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VAPOR INTRUSION

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FORT GILLEM VAPOR INTRUSION ASSESSMENT

presented by | Shanna Thompson, P.E.
Atlanta, GA

Overview

- Intro to Fort Gillem
- Fort Gillem Vapor Intrusion (VI) Study – The Short Story
- Key Elements to Fort Gillem VI Forensics
  - Importance of a VI-CSM
  - Background Sources vs. VI Sources
  - Desktop Methods to Distinguish Background from VI
  - Field Methods to Distinguish Background from VI

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In the News….

Toxic chemicals found in homes near Fort Gillem

NEWS By Shannon McCaffrey - The Atlanta Journal-Constitution

Fort Gillem: Toxic vapor

GEORGIA HEADLINES September 16, 2014 WABE 0 Comments

State environmental officials say the U.S. Army has not fulfilled a commitment to help residents of 26 homes that have tested positive for toxic vapor near Fort Gillem.

Georgia DNR: Army Has Yet to Address Toxic Vapor Found in Homes Near Fort Gillem

By MICHELLE WIRTH • SEP 15, 2014

First-ever RCRA "imminent and substantial endangerment" Order for Vapor Intrusion

Letter Health Consultation

Vapor Intrusion Investigation

FORT GILLEM SITE – PRIDE AND JOY DAYCARE

MORROW, CLAYTON COUNTY, GEORGIA

Off-Post Contamination a Serious Concern at Ft. Gillem, Georgia

By Lenny Siegel
February, 2015

CLAYTON COUNTY NAACP & OTHERS TO HOST VAPOR INTRUSION COMMUNITY FORUM FOR FORT GILLEM AREA RESIDENTS

Posted Tuesday, November 25, 2014

Fort Gillem VI Study Challenges

- Data volume
  - 1,750 samples … over 200,000 lines of data
  - IA/CS/SS/OA
  - Every building-specific sample had detections (many above screening levels)
- Background sources
- Managing expectations

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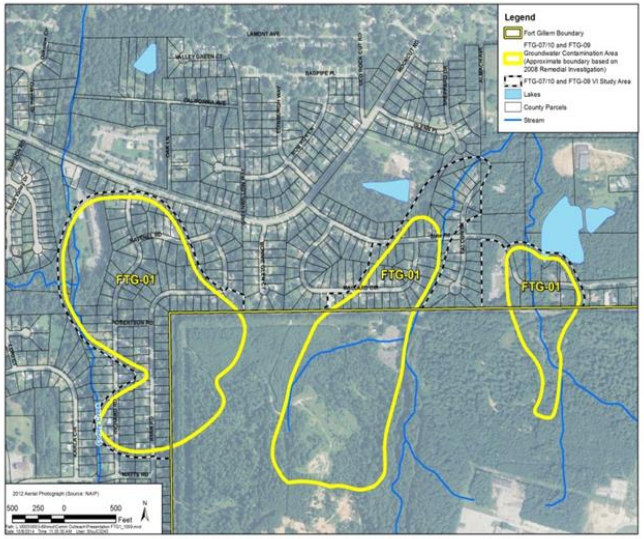
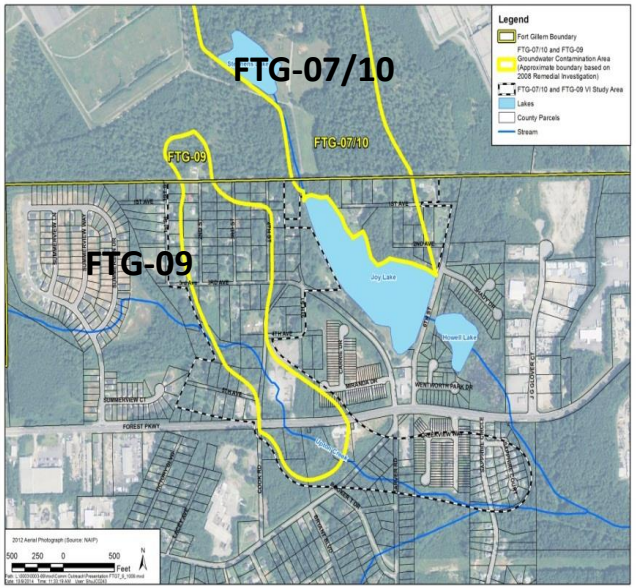
Large-Scale Residential Study

- Multiple GW plumes
  - 1940 to 1980 - waste disposal
  - VI related compounds: TCE, PCE, 1,1,2,2-TeCA, CT, Chloroform
  - Groundwater treatment in place
- Over 300 buildings
- Building access challenges
- Regulatory pressures to sample IA
- Potentially sensitive receptors





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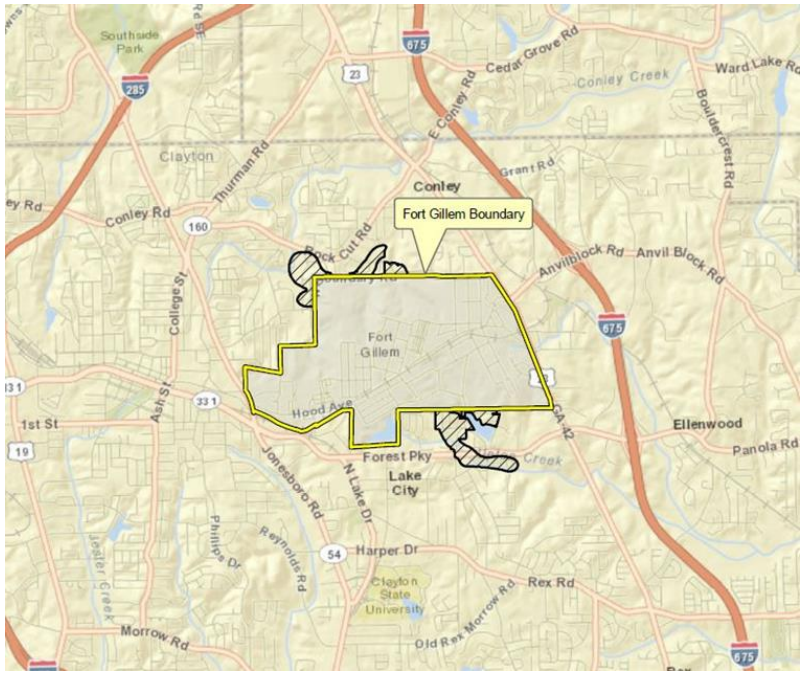
The Fort Gillem VI Study Team

- **Army**
  - HQDA, BEC
  - USACE
  - USACE contractors
- **Regulators**
  - US EPA & GA EPD
- **Others**
  - Community/Residents
  - GA Department of Health
  - Press



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Tier Response Action Levels

Tier	Criteria	Response
Tier I	10% LEL	Notify EPD/EPA - 3 days Evacuate – large effort need an evacuation plan Kids, pets, $$
Tier II	VISL (10-4 and HQ2)	Notify EPD/EPA - 3 days Prompt action – 21 days
Tier III	RSL(10-6 and HQ1)	Notify EPD/EPA Evaluate and proceed
Tier IV	Below RSL	Proceed with VI Study

Fort Gillem Vapor Intrusion Study: The Short Story

Fort Gillem VI Study – The Short Story

- Within 4 months, the VI Study was in the news …
  - June 2014: Vapor Intrusion Study Work Plan
  - Summer 2014: Sample Set 1
  - September 2014: Political and regulatory pressures build
    - Secretary of Army receives **letter from Governor Nathan Deal** that directs the Army to expedite sampling
    - Secretary of the Army receives **letter from USEPA HQ expressing concerns** "that the Army is endangering residents of Forest Park, Georgia...."
    - **USEPA issues a RCRA Section 7003 Unilateral Administrative Order (UAO) to Fort Gillem** requiring specific actions related to VI. Response and comment through Dec 14.
- Sept. 2014: Geosyntec contracted for VI forensic analysis

Fort Gillem VI Study – The Short Story

- Building a VI-CSM in retrospect: 9/2014 – 3/2015
  - Shallow GW data collection
  - Soil gas data collection
- Mitigation
  - Installed sub-slab depressurization system at a daycare out of abundance of caution
  - Installed interim mitigation at homes exceeding risk triggers
- Winter 2015 –Sample Set 2; removed household VOCs 24 hrs. in advance

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Fort Gillem VI Study – The Short Story

- **2015 - Desktop Forensic Evaluation**
  - VI Database Tool used to evaluate large data sets; ★
  - Air dispersion modeling study;
- **2015 - Field Forensic Secondary Evaluation**
  - HAPSITE Investigations ★
  - Building Pressure Cycling ★
- **Summer 2015 – Sample Set 3, 4;**
- **March 2016 – Final VI Report submitted**

Importance of a Vapor Intrusion Conceptual Site Model

Importance of a VI-CSM

- Need a VI-CSM before collecting indoor air samples
  - Without it, there is no context for indoor air results
  - Some IA data taken out of context requires immediate action
- Can be graphic or tabular, depending on amount of data available
- Developing a graphic CSM helps identify data gaps
- Let's look at an example from Fort Gillem

