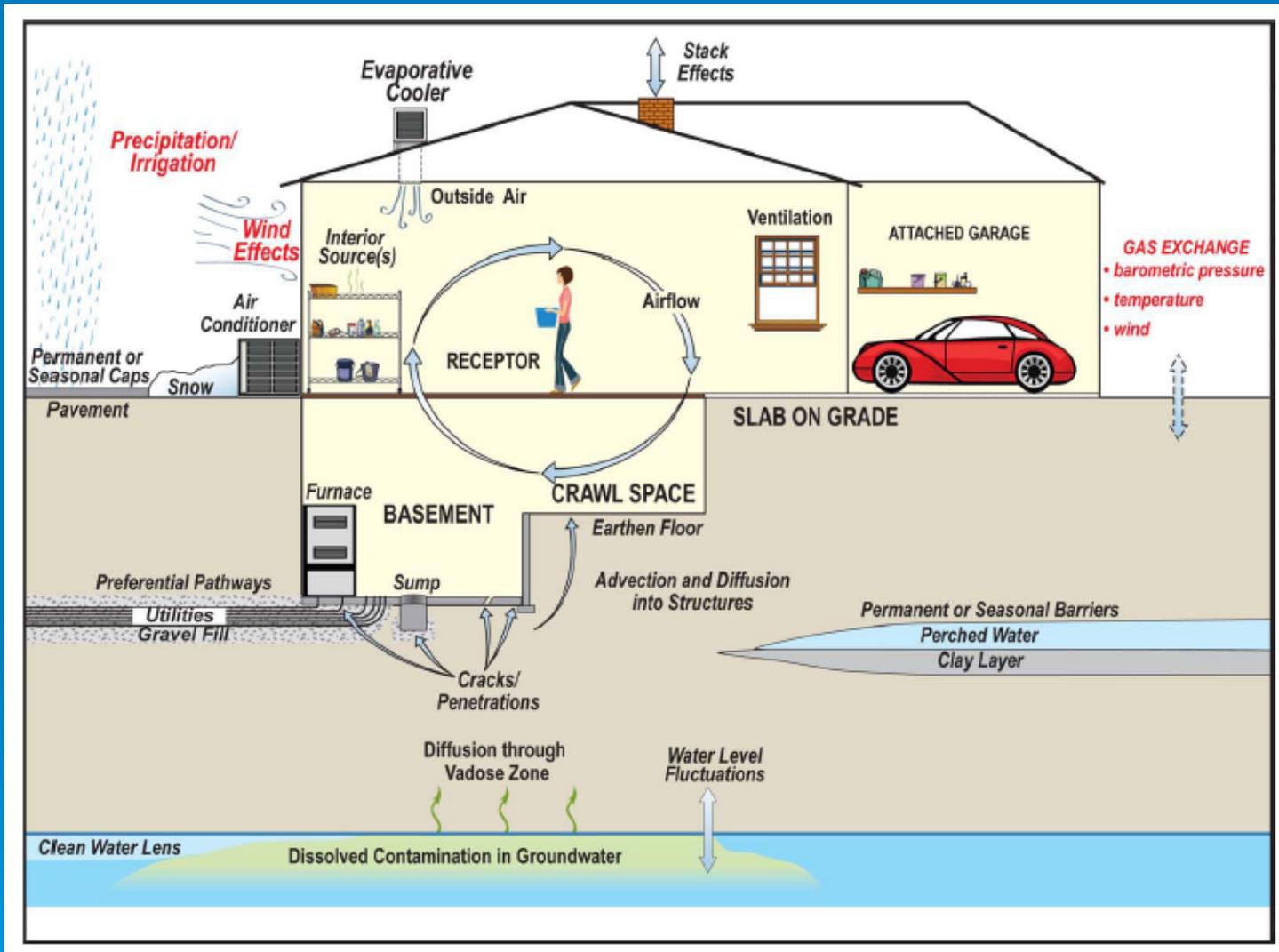


Update on Vapor Intrusion into Indoor Air

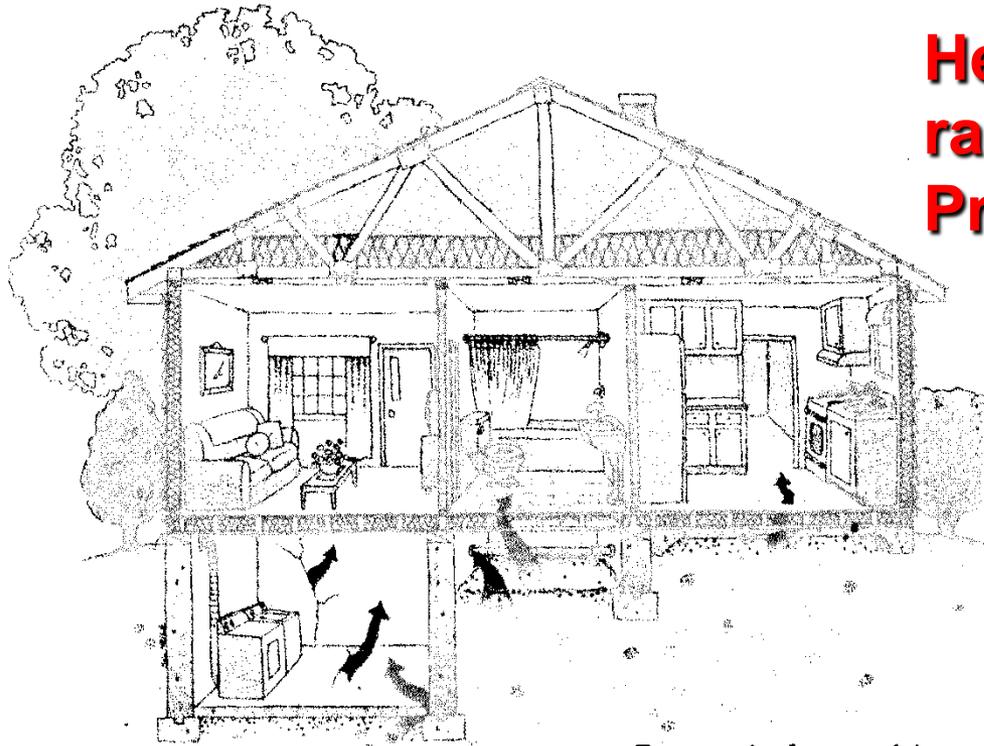


Basic Conceptual Site Model (CSM)



CSM

How Does Radon Enter A House?



Here's an illustration of radon entering a house. Pretty similar looking.

Common Radon Entry Points

Four main factors drive radon entry into homes. All of these factors exist in most homes throughout the country.

1. Uranium is present in the soil nearly everywhere in the United States.
2. The soil is permeable enough to allow radon to migrate into the home through the slab, basement or

3. There are pathways for the radon to enter the basement, such as small holes, cracks, plumbing penetrations or sumps. All homes have radon entry pathways.

4. An air pressure difference between the basement or crawlspace and the surrounding soil draws radon into the home.

Vapor intrusion is very similar to radon.

A lesson learned from radon:

Sampling radon outside the house
doesn't tell you what levels are actually in
the indoor air in the house!

The Nature of Vapor Intrusion

➤ Exposures in personal living spaces

➤ Unavoidable (inhalation)

➤ Involuntary

➤ Intake 20,000 liters (20m³) air per day



- Results in low acceptable levels in indoor air
 - sometimes from low concentrations of COCs in groundwater.
 - exposures comparable to a 2 L/day of water MCL of 5 ug/l water ~ 0.5 ug/m³ air

EPA never finalized the draft 2002 Vapor Intrusion guidance

This ultimately led to an Inspector General Report that said they needed to finalize it.

In September 2010 USEPA Region 6 came up with their own policy for RCRA sites.



Why Issue a Region 6 RCRA Vapor Intrusion Policy?

- Concern for human health (often overlooked or minimized pathway).
- Encourage a more consistent approach to investigation and evaluation in our Region.
- Provide updated guidance based on best available science and experience (final guidance is due 11/30/12).
- EPA Region 6 and Region 6 states appear to be lagging behind in vapor intrusion know-how compared to many areas of nation.



- What's was new in the 2010 Region 6 policy?
- Bottom Line:
