

STREAMLINING VAPOR INTRUSION INVESTIGATIONS WITH ON-SITE ANALYSIS AND BUILDING PRESSURE CONTROL



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ACKNOWLEDGEMENTS

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Tier 2 and 3 Evaluation of Vapor Intrusion
(Project ER-200707)

**Use of On-Site GC/MS Analysis to Distinguish
between VI and Indoor Sources of VOCs**
(Project ER-201111)

**PROJECT OF
THE YEAR**

2014

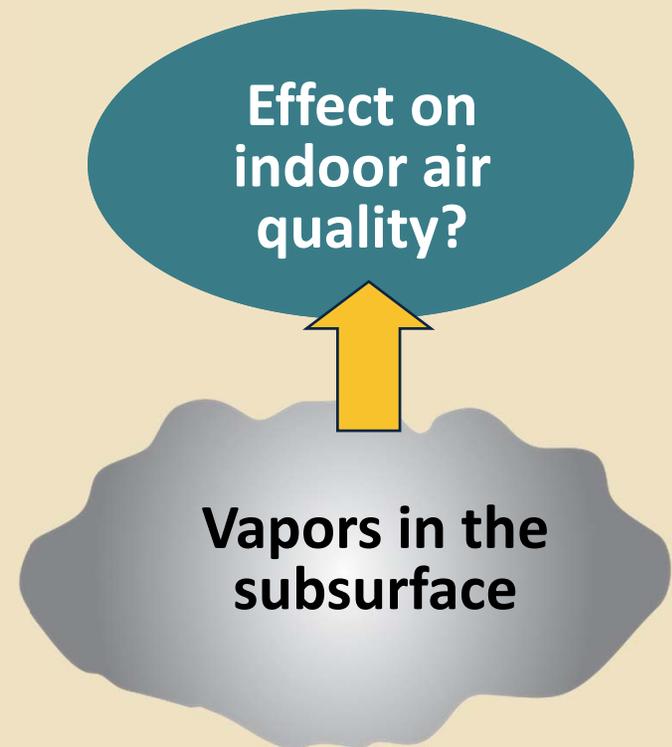
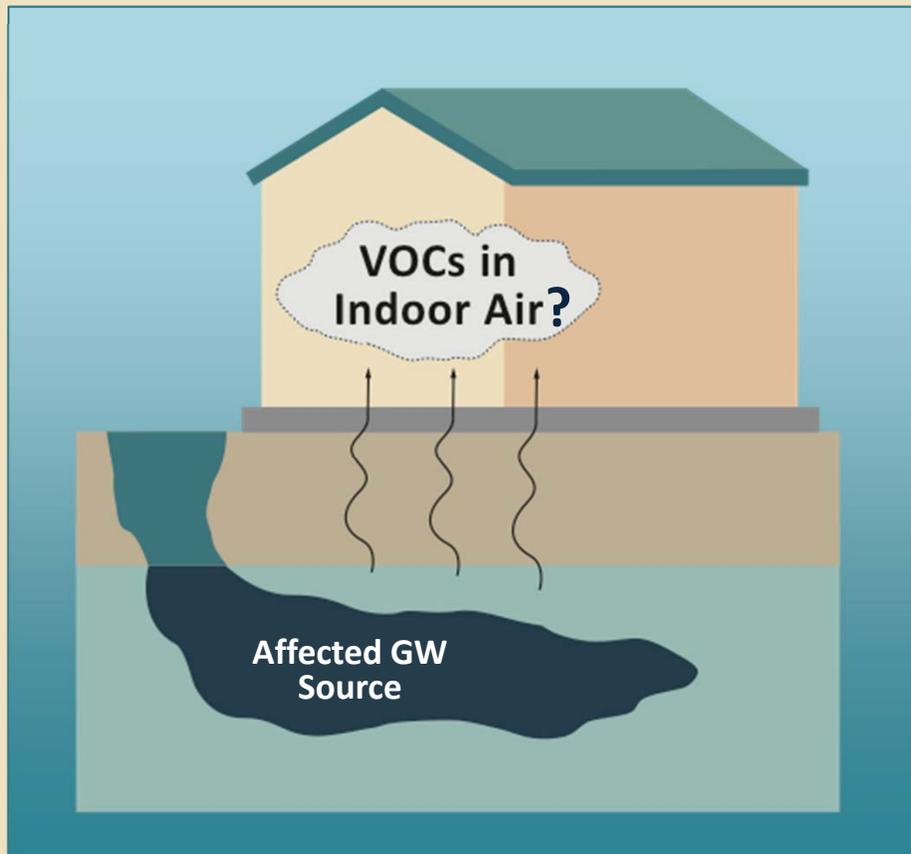
ESTCP = Environmental Security Technology Certification Program

Thank you!

