

US EPA ARCHIVE DOCUMENT

The Air We Breathe: What You Need to Know About Vapor Intrusion

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Presentation Outline

- Vapor Intrusion Pathway
- Scope of the Problem
- Assessment, Sampling & Analysis
- Vapor Intrusion Evaluation (and TCE)
- Mitigation
- Challenges & Future Research Needs

Generic Conceptual Site Models for Vapor Intrusion (VI)

General schematic of the pathway of subsurface vapor intrusion into indoor air
<http://www.epa.gov/correctiveaction/eis/vapor.htm>

Vapor Intrusion (VI)

- Chemicals: Volatile compounds (e.g., TCE, PCE, benzene, carbon tet, mercury)
- Matrix: groundwater, soil, soil gas
- Vadose (unsaturated) or saturated zone
- VI caused by the pressure differential between indoor and outdoor air (lower pressure in indoor air)
- Physics of VI pathway are similar to radon vapor intrusion

Vapor Intrusion – Why It Matters

Vapor Intrusion is Real (sometimes visible)

Hartford, Illinois
(gasoline vapors)
Not a perimeter crack (not even on the floor)

“Indoor air pollution among the top five environmental risks to public health”

- Explosive risk (rare)
- Acute health hazard (rare)
- Chronic health hazard

Scope of the Problem – (TCE)

- **374,000-500,000 contaminated sites nationwide**
 - » USEPA, 2002; NRC, 1997
- **50% of high priority sites have TCE**
- **50% of those TCE sites have potential VI concern**
- **25% of high priority sites - VI of TCE**
 - » USEPA, 2003; NRC, 2006
- **1,428 NPL sites (TCE in at least 861 sites)**

How many (water-table) VOC plumes w/ Vapor Risks ?

15-40% of sites?

Defina, 2000

EPA Region 9 Began Taking a Second Look at TCE and PCE Sites

- In 2002-2003, EPA Region 9 Superfund and RCRA Programs screened over 200 TCE and PCE sites based on existing data to determine the priority of further evaluation of the vapor intrusion pathway.
- Region 9 conducted VI investigations at those sites with the highest potential for vapor intrusion.

Screening of TCE Sites – Prioritization of VI Pathway Evaluation

- Depth to groundwater – Shallow
- High concentrations of TCE in soil, soil gas, and/or groundwater
- Current land use, occupancy of buildings and future use
- Professional judgement and community concerns

Expedited Review of High Priority Sites

- **High Priority Sites** prompted Site-specific evaluation (e.g., Tier 3 of Draft 2002 EPA VI Guidance)
- **Other Medium and Low Priority Sites** – review information during normal course of process (Remedial, Design, RA, 5-Year Review)
- **Brownfields, UST, Other sites**

EPA Region 9 Mountain View Sites Vapor Intrusion Fact Sheet – Jan 2003

for TCE. EPA Region 9 is currently using the provisional TCE toxicity values from the draft reassessment when assessing potential health impacts from the vapor intrusion-to-indoor-air pathway.

EPA will be using the provisional TCE toxicity values when assessing the potential health risks to both on-site workers and off-site nearby residents from the vapor intrusion pathway and the air stripper treatment system emissions.

Lots of local press coverage

San Francisco Chronicle

EPA alert on toxin in Mountain View
Officials say TCE vapor in some houses

The studies showing that TCE may be five to 65 times more toxic

"We're evaluating all the Superfund sites in the region... to see if there's something where we should be taking a second look."

Jan 25, 2003

How Do We Assess Vapor Intrusion Pathway ... Measure?...Model? ...????

- **Indoor/Outdoor Air Sampling**
- Concern about potential sources of VOCs in indoor air
 - Consumer products
- Concern about Outdoor air (e.g., Ambient, Air Strippers, SVE)
- **Soil gas Sampling**
 - outside, sub-slab (inside), shallow, deep, how many?
- **Model**
 - Controversy about predicting indoor air by relying on a model
- Community concerns about potential health impacts of what people are actually breathing (homes, schools, workplace)

Combination

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Indoor Air Sampling & Analysis

- Work w/ toxicologist to establish action levels
- Obtain permission to sample from property owner and occupant/resident.
- Pre-sampling survey (i.e., construction/age of home, household chemical use, smokers)
- 6-liter summa canisters
- Collect sample over 24 hours at residences (10 hrs, 12 hrs, and 24 hrs, depending on occupancy of building).
- Analyze by TO-15 or TO-15 SIM (Selected Ion Monitoring)
- Test for primary chemicals of concern found in shallow groundwater)

