

Vapor Intrusion (VI)

What Is It?

Why Is It a Problem?

Regulatory Status?

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**Minnesota State Bar Association
Environmental Science for Attorneys**

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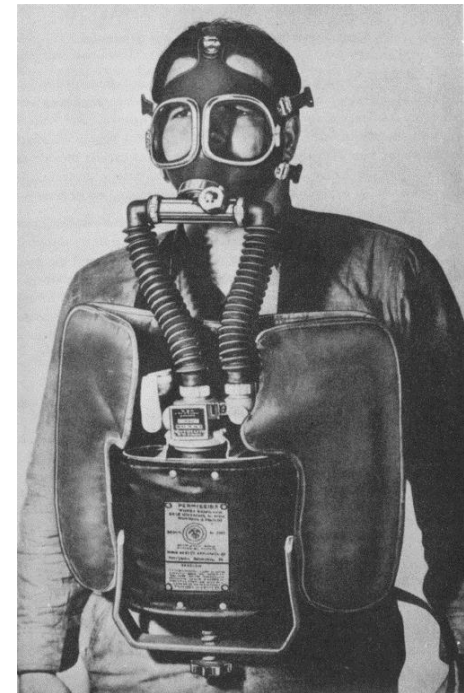
Concerns Over Vapor Intrusion
Prompt Closing of Two North Carolina
Schools

Our Team Today

	Name and Position	Areas of Expertise and Practice
	<p>Paul Brookner, P.G., MBA</p> <p>Sr. Principal Minneapolis, Minnesota Office 612.253.8203 Office 612.599.7473 Mobile pbrookner@geosyntec.com</p>	<ul style="list-style-type: none"> - Portfolio Management for Diverse Multi-National Corporations - Remediation Strategy Development - Remedial Alternatives Evaluation - Remedial Design and Implementation - Vapor Intrusion – Investigation, Design & Mitigation - CERCLA Cost Recovery Litigation Support & Expert Testimony - Financial Reserve Development & Management
	<p>Eric Tollefsrud, P.G.</p> <p>Principal Minneapolis, Minnesota Office 612.253.8202 Office 612.791.0506 Mobile etollefsrud@geosyntec.com</p>	<ul style="list-style-type: none"> - Vapor Intrusion Assessment, Mitigation - Remediation Strategy and Regulatory Liaison - Technical Support to Legal Counsel - CERCLA, RCRA and State environmental regulation matters - Soil and Groundwater Contaminant Investigation - Remediation Design and Implementation - Remediation Feasibility Studies, Cost Estimating

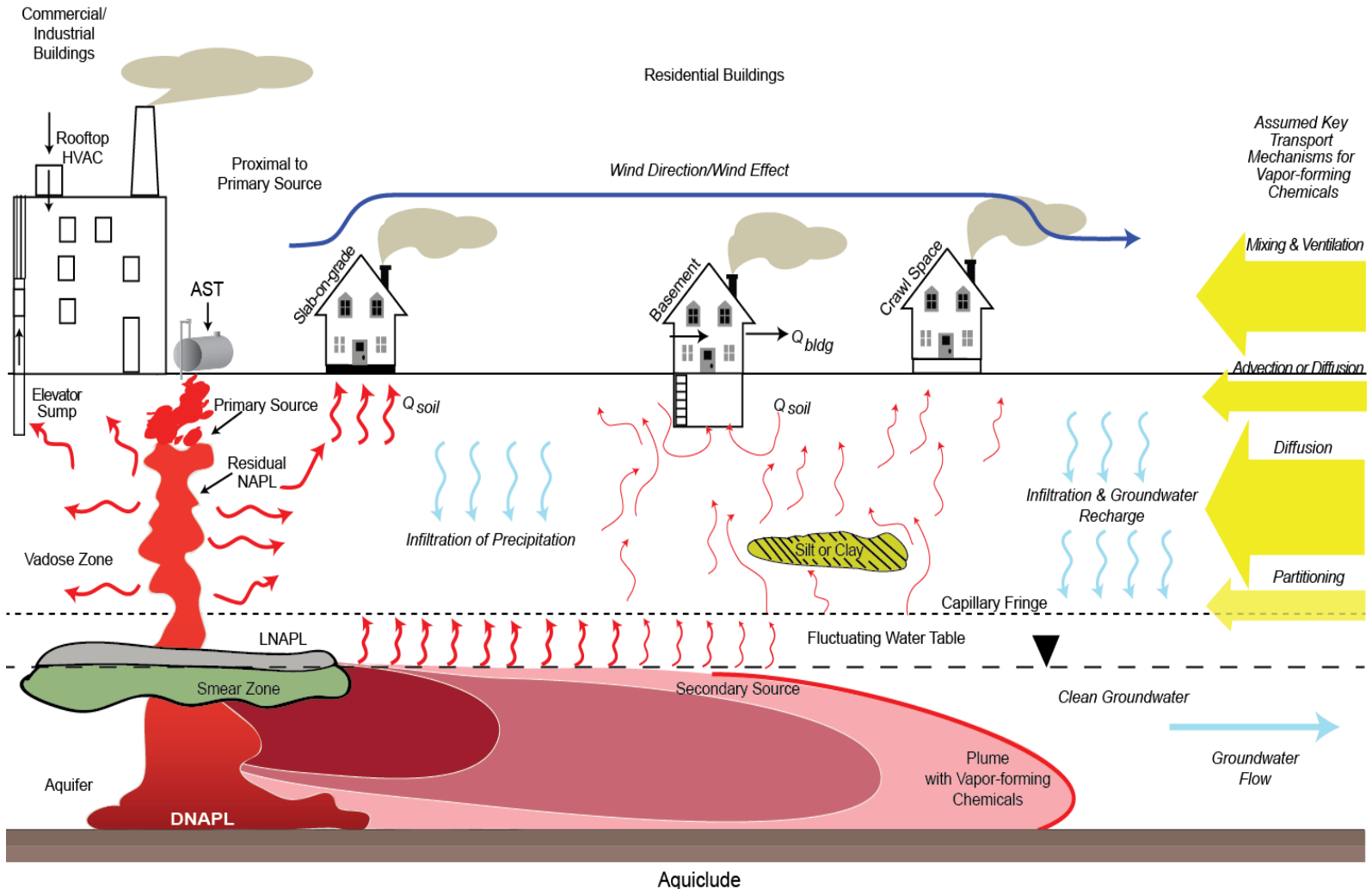
Why is VI Problematic?