- Tom McHugh, GSI
- Kyle Gorder, Erik Dettenmaier, Ignacio Rivera, many others



VAPOR INTRUSION: *THE BASICS*

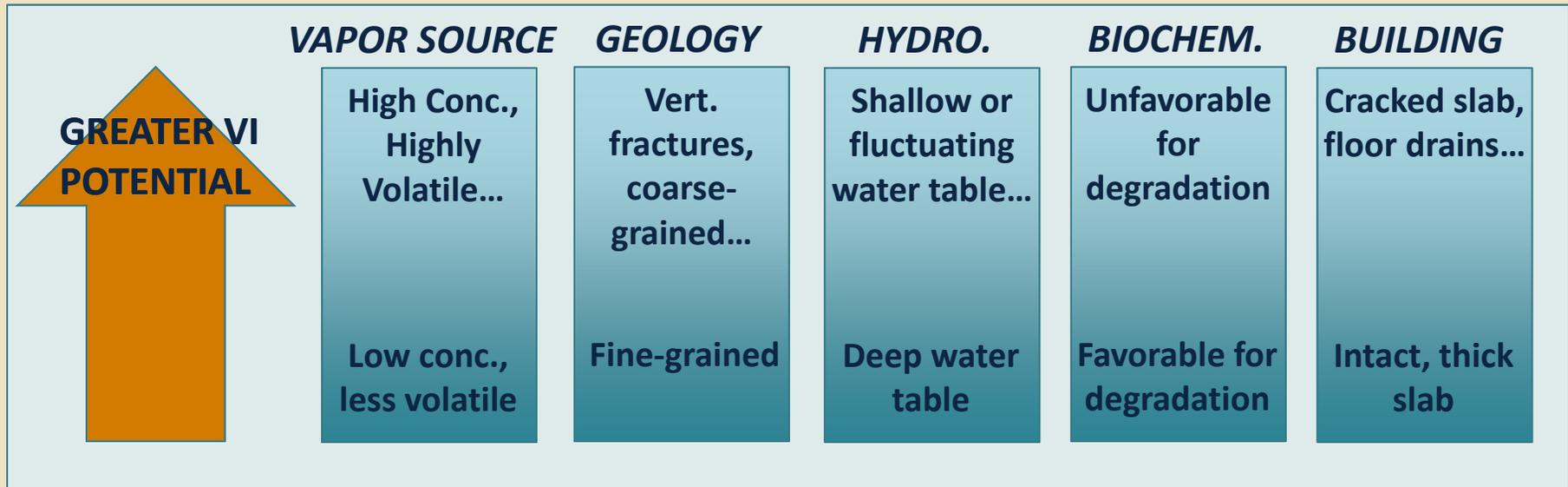


DEFINITION: Vapor intrusion is the vapor-phase migration of volatile organic compounds (VOCs) from the subsurface into indoor air.

TYPICAL VI ASSESSMENT PROCESS



- USEPA (draft) guidance, plus state guidance
- Multiple lines of evidence to characterize VI pathway



KEY POINTS: 1) Different types of data are collected and results weighed together.
 2) If the various lines of evidence aren't consistent, collect more data.

CONVENTIONAL INVESTIGATION APPROACHES: *INDOOR AIR*



■ Typical methods:

- Questionnaire, visual survey to identify pot'l indoor sources of VOCs prior to sampling;
- Collect 1-2 samples.

■ Problems:

- Invasive, storage conditions, unpredictability of indoor sources; minimalist.



KEY POINT: Testing at point of exposure is the most direct method, but can be discouraged (e.g., HI [2013]: “..testing of indoor air.. is fraught with potential error”).

SIGNIFICANCE OF BACKGROUND SOURCES

EXAMPLES OF INDOOR SOURCES: CVOCS

Tetrachloroethylene (PCE)



Hobby Glue



Dry Cleaning



Water-Proofers, Spot Cleaners

Trichloroethylene (TCE)



Pepper Spray



Gun Cleaner



De-greaser



Bleach Cleaners:

Chloroform, Carbon tet

Certain Plastics:

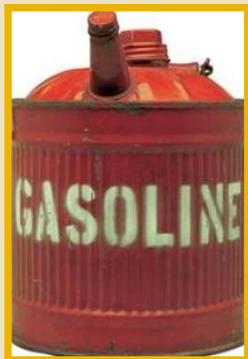
1,2-DCA



KEY POINT: Indoor VOC sources are everywhere and can cause indoor air screening level exceedances.

SIGNIFICANCE OF BACKGROUND SOURCES

EXAMPLES: MORE



Gasoline: **BTEX**



Smoking: **Benzene**



Cooking: **Naphthalene**

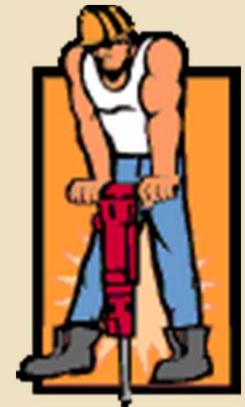


Natural Gas: **Benzene**

KEY POINT: Indoor (and outdoor) VOC sources are everywhere and can cause indoor air screening level exceedances.

CONVENTIONAL INVESTIGATION APPROACHES: *SOIL GAS AND SUB-SLAB*

- Typical methods: Installation of soil gas and/or sub-slab sampling probes
- Problems:
 - Indirect measure of VOC migration
 - Spatial variability? Attenuation?
 - (Sub-slab) Downward migration of indoor VOCs
 - (Sub-slab) Difficult to evaluate preferential pathways



KEY POINT: Because of problems with indoor air testing, many states prioritize soil gas sampling. But soil gas sampling can also be fraught with problems.

PRE-EMPTIVE MITIGATION?



THE PROBLEM:

If the various lines of evidence aren't consistent, the responsible party usually has to collect more data.

