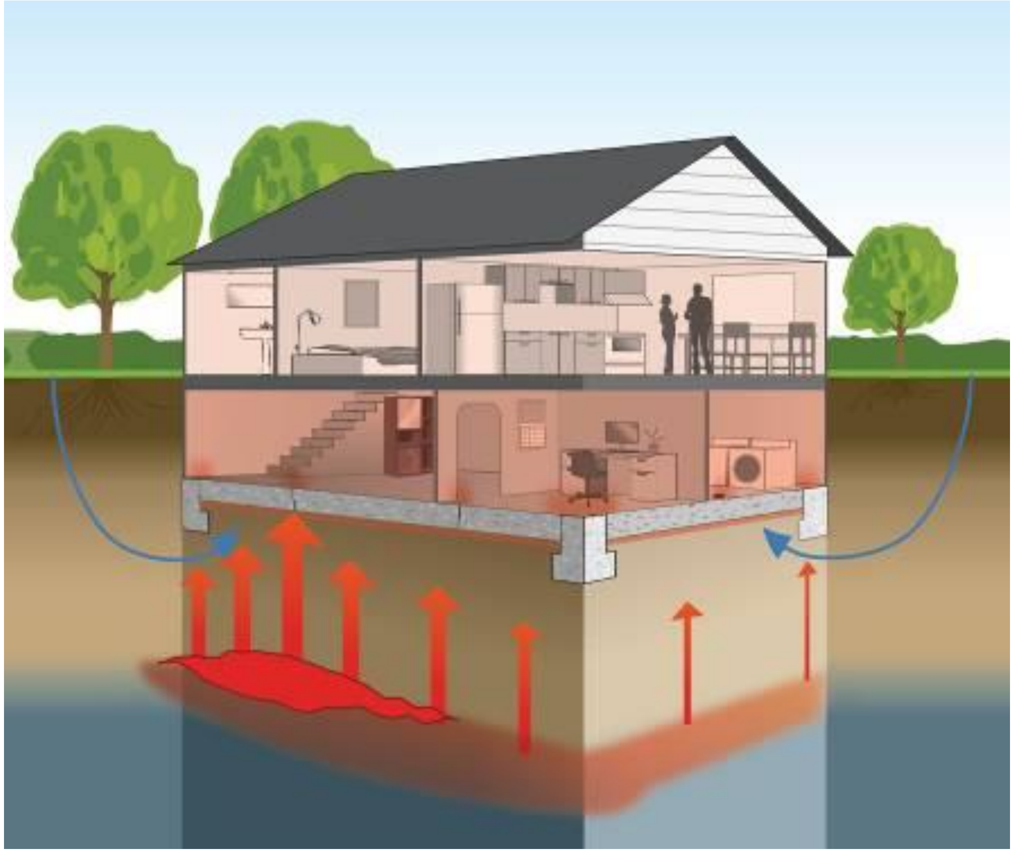


Presentation to Beverley Community on Soil Vapor Intrusion

September, 2015

Dr. Ian Hers
Golder Associates

Golder Associates

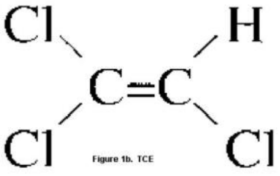
Community Presentation

- What is Vapour Intrusion (VI)
- Conceptual model for how vapour intrusion occurs
- Soil vapour intrusion mitigation basics and options
- Soil Vapor intrusion mitigation case studies

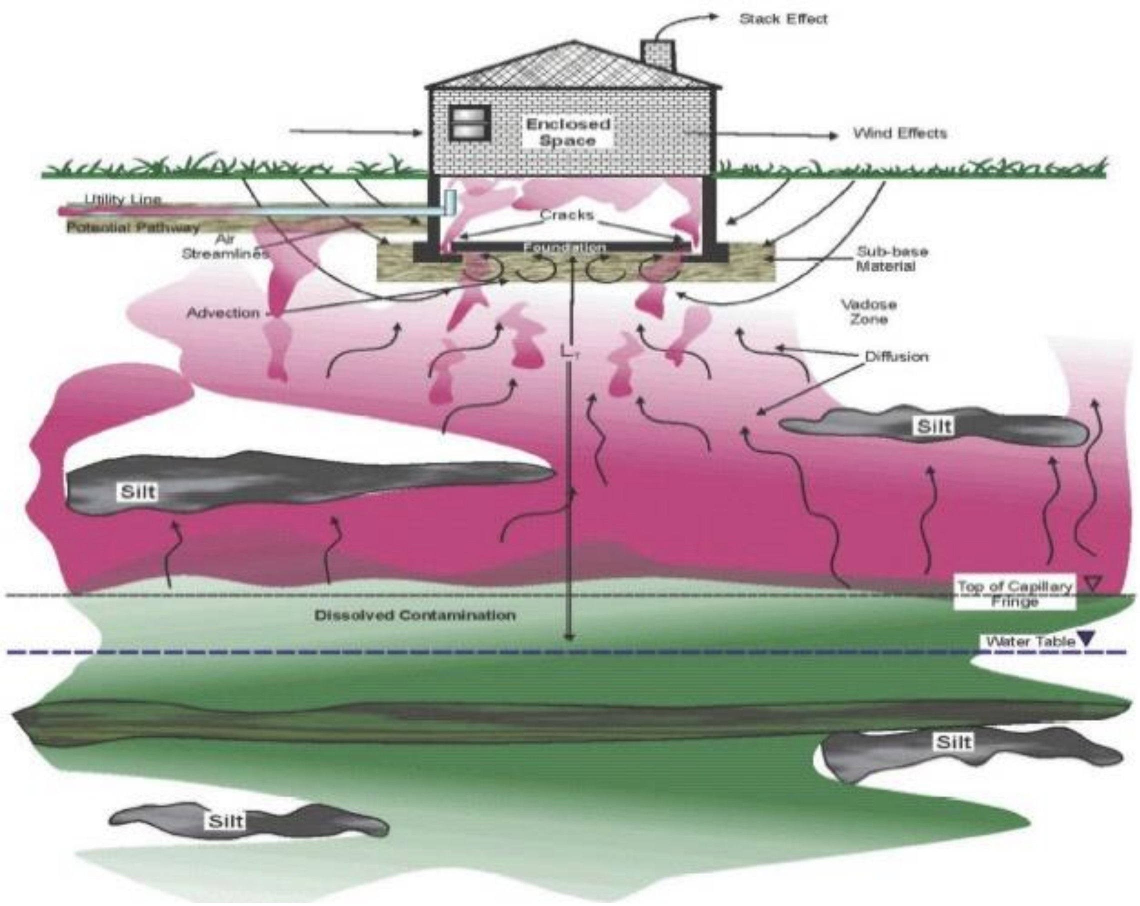
What is VI and Why is it an Issue?

- Migration of subsurface volatile chemicals or methane into enclosed building spaces
- Volatile chemicals are present at many contaminated sites; examples include manufacturing sites (chlorinated solvents) and service stations and refineries (petroleum hydrocarbons)
- Concern over exposures to toxic and/or carcinogenic chemicals and/or safety hazards
- There are well-established methods for mitigating soil vapour intrusion to acceptable levels when there is a concern