- Volatile organic chemicals (VOCs) of concern are common.
- Human health risk through inhalation exposures.
- Long term chronic exposures.
- Not practicable to provide alternative air.
- Risk Communication



What is VI?

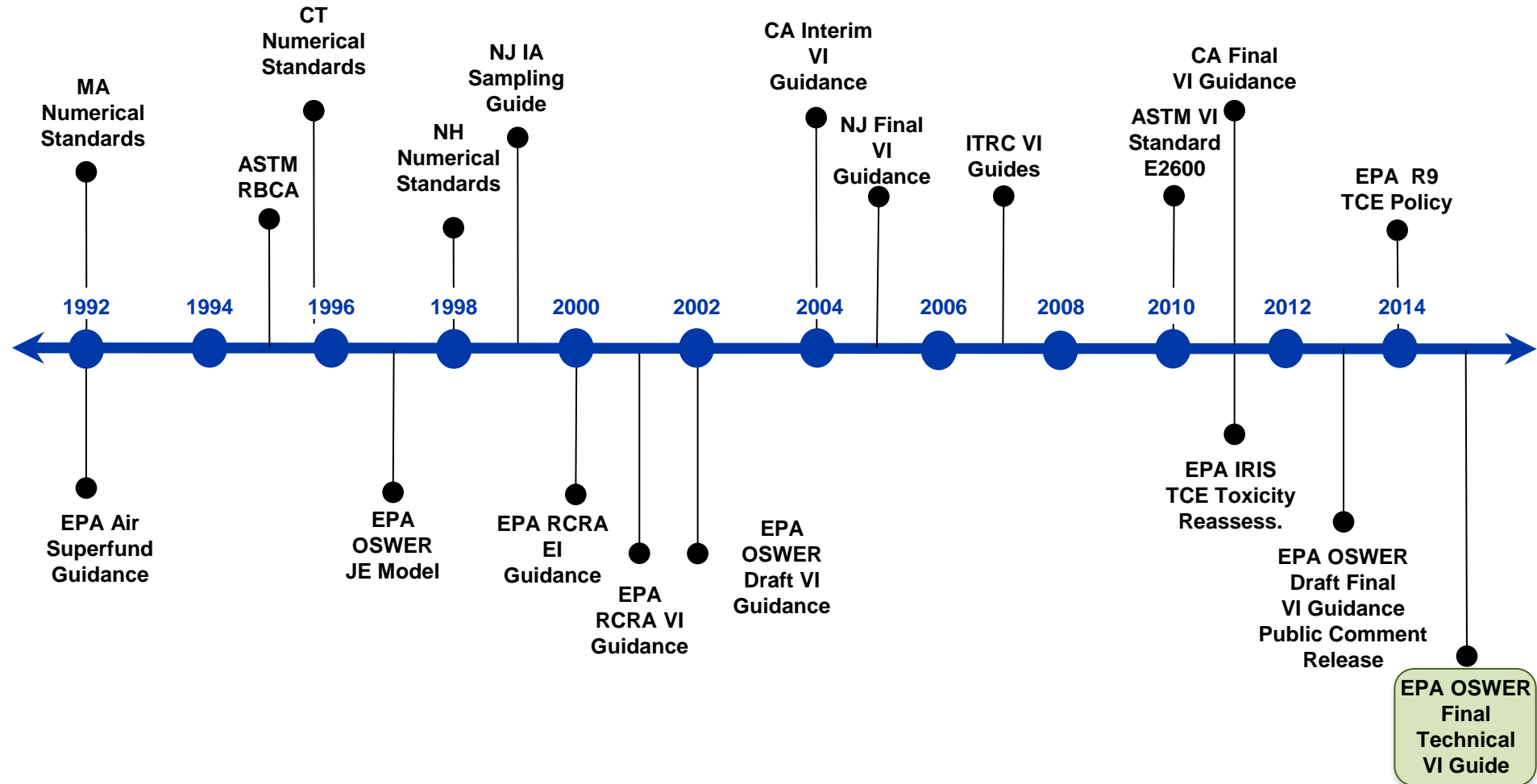
Technically Complex



Vapor Intrusion Assessment Challenges

- The subject of new and changing regulatory guidance
- Inconsistent interpretation and application of guidance
- Temporal and Spatial Variability
- Background contributions to indoor air (household products)
- Preferential Pathways
- Low concentrations of VOCs in soil and groundwater can be an issue
- Short-term action levels for TCE
- Sensitive subject for many stakeholders

U.S. EPA's Final Vapor Intrusion Guide –2015



Key Recommendations and Implications

- Multiple Lines of Evidence
- Vapor intrusion “lateral inclusion” zone
- Preferential pathways
- VI Pathway Sampling
 - Soil vapor
 - Sub-slab soil vapor
 - Indoor air
- Background Sources

Key Recommendations and Implications, Cont'd

- Generic Attenuation Factors
- Risk-Based Screening Levels
- Short Term TCE Exposures
- Non-Residential Settings
- Petroleum Hydrocarbons

➤ *Implications*

Regulatory Challenges

- New and changing regulatory guidance
- Short-term TCE exposures
- Conservative screening levels
- Screening levels as action levels
- Inconsistent interpretation of guidance
- Uncertainties associated with VI → increasing data needs
- Termination criteria for mitigation or monitoring