- Pre-emptive mitigation in lieu of investigation?
- Appropriate in some cases
- Cautions:
 - If VOCs aren't from VI, then mitigation won't help
 - If vapor entry mechanism isn't identified, then mitigation is hard to design
 - On-going maintenance, liability

PROBLEM STATEMENT: **SITE CHARACTERIZATION**

Need more reliable tools to distinguish between vapor intrusion and indoor sources of VOCs



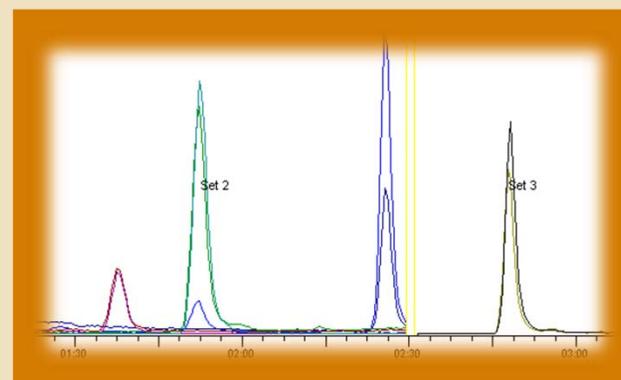
PROJECT OBJECTIVES



- Focus on indoor air and **VOC source identification**
- Develop step-by-step investigation protocol
- Test protocol and data interpretation methods

PORTABLE GC/MS INSTRUMENT

- **Inficon HAPSITE®**
- **Key features:**
 - GC/MS and MS-Only Operating Modes
 - Custom GC/MS Methods
 - Positive ID for 5-10 compounds
 - ~6 min sample turn time
 - Low quantitation limits
- Data quality evaluated in lab study



KEY POINT:

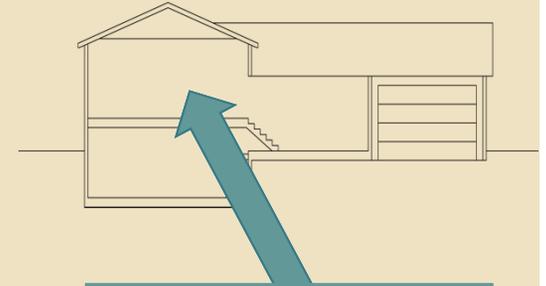
Approach relies on instrument with rapid sample throughput, high sensitivity and precision, quantitative and semi-quantitative capabilities.

ON-SITE ANALYSIS APPROACH



1. Define “baseline” conditions

- Indoor/outdoor air measurements
- Concentration gradient?



2. Find / remove VOC source

- Real-time, dynamic approach to locate “hot spots”
- Source ID/removal reduces uncertainty



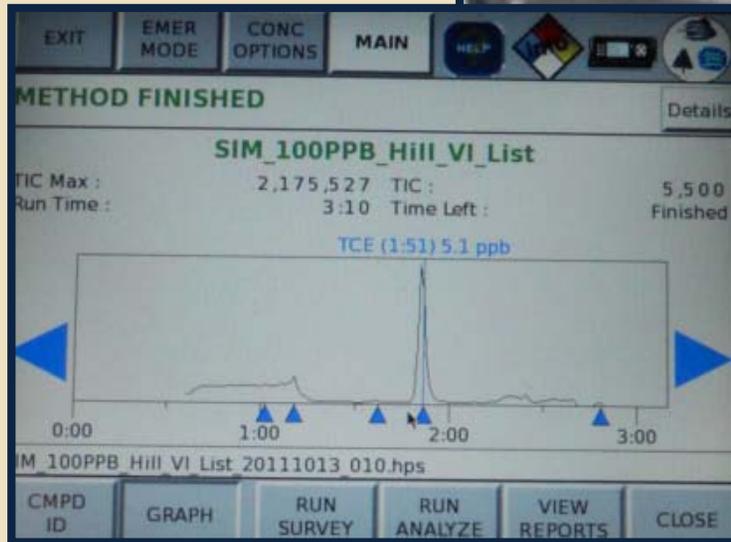
3. Collect confirmation samples

- Off-site lab analysis for regulatory decisions



KEY POINT:

More detailed investigation of sources can eliminate the need for multiple sampling events.

