Where are we now? An updated summary of state approaches to VI

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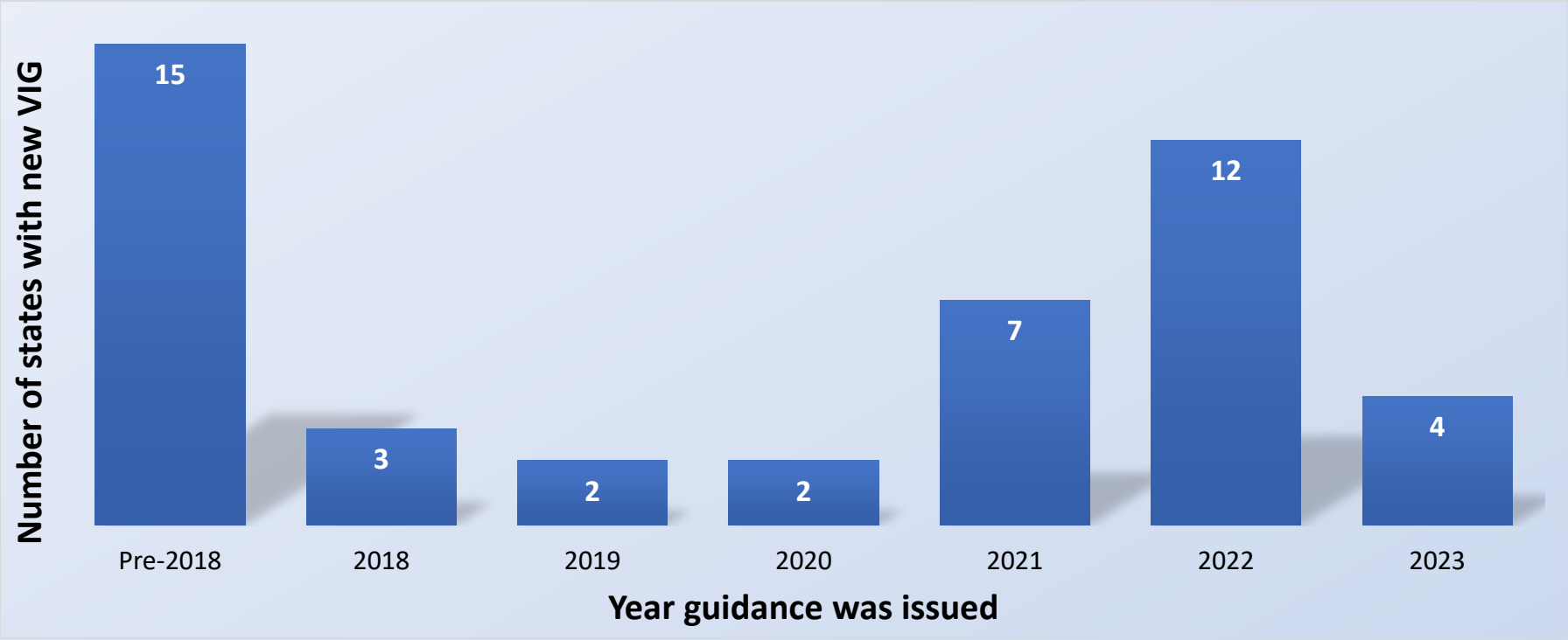
Agenda

1. Why another paper?
2. Sources reviewed and areas of focus
3. Screening values, exclusion distances, and attenuation factors
4. Specialty topics

Why another paper?

- 2018 – last paper published reviewing guidance documents from January 2018 and earlier
- Since January 2018 – 30 new VI guidance (VIG) documents or updates published as of April 2023



Why another paper?

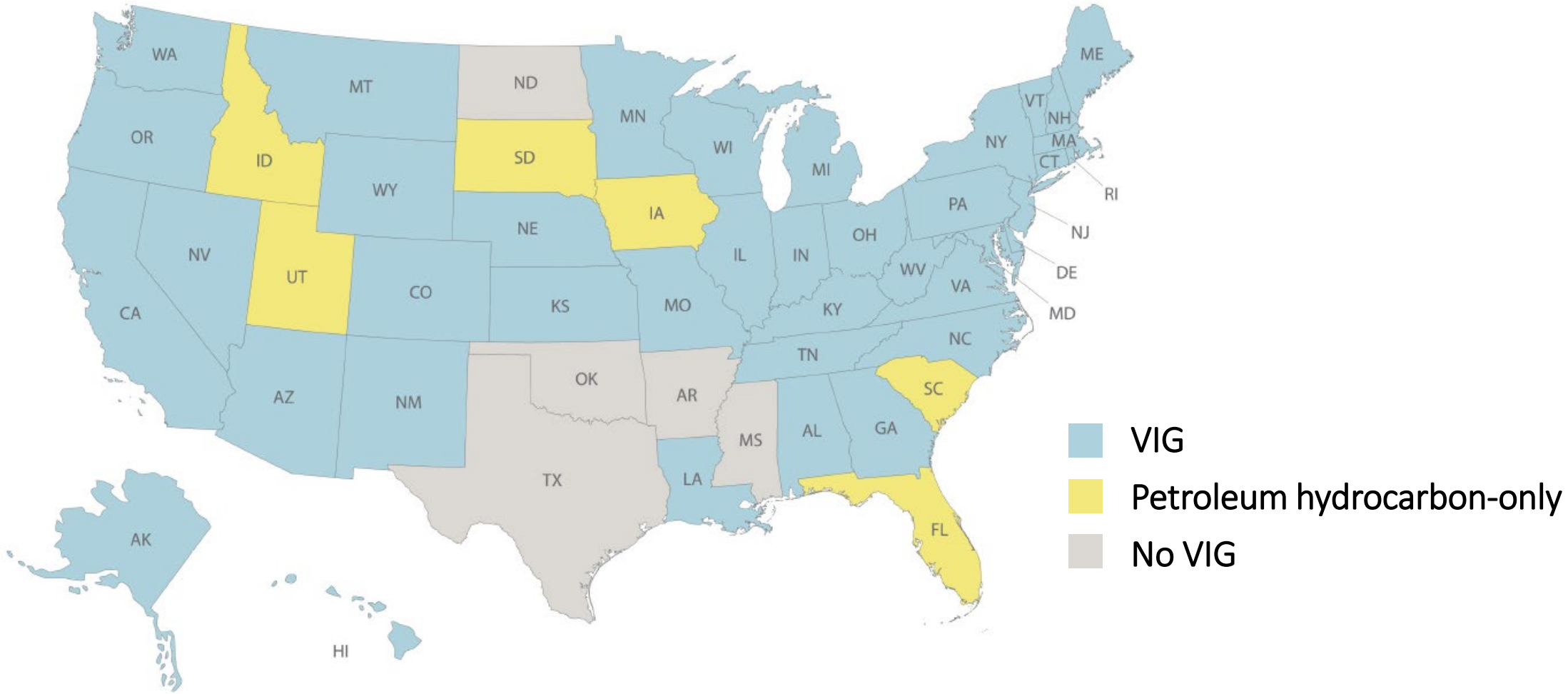


Figure 1. States with draft or final guidance or regulation as of April 2023.

