

Vapor Intrusion: Changes in Guidance & Mitigation

New and Emerging Technologies/Best Practices Track

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Topics to Cover

- VI Guidance – EPA and others
- Mitigation Options - emerging technology
- Lessons Learned – watch for false positives

What is Vapor Intrusion?



Vapor intrusion refers to the upward migration of contaminants in the vapor phase from groundwater, soil, or soil gas sources.

Why should we care about VI?

- Health & safety of occupants
- EPA & State Guidance
- ITRC Interstate Technology Regulatory Council
- ASTM- Phase 1 ESA Standard
- Liability - Attorneys & citizens groups

Review of VI Guidances

- EPA-OSWER& OUST 2002, 2014?
- State Guidance
- ITRC Guidance
- ASTM, E-2600

Newest Changes (2012? Ever?)

EPA OSWER VI Guidance (2011 slide)

- Tier 1: Primary Screening
(any yes answer – do not pass go – go directly to Tier 2)
 - Q1: VOCs present?
 - Q2: Near buildings?
 - Q3: Immediate concern?
- Tier 2: Source Screening
 - Generic screening using near-source samples
- Tier 3: Pathway (building) Assessment
 - Multiple lines of evidence (soil gas & gw)
 - Must go inside

EPA Guidance Updates (Release Date: 2014?)

- EPA (OSWER & Superfund) – office of Solid Waste and Emergency Response
 - Preference for sub-slab & indoor air – attorney time
 - Preference for soil gas near source – bad for HC
 - Longer indoor air sampling period (7 to 21 days)
 - Fixed Att factor of 0.03 for shallow SG (~15x drop)
 - Sub-slab Att factor 0.03 (3.3x increase)
 - Modeling no longer an exit – too many variables
 - Recommend pre-emptive mitigation for new buildings

Comment Period Ended 6/24/13

<http://www.epa.gov/oswer/vaporintrusion>

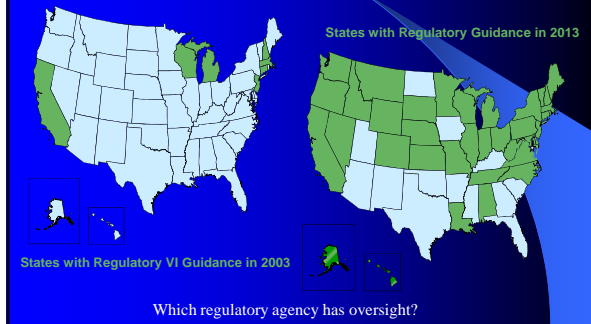
Different EPA Guidance Update (Release Date: 2014?)

- EPA-OUST: Guidance for HCs
 - Exclusion criteria? – exit ramp?
 - Testing/Adoption of Biovapor model? – allows for bio
 - No Screening Levels – refer to OSWER!!

Comment Period Ended 6/24/13

<http://www.epa.gov/oust/cat/pvi/index.htm>

VI Regulatory US State Guidance



ITRC VI GUIDANCE (2007)

Interstate Technology and Regulatory Council

ITRC is comprised of State and Federal regulators as well as consultants and industry professionals.

- Practical how-to guide
- Stepwise approach
- Investigatory Toolbox
- Thorough discussion of mitigation
- Scenarios

Many states use the ITRC guidance as a model

www.itrcweb.org/Guidance

ITRC PVI GUIDANCE (Due out early 2014)

- Introduction
- Types of PVI Sites
- Conceptual Site Model
- Basic Investigative Framework for PVI Sites
- Site Screening and Prioritization
- Investigative Toolbox – updated sampling/analysis, etc.
- Mitigation – updated and explosion proof



ASTM VI Standard E2600

- Focus on property transactions
- Prescriptive screening distances
- No assessment recommendations
- Legal standards
- Mitigation
- Released March 2008

2 Tiers: First based on search distance
Second onsite, if VEC cannot be ruled out

ASTM VI Standard revision 2010

Vapor Encroachment Screen –VES

Vapor Encroachment Condition – VEC
(formerly known as a VIC)

“The goal of conducting a VES... is to identify a Vapor Encroachment Condition (VEC) , which is the presence or likely presence of COC vapors in the sub-surface of the target property (TP) caused by the release of vapors from contaminated soil or groundwater either on or near the TP as identified by the Tier 1 or Tier 2 procedures.”