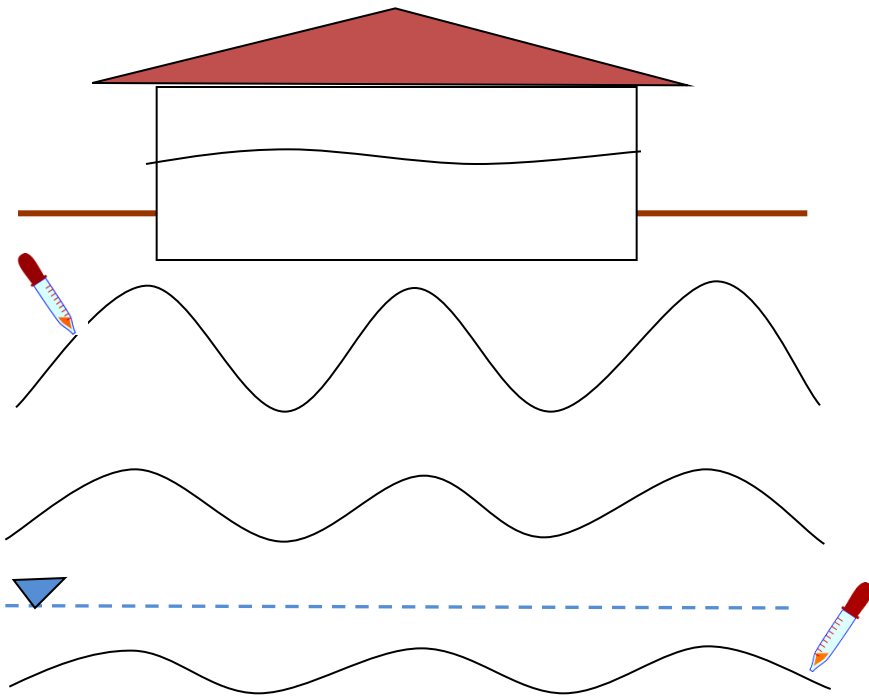
Legal Implications

- Leads to Re-opening of Closed Sites
- Real Estate Transactions are Complicated
 - ASTM E-2600-10 / ASTM E1527 (includes VI evaluation)
- Toxic Tort Suits
 - Bodily injury
 - Property damage
- Risk Communication is Difficult

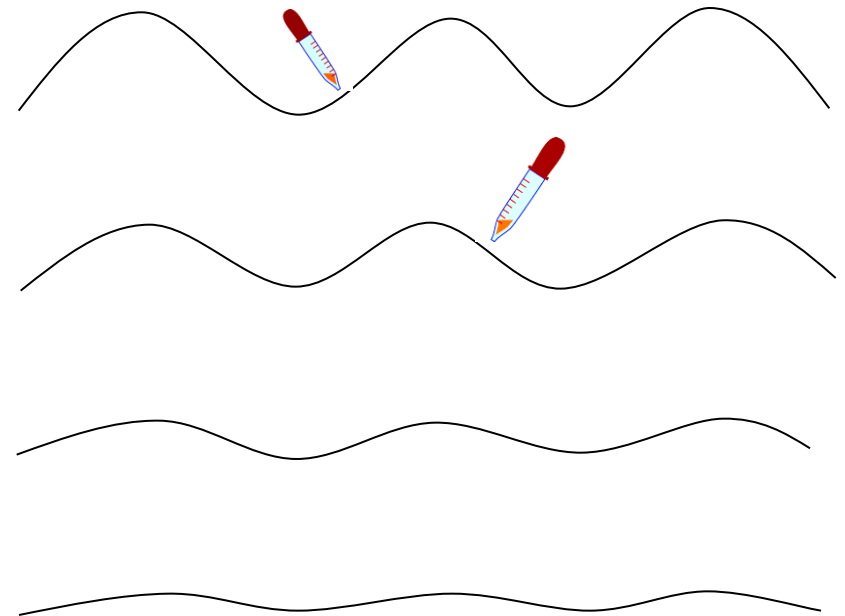
Spatial & Temporal Variability

- Variability is inherent in all media along the VI pathway.