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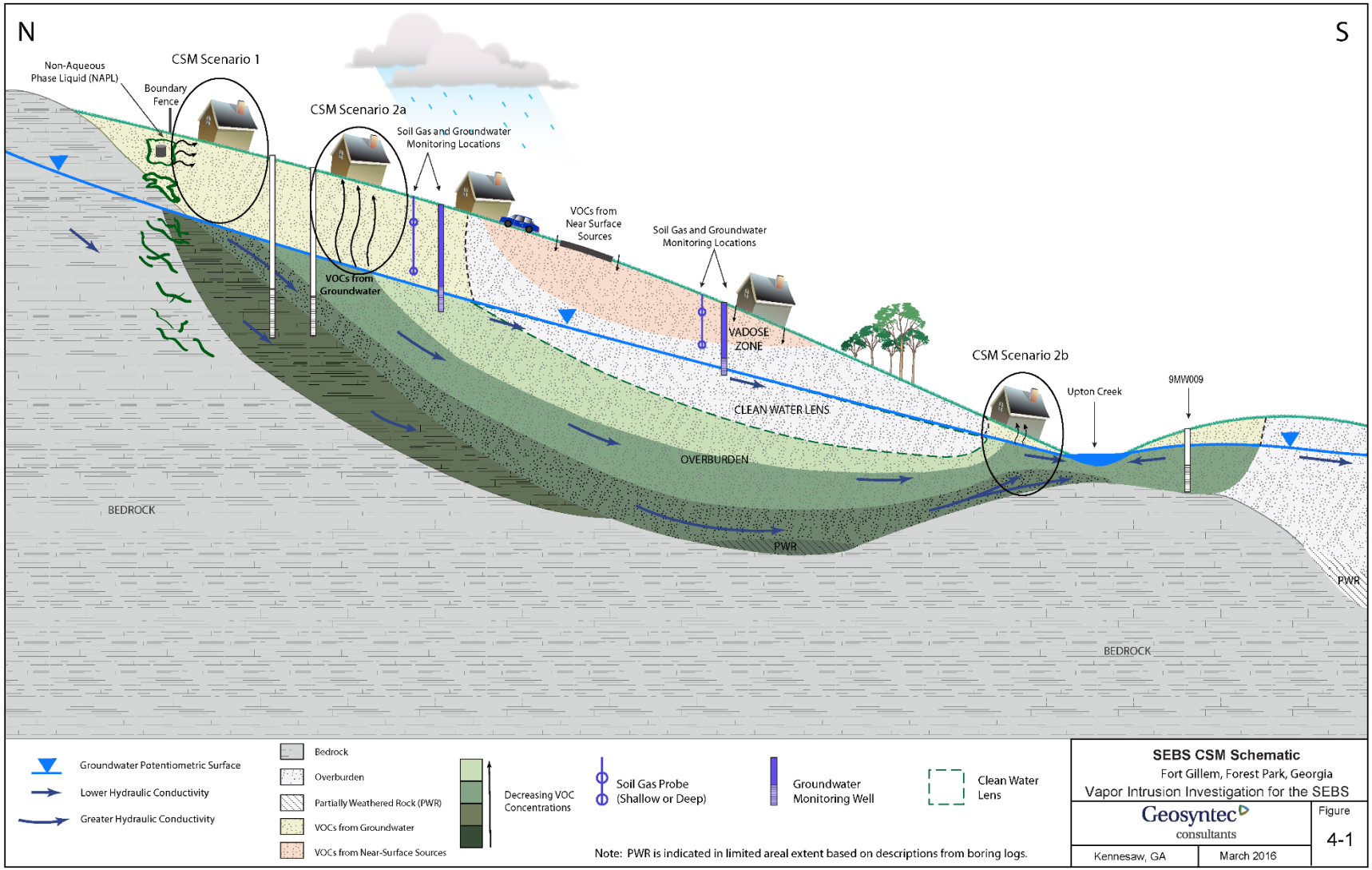
Example VI-CSM



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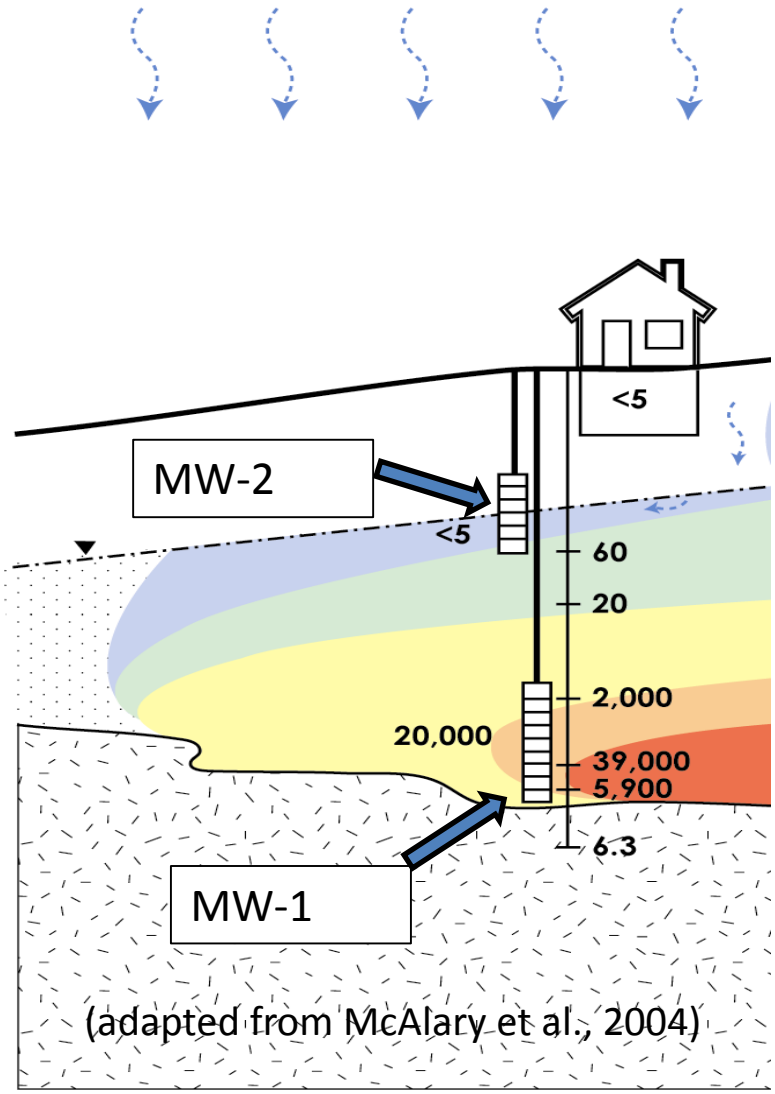
Why Shallow Groundwater Samples Matter

- Monitoring wells are installed to delineate plumes, not for VI
- What would you conclude from MW-1 data?
- Install a screen @WT MW-02



Distinguishing Background Contamination from Vapor Intrusion Contamination

(Mickunas, 2004)

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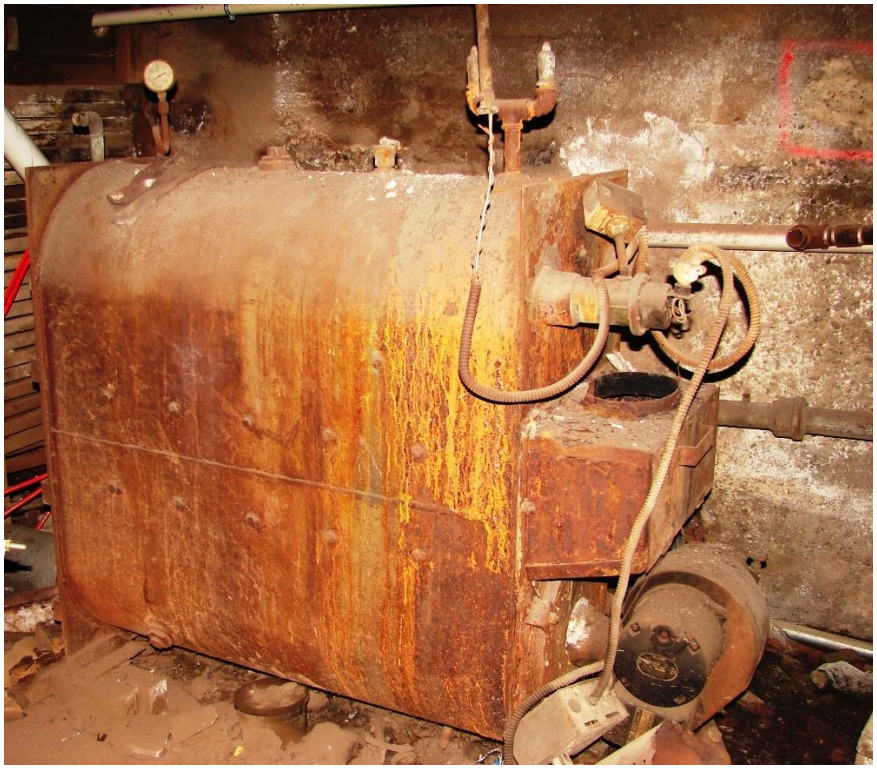
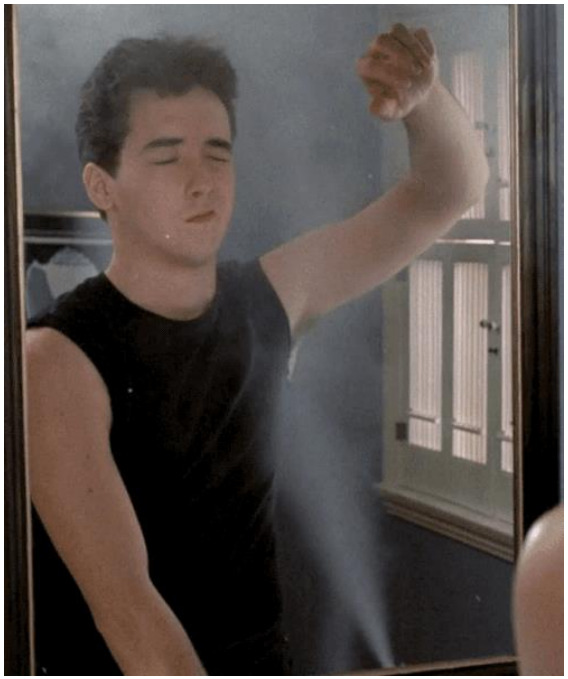
Consumer Products