Why another paper?

Highlight the differences from state to state

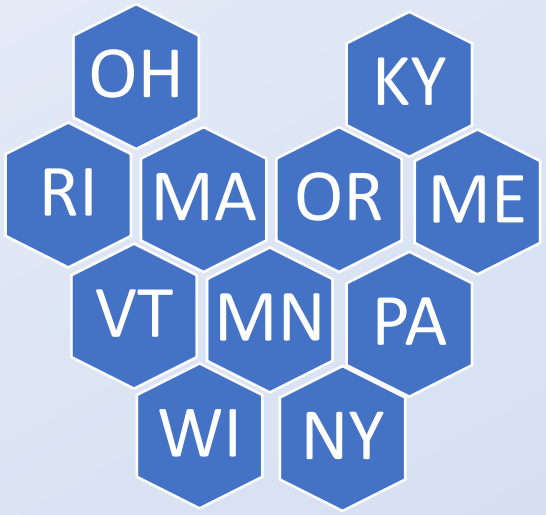
Assess whether state guidance documents are converging or diverging over time

Help with communications within the regulated community

Sources reviewed

- Identified and reviewed available VIG documents and regulatory screening levels
- Referenced over 130 guidance documents, regulations, federal guidance, and related research papers
- Searched hundreds of websites and related state content

Example:

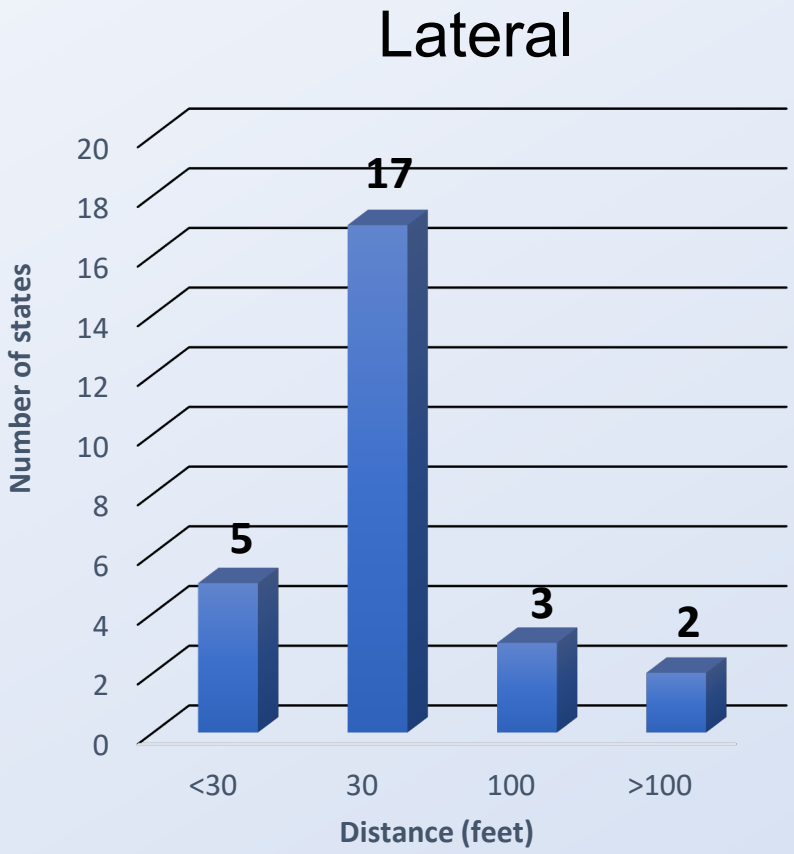


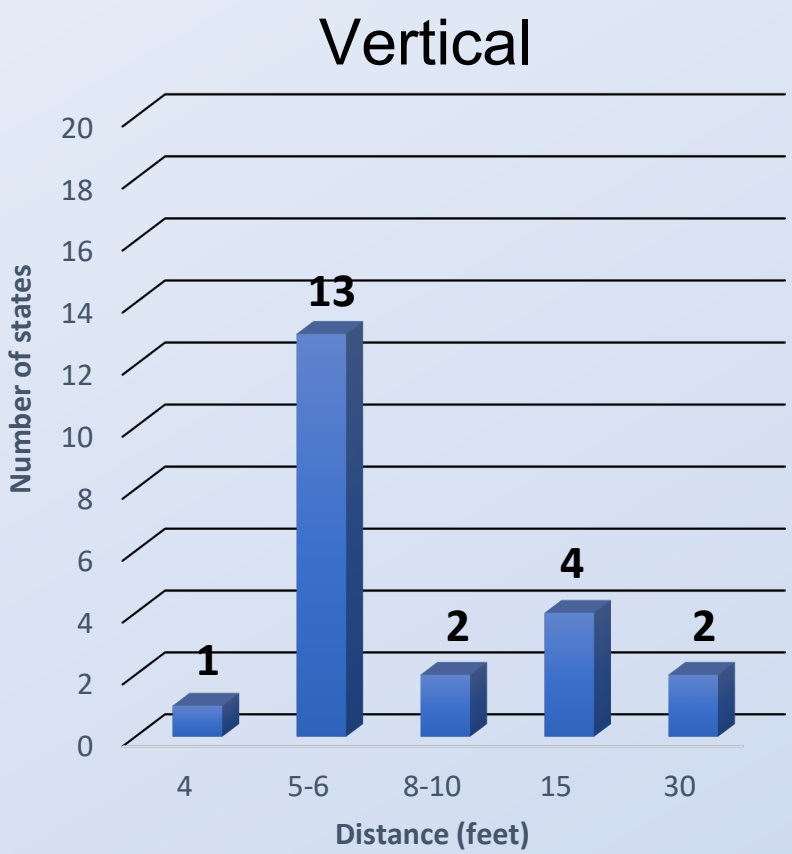
Reviewed 88 documents and websites

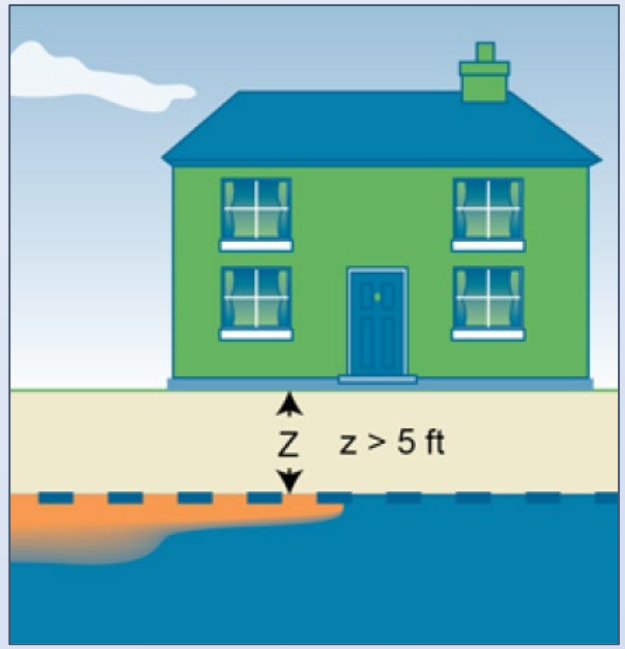
Areas of focus

- Exclusion distances
- Types of screening values
- Specific numeric screening values
- Attenuation factors (α or AF)
- VI mitigation
- Trichloroethene (TCE) considerations
- Preferential pathways

