Vapor Intrusion Presentation to MTCA Rule EAG December 18, 2009

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Vapor Intrusion
Some Key Challenges

- Many volatile chemicals are present in the ambient air and in indoor air at concentrations of regulatory concern, making it difficult to sort out vapor intrusion problems
- Many site-specific and building-specific factors determine whether vapor intrusion will be an issue of concern for a given structure
- Our standards are based on long term exposure scenarios yet our assessment methods often use one-time, short duration measurements because of time and expense considerations
- Vapor intrusion models focus on steady-state conditions; conditions that are seldom present in the real world

Vapor Intrusion
Some Key Challenges

- Based on work done by EPA to compile data from site-specific investigations throughout the nation, it is possible to estimate groundwater concentrations that have the potential to cause vapor intrusion problems in overlying structures
- However, EPA has concluded it isn't possible to correlate soil concentrations with vapor intrusion problems; instead soil gas concentrations must be used
- Vapor probe and indoor air measured concentrations depend on numerous factors, many of which can be controlled with a properly designed investigation

Vapor Intrusion Guidance MTCA Advisory Committee Questions

- Does the tiered approach in the Guidance provide a workable framework for addressing vapor intrusion in the MTCA rule?
- Guidance focuses on 70 substances plus 6 TPH fractions (volatile chemicals/mixtures with toxicity data). Should this also be the focus of the rule?
- Indoor and outdoor vapor concentrations are a complicating factor in vapor intrusion (VI) investigations. Should the guidance approach of subtracting upwind background from indoor air to screen which buildings are impacted be captured in the rule? How should background be factored into compliance testing?

Vapor Intrusion Guidance
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- What provisions in this guidance should be in the MTCA rule?
- What issues <u>not</u> addressed in this guidance should be addressed in the MTCA rule?

Vapor Intrusion Guidance Preparation Process

- Guidance prepared by Ed Jones, NWRO Hazardous Waste and Toxics Reduction Program, in consultation with HQ Toxics Cleanup Program
- Reviewed by staff from TCP and other programs with vapor intrusion experience.
- Reviewed by several external vapor intrusion experts.
- Public comment period closed November 30th. Comments generally favorable.
- Generally favorable feedback at the November 23, 2009 Science Panel meeting.
- Plan to finalize guidance by early 2010.
- It is likely several key concepts in guidance will be captured in rule amendments.

Guidance for Evaluating Soil Vapor Intrusion in Washington State

what is vapor intrusion?
[chapter 1]

preliminary assessment
[chapter 2]

"Tier 1" and "Tier 2" assessment
[chapter 3]

serving the public
[chapter 4]

mitigation
[chapter 5]

considering VI during remedy selection
[chapter 6]

GW and soil gas screening levels
[appendix B]

soil gas sampling
[appendix C]

Vapor Intrusion Guidance Content

- Similar to guidance prepared by most states, ITRC, EPA
- Recommends a "tiered" or phased approach

  (1) is there VOC contamination at the site?

  (2) are VOCs in groundwater or soil gas elevated [compared to VI-based screening levels]?

  (3) are VOCs in indoor air elevated?

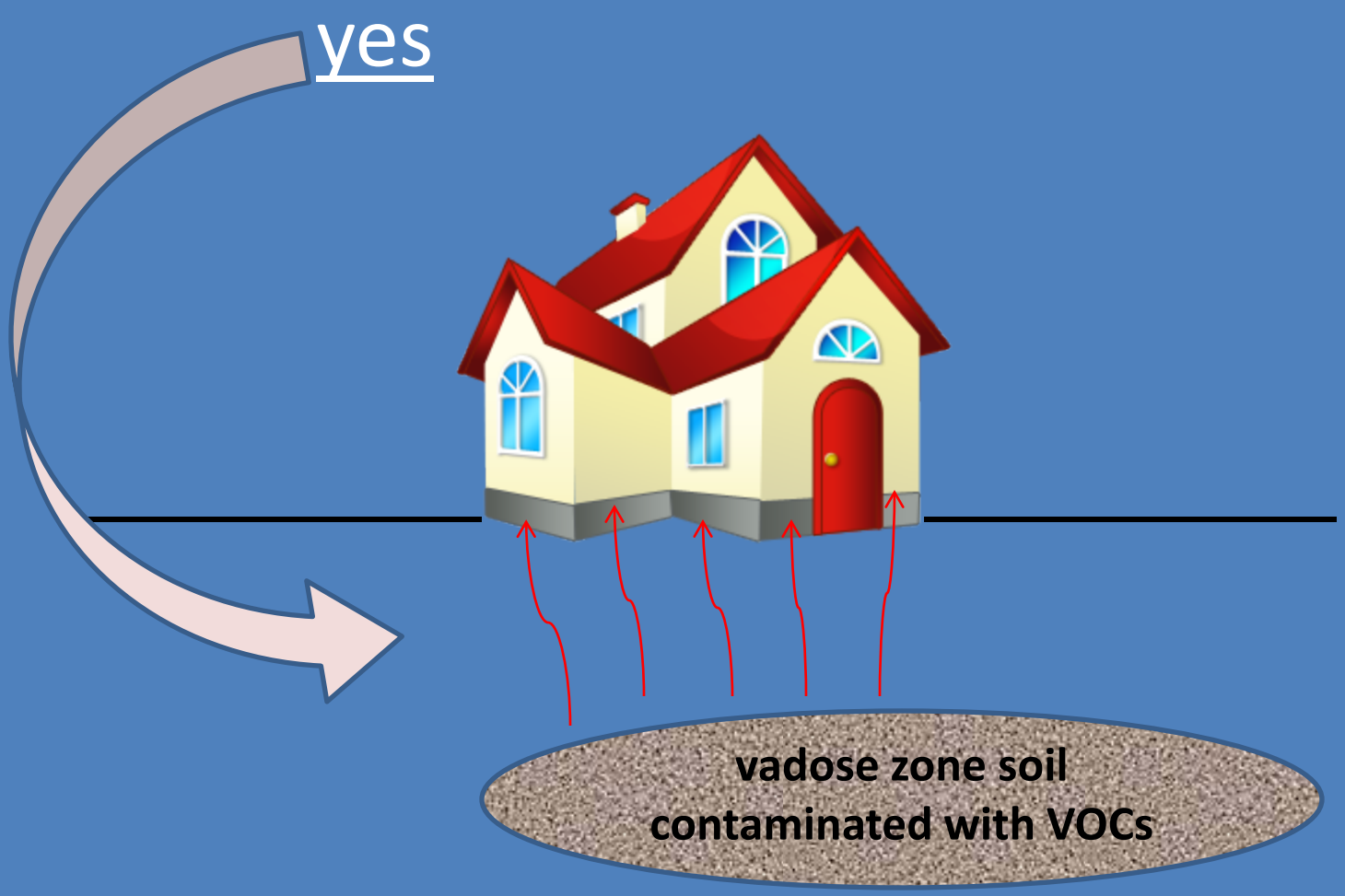
  (4) are the elevated levels of VOCs measured in indoor air due to VI?

