Vapor Intrusion & USEPA
Review of the 2002 draft Guidance

AWMA

Vapor Intrusion Specialty Conf.

Chicago, IL

Sept. 29, 2010

Presented by:

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See: http://epa.gov/oswer/vaporintrusion

http://iavi.rti.org & www.envirogroup.com/vaporintrusion

Recent Report from EPA's Office of Inspector General

- In December 2009, EPA's Office of the Inspector General released an evaluation report: ***Lack of Final Guidance on Vapor Intrusion Impedes Efforts to Address Indoor Air Risks***
- The Inspector General made four recommendations:

  1) Identify and publicly report the portions of OSWER's November 2002 draft vapor intrusion guidance that remain valid and the portions that should be updated [*EPA response - August 2010*]

  2) Issue final vapor intrusion guidance(s) [*EPA response – Nov. 2012*]

  3) Train EPA and State staff and managers and other parties on the newly updated, revised, and finalized guidance document(s) [*EPA response - initiate by May 2013*]

  4) Finalize toxicity values for TCE and PCE in the IRIS database [*EPA response - TCE December 2010, PCE Fall 2010*]

Inspector General Recommend that our final vapor intrusion guidance(s) incorporates information on:

- Updated toxicity values.
- A recommendation(s) to use multiple lines of evidence in evaluating and making decisions about risk from vapor intrusion.
- How risk from petroleum hydrocarbons should be addressed
- How the guidance applies to Superfund Five-Year reviews.
- When or whether preemptive mitigation is appropriate.
- Operations and Maintenance, the termination of the systems, and when Institutional Controls and deed restrictions are appropriate.

Approach for Developing Final VI Guidance

- Launch Vapor Intrusion website (April 2010) http://www.epa.gov/oswer/vaporintrusion/
  - Portal for information about our VI efforts
  - Resources for environmental professionals and the public
- Identify aspects of the 2002 draft that will be updated (summer 2010)
- Seek public input through a range of venues (beginning fall 2010 –2011)
- Conduct cross agency and interagency review
- To the extent possible, we will release interim guidance and supporting documents in advance of the final guidance document (fall 2012)

Recommendation #1: Review of 2002 Guidance

- Identify and publicly report:
  - portions of OSWER's November **2002 draft** vapor intrusion guidance that
  - **remain valid**
    - and the portions that
  - **should be updated**.

Note: Review focused on **Chlorinated** VOCs

&

Footnotes acknowledge areas where it does not include petroleum compounds

Posted Aug. 30, 2010 at: http://www.epa.gov/oswer/vaporintrusion/documents/review_of_2002_draft_vi_guidance_final.pdf

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE AND EMEGENCY RESPONSE

REVIEW OF THE DRAFT 2002 SUBSURFACE VAPOR INTRUSION GUIDANCE

BACKGROUND

Vapor intrusion is a potential pathway for human exposure to subsurface contamination. Vapor intrusion occurs when volatile compounds migrate from contaminated groundwater or soil into the indoor air of an overlying or nearby building. Vapor intrusion can result in human exposure to vapor-forming chemicals, such as volatile organic compounds (VOCs) and some other organic and inorganic compounds, which may pose a potential health risk.

In November 2002, the U.S. Environmental Protection Agency (EPA) released the *Draft OSWER Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soil (Subsurface Vapor Intrusion Guidance)* (EPA 530-D-02-004; henceforth referred to as 2002 Draft Vapor Intrusion Guidance).[1] Since the November 2002 Draft Vapor Intrusion Guidance was released, EPA's knowledge and experience with vapor intrusion has increased considerably. In the past 8 years, federal and state cleanup agencies have been investigating contaminated sites across the country for possible exposure via the vapor intrusion pathway, and when warranted, have taken action to significantly reduce vapor intrusion exposure. These experiences have led to an improved understanding and approaches for assessing and managing vapor intrusion.

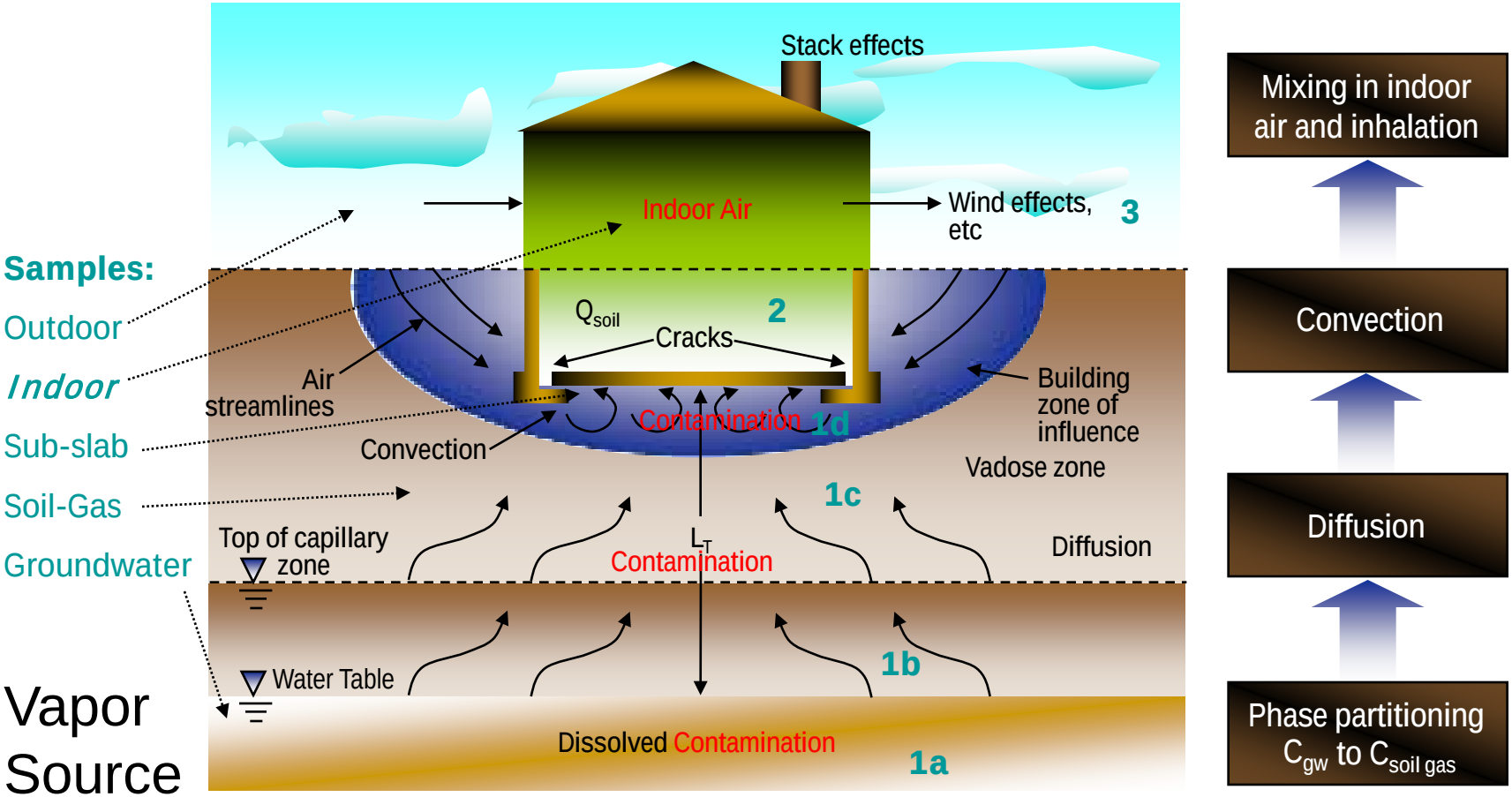
In 2009, EPA's Office of the Inspector General (OIG) released the evaluation report *Lack of Final Guidance on Vapor Intrusion Impedes Efforts to Address Indoor Air Risks* (Report No. 10-P-042; U.S. EPA, 2009a) and made a number of recommendations regarding vapor intrusion

What is Vapor Intrusion?

- Vapor intrusion is a potential pathway for human exposure to subsurface contamination.

- Vapor intrusion occurs when volatile compounds migrate from contaminated groundwater or soil into the indoor air of an overlying or nearby building.

Simple conceptual model of the vapor intrusion exposure pathway



Mod. from slide by M. Bolas, Ohio EPA, presented Jan. 2006

Why is Vapor Intrusion important?

- Vapor intrusion can result in human exposure to vapor-forming chemicals, such as volatile organic compounds (VOCs) and some other organic and inorganic compounds, which may pose a potential health risk.

What is USEPA's guidance?

- In November 2002, the U.S. Environmental Protection Agency (EPA) released the *Draft OSWER Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soil (Subsurface Vapor Intrusion Guidance)* (EPA 530-D-02-004). [1]
  - [1] The 2002 Draft Vapor Intrusion Guidance was designed for investigations of vapor intrusion conducted under authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA), and other relevant authorities and programs, such as Brownfields. However, it was not recommended for use at Subtitle I Underground Storage Tank sites. Available at: http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor/complete.pdf.

What's new?

- Since the November 2002 Draft Vapor Intrusion Guidance was released, EPA's knowledge and experience with vapor intrusion has increased considerably.

- In the past 8 years, federal and state cleanup agencies have been investigating contaminated sites across the country for possible exposure via the vapor intrusion pathway, and when warranted, have taken action to significantly reduce vapor intrusion exposure.

- These experiences have led to an improved understanding and approaches for assessing and managing vapor intrusion.

Why Review of the USEPA's 2002 Draft Vapor Intrusion Guidance?

