Vapor Intrusion
Mitigation Methods & Strategies

NEWMOA Workshop on Vapor Intrusion
Chelmsford, MA – April 12, 2006

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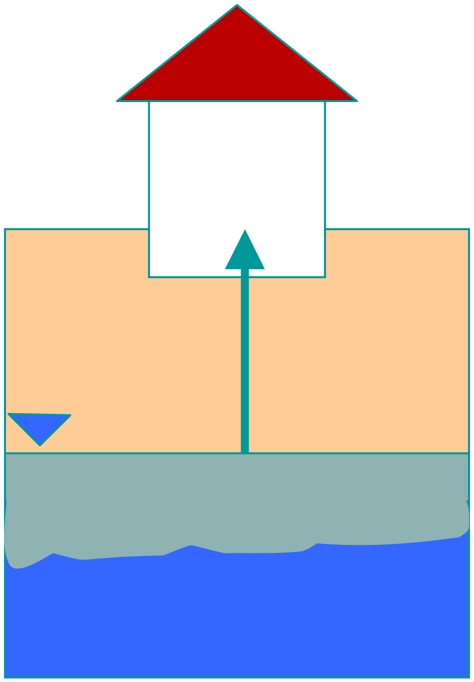
Topics

- Overview of Mitigation Approaches
- Commercial Buildings
- Sub-Slab Depressurization System Design
- Performance Testing
- Special Issues
- References

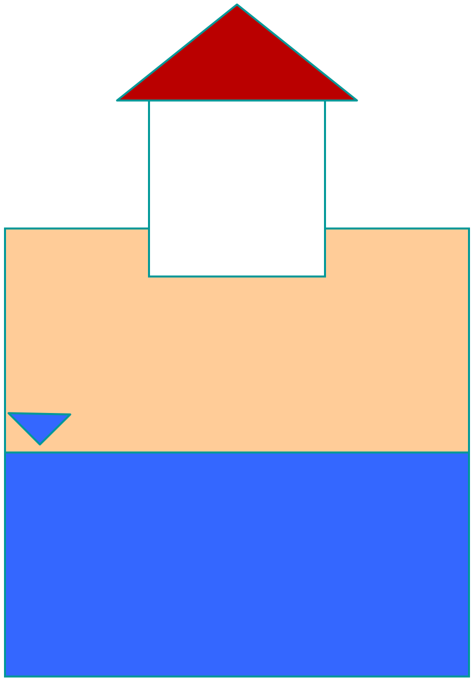
Overview of Mitigation Approaches

- Soil/Groundwater Cleanup



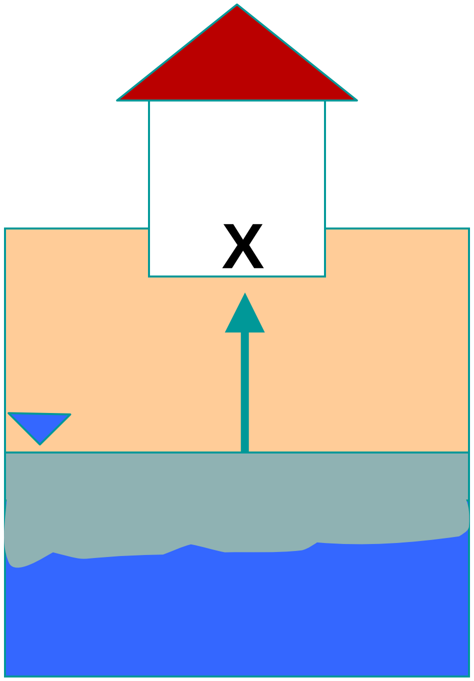
Overview of Mitigation Approaches

- Soil/Groundwater Cleanup
  - Long term solution
  - May be necessary to achieve 10-6 risk levels



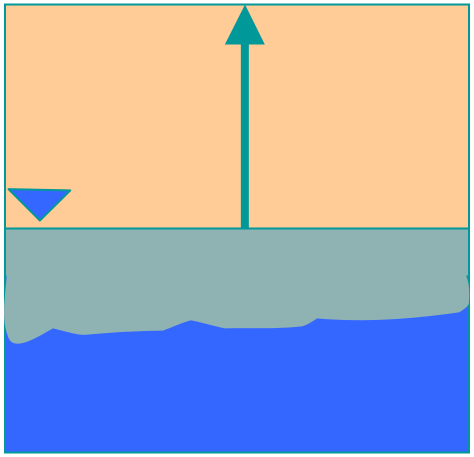
Overview of Mitigation Approaches

- Soil/Groundwater Cleanup
- Building mitigation (interim)
  - Control of vapors entering building



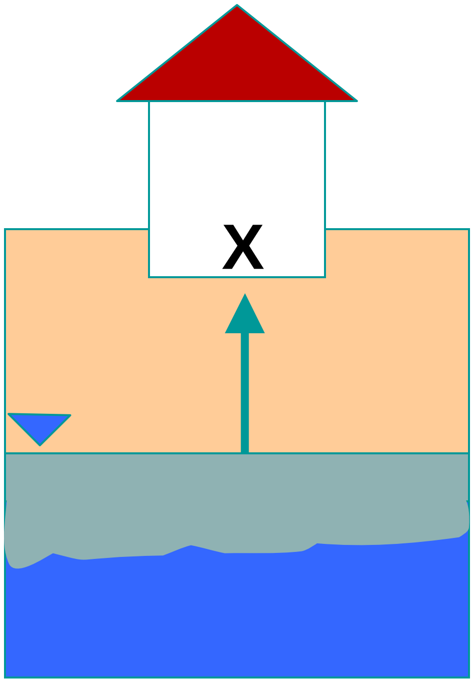
Overview of Mitigation Approaches

- Soil/Groundwater Cleanup
- Building mitigation (interim)
- Institutional controls (interim)
  - Prevent buildings



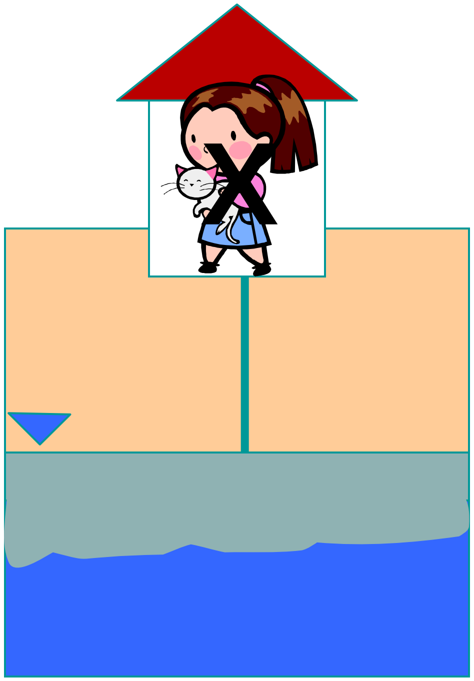
Overview of Mitigation Approaches

- Soil/Groundwater Cleanup
- Building mitigation (interim)
- Institutional controls (interim)
  - Prevent buildings
  - Require controls in new buildings



