



Using the Vapor Intrusion Model (ViM) to bring out the best in the Johnson and Ettinger (J&E) Model

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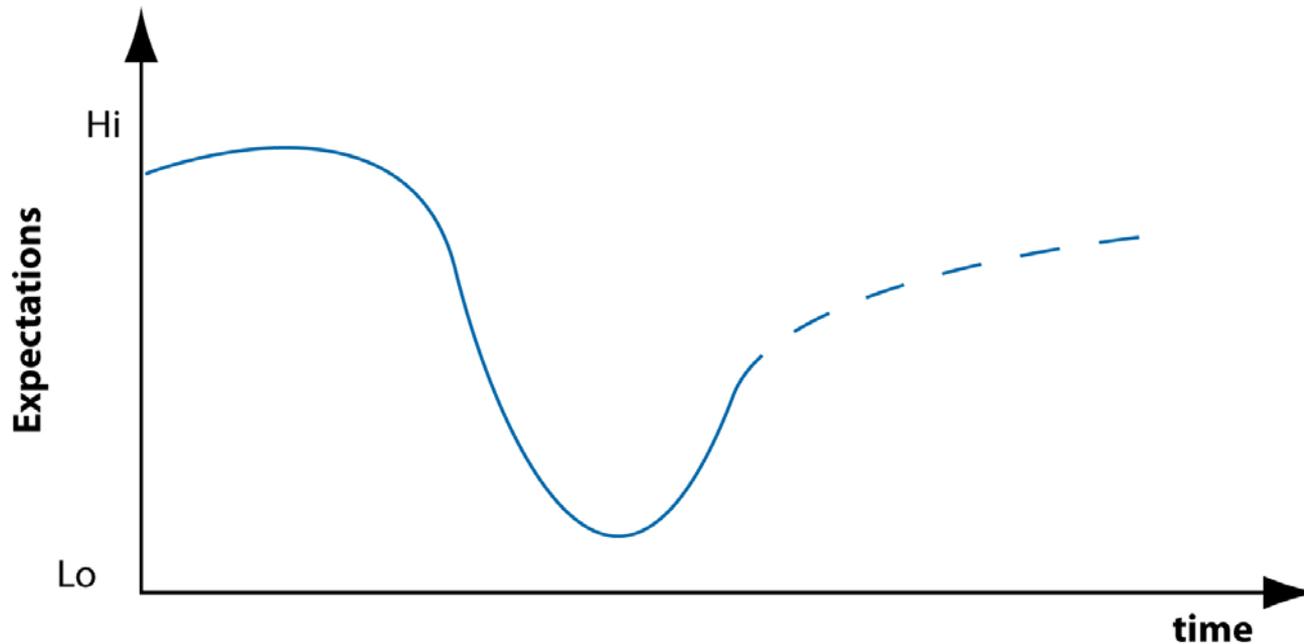
April 2, 2009

Presentation Outline

- Background: A little bit about the models
- What makes us think we can use ViM to inform J&E?
- How we can do that (some examples)
- Conclusions

What are models?

- Simplifications of reality
- Models *may* be useful
- Often there is a mismatch: expectations vs. performance

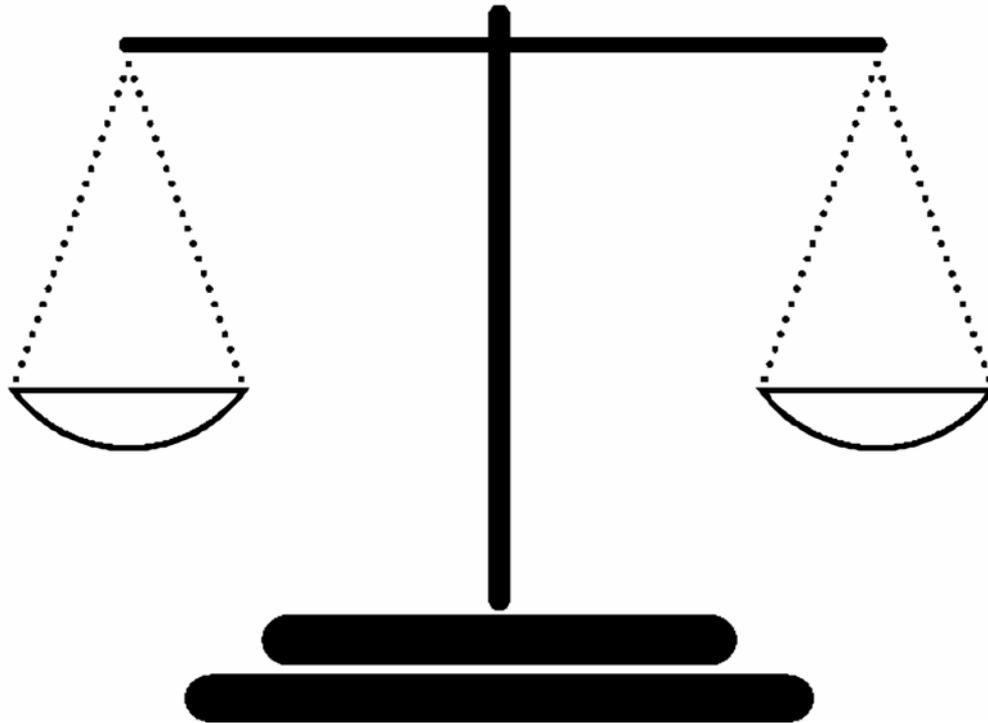


Why model VI?