- In 2009, EPA's Office of the Inspector General (OIG) released the evaluation report *Lack of Final Guidance on Vapor Intrusion Impedes Efforts to Address Indoor Air Risks* (Report No. 10-P-042; U.S. EPA, 2009a) and made a number of recommendations regarding vapor intrusion guidance efforts.

- Among other things, the OIG recommended that EPA identify and publicly report the portions of Office of Solid Waste and Emergency Response's (OSWER's) November 2002 Draft Vapor Intrusion Guidance that remain valid and the portions that should be updated.[1]

- [1] OIG's 2009 Report also contained a number of other recommendations, which are not discussed in this document. See http://www.epa.gov/oig/reports/2010/20091214-10-P-0042.pdf for a copy of OIG's report and a complete list of the recommendations.

What is the Review?

- The following review of the 2002 Draft Vapor Intrusion Guidance summarizes EPA's current understanding of the portions of the guidance that remain valid and those that may need to be updated.

- However, this review summary may not fully capture all possible areas that will be updated in the final version of the Vapor Intrusion Guidance, which EPA has committed to release by November 2012.

What did the review find generally?

- EPA has reviewed the 2002 Draft Vapor Intrusion Guidance and the public comments received on the guidance in detail.

- Most of the draft guidance remains consistent with the current state-of-the-science (i.e., remains valid) and is appropriate for its intended scope and purpose.

- However, there are areas of the 2002 Draft Vapor Intrusion Guidance, detailed below, that should and will be updated based on the Agency's current understanding of vapor intrusion.

What was the basis and findings for updates?

- Considerable information, primarily observational data sets has been generated since publication of the 2002 Draft Vapor Intrusion Guidance.[1]

- These observations and experience with vapor intrusion investigations enabled the Agency to more fully appreciate the fact that the spatial and temporal distribution of VOC concentrations in the subsurface and in indoor air can be highly variable.

- [1] It is important to note that the vast majority of the observational data sets are for the more common chlorinated solvents, and the generalized statements in this document may not pertain to the more readily degradable petroleum compounds. A separate component to the guidance is being developed that focuses on petroleum vapor intrusion.

Summary of findings for updates

- Some of this variability can be attributed to vertical and horizontal differences in subsurface conditions, the differences in structural conditions (e.g., foundation cracks) and the air exchange rates from one building to another.
- Variation in weather conditions (e.g., rainfall, barometric pressure, wind) has also been observed to have a potentially significant impact on the distribution of VOCs in the environment near a building and the entry of VOCs into a building via the vapor intrusion pathway.

- In summary, EPA's observations and experiences have indicated that there is greater complexity in the processes and number of variables that affect the migration and distribution of VOCs, and consequently, the potential for vapor intrusion than was generally appreciated when EPA issued the 2002 Draft Vapor Intrusion Guidance.

TIER **1** (Primary Screening)

- Tier 1 of the 2002 Draft Vapor Intrusion Guidance identifies potential contaminants of concern and locations where there is potential for unacceptable vapor intrusion.

- In general, the approach described in this section remains largely consistent with the current state of the science (i.e., remains valid).

- However, based on new information, EPA plans to update some aspects of Tier 1, including a few chemical-specific physical characteristics used for identifying the vapor-forming chemicals of concern.

Table 1: Question 1 Summary Sheet.

Table 1 (for Q1)

Vapor pressure may also be considered, e.g., for NAPL/soil sources

CAS No.	Chemical	Is Chemical Sufficiently Toxic? [1]	Is Chemical Sufficiently Volatile? [2]	Check Here if Known or Reasonably Suspected To Be Present [3]
83329	Acenaphthene	YES	YES	
75070	Acetaldehyde	YES	YES	
67641	Acetone	YES	YES	
75058	Acetonitrile	YES	YES	
98862	Acetophenone	YES	YES	
107028	Acrolein	YES	YES	
107131	Acrylonitrile	YES	YES	
309002	Aldrin	YES	YES	
319846	alpha-HCH (alpha-BHC)	YES	YES	
62533	Aniline	YES	NO →	NA
120127	Anthracene	NO	YES	NA
56553	Benz(a)anthracene	YES	NO	NA
100527	Benzaldehyde	YES	YES	
71432	Benzene	YES	YES	
50328	Benzo(a)pyrene	YES	NO	NA

[1] A chemical is considered sufficiently toxic if the vapor concentration of the pure component (see Appendix D) poses an incremental lifetime cancer risk greater than 10 -6 or a non-cancer hazard index greater than 1.

[2] A chemical is considered sufficiently volatile if its Henry's Law Constant is 1×10^{-5} atm-m^3/mol or greater (US EPA, 1991).

[3] Users should check off compounds that meet the criteria for toxicity and volatility and are known or reasonably suspected to be present.

Some more detailed findings for TIER 1

- Additionally, EPA has updated the toxicity values for many of the chemicals found in Table 1 and the toxicity-based concentration criteria in Table D-1 in the draft guidance will be updated accordingly.[1]

- Finally, based on knowledge gained from vapor intrusion site evaluations since 2002 and based on public comments on the 2002 Draft Vapor Intrusion Guidance, this section's limited guidance for the documentation of the *extent* of subsurface contamination, including spatial and temporal variability, as well as the potential for *future building* construction in potentially impacted areas is being considered for updates.

- [1] One of the bases for some of the changes in toxicity values is that EPA is no longer routinely using inhalation toxicity values derived from route-to-route extrapolation (e.g., from oral-based studies; see EPA 2009b).

TIER **2**
(Secondary Screening)

- In Tier 2, contaminant concentrations for single environmental media (from samples collected external to a building of potential concern) are quantitatively compared to their appropriate (i.e., groundwater or soil gas) concentration screening values.

- These screening values were designed to be sufficiently protective such that the risk of vapor intrusion related exposure at sites where the concentrations are below the screening levels was not considered significant.

- Tier 2 uses *two methods* to estimate the reduction (attenuation) in vapor concentrations as vapor migrates between the locations of subsurface samples and indoor air:

1st part of Tier 2

- The first part of the Tier 2 screening process uses conservative (health-protective) "generic" attenuation factors that are considered to reflect generally reasonable high-end conditions for a first-pass screening (e.g., 95th percentiles).

- This portion of the draft guidance allows the "screening out" of entire sites from further consideration for vapor intrusion by performing a basic 'source-strength' screen based on a single line of evidence (in this case, external samples of groundwater or soil-gas, or interior structure samples of sub-slab vapor, crawlspace, or indoor air), combined with observation-based conservative (health-protective) "generic" attenuation factors.

Summary of Findings from the 1st part of Tier 2?

- These [attenuation] factors are being updated with a larger database developed since 2002.

- Although the analysis is ongoing, the evidence collected to date appears to *support the continued use of the 2002* observation-based generic attenuation factors for screening populations of samples from the groundwater media (i.e., for the *groundwater* media, this approach appears to remain valid), although as discussed below, the Agency believes that a multiple lines of evidence approach would provide greater certainty in the decisions made.[1]

- However, the evidence collected to date indicates that the 2002 generic attenuation factors (and/or the sampling methodologies) for external *soil-gas needs to updated*.

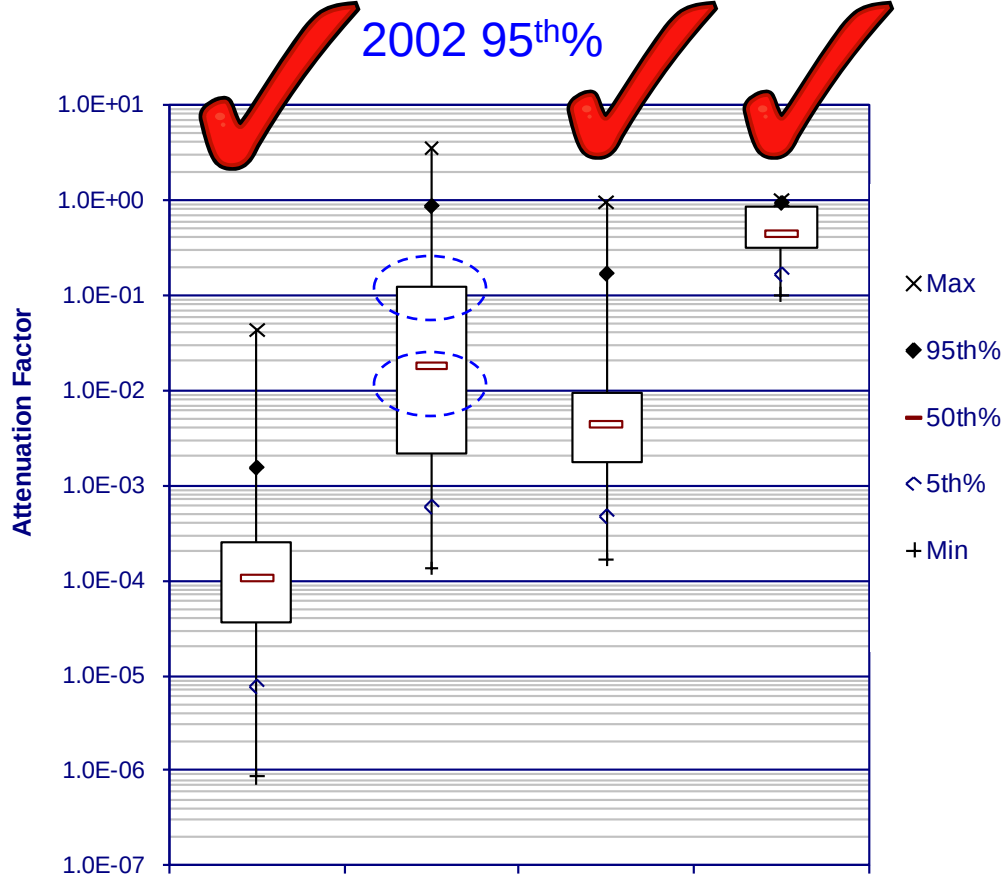
- [1] Note that these screening values may not be appropriate for some individual site conditions with exceptional 'precluding' factors.