- The new region 6 policy called for indoor air sampling and sub slab sampling if you have an occupied building within 100 feet of a groundwater plume with a concentration greater than the MCL. But it also focussed on multiple lines of evidence.
- (Pathway not always vertical, more like a subsurface cloud or mist).

Multiple Lines of Evidence

- Since the Nov. 2002 draft there has been considerable improvement in understanding the science behind vapor intrusion and the methods to address it. It takes multiple lines of evidence to determine if VI is occurring or not.
- Not all lines of evidence are created equal or should be given the same weight.

Components:

- 1) indoor air
- 2) subslab data
- 3) comparison to outdoor (ambient) levels
- 4) comparison to indoor background levels
- 5) chemicals of concern and degradation products
- 6) building construction and current condition
- 7) J&E model estimates
- 8) constituent ratios (indoor air, subslab, soil gas, groundwater)
- 9) marker chemicals
- 10) spatial correlations
- 11) chemical concentration
- 12) pressure gradients
- 13) expected attenuation factors



Vapor Intrusion

Draft Final Guidance

April 2013



The decision trees are really easy to follow

Does data indicate the need for prompt action?

Yes

Implement response actions as appropriate
(See sections 8 & 9)

The decision trees are really easy to follow

Does information indicate a source of vapor forming chemicals in the subsurface?



Does information indicate the actual or potential future presence of buildings nearby?



Plan and conduct a detailed vapor intrusion Investigation/evaluate data (see Figure 6-1)

The decision trees are really easy to follow

Scope and prepare a work plan



Collect samples and complementary lines of evidence. Characterize subsurface vapor sources. Test indoor air. Characterize vapor migration from source to sub slab. Evaluate contribution from background sources.



Update Site Conceptual Model
Resolve inconsistencies
Verify boundaries of inclusion zone

Major Themes

- **Gather indoor air samples sooner**
- Gather multiple lines of evidence (such as)
 - Groundwater
 - External soil gas
 - Sub slab soil gas
 - Indoor air
 - Ambient air
 - Modeling
 - Background indoor air concentrations