  (5) *mitigate* buildings when VOCs are elevated in indoor air due to VI

  (6) when setting site cleanup levels, ensure that indoor air is protected
- Assumes the RI/FS will be conducted per <u>existing</u> regulations

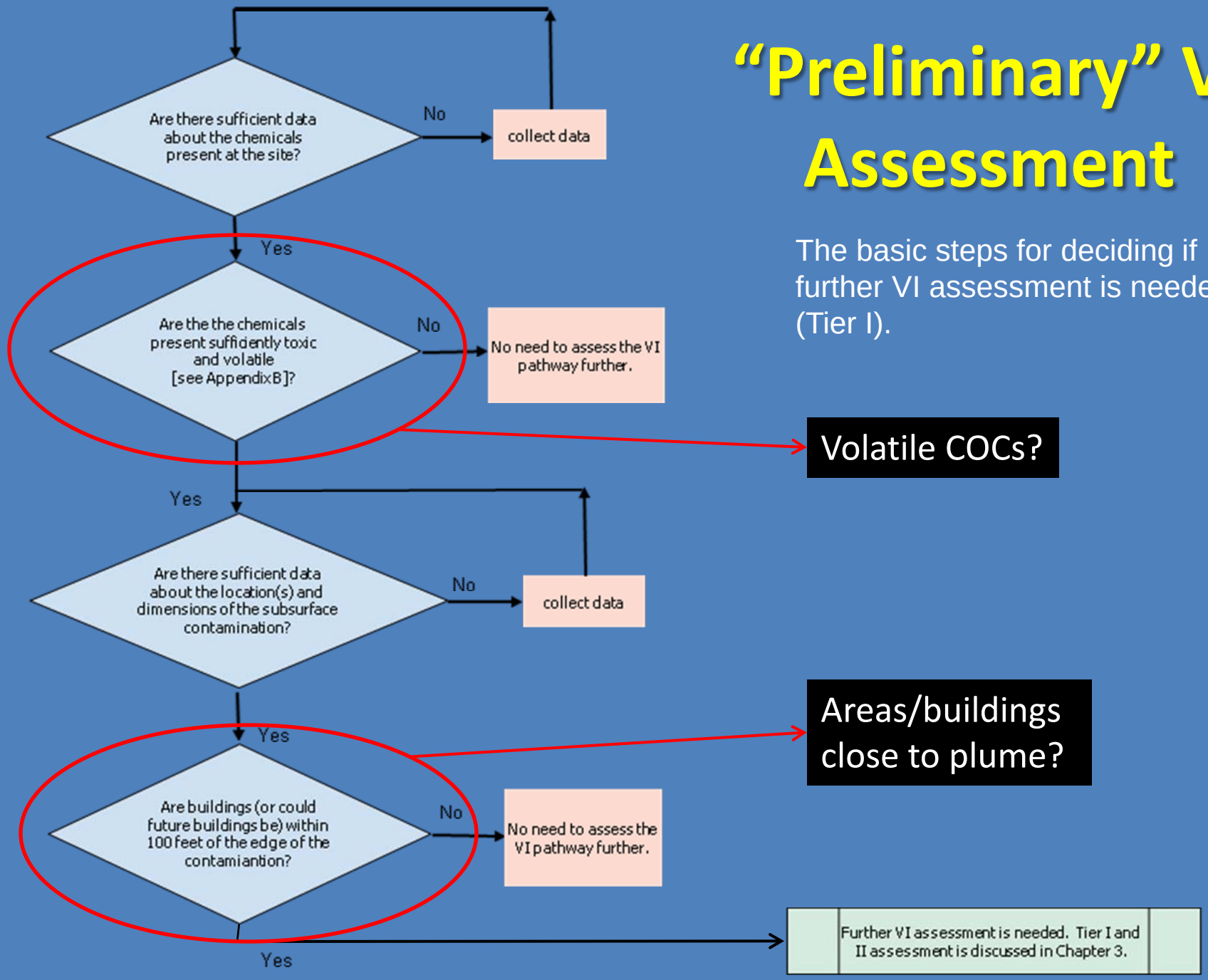
What is VI?

What is VI?



"Preliminary" VI Assessment

The basic steps for deciding if further VI assessment is needed (Tier I).