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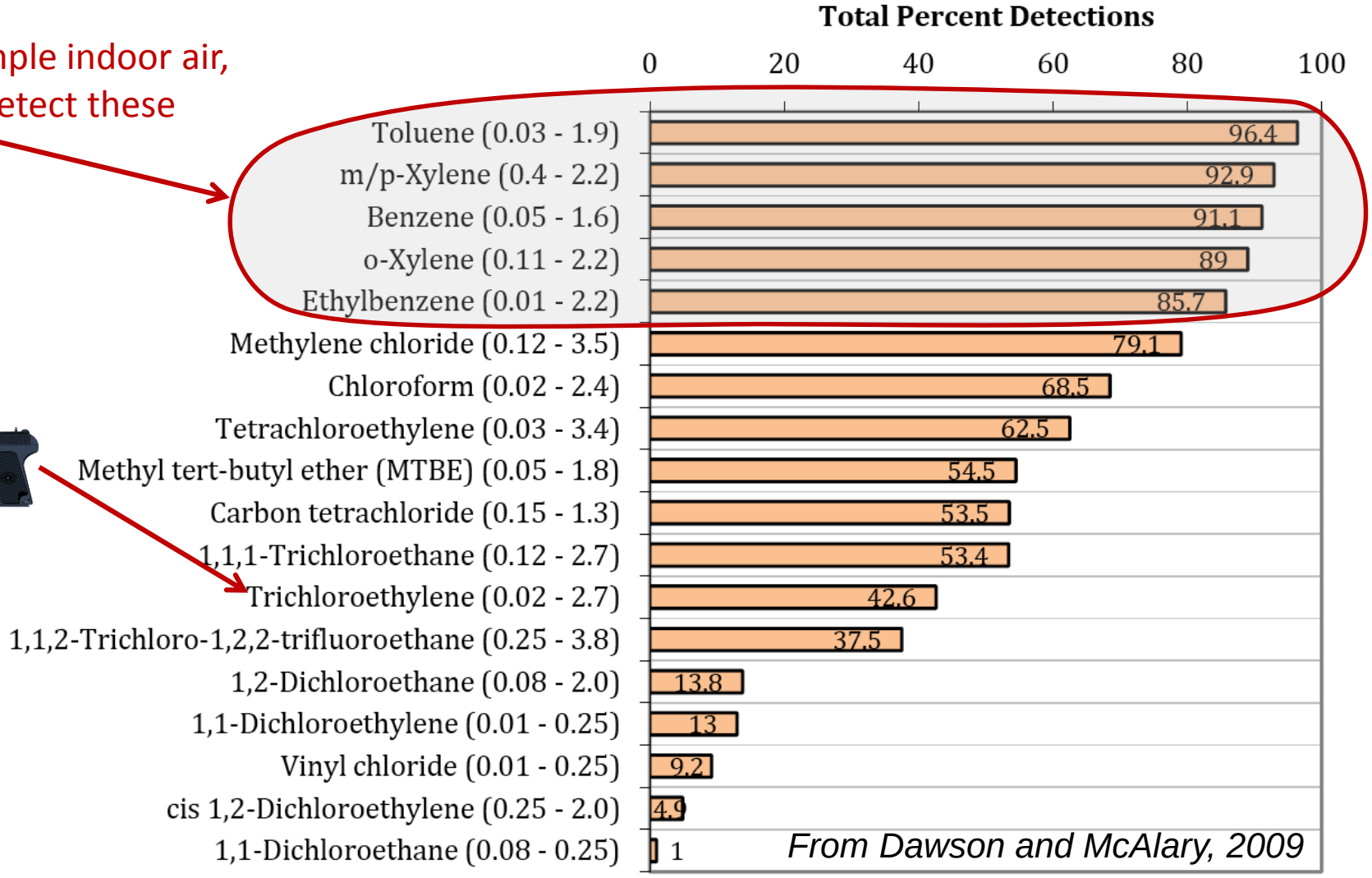
How Frequently do we Detect Background Sources?

If you sample indoor air, you will detect these



From Dawson and McAlary, 2009

Household Products Database

householdproducts.nlm.nih.gov

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Example:

- Rental Property
- Crawl Space home
- Moved due to VI Concerns
- Media
- Used mothballs in planter beds
- Second event – empty house

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Example Results:

Compound	Fall Data September 18, 2014 (µg/m^3)			Winter Data February 24, 2015 (µg/m^3)		
	BG	CS	IA	BG	CS	IA
Benzene	0.9	1.6	0.84	0.94	1.4	0.7 M
BDCM	0.19 U	0.19 U	0.83 J	0.19 U	0.19 U	0.19 U
Carbon tetrachloride	0.51 J	0.5 J	0.58 J	0.55 J	0.71 J	0.51 J
Chloroform	0.24 J	0.24 JM	2.8	0.19 U	0.31 JM	0.2 JM
DBCM	0.17 U	0.17 U	0.32 J	0.17 U	0.17 U	0.17 U
1,4-DCB	0.13 J	0.3 J	16	0.11 U	0.11 U	0.11 U
Ethylbenzene	0.45 J	0.66 J	0.49 J	0.087 U	1.5	0.11 J
Naphthalene	0.16 U	1.4 J	13	0.16 U	0.16 U	0.16 U
Cumulative Cancer Risk Estimate	**3 E-4**			**9 E-6**		
Hazard Index Estimate	**5**			**0.4**		
Tier Rating	**Tier II (Naphthalene)**			**Tier III**		

Desktop Methods Used to Distinguish Background from VI

Desktop Methods to Distinguish Background from VI

- So how do you make sense of a large data set in a timely manner?
  - Built database (DB) modeled after EPA DB – (Helen Dawson, USEPA → Geosyntec)
  - Use Excel charts to examine ratios and building specific attenuation factors

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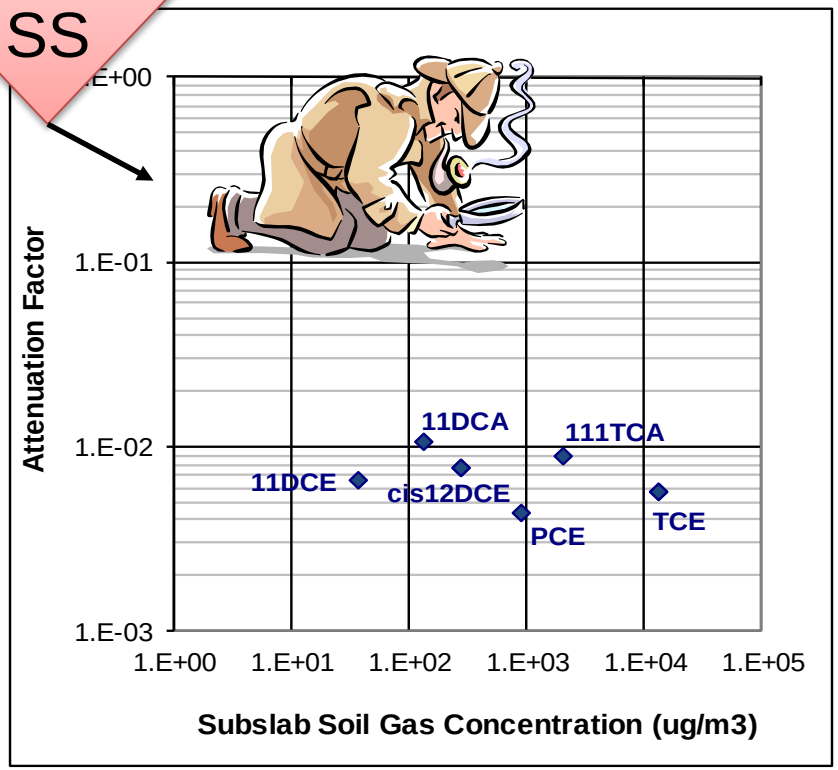
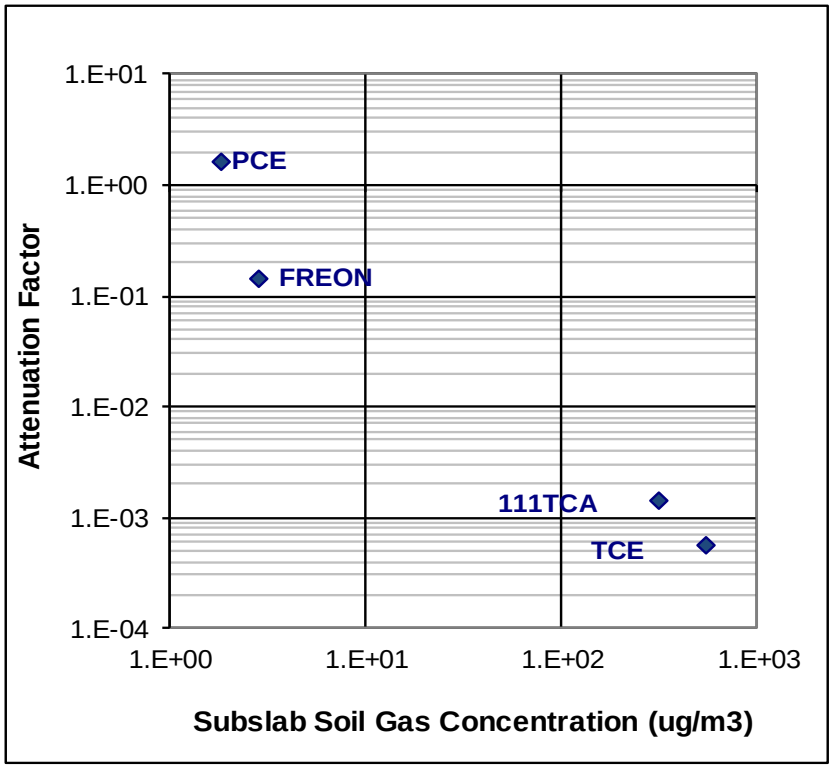
Attenuation Factors Shed Light on VOC Sources

