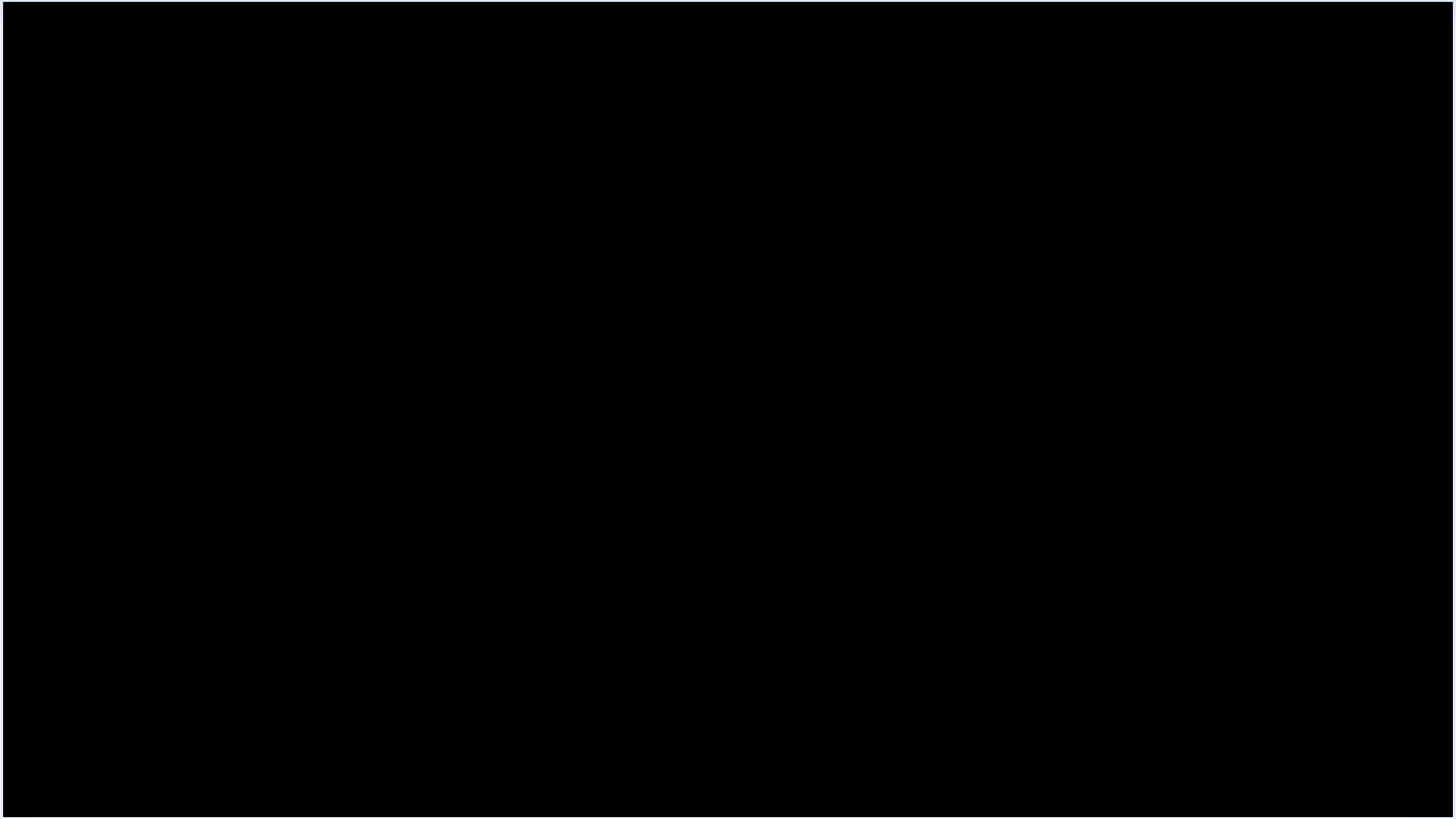
How a Legacy of Incomplete Science, *Conflicting with Reality*, Causes Community Wide Mitigation Failures



Gary Hodgden 2026



1960s

About 60 years ago, on the edge of a small but growing rural town, the owners of a chemical recycling and storage warehouse were storing numerous ~50-gallon barrels of Trichloroethylene (TCE)