From - AEHS Spring 2010

Background Screened Attenuation Factors by Media

draft U.S. EPA's Vapor Intrusion Database and a Preliminary Evaluation of Attenuation Factors for Chlorinated VOCs in Residences

Note: Focused on **Chlorinated** VOCs – does not include petroleum compounds



Statistic	Groundwater	Soil Gas	Subslab	Crawlspace
Min	8.6E-07	1.3E-04	1.6E-04	1.0E-01
5%	7.6E-06	6.0E-04	4.7E-04	1.7E-01
25%	3.5E-05	2.2E-03	1.7E-03	3.2E-01
50%	1.1E-04	1.8E-02	4.3E-03	4.4E-01
75%	2.5E-04	1.2E-01	9.2E-03	8.3E-01
95%	1.5E-03	8.5E-01	1.7E-01	9.2E-01
Max	4.3E-02	3.5E+00	9.4E-01	1.0E+00
N	607	74	260	35
N (IA > RL)	607	74	260	35
N (IA < RL)	0	0	0	0
No. of Sites	21	10	11	4

2nd part of Tier 2

- The second part of Tier 2 allows the use of EPA's 'semi-site-specific' spreadsheet implementation of the Johnson and Ettinger (1991) *model* (with some site-specific inputs) to modify the generic screening levels for groundwater and external soil-gas samples which can allow a greater reduction in vapor concentrations than the generic estimates.

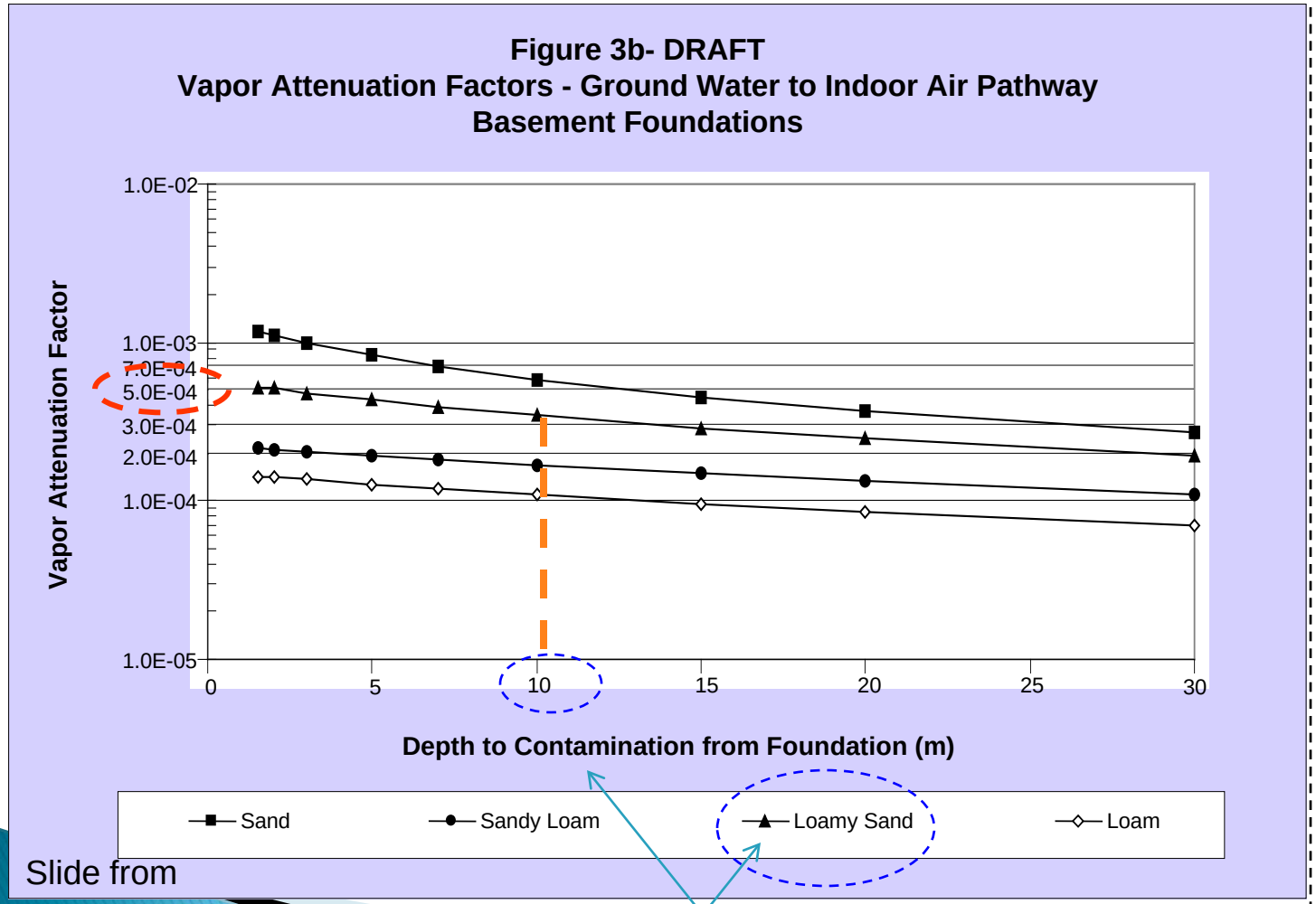
- This portion of the draft guidance allows the screening out of entire sites from further consideration for vapor intrusion based on a single line of external evidence (in this case, externally collected groundwater or soil-gas samples), combined with a semi-site-specific, *model-based estimated* attenuation factor.

Findings from the 2nd part of Tier 2?

- Although the analysis of this screening process is ongoing, observational data collected since 2002 suggest that the EPA's 2002 approach (see Figure 3 of the 2002 Draft Vapor Intrusion Guidance) may be sufficiently *protective* for site screening based on ***Groundwater*** data.[1] [See the next 3 slides]
  - However, experience gained since 2002 has indicated that assessments involving a multiple lines of evidence[2] approach is generally better for understanding site conditions, and improving the level of confidence and reducing uncertainty when evaluating vapor intrusion at such sites.
- Furthermore, the observational data collected indicates the 2002 "single line of evidence" approach with site-estimated (Figure 3 of the Draft 2002 Guidance) attenuation factors is generally ***not*** appropriate *for external* ***Soil-Gas*** samples (collected using existing sampling methodologies) and needs to be updated. [See the following 4 slides]
  - EPA is currently conducting further analyses and preparing documentation to support updates to this approach in the guidance.
-

[1] Note that these screening values may not be appropriate for some individual site conditions with exceptional 'precluding' factors.

Secondary Screening – Question 5 Groundwater Attenuation Factors



Slide from

Selected example from 2002 VIG training class

SLE w/ site-est. alpha;

2010 database may support the use of these model-based predictions (IA) as a SLE for groundwater (with these two combined site-specific parameters)

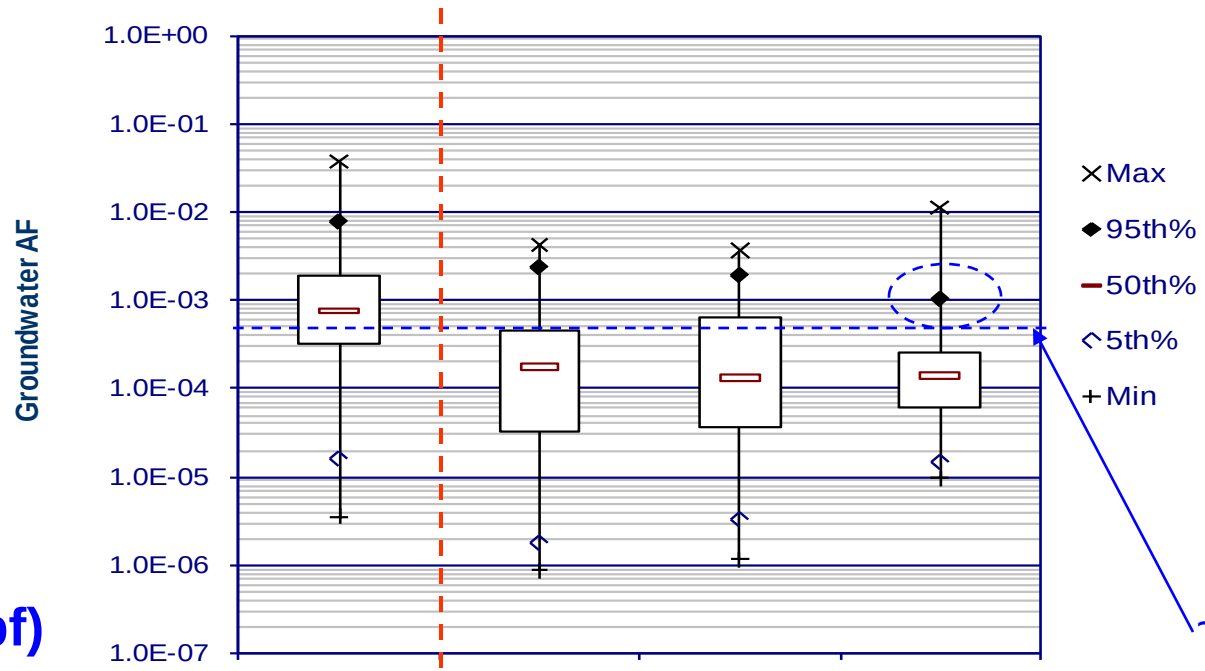
E.g., Only ~ 25% of data has less attenuation than the circled value (5.0E-4) but …

