The Vapor Caper

Part I: Considerations and Remedies

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WHAT IS VAPOR INTRUSION?

The migration of vapor-forming chemical from any subsurface source into an overlying building.

- VOCs
- Some SVOCs*
- Select Inorganics (Mercury, Cyanide)
- Select PFAS (regulations in development)

*SVOCs are volatile if they have a
Boiling Point < 200° C *or*
Henry's Law Constant > 1×10^{-5} AND
Molecular Weight < 200 g/mol (PADEP)

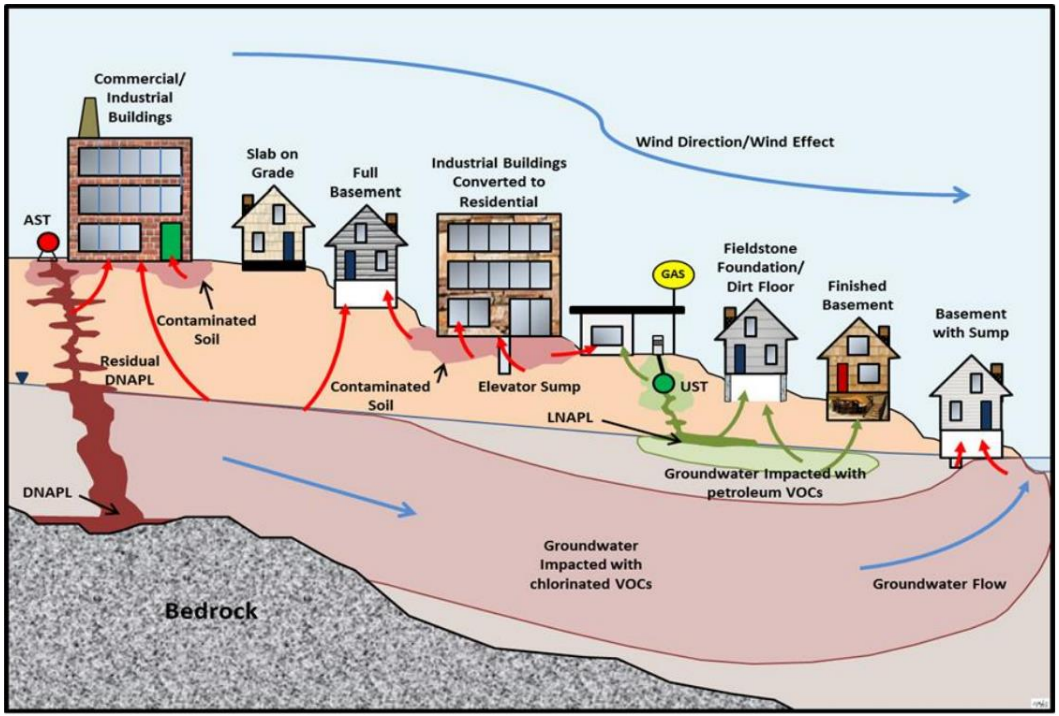


Image from Massachusetts DEP (https://www.mass.gov/doc/wsc-16-435-vapor-intrusion-guidance-site-assessment-mitigation-and-closure/download)