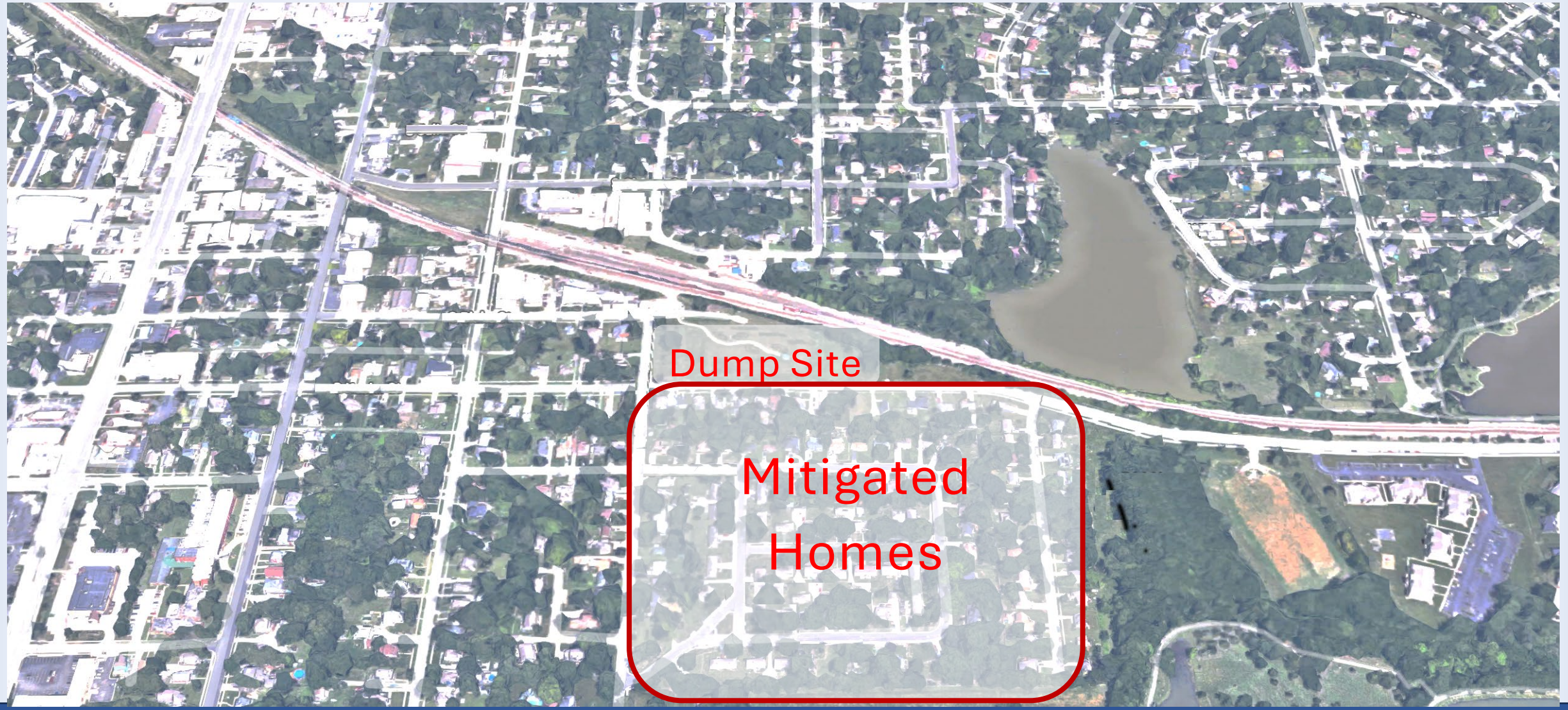


1980s

About 40 years ago, these barrels had leaked into the ground to contaminate soil throughout the local neighborhood.



2026 The Whole Community



- **25 years ago,** after 12 years of full-time radon mitigation / measurement, my crew and I successfully installed ASD for VI in about 40 homes.
  - Some of these homes had indicated indoor TCE vapor concentrations of more than 300 times the action level.

- **25 years later**, **I walk into a disaster** for unsuspecting folks in a community.
- **Inhaled chemical vapors go directly into the bloodstream (unfiltered).**
- Over time, this causes an unknown number of serious health problems to include birth defects and premature deaths.

25 years ago, I found myself going door-to-door *explaining to sick people* how we were going to fix this.

Recent indoor measurements 2024-2025

Prior to alterations	Location		TCE (ug/m^3)
			Action Level 2.0
November 2024	Bldg X	Living Room	220
		Garage	340
December 2024	Bldg X	Living Room	48
		Garage	489
February 2026	Bldg X	Living Room	7.9
		Crawlspace	22

- It is easy to see the seasonal (pressure).For radon, day to night hourly data from CRMs can often help to see this.