TCE

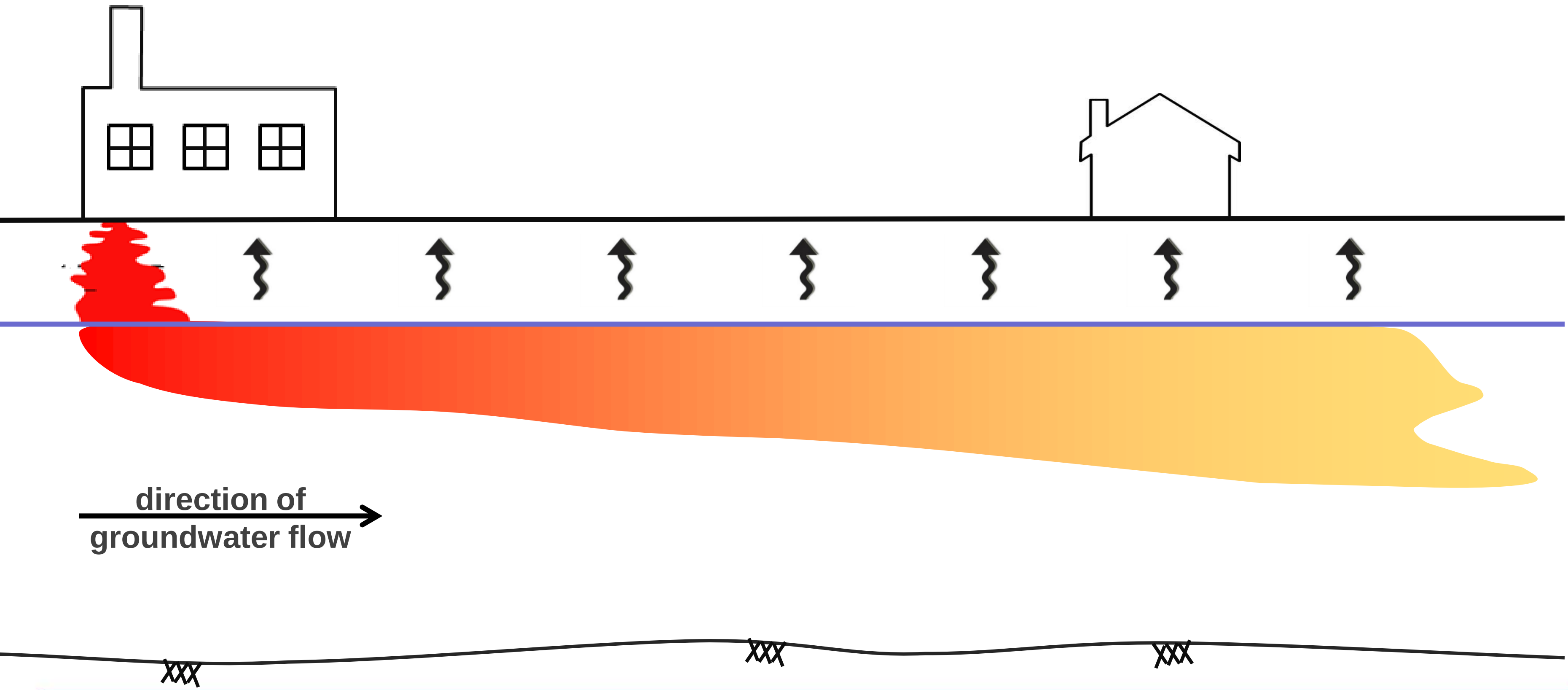


Conceptual Site Model for Vapour Intrusion

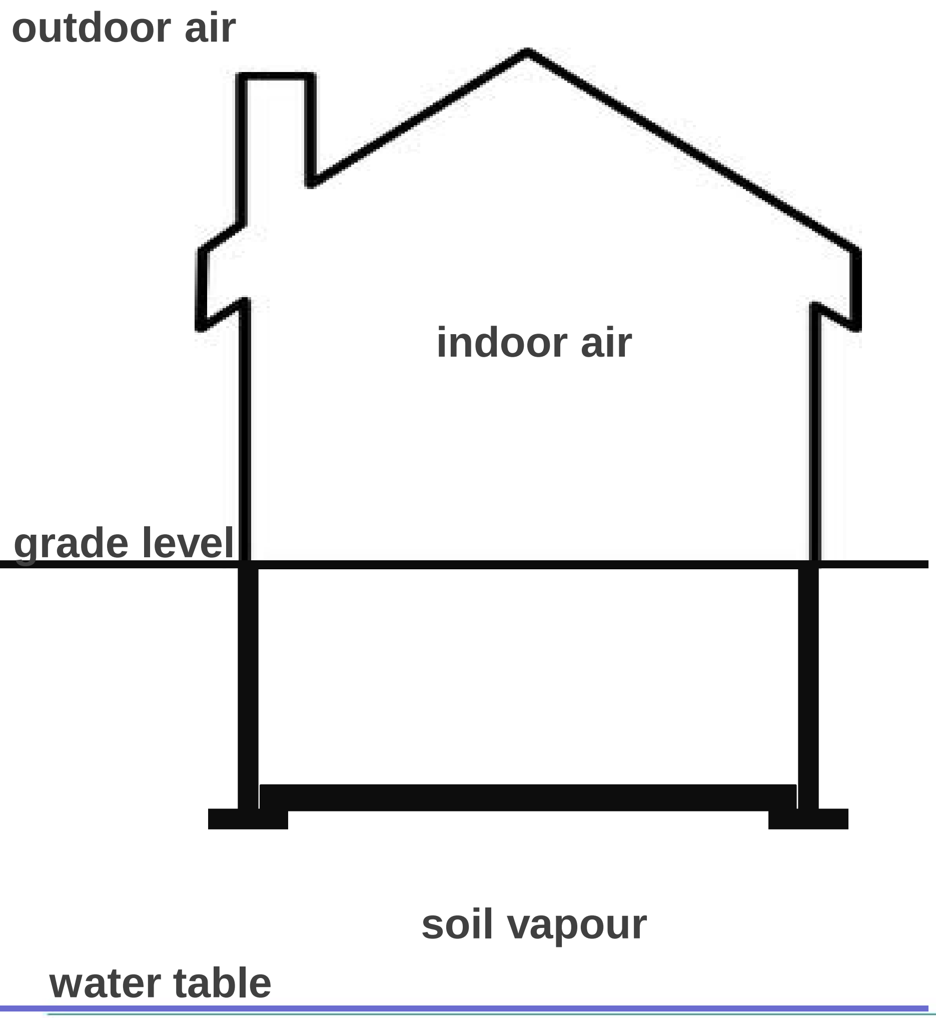


USEPA 2002

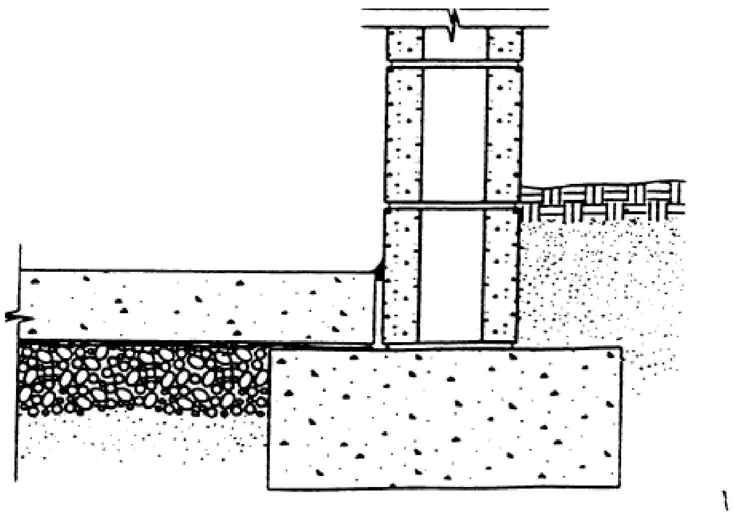
Soil and Groundwater Contamination



The Building Foundation

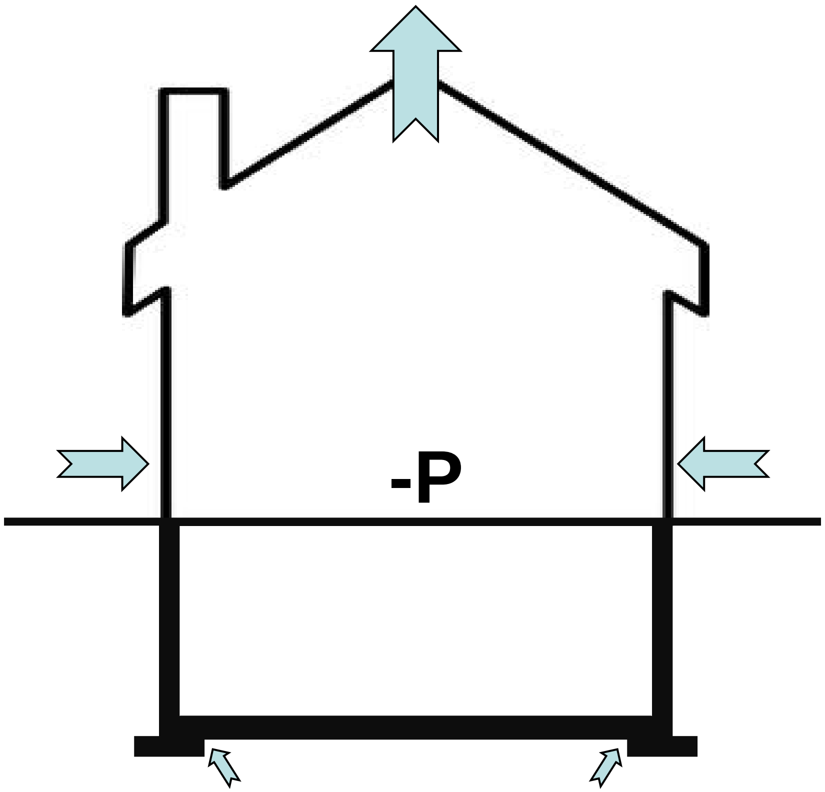


- Buildings always have some entry points for soil gas entry (cracks, utilities)



foundation detail

Building Depressurization: Operational Factors



- Air exhaust: some types of furnaces and hot water heaters, fireplaces, clothes dryers, and bathroom/kitchen fans exhaust air
- Balanced by leakage into the building including soil gas