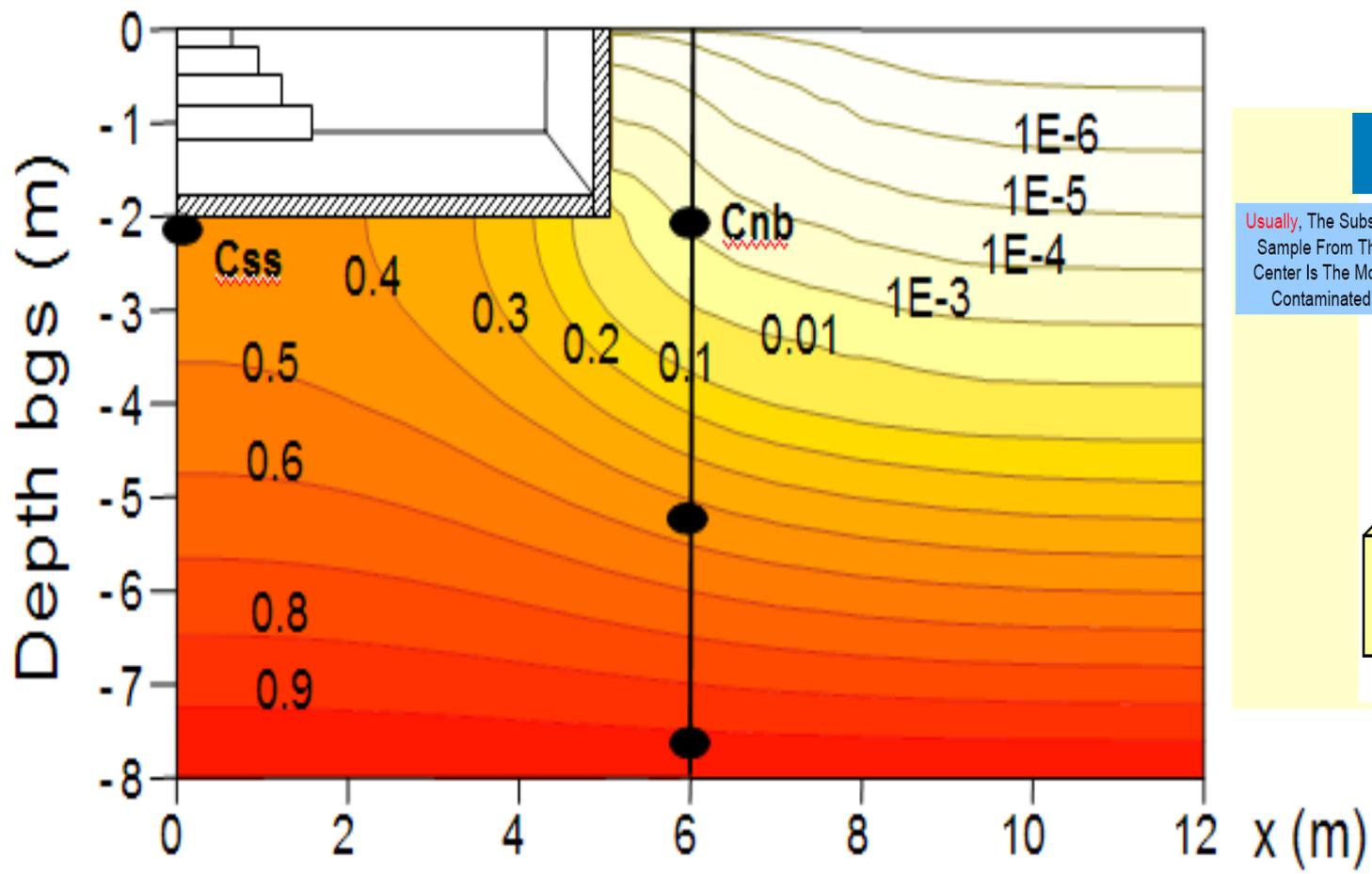
Groundwater

(Not a lot of change. Usually what screens things in)



External Soil Gas

- Recommended to take sample from directly above groundwater
- Can be used for corroborating line of evidence, but can't be expected to accurately estimate indoor air concentrations
- Not appropriate for use as single line of evidence with site specific attenuation factors



C_{nb} : near building soil gas concentration
 C_{ss} : subslab concentration

L. Abreu, 2006

Usually, The Subslab Sample From The Center Is The Most Contaminated

Variable Sub-Slab VOC Concentrations

Sub Slab Soil Gas

- Typically, three samples taken for buildings <math><1500\text{ ft}^2</math>
- Can be used to determine the potential for a vapor intrusion pathway to pose a health concern
- Can be used with attenuation factor to estimate upper bound indoor air concentrations, but several sampling rounds are recommended to observe temporal variability

Indoor Air

- **Most direct approach** of estimating concentrations of chemicals in air
- Evidence since 2002 illustrates the importance of collecting indoor air early

So how often do you have to sample indoor air? In the past there were concerns about temporal variability.