Overview of Mitigation Approaches

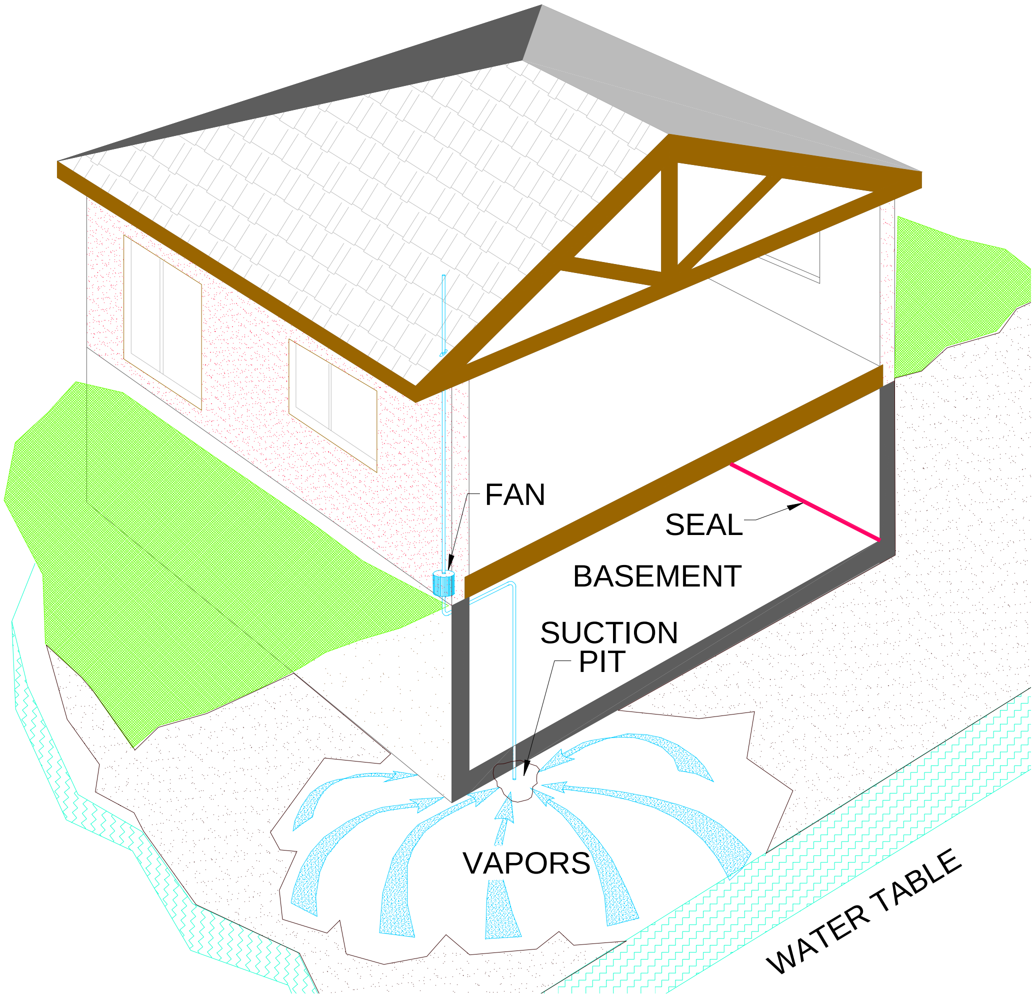
- Soil/Groundwater Cleanup
- Building mitigation (interim)
- Institutional controls (interim)
  - Prevent buildings
  - Require controls in new buildings
  - Restrict occupancy or use



Building Mitigation Approaches

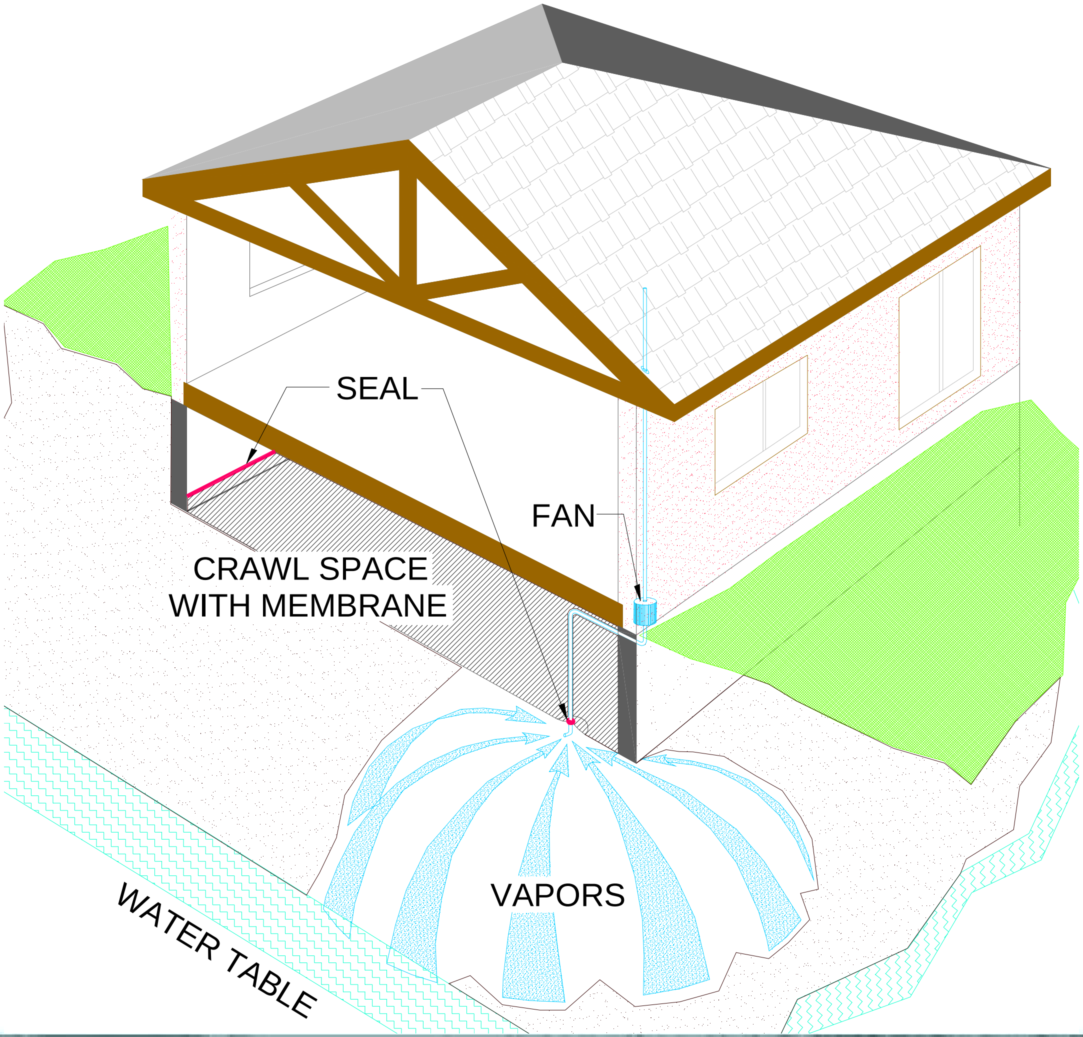
- Sub-Slab Depressurization
- Sub-Membrane Depressurization
- Sub-Slab Pressurization
- Building Pressurization
- Indoor Air Treatment
- Passive Barriers