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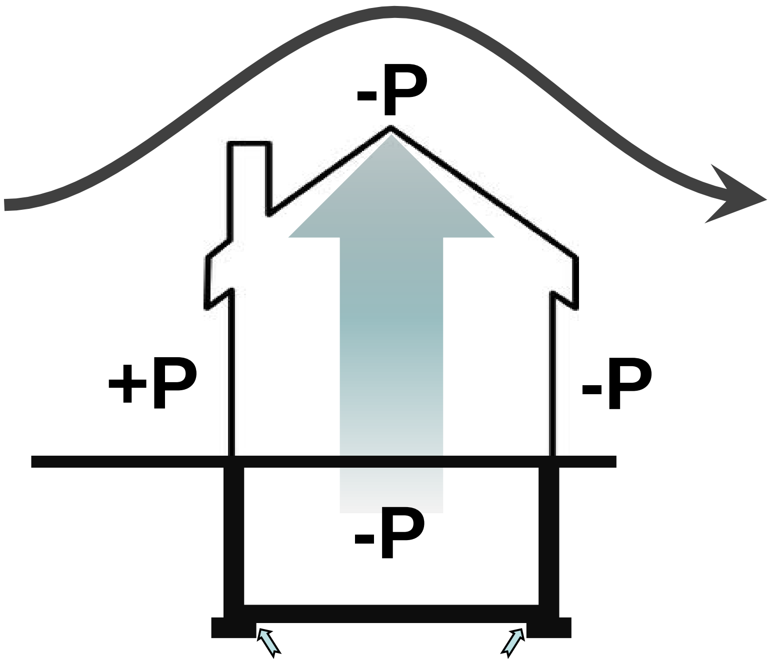
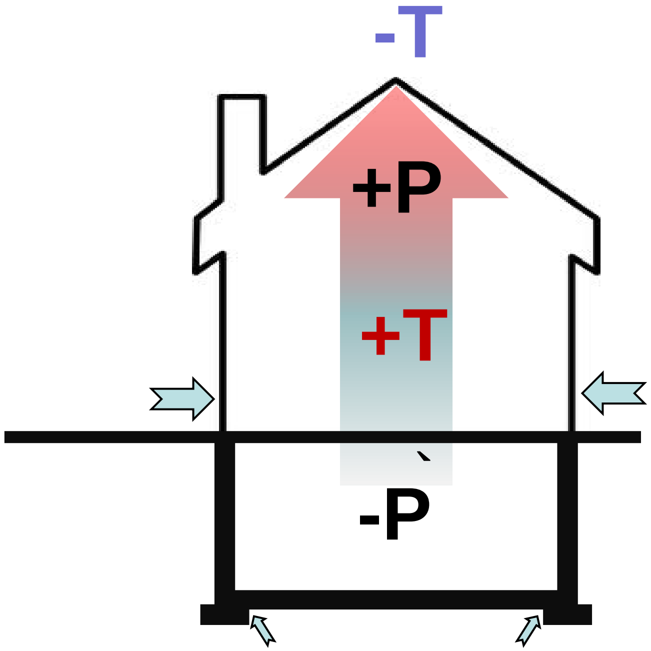
Building Depressurization: Wind and Temperature Effects





- Wind effect – pressure of wind on building wall causes negative pressure in building
- Stack effect – warm air rises when temperature in house greater than outdoor air

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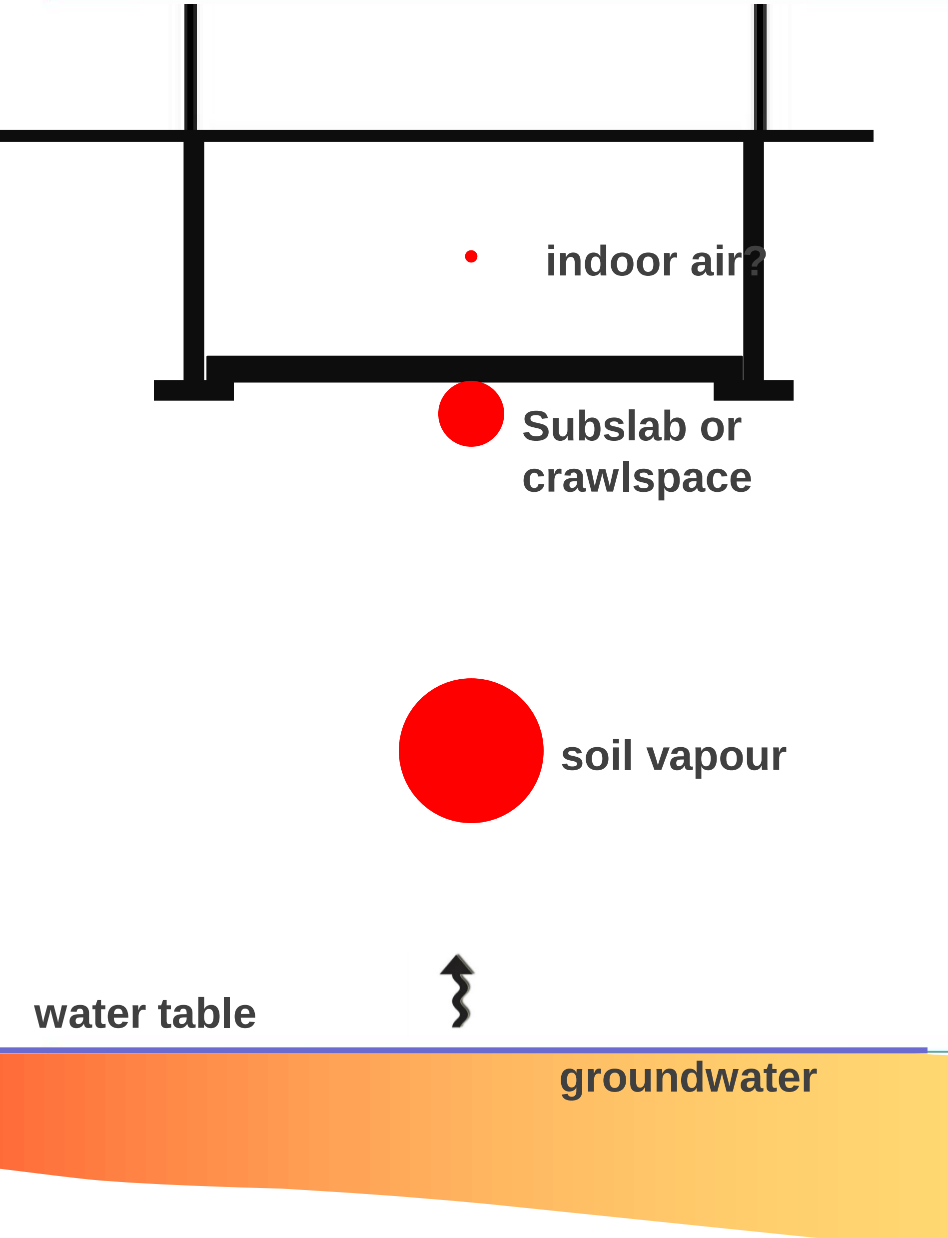
Vapour Intrusion Assessment Considerations



- Background can be greater indoor air criteria
- Indoor air can be temporally variable

