DERP Forum

Strengthening Relationships with our Regulatory Partners

St. Louis, Missouri
May 8-9, 2019
2019 Defense Environmental Restoration Program (DERP) Forum: Vapor Intrusion Tools and Challenges

Applying New Tools in Vapor Intrusion Assessments and DoD's Vapor Intrusion Database of Industrial Buildings
Vapor Intrusion (VI) Challenges

- New tools to address VI challenges:
  - Background indoor sources
  - Temporal and spatial variability
  - Atypical preferential pathways

- DoD industrial building VI database / analyses developed to:
  - Provide defensible alternatives to overly conservative assumptions
  - Better understand the causes of variability
  - Identify key factors with greatest influence on VI potential
  - Develop a systematic process to evaluate multiple lines of evidence
Applying innovative technologies reduces uncertainties, time, and cost.
## Applying New Tools to Address VI Challenges

**Challenge**

### Background Sources
- Constituent ratio analysis
- Pressure cycling
- Near real-time monitoring
- Comparison to outdoor air

### Temporal and Spatial Variability
- Pressure cycling & near worst-case VI
- High volume sampling
- Real-time monitoring
- Indicators / tracers
- Longer duration sampling
  - Passive sampler
  - Ultra-low-flow controller on canister

### Preferential Pathways
- Utility surveys
- Pressure cycling
- Real-time monitoring
- Indicators / tracers
VI Industrial Building Database

- Default attenuation factors (AF) are not representative of industrial buildings

- Created industrial VI database (49 bldgs.)
  - Applied same data filters used by EPA for residential database
    - 90th % published background
    - 50x source strength
  - Analysis showed 1-2 orders of magnitude more attenuation than EPA residential default
  - Conducted robust statistical analysis to identify key influencing lines of evidence
  - VI SMEs ranked the strength of these key influencing lines of evidence
  - Developed Quantitative Decision Framework for systematically assessing multiple lines of evidence

Key Points
- Tool to systematically and defensibly review multiple lines of evidence
- Provides defensible alternative to using overly conservative assumptions
- Useful tool during planning, investigation, and long-term stewardship

Expanded VI Industrial Building Database

- Added 30 industrial buildings to VI database
- 22 installations, 27 sites, and 79 bldgs.
  - Majority sites with depth to water <15 ft
  - Large (50%), medium (35%), and small (15%) buildings
- More robust database
  - TCE indoor air results increased from 270 to 1082 (pre-filter)
  - PCE indoor air results increased from 202 to 923 (pre-filter)
- On-going re-analysis of expanded database
Expanded Database Preliminary Re-Analysis: Attenuation Factors

Preliminary re-analysis for PCE is consistent with attenuation in industrial bldgs. conservatively 1-2 orders of magnitude greater than EPA residential defaults.

Key Point

- **EPA SS AF = 0.03**
- **Empirical SS AF = 0.001**
- **EPA GW AF = .001**
- **Empirical GW AF = .0001**

**VISL = VI Screening Level; SS = Subslab; GW = Groundwater**

VISL = 47

EPA Default SS VISL (1,600 µg/m³)

Empirical Industrial SS VISL (47,000 µg/m³)

EPA Default GW VISL = 65 µg/L (47,000 µg/m³)

Empirical Industrial GW VISL = 650 µg/L (470,000 µg/m³)
Ongoing Re-Analysis of Expanded VI Database

• VI SME Team:
  - Jacobs: Dr. L. Lund and C. Lutes
  - Geosyntec: Dr. H. Dawson and Dr. T. McAlary
  - EPA: Dr. R. Kapuscinski

• Expanding robust statistical analyses to include:
  - Applying various source strength screens (e.g. 50x, 100x, and 1000x)
  - Applying various paired data combinations in a sampling zone (e.g. individual pairs, averages, averages over time)
  - Statistical analysis to re-assess key influencing factors in VI potential

• VI Industrial Database Re-Analysis Summary
  - Evidence of >1 order of magnitude more attenuation in industrial vs residential buildings
  - Re-assessing/confirming key VI influencing parameters with expanded database analysis
  - Updating Quantitative Decision Framework for systematically evaluating multiple lines of evidence

Key Point
VI assessments are more than comparing VOCs to VISLs
Thank You
Backup Slides
On-going Research of Temporal Variability in Industrial Buildings

• Objectives
  – Compare temporal variability of VI in Navy industrial buildings to residences
  – Evaluate if near worst case VI conditions can be induced by controlled building pressure
  – Strategies for selecting sampling zones to optimize VI evaluations

Project Components

- **Building Survey/Diagnostic Testing**
  - HVAC Analysis
  - Tracer Gas Testing
  - Pressure Differential Monitoring
  - Temperature Differences

- **Pressure Cycling of Four Zones**
  - Building pressure cycling method
  - GC/ECD
  - HAPSITE

- **Year-long Indoor/Sub-slab/Outdoor Air Monitoring**
  - GC/ECD – grab sample
  - Summa Canisters
  - Pressure Differential
  - Temperature Differential
New Sites Have Added A Lot of Data