Sub-Slab Depressurization



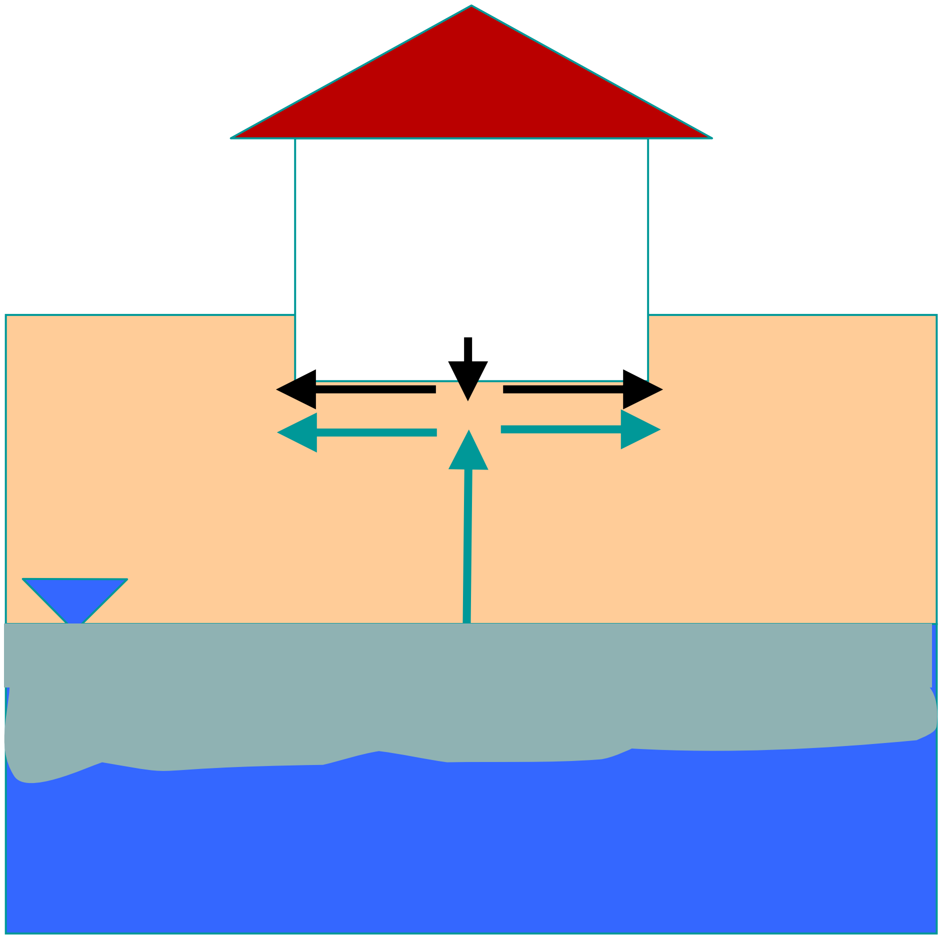
- Intercepts vapors prior to building entry
- Same as “radon” system
- Most commonly used method for radon and VOC control
- Highly effective in most settings
- Up to 99.5%+ reductions
- Reduction >90% requires higher QAQC

Sub-Membrane Depressurization



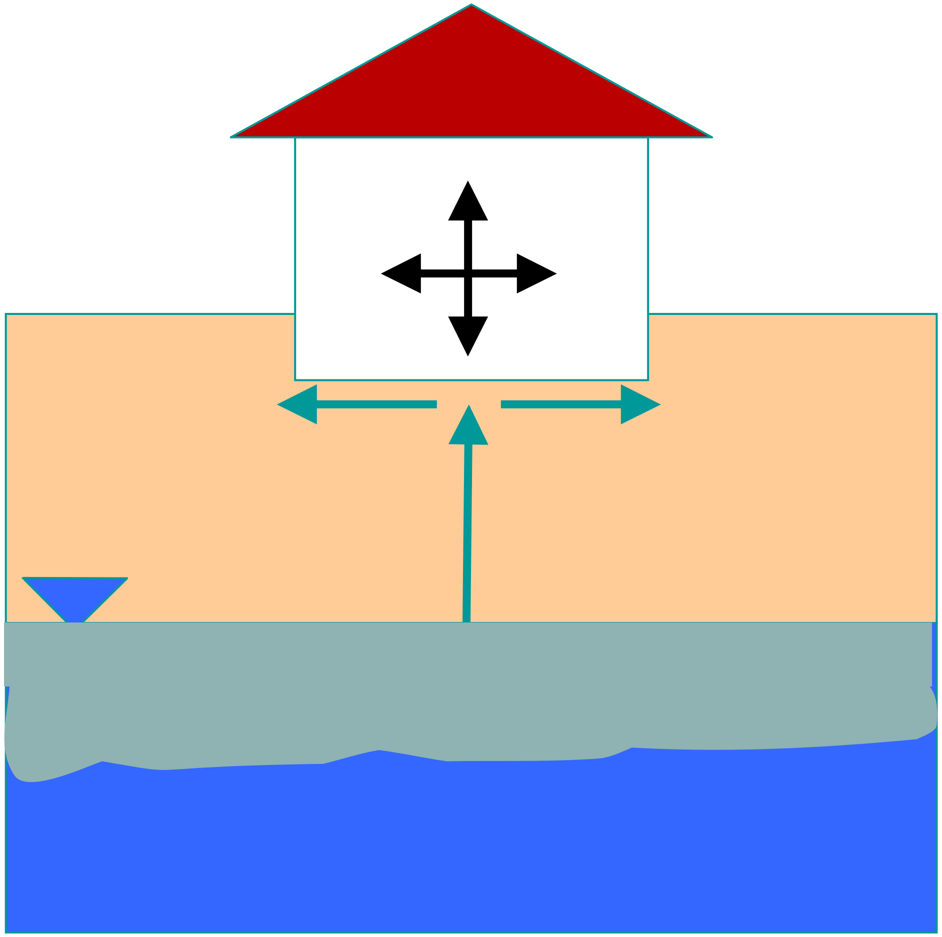
- Same concept as SSD
- Good foundation seals critical
- More susceptible to damage (liner)
- Highly effective in most settings
- Up to 99.5%+ reductions
- Reduction >90% requires higher QAQC