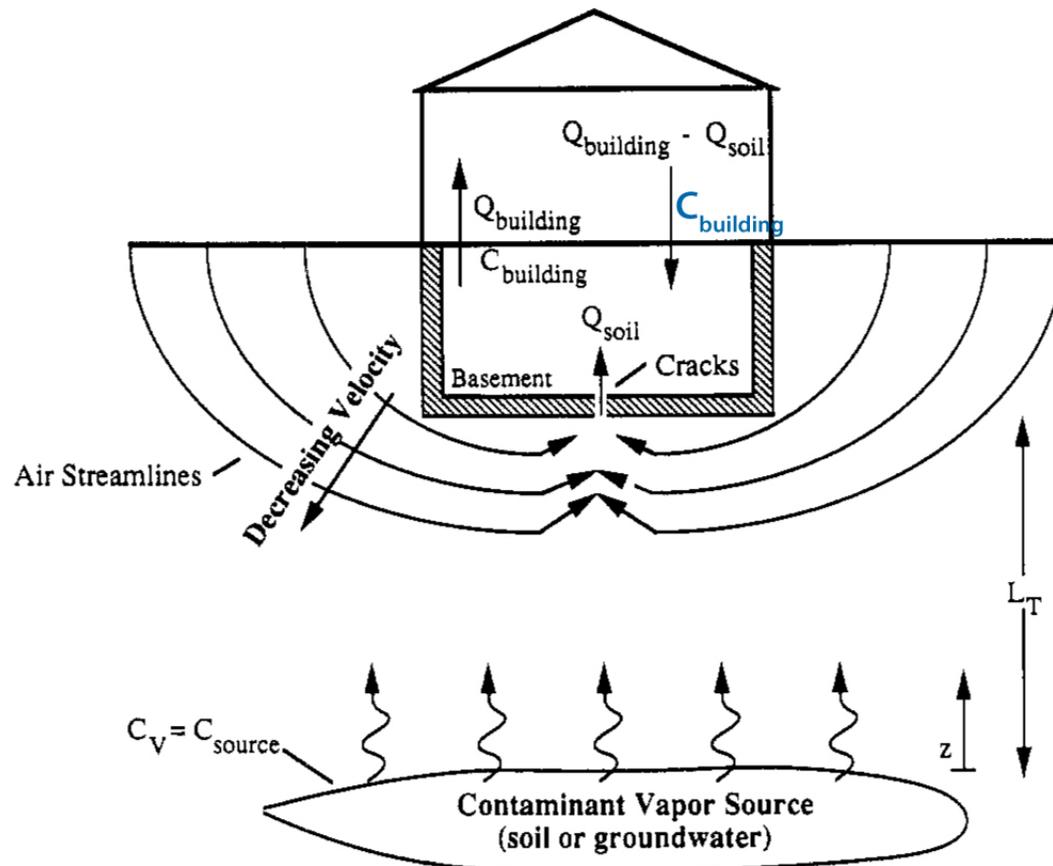
- Directly sample indoor air

OR

- Generate multiple lines of evidence for VI
- Suppose building does not exist

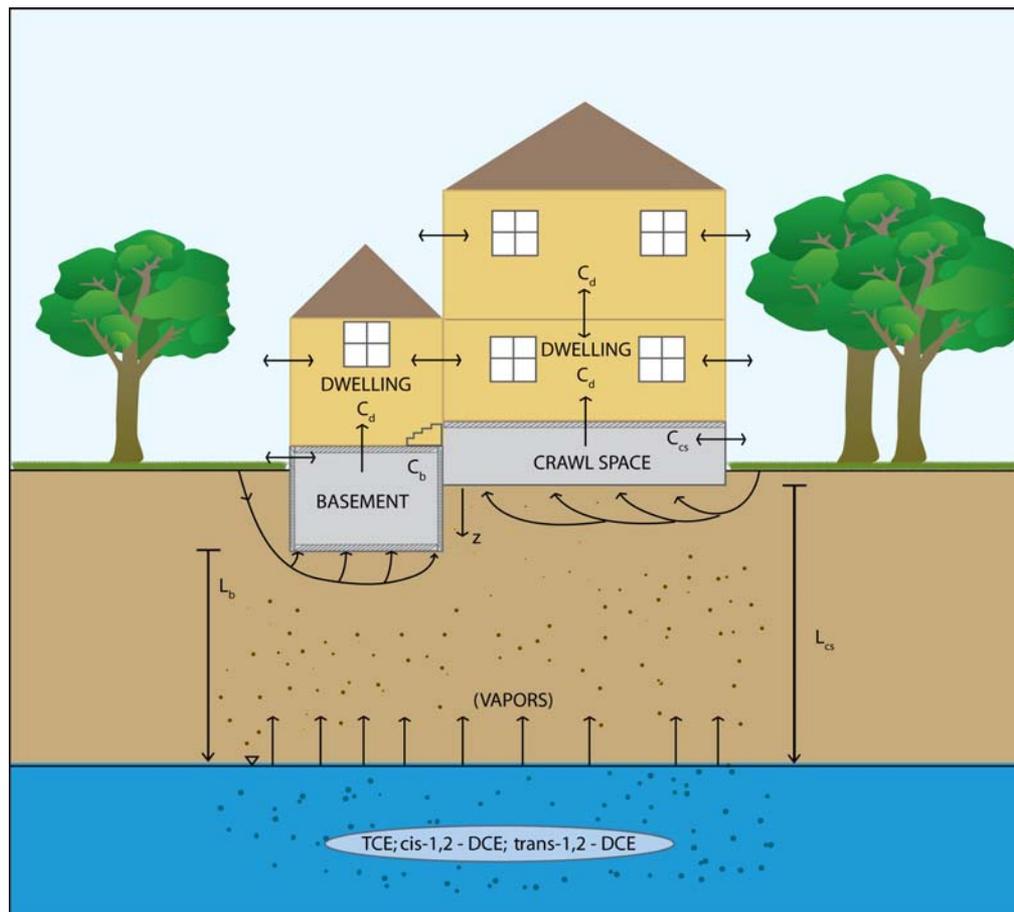


A little bit about the J&E model and vapor intrusion



(From Johnson & Ettinger, 1991)