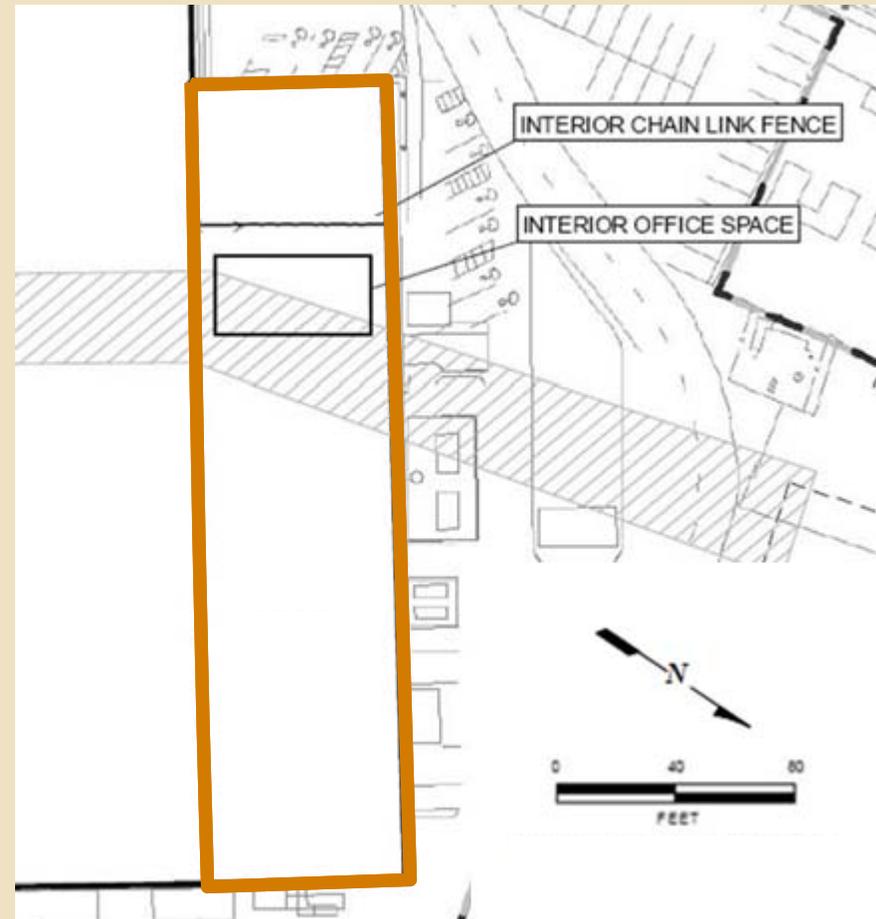


VOC SOURCE IDENTIFICATION EXAMPLE

VOC SOURCE IDENTIFICATION: *EXAMPLE*



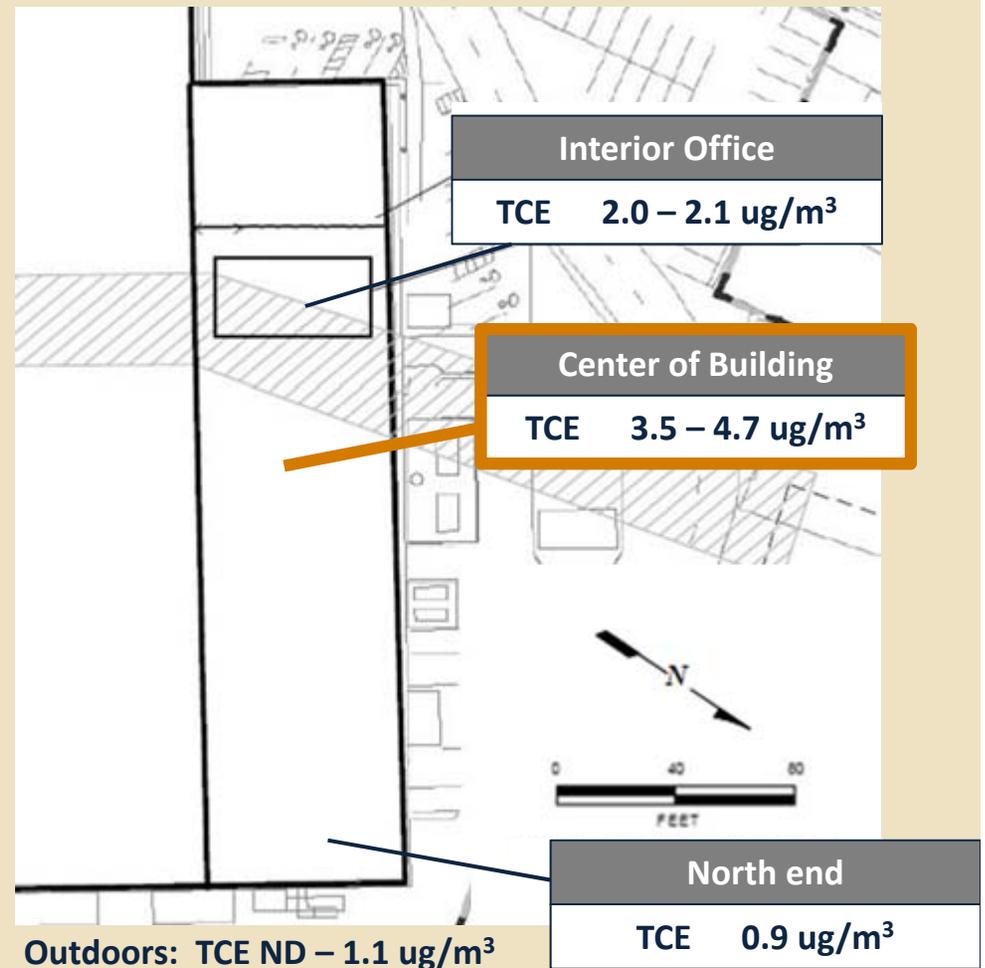
- 16,000 sq ft industrial building
- TCE plume in shallow groundwater
- No previous VI investigation



VOC SOURCE IDENTIFICATION: *EXAMPLE (CON'T)*



- Indoor and outdoor air sampling with HAPSITE
- TCE at center of bldg >2x higher than either end