Sub-Slab Pressurization



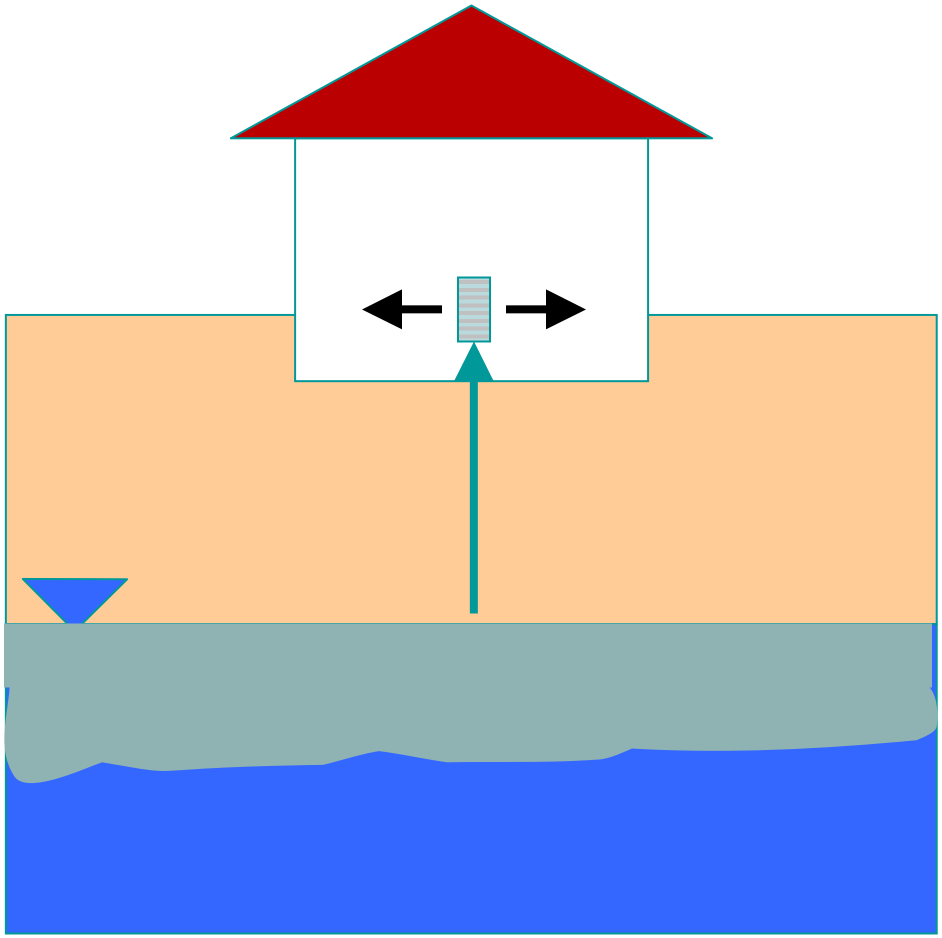
- Positive pressure below slab deflects soil vapors
- Not commonly applied
- Less effective than SSD in most settings
- May be alternative if sub-soils highly permeable

Building Pressurization



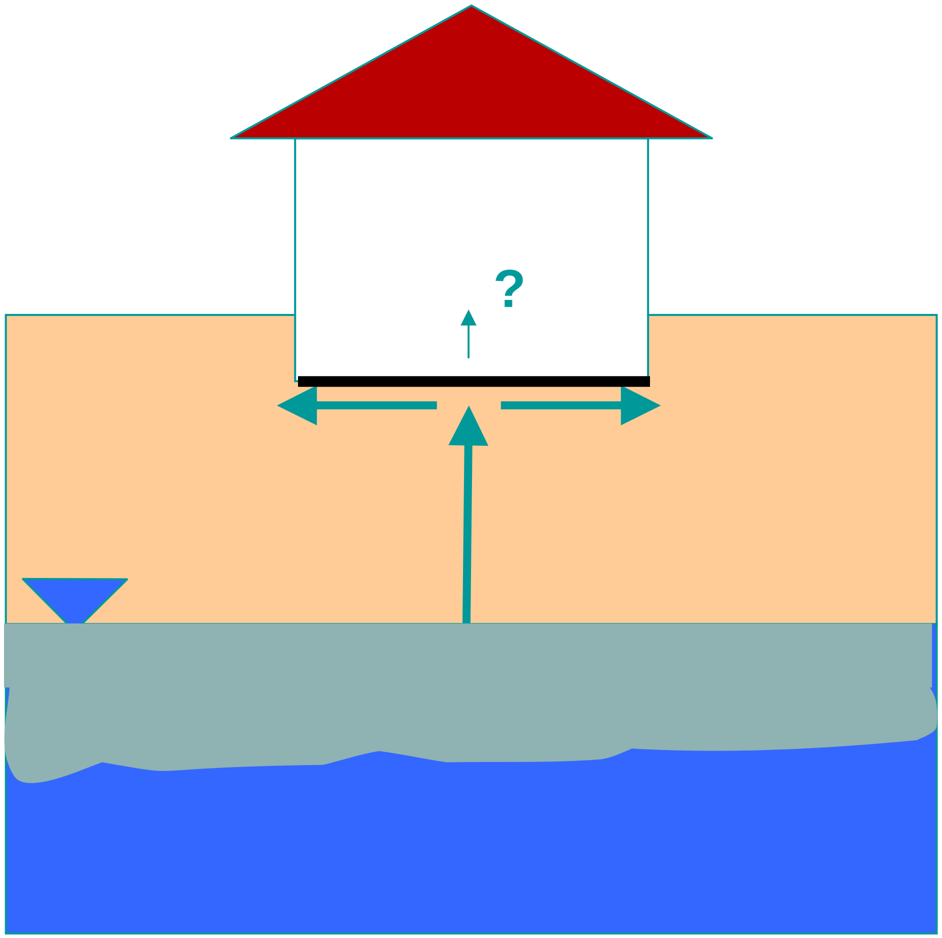
- Positive pressure in building prevents vapor entry
- Not commonly used
- Potential high energy cost due to air and heat loss
- Less effective than SSD
- May be alternative if sub-soils wet or difficult to depressurize