Spatial Variability



Temporal Variability

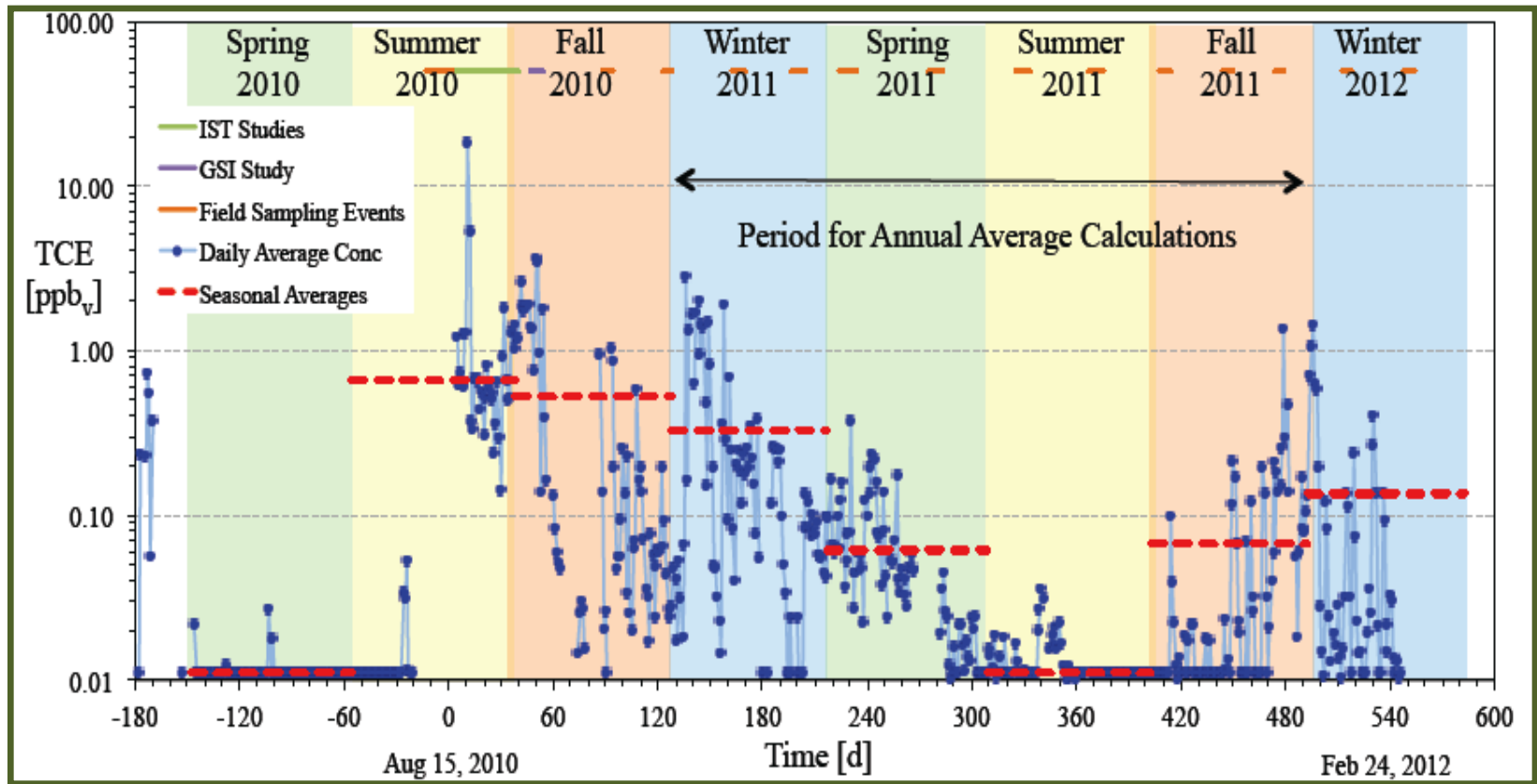


Spatial Variability in Sub-Slab Vapor (10,000X)



Temporal Variability in Indoor Air (1000X)

Daily Average Indoor Air TCE Concentration in a House over a TCE Plume Hill Air Force Base, Utah (Johnson et al, 2012)



Background Sources of VOCs

- VOCs in urban air = ambient background
- Consumer products = indoor sources
- For example, TCE found in...



degreasers



Gun cleaners

MATERIAL SAFETY DATA SHEET

*** 2%, 5.3MM SHU, OC PROTECTION SPRAY with UV DYE

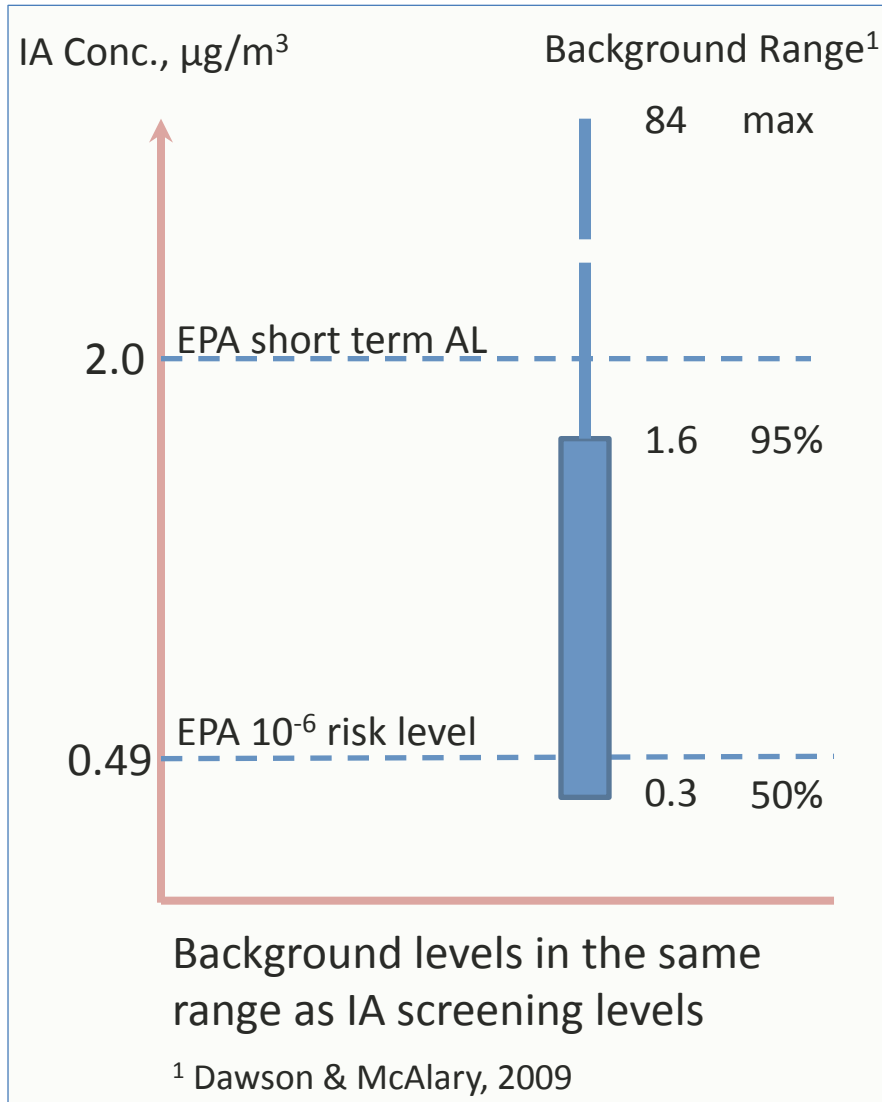
I. PRODUCT IDENTIFICATION

MSDS #: 103
 DATE: 8-13-98
 EDITION: 001
 PRODUCT NAME: "2% OC + UV" 1½ oz., 2 oz., 3 oz., and 4 oz. (Stream Delivery)
 PRODUCT TYPE: PERSONAL PROTECTION IRRITANT SPRAY