Attenuation Factors vs. Depth to Groundwater

Draft - AEHS Spring 2010

By itself, i.e., univariate

(includes all Soil types)



~5E-4

This Supports 2002's (< 5 ft. bf) 'Precluding Factor'

(2002 hypothesized now empirical)

Depth to Groundwater

Statistic	< 1.5 m	1.5 - 3 m	3 - 5 m	> 5 m
Min	3.6E-06	8.6E-07	1.1E-06	9.6E-06
5%	1.6E-05	1.8E-06	3.4E-06	1.5E-05
25%	3.3E-04	3.2E-05	3.7E-05	6.1E-05
50%	7.6E-04	1.8E-04	1.3E-04	1.4E-04
75%	1.8E-03	4.5E-04	6.5E-04	2.5E-04
95%	7.7E-03	2.4E-03	1.9E-03	1.0E-03
Max	3.7E-02	4.2E-03	3.7E-03	1.1E-02
N (AF)	33	60	63	101
N (IA > RL)	33	55	63	101
N (IA < RL)	0	5	0	0

10 m

In 2002

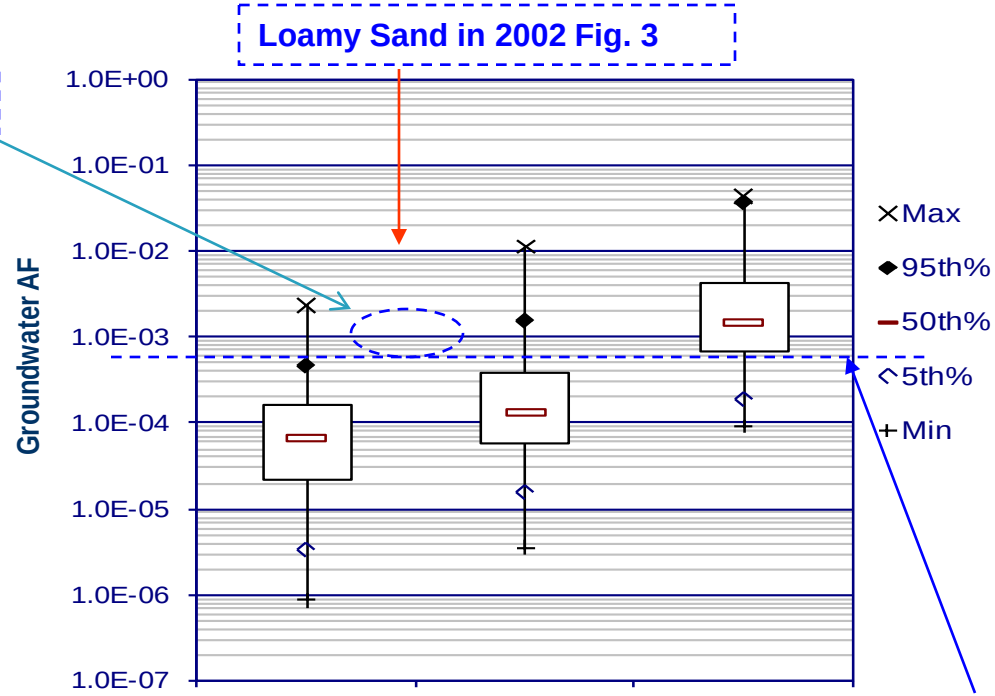
= generic 2002 GW AF

Slide from
AEHS
Spring 2010
H. Dawson US EPA

GW Attenuation Factors vs. Soil Type

By itself, i.e., univariate

(includes all Depths)



~5E-4

Statistic	Fine	Coarse	V.Coarse
Min	8.6E-07	3.6E-06	9.2E-05
5%	3.4E-06	1.6E-05	1.9E-04
25%	2.2E-05	5.8E-05	6.8E-04
50%	6.8E-05	1.3E-04	1.5E-03
75%	1.6E-04	3.9E-04	4.2E-03
95%	4.6E-04	1.5E-03	3.7E-02
Max	2.4E-03	1.1E-02	4.3E-02
N (AF)	291	294	22
N (IA > RL)	291	294	22
N (IA < RL)	0	0	0
No. of Sites	7	15	3

From - AEHS Spring 2010

Slide from
AEHS
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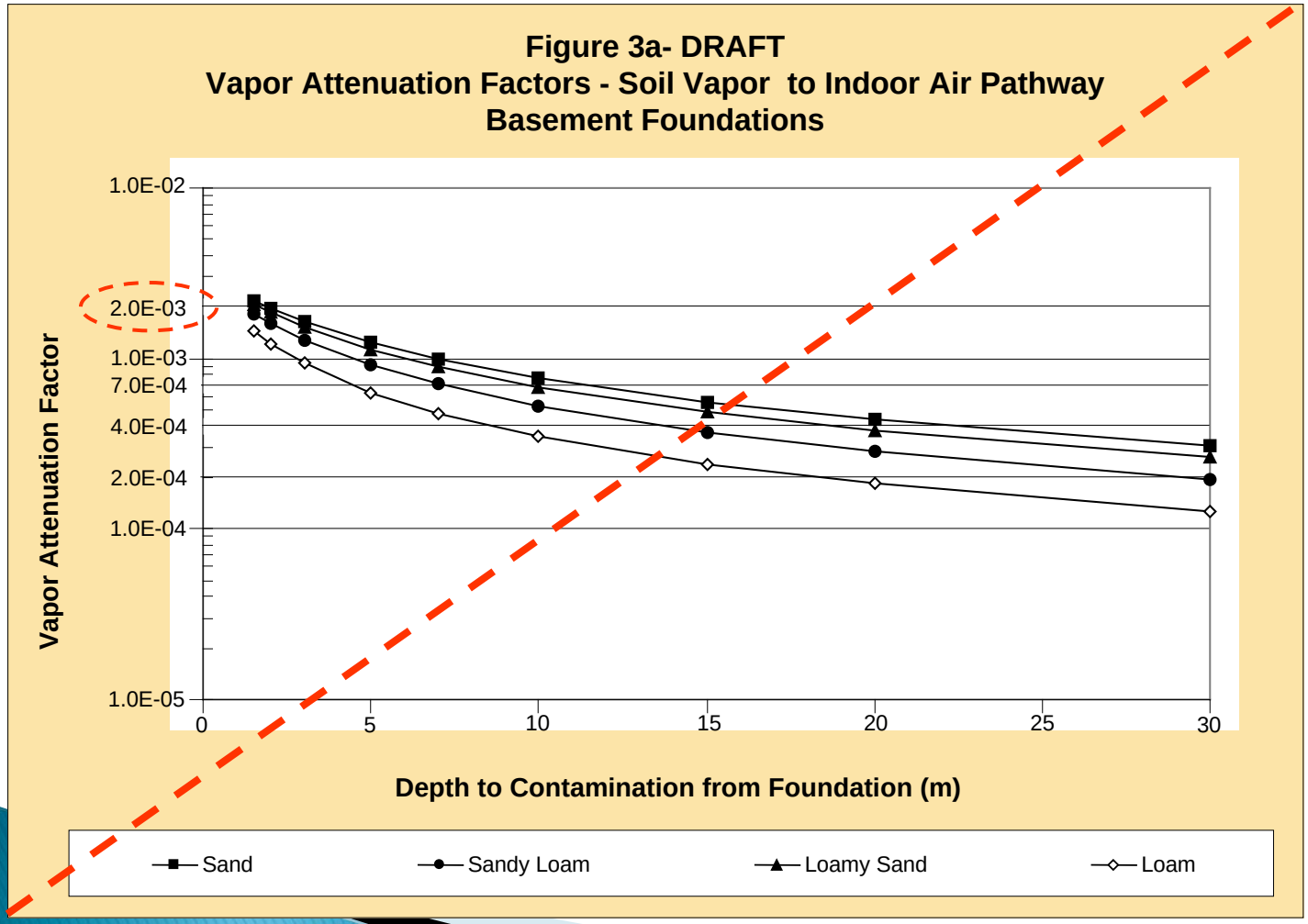
H. Dawson US EPA

Secondary Screening – Question 5
[Soil Gas] Attenuation Factors



SLE w/ site-estimated attenuation;

2010 database shows >75% of soil gas data has an attenuation factor high than this *max.* circled *value* (2.0E-03)

[*representing the 25th%*]; [See the next slides]