Indoor Air Treatment



- •Air cleaned after entry into house
- •Carbon typically used
- •Not commonly applied
- •Less effective
- •Higher costs
- •O&M intensive
- •May be alternative to building pressurization if SSD not possible

Passive Barriers



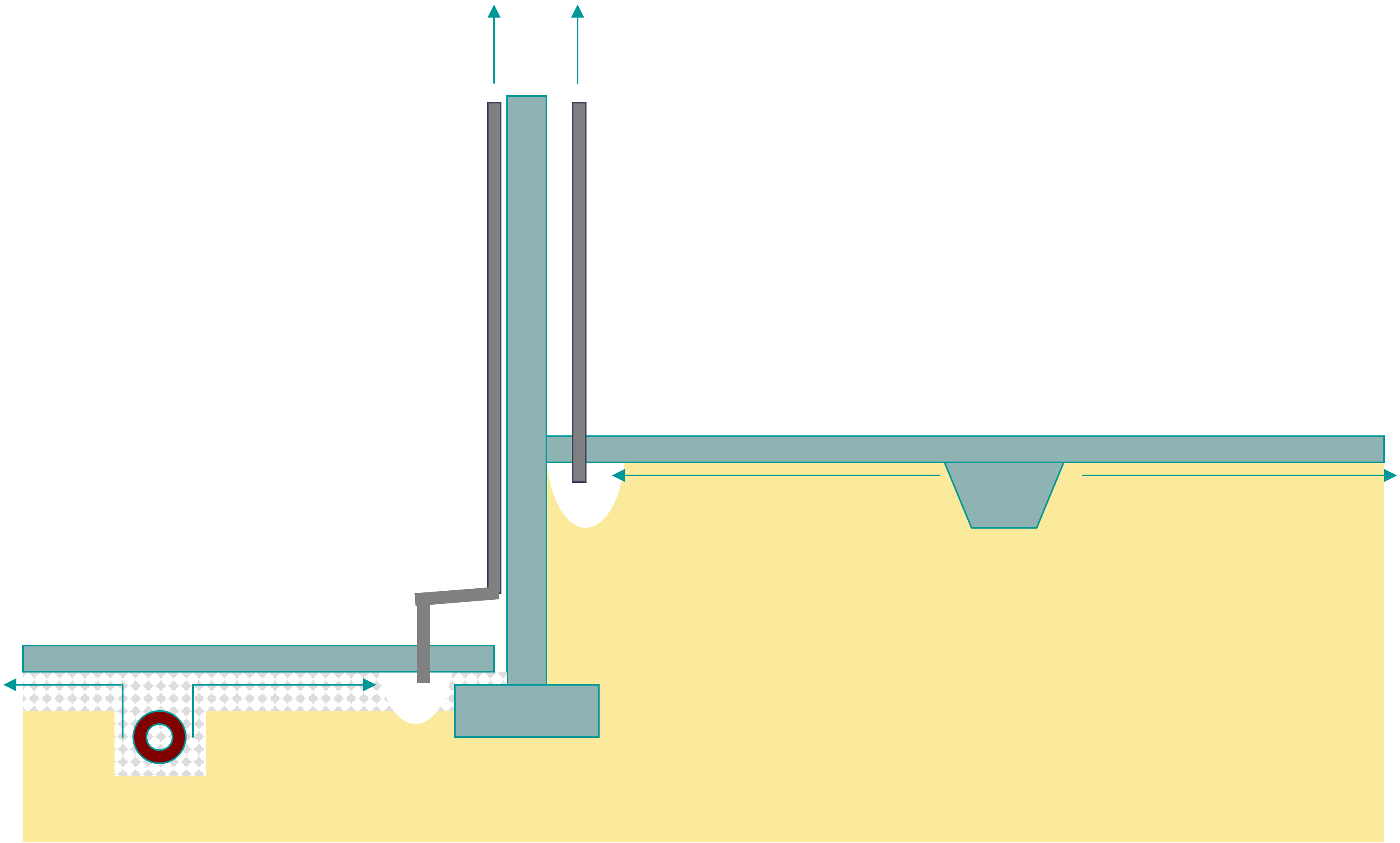
- Synthetic barrier placed below slab to prevent vapor entry
- Typically considered for new construction, but may be retrofitted
- Liners vary from thin plastic sheets to thick HDPE liners, spray-on elastomers, etc.
- Not recommended without passive venting layer
- May have to "go active" to meet objectives
- Consider barrier as an enhancement, not replacement for SSD