Liability Concerns

- Phase I Environmental Professional
- Prospective property owner
- Prospective purchaser
- Property lender
- Property insurer

Top Changes in Future VI Guidance

- The EPA Vortex opens..... 2014?
- Bioattenuation of HydroCarbons Sites?
- EPA TCE & PCE
- Napthalene and 2-Methylnaphalene
- Re-evaluation of compounds - creates moving targets
- Passive long term sampling?

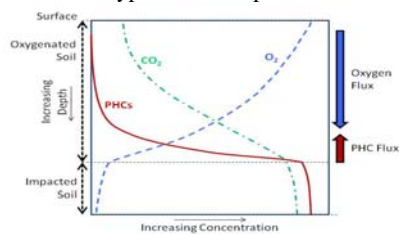
Bio-attenuation of HCs

Can we screen out HC sites from VI assessments?

- Existing data suggest >6% O₂ effective barrier
- Attenuation > 10,000 times
- Vertical profiles of COC & O₂
- How to account for it?

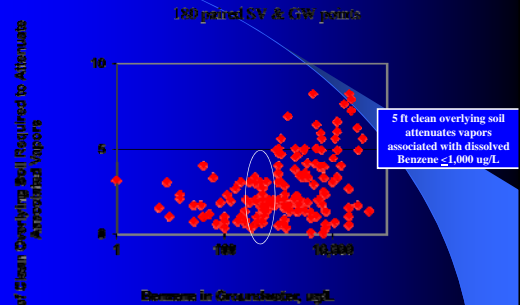
ITRC PVI group currently working guidance

Typical vertical profile



If you have oxygen greater than 6% then Biodegradation is occurring and PHC are decreasing.

Results for Dissolved Benzene



Slide courtesy of Robin Davis, Utah DEP

New EPA TCE Standard (As of October 2011)

- Residential (1e-6 cancer risk)
 - Indoor Air cancer: 0.43 ug/m3 (down from 1.2 ug/m3)
 - Indoor Air non-cancer: 2.1 ug/m3 *Short-Term Exposure?*
 - Groundwater: 1.1 ug/L
- Commercial/Industrial (1e-6 cancer risk)
 - Indoor Air: 3.0 ug/m3 (down from 6.1 ug/m3)
 - Indoor Air non-cancer: 8.8 ug/m3 (*Pregnant employees?*)
 - Groundwater: 7.4 ug/L

NJDEP did not follow TCE reduction *

New EPA PCE Standard (As of March 2012)

- Residential (1e-6)
 - Indoor Air cancer: 9.4 ug/m3 (up from 0.41 ~22x !!)
 - Indoor Air non-cancer: ~47 ug/m3
- Industrial (1e-6)
 - Indoor Air: ~47 ug/m3 (up 22x)
 - Indoor Air non-cancer: 175 ug/m3

CA-EPA Ignored new PCE Standard
NJDEP did follow PCE increase *

Example of Moving Targets

Component	CAS	Preconstruction Screening Level (PCL)		Full Site Screening Level (SSL)		Action or Remedial Level (ARL)		Remedial Action Level (RAL)	
		Indoor Air	Groundwater	Indoor Air	Groundwater	Indoor Air	Groundwater	Indoor Air	Groundwater
Benzene	71-43-2	1.0	1.0	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
Chloroform	70-82-2	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
1,1-DCE	70-81-1	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
1,1-DCE	70-81-1	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
1,1-DCE	70-81-1	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
1,1-DCE	70-81-1	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
1,1-DCE	70-81-1	0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01
		0.1	0.1	0.01	0.01	0.05	0.05	0.01	0.01

Napthalene and 2-Methylnapthalene

- Made a brief appearance in NJDEP VIT document, and ruffled a lot of feathers....
- Would have required TO-15 + TO-17 sampling w/ activated charcoal
- Enough data to demonstrate Naphth from TO-15 analysis – luckily! Methyl dropped all together – for now.