IA/ SS

Minimal Influence on IA from Consumer Sources



Substantial Influence on IA from Consumer Sources



Source: Dawson & Kapuscinski, 2012

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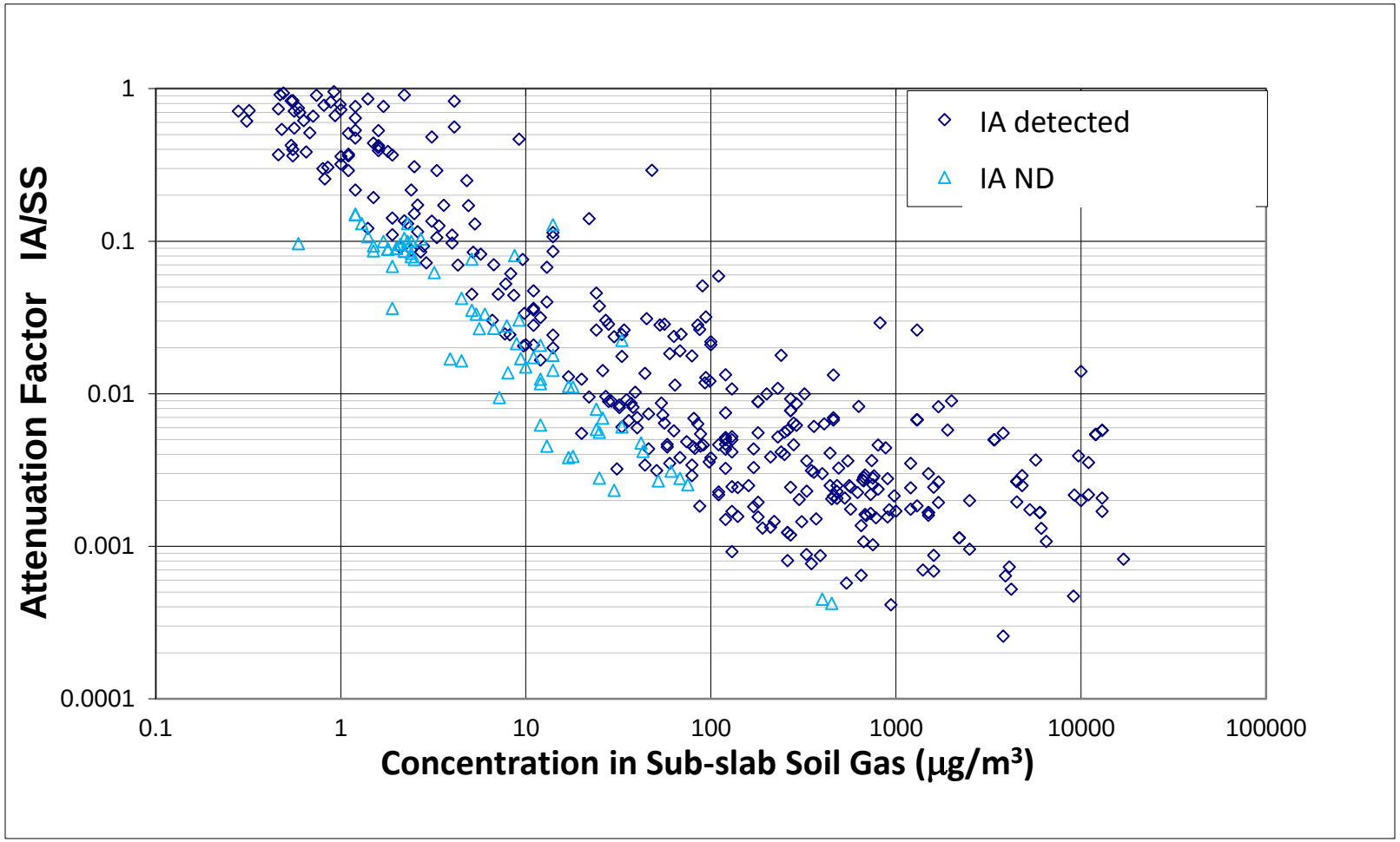
Measuring the "True" Attenuation Factor from a Large Empirical Dataset



Data from USEPA (Helen Dawson)

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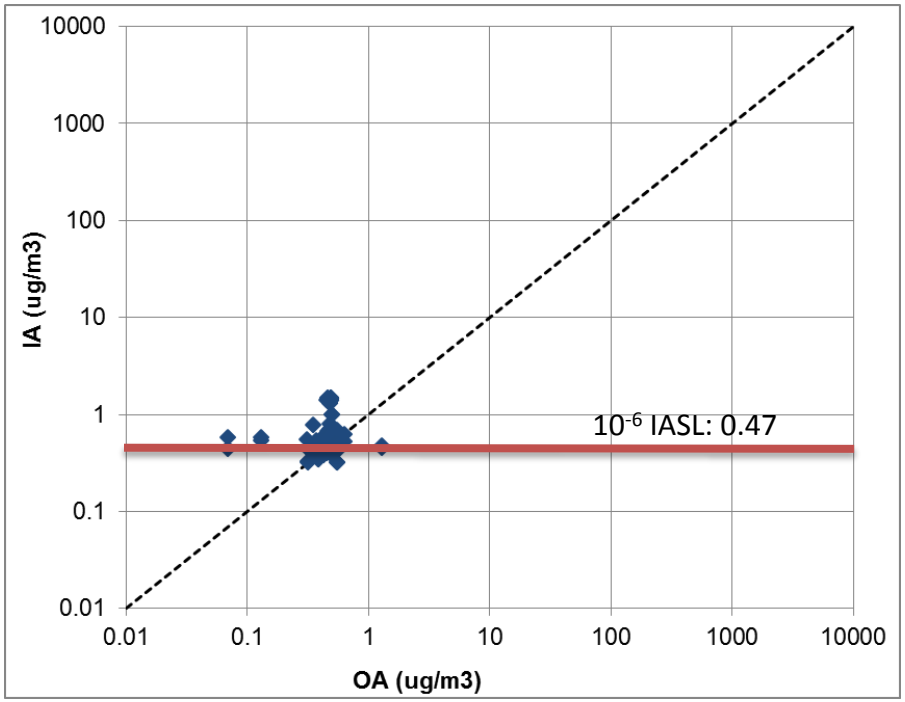
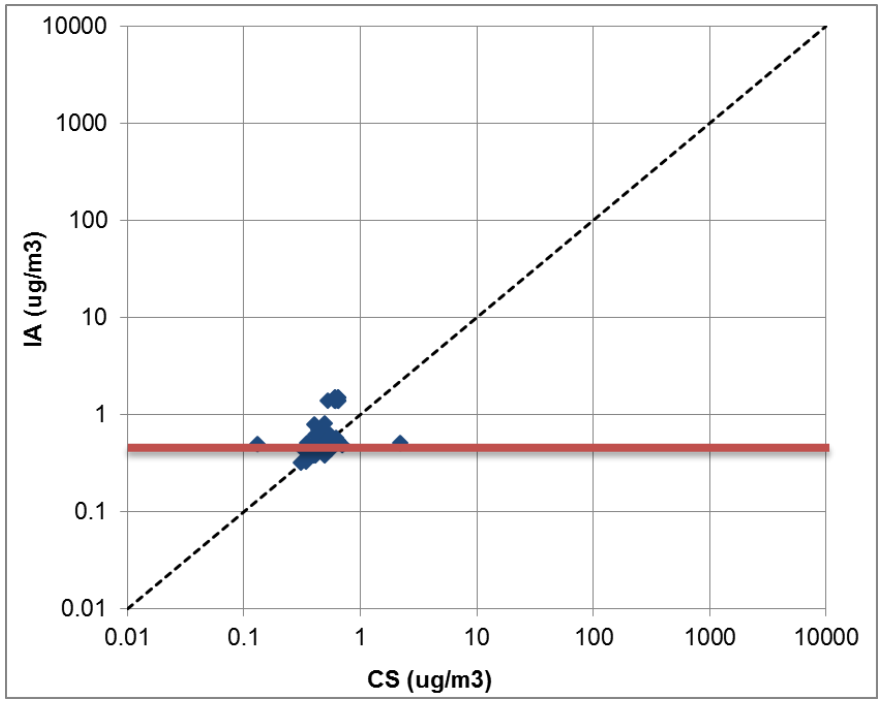
Carbon Tetrachloride - media comparisons

Plots include samples w/ detections in IA

Buildings: n=63
IA samples: n=156





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Chloroform - media comparisons