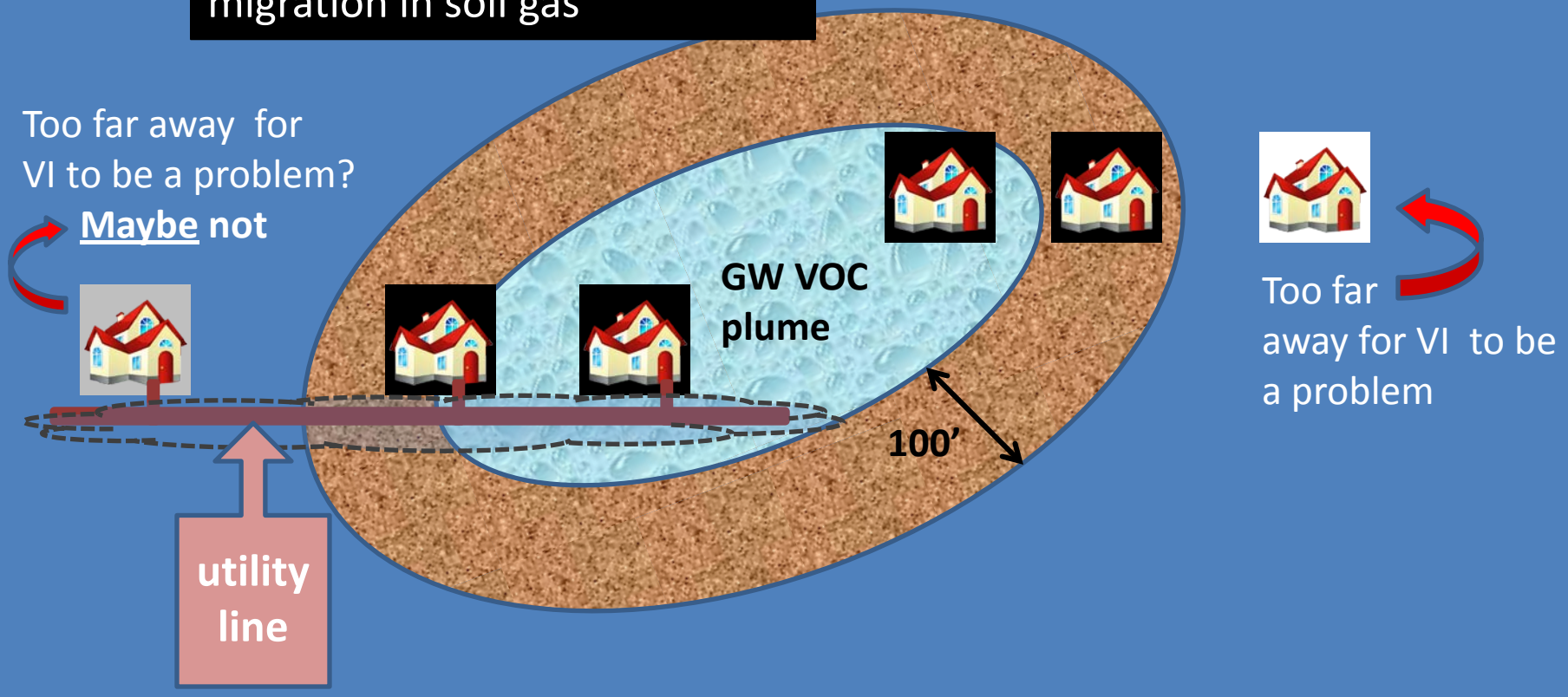


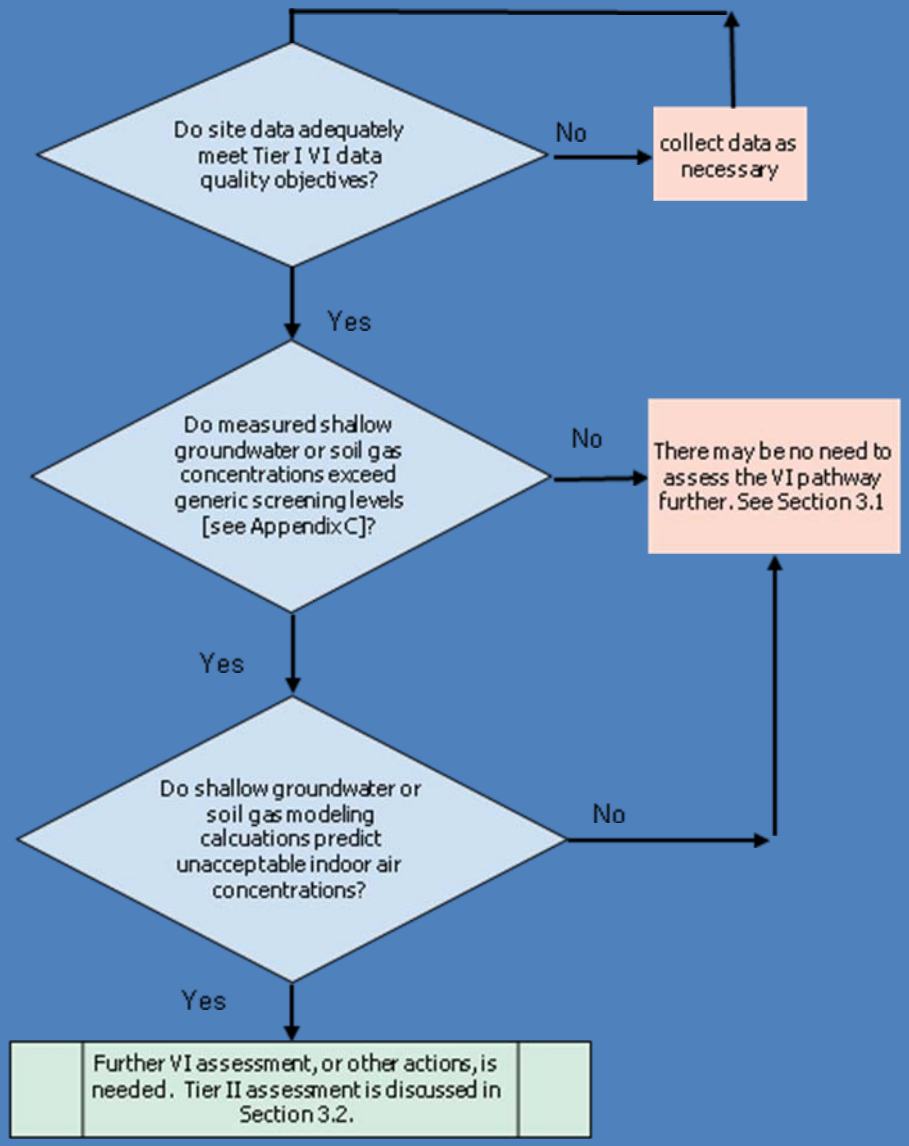
Volatile COCs?

Areas/buildings close to plume?

Preliminary Assessment

Subsurface utility lines can be a preferential pathway for VOC migration in soil gas





Tier I Assessment

Determine from subsurface media samples [**shallow GW or soil gas**] whether VOC concentrations are high enough to potentially result in unacceptably elevated indoor concentrations

Tier I Assessment: Groundwater

There are three primary sources of attenuation values:

a) EPA's national VI database

b) model calculations

c) site-specific paired indoor air and soil gas data

EPA 2008

measured

Groundwater

concentrations

(x axis)

vs

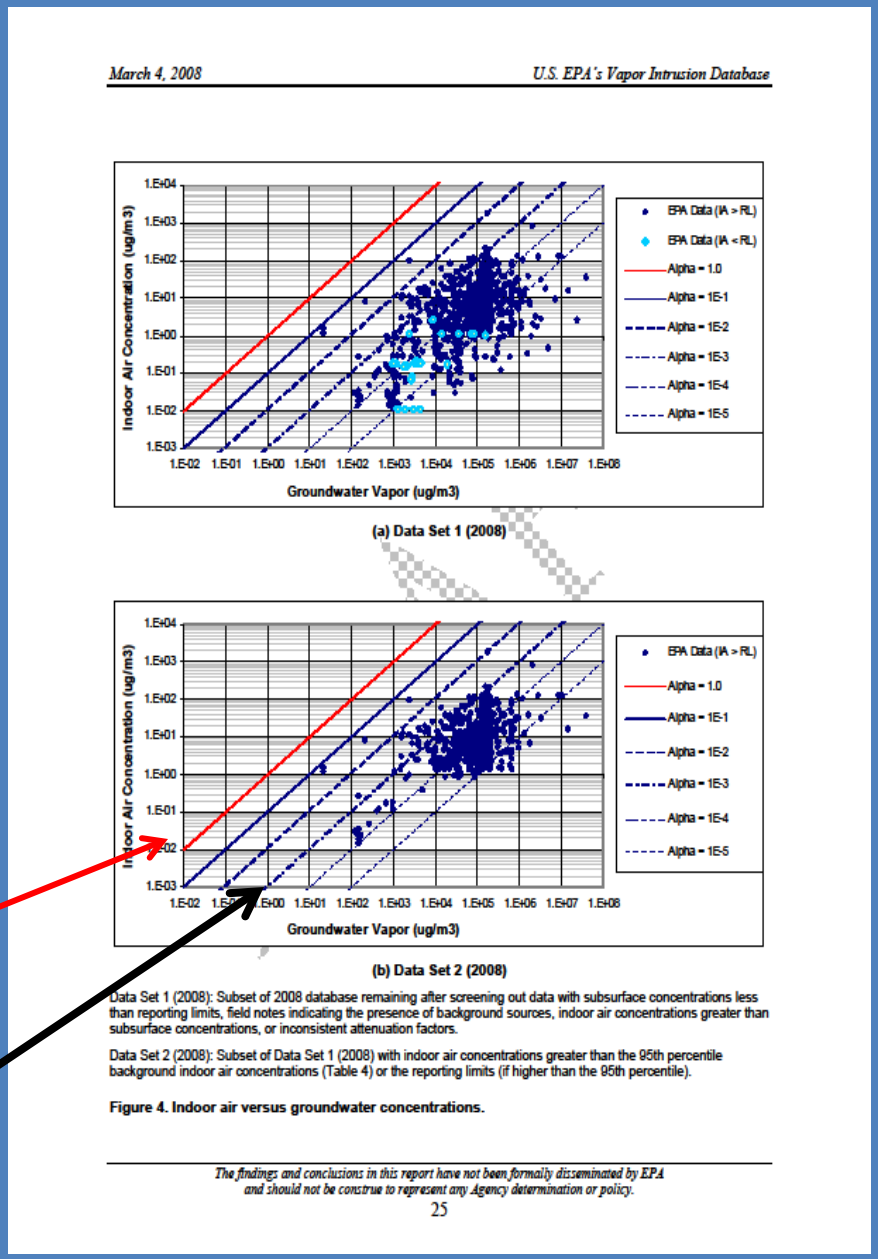
Indoor Air

Concentrations

(y axis)

VAF = 1 line (red)

VAF = 0.001 line



March 4, 2008 *U.S. EPA's Vapor Intrusion Database*

(a) Data Set 1 (2008)

(b) Data Set 2 (2008)

Data Set 1 (2008): Subset of 2008 database remaining after screening out data with subsurface concentrations less than reporting limits, field notes indicating the presence of background sources, indoor air concentrations greater than subsurface concentrations, or inconsistent attenuation factors.

Data Set 2 (2008): Subset of Data Set 1 (2008) with indoor air concentrations greater than the 95th percentile background indoor air concentrations (Table 4) or the reporting limits (if higher than the 95th percentile).

Figure 4. Indoor air versus groundwater concentrations.

The findings and conclusions in this report have not been formally disseminated by EPA and should not be construe to represent any Agency determination or policy.