Pepper Sprays

II. COMPOSITION

INGREDIENTS:	CAS No.
TRICHLOROETHYLENE.....	79-01-6
OLEORESIN CAPSICUM.....	8023-77-6
CARBON DIOXIDE.....	124-38-9
UV DYE.....	7128-64-5



Background Sources

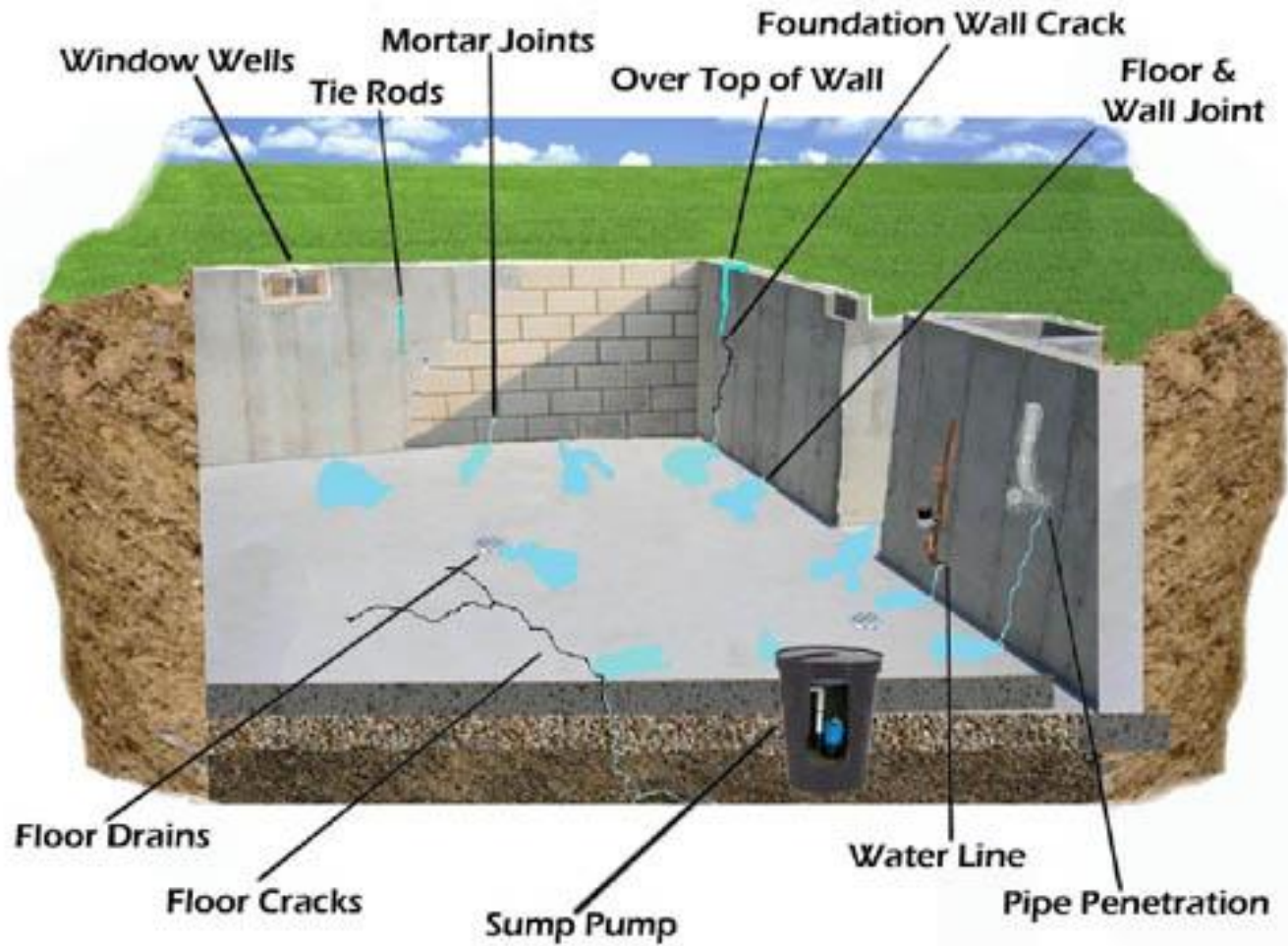
- EPA clarifies risk management policy:

If background sources are primarily responsible for indoor air concentrations, response actions for VI generally not warranted for current conditions.

- Provides examples of methods for evaluating background sources:
 - Compare indoor air to sub-slab vapor or outdoor air concentrations.
 - Building pressure cycling.

➤ *Forensic evaluations & building pressure cycling.*

Preferential Pathways (Common vs. Atypical)?



How Do We Assess the VI Pathway?

