Vapor Intrusion

Lisa Quiggle MDHHS
Types of Vapor Intrusion

- Petroleum Vapor Intrusion (PVI)
- Chlorinated Vapor Intrusion (CVI)
Why Now?
Love Canal
A Special Report

To the Governor and Legislature

September 1978

State of New York
Hugh L. Carey
Governor

Love Canal

6.0 ug/m³

Toxic levels of chemicals in drinking water, air, and soil prompted the Health Department to give priority to evaluating basement air samples from all homes contiguous to the Canal, before ground and surface water samples, to minimize the risk of chemicals entering the human body by inhalation.

As data flowed in, it became evident that unacceptable levels of toxic vapors associated with more than 80 compounds were emanating from the basements of many homes in the first ring directly adjacent to the Love Canal. (See Figure 1) Ten of the most prevalent and most toxic compounds - including benzene, a known human carcinogen - were selected for evaluation purposes and as indicators of the presence of other chemical constituents.

<table>
<thead>
<tr>
<th>COMPOUNDS</th>
<th>NO. OF TIMES FOUND IN HOUSES</th>
<th>PERCENT OF TOTAL HOUSES SAMPLED</th>
<th>HIGHEST VALUE OBSERVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroform</td>
<td>23</td>
<td>26</td>
<td>24 ug/m³</td>
</tr>
<tr>
<td>Benzene</td>
<td>20</td>
<td>23</td>
<td>270 ug/m³</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>74</td>
<td>84</td>
<td>73 ug/m³</td>
</tr>
<tr>
<td>Toluene</td>
<td>54</td>
<td>61</td>
<td>570 ug/m³</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>82</td>
<td>93</td>
<td>1140 ug/m³</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>6</td>
<td>7</td>
<td>240 ug/m³</td>
</tr>
<tr>
<td>Chlorotoluene</td>
<td>32</td>
<td>36</td>
<td>6700 ug/m³</td>
</tr>
<tr>
<td>m+p xylene</td>
<td>35</td>
<td>40</td>
<td>140 ug/m³</td>
</tr>
<tr>
<td>o-xylene</td>
<td>17</td>
<td>19</td>
<td>73 ug/m³</td>
</tr>
<tr>
<td>Trichlorobenzene</td>
<td>11</td>
<td>13</td>
<td>74 ug/m³</td>
</tr>
</tbody>
</table>
In Response

December 1970

The US Environmental Protection Agency was created by executive order

October 21, 1976

Resource Conservation and Recovery Act (RCRA)

- Set requirements for landfills
- Requirements for hazardous wastes “Cradle to Grave”
- Regulated underground storage tanks
The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) –

- Created Superfund – “Joint and Several”
- Triggers from mismanagement of wastes
- Authorizes EPA to respond to chemical releases or a contaminant that presents an imminent and substantial treat to human health
Recent Changes

- **2011** - USEPA’s Integrated Risk Information System (IRIS) established a lower *trichloroethylene* (TCE) Inhalation Reference Concentration for short term exposures

- **December 2012** – USEPA issued a directive that all Superfund sites would be reviewed for VI during the five year review cycle
A hypothesis-driven weight-of-evidence analysis of epidemiological, toxicological, in vitro, in ovo, and mechanistic/AOP data concluded that TCE has the potential to cause cardiac defects in humans when exposure occurs at sufficient doses during a sensitive window of fetal development. The study by Johnson et al. [51] was reaffirmed as suitable for hazard characterization and reference value derivation, though acknowledging study limitations and uncertainties.
Hazard Ranking System Subsurface Intrusion Component

- May 22, 2017 – US EPA rules took effect to include a VI evaluation in new Superfund listings.
July 9, 2014 – US EPA issued guidance to take an accelerated response and an urgent response for TCE from vapor intrusion.
What is a Hazard Quotient (HQ)

- **Trichloroethylene (TCE) as an example:**
  - TCE has an uncertainty (safety) factor used in deriving an MRL
  - The uncertainty factor is 90
    - A factor of 10 for the use of a lowest observed adverse effect level
    - A factor of 3 for interspecies extrapolation (rat study to human)
    - A factor of 3 for human variability

- At HQ of 1 the uncertainty factor is 90
- At HQ of 3 the uncertainty factor is 30
# EPA Vapor Intrusion Screening Level (VISL) Calculator

**OSWER VAPOR INTRUSION ASSESSMENT**  
**Vapor Intrusion Screening Level (VISL) Calculator Version 3.4, November 2015 RSLs**

The primary objective of risk-based screening is to identify sites or buildings unlikely to pose a health concern from pathways. Generally, at properties where subsurface concentrations of vapor-forming chemicals (e.g., groundwater or “near source” soil gas concentrations) and levels (i.e., VISLs), no further action or study is warranted, so as long as the exposure assumptions match those taken into account by the calculations and the site’s assumptions of the generic conceptual model underlying the screening levels. In a similar fashion, the results of risk-based screening can help the data review findings, and for chemicals that can be eliminated from further assessment. The generic conceptual model underlying these screening levels is described in OSW14 (OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Vapor Sources to Indoor Air) (EPA 2015, Section 8.5).

### Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure Scenarios</td>
<td>Residential</td>
<td>Select residential or commercial scenario from pull down list</td>
</tr>
<tr>
<td>Target Risk for Carcinogens</td>
<td>10E-05</td>
<td>Enter target risk for carcinogens</td>
</tr>
<tr>
<td>Target Hazard Quotient for Non-Carcinogens</td>
<td>1</td>
<td>Enter target hazard quotient for non-carcinogens</td>
</tr>
<tr>
<td>Average Groundwater Temperature (°C)</td>
<td>25</td>
<td>Enter average of the stabilized groundwater temperature to use</td>
</tr>
</tbody>
</table>

### Chemicals

<table>
<thead>
<tr>
<th>CAS</th>
<th>Chemical Name</th>
<th>Does the chemical meet the definition for volatility?</th>
<th>Does chemical have inhalation toxicity data?</th>
<th>Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source?</th>
<th>Target Indoor Air Conc. @ TCA = 10E-06 or THQ = 1</th>
<th>Target Sub-Slab and Exterior Soil Gas Conc. @ TCA = 10E-06 or THQ = 1</th>
<th>Toxicity Basis</th>
<th>Target Ground Water Conc. @ TCA = 10E-06 or THQ = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>97-18-4</td>
<td>Tetrahydrothiophene</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>4.2E+01</td>
<td>14E+03</td>
<td>C12g</td>
<td>5.8E+01</td>
</tr>
<tr>
<td>72-54-3</td>
<td>Trithiolethylene</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>2.7E+00</td>
<td>7.1E+01</td>
<td>C12g</td>
<td>5.2E+01</td>
</tr>
</tbody>
</table>
# DHHS & DEQ

## Action & Trigger Levels

### Table of Action and Trigger Levels for Vapor Intrusion sites (pending MDHHS & MDEQ consensus interim values)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Indoor air (µg/m³)</th>
<th>Subslab soil gas (µg/m³)</th>
<th>Groundwater (µg/L)</th>
<th>Indoor air (µg/m³)</th>
<th>Subslab soil gas (µg/m³)</th>
<th>Groundwater (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential, Mixed Use, Sensitive Populations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>(2.6)±0.13</td>
<td>(85)±14</td>
<td>26</td>
<td>(11)±1.8</td>
<td>(370)±62</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>(2.6)±0.13</td>
<td>(85)±14</td>
<td>26</td>
<td>(11)±1.8</td>
<td>(370)±62</td>
<td>110</td>
</tr>
<tr>
<td>cis-1,2 Dichloroethene</td>
<td>(3.9)±2.9</td>
<td>(280)±21</td>
<td>50</td>
<td>(35)±8.6</td>
<td>(1,200)±500</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>(25)±6.5</td>
<td>(830)±21</td>
<td>150</td>
<td>(100)±25</td>
<td>(3,300)±880</td>
<td>620</td>
</tr>
<tr>
<td>trans-1,2 Dichloroethene</td>
<td>(83)±21</td>
<td>(2,800)±710</td>
<td>220</td>
<td>(35)±9.8</td>
<td>(11,700)±5,000</td>
<td>920</td>
</tr>
<tr>
<td></td>
<td>(250)±60</td>
<td>(8,300)±210</td>
<td>660</td>
<td>(1,100)±250</td>
<td>(35,000)±8,800</td>
<td>2,800</td>
</tr>
<tr>
<td>Tetrachloroethylene (PCE)</td>
<td>(42)±6.0</td>
<td>(1,400)±206</td>
<td>58</td>
<td>(180)±27</td>
<td>(5,800)±650</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>(110)±16</td>
<td>(3,600)±530</td>
<td>150</td>
<td>(470)±99</td>
<td>(16,000)±2,360</td>
<td>650</td>
</tr>
<tr>
<td>1,2,3-Trimethylbenzene</td>
<td>(59)±13</td>
<td>(2,100)±420</td>
<td>170</td>
<td>(260)±53</td>
<td>(9,000)±1,800</td>
<td>730</td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene,</td>
<td>(180)±38</td>
<td>(6,300)±1,300</td>
<td>520</td>
<td>(750)±160</td>
<td>(20,000)±5,300</td>
<td>2,200</td>
</tr>
<tr>
<td>and 1,3,5-Trimethylbenzene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>(5,200)±960</td>
<td>(170,000)±31,000</td>
<td>7,400</td>
<td>(22,000)±4,000</td>
<td>(730,000)±130,000</td>
<td>31,000</td>
</tr>
<tr>
<td></td>
<td>(16,000)±2,900</td>
<td>(520,000)±95,000</td>
<td>22,000</td>
<td>(66,000)±12,100</td>
<td>(2,200,000)±400,000</td>
<td>93,000</td>
</tr>
<tr>
<td>Trichloroethylene (TCE)</td>
<td>(2.1)±0.4</td>
<td>(70)±13</td>
<td>5.2</td>
<td>(8.8)±1.8</td>
<td>(290)±54</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>(4.8)±0.19</td>
<td>(160)±30</td>
<td>12</td>
<td>(26)±4.8</td>
<td>(880)±160</td>
<td>65</td>
</tr>
<tr>
<td>Vinyl Chloride (VC)</td>
<td>(1.7)±0.67</td>
<td>(56)±22</td>
<td>1.5</td>
<td>(29)±11</td>
<td>(990)±950</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(1.7)±0.67</td>
<td>(56)±22</td>
<td>1.5</td>
<td>(29)±11</td>
<td>(990)±950</td>
<td>25</td>
</tr>
</tbody>
</table>