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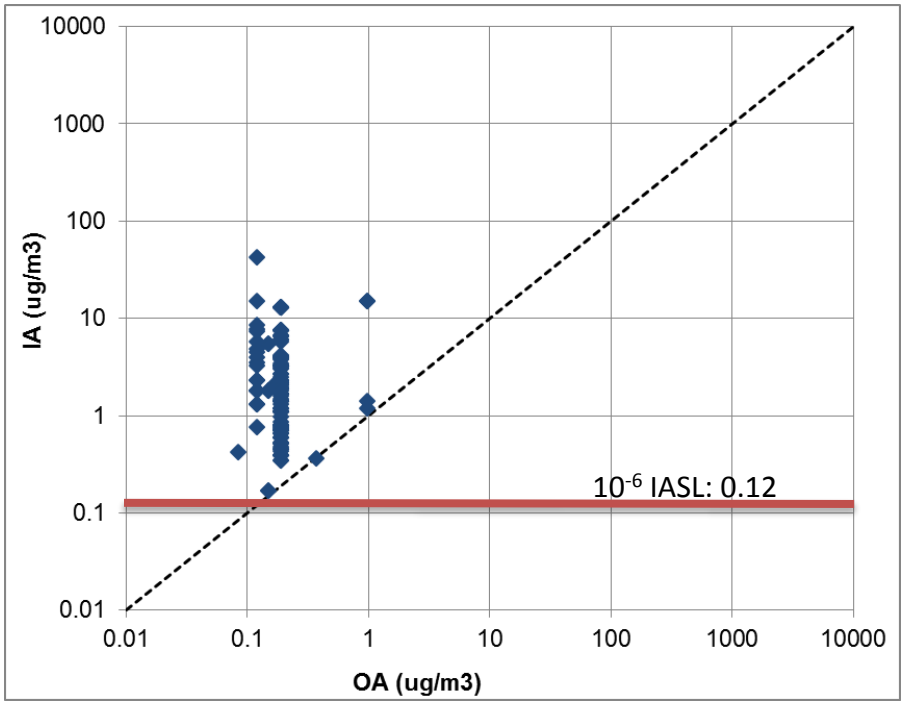
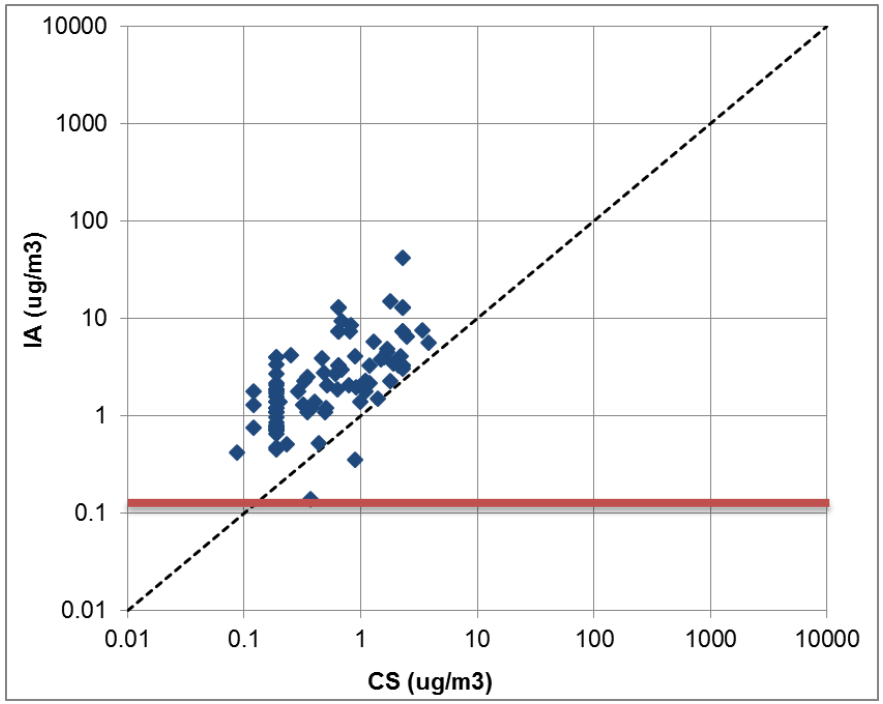
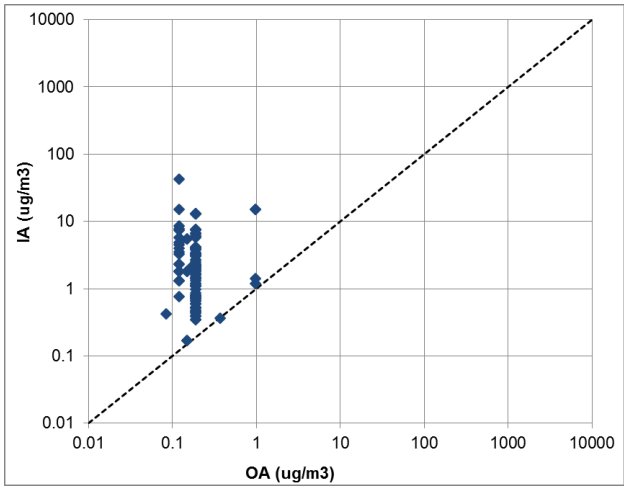




Desktop Forensics Helped at Fort Gillem

- Shows messages graphically that can be challenging to convey in text and tables
- Allows simple visualization of trends/non-trends in large data sets
- With just a few clicks, you can make queries about specific areas or compounds



Field Methods Used to Distinguish Background from VI

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Field Methods to Distinguish Background from VI

- Building inspections: remove suspected sources
- Flux chambers
- Field GC-MS like HAPSITE or mobile labs
- Building pressurization

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First Event vs. Second Event

First Event

Home Questionnaire
- No product removal
- Few photographs

Sampled 69 Buildings
- 34 Tier II
- 34 Tier III
- 1 Tier IV

Second Event

Home questionnaire & product removal

Sampled 80 buildings (incl. 67 of 69)
- 7 Tier II
- 73 Tier III
- 0 Tier IV

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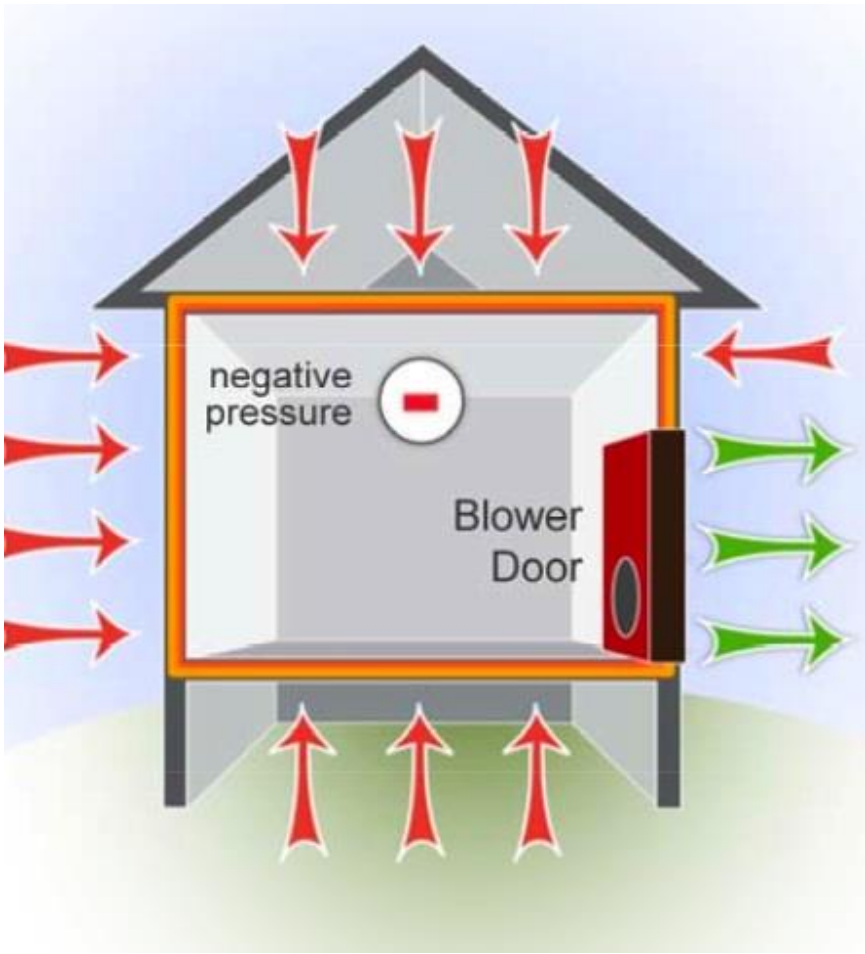
HAPSITE Field GC-MS

- HAPSITE
  - Continuous run “sniff” mode available
  - Calibrate to 5-10 VOCs
  - PPB RLs achievable
  - Need trained technician
- FROG is another option, but then your staff/consultants are operating the GC/MS
- Flux chambers can be used to enhance clarity of suspected sources
- Helped identify chloroform, 1,2-DCA, and xylene sources at Fort Gillem