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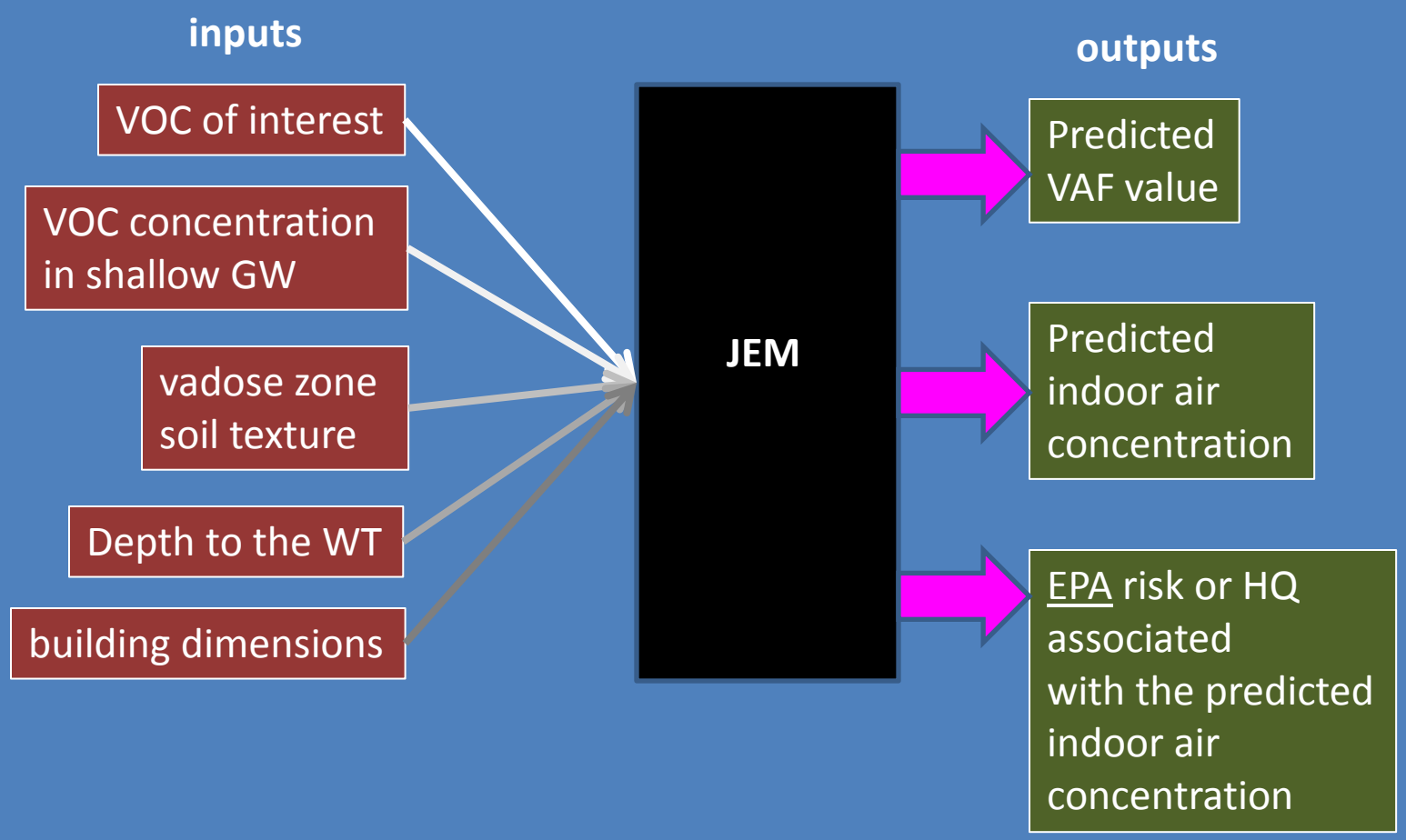
Tier I assessment: Groundwater Screening Levels

Parameter	Gd Water Screening	Method A Gd Water
Benzene GW SL	0.3 µg/l	5 ug/l
PCE GW SL	0.4 µg/l	5 ug/l
TCE GW SL	0.1 µg/l	5 ug/l
Vinyl chloride GW SL	0.3 µg/l	0.2 ug/l

Tier I Assessment: Modeling Indoor Air Predictions from GW Concentrations



Tier I assessment: GW & Soil

Another alternative-Soil Gas Measurements:

If the "VI source" is contaminated shallow groundwater, the question can be answered by sampling soil gas and comparing these concentrations to soil gas screening levels.

EPA 2008

measured

Soil Gas

concentrations

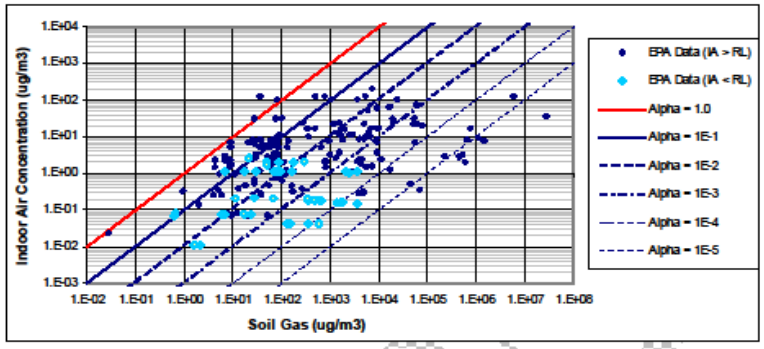
vs

Indoor Air

concentrations

VAF = 1 line (red)

VAF = 0.1 line



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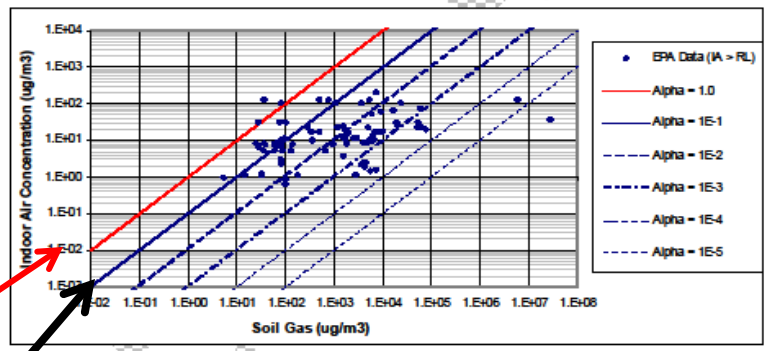

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Figure 7. Indoor air versus soil gas concentrations.