PRESENTATION OUTLINE

01

BUILDING CONSIDERATIONS

02

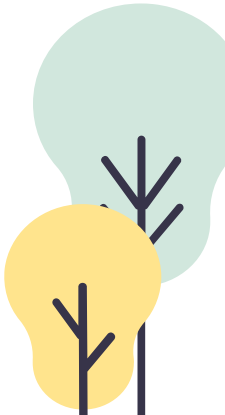
HYDROGEOLOGIC CONSIDERATIONS

03

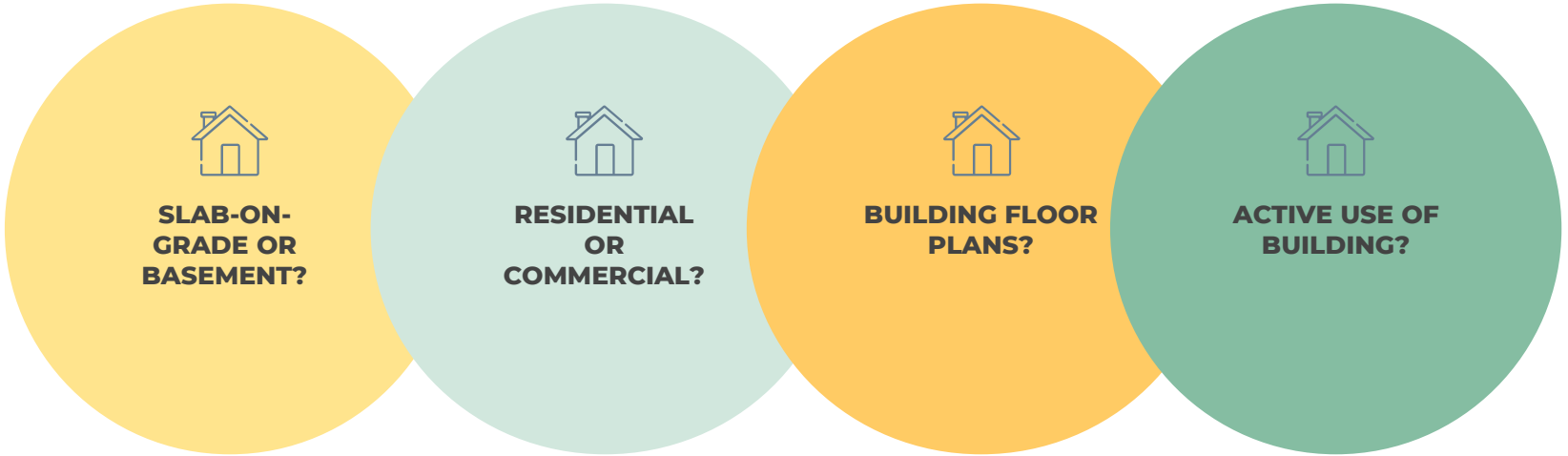
SCREENING VALUE USE LIMITATIONS

04

REMEDIES



INITIAL BUILDING CONSIDERATIONS



DETERMINING FEATURES OF A BUILDING FOUNDATION

Need to know the depth to the bottom of the foundation for

- **Sampling**
- **Modeling**
- **Distance to groundwater**

- Residential buildings are more likely to have a basement
- Commercial buildings usually have a thicker slab
- Basements can be below grade or partially above grade

Images from Google Earth (https://www.google.com/maps/@42.2161337,-79.8277475,3a,49y,91.93h,91.33t/data=!3m6!1e1!3m4!1st9qq1O42Wvk9O41xMFBeNA!2e0!7i16384!8i8192?entry=ttu)

BUILDING LAYOUT AND USE SHOULD BIAS SAMPLING

Image from Overhead Door (https://www.overheaddoor.com/auto-repair-service-bay-doors)

Ventilation patterns and building use affect sampling (especially for indoor air)

- Bias sampling relative to internal conditions, uses, and sources
- Garage & large bay doors can affect ventilation
- Presence of VOCs from non-release source can affect indoor air results
  - Fresh paint, furniture, textiles, fireplaces, storage of household chemicals

STRUCTURAL ISSUES THAT MAY INCREASE VAPOR INTRUSION INTO BUILDING

DIRT FLOOR

STONE WALLS

SUMP

PREFERENTIAL PATHWAYS

CRAWL SPACES

Images from https://www.northernnefoundations.com/basement-waterproofing/case-studies/15269-stone-foundation-with-dirt-floors-in-cambridge-vermont.html
https://www.doityourself.com/forum/wells-sump-pumps-septic-sewage-systems/592653-wall-leaking-where-sewage-line-leaves-house.html

WHAT TO DO IF THERE IS NO ACCESS TO POTENTIALLY IMPACTED BUILDINGS?