The question to answer?

- **With my cousin's family and friends of my children living in this neighborhood,** *I am angry.* **"How the hell did this happen?"**
- Smart people were well funded to take care of this.
- At least 2 different companies had contracts during that 25 years. So, it is not one company or one mitigator. It is a systematic problem.

Methods for evaluating why this happened

- I joined my son for the initial walk-through.
- It was clear from mere visual evidence.
- Diagnostics and post-mitigation testing of indoor air are part of this project for every building.

2026 Results: Indoor air measurements (after modifications to ASD Systems)

After alterations	Location		TCE (ug/m^3)
			Action Level 2.0
	Building A	Living Room	ND
		Crawlspace	ND
	Building B	Living Room	ND
	Building C	Living Room	ND
		Crawlspace	ND

(reversing the otherwise natural condition to cause a layer of depressurized air in surrounding soil compared to indoor air.)

- **Mind you** like radon, some do not work the first try, no matter what diagnostics tell you. *Especially with this age of home.*

Most buildings

- Built between 1940 - 1960 with crawl spaces and “cinder block” foundation walls. Slabs were poured directly on soil.



Packed Soil = Virtually zero permeability

Results of Visual and Diagnostic Review:
Untrained installer/designers

- Someone had turned most all system discharges downward ~15 years ago.





Untrained installer/designers

- Several point down on backyard patios.
- Original exhausts cut off in the attic and left dangling.
- Yes, that is the fan next to the door.



Untrained installer/designers

- TCE vapors to **shower the kids** as they go in and out the back door.





- *Some U-tubes outside filled with water*

Untrained installer/designers

- The other U-Tubes had been moved into the crawl spaces.





Untrained installer/designers

- Many of our original suction pipes had been cut off.
- This one had been tapping air from within a void below the slab.



Lack of building construction knowledge

- Soil below the plastic would seem the obvious preferential pathway for vapor intrusion.
- But from *your mouth*, you can blow air through these old cinder blocks.
- The *volume* of pressure driven vapor sucked by the building through these blocks can be of *equal or higher volume* than from open but packed soil.



Lack of building construction knowledge

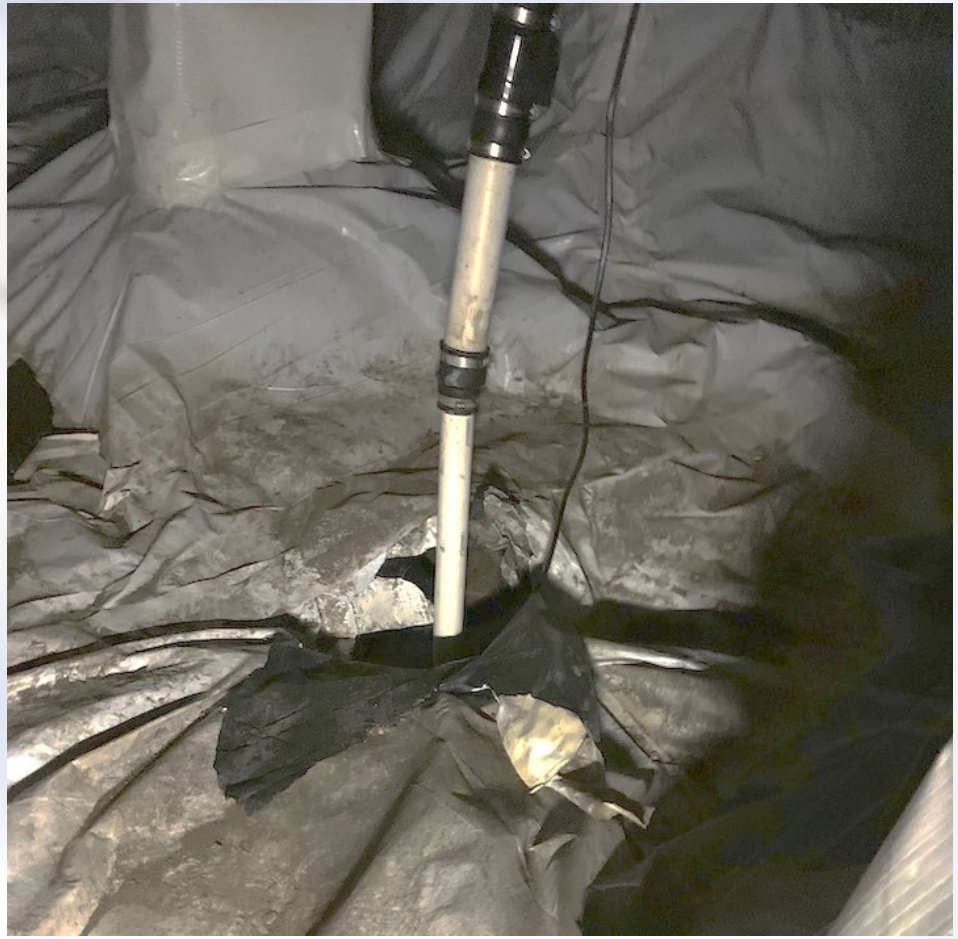
- **In 2021**, the 4 ft tall crawl space in this rental property was full of contaminated water up to just under the wood flooring.
- Sump pumps were installed.
- **By 2026**, most pumps had died long ago.