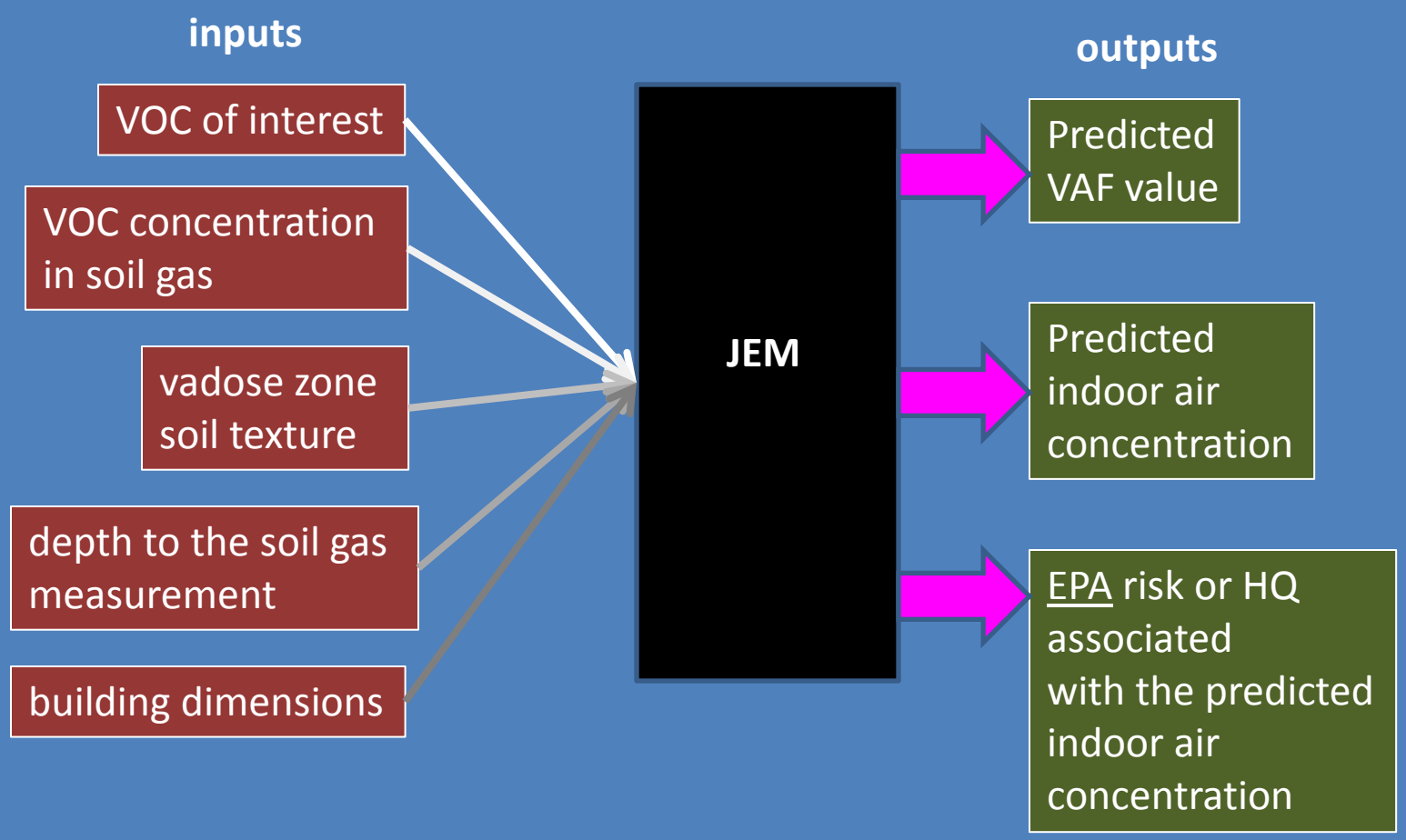
Tier I Assessment: Soil Gas Screening Levels

Parameter	Method B Air CUL (ug/m^3)	Shallow & Sub-slab* (ug/m^3)	Deep * (ug/m^3)	Ambient Air (ug/m^3)**
Benzene	0.32	3.2	32	0.5 to 4.8
PCE	0.42	4.2	42	0.1 to 1.4
TCE	0.1	1.0	10	0.1 to 1.1
Vinyl Chloride	0.28	2.8	28	0.0 to 0.1

* Soil gas screening level (deep is greater than 15 feet deep)

** Estimated (modeled) median concentrations for WA State (1996 EPA Air Toxics Assessment) http://www.epa.gov/ttn/atw/nata/mapconc.html

Tier I Assessment: Modeling Indoor Air Predictions from Soil Gas Concentrations



Tier I Assessment: Sampling

Typically, soil gas samples are collected in **Summa canisters** and analyzed via **EPA Method TO-15** (for VOCs).

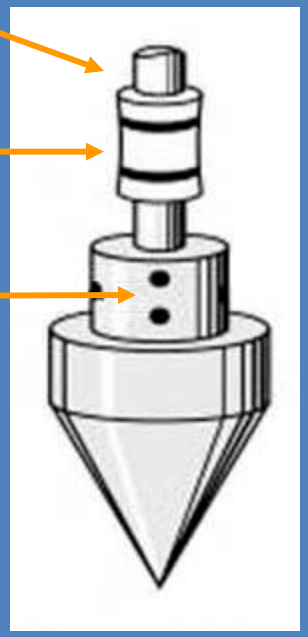
Canisters come evacuated from the lab (under negative pressure) with a **flow regulator set for a given fill time**.