Mitigation Techniques

Addressing VI Pre-construction

- Vapor Barrier
 - HDPE Membrane often up to 60 mils (1 sheet of paper is 4 mils).
 - Spray on liner
 - Used beneath future foundation to create a bathtub seal around foundation preventing vapors from migrating into building. - *great, until...*
 - Typically in conjunction with SSDS – *added cost*
 - **Much** cheaper than post construction (\$2-\$8 sq.ft)

Vapor Barriers



Vapor Barriers



Addressing VI Pre or Post construction

- Sub-Slab Depressurization System
 - Works on the concept of creating a pressure differential between the sub-surface and the basement/first floor of the building
 - Slotted pipe in a gravel trench collects the accumulated vapor and vents to the atmosphere.
 - Active systems are connected to low horsepower suction fans which create active gradient
 - EPA accepts (.004 " H₂O)
 - Price range: Pre \$3 - \$6 Post \$5-\$12-\$20+ /sq. ft.

Sub-Slab Depressurization

- Pre-construction



Sub-Slab Depressurization



Sub-Slab Venting System Pre or Post construction

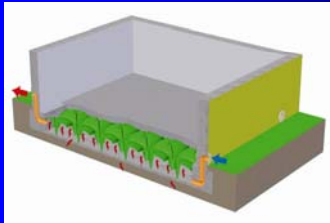
- Aerated Flooring
 - Void space provides dilution and removal of contaminants
 - 1-30w fan can depressurize over 60,000 sq.ft.
 - Eliminate the need for piping, gravel beds, and vapor barrier
 - Addresses Radon, Methane, moisture, and other VOCs
 - Offers pre-emptive protection for minimal cost vs. conventional slab
 - Adjustable heights to reduce backfill requirements
 - Costs ~ \$2.25 sq/ft

Other benefits: reduced concrete, significantly reduced backfill, LEED points, very fast installation

Emerging technology in the US

Sub-Slab Venting/Aerated Flooring

Cupolex Building Systems
www.Cupolex.ca



The solution to Pollution..... Dilution!

A note about passive systems

Table 6-2
Tiger Mitigation Techniques and OSM Criteria

Category	Active TCE or SVOCs	Passive SVOCs	Allegedly VI Remediation
Location	Below the floor or in a...	Not in the ground directly...	Not in the ground directly...
Construction	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Design	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Operation	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Maintenance	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Monitoring	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Reporting	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Documentation	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Approval	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Implementation	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Completion	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...
Final Review	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...	1. 100% TCE or SVOC...

Great idea/concept –but state requirements may make it cost prohibitive

Lessons Learned

- Some the hard way.....

Lessons Learned

- Do not mark sample locations with spray paint: toluene
- Watch what you use to seal holes



Loaded with TCE



Loaded with TBA

But We Don't Use "CHLORINATED" Chemicals Anymore.....



Gun Cleaner:
TCE



Pepper Spray:
TCE



Brake Parts Cleaner:
TCE/PCE



Hobby Glue:
TCE



Inexpensive Plastics:
1,2-DCA

Deconning or Conning?



Better Be Sure to Triple Wash!

H&P Mohr Geochemistry, Inc.