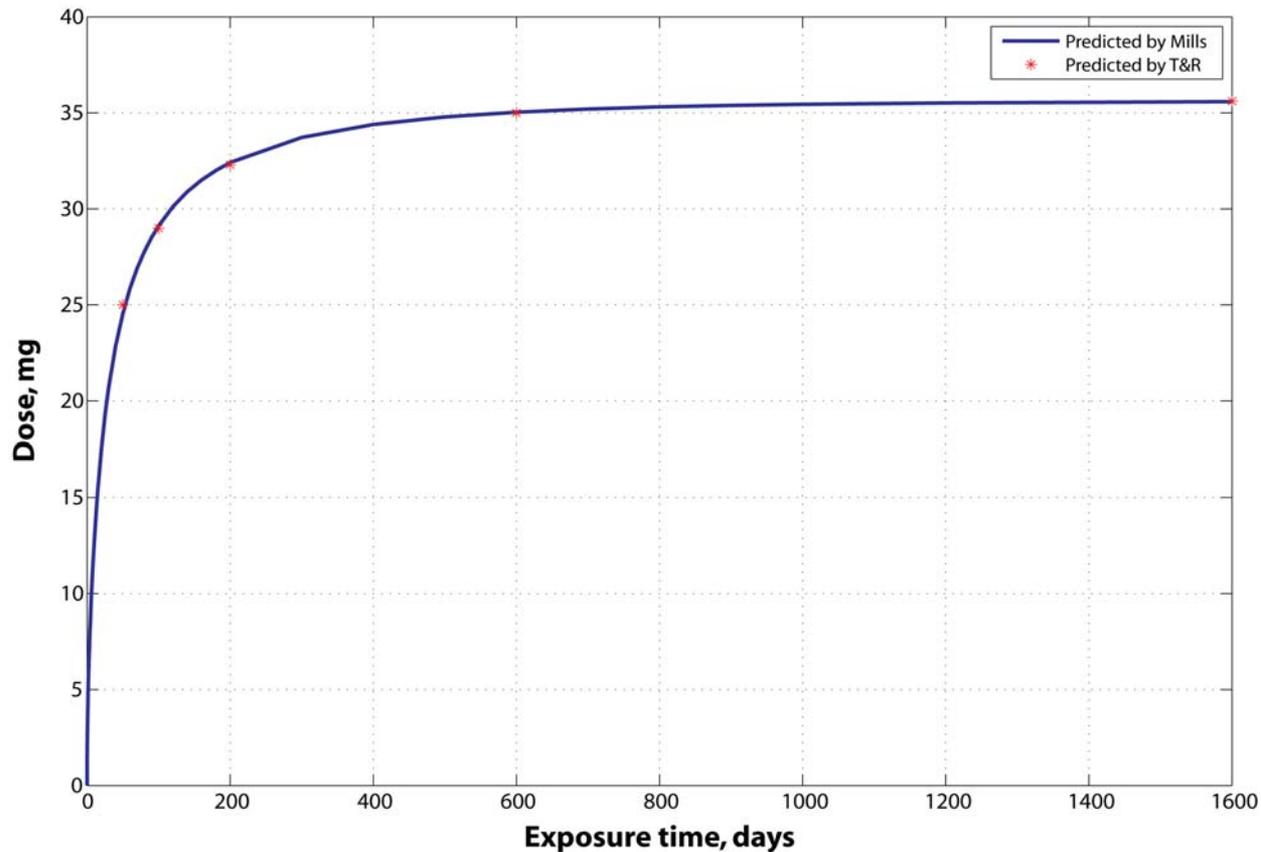
A little bit about ViM, a second VI model



(From Mills et al., 2007)

How ViM came to be

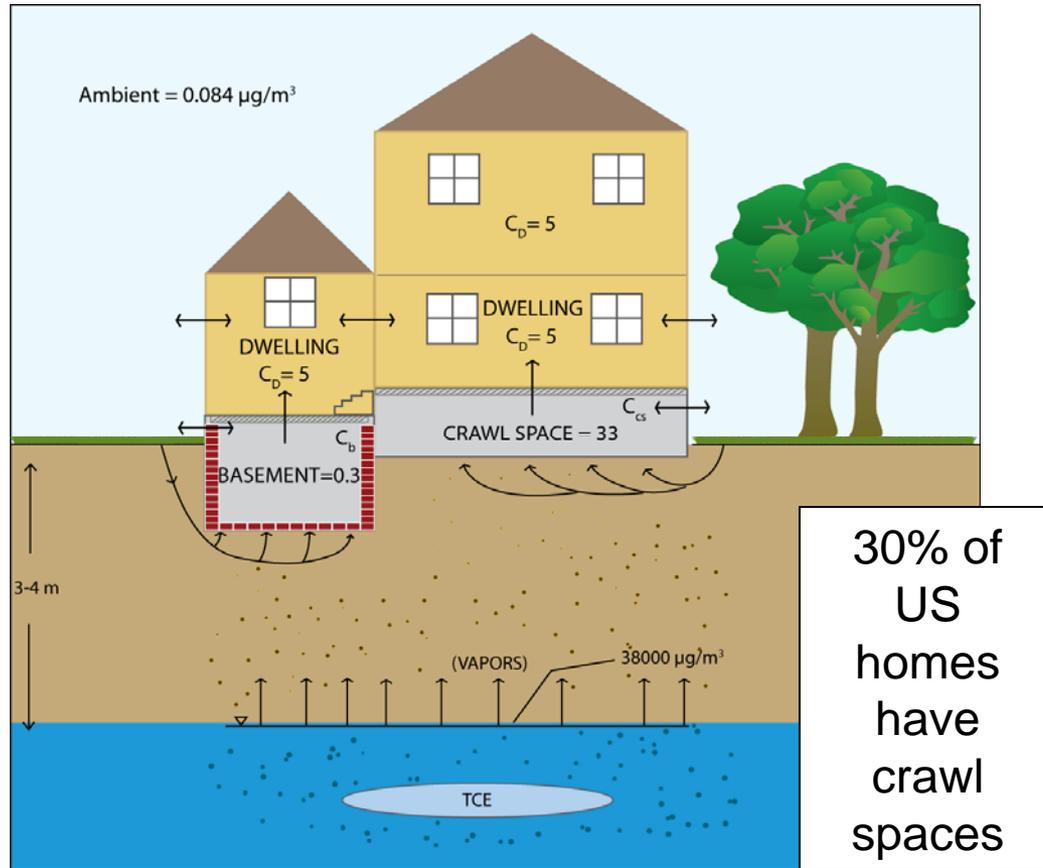
- Turcznowicz and Robinson (2001) were interested in VI from buildings with crawl spaces