Multi-depth Nested Soil Gas Probe

1/8" or 1/4" tubing

Wire wrap

Gas inlet perforations

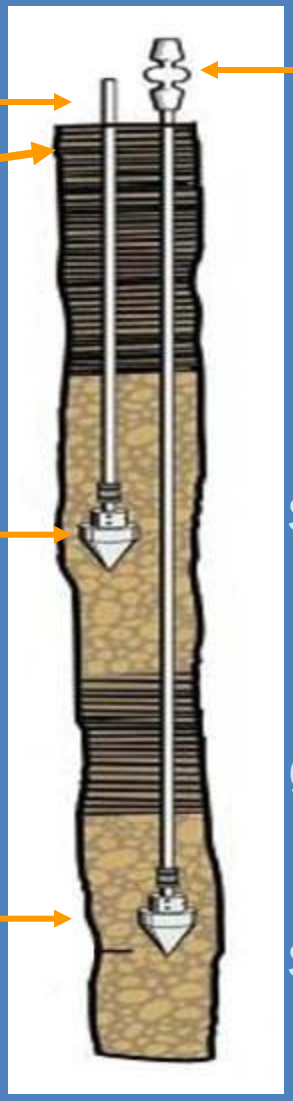


1/8" or 1/4" tubing

Important that annulus at the ground surface be well-sealed

Second soil vapor implant

First soil vapor implant



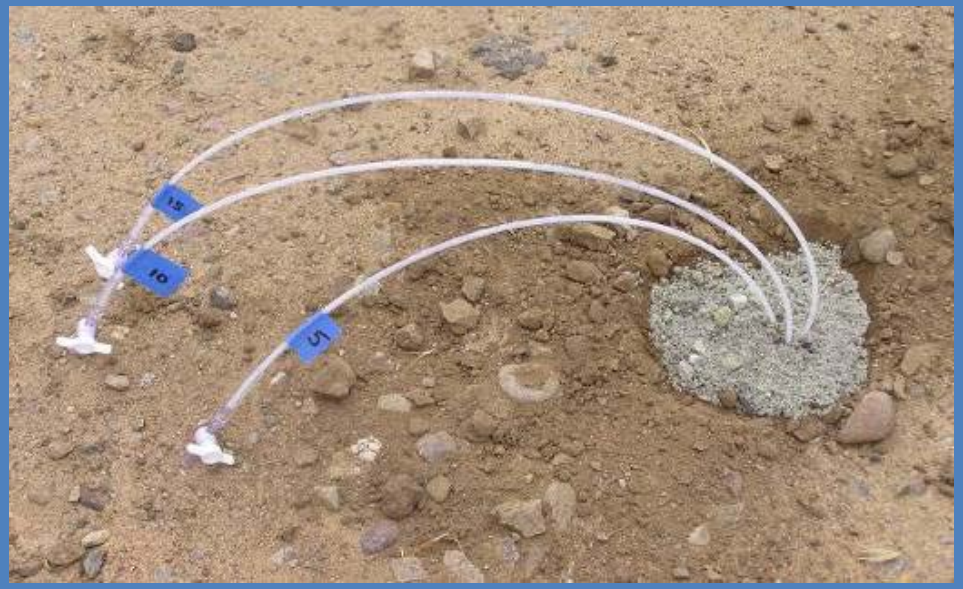
off/on valve

Sand pack

Bentonite grout seal

Sand pack

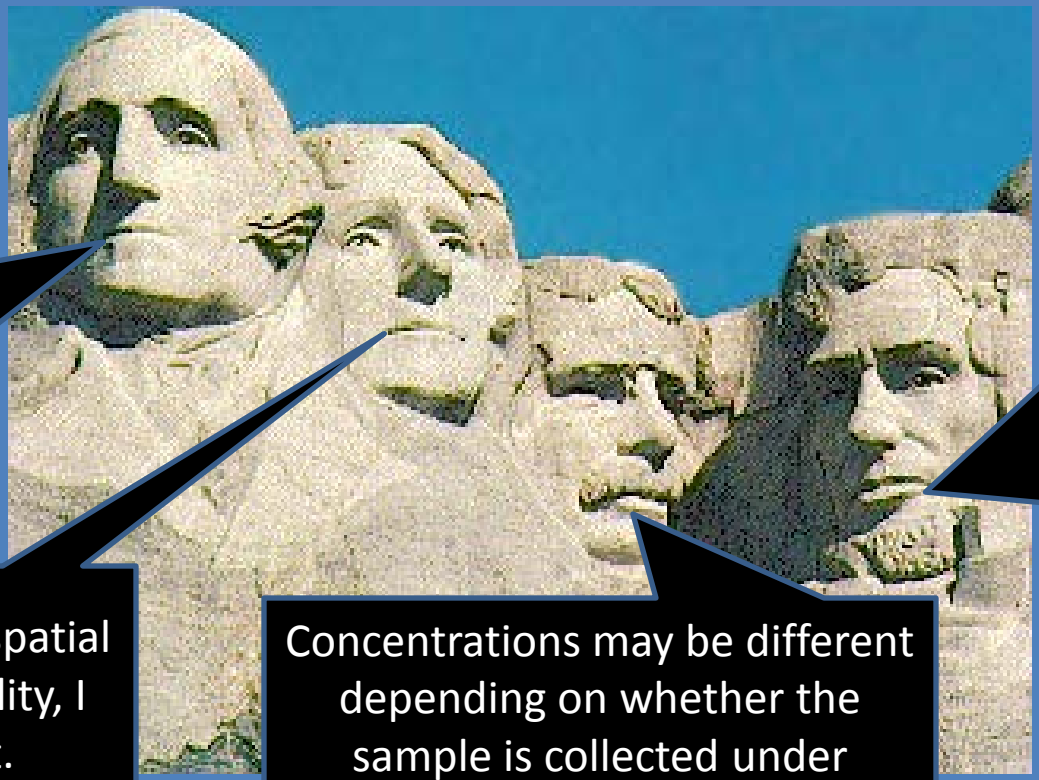
Soil Gas Sampling Probes



Each line (tubing) terminates at a discrete depth interval

Tier I Assessment: Using Soil Gas

Tier I measurements of soil gas VOC concentrations must be representative.



What kinds of measurement variability should be expected?

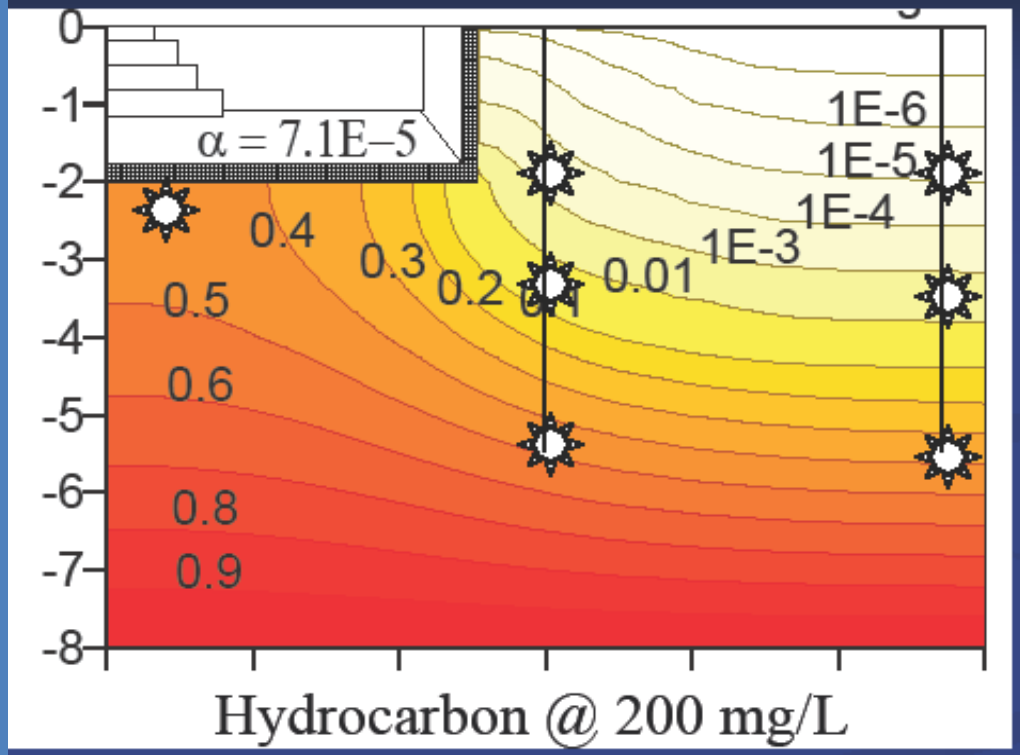
Lateral spatial variability, I bet.

Concentrations may be different depending on whether the sample is collected under covered or uncovered ground.

I wouldn't be surprised if there was seasonal or even temporal variability, especially at shallower depths.

Soil Gas Spatial Variability

Sample Depth and Distance



Potential for many orders of magnitude differences in concentrations, depending on depth and distance

Abreu and Johnson, 2005

GeoSyntec Consultants
www.geosyntec.com

Tier I Assessment Conclusion

Site areas & buildings identified in the Preliminary Assessment

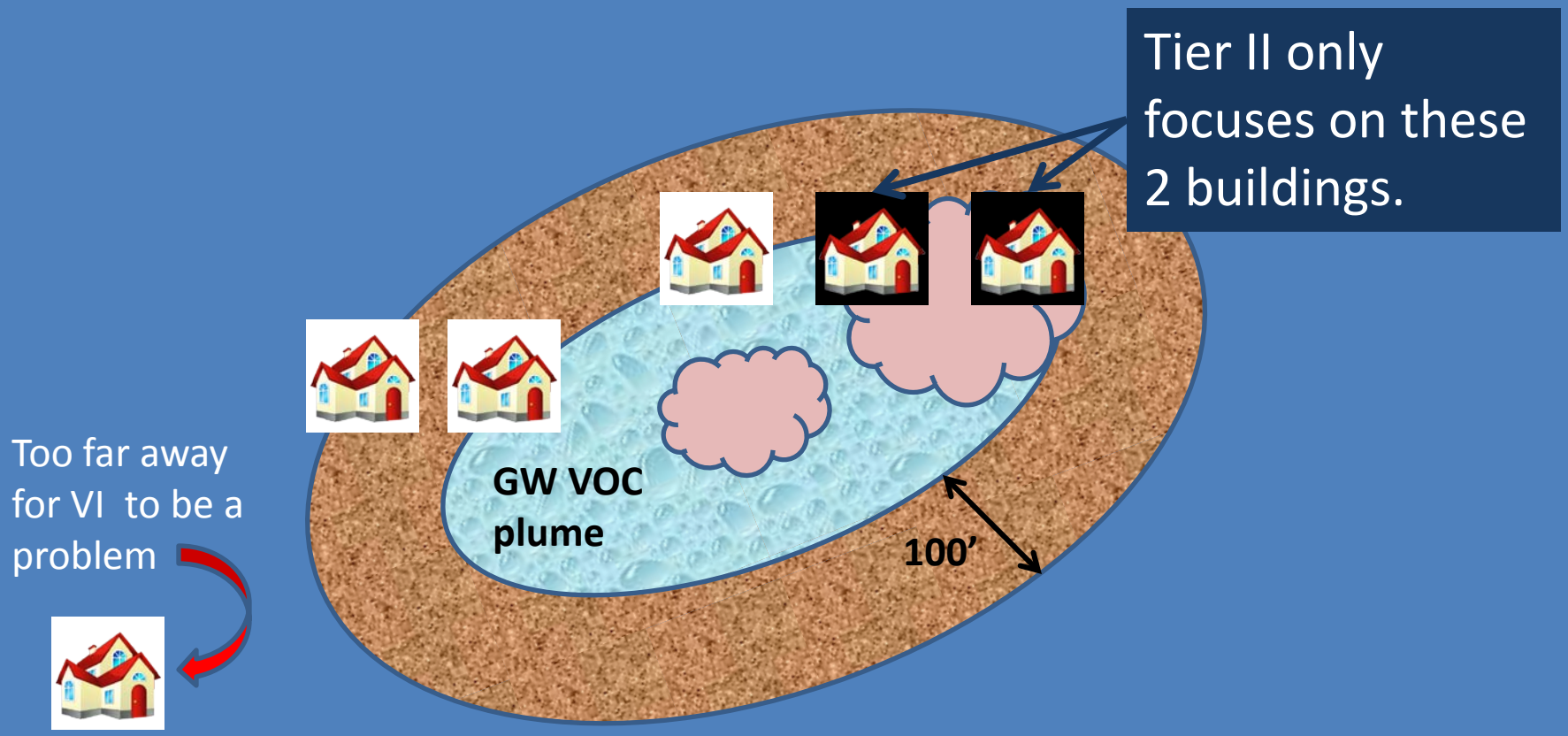
Tier I site areas with or without buildings where **soil gas levels are too low to pose a VI threat** → done