Building Pressure Cycling



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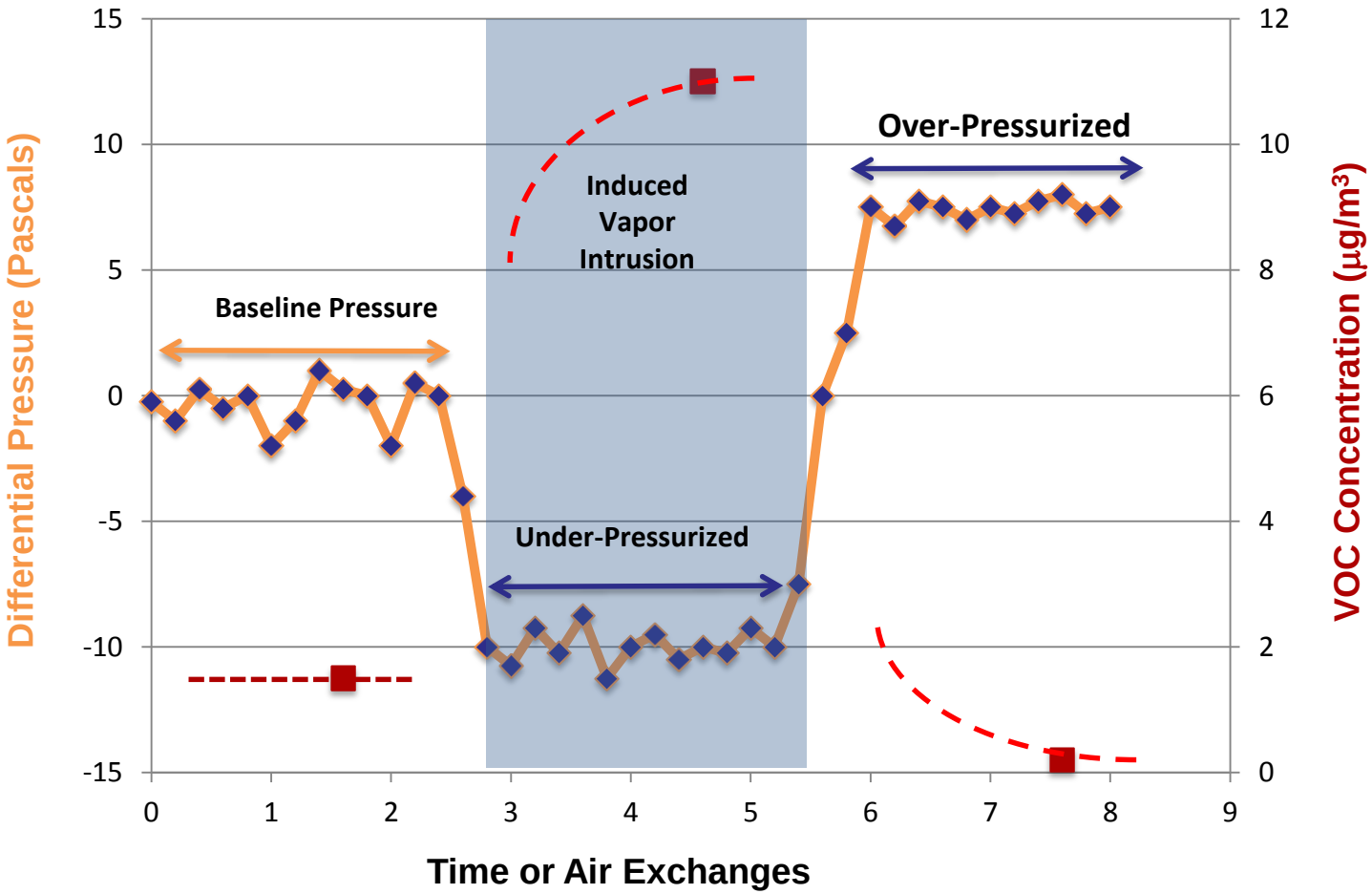
Building Pressure Cycling to Demonstrate VI Pathway Complete



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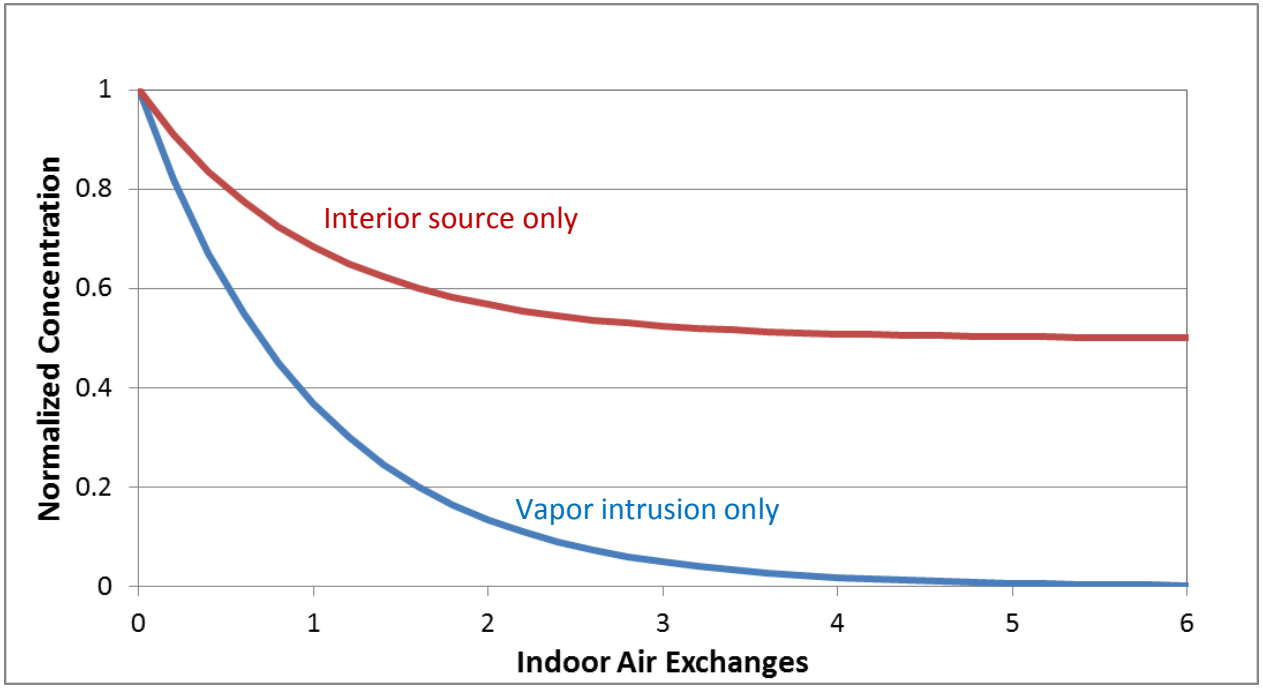
Building Pressure Cycling to Test VOC Sources

Idealized results during building pressurization



At Fort Gillem, Building Pressure Cycling showed no evidence of VI

Field Forensics Helped at Fort Gillem

- HAPSITE (portable GS/MS)
  - Majority of buildings surveyed identified an IA source, e.g.:
    - chloroform in heavily used laundry area
    - 1,2-DCA from plastic products
    - Xylenes from household solvent
  - In some cases the HAPSITE did not locate an IA source
  - Can seem invasive to residents

- Building Pressure Cycling results at Fort Gillem
  - Gradients were induced that would cause VI if it were a concern
  - Results from IA samples during test were below screening levels

Summary

- Disparity between perception and reality
  - Can be the biggest hurdle
  - Needs a science-based solution
  - However, emotions are often driving when citizens and politicians are involved
- How do you bring these two things back in line?
  - Use science to get to the truth
  - Use multiple lines of evidence
  - Use a robust VI Conceptual Site Model
- Lesson learned: managing expectations up front is crucial

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Thank you

Gillem VI Team Members

HCR Construction, Inc.
SCF
Wenck
Atlas-Geo Sampling

Geosyntec VI Leaders

Helen Dawson
Todd Creamer
David Bertrand
Todd McAlary
Justin Knight

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Mitigation Options

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Mitigation Options

- Engineering Controls
  - Building Ventilation (minutes - hours)
  - HVAC System Modifications (hours – days)
  - Indoor Air Filtration (hours – weeks)
  - Passive Vapor Barrier (membranes and seals) (days – months)
  - Sub-Slab Venting or Depressurization (days – months)
  - Aerated Flooring (new construction)
- Institutional Controls
  - New construction or building occupancy (future)
  - Intrinsically Safe Building Design

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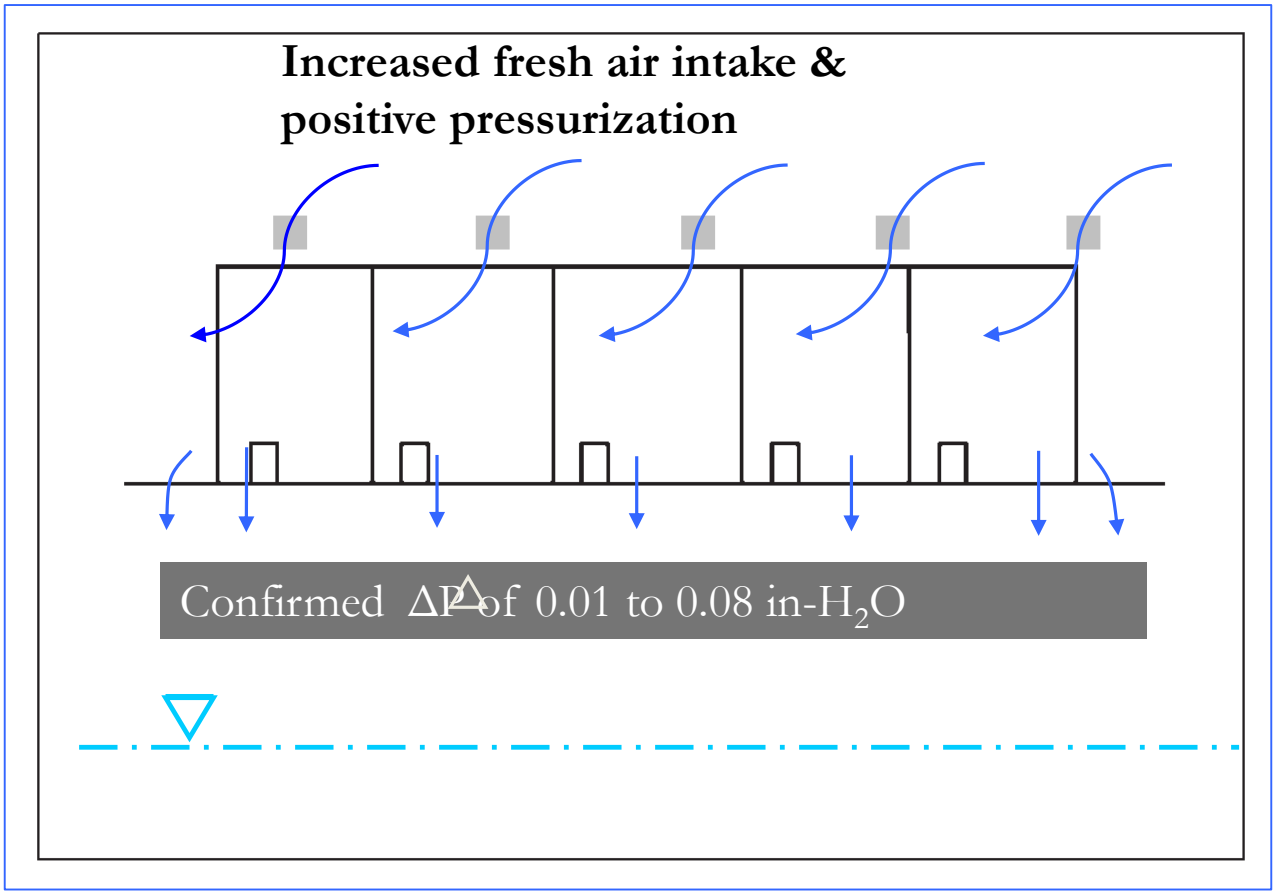
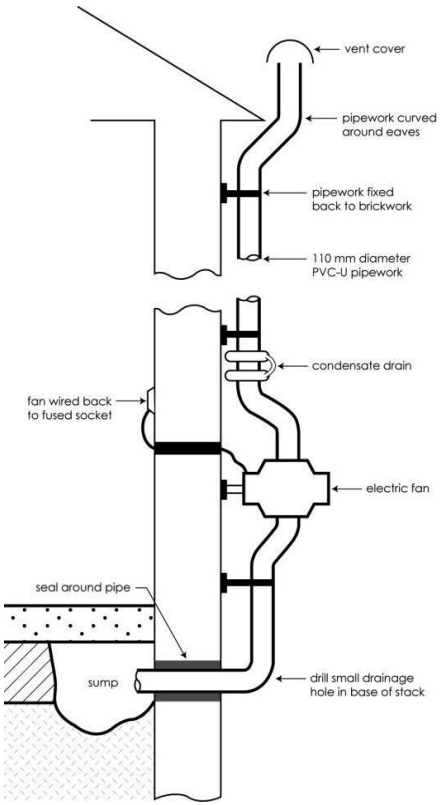
HVAC Modification