Lack of building construction knowledge

- Where the soil outside foundation walls *sits higher* than the membrane inside …….

- **Mud** on top of the refitted membranes is from *contaminated water pouring through blocks* when the water table rises *higher* than the membrane.



Lack of HVAC knowledge

- **Corrections** to bring furnace ducts back to original balanced condition.
- **A few times:** While diagnostics confirmed ~ -6 pa PFE under membranes, some living spaces remained over ~100 times the action level.
- Air pressure checks between the crawl space and living space sometimes revealed > 20 Pa difference.
  - The bigger fan wins!





Lack of HVAC knowledge

- If they followed the trend in VI of judging success by only pressure measurements, it would explain a lot.
- Mitigating a building is a whole building problem.
- This is an example of many scenarios where failed systems are only found by testing indoor air.





Discussion

Incomplete Science (RN & VI)

- Initial studies on both radon and VI from 1970s – 1990s were critical efforts to wrap our arms around big issues.
- But conclusions from studies of often a small number of buildings *leave a big hole* as to why what was witnessed is happening.
- Over time, the validity of many conclusions about radon and vapor intrusion have been found to be only part of the truth.

In radon we quickly learned that everything is “sometimes”, “maybe”, and “it depends.” For many small studies, mostly “it depends.”

The Legacy

- Both Radon and VI folks began using ASD in the 1990s.
  - ***ASD and HVAC building pressurization reverse the otherwise natural condition to cause a layer of depressurized air in surrounding soil compared to indoor air.***
- For VI, however, the subjectively interpreted **concept of "Engineered Solutions"** has remained.
- Recently published VI mitigation methods now provide a range of options for selecting "engineered solutions".

Currently published VI mitigation methods

- **Passive Mitigation.** …… ……. ……. *Author Notes*
  - Membranes
  - Ventilation

Sometimes & maybe.
Because it certainly depends

- **Active Mitigation**
  - ASD (Soil depressurization)
  - HVAC (indoor pressurization)
  - Ventilation …… ……. ……. ……. ……. ……. ……. *Sometimes & maybe)*
- **Active Remediation** …… ……. ……. ……. ……. *Commonly takes decades*
  (Remove pollutant e.g., soil gas extraction)

The real culprit (a systematic problem)

- A minimum degree of mitigation experience and training is not required of both those choosing options and designer/installers.
- I have met a number of people here who are highly experienced and competent in design of VI mitigation systems.
- However, for many we meet in the field, the “Engineered Solution” used is a mix and match of solutions based on incomplete science.

The real culprit (a systematic problem)

- Now .. Unlike radon, the VI community does not have affordable continuous monitors to routinely obtain hourly indoor measurement data.
- So, they can’t see pressure driven fluctuations.
- As a result: Instead of a focus on high volumes of pressure driven soil gas, there is focus on “gradient diffusion.”
  - Diffusion through slabs and plastics is routinely discussed.

The real culprits (a systematic problem)

- **Overshadowing all this**: Initial site evaluations and remediation (i.e., removal of contaminants) are very expensive and complicated high priorities.

- Decisions on whether to abandon or mitigate occupied buildings come afterwards.