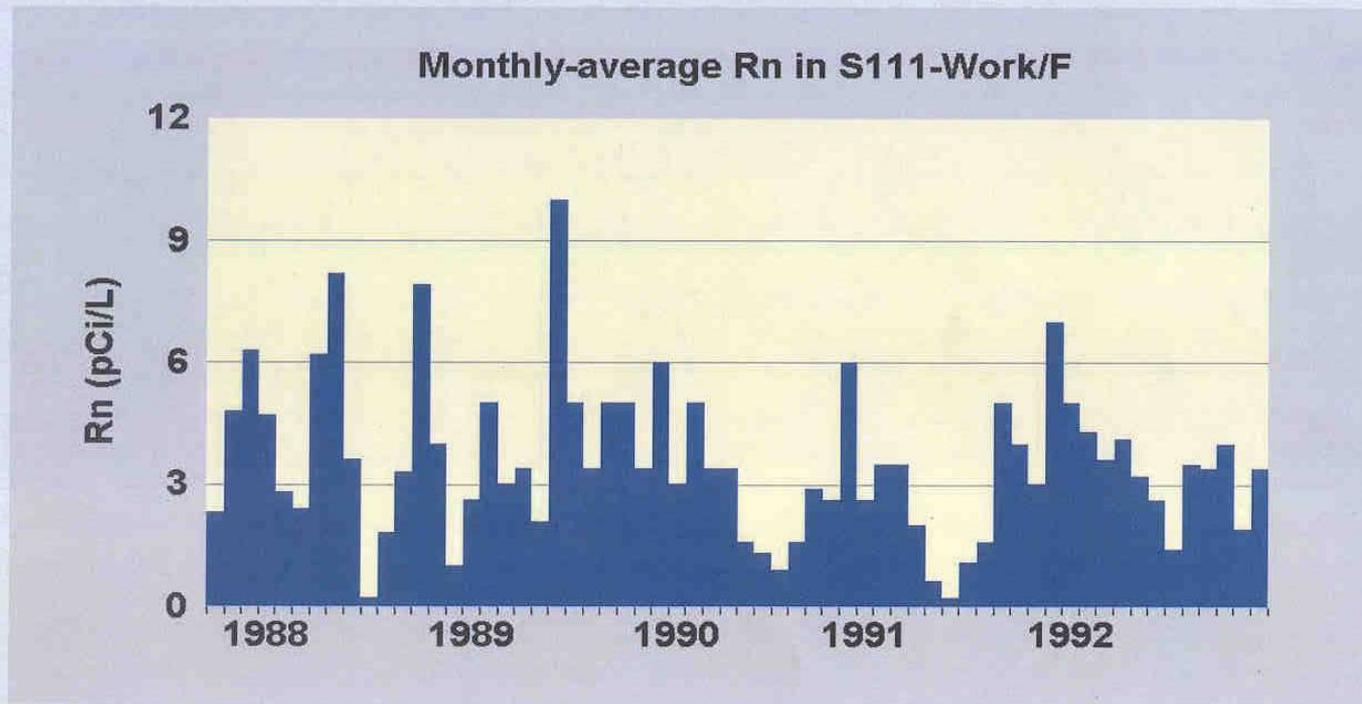
More than one round of sampling is recommended; a single grab sample is not adequate

Steck \leq 2004

<http://www.csbsju.edu/MNradon/indoor radon variation over time.htm>

Month-to-month

Here is a graph of the monthly average radon in a house for the period from the beginning of January 1988 to January 1993. Note that the average radon concentration ranged from a high of 10 pCi/L to less than 1 pCi/L. The true average over the period was 3.5 pCi/L. Even a month-long measurement can be quite far from the long-term average.



If you analyze this graph for seasonal variation, you will find the highest readings in spring and fall, with summer being the lowest. Spring and fall are seasons of active weather at this site that often requires that the house be closed and heated.

Modeling

- The reliability of modeled results needs to be questioned if the model is not calibrated to indoor air concentrations.
- Should not be used as the only line of evidence for ruling out a site

Additional points to consider

- There are some situations when prompt action may be needed
 - Chemical odors are present
 - Physiological effects are observed
 - Wet basements over a plume
- Typically, DEQ uses 1×10^{-5} excess cancer, unless it exceeds the non-cancer endpoint (which is the case for PCE and TCE, as well as a few other chemicals)

Some Positives

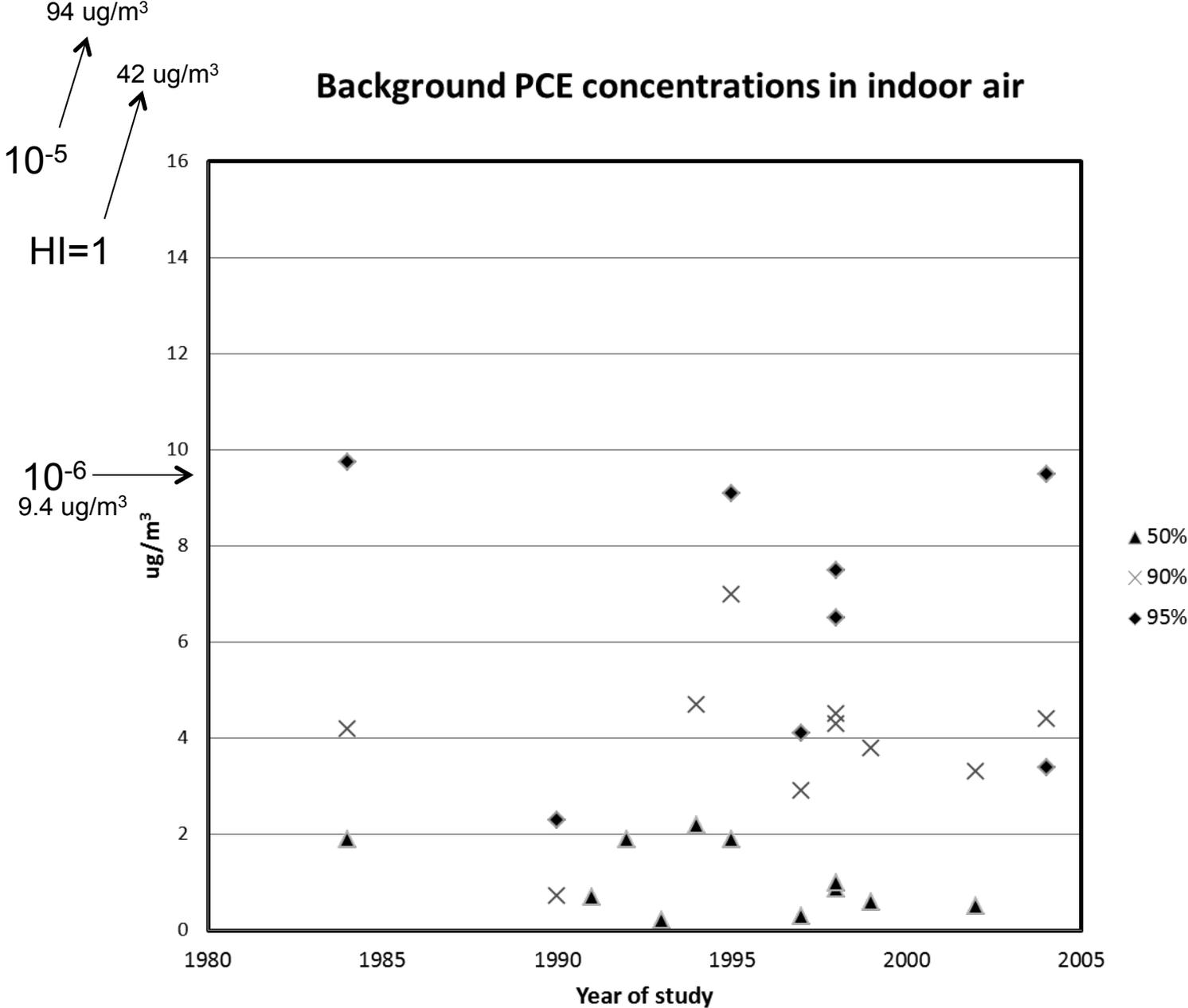
- Site specific attenuation factors can be used for biodegradation of BTEX compounds.
- Not every building needs to be investigated. Representative buildings can be used.