- Typically begin groundwater and soil vapour, then move to subslab or crawlspace vapour
- Soil vapour and subslab vapour can be spatially variable

Assessment approach depend on Site-specific circumstances

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Golder uses State of Art Methods and Equipment

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VI Mitigation Options - Depressurization

- Preferred option based on performance, relatively low cost and small equipment footprint
  - Concrete foundation: **Subslab depressurization (SSD)** and sealing cracks
  - Crawlspace (accessible): **Submembrane depressurization (SMD)** and sealing cracks
  - Crawlspace (not accessible): **Crawlspace depressurization** and sealing cracks

VI Mitigation Options - Depressurization

- Typical 80->99%[3] reduction in VOC concentrations for residential SSD systems in existing buildings[1,2]
- Goal is to create ***very small negative subslab or crawlspace pressure*** to reverse gradient

[1] Folkes and Kurtz, 2002. Efficacy of Sub-slab Depressurization for Mitigation of Vapor Intrusion of Chlorinated Organic Compounds. Proc. of Indoor Air, 2002. report 2-3 orders of magnitude reduction but ¼ of houses required some modification of system before successful

[2] Golder Calgary site data ~ 80-99% reduction (average 94%)

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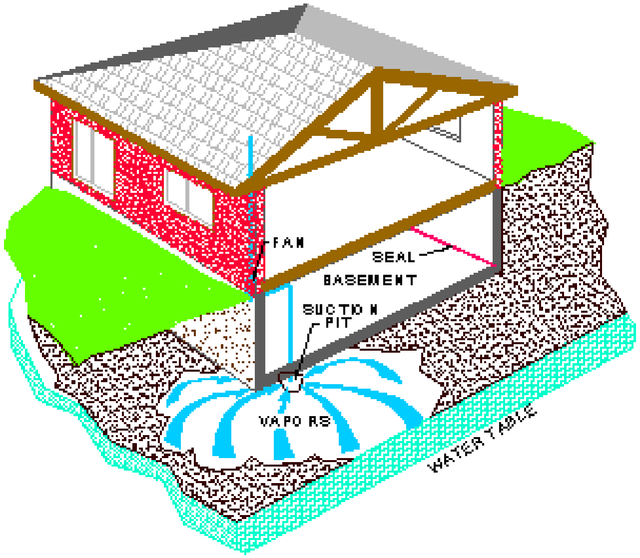
Subslab Depressurization

- Technology borrowed from radon mitigation industry - subslab sump connected to small fan
- Important to seal cracks (typically polyurethane) and seal drains
- Diagnostic testing of flow and pressure is conducted
- Key parameter is Pressure Field Extension (PFE), typically goal is 6-9 Pa depressurization across at least 90% of the building footprint (ASTM 2121-12)

SSD (BASEMENT) SYSTEM



Typically 1 to 2 sumps for house

90-150 Watt fans

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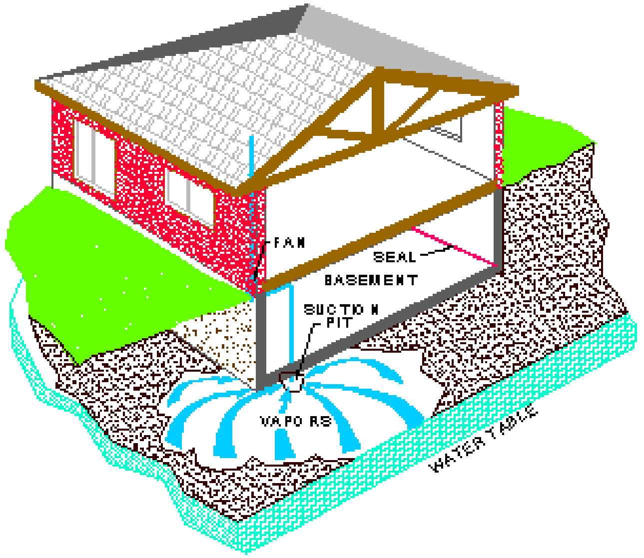