Typical Approach

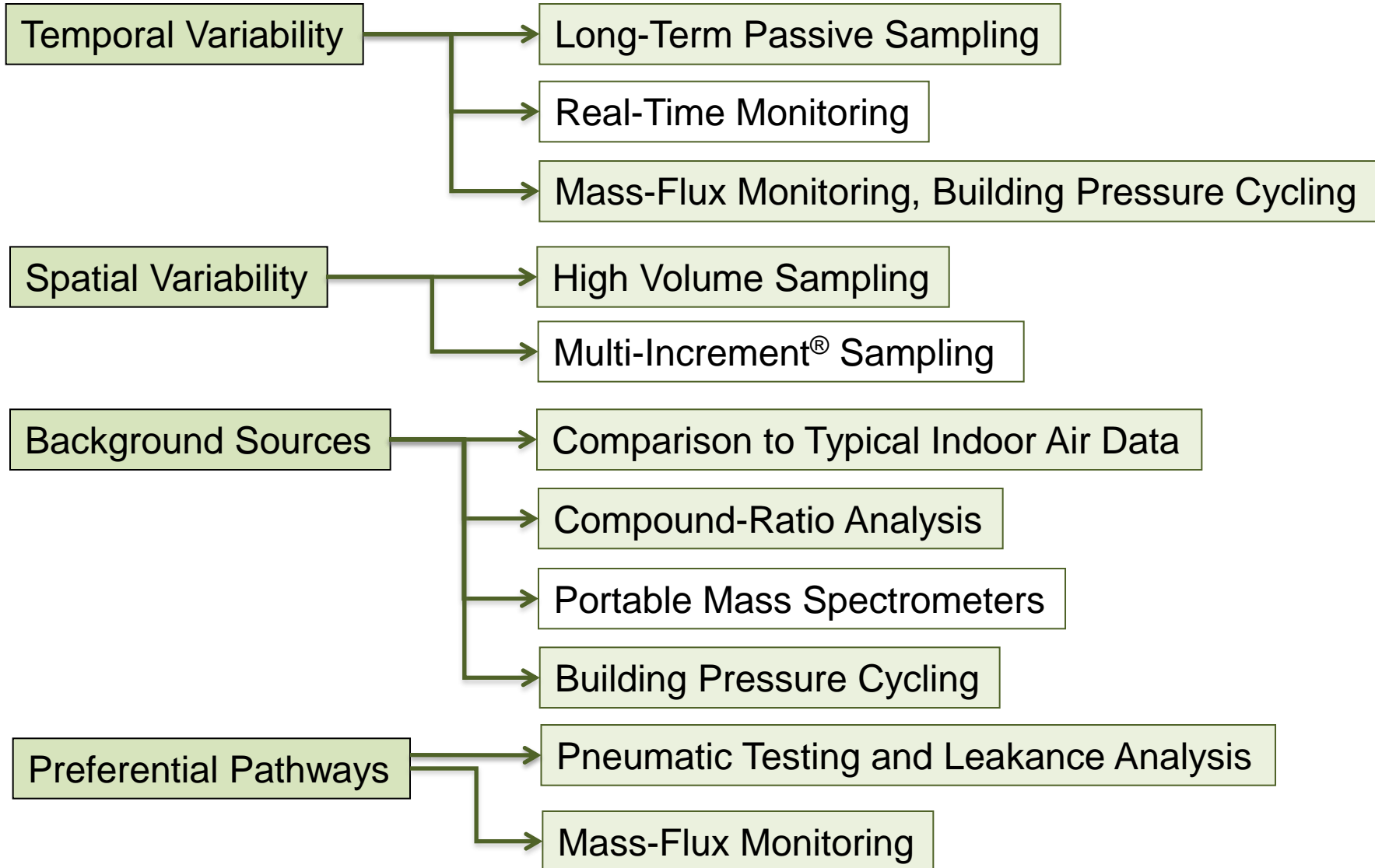
- Groundwater sampling
- Soil gas sampling
- Sub-slab sampling
- Indoor air sampling
- Compare to screening levels



Better Approach

- Develop a conceptual model
 - Select appropriate lines of evidence
 - Develop site-specific screening levels
 - Negotiate regulatory approval
 - Provide robust documentation
-
- Deductive reasoning
 - Multiple lines of evidence

Solutions to VI Assessment Challenges

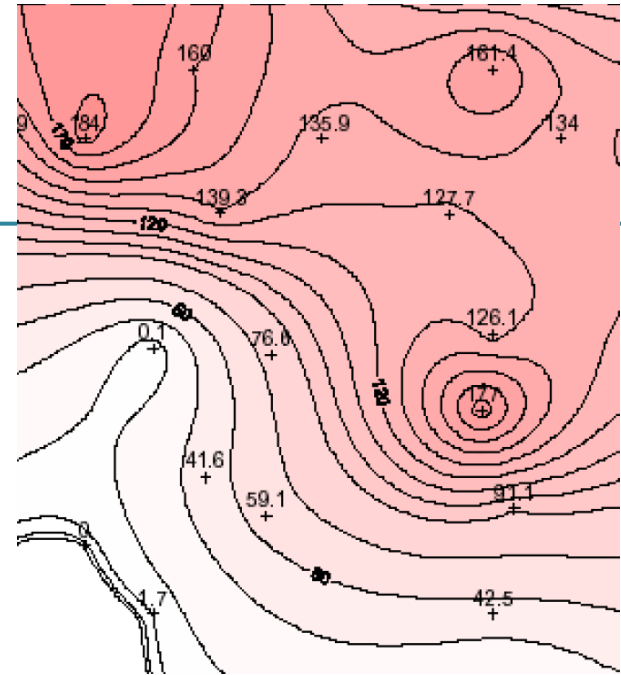
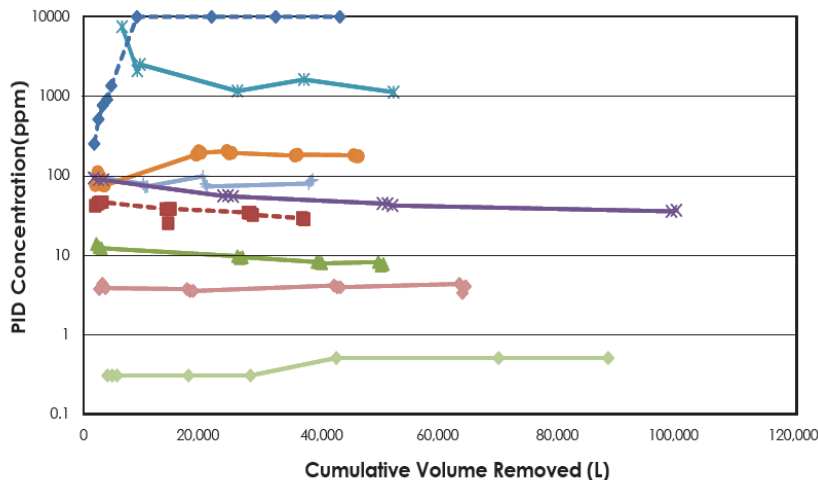