Sub-Slab Venting, Depressurization



Residential

Commercial

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Aerated Flooring

A plastic form is used to create a continuous void below concrete slabs and concrete is poured over the forms.

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Challenges → Innovative Solutions

Temporal Variability	Long-Term Passive Sampling
Endless Monitoring	Building Pressure Cycling ★
Spatial Variability	High Volume Sampling
Background Sources	Compound Ratio Analysis ★
	Compound-Specific Isotope Analysis
	Portable Mass Spectrometers ★
Preferential Pathways	Pneumatic Testing and Leakance Analysis
Geologic Barriers	Vadose Zone Pumping Tests
Building Susceptibility	Building Pressure/Ventilation Testing

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Carbon Tetrachloride - media comparisons

Plots include samples w/ detections in IA

Buildings: n=63
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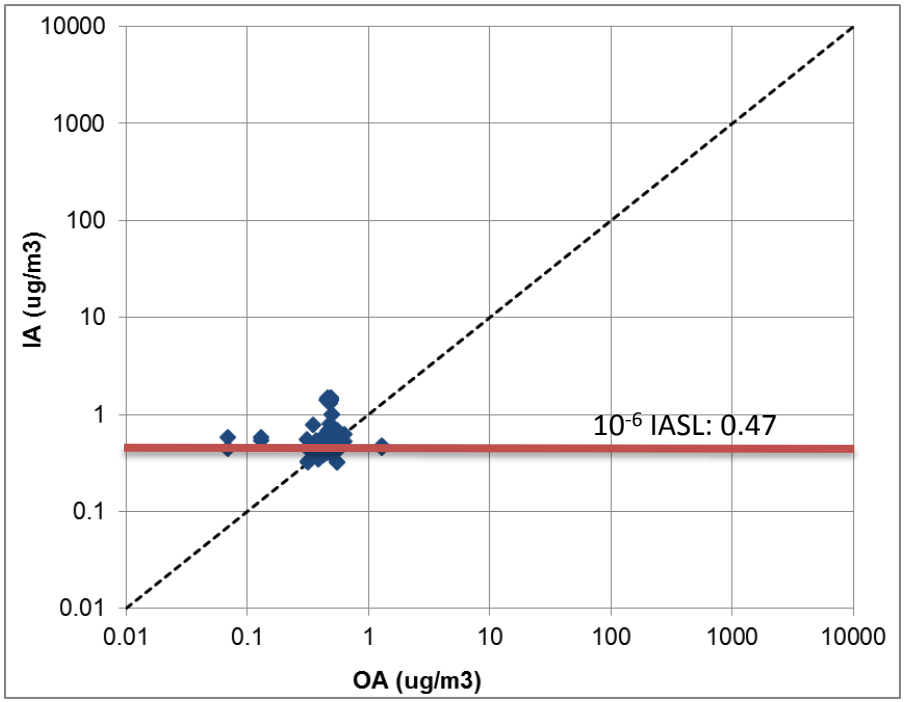