Commercial Buildings

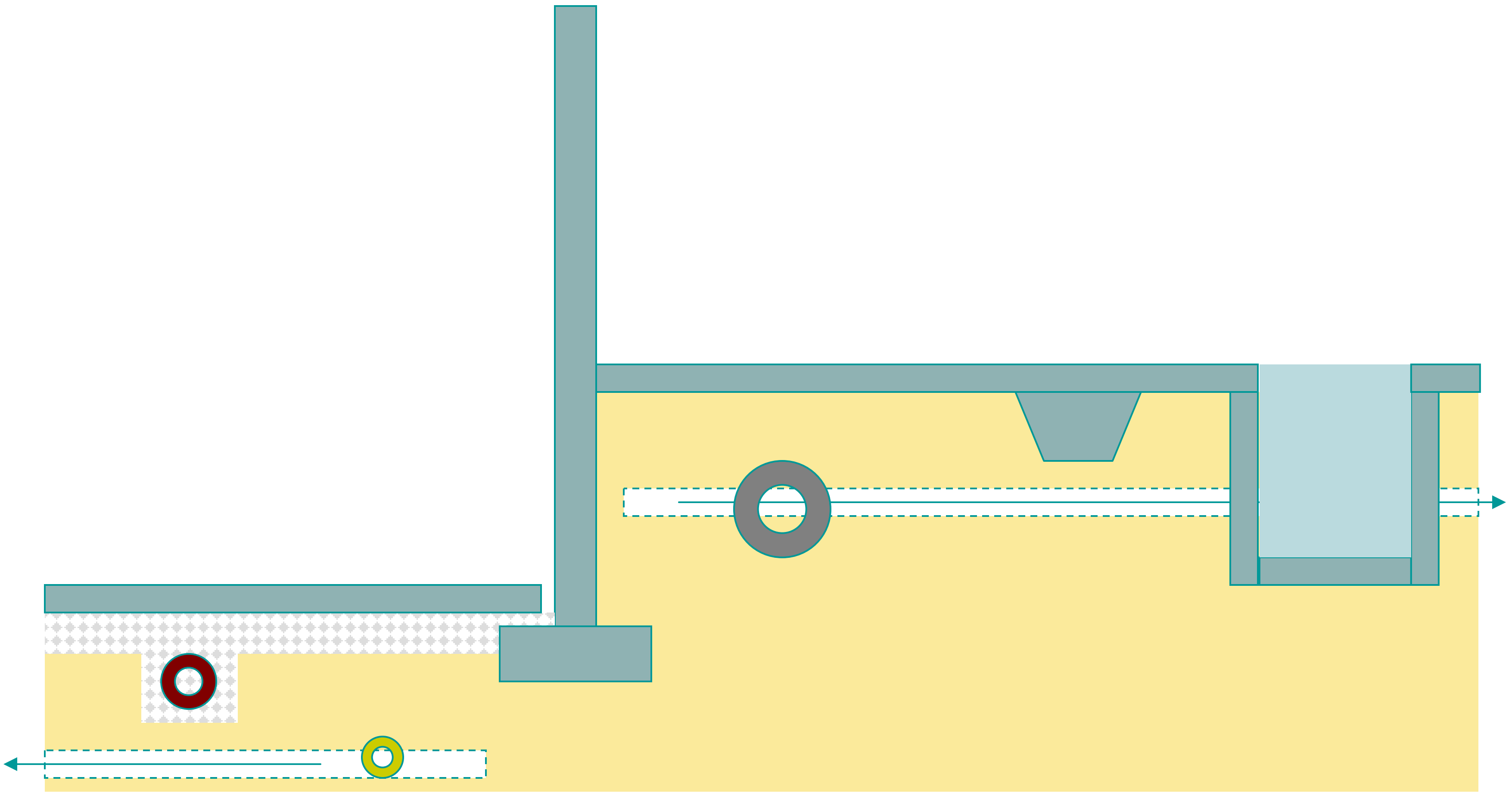
- Larger footprint
- Access for SSD difficult
- Pipe runs challenging
- Horizontal drilling $100 LF
- Asbestos/lead paint
- $5+ per SF

Pipe Runs Complicated

Sub-Slab Complicated



Sub-Slab Complicated



SSD Issues

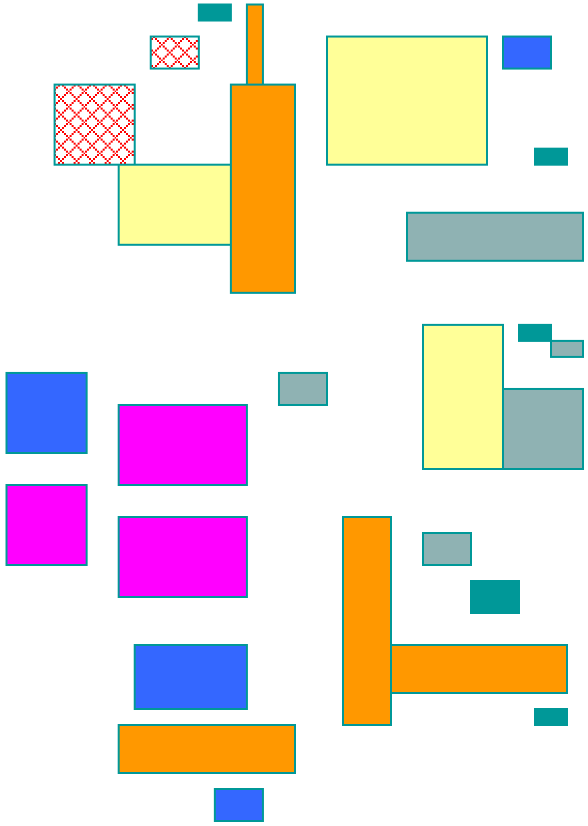
- Vertical suction points
  - Suction field coverage uncertain
    - Sub soil permeability
    - Presence of cracks, utilities, short circuit field
    - Presence of grade beams, foundation walls, that block suction field
    - Varying slab elevations
  - Pipe runs complex in multi-floor buildings

SSD Issues

- Horizontal pipes
  - Expensive $100 linear foot
  - Difficult to predict suction field
  - May require varied slot size or density
  - Utilities (known and unknown), foundations get in the way
  - Raised floors on fill present opportunity

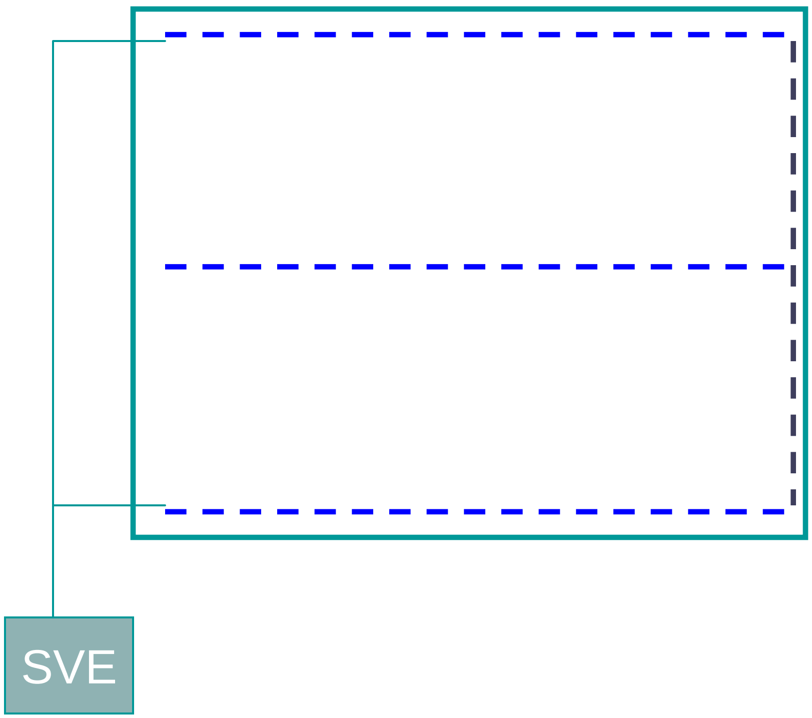
Industrial Complex Strategies

- OSHA
- Demo
- Unoccupied
- Limit/restrict use
- HVAC
- Depressurization



Vapor Intrusion, Inc.