Tier I site areas **without buildings** where **soil gas levels are high enough to pose a VI threat** → utilize info in cleanup decision

Tier I site areas **with buildings** where **soil gas levels are high enough to pose a VI threat** → go to Tier II

The **Tier II goal** is to identify:

a) Buildings where VI is **not** unacceptably contaminating indoor air, and
b) Buildings where VI **is** unacceptably contaminating indoor air.



Tier II Assessment

- Visit building.
- Develop a sampling & analysis plan.
- Instruct occupants about "do's/ don'ts" during the sampling period.
- Remove obvious indoor VOC emitters.
- Perform sampling.
- Assess resulting data.

Are measured indoor air VOC concentrations, corrected for ambient contributions, **higher than acceptable** levels?

NO → There may be no need to assess the VI pathway further for this building. See Section 3.2.4

Evaluate other *lines of evidence.*

Does there appear to be an **unacceptable VI impact?**

NO → There may be no need to assess the VI pathway further for this building. See Section 3.2.4

MITIGATION or other interim action may be necessary

Tier II Assessment

Site areas with buildings where soil gas levels are high enough to pose a VI threat

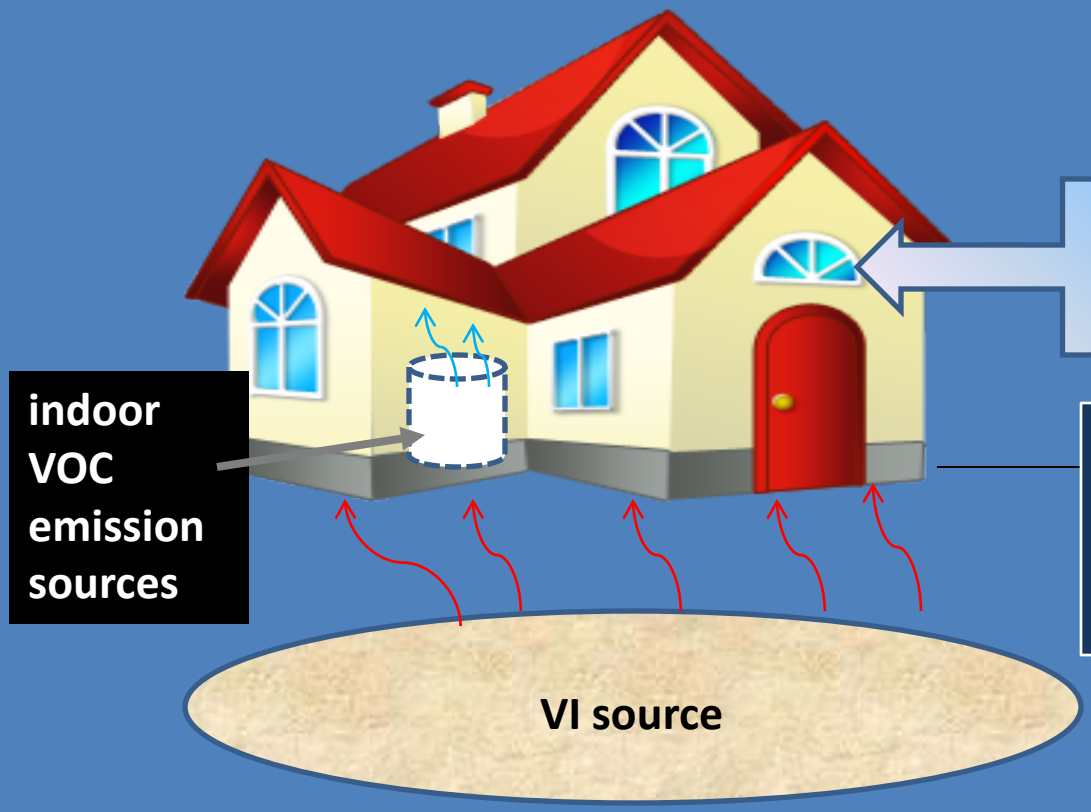
Before starting Tier II it's wise to evaluate whether it makes more sense to **simply mitigate** the building of concern.

- Tier II sampling is expensive, and mitigating houses is usually relatively cheap.
- When soil gas concentrations are >> SLs, there is a good chance that indoor air concentrations may be > air CULs.

In these cases, then, **from a strictly financial perspective it may be preferable to implement a mitigation system before performing a Tier II investigation**.

Tier II Assessment

Tier II assessment is based on the *conceptual model* below:

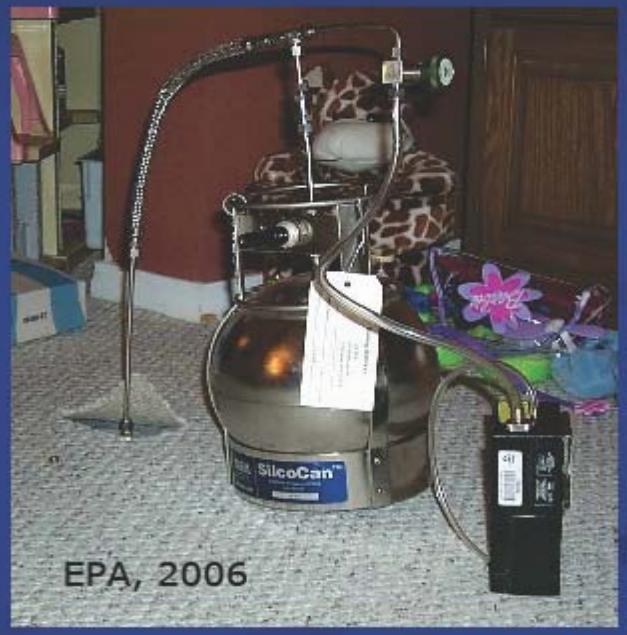


A VOC measurement indoors could be affected by contaminated outdoor (ambient) air, indoor VOC emission sources, and vapor intrusion

Tier II Assessment: Sampling

Tier II Assessment: Sampling

Direct Summa Canister Collection



EPA, 2006

GeoSyntec Consultants
www.geosyntec.com

Tier II Assessment: Sampling

Tier II Assessment: Sampling

Tier II Assessment Conclusion

Buildings identified in the Tier I assessment

Tier II buildings where indoor air sampling suggests that VI **is not a problem**

What is the confidence level in this conclusion? Has indoor air been sampled > 1? Was indoor air sampled during a period when the building was depressurized?