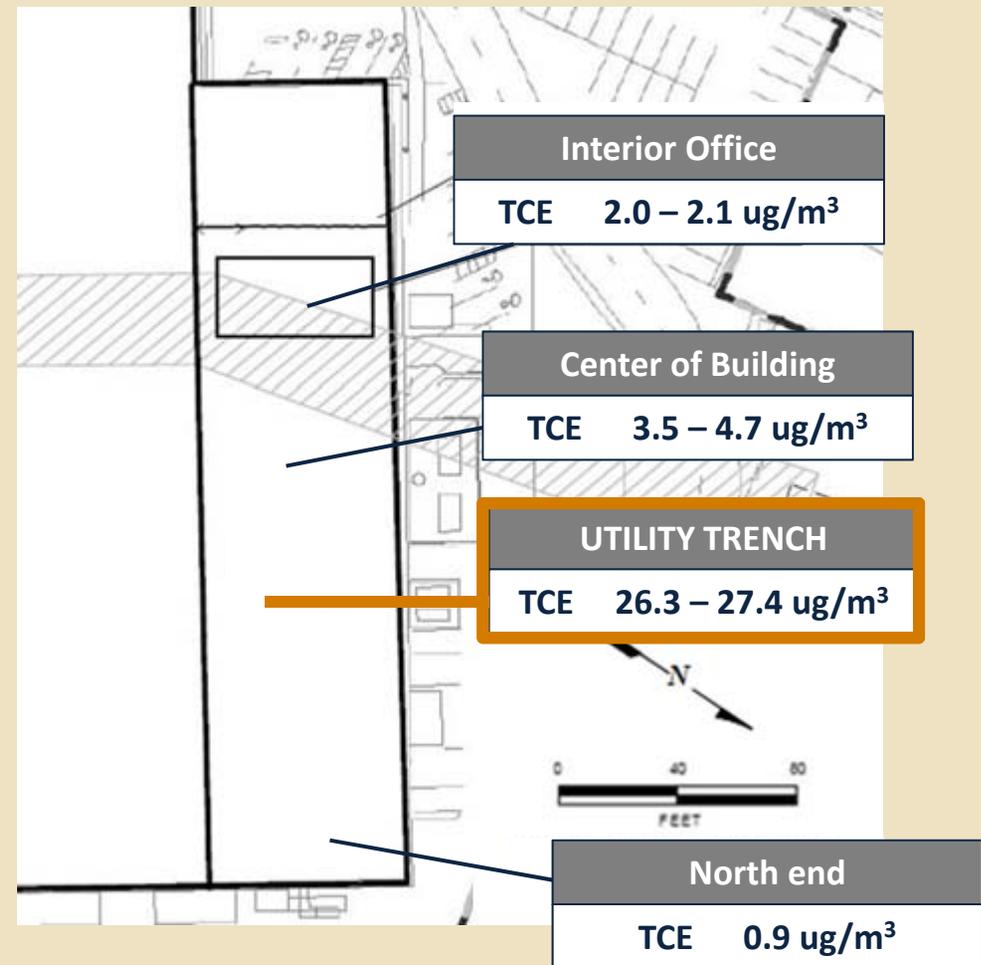


VOC SOURCE IDENTIFICATION: *EXAMPLE (CON'T)*



- Utility trench (source) found
- TCE >5x higher than elsewhere in bldg

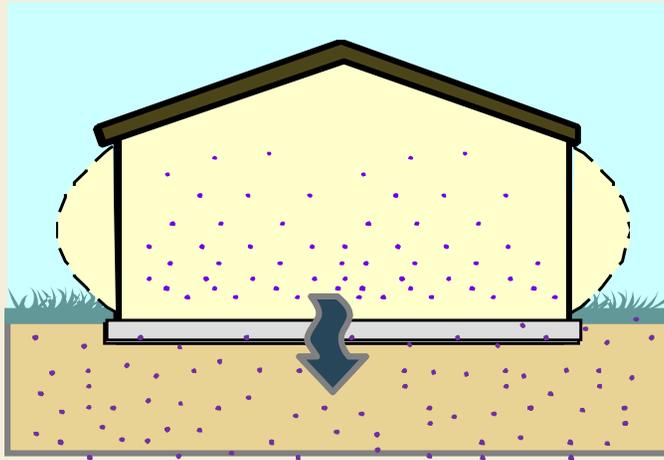
RESULT: TCE source positively ID'd using GC/MS in 2.5 hr investigation



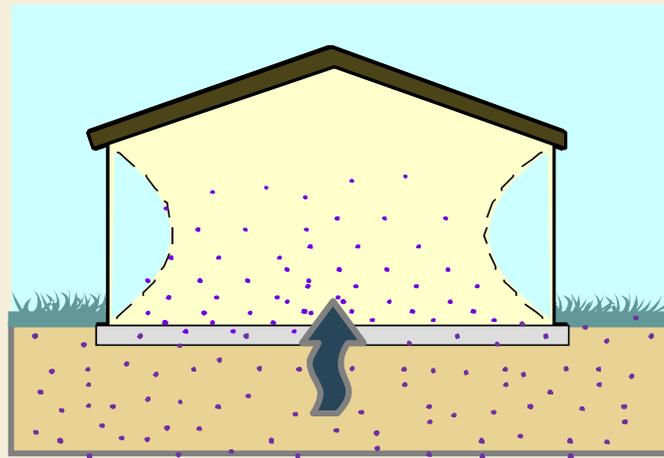
PRESSURE CONTROL EXAMPLE

BUILDING PRESSURE EVALUATION

POSITIVE
Pressure in
Building
= VI Off



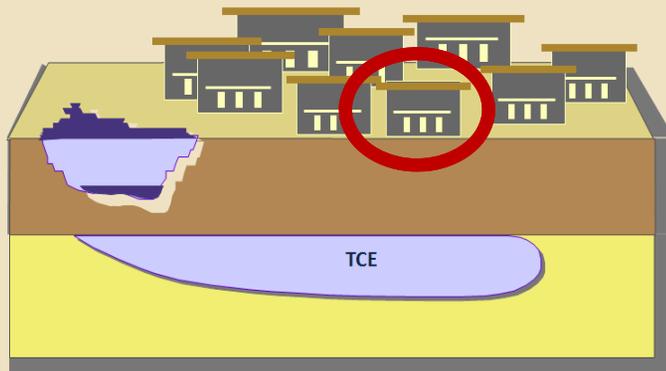
NEGATIVE
Pressure in
Building
= VI On



General Concept:

- 1) **NEGATIVE** pressure TURNS ON vapor intrusion
- 2) Evaluate potential for vapor intrusion using on-site analysis procedure under different pressure conditions
- 3) “Make it worse” to address temporal variability

BUILDING #2: WAREHOUSE



- 20,000 sq ft supply distribution warehouse
- Many potential indoor and subsurface VOC sources



Building #2

CONVENTIONAL VS. ON-SITE PROTOCOL

CONVENTIONAL

Conventional Program	No. Samples	TCE Concentration
Indoor Air (8 hr)	2	1.2 – 1.5 ug/m ³
Sub-slab	3	1.5 – 320 ug/m ³
Groundwater	2	55 - 96 ug/L

ON-SITE PROTOCOL *Baseline Evaluation* (22 samples)

8 HAPSITE samples:
TCE 0.81 – 2 ug/m³

5 HAPSITE samples:
TCE 0.75 – 1.8 ug/m³

3 HAPSITE samples:
TCE 0.97 – 1.7 ug/m³

6 HAPSITE samples:
TCE 1.5 – 4.1 ug/m³

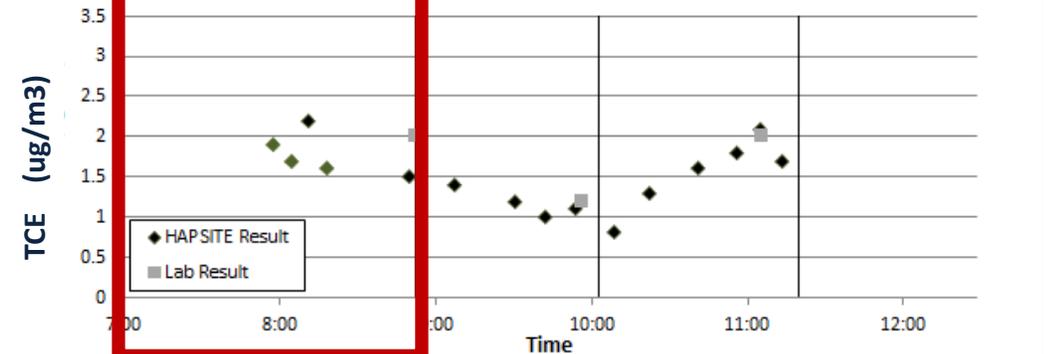
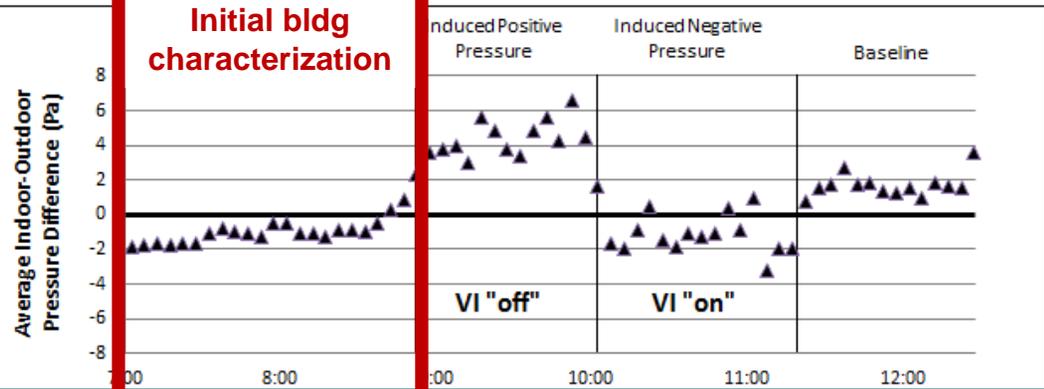


Building #2

PRESSURE CONTROL RESULTS

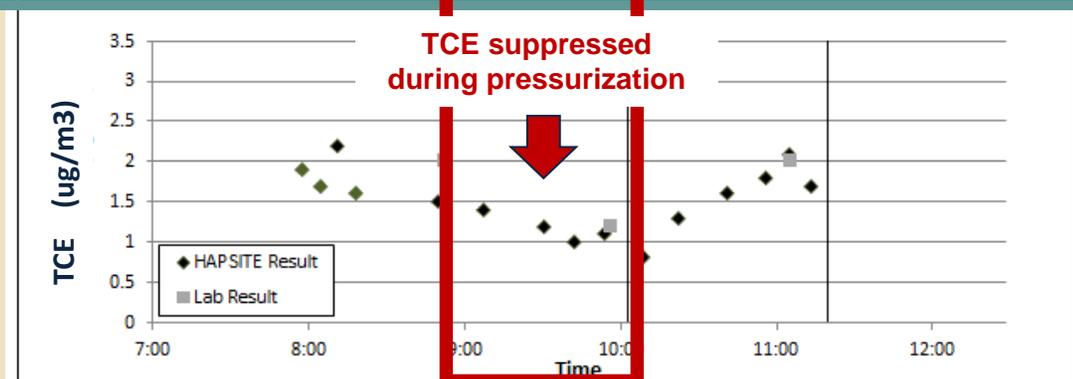
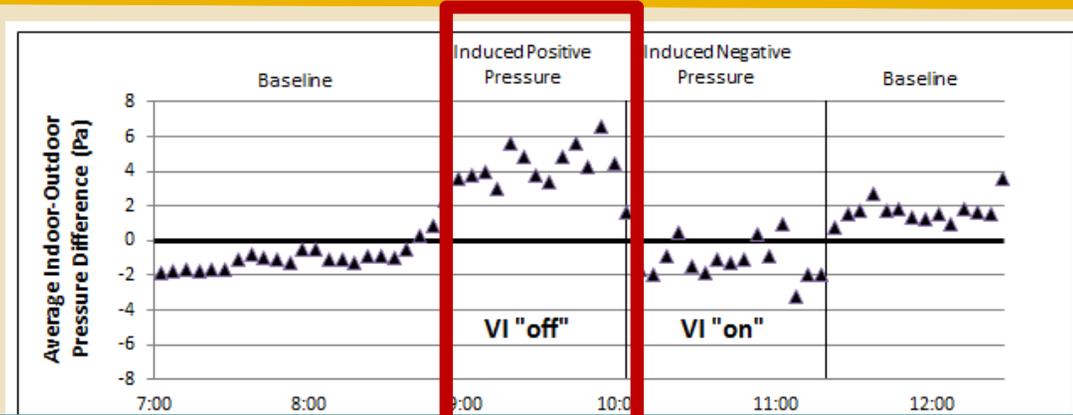