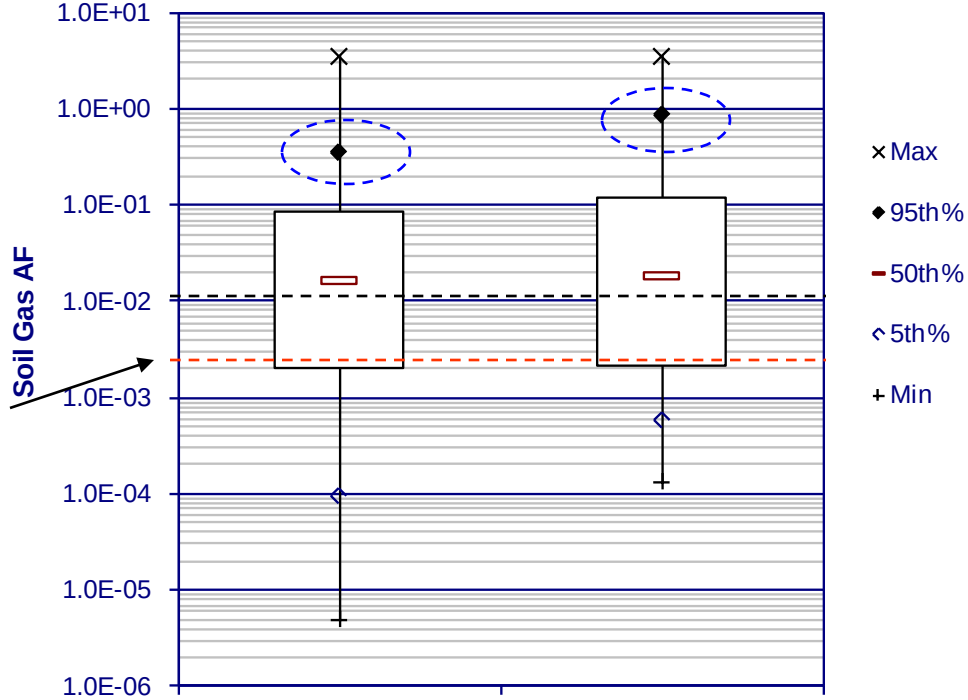
[& the model curves *only predict lower* attenuation factors w/ D & S]

(Slide from)

Draft - AEHS Spring 2010

Screened Soil Gas Attenuation Factors

~2E-3



Statistic	CHCs in Residences Screen 2010	Bacground Indoor Air Screen 2010
Min	5.0E-06	1.3E-04
5%	9.4E-05	6.0E-04
25%	2.1E-03	2.2E-03
50%	1.6E-02	1.8E-02
75%	8.4E-02	1.2E-01
95%	3.6E-01	8.5E-01
Max	3.5E+00	3.5E+00
N	176	74
N (IA > RL)	176	74
N (IA < RL)	0	0
No. of Sites	13	10

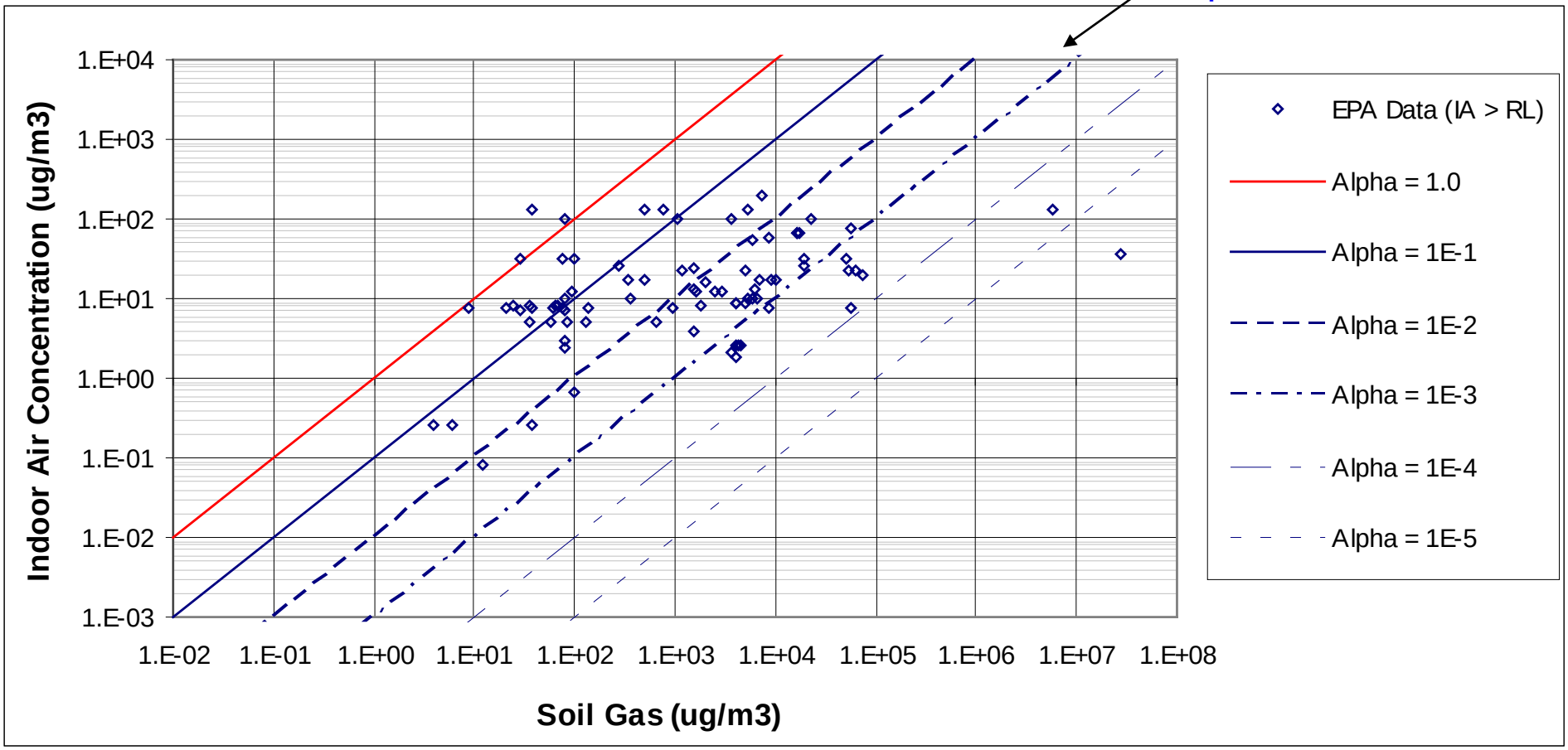
Only considers indoor air data w/ >95th% of back-ground

In summary, ~ 3 out of 4 sample pairs (indoor air and soil gas) had conc. ratios showing less attenuation than Fig. 3 predicted for the min. 95th%.

Slide from
AEHS
Spring 2010
H. Dawson US EPA

Background Screened Soil Gas Attenuation Factors

Alpha ~ 2E-3



From - AEHS Spring 2010

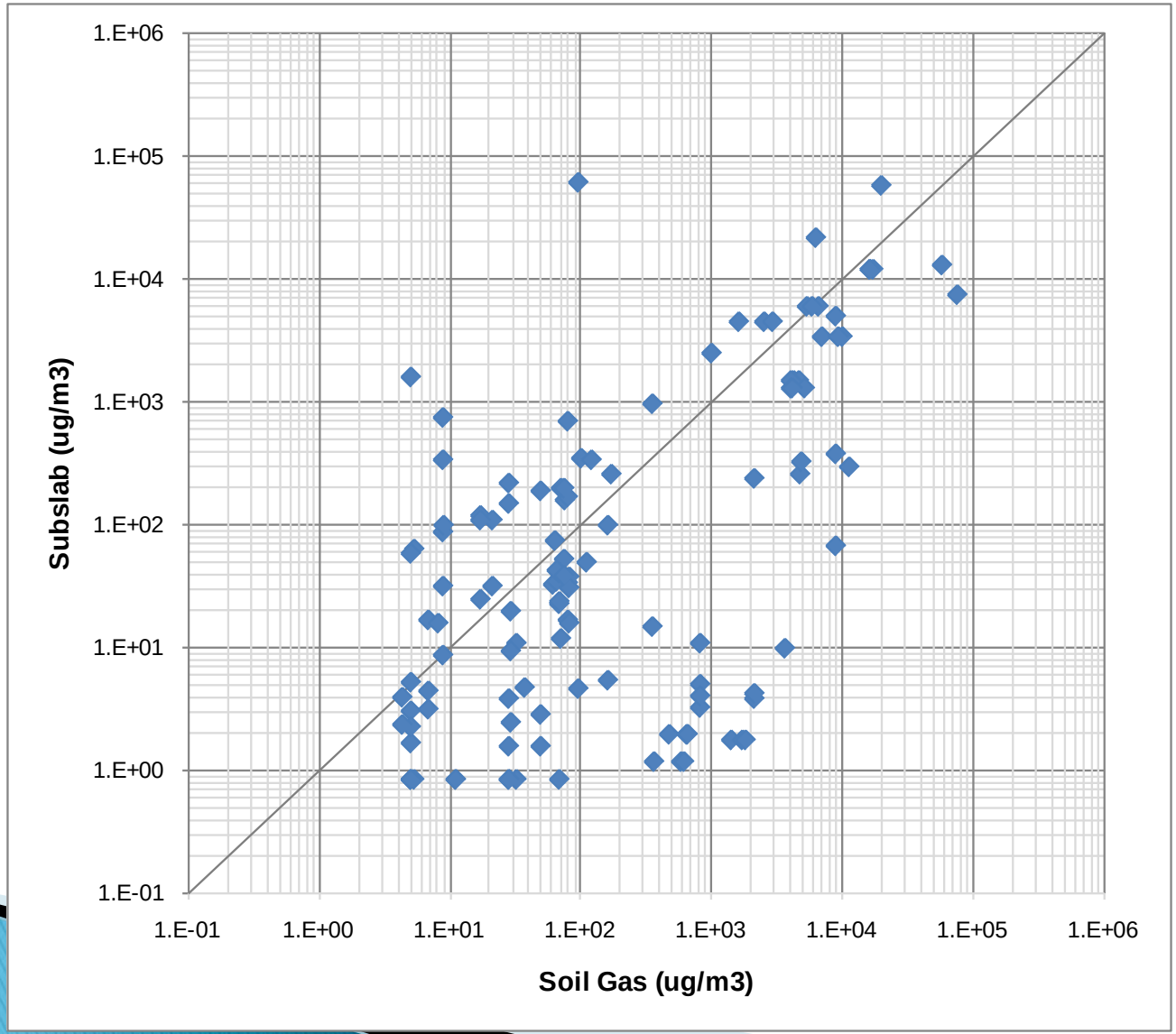
Slide from
AEHS
Spring 2010
H. Dawson US EPA

Soil Gas vs. Subslab Concentrations

From - AEHS Spring 2010

i.e., environmental-only migration, without effects of transport into building

Higher conc. In ***Subslab*** than in Soil Gas



How well do external Soil Gas samples represent Subslab conc?