Another Positive

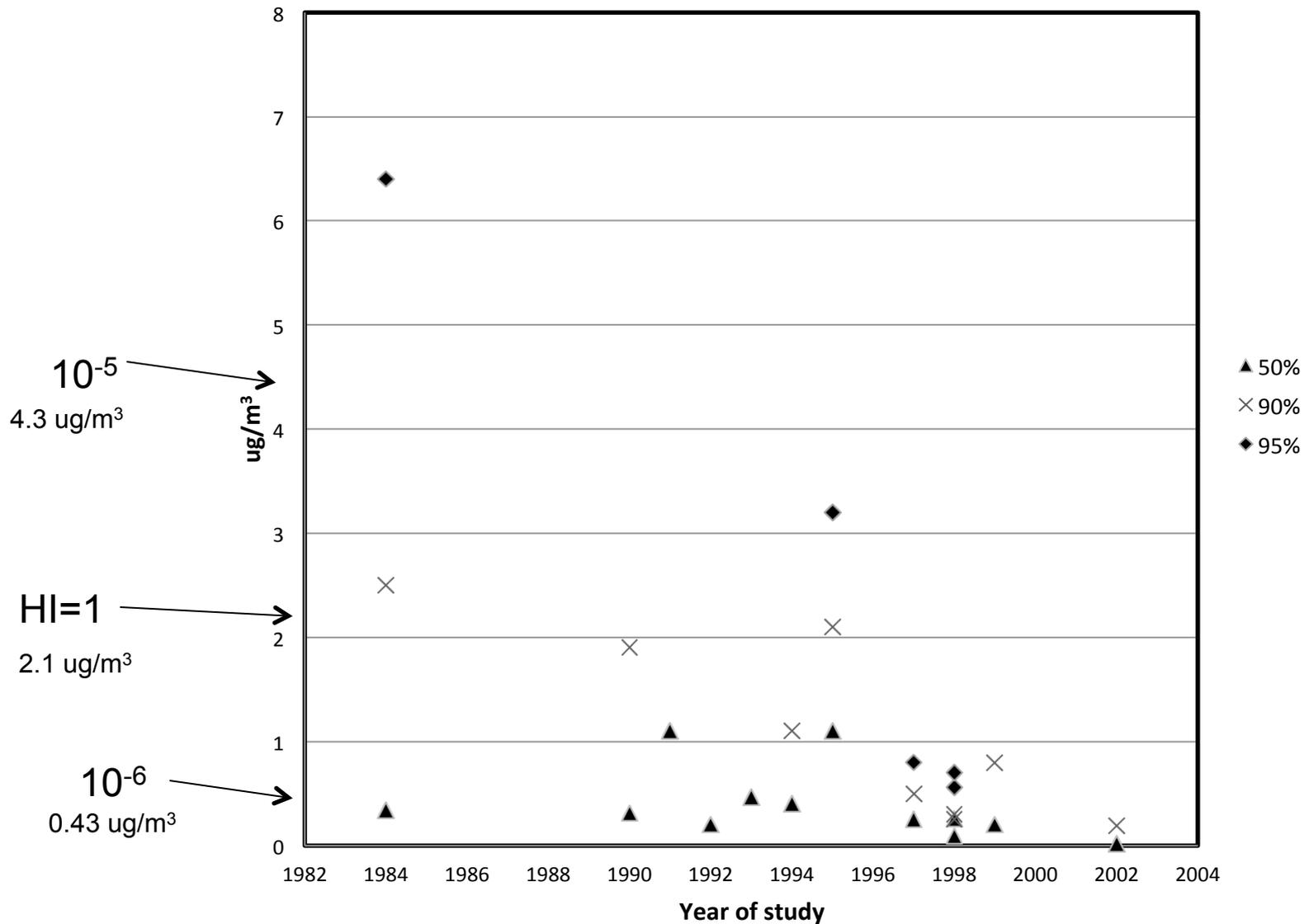
It looks like “background” indoor air concentrations aren’t turning out to be all that bad.