Exclusion distances – petroleum volatile organic compounds (VOCs) (dissolved phase)

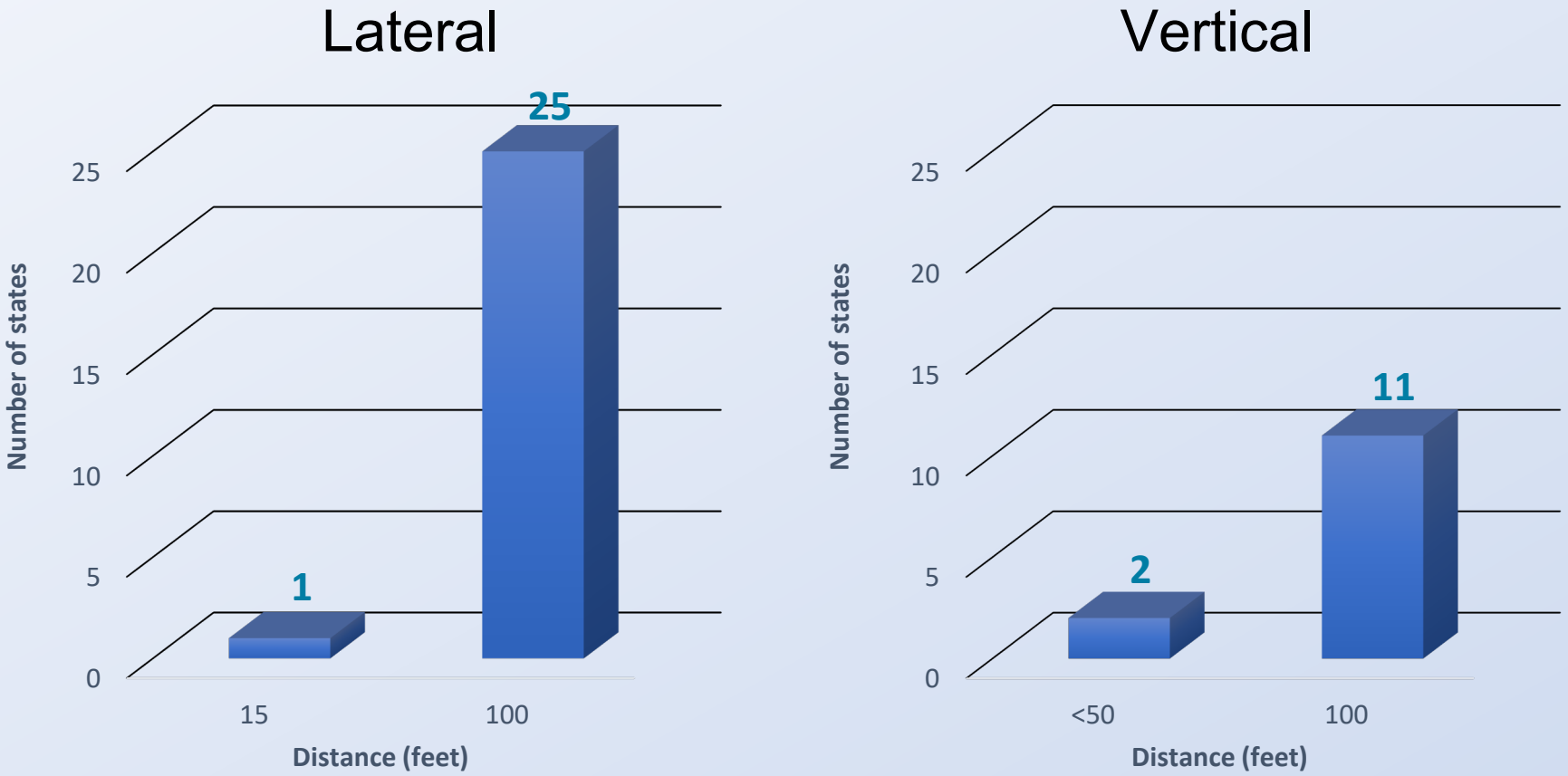


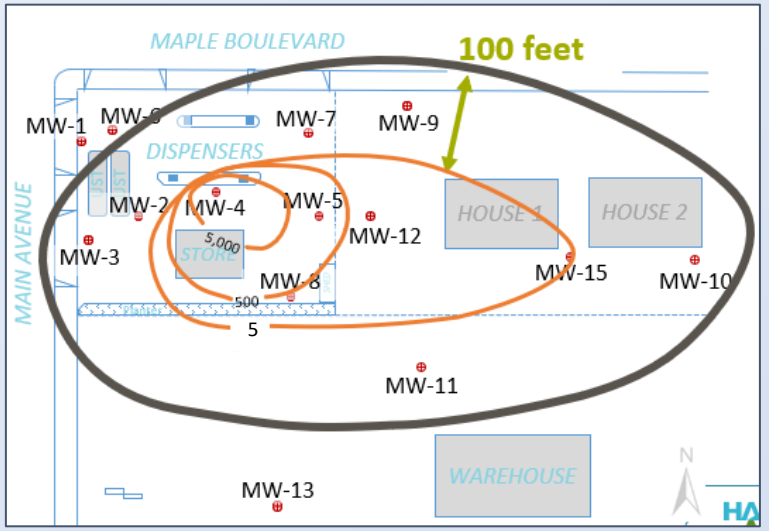




Example vertical exclusion distance