EXTERNAL VISUAL OBSERVATIONS

Look for doors or windows leading to basement/crawl space and elevated front stoops.

BUILDING HISTORY AND USE

Residential buildings may be more likely to have basements than commercial buildings.

INTERVIEW

Interview the owner or resident to verify building construction and layout.

HYDROGEOLOGIC CONDITIONS

GROUNDWATER AQUIFER

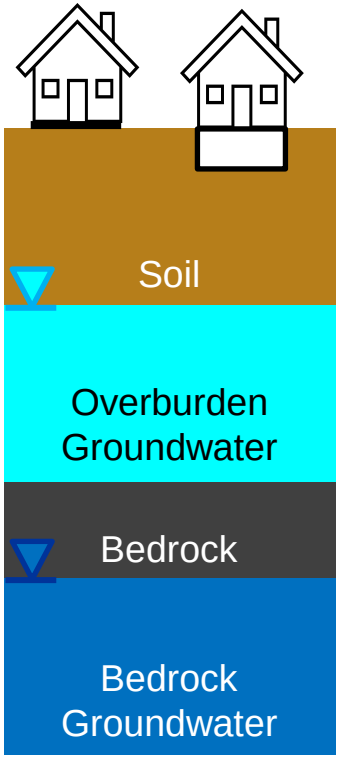
- Overburden and/or Bedrock
- Temporary or Continuous Zone

DEPTH TO GROUNDWATER

- Groundwater > 5 feet below foundation

PRESENCE OF NAPL

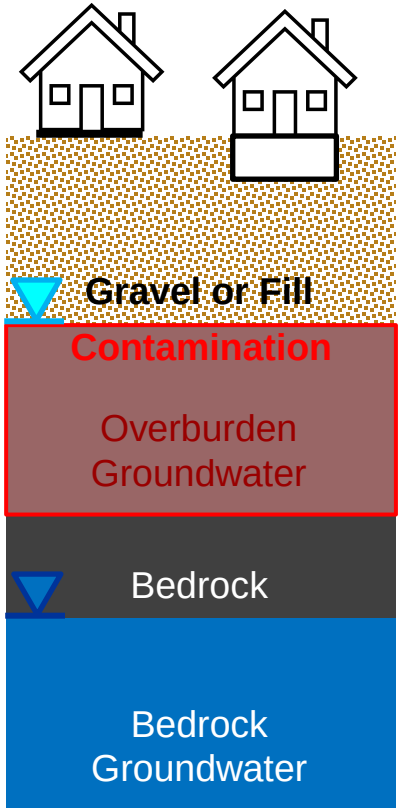
USING GROUNDWATER TO EVALUATE VI



Several conditions must be considered in order to use groundwater to evaluate VI:

- Soil types
- Soil-like material in vadose zone
- Depth to groundwater
- Product in groundwater

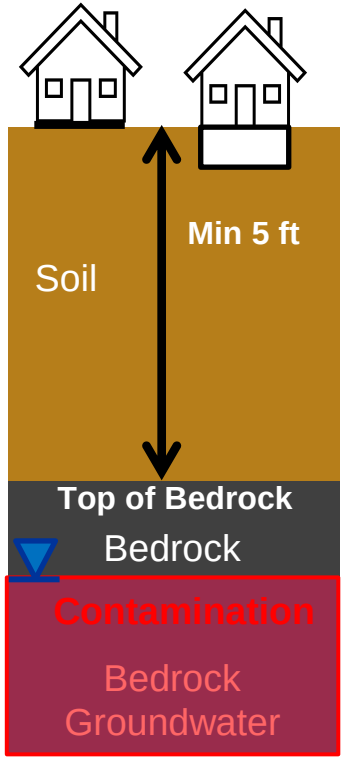
USING GROUNDWATER TO EVALUATE VI – SOIL-LIKE MATERIAL



Must have soil-like material present between the bottom of the building foundation and contaminated groundwater to use VISLs.