Tier II buildings where indoor air sampling suggests that VI **is a problem**

Mitigate, or implement some other action (quickly)

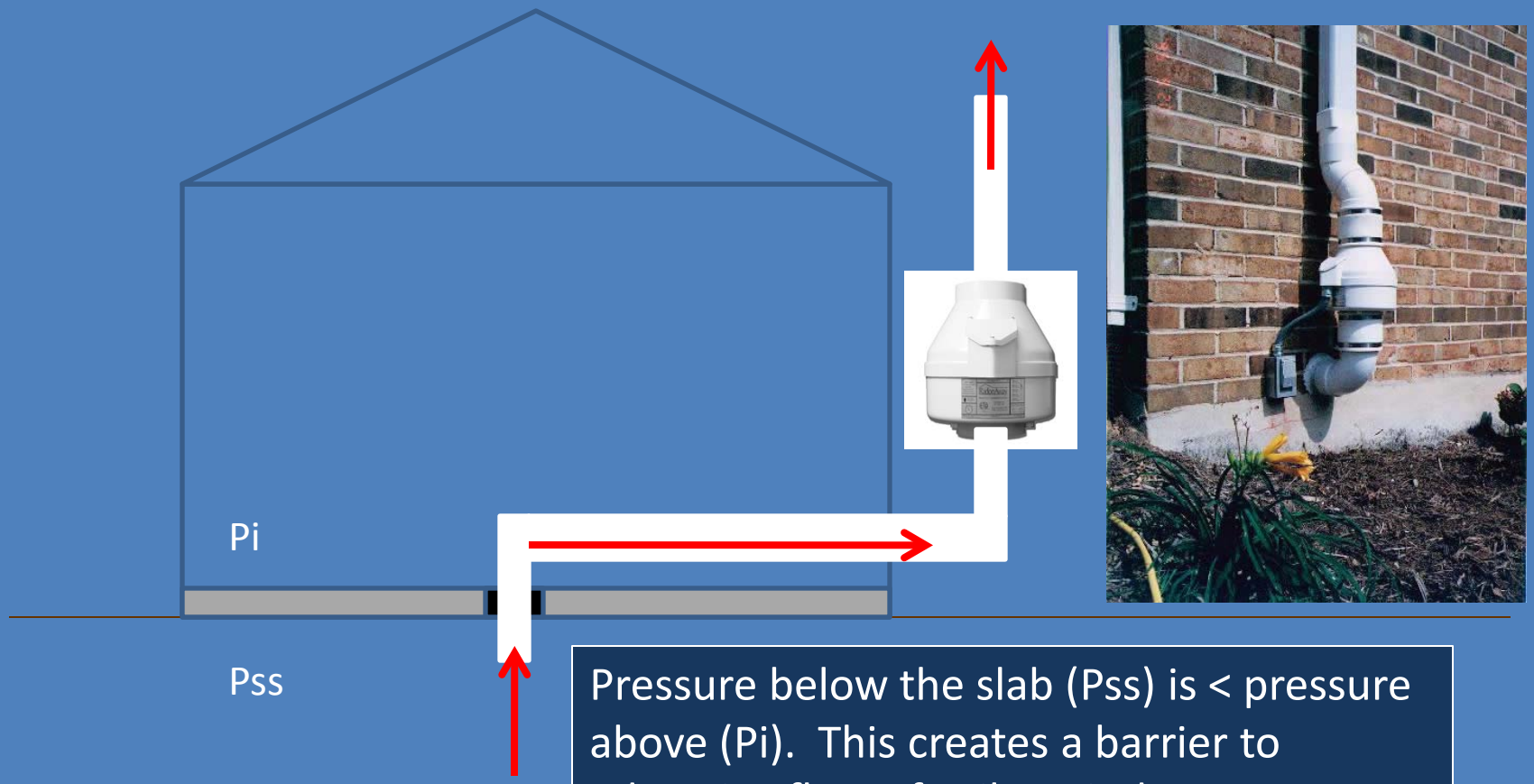
Tier II Assessment Decision Matrix-Carcinogens

indoor air measurement/ sub-slab soil gas measurement	**indoor air** concentration < indoor air SL	**indoor air** concentration > indoor air SL, but < 10 times the SL	**indoor air** concentration > 10 times the SL
sub-slab soil gas concentration < applicable SL	no need for mitigation	Repeat sampling; investigate potential indoor sources	Repeat sampling; investigate potential indoor sources
sub-slab soil gas concentration > applicable SL, but < 10 times the SL	no need for mitigation	repeat sampling; mitigate if multiple consecutive indoor air samples exceed the SL.	investigate potential indoor sources; mitigate if unable to locate/isolate indoor sources
sub-slab soil gas concentration > 10 times the applicable SL	Repeat sampling	Repeat sampling; mitigate if multiple consecutive indoor air samples exceed the SL.	mitigate
no **sub-slab** soil gas data	Repeat sampling if sub-slab soil gas concentration is likely to be > 10 times the SL; collect sub-slab data, if possible, during repeat sampling	Repeat sampling; collect sub-slab data if possible	mitigate

[1] This refers to the indoor measurement due to VI.
Commonly this will be estimated to be the [max measured indoor concentration] – [representative measured, same-day, ambient air concentration]

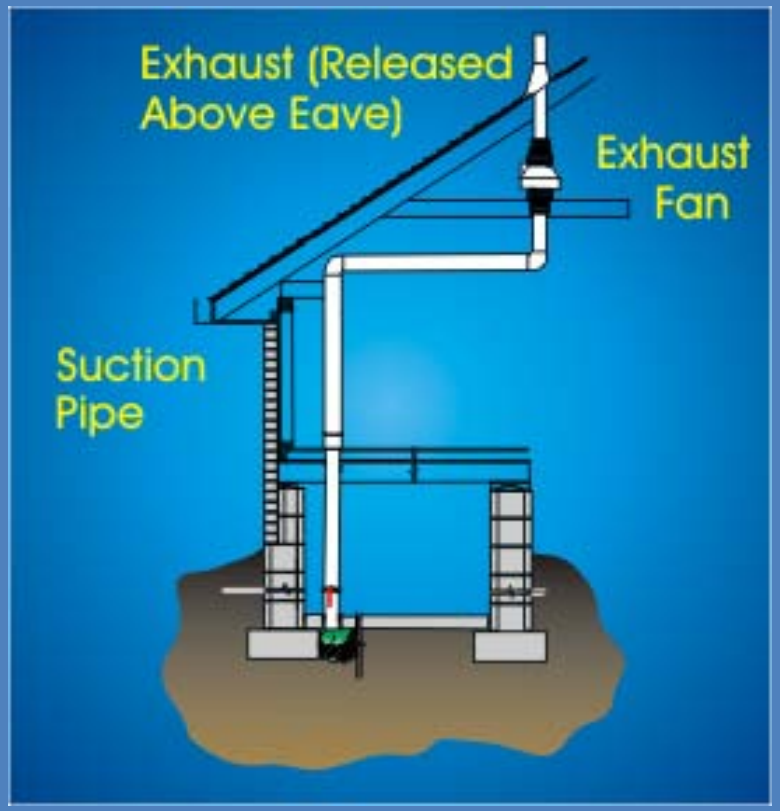
Example Mitigation:
sub-slab depressurization

Buildings constructed slab-on-grade or with basements



Pressure below the slab (Pss) is < pressure above (Pi). This creates a barrier to advective flow of soil gas indoors.

Example Mitigation



At the End of the RI:

From Tier I:

- Site areas where VI should not be a problem
- Site areas where there are no buildings, but VI could be a problem if buildings were constructed

From Tier II:

- Site areas with buildings where VI is not currently a problem
- Site areas with buildings where VI is currently a problem, and the buildings have not been mitigated
- Site areas with buildings where VI is currently a problem, and the buildings have been mitigated

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