Background PCE concentrations in indoor air

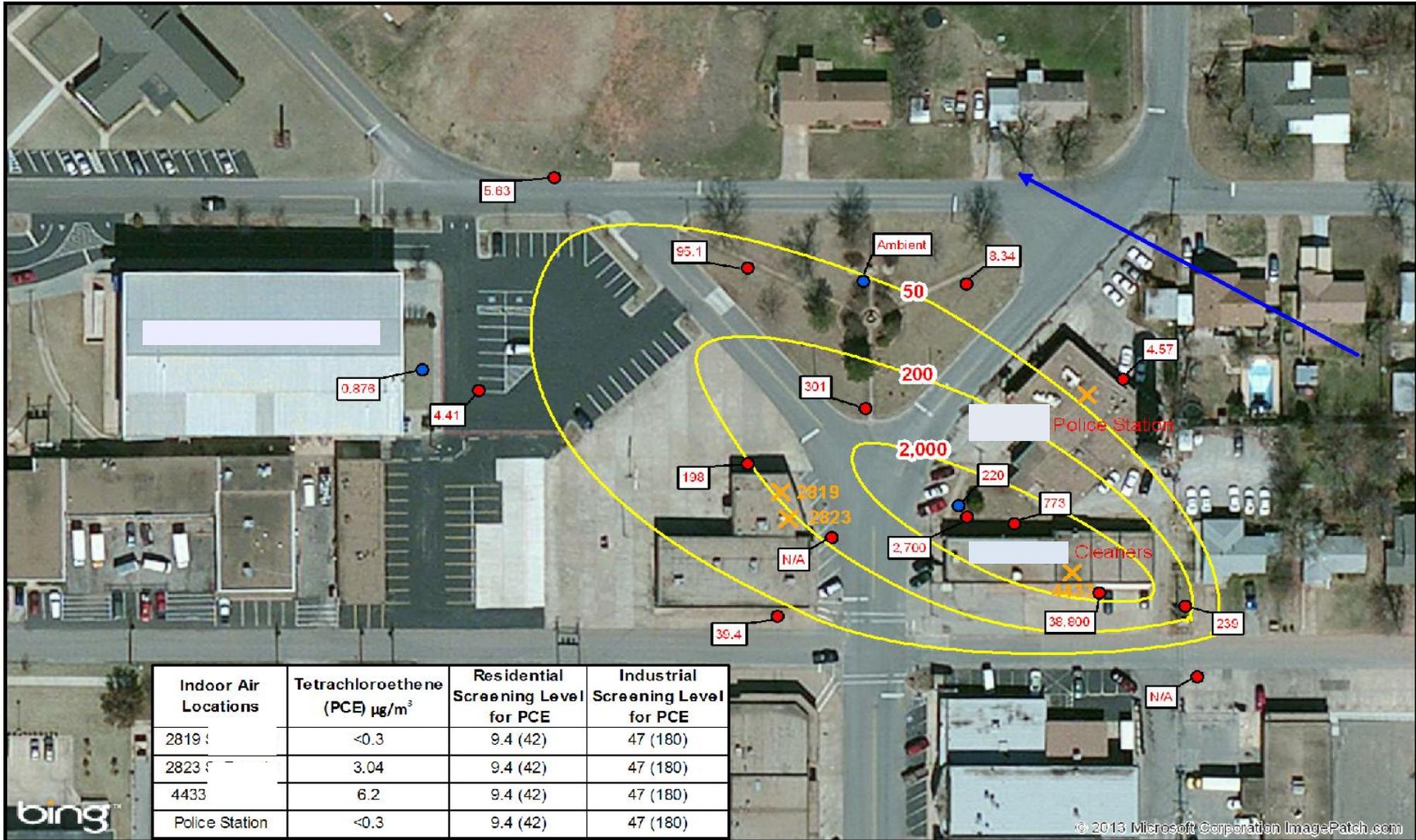


Background TCE concentrations in indoor air



Some examples of multiple lines of evidence





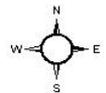
Legend

- Groundwater Monitoring Well
- Soil Gas Sample
- Direction of Groundwater Flow
- ✕ Indoor Air Location



Plume Length : 700+ ft

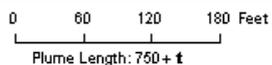
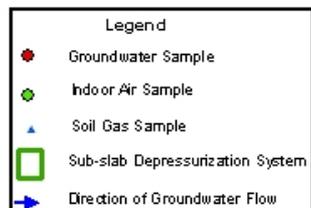
PCE Concentrations ($\mu\text{g}/\text{L}$)



Map Created by Alea Thacker on 11/05/2012

We make every effort to provide and maintain accurate, complete, usable, and timely information. However, some data and information on this map may be preliminary or out of date and is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from, or actions undertaken on the basis of, such data and information are the sole responsibility of the user.

Locations are approximate and contours are interpretive.