Higher conc. In ***Soil Gas*** than in Subslab

Slide from

AEHS
Spring 2010
H. Dawson US EPA

Additional findings from Tier 2?

- Tier 2 is generally focused on **existing** buildings, and particularly, existing **single-family** residential buildings.

- EPA's experiences since 2002 have shown that ***other types of buildings***, such as multi-family residential, non-residential and mixed-use buildings are a part of many vapor intrusion sites.

  – For example, at some sites, retail stores, civic and municipal buildings, and apartments have represented more than one-third of the structures of concern for potential vapor intrusion exposures.

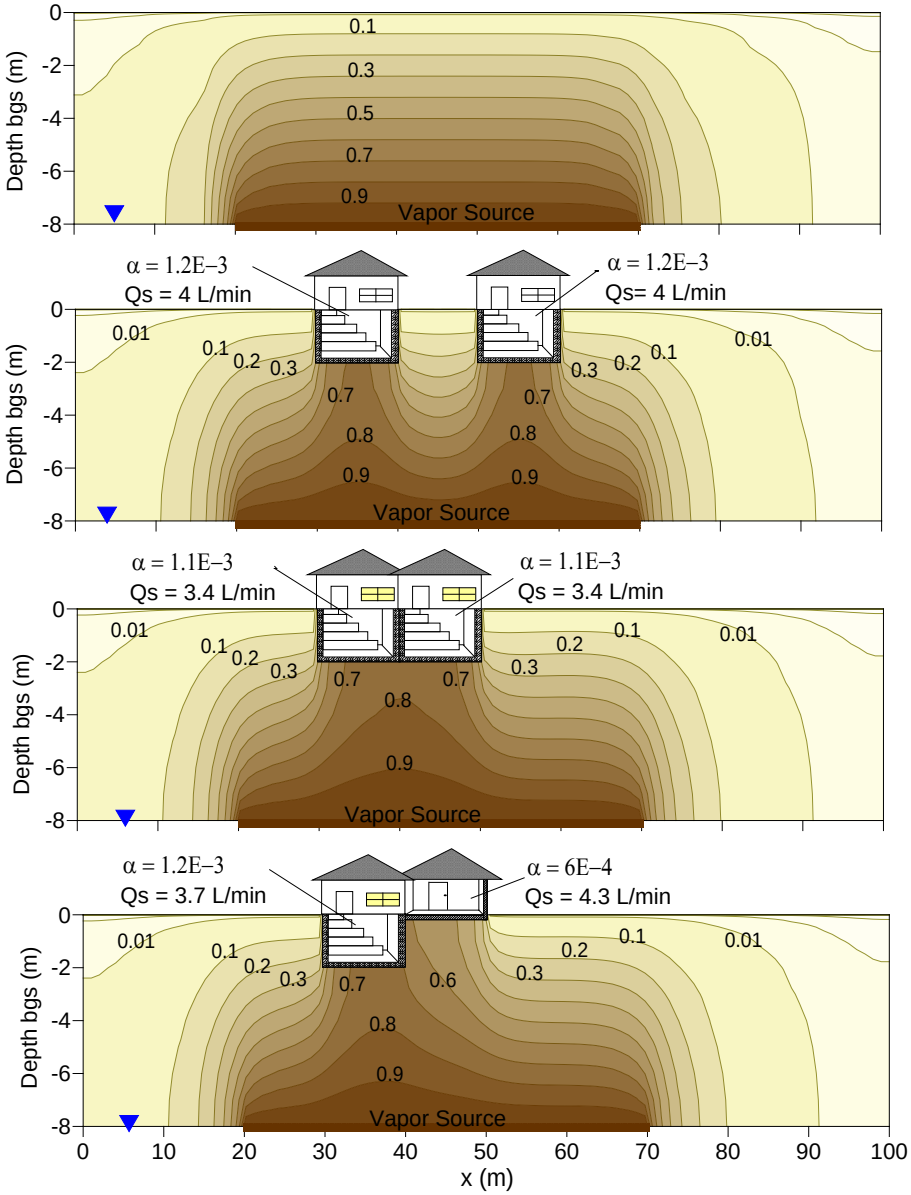
- Furthermore, many subsurface contaminant vapor source areas include large areas that are currently undeveloped, but have a potential for ***future buildings***.

- Site experiences and research studies of both subsurface and building variables suggest that predictions of indoor air concentrations on yet-to-be-constructed (i.e., future) buildings can be even more challenging than for existing buildings.

- Thus, the portions of the 2002 Draft Vapor Intrusion Guidance with limited guidance for a number of building types, including non-residential and future-use buildings, are likely to be updated.

Building Effects [predicted] on Subsurface Distribution

Draft Conceptual Model Scenarios document Figures 13, 14 & 15 combined



Illustrates how:

The ***building's*** presence can ***change*** the ***distribution*** of subsurface ***gases***

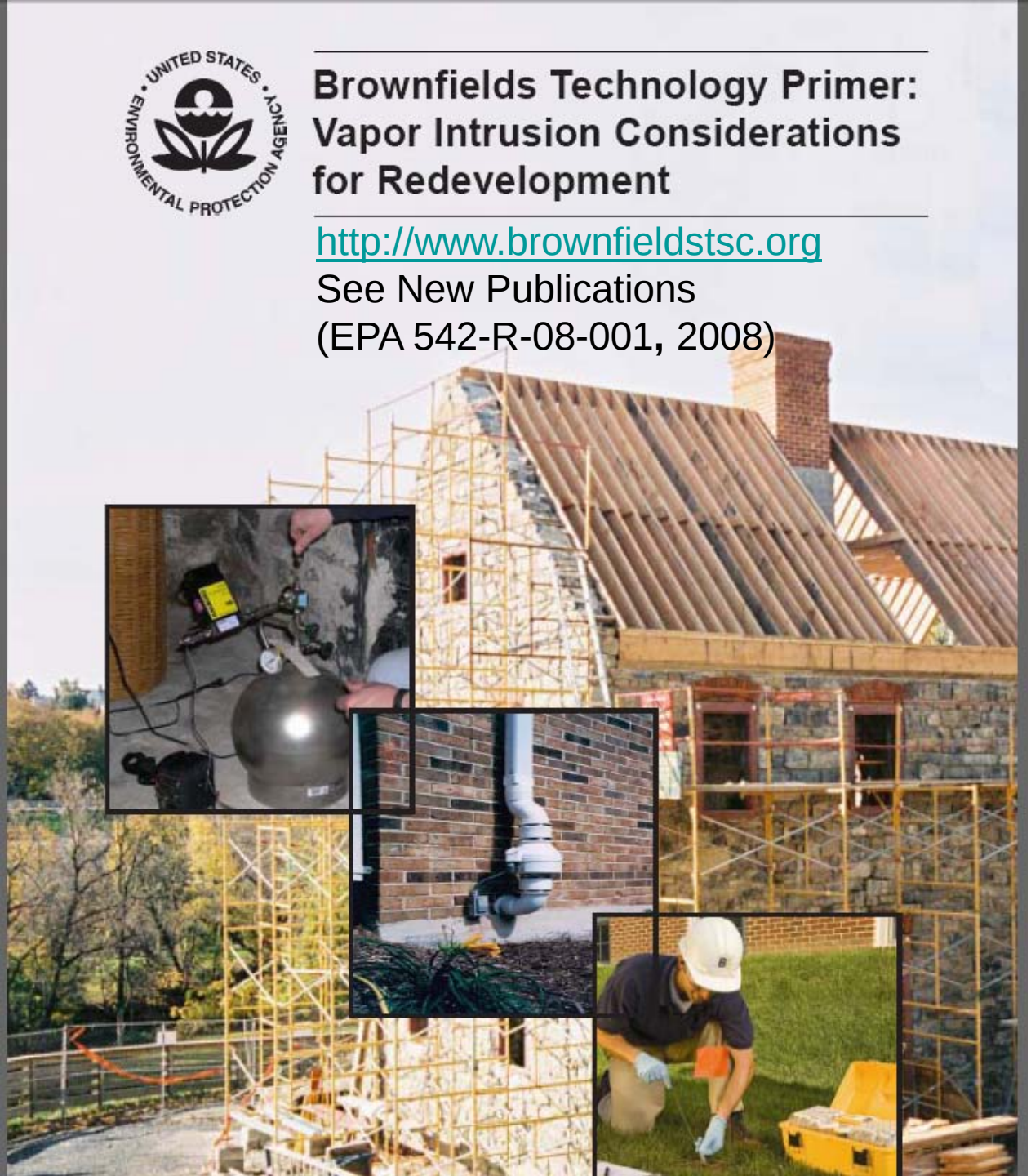
& attempts to ***predict VI into future*** or to-be-modified buildings raises ***significant*** assessment and prediction **challenges**

More findings from Tier 2?

- EPA issued a Brownfield Primer on Vapor Intrusion (U.S. EPA, 2007) that generally recommended the 'preemptive'[1] installation of cost-effective passive vent piping beneath new buildings overlying subsurface vapors for a number of reasons, such as costs, time, and confidence in the results.