**Initial bldg
characterization**



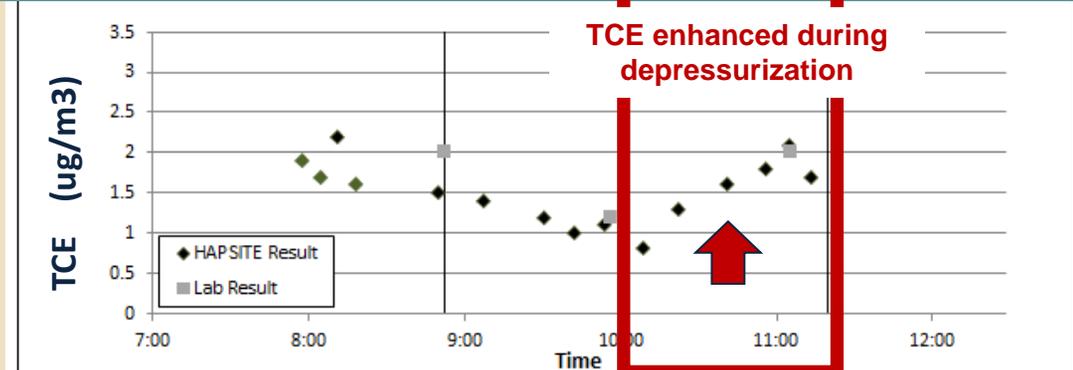
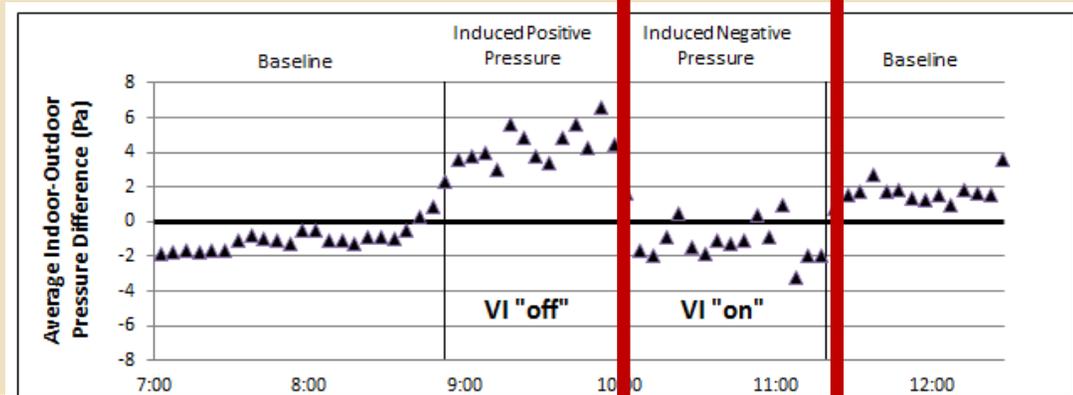
Building #2