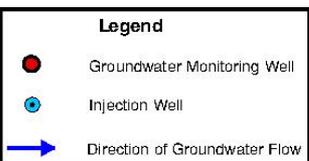
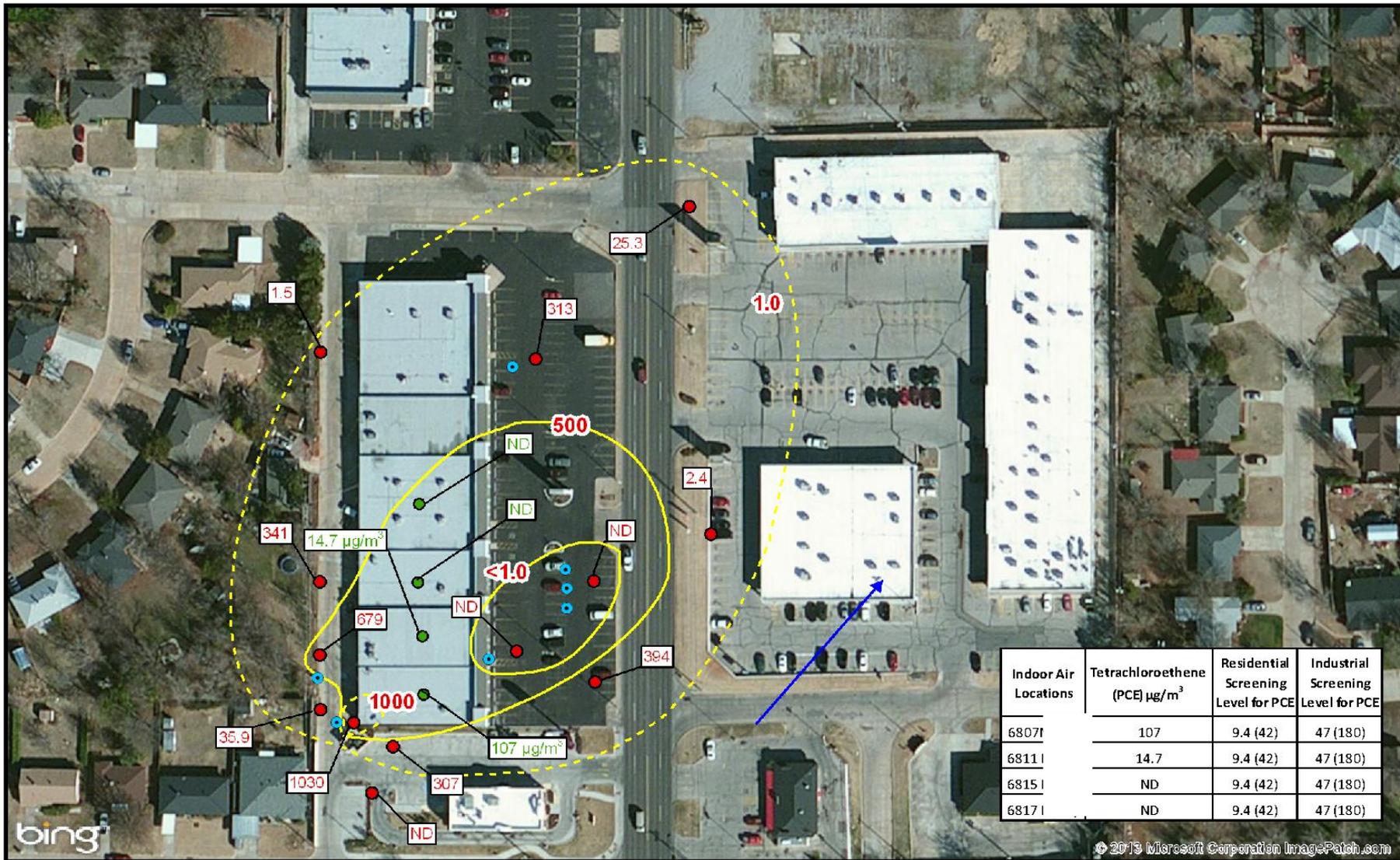
PCE Concentrations ($\mu\text{g}/\text{L}$)



Map Created by Aiba Tacke on 11/13/2012

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PCE Concentrations ($\mu\text{g}/\text{L}$) in Groundwater (Post-Injection)

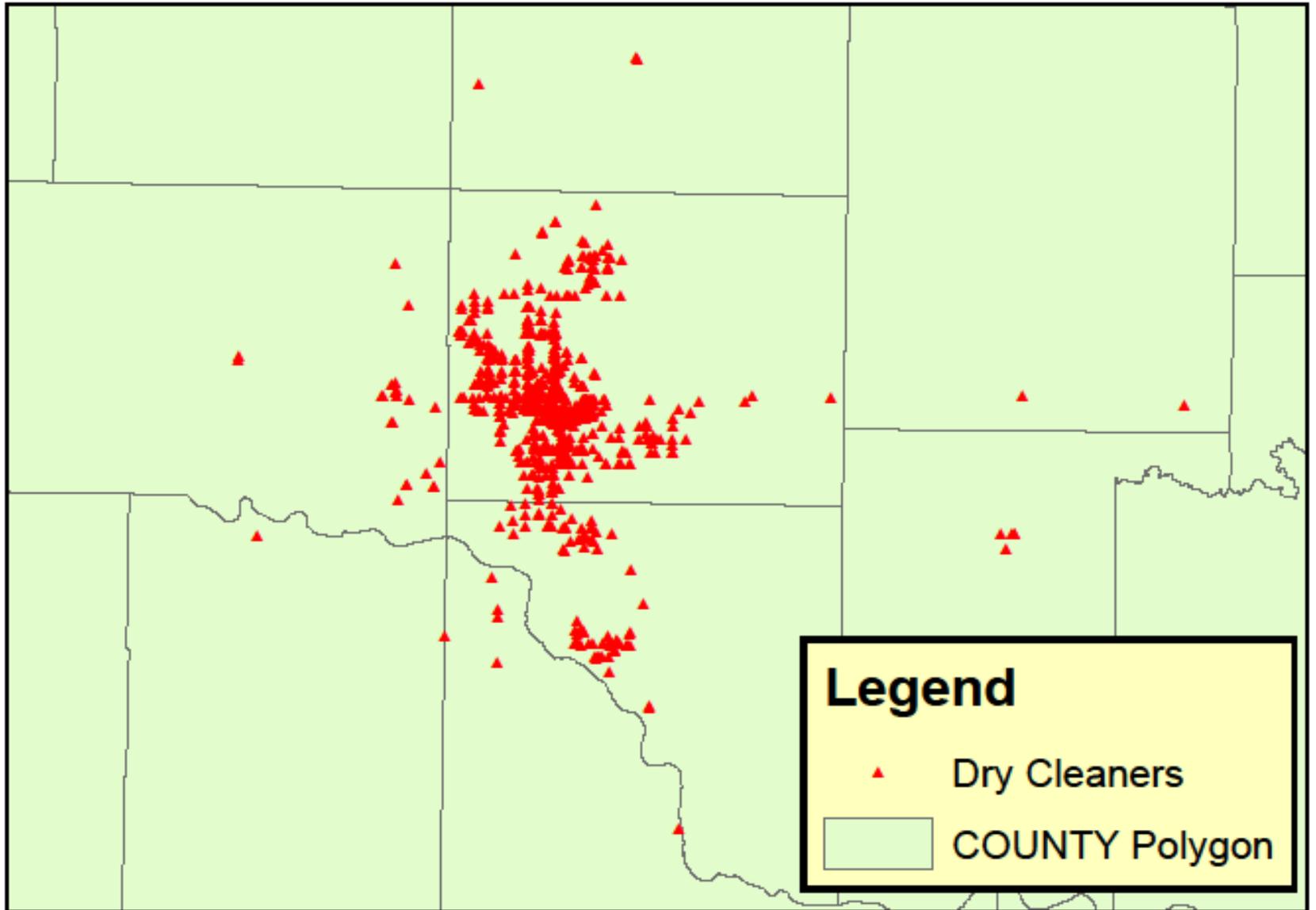
Map Created by Alea Thacker on 11/05/2012