The technical disconnect starts here

You can't escape mother nature

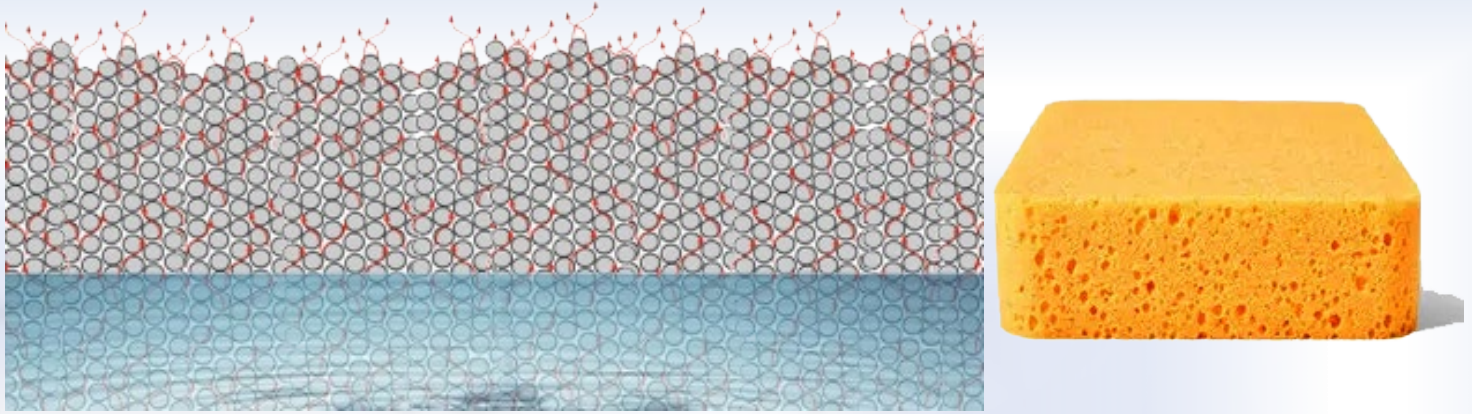
- Water weighs 8.34 pounds per U.S. gallon.
- Liquid water and chemicals move along the least path of least resistance as dictated by their weight. Liquids move through permeable soils and around impermeable objects (i.e., predictable preferential pathways).
- They end up mixing into the water table below ground.
- Liquids also move vertically up and down as the water table below rises and falls.

However

- By comparison, a cubic foot of air with humidity of 50-70% weighs on average about 1.2 ounces.
- The destination for air is dictated by the slightest change in air pressure along the least path of least resistance.
  - *By comparison*, dozens of unknown preferential pathways.

- Air pressure drives high volumes of radon and vapor laden (soil gas) through openings that are even too small to see.

Another detail (Permeability)



- We often find damp soil below slabs. Air gaps between damp soil clumps allow both volatilization and pressure driven transport of chemical vapors.
- Like a sponge, contaminated water leaching into soil can be a constantly replenished source of vapor.
- The total surface area of thousands of damp soil clumps volatilizing into air gaps is enormously larger than the total flat surface area of the water table below a building.

Playing with rough numbers

- A cubic foot of air contains about 0.00006 gallons of liquid mass.
- If, for instance, an ASD system needed ~50 cfm to establish a vacuum under a building, we might assume ~ 50 cfm of soil gas is otherwise entering the building. If true:
  - ~ 4.32 gallons of soil vapor is entering a building each day for > 6 months per year (in most of the U.S.)
  - Depending upon soil permeability, water tables and times of stronger air pressures, the calculations indicate it could be 15 gallons a day.

Conclusions—Similarities to Radon

1. The source releasing hazardous gas won't usually disappear for many decades
2. When it comes to gases including vapors, there is not a single preferential pathway. Gases driven by air pressure even enters the building through pathways that are too small to visually identify.
3. The volume of hazardous gas available to be naturally delivered into occupied spaces greatly depends on the degree of permeability existing in surrounding soils

Conclusions—Similarities to Radon

4. The volume of soil gas entering a building fluctuates depending upon changes in air pressure.
5. The high volumes of soil gas driven a building due to air pressure are overwhelmingly the primary concern.
6. There are many scenarios where failed systems are not found without testing indoor air.

Final Conclusion—There is no way around it

7. Successful mitigation requires experience in multiple disciplines, to include:
   - building construction practices and structural foundations,
   - building science relative to HVAC principles, and
   - Trade skills associated with plumbing /concrete / electricity

- In short, training fills in missing gaps between these disciplines no matter how much a person thinks they know.
- Without detailed specific training and experience, smart people are fully capable of creating a radon or VI disaster.

The Whole Community