ITRC PVI guidance excerpt of Figure 3-6

Exclusion distances – chlorinated

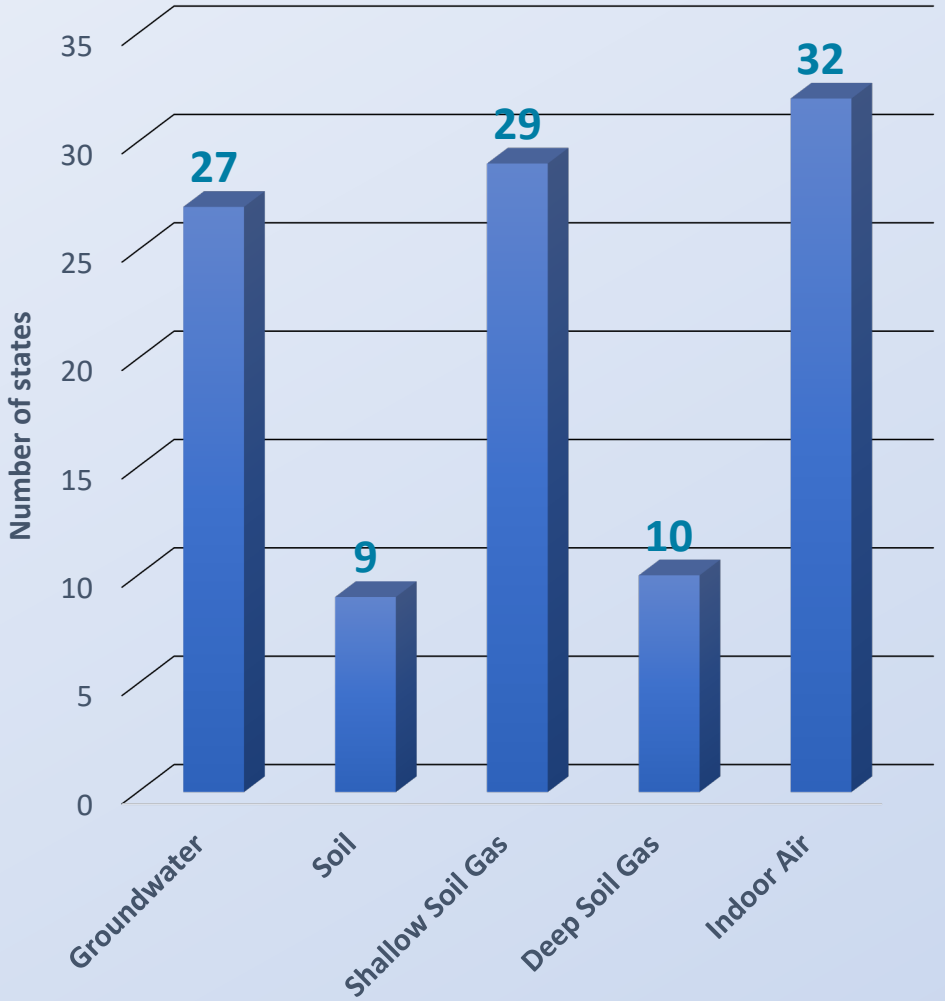




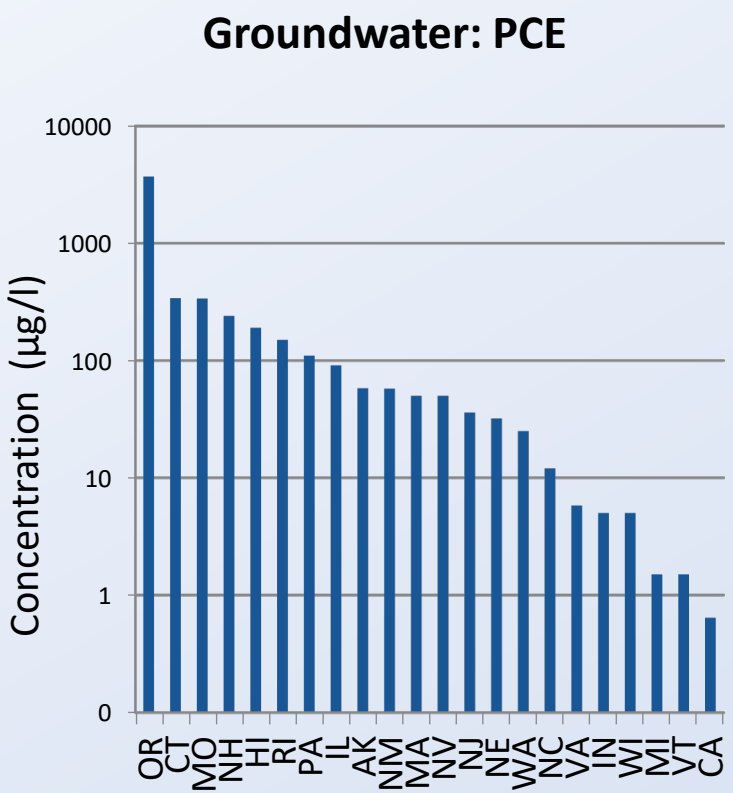
Example lateral exclusion distance
Modified from ITRC Training Class