Typically 1 to 2 sumps for house

90-150 Watt fans

Possible Mitigation Strategy Conceptual House 1 at Beverley Site

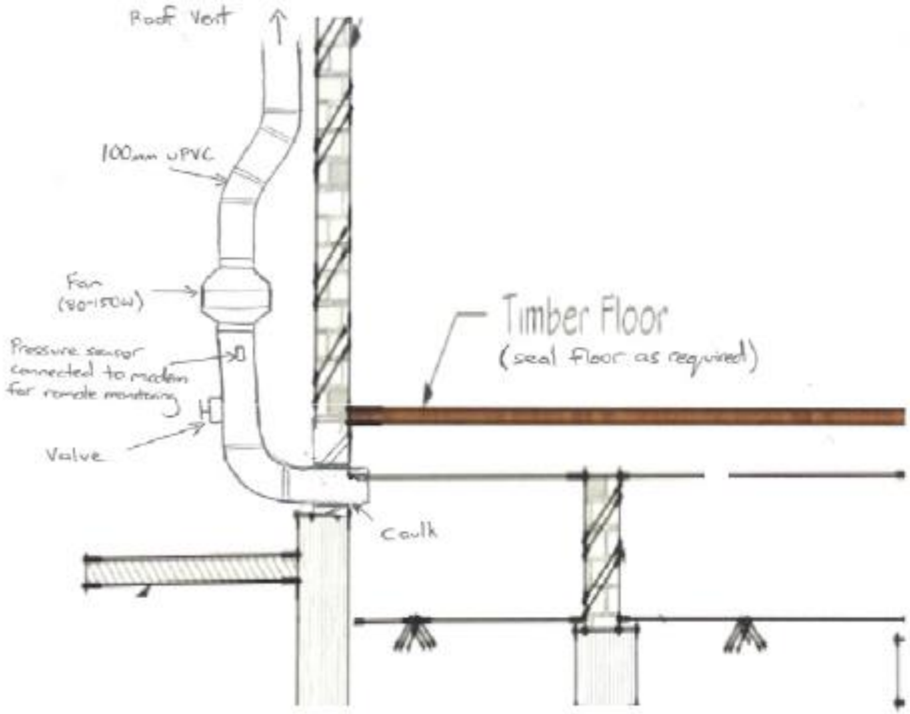


Figure 4: Typical crawlspace depressurisation detail

Possible Mitigation Strategy Conceptual House 3 at Beverley Site

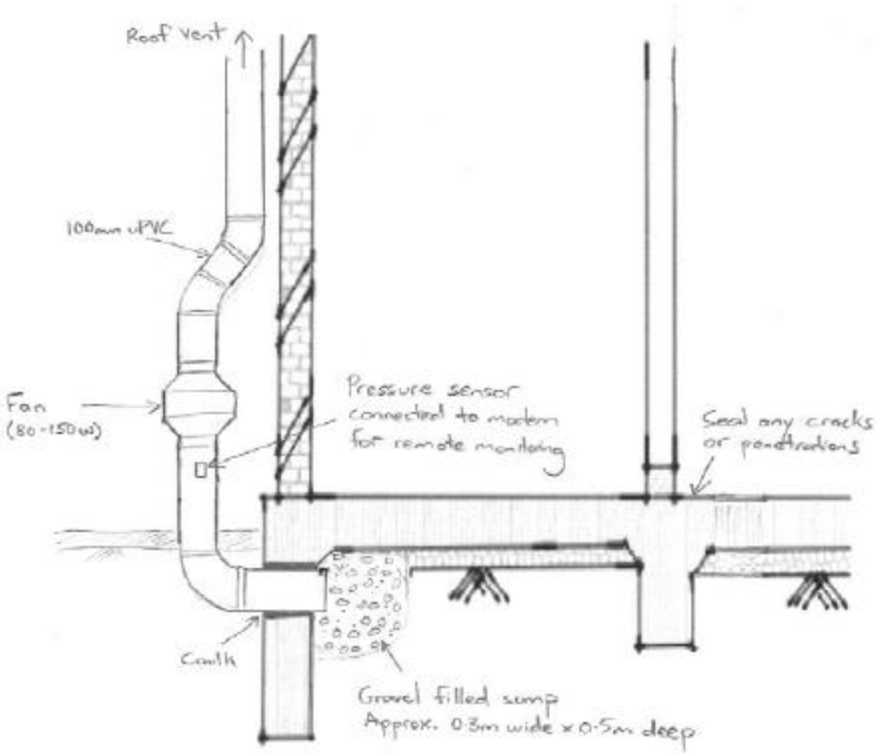
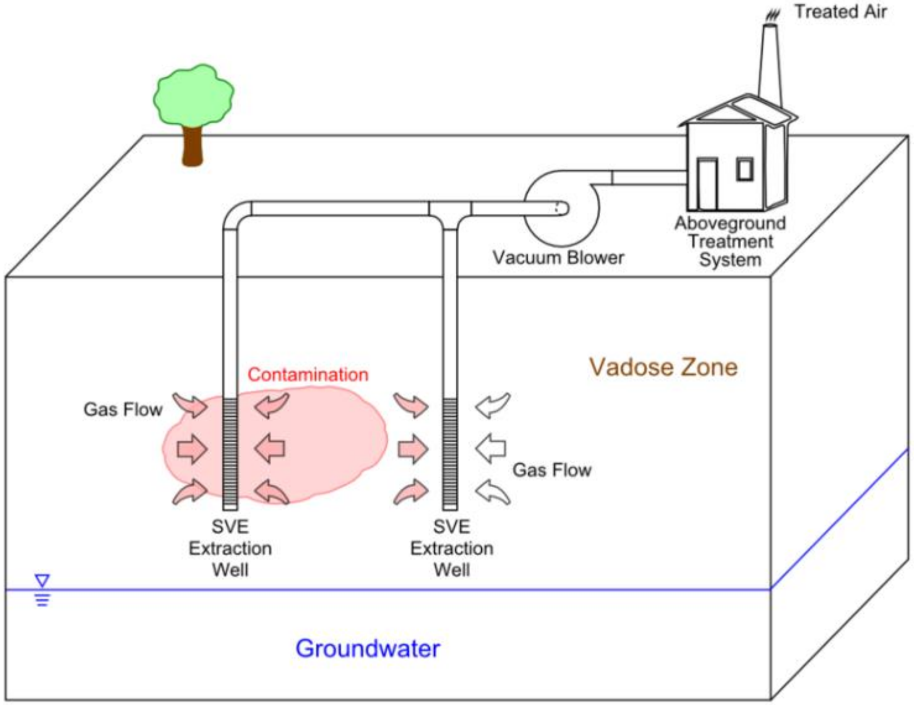


Figure 7: Typical sub-slab depressurisation perimeter sump detail

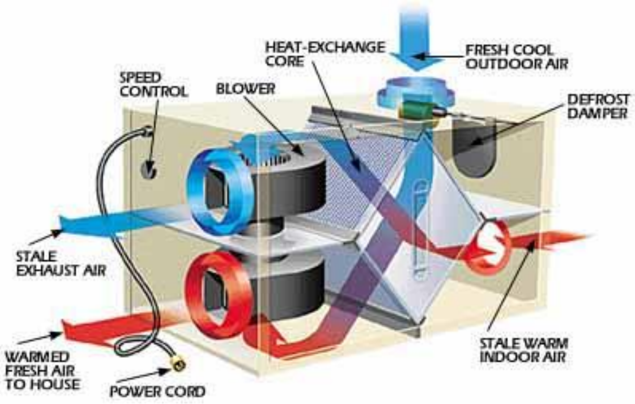
VI Mitigation – Soil Vapour Extraction

- Subslab or crawlspace depressurization technologies are substantially different than soil vapour extraction, which involves deeper wells, higher air flows and larger equipment footprint
- Can be appropriate technology for large impacted site with coarse-grained soils
- Possible disadvan-tage is drawing up of deep soil vapour



VI Mitigation – Other Options

- **Increase ventilation**
- **Sealing of cracks**
- **Adjustment of building heating and ventilation system** – if exhaust only ventilation install *Heat Recovery Ventilator (HRV)* to balance system

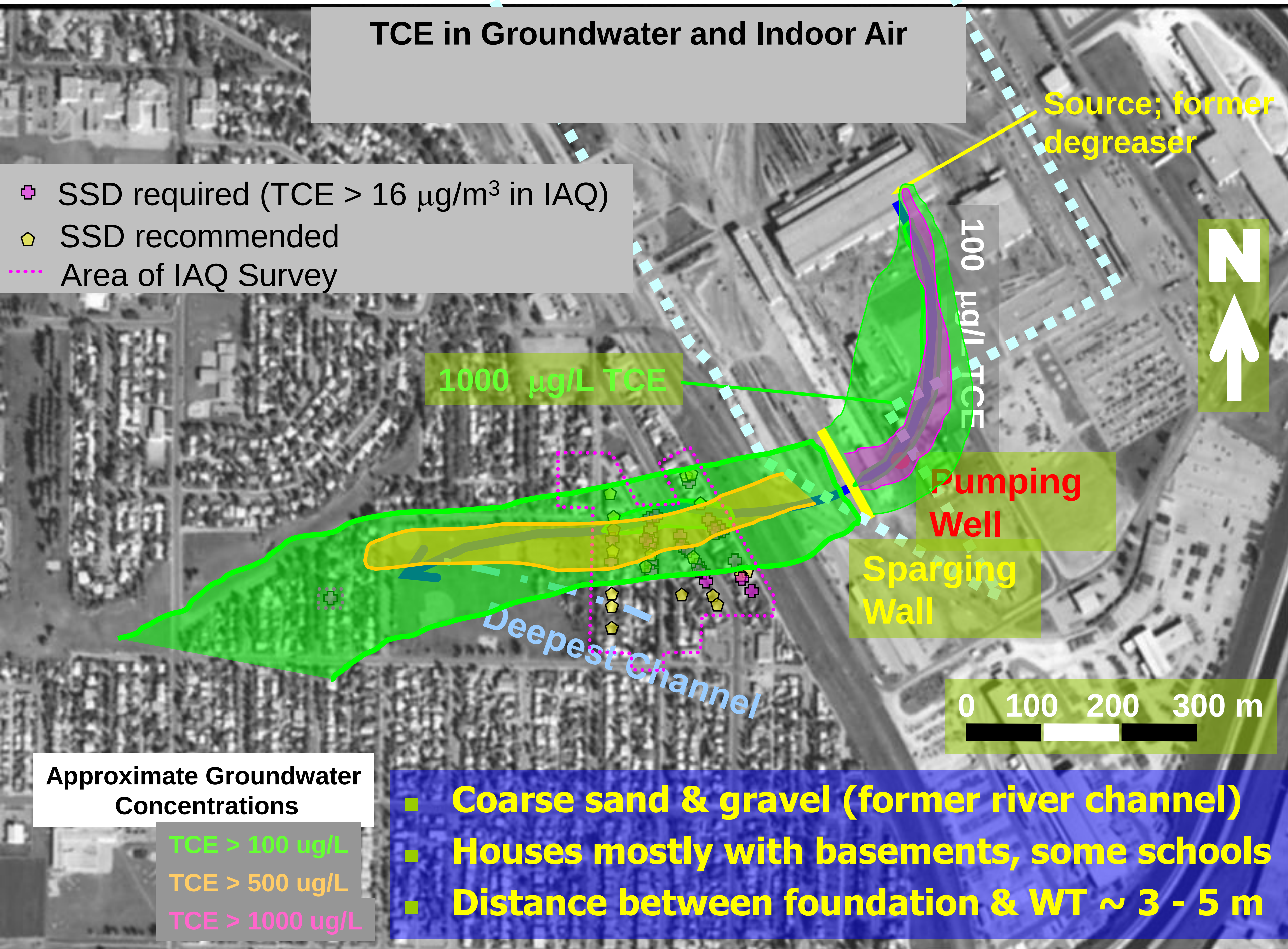


- **Above measures** generally not effective as stand-alone option but can be considered if small concentration reduction needed
- **Building pressurization** – can be effective but often high energy cost for heating/cooling outdoor air; may bring moisture inside the building envelope (mold)
- **Air purifying unit** – may be temporary solution

Case Studies

- Western Canada Site
- Wall Township, New Jersey, USA Site
- Cambridge, Ontario, Canada Site
- Redfield, Denver, Colorado, USA Site