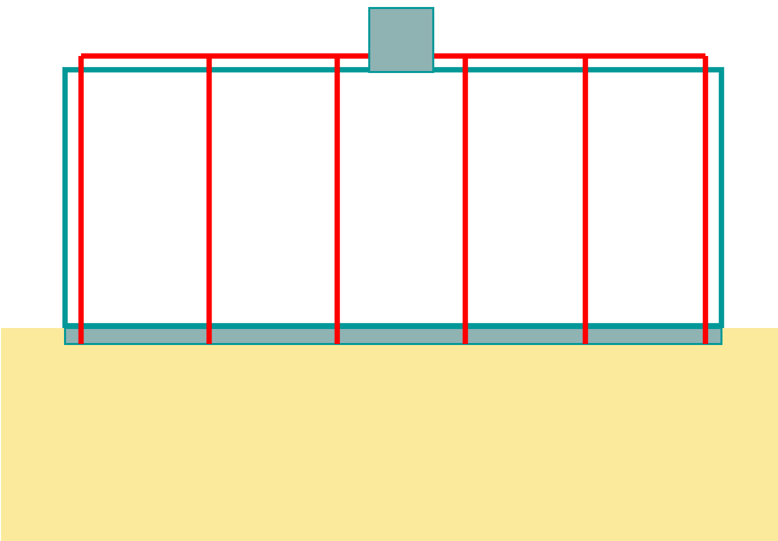
French Drain Example



- School with many small rooms
- Foundation drain system
- SVE blower for UST remedy
- Ambient air O2 levels in sub-slab
- Energy and HVAC issues

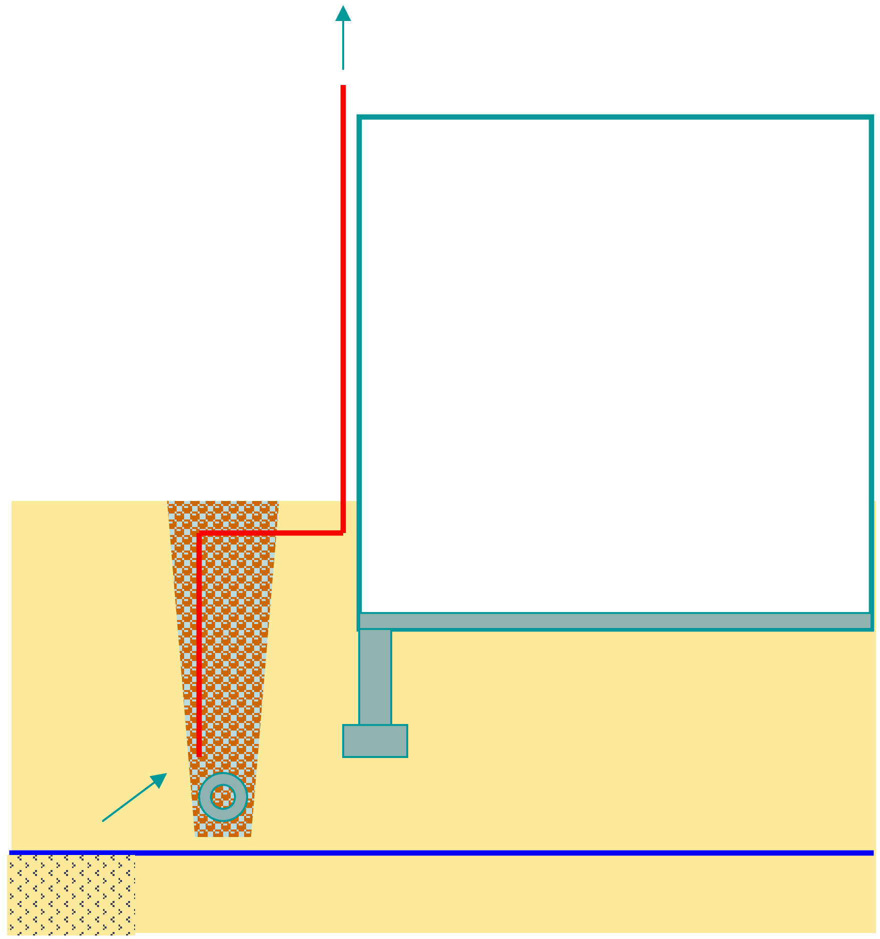
Single Story SSD

- Multiple suction points
- Run risers up columns & walls
- Manifold on roof to blower
- $1-2/sf



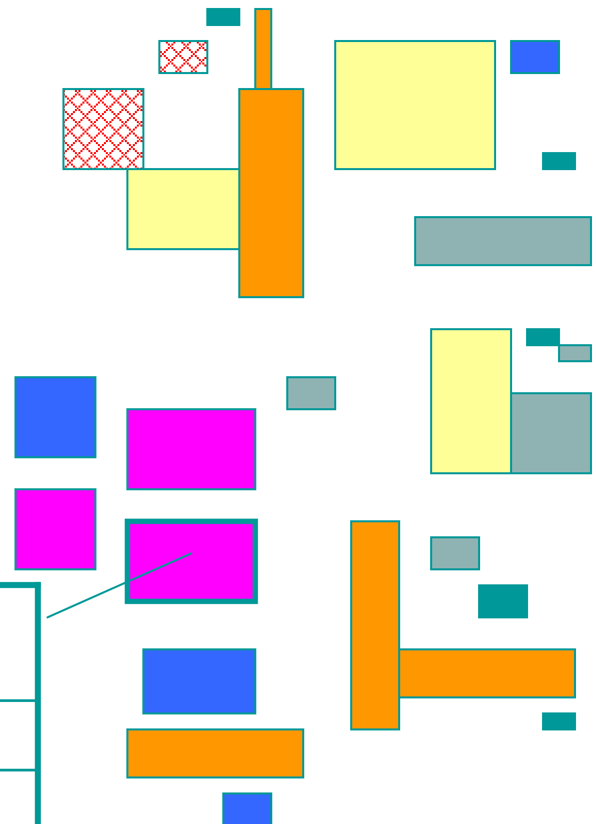
Depressurize Backfill

- Plume adjacent to building
- Storm sewer backfill used to intercept vapors



EG VI-GIS Tracking Tool

- Tracking VI status
- Institutional controls
- Action levels
- Building specific data
- Modeling/media data