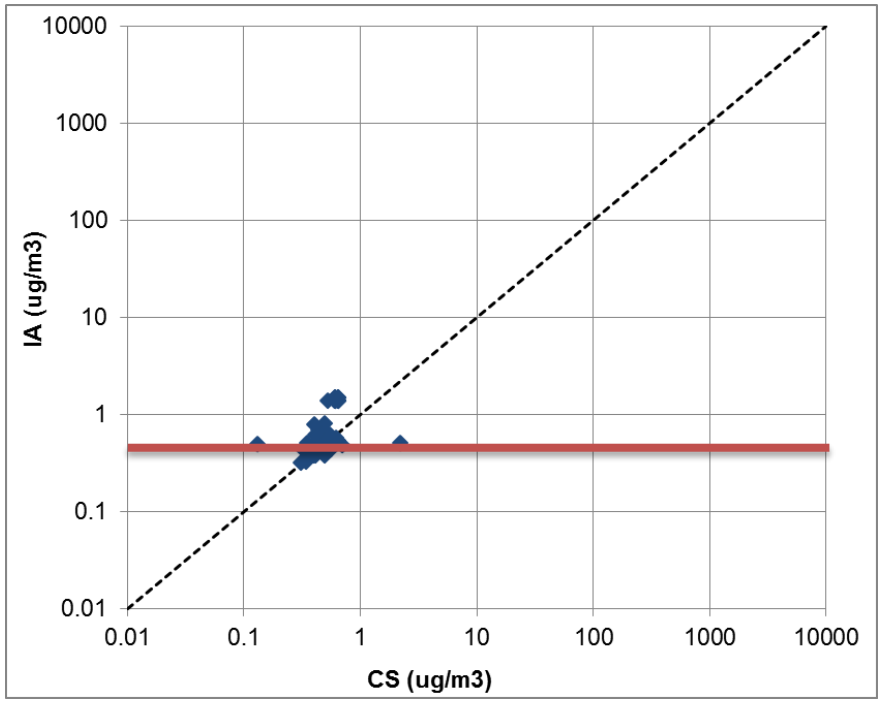

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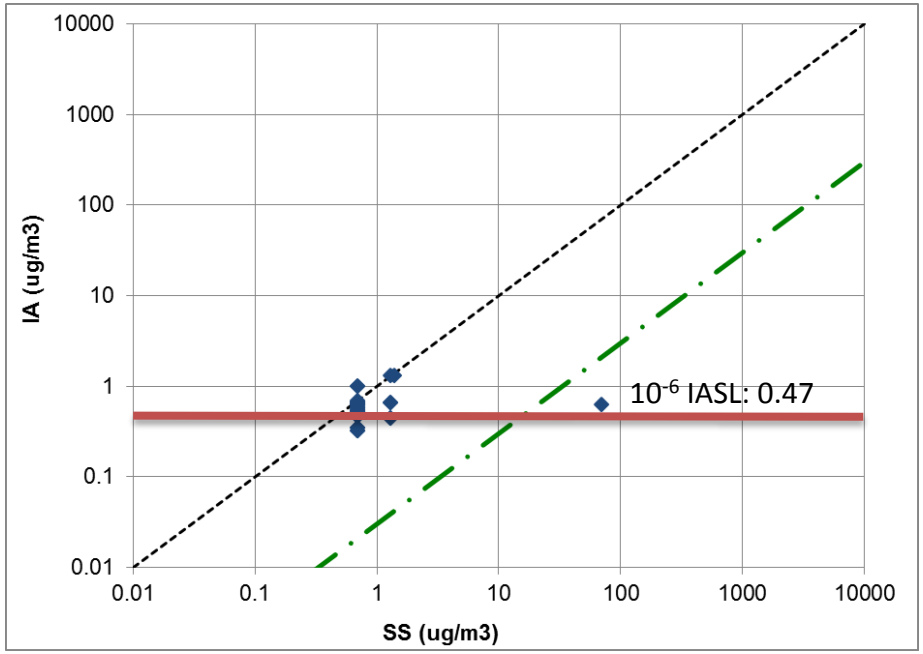
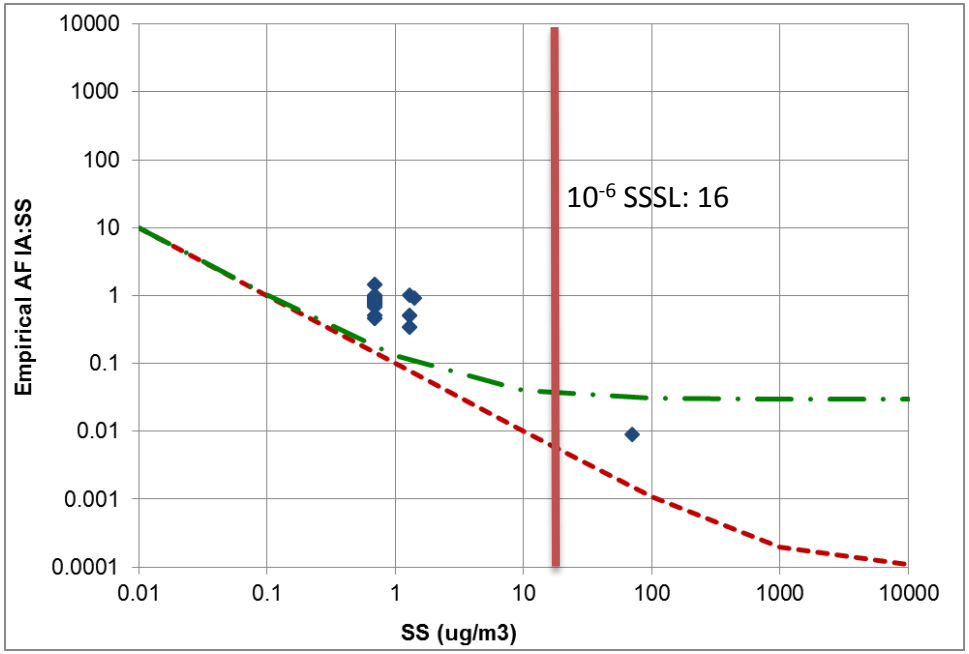
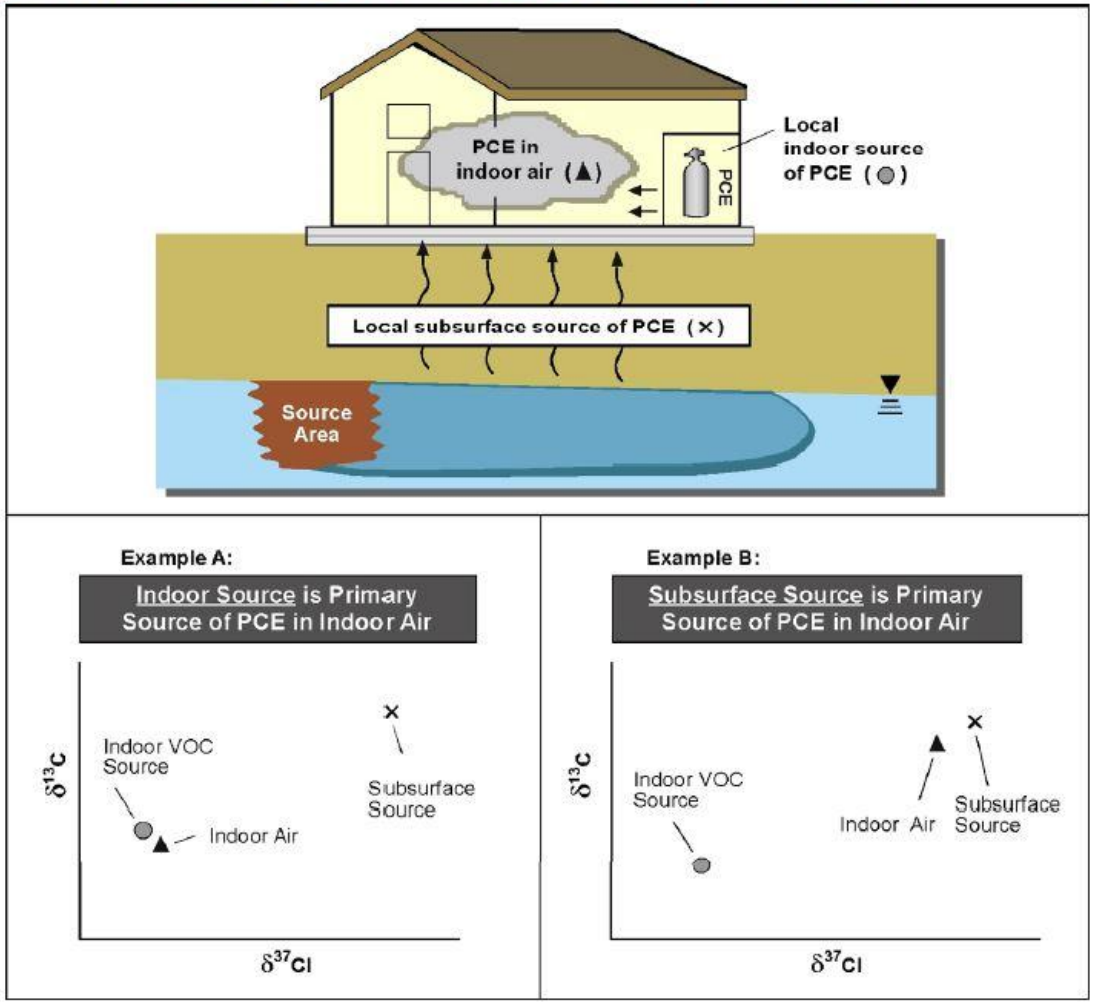




These exercises work for single buildings too, using multiple VOCs

TECHNOLOGY DESCRIPTION



(McHugh et al., 2010. Use of compound-specific stable isotope analysis to distinguish between vapor intrusion and indoor sources of VOCs; AWMA)

Timeline of TCE Toxicity Assessment

1985 – EPA posts TCE health assessment in IRIS

1989 – Withdrawn from IRIS

2001 – Draft EPA TCE health assessment for review

2006 – NRC review report

2009 – Revised draft EPA TCE toxicity review

2011 – EPA posts revised TCE health assessment in IRIS

- Identified non-cancer effects (including developmental effects)
- Controversy regarding developmental effects
- Significant implications for VI assessment and mitigation

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Chloroform - media comparisons

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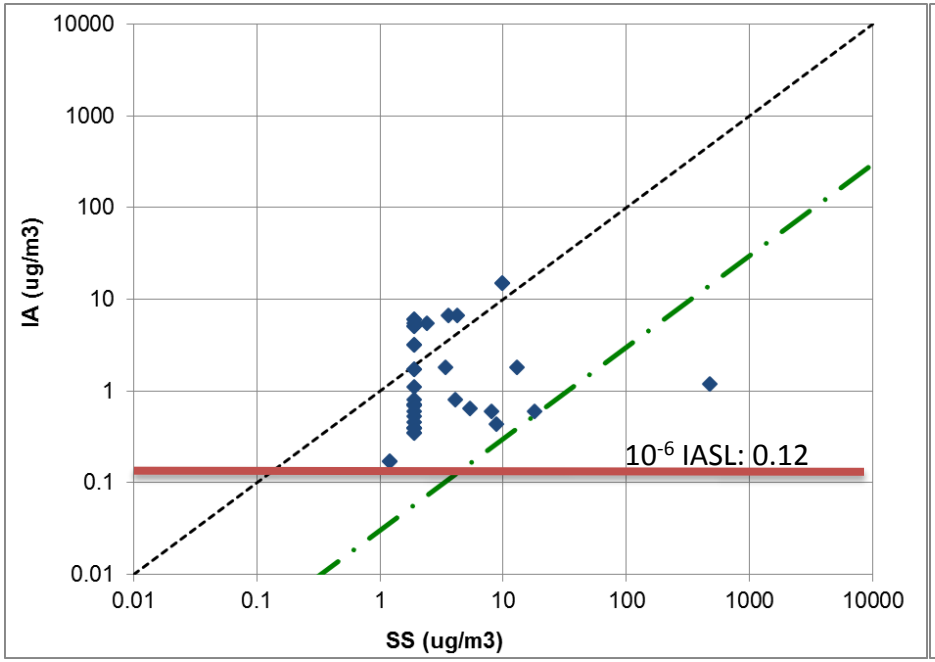

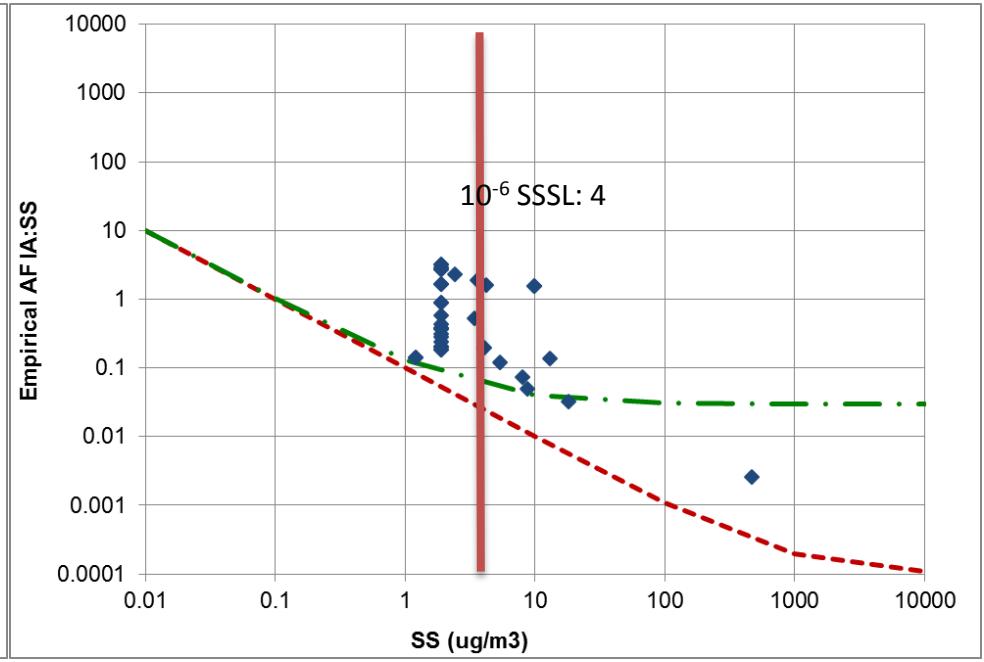

Summary

- Develop a VI CSM before collecting IA data
- Risks of having only IA data
  - Many detections
  - Ineffective mitigation
- Our best defense
  - Robust VI Conceptual Site Model
  - Multiple Lines of Evidence
- Industry has developed innovative solutions to VI evaluation challenges