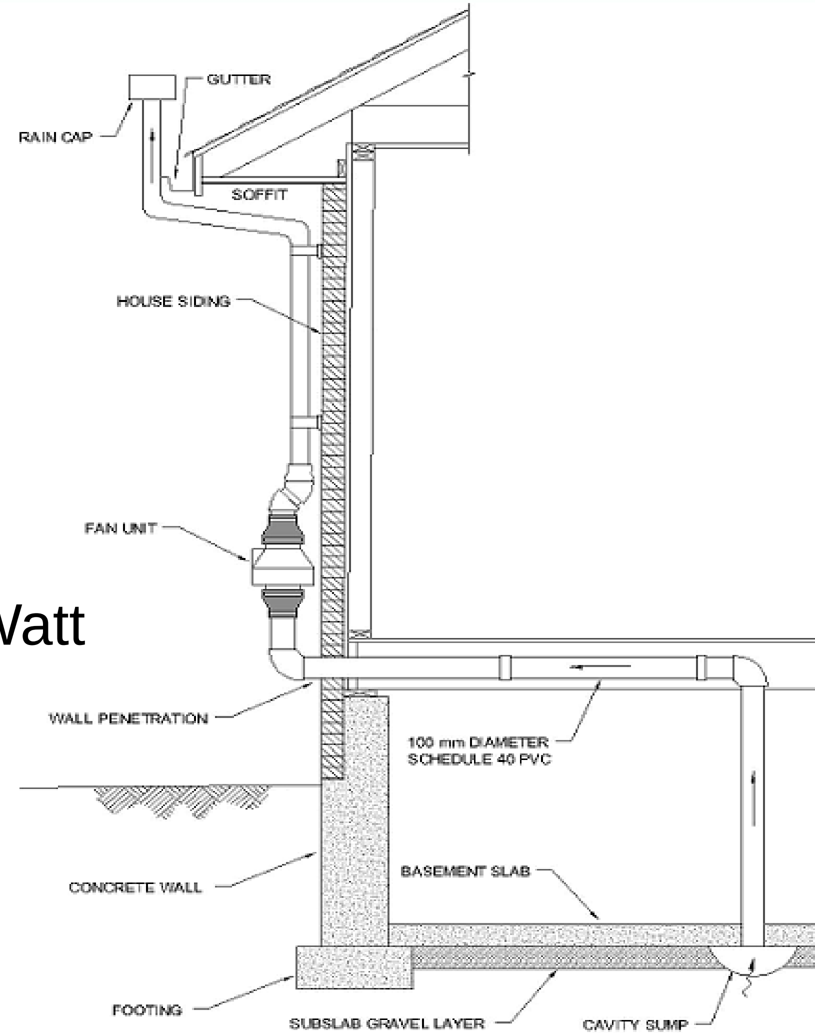
TCE in Groundwater and Indoor Air



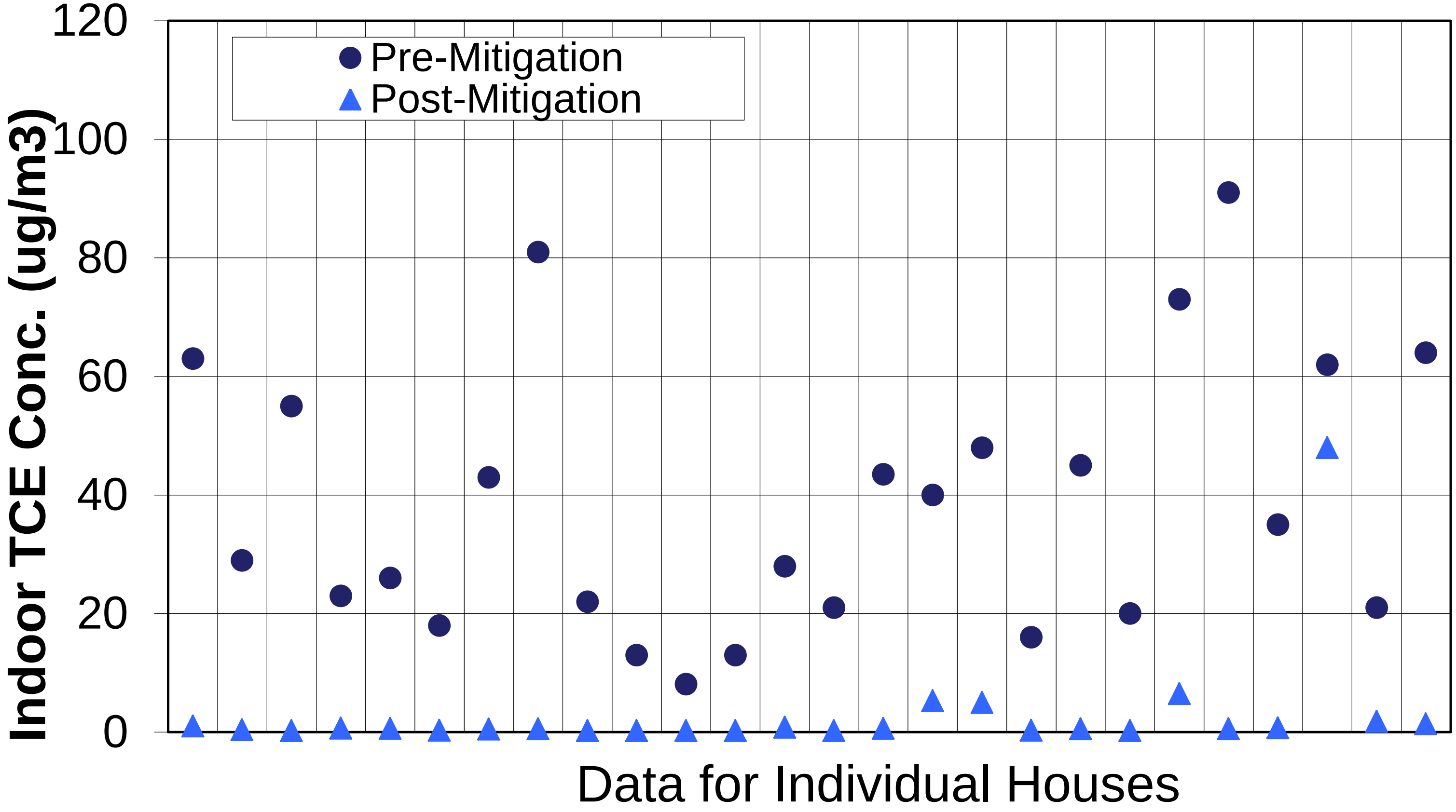
- Coarse sand & gravel (former river channel)
- Houses mostly with basements, some schools
- Distance between foundation & WT ~ 3 - 5 m

Western Canada Site

90 Watt Fan



Western Canada Site



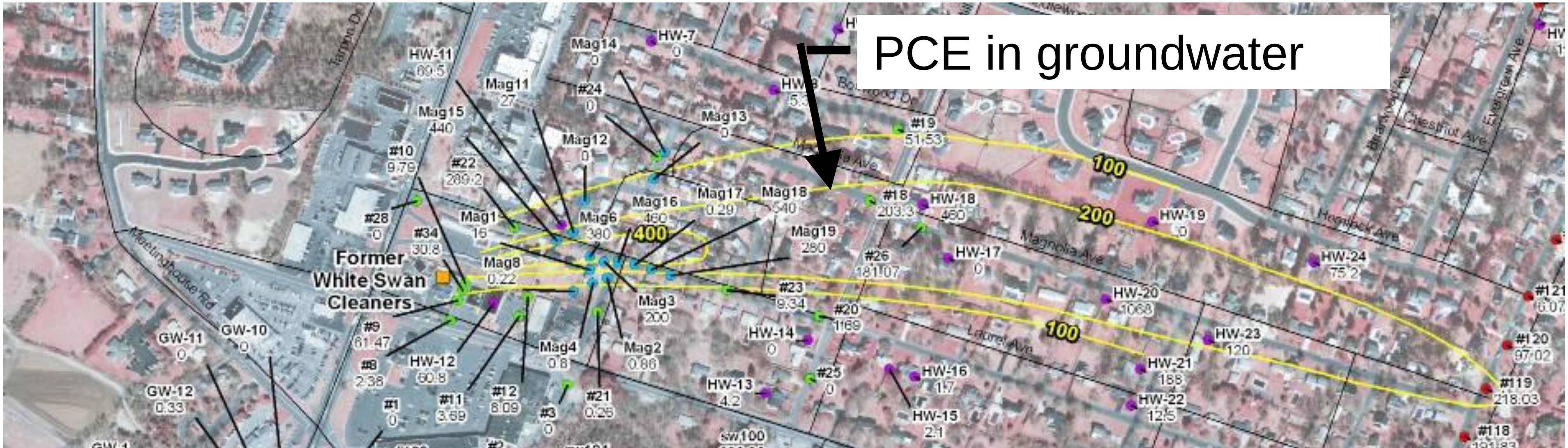
SSD and SMD highly successfully – TCE Concentration reduction generally 80-99% (avg TCE = 94% (N=26)

