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations

Dominic DiGiulio, Ph.D.
U.S. Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory
Ground-Water and Ecosystem Restoration Division
Ada, Oklahoma

phone: 580-436-8605
e-mail: digiulio.dominic@epa.gov

Figure 1. Drilling through a slab

Figure 2. "inner and "outer

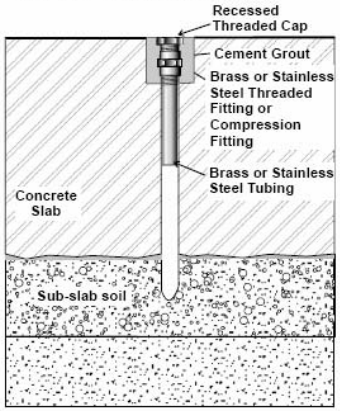


Figure 3. General schematic of sub-slab vapor probe

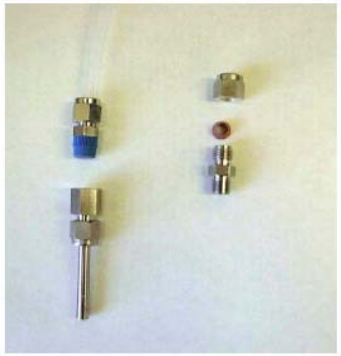


Figure 4. Stainless steel sub-slab vapor probe components

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Field Leak Check testing

Quantitative proof of sample integrity in the field

Concurrent in Indoor Air Sample (elevated)

Helium cylinder

Probe Installation Enclosure

Peristaltic pump for purging

Sub-Slab sample Canister

Sub-Slab Probe

Field Helium Meter

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Summary

Vapor Intrusion

- Risk & Liabilities are still unclear
- Guidance from the EPA, States and agencies are being developed and/or being updating, Soil Gas Screening verses Indoor Air.
- Best Practices Vapor Intrusion Pathway investigations are still developing, engage experience professionals
- Empirical Data reported shows that Background Sources, Site Conditions and field sampling have a significant impact

- Smart Building design and Mitigation systems can effectively reduce exposure once a VI exposure potential has been identified.

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Questions?

Local Area

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TestAmerica Air Program

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Town is a time bomb!

Welcome to Hartford

It's sitting on sea of gasoline — and could blow up at any minute

It's a town that could explode at any minute!

The 1,700 residents of Hartford, Ill., are sitting on a ticking time bomb — because the whole town rests on an underground pool of close to four MILLION gallons of gasoline leaked from refinery pipes.

At any moment, a lit match or even a spark could ignite the ever-present gasoline fumes. The village has even put up street signs warning drivers not to leave their car motors running.

It's no empty threat — fires have already erupted at two homes when gas fumes ignited.

A year ago, the house that Harold and Norma Settles had built and lived in for 25 years caught fire and exploded, destroying the home and a lifetime of possessions.

"According to the fire department, the gas fumes entered the basement and were ignited by our furnace," said Norma, who now lives with her husband in a neighboring town, Wood River.

"It was a devastating sight. All the things I had saved for decades were gone. My husband and I are retired and had planned to live there the rest of our lives. But there was nothing left."

Everyone in town lives with the terror of the gas fumes, but it's especially frightening to Police Officer Doug Neal and his wife Nora, whose basement caught fire last May.

"Fumes in the basement were ignited by the water heater," Nora said. "That set the basement walls on fire. We were able to extinguish the flames quickly, so there was little physical

— Even the dirt burns

turn it off. But no matter what you do, you live in fear."

Edwin Gallagher, a retired carpenter, invested his

smell of gasoline in the air. Last year the fumes were so bad I had to move my renters out for several days.

state hopes to have a plan to put into action. Yet many people continue to live in fear."

POWDER KEG: The town of Hartford, Ill., (above) is soaking in gasoline as Edwin Gallagher (below) shows — he got this jar full from a well.

DEADLY DANGER: This sample of the town's soil is so lethal it bursts into flames when lit!

partment of Public Health, says the gas fumes "are a terrible threat to public health" that can cause irritation of the eyes, nose and throat; headaches; nausea, and breathing difficulties.

Cindy Filson, a geologist with the Illinois Environmental Protection Agency, said the problem is especially bad during heavy rains when the water table rises, pushing the gasoline closer to the surface and increasing the fumes.

She added: "There's always the possibility that a large building could explode and cause a major fire, injuring or killing innocent vic-