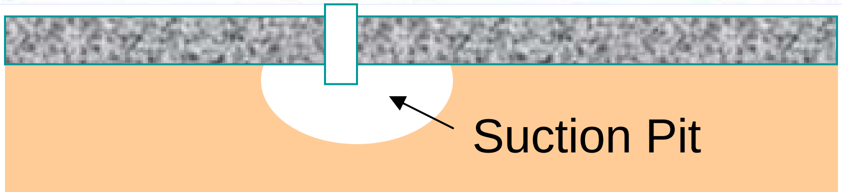
- OSHA
- Demo
- Unoccupied
- Limit/restrict use
- HVAC
- Depressurization

Status	>	IC	HVAC, +
Bldg	O	2 f	Basement
GW	>	10’	PCE, TCE

Depressurization System Design

Suction Points

- Unfinished location preferred
- Central location best but often not necessary
- Enlarging hole may enhance suction field
- 1 to 2 suction points usually sufficient



Depressurization System Design

Suction Points

Fans

- 90 to 150 watts typ
- Usually installed outside
- Also attic or garage
- Inexpensive to install and operate

Depressurization System Design

Suction Points

Fans

Exhaust Points

- above roof line
- EPA distance criteria
- Consider neighboring buildings

Depressurization System Design

- Aesthetic Issues
- Access and Scheduling
- Permits

Design Approach

A. Custom Design Approach

1. Visit site and conduct diagnostic tests
2. Prepare design drawings
3. Install system and test
4. Modify system if necessary

Design Approach

B. Standard Design Approach

1. Visit site and discuss options with owner
2. Install system same visit
3. Test system during installation (diagnostics)
4. Modify system if necessary (e.g., add suction points)

Design Approach

	Advantages	Disadvantages
Custom Design	•Modifications less likely •Best for large or complex buildings	•Slower process •Unnecessary for most homes •More expensive
Standard Design	•Much faster •Suitable for multi-home sites where you can build on experience	•More likely to require modifications, particularly in large buildings or where large reductions needed

Performance Testing

- Smoke Tests
  - Direction of smoke indicates pressure gradient (want to be downward)
  - Very sensitive
  - Perform at construction joints, penetrations, and cracks

Performance Testing

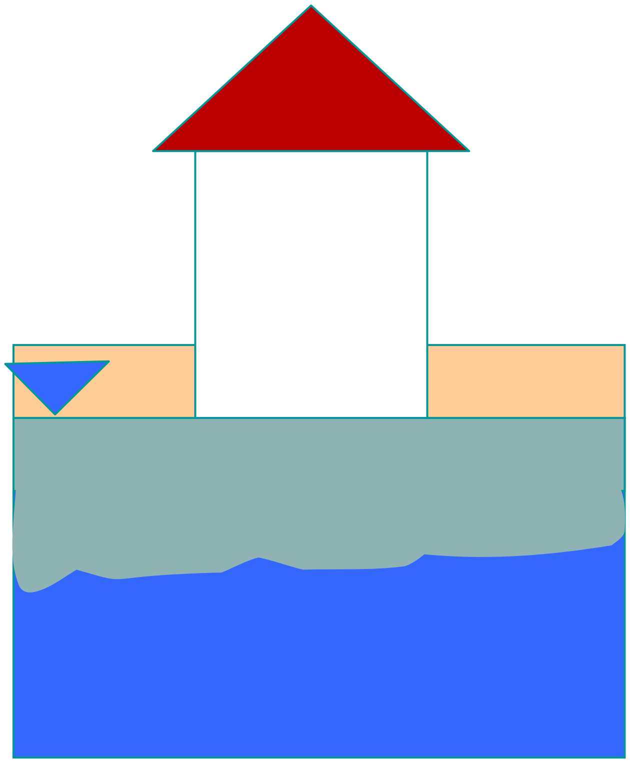
- Smoke Tests
- Pressure Tests
  - Confirms downward pressure gradient
  - Perform at far walls from suction points
  - More time consuming
  - Perform with HVAC operating

Performance Testing

- Smoke Tests
- Pressure Tests
- Indoor Air Tests
  - More direct measure of performance
  - Complicated by background sources (unless finger-print compound present)
  - May vary by ½ to 1 order of magnitude due to seasonal fluctuations
  - Non-extreme weather conditions most likely to reflect long-term average conditions

Special Issues

- High Water Tables



- May interfere with SSD
- May require drainage systm
- Waters in sumps or seeping into basements direct source of VOCs
- Seal sumps and depressurize
- Install false floor, seal and depressurize

Special Issues

- High Water Tables
- Old Buildings

- Dirt floors
- Dug-out basements
- Degraded slabs
- Field-stone foundation walls
- New slabs, grouted surfaces, liners may be required

Special Issues

- High Water Tables
- Old Buildings
- Explosive Concentrations

- Make sure well below LEL
- Intrinsically safe fans required if >10% LEL
- Methane may be a by-product of BETX degradation
- Exercise caution!!

Special Issues

- High Water Tables
- Old Buildings
- Explosive Concentrations
- Asbestos and Lead Paint

- Older buildings may have asbestos and lead-based paint
- Requires proper handling and disposal during retrofits

References

- U.S. Environmental Protection Agency. 1993. Radon Reduction Techniques for Existing Detached Houses: Technical Guidance (Third Edition) for Active Soil Depressurization Systems. Office Research and Development. EPA/625/R-93/011.
- D.J. Folkes, 2002. “Design, Installation, and Long-Term Effectiveness of Sub-Slab Depressurization Systems”. Presented at the EPA Vapor Intrusion Seminars in San Francisco, 2002 and Dallas and Atlanta, 2003.

- Links to these and other references:

www.envirogroup.com