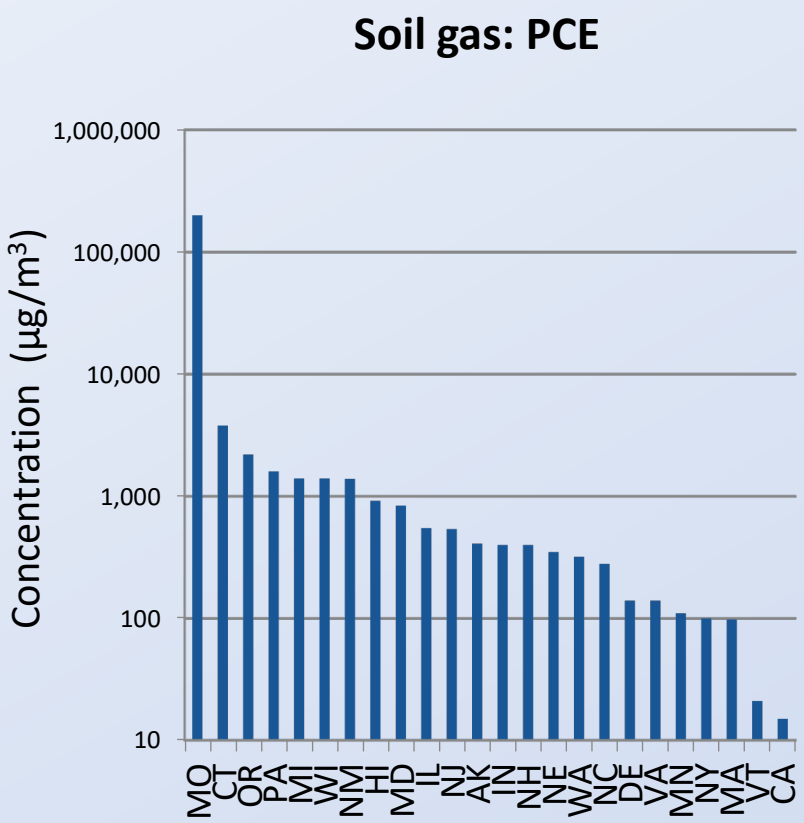
Screening values

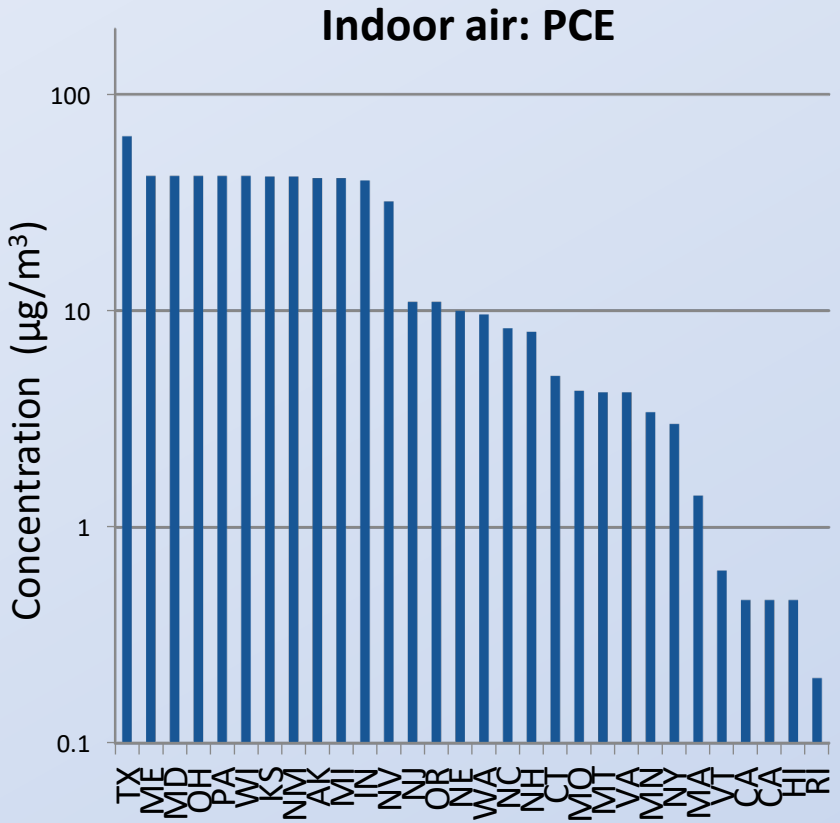
- Little consistency among states
- More reliance on shallow soil gas data than deep soil gas data
- Depending on state, values for <10 to 100+ individual VOCs
- Forty-six states and the District of Columbia have nonresidential values



Screening level distribution example – tetrachloroethene (PCE)







Selected screening values – PCE

Compound	California	New Jersey	Oregon	Range of Values (all states)
Groundwater (µg/l)	0.64	36	~~3,700~~ 130*	~~5,800x~~ (now 530x*)
Soil Gas (µg/m^3)	15	540	~~2,200~~ 1,600*	13,000x
Indoor Air (µg/m^3)	0.46	11	~~11~~ 47*	140x

* Updated Oregon RBCs as of March 2024

Selected screening values – TCE

Compound	California	New Jersey	Missouri	**Range of Values (all states)**
Groundwater (µg/l)	1.2	3	1,600	22,000x
Soil Gas (µg/m^3)	16	34	546,000	91,000x
Indoor Air (µg/m^3)	0.48	1.1	12.8	64x

Selected screening values – benzene

Compound	California	New Jersey	Iowa	Range of Values (all states)
Groundwater (µg/l)	0.42	23	1,540	6,900x
Soil Gas (µg/m^3)	3.2	18	600,000	190,000x
Indoor Air (µg/m^3)	0.097	0.64	39.2	400x

Note: *median residential indoor air background falls here*

Selected screening values – 1,1,1-trichloroethane

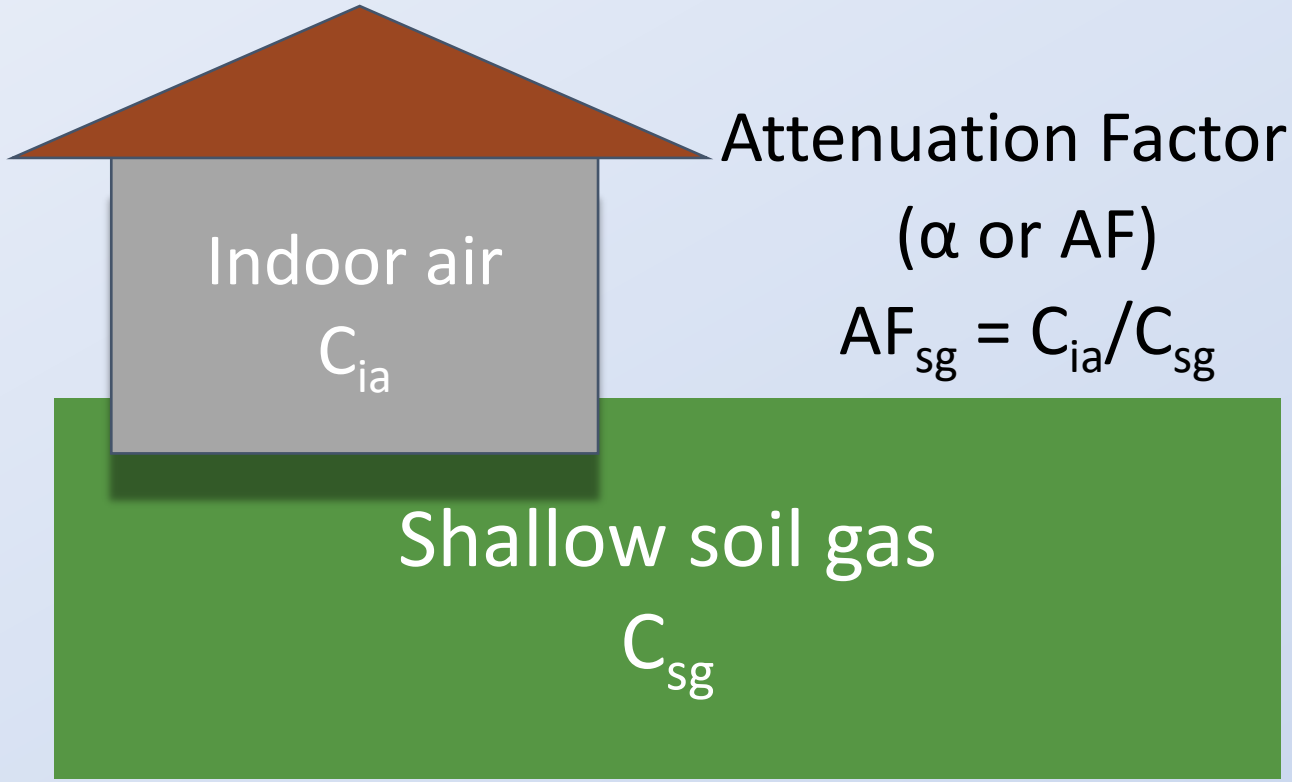
Compound	California	New Jersey	New York	Range of Values (all states)
Groundwater (µg/l)	1,500	13,000	--	~~7,200x~~ (now 5,600x*)
Soil Gas (µg/m^3)	35,000	260,000	100	570,000x
Indoor Air (µg/m^3)	1,000	5,200	3	1,700x