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Project	Analyzed	Method	Notes
DRAFT: Liquinox (E102048-02) Vapor Sampled: 10-Feb-11 Received: 10-Feb-11									
Benzene	1530	16.2	ug/m3	5	EB11401	10-Feb-11	10-Feb-11	EPA TO-15	
Carbon tetrachloride	ND	31.9	*	*	*	*	*	*	
Tetrachloroethane	ND	27.3	*	*	*	*	*	*	
1,2-Dichloropropane	ND	46.9	*	*	*	*	*	*	
Bromochloroethane	ND	34.0	*	*	*	*	*	*	
cis-1,2-Dichloroethane	ND	23.0	*	*	*	*	*	*	
4-Methyl-2-pentanone (MIBK)	ND	41.5	*	*	*	*	*	*	
trans-1,2-Dichloroethane	ND	23.0	*	*	*	*	*	*	
Toluene	50.2	19.1	*	*	*	*	*	*	Benzene = 1530 ug/m3 2ug/m3 for IA in NJ
1,1,2-Trichloroethane	ND	27.6	*	*	*	*	*	*	
2-Hexanone (2HEX)	ND	41.5	*	*	*	*	*	*	
Dibromochloroethane	ND	43.2	*	*	*	*	*	*	
Tetrachloroethane	ND	34.4	*	*	*	*	*	*	
1,2-Dibromoethane (EDB)	ND	39.0	*	*	*	*	*	*	
1,1,1,2-Tetrachloroethane	ND	34.8	*	*	*	*	*	*	
Chloroform	ND	23.4	*	*	*	*	*	*	
Ethylbenzene	671	22.0	*	*	*	*	*	*	
m,p-Xylene	1950	44.0	*	*	*	*	*	*	
Styrene	ND	21.6	*	*	*	*	*	*	
o-Xylene	612	22.0	*	*	*	*	*	*	
Bromoform	ND	52.4	*	*	*	*	*	*	

Cleaning Your Dishes? (or Polluting Your House)



Dawn VOC Analysis Results

Beware of false positives

DRAFT: Dawn Dish Soap (E102048-02) Vapor Sampled: 10-Dec-10 Received: 13-Dec-10

Analyte	Result	Reporting Limit	Units	Dilution Factor	Batch	Project	Analyzed	Method	Notes
1,2,3-Trichloropropane	54	5.0	ug/m3	1	EB11401	10-Dec-10	13-Dec-10	EPA TO-15	
n-Heptane	230	5.0	*	*	*	*	*	*	
Dibromochloroethane	760	5.0	*	*	*	*	*	*	
n-Butylbenzene	8100	5.0	*	*	*	*	*	*	
1,2,3-Trichloropropane	145	5.0	*	*	*	*	*	*	
trans-1,2-Dichloroethane	120	5.0	*	*	*	*	*	*	
1,1,2-Trichloroethane	ND	5.0	*	*	*	*	*	*	
2-Hexanone (2HEX)	ND	5.0	*	*	*	*	*	*	
Dibromochloroethane	ND	5.0	*	*	*	*	*	*	
Tetrachloroethane	ND	5.0	*	*	*	*	*	*	
1,1,2-Trichloroethane (PCE)	ND	5.0	*	*	*	*	*	*	
1,1,1,2-Tetrachloroethane	ND	5.0	*	*	*	*	*	*	
Chloroform	ND	5.0	*	*	*	*	*	*	
Ethylbenzene	28	5.0	*	*	*	*	*	*	
m,p-Xylene	27	5.0	*	*	*	*	*	*	
Heptane	ND	5.0	*	*	*	*	*	*	
o-Xylene	18	5.0	*	*	*	*	*	*	
Bromobenzene	ND	5.0	*	*	*	*	*	*	
1,1,2,2-Tetrachloroethane	ND	5.0	*	*	*	*	*	*	
n-Butylbenzene	ND	5.0	*	*	*	*	*	*	
1,1,1-Trichloroethane	ND	5.0	*	*	*	*	*	*	
Diethylbenzene	ND	5.0	*	*	*	*	*	*	
2-Chloroethane	ND	5.0	*	*	*	*	*	*	
n-Propylbenzene	ND	5.0	*	*	*	*	*	*	
1,2-Dichlorobenzene	1300	10	ug/m3	1	EB11401	10-Dec-10	13-Dec-10	EPA TO-15	
1,2-Dichlorobenzene	ND	10	*	*	*	*	*	*	
o-Butylbenzene	ND	50	*	*	*	*	*	*	
Naphthalene	31	5.0	*	*	*	*	*	*	1,4-Dioxane 2100 Naphthalene 31 3 ug/m3 for IA in NJ

Indoor Air Consumer Products Containing PCE

Product	PCE Concentration
ARAMCO Art and Crafts Goop	Not Specified
Aleenes Patio & Garden Adhesive	70%
Gumout Brake Cleaner	50 - 90%
Liquid Wrench Lubricant w/ Teflon	65 - 80%
Plumbers Goop Adhesive	67.5%
Hagerty Silversmith Spray Polish	30.5%
Champion Spot it Gone	20 - 25%

KEY Wide variety of consumer products still contain high **POINT**: concentrations of PCE.