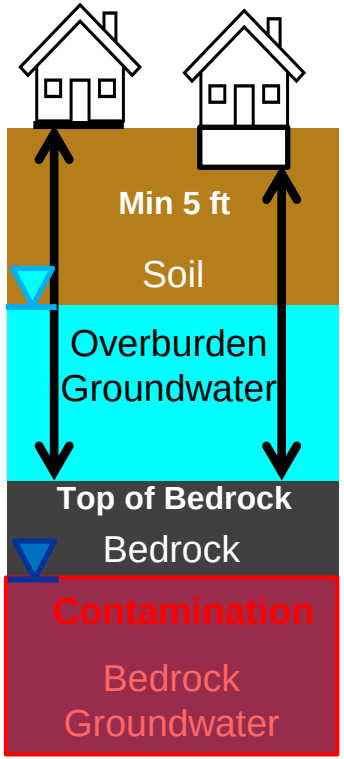
Gravel is not soil-like material. Fill may or may not be soil-like (depending on coarseness and air-filled porosity) and should be evaluated on a case-by-case basis.

USING GROUNDWATER TO EVALUATE VI – DEPTH TO GROUNDWATER

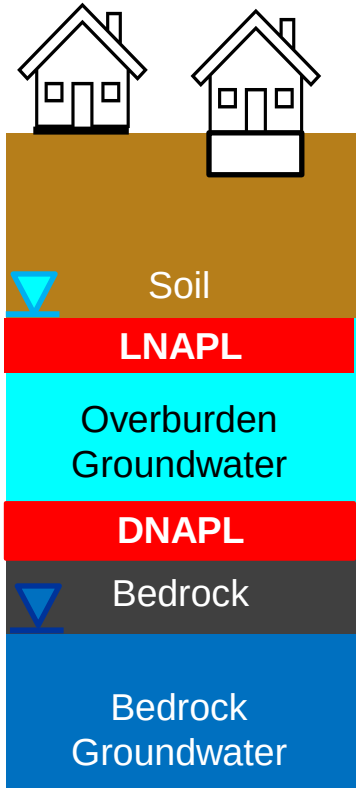


If a vapor source is only in bedrock groundwater, measure to the top of the bedrock.

If a vapor source is only in bedrock groundwater, but overburden groundwater is present, use overburden to evaluate VI.



USING GROUNDWATER TO EVALUATE VI - PRODUCT



The presence of product is a limiting factor that precludes the use of the groundwater VISLs.

Use soil gas or indoor air to evaluate VI.