Western Canada Site

Submembrane Depressurization
Layfield EL-20 (20 mil)

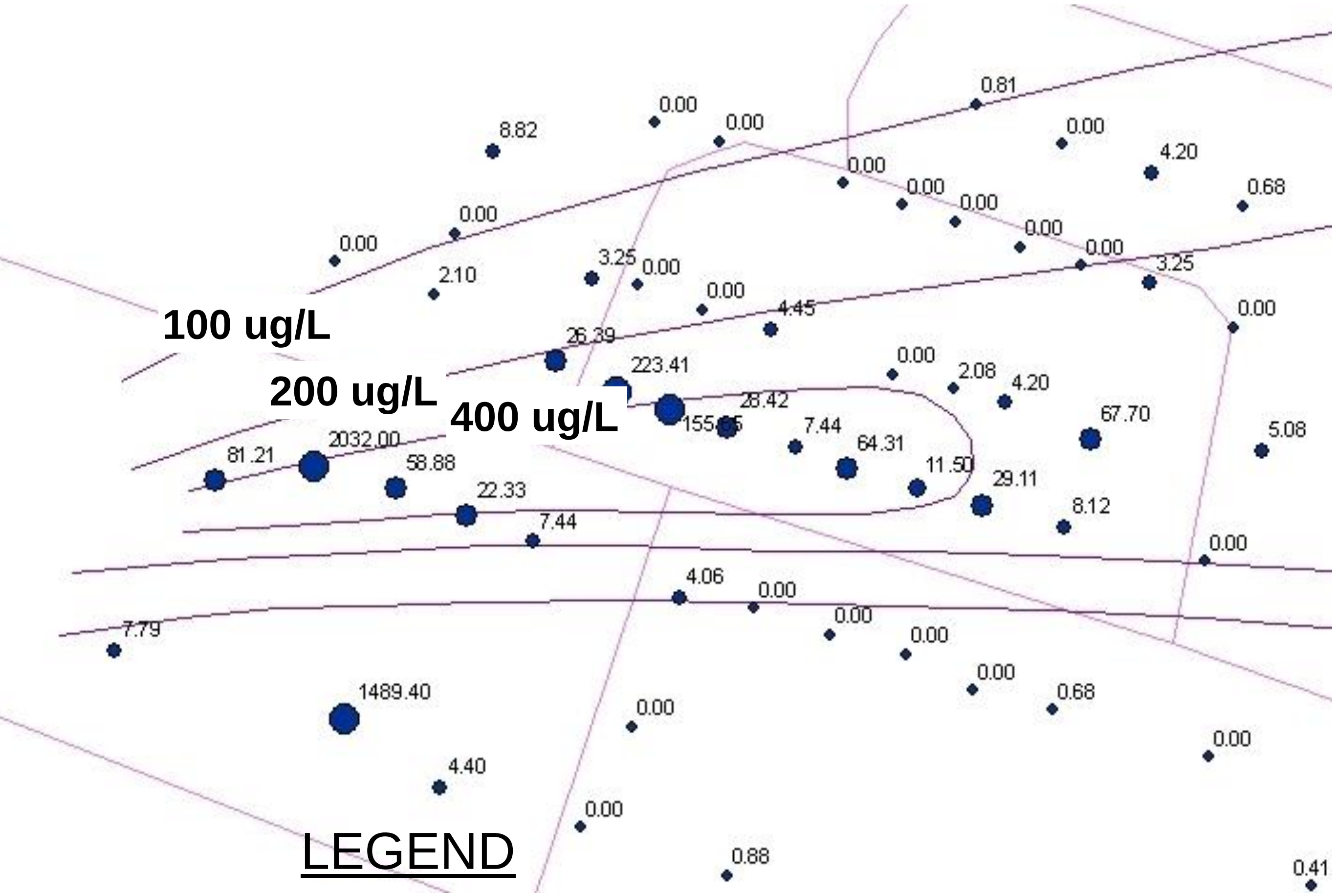
There were a few sealing Challenges!

Wall Township, New Jersey, USA
(New Jersey DEP-Golder research study)



- Dry cleaners source of two large PCE plumes (2 by 3 kilometres!), sand, depth to groundwater = 6.1 m
- PCE concentrations in groundwater in source > 500 ug/L
- Max indoor PCE concentrations!: Residential ~ 2000 ug/m³, Commercial ~ 1500 ug/m³

Wall Township, New Jersey, USA
(New Jersey DEP-Golder research study)

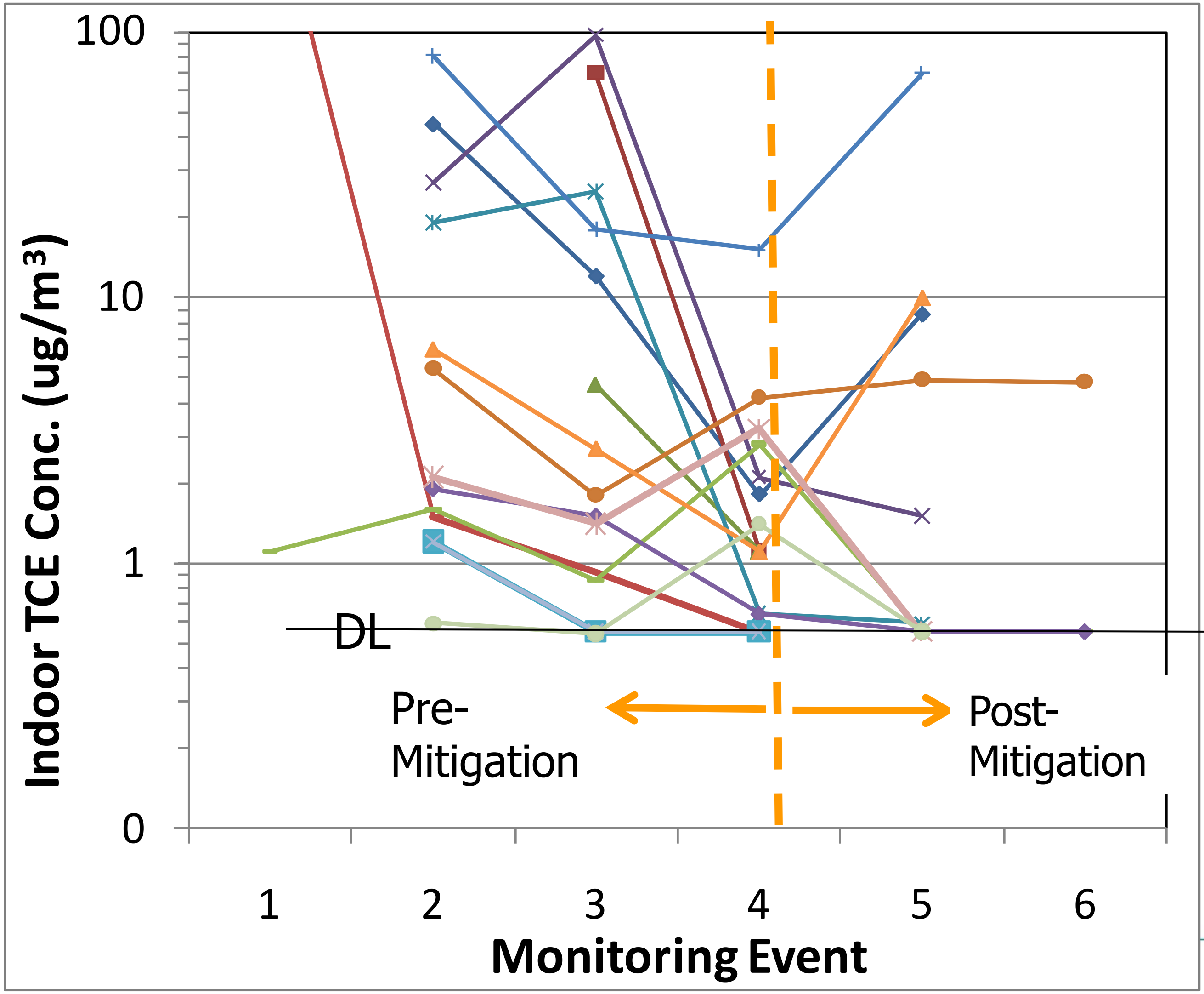


LEGEND

● PCE concentration in building air (ug/m³)