Building with crawl space

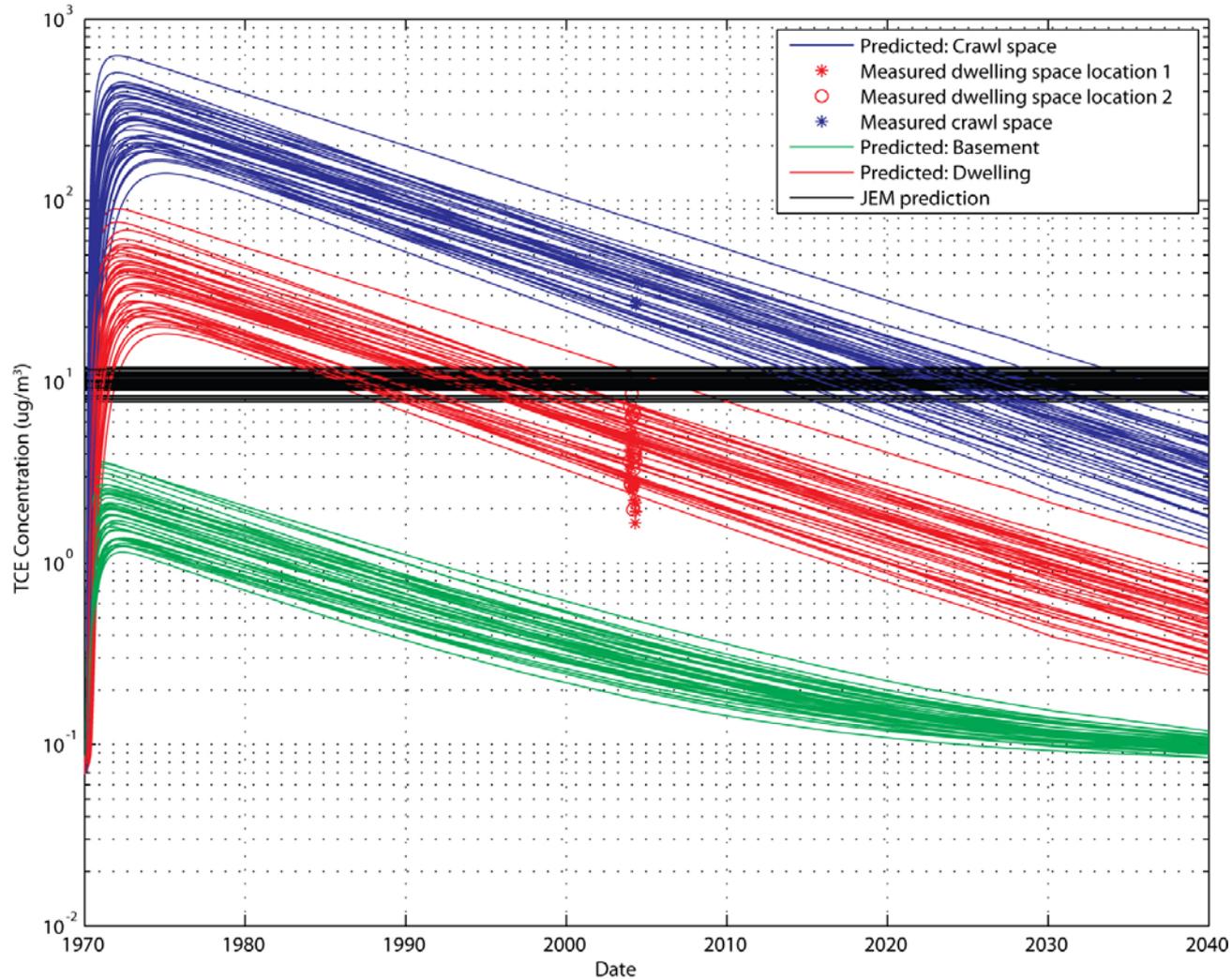


Building Conceptualization



- Crawl space was more conducive to vapor intrusion than basement

By the way...How ViM and J&E compare

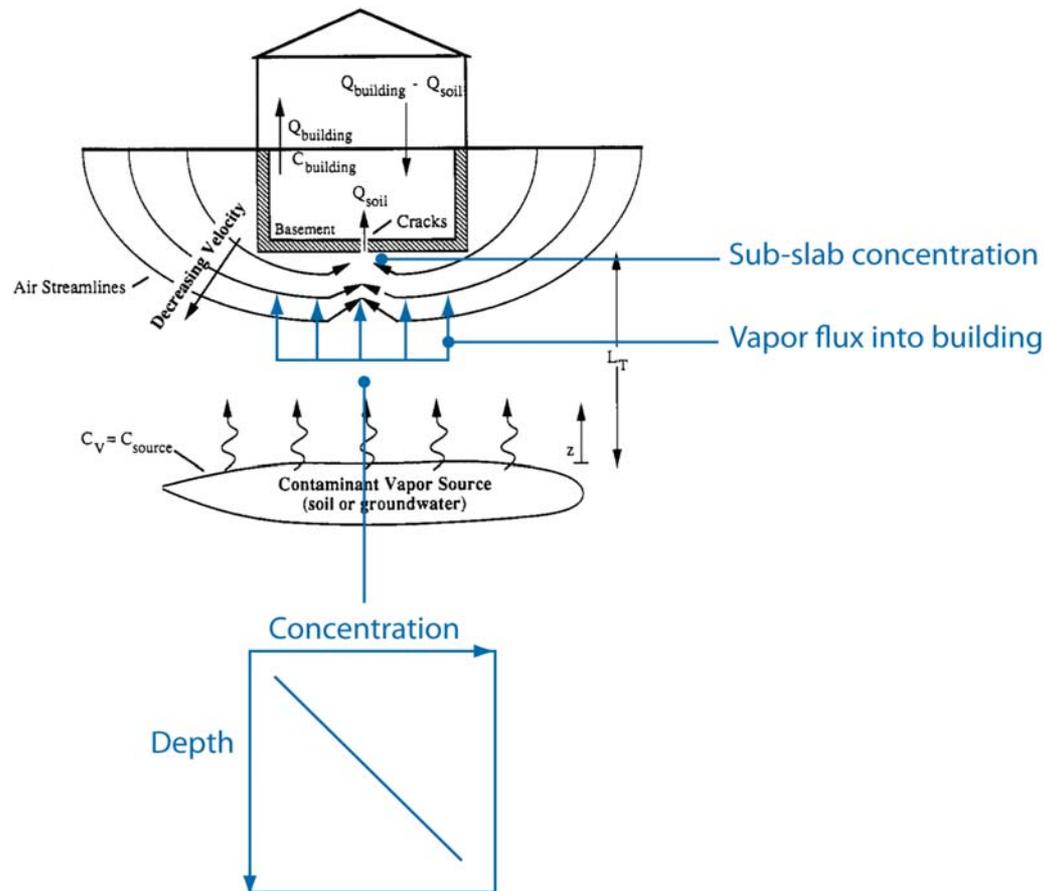


How ViM can inform J&E

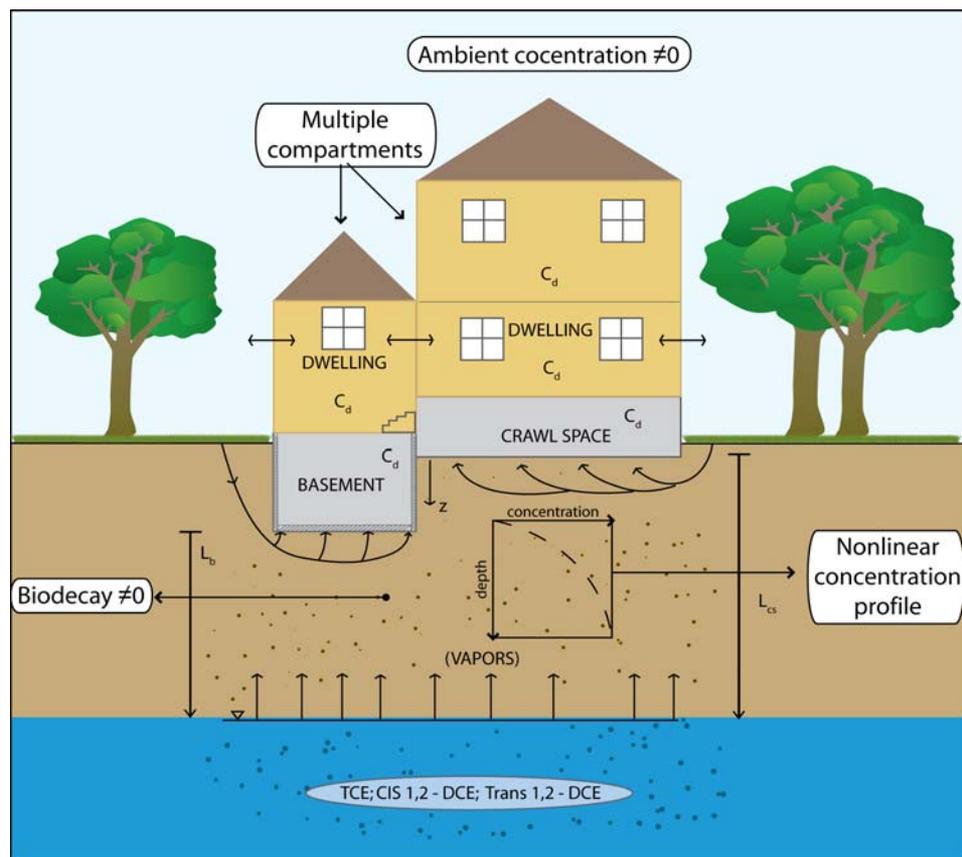
- Motivation: Experience at DoD sites with ViM and a generalized version of J&E programmed in ViM
- Three categories of ways ViM can inform J&E:
 - **Generate additional J&E output/predictions** without changing the model at all
