INVESTIGATION METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS

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Indoor sources of volatile organic chemicals (VOCs) are ubiquitous, resulting in detectable concentrations in indoor air, often at concentrations above regulatory screening levels. At VOC contaminated sites with potential vapor intrusion concerns, the presence of indoor VOC sources significantly complicates the exposure pathway investigation. Because of these indoor sources, the detection of a site-related VOC in a potentially affected building at a concentration above the regulatory screening level does not necessarily indicate a vapor intrusion impact. Instead, additional analysis is required to determine the sources of the detected VOCs. We have developed several approaches to distinguish between vapor intrusion and indoor sources of VOCs including: (i) use of a field-portable gas chromatograph/mass spectrometer (GS/MS) to evaluate the distribution of VOCs within a building and to identify specific indoor sources of VOCs, (ii) collection of indoor air and sub-slab soil gas samples under controlled negative building pressure conditions designed to maximize vapor intrusion and controlled positive building pressure conditions designed to inhibit vapor intrusion, and (iii) use of compoundspecific stable isotope analysis to determine the original source of VOCs detected in indoor air samples. Each of these methods has been has applied to one or more buildings potentially impacted by vapor intrusion and has proved useful to distinguish between vapor intrusion and indoor sources of VOCs.
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VAPOR INTRUSION VS. INDOOR SOURCES

- Background: Indoor Sources
- On-Site GC/MS
- Building Pressure Control
- Compound-Specific Stable Isotope Analysis
PROBLEM: INDOOR SOURCES

- At a vapor intrusion site, testing of indoor air is the most direct way to identify VI impacts.
- Indoor sources of VOCs are ubiquitous: cleaners, glues, plastic, etc.
- Detection of VOCs in indoor air does not necessarily indicate vapor intrusion.

Key Point: Critical need for reliable methods to distinguish between vapor intrusion and indoor sources of VOCs.
Background indoor and outdoor air concentrations commonly exceed risk-based limits for indoor air.

1) Background concentrations from Sexton et al. 2004 ES&T 38(2); 423-430.
2) USEPA Master Screening Values Table, September 2008
Technical Update
Topics, trends, and news in the environmental industry…

**TCE Contamination Affects Community's Water Wells**

“The TCE, *which was banned from public use in the 1970s*, was detected at levels greater than the U.S. EPA's maximum contaminant level for public drinking water.”

**KEY POINT:** Many people believe that TCE and other chlorinated solvents are no longer used in industrial operations or consumer products.
But We Don’t Use “TOXIC” Chemicals Anymore......

**KEY POINT:**

TCE, PCE, etc., are legal and are still used in a wide range of consumer products currently available for purchase.
INDOOR SOURCES:
Remove before sampling
INDOOR SOURCES: Find’em if you can

Key Point: Source remove often not practical or effective. Need investigation program that deals with indoor sources.
SOLUTION: TEST METHODS

POTENTIAL METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS

<table>
<thead>
<tr>
<th>Method</th>
<th>Details</th>
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**KEY POINT:** Indoor “fear factor” will disappear when we can accurately identify the source of the VOCs.
SOLUTION: TEST METHODS

POTENTIAL METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS

- Real-time On-site Analysis
  - Used successfully by USEPA and Hill AFB
  - Requires expensive equipment: Hapsite GC/MS or USEPA TAGA unit.

Covered by Kyle in previous talk

TAGA Unit

HAPSITE GC/MS
### SOLUTION: TEST METHODS

**POTENTIAL METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS**

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**KEY POINT:** Indoor “fear factor” will disappear when we can accurately identify the source of the VOCs.
Concept:

1) Use controlled NEGATIVE building pressure to MAXIMIZE vapor intrusion.

2) Use controlled POSITIVE building pressure to TURN OFF vapor intrusion.
CONTROL OF BUILDING PRESSURE
ASU HOUSE: BUILDING PRESSURE

<table>
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<tr>
<th>Time</th>
<th>Baseline</th>
<th>Negative</th>
<th>Positive</th>
<th>Baseline</th>
<th>Negative</th>
<th>Positive</th>
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<td>5</td>
<td>8</td>
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EFFECT OF BUILDING PRESSURE ON INDOOR RADON CONCENTRATION

Key Point: Control of building pressure resulted in control of radon vapor intrusion.
ASU HOUSE: VOC CONCENTRATIONS

NORMALIZED CONCENTRATION

Vapor Intrusion Source

Garage Source

Ambient Source

Indoor Source

Concentration in Outdoor Air
MOFFETT BLD 107: BUILDING PRESSURE

Pressure Gradient (Pa)

Baseline  Negative  Positive  Baseline  Negative  Positive

28-Oct-10  29-Oct-10  30-Oct-10  31-Oct-10  1-Nov-10  2-Nov-10  3-Nov-10  4-Nov-10

Building Envelope

Building Foundation
SOLUTION: TEST METHODS

POTENTIAL METHODS TO DISTINGUISH BETWEEN VAPOR INTRUSION AND INDOOR SOURCES OF VOCS

- **Real-time On-site Analysis**
  - Used successfully by USEPA and Hill AFB
  - Requires expensive equipment: Hapsite GC/MS or USEPA TAGA unit.

- **Building Pressure Control**
  - Current ESTCP Project ER-0707
  - May not be suitable in very large or very leaky buildings.

- **CSIA / Fingerprinting**
  - Completed “Proof of Concept” study
  - Additional funding for development and validation.

**KEY POINT:** Multiple methods available to distinguish between vapor intrusion and indoor sources.
TECHNOLOGY DESCRIPTION

Example A:
Indoor Source is Primary Source of PCE in Indoor Air

Example B:
Subsurface Source is Primary Source of PCE in Indoor Air

Range for indoor sources
RESULTS FOR INDOOR AIR

FINDING:

GW with TCE discharged into sewer.

TCE is moving from sewer into house.
RESULTS FOR INDOOR AIR

FINDING:

PCE in indoor air is from indoor source. (Source later identified as E6000 glue)
RESULTS FOR INDOOR AIR

FINDING:

TCE in indoor air matches TCE in GW.

TCE is too heavy to be an indoor source.

> Vapor Intrusion
SUMMARY: CSIA FOR VAPOR INTRUSION

- Sorbent tubes (active sampling) can be used to collect VOC samples for CSIA
- Conducting further validation to evaluate robustness of sampling method

Sample Collection

Source Identification

CSIA for Vapor Intrusion

- Preliminary results support the hypothesis that INDOOR and SUBSURFACE sources of VOCs will often have different isotope signatures
- For some buildings, CSIA will provide clear results based on ONE indoor air sample and ONE subsurface sample
ACKNOWLEDGEMENTS

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