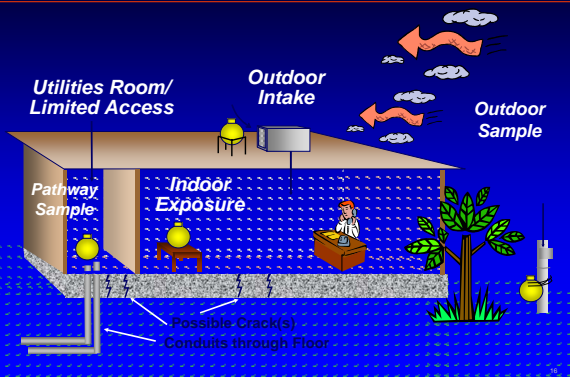
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Types of Air Samples Collected

- **Indoor air (breathing zone – 3 to 5 ft above ground)** – assess potential air exposure
- **Preferential Pathway** - collected in areas/rooms with cracks or penetrations - (i.e., utility or electrical rooms, floor drains, utility vaults, elevator shafts) to assess whether there may be a “completed” pathway from the subsurface into the building
- **Outdoor air (HVAC Intake, outside homes)** – assess what is coming into the building and compare to indoor air samples
- **Outdoor Reference** – compare to indoor air samples
- **Quality Assurance** – duplicates, blanks, EPA co-located (split) samples

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Types of Air Samples



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Chris Cagurangan working in the R9 air lab



Placeholder for photo of R9 air lab, Chris C. working in lab??



Summa canisters (duplicate sample) at a residence in Mountain View



Criteria EPA is Using to Evaluate Air Results

- **Compare indoor air to outdoor air results**
concurrent indoor/outdoor sampling to help determine outdoor air levels entering the building
- ❖ **Note:** It is EPA's policy not to set cleanup levels or take action to reduce levels below background or outdoor ambient levels.
- **Compare indoor air results to immediate and short-term health-based screening levels**
{ATSDR Minimal Risk Levels}
- **Compare indoor air results to long-term health-based screening levels for residents / indoor workers**
{Using EPA Region 9 PRGs - draft provisional health protective risk range for TCE and Cal EPA's health-based screening level}

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What is TCE?

Trichloroethene (TCE) is a solvent that has been widely used by industry as a cleaning and degreasing agent. TCE is a volatile organic chemical, which means it evaporates readily in air.

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What are the Challenges in assessing TCE?

- TCE is inherently complex toxicologically, with multiple metabolites and multiple potential modes of action.
- There is a large database of information on TCE, but there are significant gaps in knowledge.
- There are diverse perspectives on a number of science policy issues.



TCE Metabolism is Complex

- Rapid absorption via inhalation and ingestion
- Readily distributes to blood-rich organs, with sequestration in fat
- TCE is metabolized by two competing pathways
 - Oxidative (P450) pathway
 - Metabolites TCA, DCA, CH
 - Glutathione-S-transferase (GST) pathway
 - Metabolites DCVG, DCVC
- Urinary metabolites are used as biomarkers of exposure

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Major Findings of 2001 Draft TCE Toxicity Assessment

- TCE is likely to cause cancer in humans
 - Exposure to high levels of TCE increase the risk of kidney, liver, hemato-poietic, cervical, and prostate cancers
- TCE can also cause a variety of non-cancer effects if people are exposed to high levels
 - Affects nervous and immune systems, liver and kidney, endocrine and developing fetus

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TCE Assessment Focuses on Susceptible Populations

- Those who may be more sensitive to TCE's harmful effects:
 - Children, infants and the developing fetus
 - People with chronic illness (diabetes, liver disease)
 - People using medications (e.g. acetaminophen) or alcohol
 - People with background exposures to solvents and disinfection byproducts

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Status of TCE Re-assessment

- **2001** Draft TCE Health Risk Assessment – public review.
- **2002** EPA Science Advisory Board review.
- **2004** EPA and other federal agencies initiate scientific consultation with the National Research Council (NRC) to obtain the best available science on key scientific issues related to TCE.
- **2005** Public meetings held to gain additional insights on TCE.
- **July 2006** Advice from NRC expert panel on TCE science issues.
- **2008 and beyond?** New revised draft TCE assessment for peer review and public comment. Final assessment and IRIS.