 - **Expand the model's capabilities** slightly but keep in Excel spreadsheet (don't destroy this convenient feature)
 - **Add some supplemental external calculations** that help to interpret J&E results (but don't modify the model at all)

J&E: Report additional predictions (no new capabilities)

- Additional predictions
 - Sub-slab concentrations
 - Vapor intrusion flux rate into building
 - Concentration profile in unsaturated zone



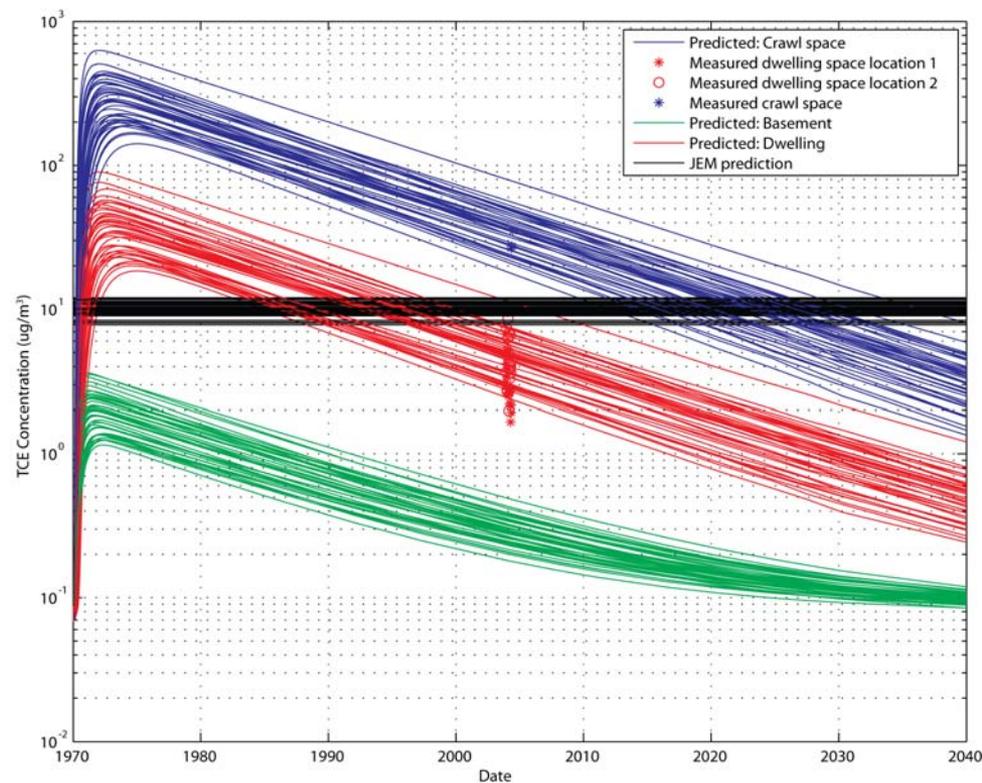
Slightly expand J&E's capabilities



- Still in Excel!
- Equations in Mills et al. (2007)