SCREENING GROUNDWATER DATA - SUMMARY

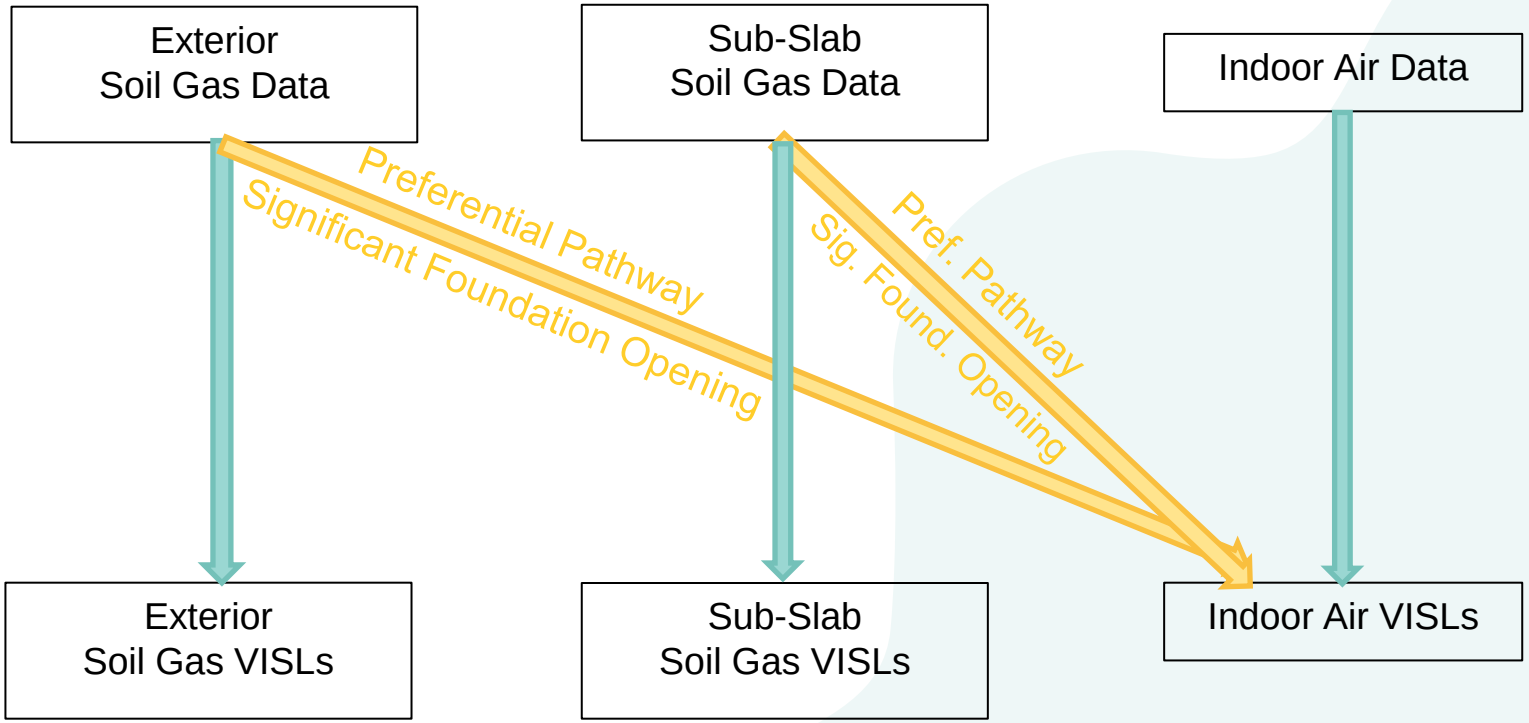
Conditions that limit the use of groundwater VISLs

- **Presence of significant building foundation opening**
  - (e.g., dirt floor, sump, unlined crawlspace, etc.)
- Contaminated groundwater enters a preferential pathway
  - (e.g., utilities, fractured bedrock, etc.)
- Groundwater is <5 ft from building foundation
- Lack of soil-like material above water table
- **NAPL**

Bolded bullets apply to soil screening values as well.

****A combination of media may be needed to assess the entire site.***

SCREENING SOIL GAS/INDOOR AIR DATA - SUMMARY



**A combination of media may be needed to assess the entire site.*

GROUNDWATER, SOIL GAS, OR INDOOR AIR SAMPLING?

	PROS	CONS
Groundwater	- Cost effective (can use data collected for general site characterization purposes). - Can be used to evaluate both current and future buildings.	- Depth to water must be >5 ft below foundation, <20 ft below grade. - Unable to be screened if product present. - Groundwater VISLs are highly conservative, and may require additional sampling (soil gas, indoor air)
Soil Gas	- Best measure of VI potential from any subsurface source (soil, groundwater, or product). - Unaffected by external sources. - Can be used to evaluate both current and future buildings. - Can be used to sample within preferential pathways, but screen against IA VISLs.	- Cannot use sub-slab SG if significant foundation opening (e.g. dirt floor) due to lack of slab. - Sampling recommended during warmer temperatures (ambient air temperature is at least 70°F).
Indoor Air	- No limitations to consider for sampling or screening data. - Most accurate measurement of vapors at point of exposure.	- Potential for results to be affected by other sources (inside or outside of the building). - Sampling recommended during winter months when buildings have negative pressure.

For each of these media, should collect at least 2 rounds of samples in different seasons to assess variability.

HOW TO RESOLVE A VAPOR INTRUSION ISSUE