* Updated Oregon RBCs as of March 2024

** In February 2024, New York added three new decision matrices, primarily for petroleum hydrocarbons (e.g., BTEX).

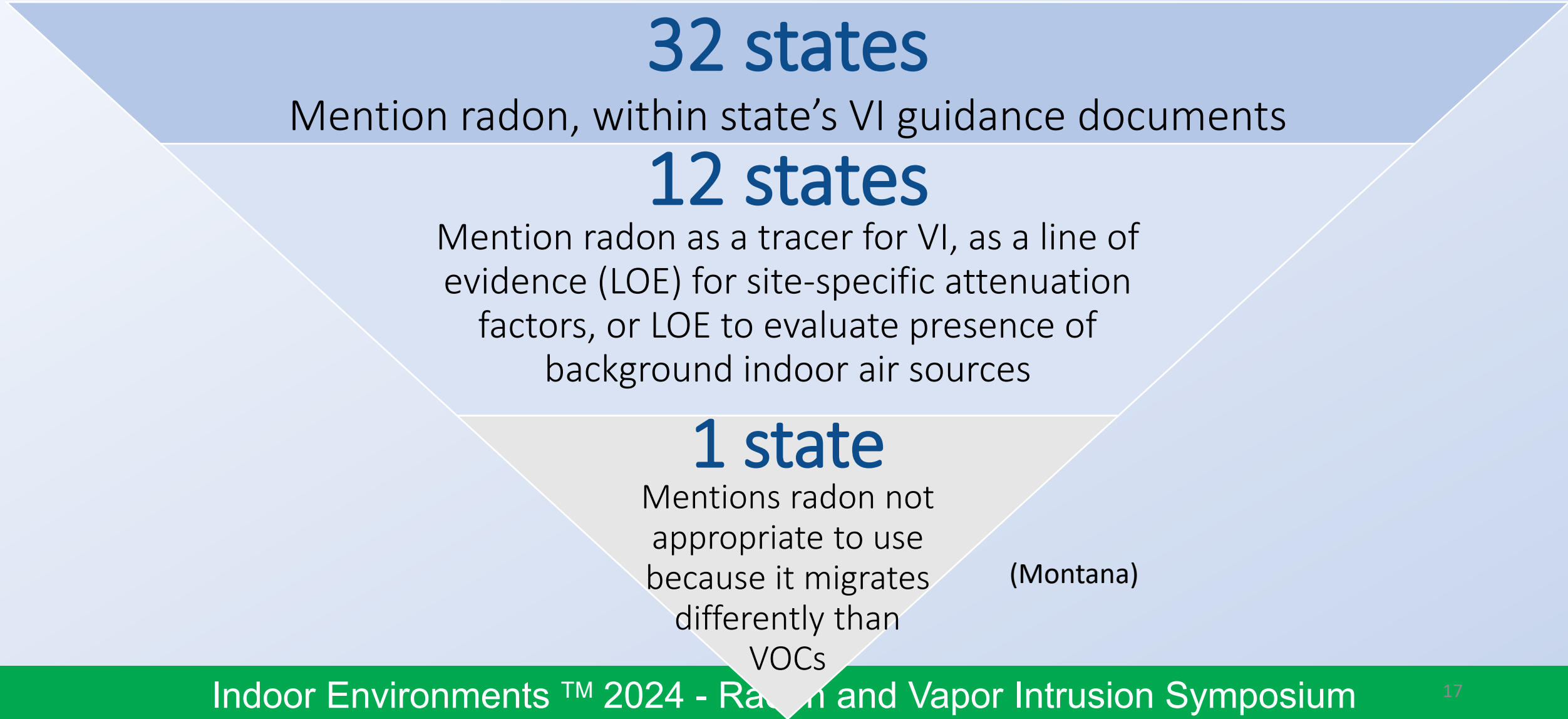
Attenuation factors

- General α (AF) values
  - Groundwater α = 0.001
  - Deep soil gas α = 0.01 to 0.03
  - Shallow soil gas α = 0.1 to 0.03
- Crawl space α = 1 in all 16 states that give values
- Only a few states use different soil gas-to-indoor air attenuation factors for residential and nonresidential structures (e.g., Indiana, Pennsylvania)



Attenuation Factor
(α or AF)
$AF_{sg} = C_{ia}/C_{sg}$

Radon


32 states
Mention radon, within state's VI guidance documents
12 states
Mention radon as a tracer for VI, as a line of evidence (LOE) for site-specific attenuation factors, or LOE to evaluate presence of background indoor air sources
1 state
Mentions radon not appropriate to use because it migrates differently than VOCs
(Montana)

Radon

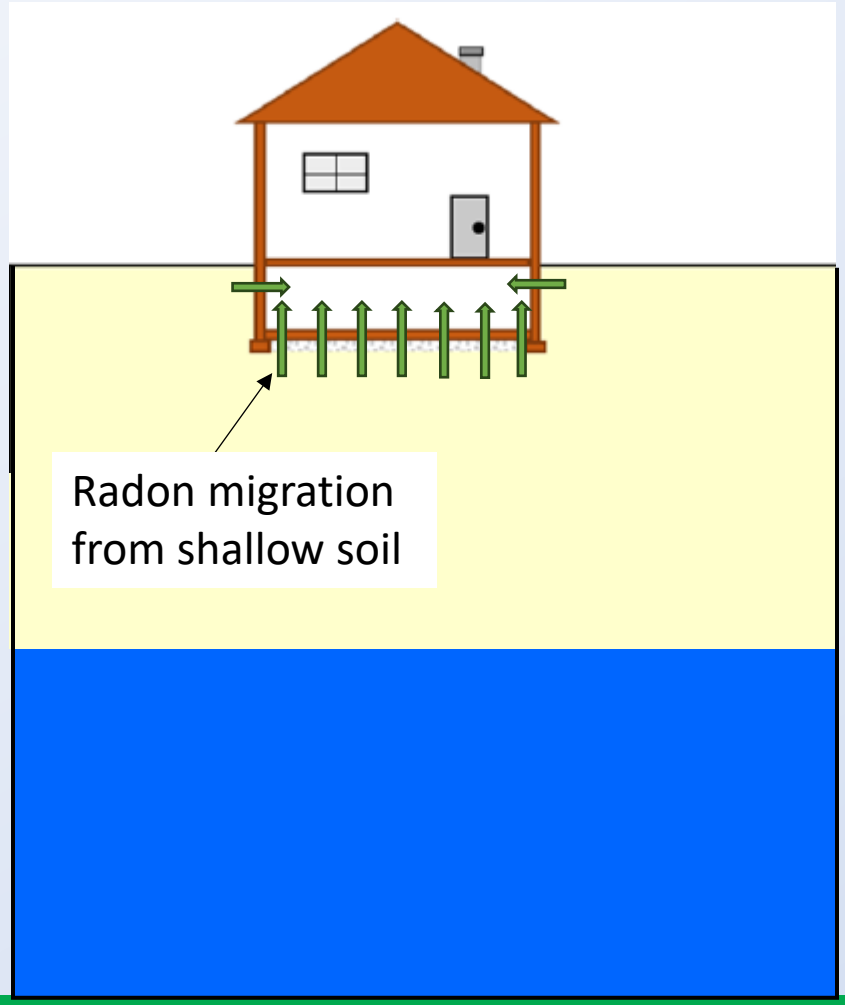
North Carolina (NCDEQ) *"Concurrent measurement of sub-slab and indoor air radon gas concentrations may be used in order to estimate building specific sub-slab to indoor air attenuation factors…… A radon-derived attenuation factor should be used as an* ***additional line of evidence*** *and* ***not…sole factor in determining if vapor intrusion is occurring****.*