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1. Calculated using the U.S. EPA RIS calculator for indoor air with MDEQ-derived Reference Concentrations (1 µg/L for cis and 80 µg/m³ for trans); indoor air values were adjusted using the attenuation factor of 0.08 for subslab soil gas levels; groundwater levels were calculated using the equation provided in the U.S. EPA's Vapor Infiltration Screening Level Calculator User Guide (Groundwater screening level = Indoor air level / Henry's Law Constant x attenuation factor groundwater x 1000 /m³)

2. Adjusted to match the Agency for Toxic Substances and Disease Registry inhalation acute, intermediate, and chronic Minimal Risk Levels for tetrachloroethylene (PCE)
DHHS & DEQ Consensus Interim Values

Recommended Interim Action Screening Levels (RIASLs)

• If RIASLs are exceeded action needs to be taken within a few days

Time-Sensitive Interim Action Screening Levels (TSRIASLs)

• If TSRIASLs are exceeded immediate action needs to be taken, up to and including evacuation
VI Sampling

Begin with groundwater
  • Above RIASL, test soil gas

Test soil gas
  • Above RIASL, test indoor air

*Use indoor air results for public health decisions*
  • Above RIASL take actions within a few days
  • Above TSRIASL take immediate actions
Michigan Unique Issues

Manufacturing boom in 1900’s – many smaller industrial buildings adjacent to residential areas

Large proportion of single family homes

Automobile economy

Manufacturing sites spread throughout the state due to the abundant groundwater

Geology - Clay in southeast Michigan, sand in west
Michigan Unique Issues

High Percentage of Single Family Homes

<table>
<thead>
<tr>
<th>US Population Rank</th>
<th>City</th>
<th>1950 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New York</td>
<td>7,891,957</td>
</tr>
<tr>
<td>2</td>
<td>Chicago</td>
<td>3,620,962</td>
</tr>
<tr>
<td>3</td>
<td>Philadelphia</td>
<td>2,071,605</td>
</tr>
<tr>
<td>4</td>
<td>Los Angeles</td>
<td>1,970,358</td>
</tr>
<tr>
<td>5</td>
<td>Detroit</td>
<td>1,849,568</td>
</tr>
<tr>
<td>6</td>
<td>Baltimore</td>
<td>949,708</td>
</tr>
</tbody>
</table>

![Bar chart showing occupied housing units by building type](image)

Source: U.S. Census Bureau, American Community Survey

Icons by Martin Lebreton and Arthur Shlain, The Noun Project
Michigan Unique Issues

High Percentage of Single Family Homes

From Google Maps

Detroit
Michigan Unique Issues

Philadelphia

Baltimore

From Google Maps
Michigan - Known Sites of Reported Chlorinated and Petroleum Releases

- Between 3,000 and 4,000 reported releases
- Over 200 regulated hazardous waste facilities
- 65 Superfund Sites
Over 300 dry cleaners on the west side of Detroit in 1958!!!
Public Health Role
Michigan Local Health Departments
Evacuations

- Local Health Department has the authority to issue evacuation orders

- Use of the public health code

- Occupancy restrictions
PUBLIC HEALTH CODE (EXCEPRT)
Act 368 of 1978

333.2433 Local health department; powers and duties generally.
Sec. 2433.

(1) A local health department shall continually and diligently endeavor to prevent disease, prolong life, and promote the public health through organized programs, including prevention and control of environmental health hazards; prevention and control of diseases; prevention and control of health problems of particularly vulnerable population groups; development of health care facilities and health services delivery systems; and regulation of health care facilities and health services delivery systems to the extent provided by law.
PUBLIC HEALTH CODE (EXCERPT)
Act 368 of 1978

333.2455 Building or condition violating health laws or constituting nuisance, unsanitary condition, or cause of illness; order; noncompliance; warrant; assessment and collection of expenses; liability; judicial order; other powers not affected.

Sec. 2455.
(1) A local health department or the department may issue an order to avoid, correct, or remove, at the owner's expense, a building or condition which violates health laws or which the local health officer or director reasonably believes to be a nuisance, unsanitary condition, or cause of illness.
Data Trends

TCE Commercial Building Mitigation System Installed ppb
Benzene Background in Commercial Building in ppb

RIASL
Questions?