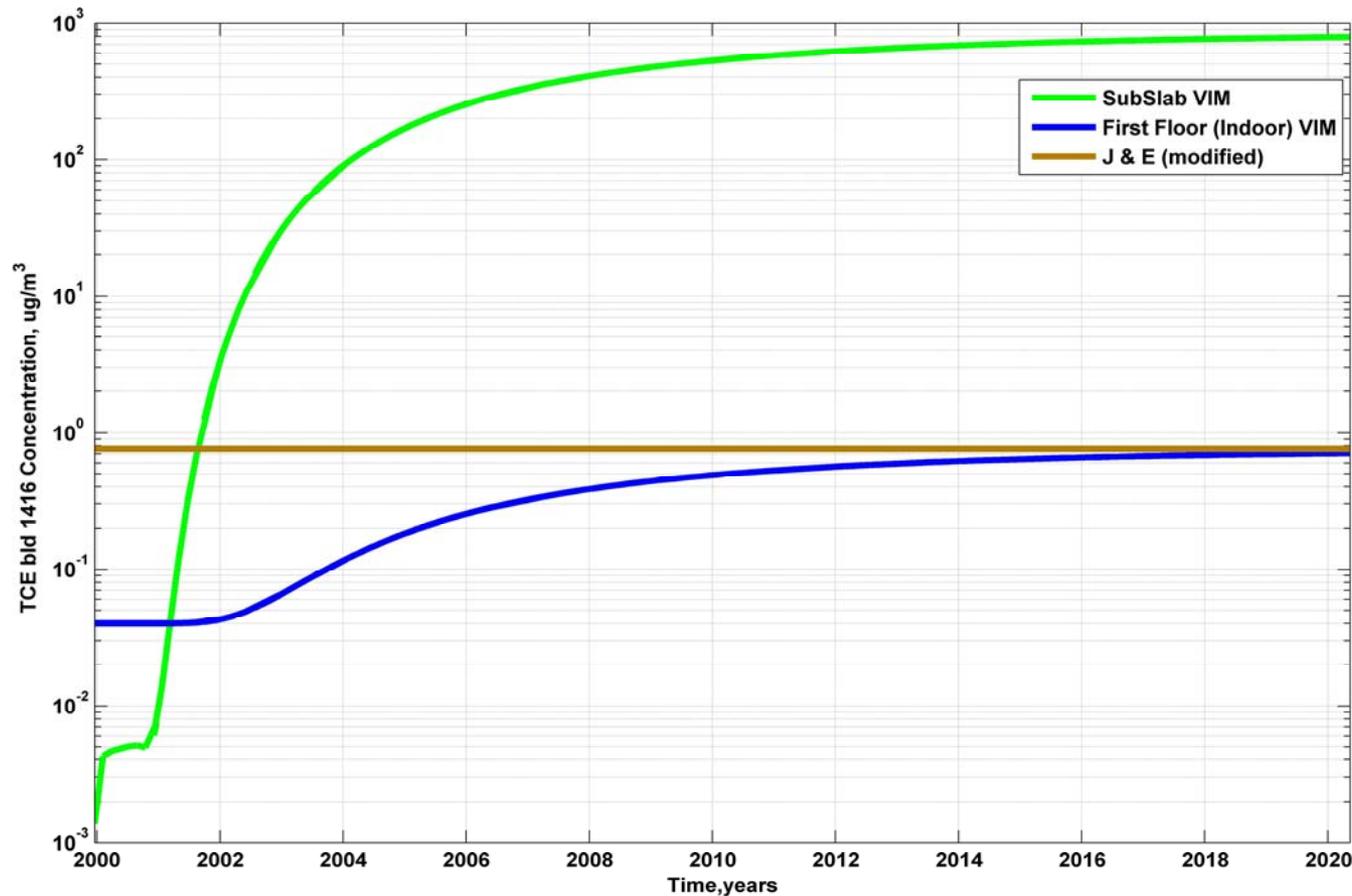
Moderately expand J&E for Monte Carlo analysis (still in Excel)

- Monte Carlo: Technique to account for range of predictions in terms of data uncertainties
- Need more data to do this: plausible ranges will work