Innovative Solutions

High Volume Sampling

■ Dealing with Spatial Variability

- Large volume samples collected over time
- Fewer points = MORE data
- Less risk of false negative AND false positive results
- Much less disruptive
- Similar to an aquifer pump test
- Rapid, real-time assessment

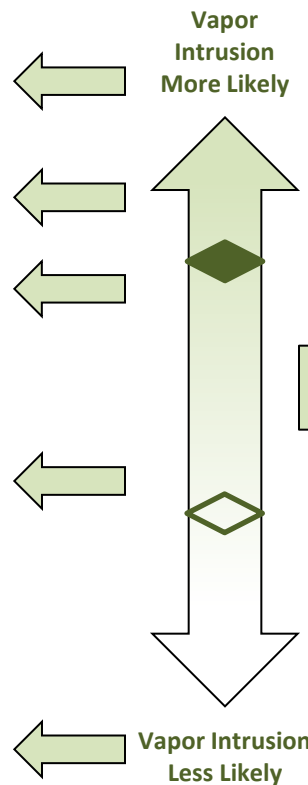
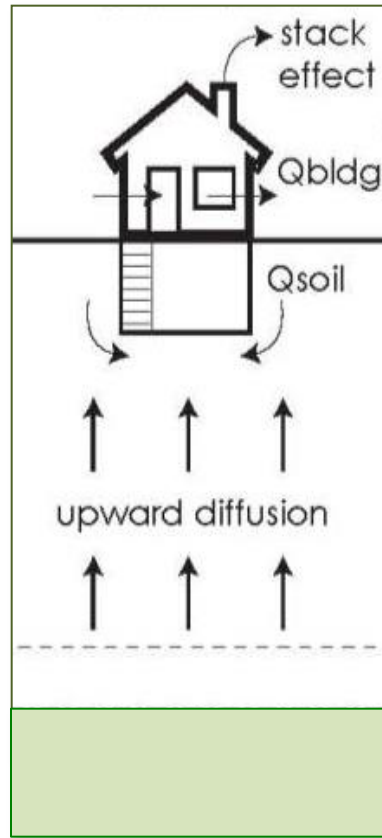
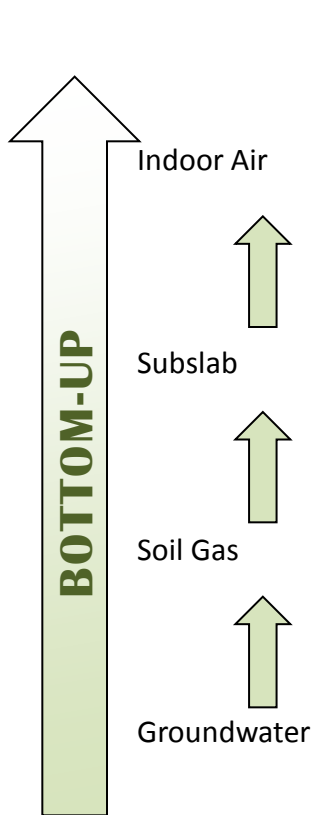


Multiple Lines of Evidence

2002 Draft
VI Guidance

Generic
Concept

2015
Final VI Guidance



Conc.	Geology	Hydro.	Weather	Building
High Source Conc., Highly Volatile Compounds	Coarse-Grained, Vertically Uniform Media	Low Moisture Content, Shallow Water Table	Heating Season, Falling Barometric Pressure, Strong Winds	Cracked Slab, Sumps, Partial Slabs, Low Air Exchange Rate
Multiple Lines of Evidence				
Low Source Conc., Less Volatile Compounds	Horizontal and Laterally Extensive Fine-Grained Layers	Deep Water Table, High Moisture Content	Increasing Barometric Pressure, Minimal Wind, Moderate Temperature	High Air Exchange Rate, Intact Slab

Modeling



Comprehensive Conceptual Site Model

Indoor Air as a Line of Evidence

Planning is Important

- Considerations for conventional sampling
 - Number & season of sampling events → temporal variability
 - Number of locations → spatial variability
 - Concurrent sub-slab and ambient air sampling → background sources; preferential pathways
 - Concurrent groundwater and soil gas sampling → pathway complete
 - Detection limits vs. risk-based screening levels → data adequacy
- Alternatives to conventional sampling
 - Long-term passive sampling (for chronic exposures)
 - Building pressure cycling → upper bound indoor air concentration; temporal and spatial variability; background; pathway complete

Innovative Solutions

Waterloo Membrane Samplers



WMS™ Sampler in a glass overpack for shipping



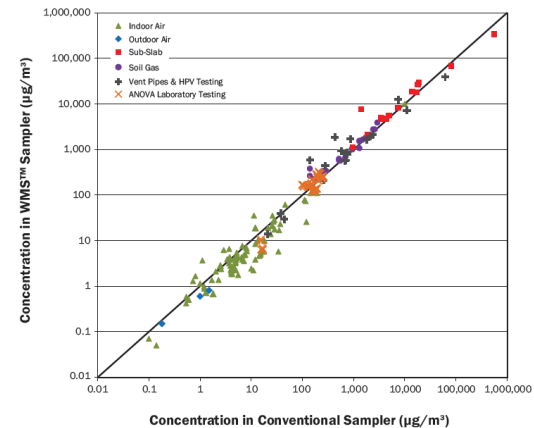
WMS™ Sampler collecting an indoor sample



WMS™ Sampler being deployed for sub-slab gas sampling



Example Correlation Between Waterloo Membrane Sampler™ and Active Sampler



Risk-Based Screening Levels

- EPA provides Vapor Intrusion Calculator
 - Provides generic screening levels based on generic attenuation factors.
 - Can be used to derive site-specific screening levels or candidate cleanup levels.
 - Toxicity values updated every six months.
- EPA notes that exceedance of a screening level does not mean that indoor air in an overlying building necessarily will pose an unacceptable health risk.