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TCE Re-assessment Updates

For more information and TCE reassessment updates

- Go to <http://www.epa.gov/ncea/>
Click on the "TCE" link under "Risk Assessments"
<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=119268>
- The NRC report – Assessing the Human Health Risks of TCE: Key Scientific Issues can be downloaded for free

<http://www.nap.edu/catalog/11707.html>

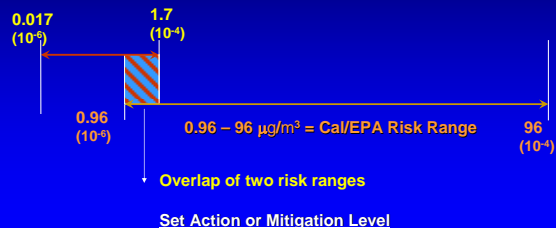
(click on little button "Sign in to download free PDFs").

What Region 9 is Doing in the Interim While There Is No Final TCE Value...

- In the interim, EPA Region 9 continues to use both the EPA health protective risk range for long-term exposure and the Cal/EPA health-based screening level.
- Selecting TCE action or mitigation levels where these risk ranges overlap helps to ensure continued protectiveness at each site even if EPA's draft TCE Risk Assessment should change upon finalization.
- Region 9 will continue using the best available science to make site-specific risk management decisions.
- When the TCE reassessment is finalized, Region 9 will incorporate the information into our decision-making process and continue to ensure that existing remedies are protective.

EPA Region 9's Use of Both Provisional TCE Risk Range and California EPA Health-Based Screening Level RESIDENTIAL

0.017 – 1.7 $\mu\text{g}/\text{m}^3$ = EPA Region 9 Provisional Risk Range



What We Found

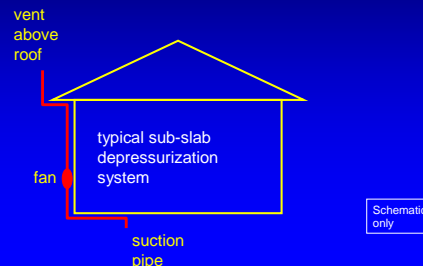
- Completed vapor intrusion pathway into several buildings and residences
- Preferential Pathway samples useful in identifying completed VI pathway (utility/piping conduits, cracks in slab, floor drains).
- Subsurface structures (wet basements, utility vaults, elevator shafts)
- Varying ventilation conditions in commercial buildings and ventilation makes a difference

Interim Mitigation Measures – Easy Fixes

- Mitigation measures implemented to reduce levels of TCE and other VOCs (sealing potential conduits, modifying ventilation systems, installing air purifiers, sub-slab ventilation systems)
- Confirmation air samples collected to make sure mitigation measures are effective.

Mitigation of Vapor Intrusion

- Sub-slab depressurization system
- Modifications to HVAC system



Sub-Slab Depressurization – very effective

99.5% Reduction Possible

Decontamination process

- 1 Seams and cracks in the foundation are sealed. If the house has a crawl space, a membrane is put down and sealed to the foundation walls.
- 2 A suction pit is dug beneath the foundation.
- 3 A ventilation system is installed to pull the vapors out from beneath the house.

\$1,500 - \$2,500 Cuts off the Pathway

Source: 2000 Conference on Hazardous Waste Research, The Denver Post

Proposed Mitigation Measures-retrofitting buildings??



Conventional residential-type sub-slab ventilation systems may not be practical at these large existing commercial campuses.

Region 9 generally recommends mitigation measures in design of new building to help prevent vapor intrusion.

Long Term Strategies and Challenges Ahead

- Selecting Superfund /RCRA remedies to address potential long-term exposure to TCE and other VOCs from the vapor intrusion pathway existing & future land use
- Implementing Engineering and Institutional Controls to ensure remedy is effective
- Developing Long-Term Air Monitoring Strategies
- Reliance on HVAC systems for commercial buildings? (ensure adequate ventilation, positive pressure)

Long-term Strategies and Challenges Ahead

- Long-term O&M of mitigation systems and long-term effectiveness and monitoring of "sealing of cracks and conduits", vapor barriers and other passive measures
- Future developments - considering of mitigation measures in design of new buildings overlying contaminated shallow groundwater
- Alternative remedial technologies assessing remedial alternatives other than pump and treat for cleaning up the groundwater faster
- Responsibilities and resources

Future Research Needs

- Improvements in predictive modeling
- Toxicity assessments of chlorinated solvents (e.g., PCE)
- Optimization and analysis of operating HVAC systems to mitigate vapor intrusion
- Future Re-development sites (i.e., Brownfields) – engineering options to minimize the potential for future vapor intrusion

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