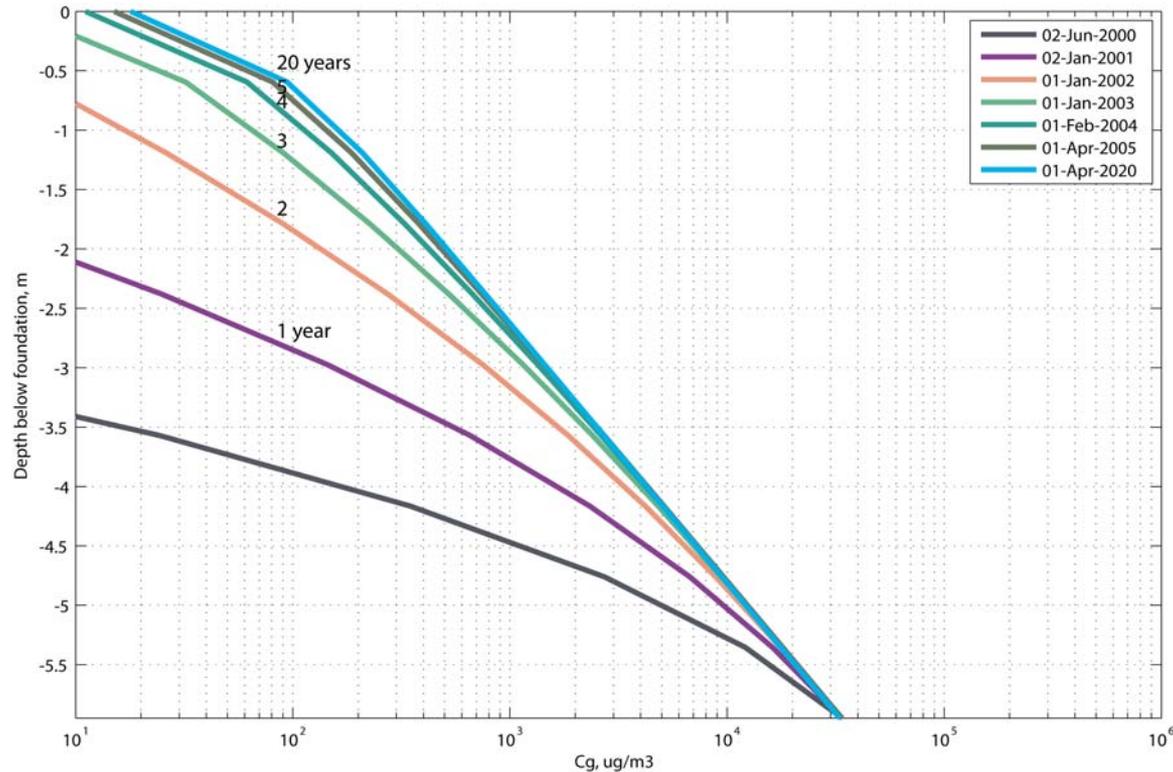


Helping with the steady-state assumption

What is the issue? (AFB in TX)



Time evolution of soil gas profiles



- About 5-20 years to steady-state
- Can we predict this?

$$\Delta t = \frac{z^2}{4D_e} \approx 11 \text{ years}$$

Biodegradation in ViM

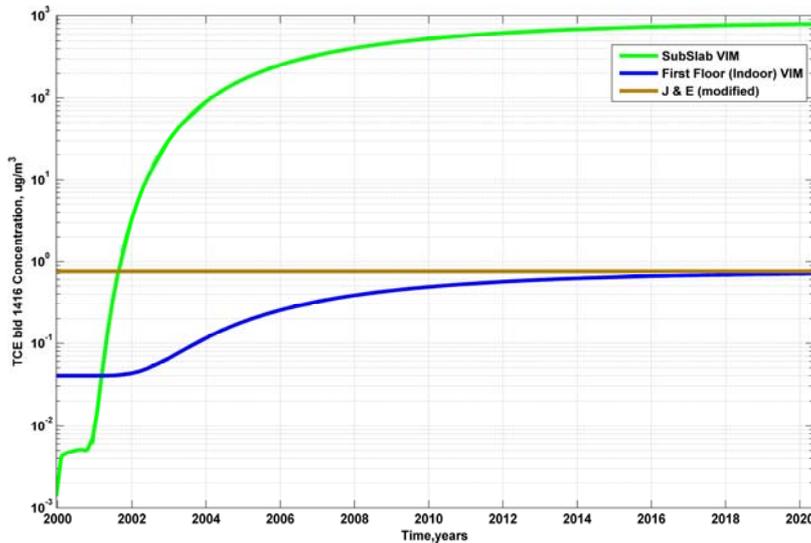
- ViM allows chemicals to biodegrade in soils
- Is it important?

Chemical	Typical half life, aerobic soil
TCE	25-50 days
Benzene	1-2 days

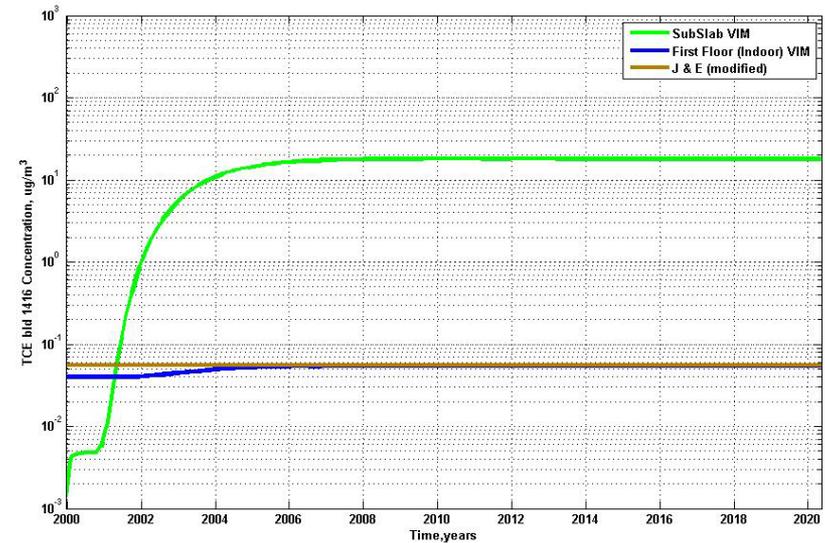
- We demonstrate potential importance for TCE

When is bio-decay important?