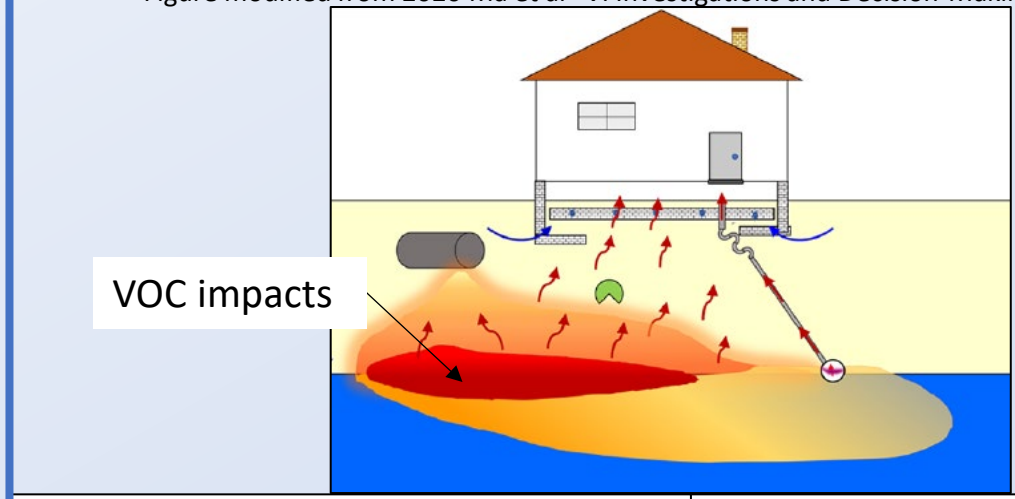
California (SFRWQCB) *"Radon* ***may be used to confirm but not rule out*** *whether the VI pathway is complete. Radon should* ***not be used as the sole LOE*** *to quantitatively estimate building-specific VFC AFs because changes in radon concentrations are not always proportional to changes in VFC concentrations (Schuver et al. 2018)."*

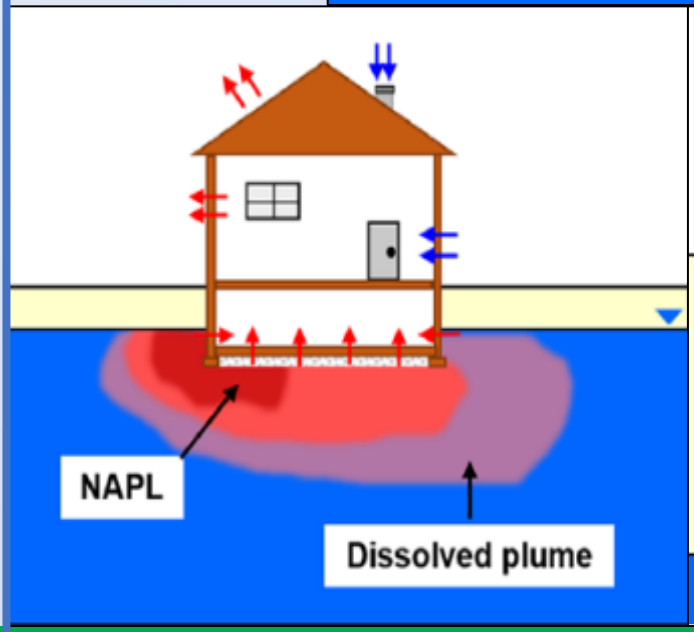
Montana (MDEQ) *"It is* ***not appropriate to use radon samples*** *to determine site-specific attenuation factors for vapor intrusion of VOCs (DEQ, 2009a and b), because* ***radon and VOCs may migrate differently****."*

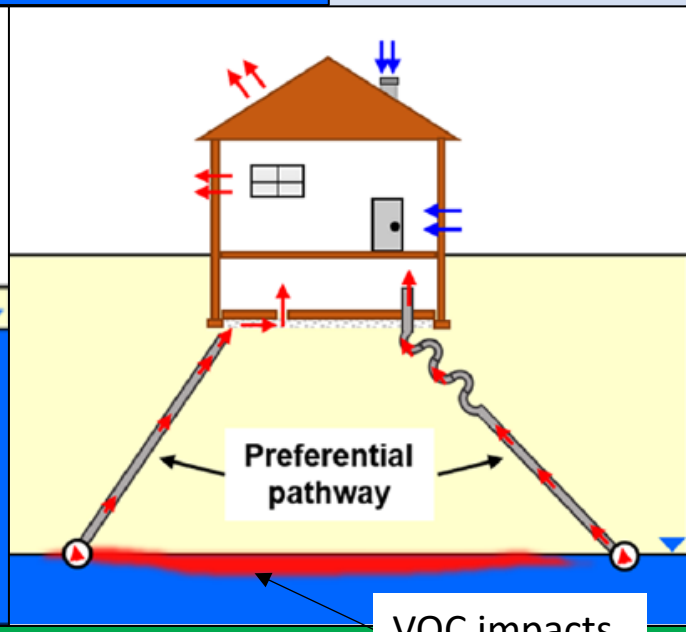
Conceptual site model differences – radon vs VOCs

Figure modified from 2020 Ma et al "VI Investigations and Decision-Making: A Critical Review"