Remember 10,000 ppm = 1%, we are measuring ppb

Got Natural Gas?



NJ Natural Gas

Sample Name	ANALYSIS	Result	Units
IAI ID	E11-07395-01	BE	ug/m3
Component	C254	Q	ug/m3
Acetone	07-54-1	D	1660
Acrylon	107-02-8	D	16
Benzene	71-42-2	D	508
1,3-Butadiene	106-95-0	D	68
2-Chloroethane	78-49-8	D	42
Cyclohexane	110-82-7	D	196
Ethanol	140-15-5	D	30
Ethylbenzene	100-41-4	D	97
4-Ethyltoluene	622-96-8	D	43
n-Heptane	142-82-5	D	810
n-Hexane	110-54-3	D	632
Isopropylalcohol	67-63-0	D	2000
Methyl ethyl ketone	78-93-3	D	14
Methyl isobutyl ketone	106-86-1	D	21
Methyl n-butyl ketone	591-78-6	D	80
n-Butane	109-97-8	D	3300
n-Pentane	111-84-2	D	447
n-Propylbenzene	100-66-0	D	3230
n-Propylbenzene	103-65-1	D	25
Propane	115-07-1	D	22300
Styrene	106-88-3	D	611
1,2,4-Trinitrobenzene	78-80-6	D	156
1,3,5-Trinitrobenzene	108-87-8	D	86
Xylene (m,p)	17801-23-1	D	546
Xylene (o)	95-47-6	D	139
Xylene - TOTAL	1330-26-9	D	725

Benzene IA 3ug/m3 in NJ

Each gas distributor has its own mix

Lots to think about when doing "simple" sampling event!

More LSRP Forms
 Indoor Sources
 Conceptual Site Model
 Determine COC's
 What if there is a leak
 Submit report when?
 Type of tubing
 Sampling Depth
 Equilibrium Time
 Shut-in test
 Field Blank
 Helium leak check
 Did I just smoke a cigarette?
 Individual summa certification
 Summa size
 Am I collecting enough samples to protect me?
 Did he just smoke a cigarette?
 Heavy Metals
 Petroleum exclusion apply
 QAQC
 Pure Volatiles
 Acceptable levels
 Spatial variability
 Near slab
 Helium leak check
 Sensor
 Label with Sharpie
 Sensor eye receptor
 EDD
 Flow rate
 Tubing storage
 Regulate Notification
 Heavy Metals
 Did he just smoke a cigarette?
 Did I just smoke a cigarette?
 Individual summa certification
 Summa size
 Am I collecting enough samples to protect me?

Previews of the VI Future

- VI Likely to be a Concern at Your Sites
- Variable Regulatory Guidance Makes Assessment Tricky & Slow
- New EPA OSWER Guidance to be Stricter
- Moving target analytes - TCE & PCE, Naph & 2-Methyl, Ethylbenzene, etc.
- Hydrocarbons to be Less of a Concern

VI Document Links

- EPA - www.epa.gov/oswer/vaporintrusion/
- ITRC - www.itrcweb.org/Guidance/
- ASTM - www.astm.org/Standards/E2600.htm
- Dr Blayne Hartman- www.handpma.com/resources/presentations
- Robin Davis' Articles on Bioattenuation:
 - Lustline #61 May 2009 (www.neiwpcc.org)
- Cupolex - www.Cupolex.ca or www.VaporControlTech.com

*slides courtesy of Dr. Blayne Hartman

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