- The EPA Office of the Inspector General's evaluation report made a specific request for further guidance on "when or whether preemptive mitigation is appropriate" and the Brownfield's Primer provides a relevant basis for 'preemptively' addressing the potential impacts of vapor intrusion for future buildings.

[1] The term 'preemptive' has been used to describe the use of various types of controls that can prevent vapor intrusion from occurring prior to having fully demonstrated that unacceptable vapor intrusion currently exists in specific buildings being considered.



http://www.brownfieldstsc.org
See New Publications
(EPA 542-R-08-001, 2008)

-Builds on the scientific concepts developed in the draft Conceptual Model Scenarios (CMS) document:

Major Points:

-**Early consideration of VI is always better**

-**Pre-construction cost savings**

- VI need not prevent re-development

Final observations from Tier 2?

- It is notable that the sequence of screening in the 2002 Draft Vapor Intrusion Guidance was generally intended to begin with sampling near the subsurface source (Tier 2), then progress closer to the overlying building, and ultimately, to include indoor air sampling (Tier 3) (i.e., an "indoor air last" approach).
- However, experiences since 2002 illustrate the value of collecting indoor air samples earlier in the investigations, including the more rapid and direct assessment of the quality of indoor air.
- Benefits can also include improved public relations and clearer communication of the results, both of which can improve the opportunities for meaningful public involvement.
- These observations suggest that while valid, the "indoor air last" approach of 2002 is being considered for updates that will allow more flexibility in the sequencing of subsurface and interior/indoor sample collection.

Figure 2. Schematic flow diagram: evaluation process recommended in guidance.

2002 VI Guidance

Tier 1 - Primary Screening

- Determine if volatile and toxic chemicals are present (see Table 1).
- Determine if inhabited buildings are, or in the future could potentially be, located near subsurface contaminants.
  - If toxic volatile chemicals are present and current, or future, human exposure is suspected, proceed with screening.
- Determine if potential risks warrant immediate action.
  - If immediate action does not appear to be necessary, proceed to secondary screening.

Tier 2 - Secondary Screening

Groundwater & Soil-Gas

Question 4

- If indoor air data are available, compare to appropriate target concentration (Table 2a, b, or c).
  - If indoor air data exceed the target concentration proceed to Question 6.
- Determine if there is any potential for contamination of soils in the unsaturated zone.
  - If contamination of the unsaturated zone is suspected, assess soil gas data.
  - If contamination of the unsaturated zone is <u>not</u> suspected, assess groundwater data.
- Compare soil gas or groundwater data to appropriate target concentration (Table 2a, b, or c).
  - If groundwater data exceed the target concentration, assess soil gas data.
  - If soil gas data exceed the target concentration proceed to Question 5.
- Determine if data are adequate to characterize the site and support an assessment.
  - If adequate data are not available, develop a sampling and analysis plan that satisfies the established data quality objectives.
- Determine if site conditions, or data limitations, would preclude the use of generic attenuation factors used in Tables 2a, b, and c.
- If appropriate data do <u>not</u> exceed target media concentration, pathway is considered to be incomplete.

Question 5

- Determine if there is any potential for contamination of soils in the unsaturated zone.
  - If contamination of the unsaturated zone is suspected, assess soil gas data.
  - If contamination of the unsaturated zone is <u>not</u> suspected, assess groundwater data.
- Compare soil gas or groundwater data to appropriate target concentration (Table 3a, b, or c).
  - If groundwater data exceed the target concentration, assess soil gas data.
  - If soil gas data exceed the target concentration proceed to Question 6.
- If adequate data are not available, develop a sampling and analysis plan that satisfies the established data quality objectives.
- Determine if site conditions, or data limitations, would preclude the use of scenario-specific attenuation factors used in Tables 3a, b, and c.
- If appropriate data do <u>not</u> exceed target media concentration, pathway is considered to be incomplete.

Tier 3 - Site Specific Pathway Assessment

Sub-slab, Crawl-space & Indoor Air

Question 6

- Determine if the nature and extent of contamination has been adequately characterized to identify the buildings that are most likely to be impacted.
  - If no, develop a sampling and analysis plan that satisfies the data quality objectives.
- Compare sub-slab soil gas or indoor air data to appropriate target concentration.
  - If sub-slab data exceed target concentration, assess indoor air data.
- Determine whether or not site data meet data quality objectives and background/ambient sources have been adequately accounted for.
- Determine if exposure pathway is complete.

TIER 3
(Site-Specific Assessment)

- When environmental sample concentrations from a site exceed the Tier 2 screening values, Tier 3 recommends the collection of samples from within individual buildings (indoor air and/or sub-slab vapor or crawl space air).

- While these samples can be more useful for assessing the vapor intrusion pathway than samples collected further from the building/structure of interest, they should be evaluated in light of the possibility that 'background' sources of VOCs (e.g., consumer products and outdoor air) may impact indoor quality as much as or more so than vapor intrusion in some structures.

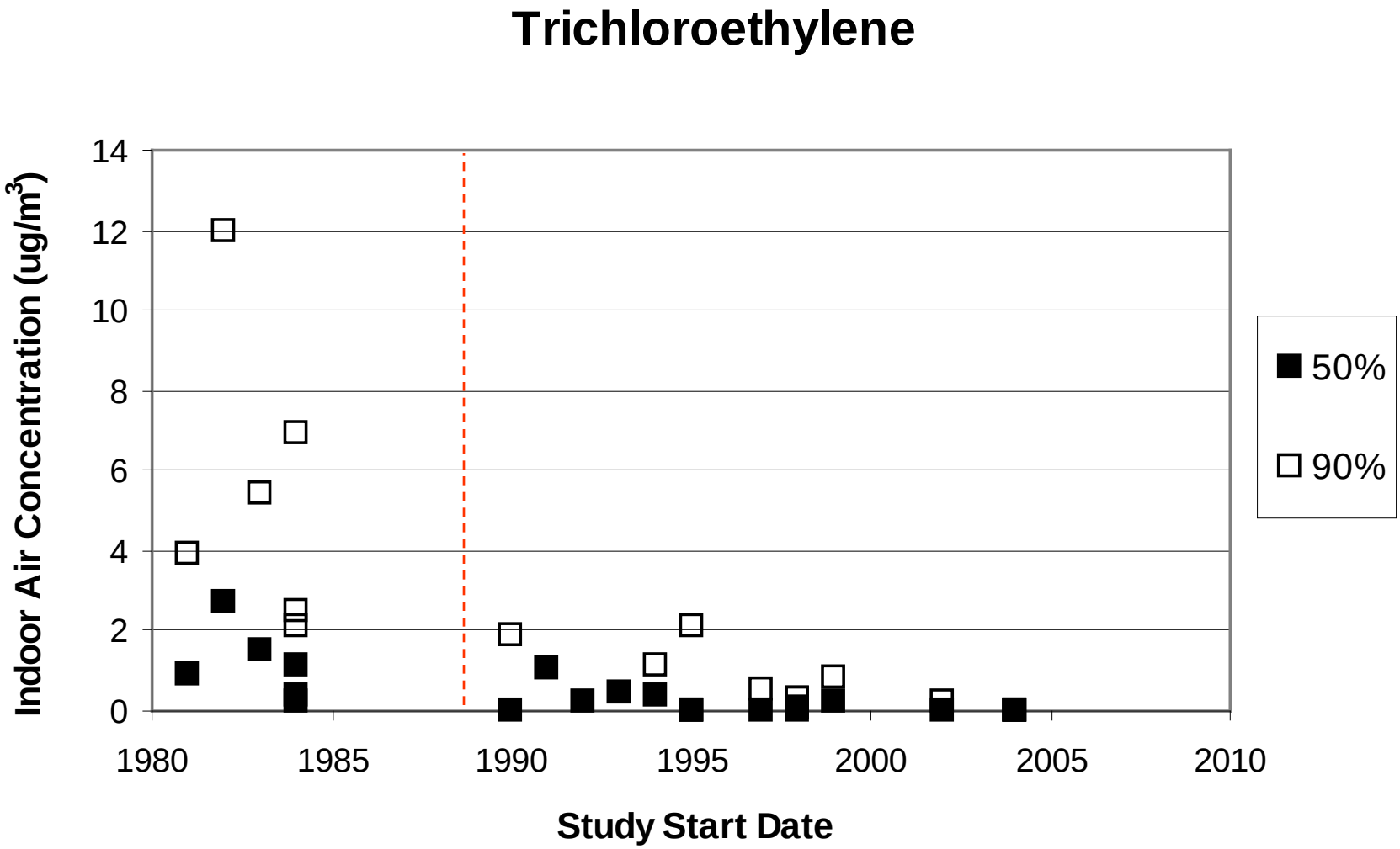
Observations from TIER 3?

- The concern for background contamination in indoor air can be found throughout the 2002 draft.
- It was generally considered a disincentive to collecting indoor air data and one of the major considerations for using the “indoor air last” approach.

More observations from TIER 3?