PRESSURE CONTROL RESULTS



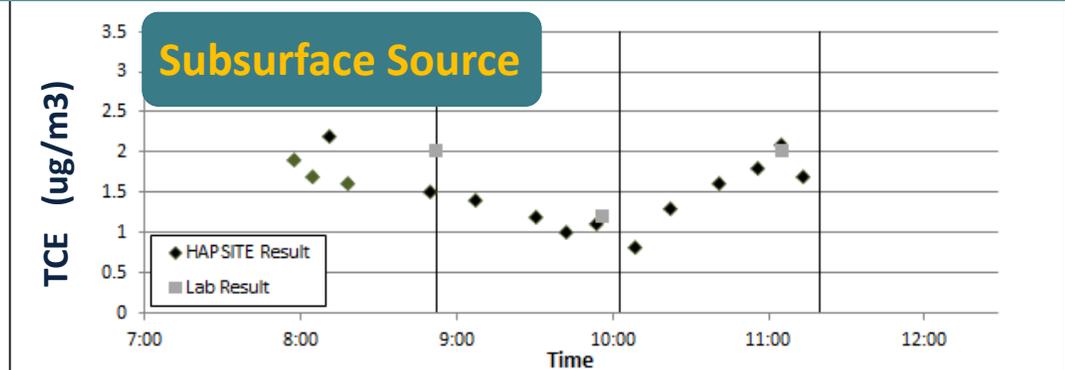
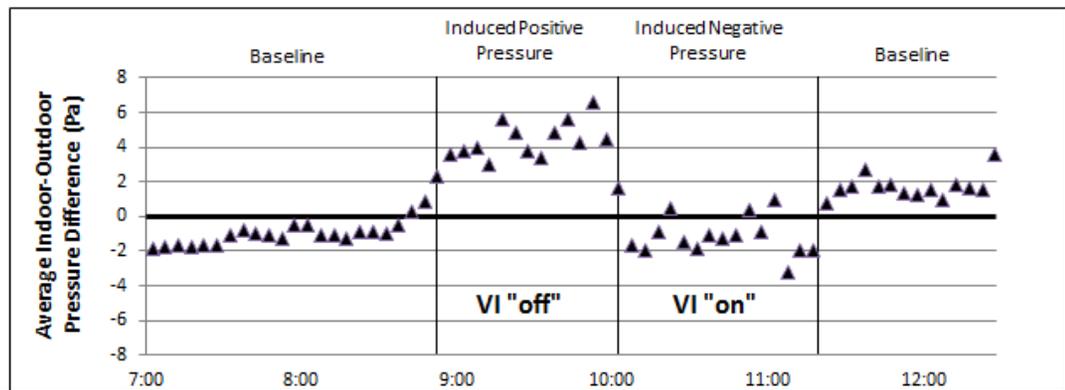
Building #2

PRESSURE CONTROL RESULTS



Building #2

PRESSURE CONTROL RESULTS



Building #2

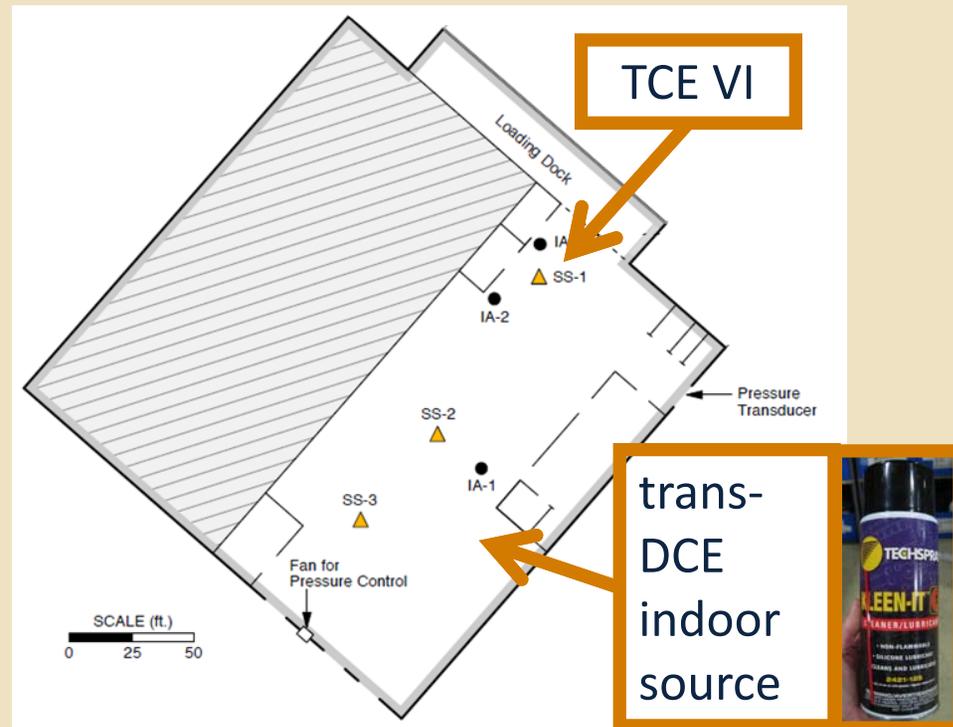
WRAP-UP

THE CHALLENGE

- 20,000 sq ft industrial building
- Open floor plan
- Many potential indoor and subsurface VOC sources

THE RESULTS

- Distinct TCE vs. trans-DCE conc. gradients in building
- Pressure control clarified indoor vs. subsurface source



CONCLUSIONS

KEY LINES OF EVIDENCE

- Streamline VI investigations by prioritizing:
 - Indoor air testing
 - VOC source identification with on-site analysis
 - Building pressure evaluation/ manipulation



KEY POINT:

Focus VI assessment at the point of exposure, the most direct way to identify vapor intrusion impacts.

RECOMMENDED STEPS FOR VI INVESTIGATION

1. Generic Screening

- Target buildings of potential VI concern based on distance from source (i.e., 100 ft for cVOCs).

2. Screen Indoor Air

- Measure COC concentration INSIDE building.
- Compare to Screening Level.

3. On-Site Analysis

- If COC > Screening level, use HAPSITE, pressure eval. to determine SOURCE of COCs.

4. Follow Up

- Mitigate real VI, or
- Sample indoor air (lab analysis); can use passive samplers (e.g., 14-day) to further address temporal variability

KEY POINT: Use On-Site Analysis & Building Pressure to identify sources, bldg susceptibility to VI. Use LAB DATA for risk evaluation.

Skip soil gas and sub-slab sampling: expensive and not definitive.

QUESTIONS?



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