- Indoor air concentrations we quite variable

Wall Township, New Jersey, USA
(New Jersey DEP-Golder research study)



Concentrations generally decreased to less than NJ indoor air threshold of 5.5 ug/m3 – some houses may have been affect by background chemicals

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Background Sources of Chemicals

Courtesy John Boyer NJDEP

- Numerous products w\ VOCs
  - Adhesives or metals cleaners – PCE, TCE, 111-TCA
  - Dry cleaning - PCE
  - Typical products in hardware store – acetone, xylenes, petroleum distillates
  - Gasoline - benzene
  - Tap water – chloroform

http://householdproducts.nlm.nih.gov/
http://webbook.nist.gov/chemistry/name-ser.html
http://chem.sis.nlm.nih.gov/chemidplus/chemidheavy.jsp
http://www.atsdr.cdc.gov/

Cambridge, Ontario, Canada Site

Nov. 21, 2007 Public Meeting

- Sand & gravel
- Depth to WT ~ 4 m
- Basement homes
- Elevated TCE in indoor air
- Mitigation combination of SVE and SSD
- Also some portable carbon treatment units and HRVs installed

4000 IAQ samples, 187 homes mitigated (2007)

Cambridge, Ontario, Canada Site

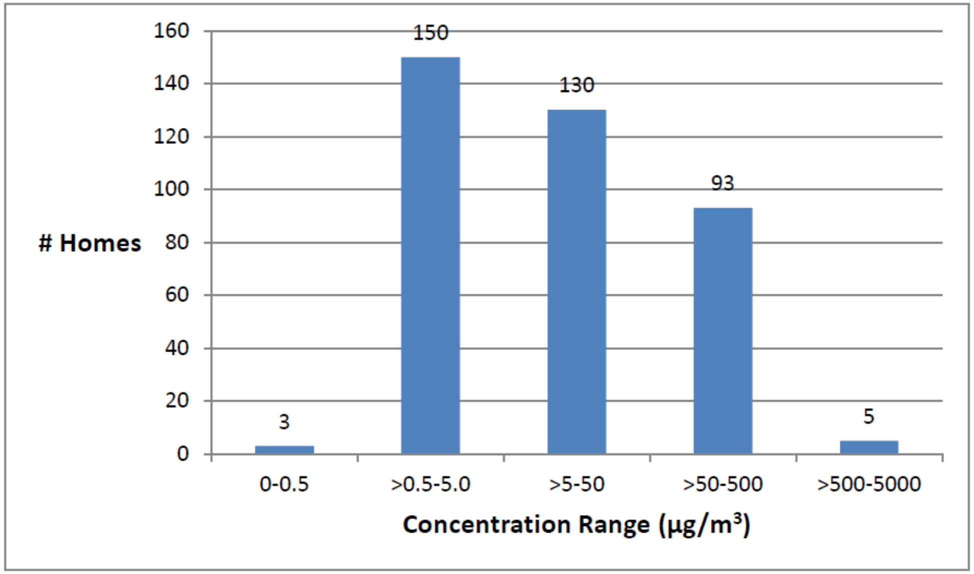

Fig. 1 Indoor Air Concentrations in Bishop Street Community Prior to Any Remediation or Mitigation, 2005-2006

- Pre-mitigation Indoor TCE

- Post-mitigation Indoor TCE as of 2009/2010 (concentrations are reported to currently be significantly lower based on continued mitigation efforts)

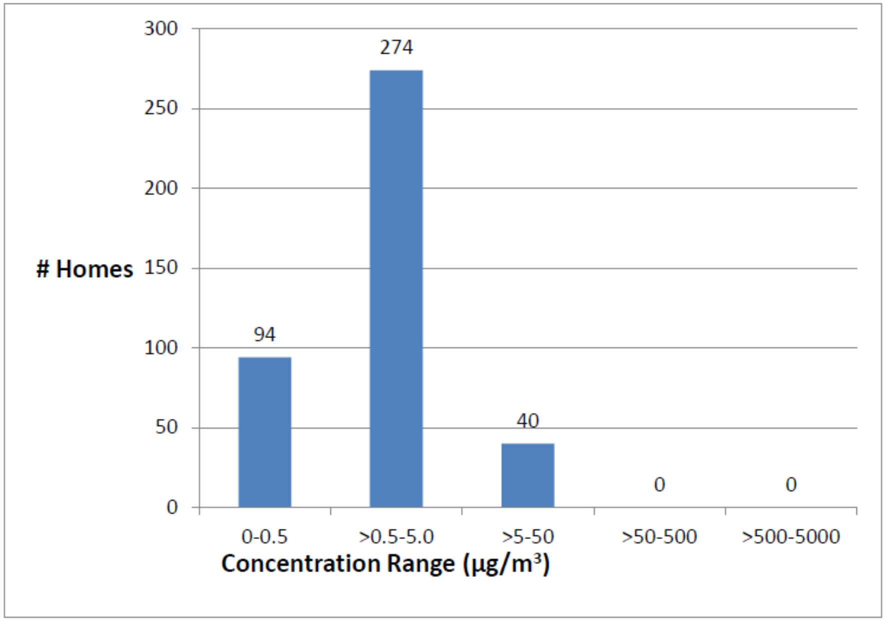

Fig. 2 Indoor Air Concentrations in the Bishop Street Community, Based on Samples Collected Between August 1, 2009 to August 31 2010

http://chd.region.waterloo.on.ca/en/healthyLivingHealthProtection/resources/OAHPP_report.pdf

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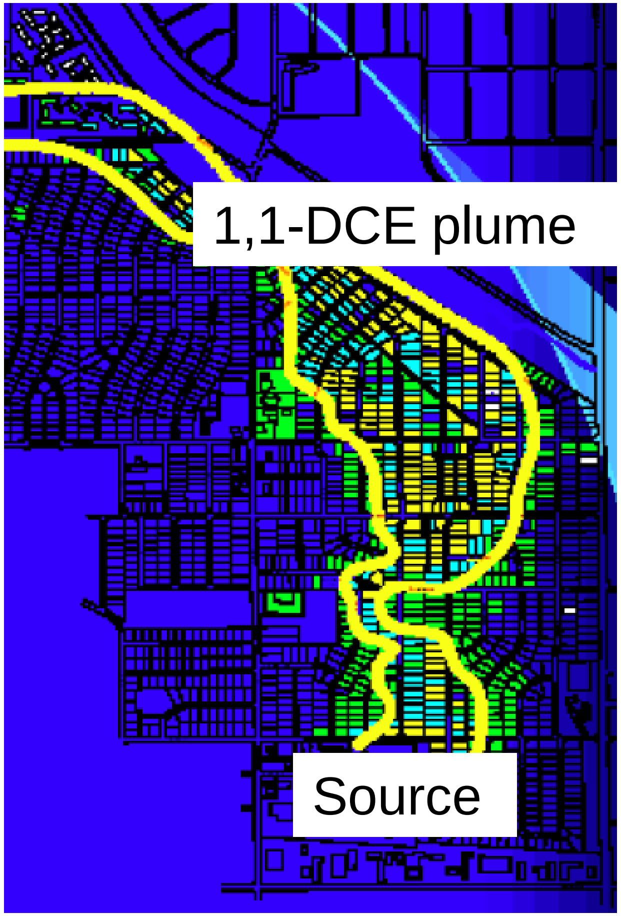
Redfield, Denver, Colorado, USA Site

Courtesy Envirogroup



> 350 homes mitigated

- 1,1 Dichloroethene (11-DCE) is breakdown product of 1,1,1- Trichloroethane (TCA)
- Depth to water up to 10 m
- Vapour intrusion occurred in basement, crawlspace and slab-at-grade homes
- > 350 homes successfully mitigated