US EPA Region 9 TCE Policy

- EPA internal memo dated 9 July 2014
 - Recommends Region-wide use of Interim “Accelerated” and “Urgent” Action Levels for TCE

<i>Exposure Scenario</i>	<i>Accelerated Response Action Level (HQ=1)</i>	<i>Urgent Response Action Level (HQ=3)⁴</i>
Residential *	2 µg/m ³	6 µg/m ³
Commercial/Industrial ** (8-hour workday)	8 µg/m ³	24 µg/m ³
Commercial/Industrial ** (10-hour workday)	7 µg/m ³	21 µg/m ³

- Accelerated or Urgent Mitigation Options
 - Temporarily relocating occupants
 - Treating indoor air (carbon filtration, air purifiers)
 - Increasing building pressure
 - Sealing conduits

Other States and EPA Regions

- Several states and other EPA Regions have also adopted short-term action levels for TCE

Region or State	Residential	Commercial
US EPA Region 10 (Removal Action Level)	2	8.8
Massachusetts (Imminent Hazard)	2	
New Hampshire (Action Level)	2	8.8
New Jersey (Rapid Action Level)	4	18
California DTSC (Accelerated Response Action Level)	2	8

Petroleum Vapor Intrusion (PVI) Guidance

- Frequently assessed, but rarely shown to be a complete pathway.
- Natural biodegradation in soil mitigates VI of petroleum compounds.
- Guidance focuses on identifying site conditions where PVI is not of concern (exclusion criteria) at UST Sites.

Vertical Exclusion Criteria

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15

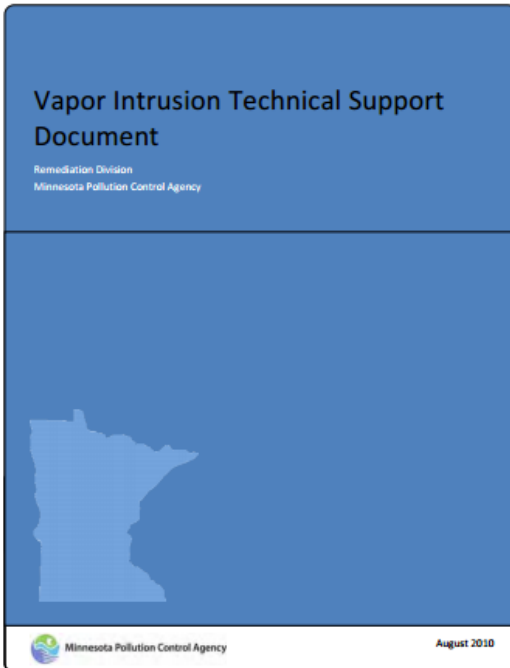
➤ *Confusion about petroleum hydrocarbons at non-UST sites.*

VI – What's new in Minnesota?

Most recent MPCA VI Guidance: 2010

VI Best Management Practices (BMPs): 2015

Updated VI Guidance: Coming soon - 2016



Minnesota Pollution Control Agency

www.pca.state.mn.us

Diagnostic testing, installation and confirmation sampling for active vapor mitigation systems in single-family residential buildings

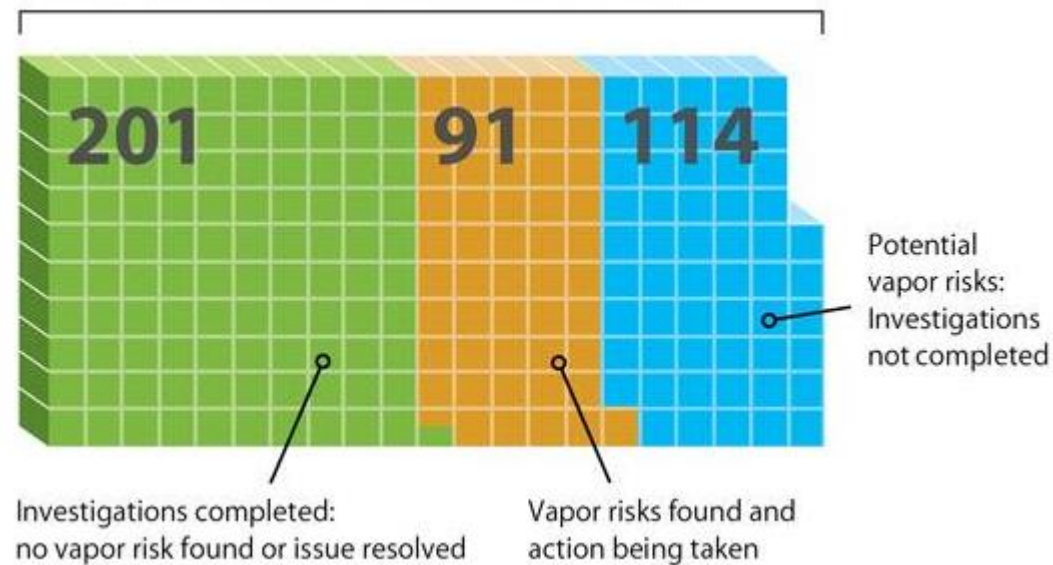
Purpose

The purpose of this document is to provide guidelines on best practices for conducting pre and post-mitigation diagnostic testing, installation and confirmation sampling for active vapor mitigation systems (active systems).

MPCA Sites Being Reevaluated

- How many soil vapor sites in Minnesota (actual and suspected)?

Sites identified as potential vapor risks (as of Oct. 2015)



The MPCA is assessing many sites themselves – and developing Best Management Practices in the process

Updated VI Guidance – Coming Soon

1. Vapor Testing (in 2010 Guidance)
2. Decision Framework (in 2010 Guidance)
3. Building Actions (in 2015 Best Management Practices)
BMPs for non-residential settings
4. Operation, Maintenance and Monitoring
In process
5. Now what? Institutional controls, etc. (in process)
In process

Next: BMPs become Guidance

Thank You!

- Questions?