Bio-decay = 0

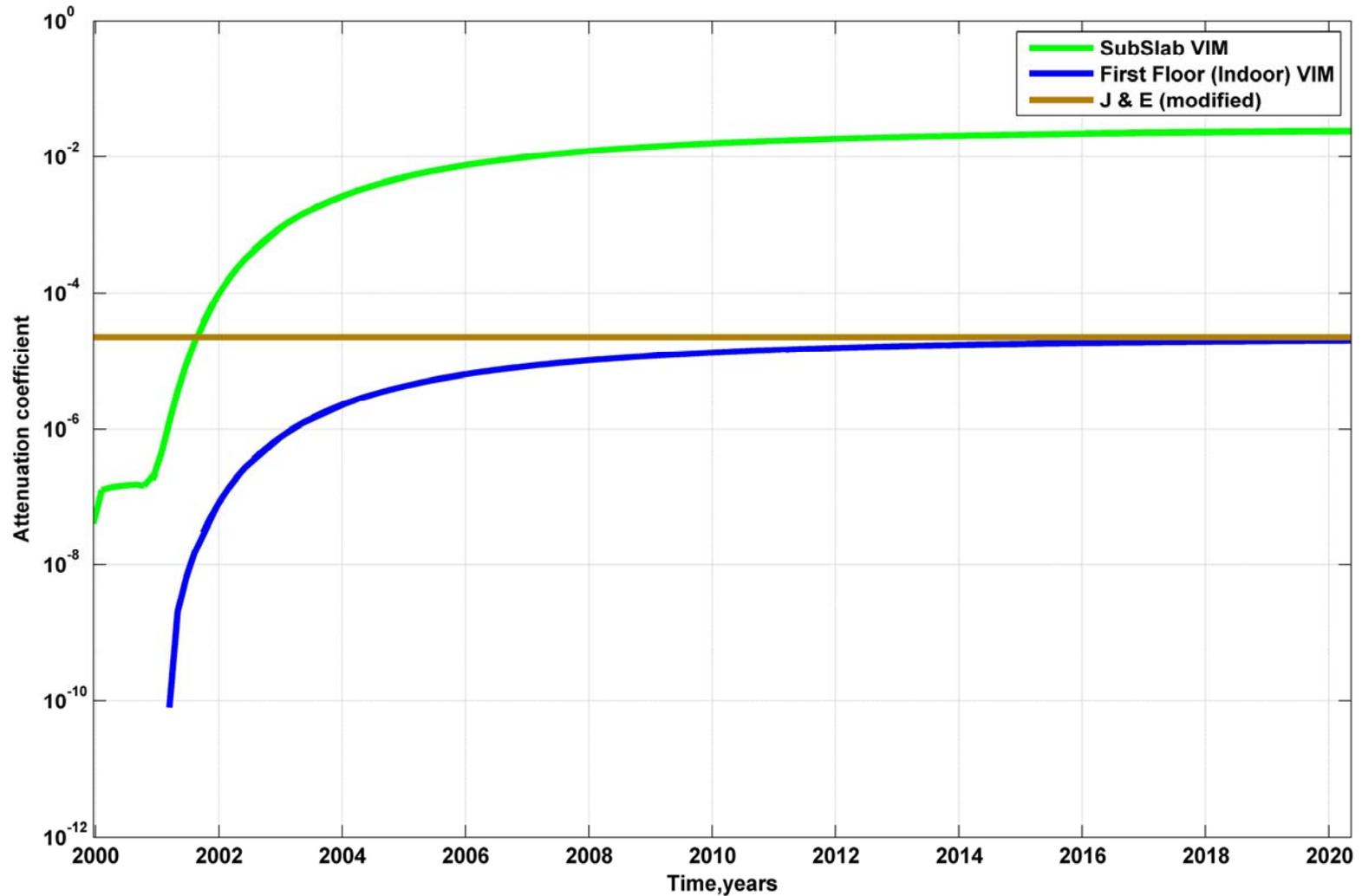


Half life = 25 days



Bio-decay begins to become important when diffusive travel time exceeds half-life

When are attenuation coefficients at steady-state?



ViM informing J&E for air exchange rate (AER)

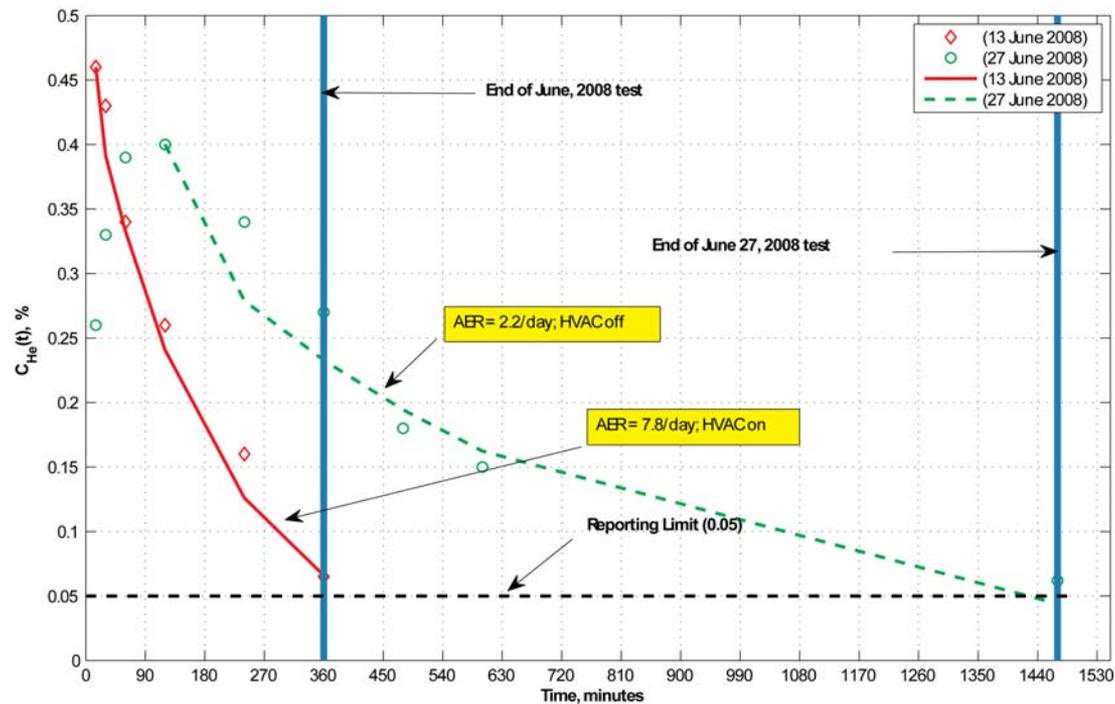
- EPA AER default: 0.25/hr
- Results from 22 studies: Hers et al. (2001)

Description	(per hour)		
	10%	50%	90%
22 studies	0.21	0.51	1.48
Cold climate-winter	0.11	0.27	0.71
Warm climate-winter	0.24	0.48	1.13

DoD study (slab-on-grade buildings)	
FL AFS, HVAC off	0.12-0.13 hr ⁻¹
TX AFB, vigorous air exchange	1.1-1.5 hr ⁻¹

Employ helium release technique

- Inexpensive, easy to implement



- Validation testing and protocol development: completed by June 2009

Conclusions

- Experience with using J&E and ViM have generated ideas regarding J&E
 - #1: J&E can report additional predictions
 - #2: J&E's capabilities can be expanded but still operable in and Excel spreadsheet:
 - Ambient concentration
 - Biodecay
 - Concentration profiles
 - Multiple compartments
 - #3: ViM features have lead to ideas to assist J&E modeling:
 - Time to steady-state
 - AER approach