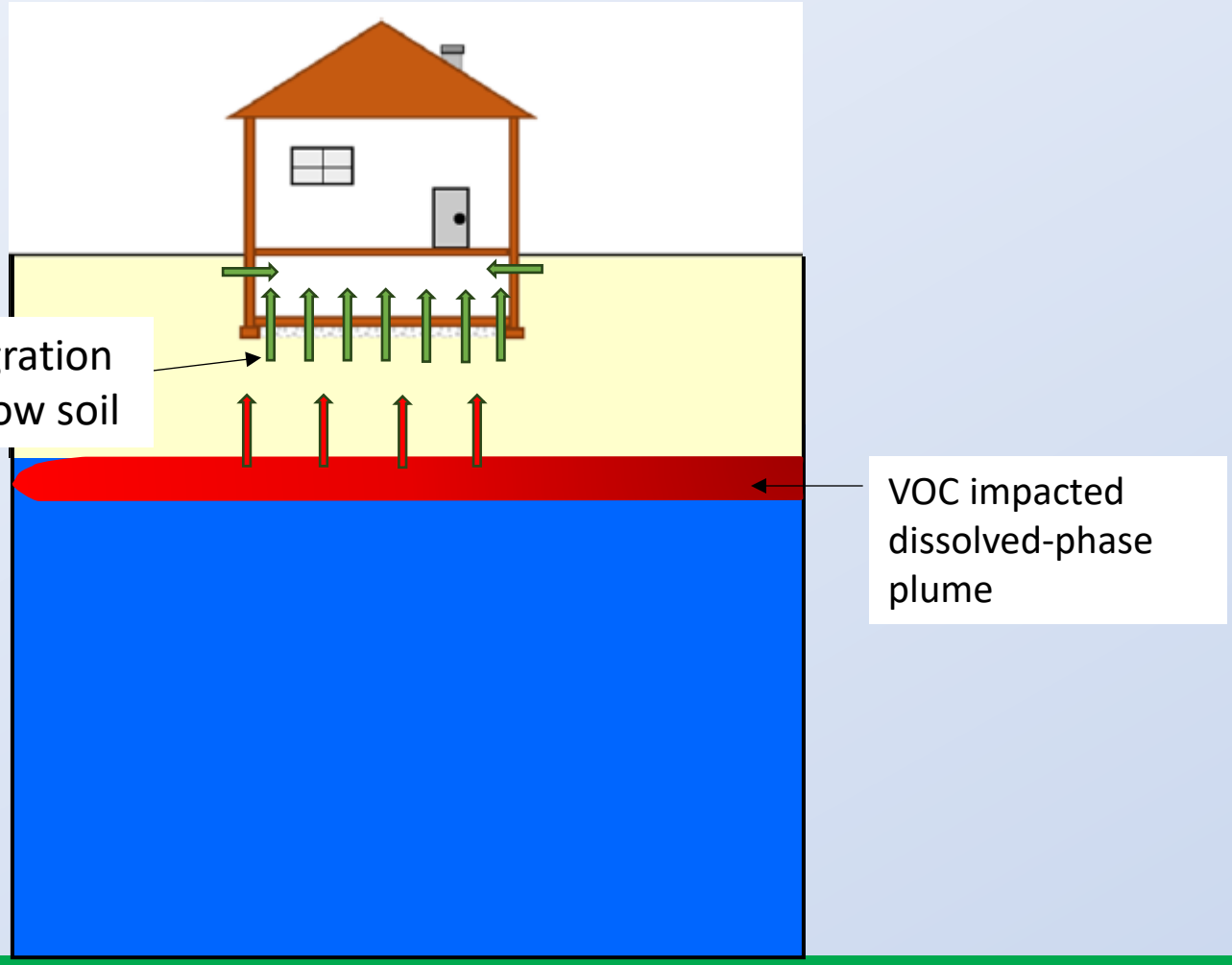






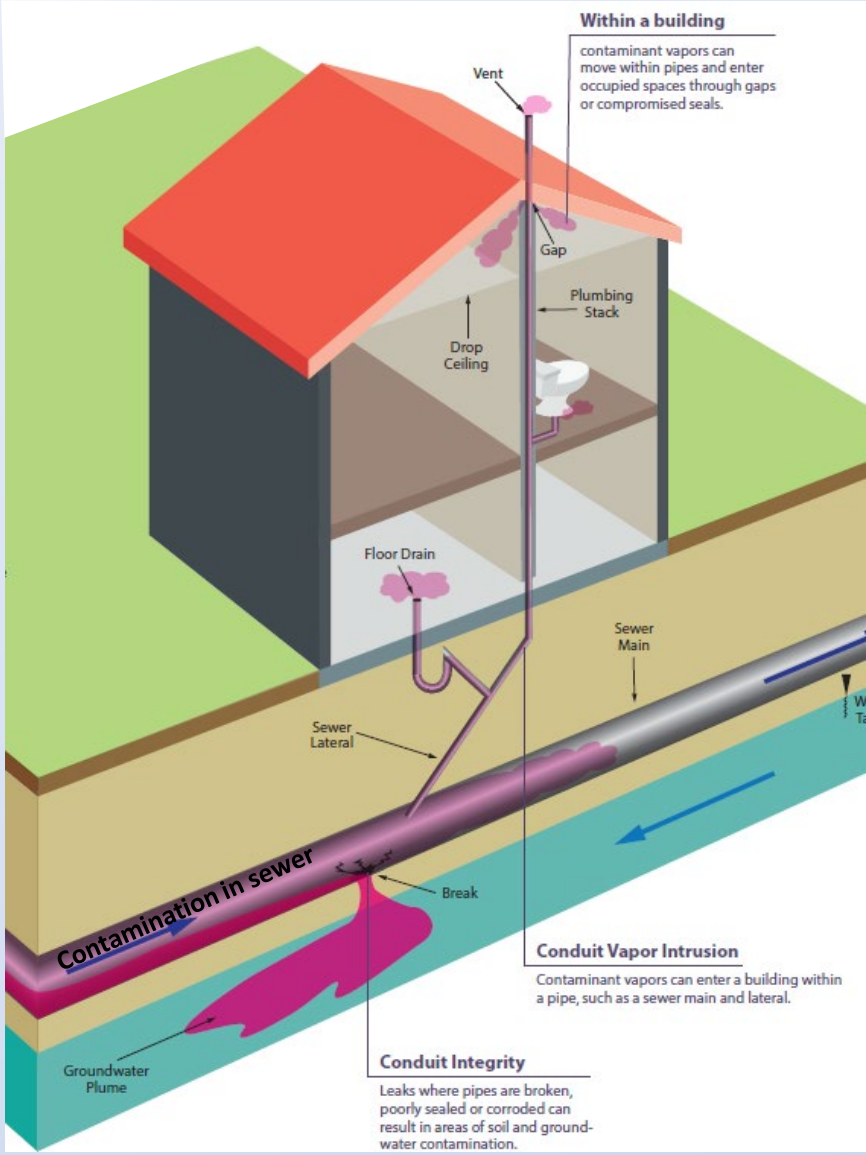


Conceptual site model differences – radon vs VOCs



Preferential pathways

- Growing recognition of the significance of “preferential pathways,” from **IN** sewers and other conduits versus only backfill material
- Terminology change expected: ‘vapor conduit pathway’ and ‘conduit vapor intrusion’
- Indiana, Wisconsin, and California guidance summarize sampling and gauging likelihood of significant vapor conduit pathways



Wisconsin DNR, Guidance for Documenting the Investigation of Human-made Preferential Pathways Including Utility Corridors, June 2021

VI mitigation – mentioned by 26 states

16

states have a target for differential pressure across slab.

Values range from ‘demonstrate the presence of negative differential pressure’ to 10 Pascals (Pa).

11

states specify a recommended thickness for a vapor membrane.

Values range from 3 to 100 mils with most between 30 and 60 mils.

Membrane thickness is not the only metric to determine effectiveness. Others include VOC resistivity, seam and termination construction, post-install QA/QC

15

states provide emission rate thresholds that may trigger either emission controls and/or permitting.

3 states (Michigan, New Jersey, and New York) either exempt or typically exempt VI mitigation in residential properties

Observations

The number of states with guidance has increased: 17 (2007) to 35 (2012) to 42 (2018) to 45 (2023).

The use of mathematical modeling to address VI has largely been replaced by preference for empirical measurements.

Gradual recognition of how petroleum hydrocarbons differ for VI. Some consensus on lateral screening distances (e.g., 30 ft. for petroleum hydrocarbons and 100 ft. for chlorinated solvents).

Indoor air attenuation factors continue to be 0.001 for groundwater, 1 for crawl spaces, and 0.01-0.03 for soil gas. Few states have different values for residential versus nonresidential buildings.

Observations

Lots of variability in types of screening levels, numbers of VOCs covered, and specific numeric values for screening VOCs. No expectation of consensus on these issues in the next few years.

Screening levels for PCE and TCE exhibit less variability now than during past surveys. Example: indoor air values for TCE varied from 0.016 to 59 µg/m^3 in 2007, now all values are between 0.2 and 12.8 µg/m^3.

States find it challenging to address what steps to take after a site is ‘screened in’. Relatively little information is given in most states’ guidance about preferential pathways, mitigation, short-term exposures, etc.

Thank you!

Open Access paper:
Groundwater Monitoring & Remediation

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