Expanded VI Industrial Building Database

<table>
<thead>
<tr>
<th>Detected Indoor Air</th>
<th>TCE</th>
<th>PCE</th>
<th>cis-1,2-DCE</th>
<th>trans-1,2-DCE</th>
<th>1,2-DCA</th>
<th>1,1-DCA</th>
<th>1,1,1-TCA</th>
<th>VC</th>
</tr>
</thead>
<tbody>
<tr>
<td>No screen</td>
<td>134</td>
<td>99</td>
<td>58</td>
<td>65</td>
<td>29</td>
<td>27</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Baseline screen</td>
<td>133</td>
<td>99</td>
<td>58</td>
<td>65</td>
<td>29</td>
<td>27</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Baseline screen + Source strength screen</td>
<td>98</td>
<td>64</td>
<td>58</td>
<td>65</td>
<td>8</td>
<td>27</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Baseline screen + Background screen</td>
<td>48</td>
<td>8</td>
<td>58</td>
<td>65</td>
<td>22</td>
<td>27</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>No screen + Preferential pathway=false</td>
<td>107</td>
<td>78</td>
<td>37</td>
<td>56</td>
<td>28</td>
<td>11</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Baseline screen + Source strength screen + Preferential pathway=false</td>
<td>78</td>
<td>43</td>
<td>37</td>
<td>56</td>
<td>7</td>
<td>11</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Baseline screen + Background screen + Preferential pathway=false</td>
<td>39</td>
<td>7</td>
<td>37</td>
<td>56</td>
<td>22</td>
<td>11</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

Expanded to 79 Buildings in Database (2019)
# Background Study Results

## Background Studies used in Filtering Data

Table 5-3. Literature Indoor Air Background Concentration Information Used in This Study

<table>
<thead>
<tr>
<th>Analyte</th>
<th>90th percentile of the BASE study indoor air distribution (NYSDOH, 2006 Appendix C-2)</th>
<th>Median of 90th Percentile Concentration from multiple studies as used in USEPA, 2012a</th>
<th>95th Percentile Rago, 2014, Commercial Buildings</th>
<th>Selected background value for the purpose of this study and for indoor air screening</th>
<th>Source Strength Screening Level for Sub-slab = 50X selected value</th>
<th>Source Strength Screening Level for Groundwater Vapor = 1000X selected vapor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>20.6</td>
<td>3.1</td>
<td>0.3</td>
<td>20.6</td>
<td>1030</td>
<td>20600</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>&lt;0.7</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethene</td>
<td>&lt;1.9</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
<td>&lt;RL</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>15.9</td>
<td>3.8</td>
<td>8.2</td>
<td>15.9</td>
<td>795</td>
<td>15900</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>4.2</td>
<td>0.5</td>
<td>24.6</td>
<td>4.2</td>
<td>210</td>
<td>4200</td>
</tr>
</tbody>
</table>
Expanded Database Preliminary Re-Analysis: Distance to Release

PCE Sub-slab vs. Distance to Release / Source

Empirical Screening Level = 47,000
EPA VISL = 1,600

Empirical ~50 ft. Distance Based on Industrial Dataset
EPA 100 ft. Default Distance Based on Residential Dataset

Key Point
Preliminary re-analysis of distance to source for PCE sub-slab concentrations is consistent with 50 ft. default for industrial bldgs.
Sub-slab Soil Gas vs. Indoor Air—PCE
Non-Detects at Reporting Limits vs. Non-Detects Excluded

Little difference if Non-Detects excluded or Reporting Limits used
EPA 2012 Residential Database: Attenuation Factors

Residential Sub-slab to Indoor Air
AF = 0.03

Residential Groundwater to Indoor Air
AF = 0.001
## Example Industrial QDF MLE Weights of Importance for VI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range Observed</th>
<th>Weight of Importance</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Zone Area</td>
<td>&lt;100 sq ft</td>
<td>4</td>
<td>Smaller sample zones provide less potential for VOC dilution if contaminant flux (from either indoor or Subslab sources) is equal.</td>
</tr>
<tr>
<td></td>
<td>100-1,000 sq ft</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,000-10,000 sq ft (or no information available)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10,000-100,000 sq ft</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;100,000 sq ft</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Average Subslab Concentration</td>
<td>&lt;300x risk-based on IA screening level</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300-2,000x risk-based IA screening level</td>
<td>2</td>
<td>Data analysis shows that concentrations above a minimum value in subslab are needed to observe any corresponding increase in indoor air concentrations.</td>
</tr>
<tr>
<td></td>
<td>2,000-10,000x risk-based IA screening level</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10,000-100,000x risk-based IA screening level</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;100,000x risk-based IA screening level</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Average Groundwater Vapor Concentration</td>
<td>&lt;1,000x risk-based IA screening level</td>
<td>0</td>
<td>Data analysis shows that concentrations above a minimum value are needed to observe increase in indoor air concentrations.</td>
</tr>
<tr>
<td>(deep soil gas calculated using Henry’s Law)</td>
<td>&lt;10,000x risk-based IA screening level</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10,000-100,000x risk-based IA screening level</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;100,000x risk based on indoor air screening level</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
Interpreting MLE with Indoor Air Data

Quantitative Decision Framework
VI Potential Score

NFA or LTM (Future VI)
Consider Building Mitigation/Source Remediation

< IA VISL
VISL
> IA VISL

NFA
Likely Background Source

Cumulative Weight for VI Potential

+36
0