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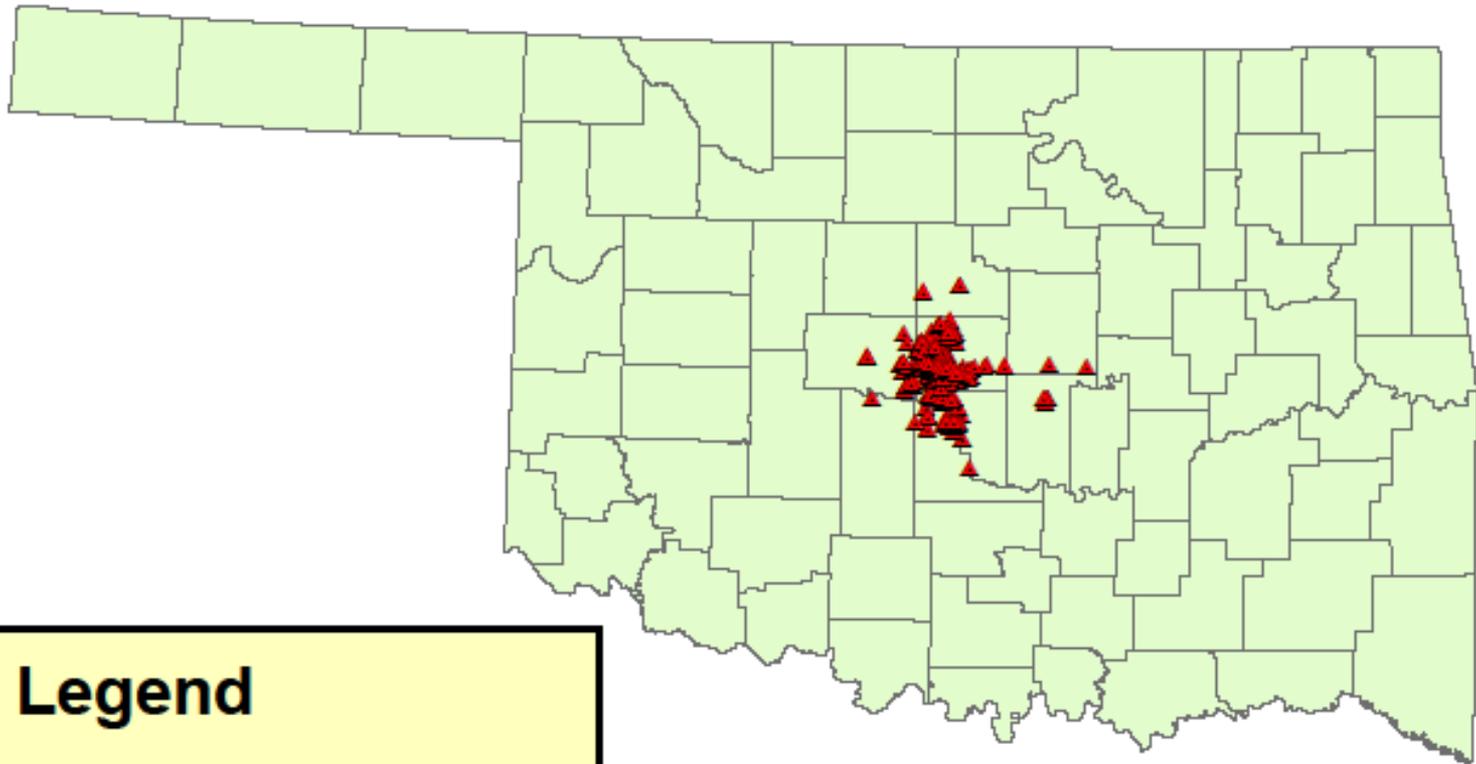


Plume Length: 750+ ft

Metro Area Map



Oklahoma Map



Legend

▲ Dry Cleaners

□ COUNTY Polygon

Any questions?