- While the issue of *'background'* sources is still an issue to be considered, the portions of the 2002 Draft Vapor Intrusion Guidance addressing background contamination in indoor air are likely to be updated as new resources are now available.
  - For example, EPA is preparing **a compilation of literature background values** specifically intended for use in vapor intrusion assessments, and these data support the conclusion that many of the chemicals present in the subsurface at vapor intrusion sites are not expected to be present at concentrations of concern in indoor or outdoor air. [See the next 3 slides]
  - Additionally, while the 2002 Draft Vapor Intrusion Guidance recommended background contaminants in indoor air be carefully considered and accounted for, it only provided limited methodologies for doing so.
- EPA is considering the possibility of updates with more specific methodologies for evaluating and/or decision making and managing background contamination for those constituents that may be present at concentrations of concern in indoor or outdoor air during vapor intrusion site investigations. [e.g., MLE w/ lit. values & other samples, e.g., Subslab]

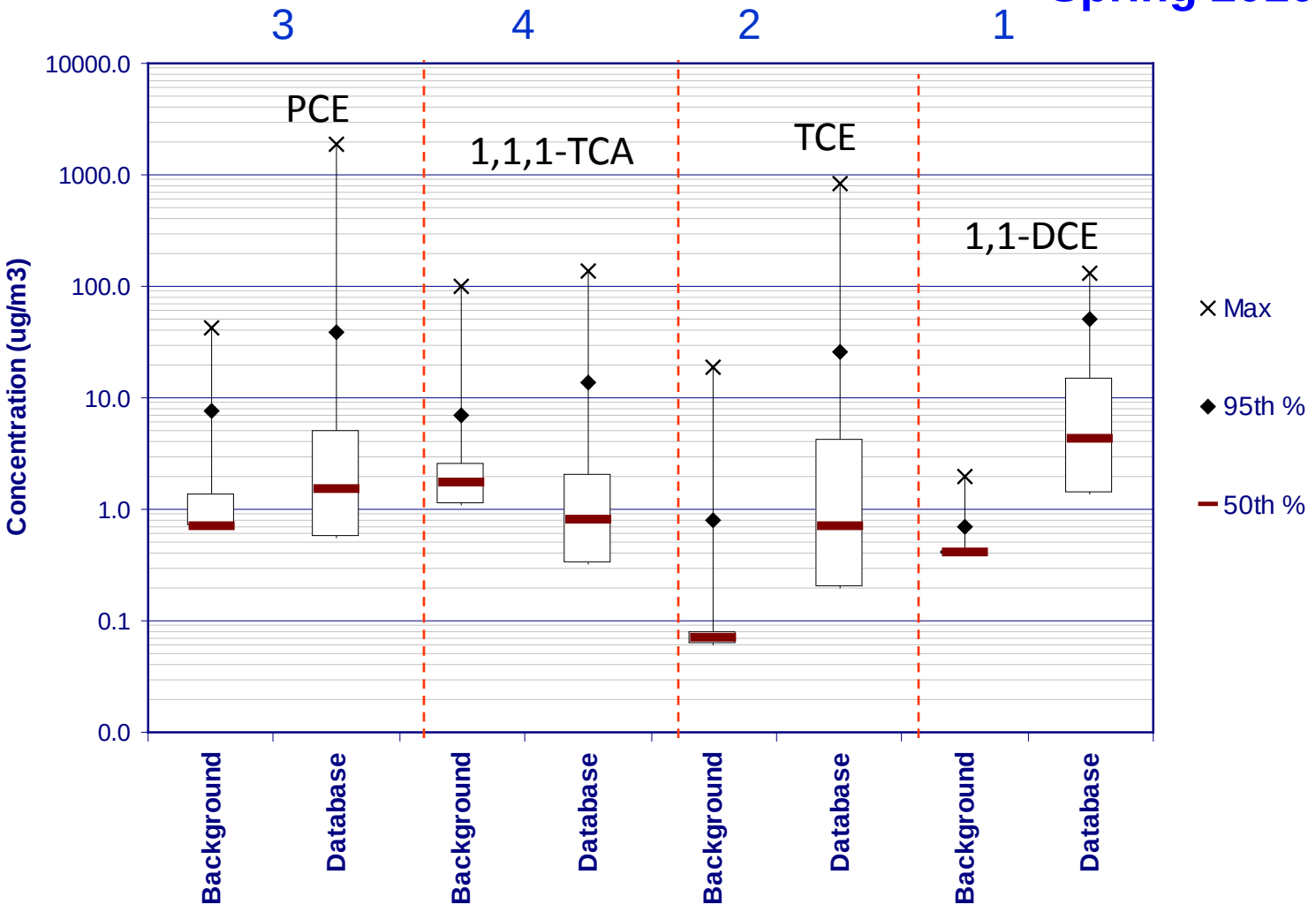
From - AEHS Spring 2010



Draft *BACKGROUND INDOOR AIR CONCENTRATIONS OF VOCS IN NORTH AMERICAN RESIDENCES* document

Comparison of Background and VI Site Database Indoor Air Concentrations

From – AEHS Spring 2010



Selected plate from Fig. 5 of draft Background document

2

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4

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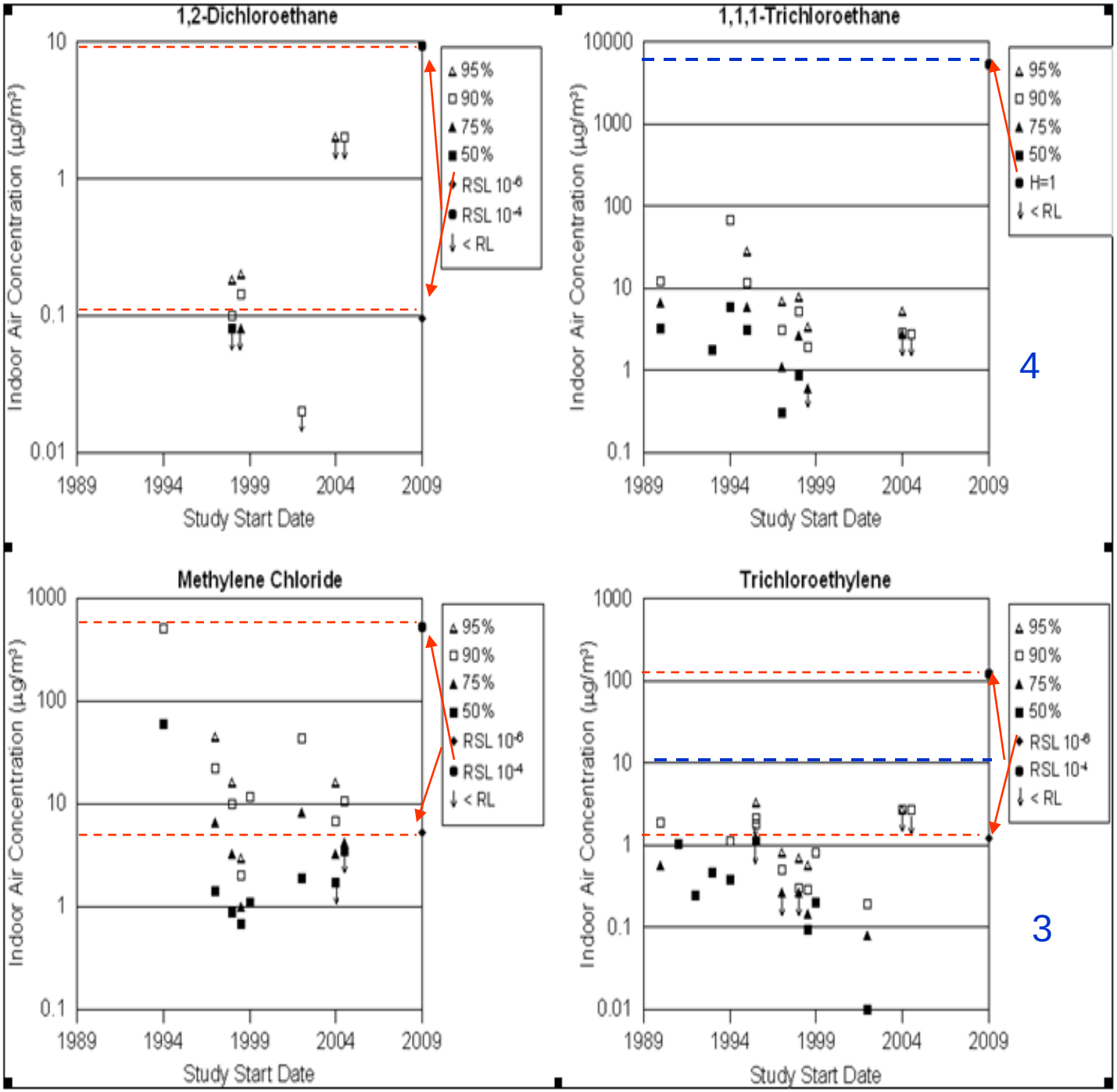


Sample Durations – Tier 3

- Tier 3 is largely based on an expectation that a ***24-hour duration*** indoor air sample, most commonly using canister methodologies (e.g., TO-15), will be used to sample indoor air. Vapor intrusion experiences since 2002, as well as decades of radon studies, have indicated that other approaches can also be used.
  - For example, ***short duration*** (i.e., real-time) samples collected with EPA's mobile Trace Atmospheric Gas Analyzer (TAGA), as well as field-portable gas chromatographs and/or mass spectrometers, have proven very useful for identifying background sources and confirming vapor intrusion in building openings to the subsurface (i.e., pathway samples).
  - Also, ***longer-term duration*** samples (e.g., days or longer) have been shown to greatly reduce temporal variability in indoor air concentrations and improve risk estimates.
- In summary, the portion of the 2002 Draft Vapor Intrusion Guidance focusing primarily on 24-hour time-composite samples for testing indoor air, while still valid, is likely to be updated to allow ***more flexibility*** in the ***duration of sampling*** to take advantage of the benefits of other sampling durations and methods.

Portable Field Units

1) Indoor Source ID & 2) Entry Pathway Screening

INFICON Opening The Field To New Ideas®

ppb RAE – PID DL low ppb tot. VOC

Contacts: Ray Cody, R1

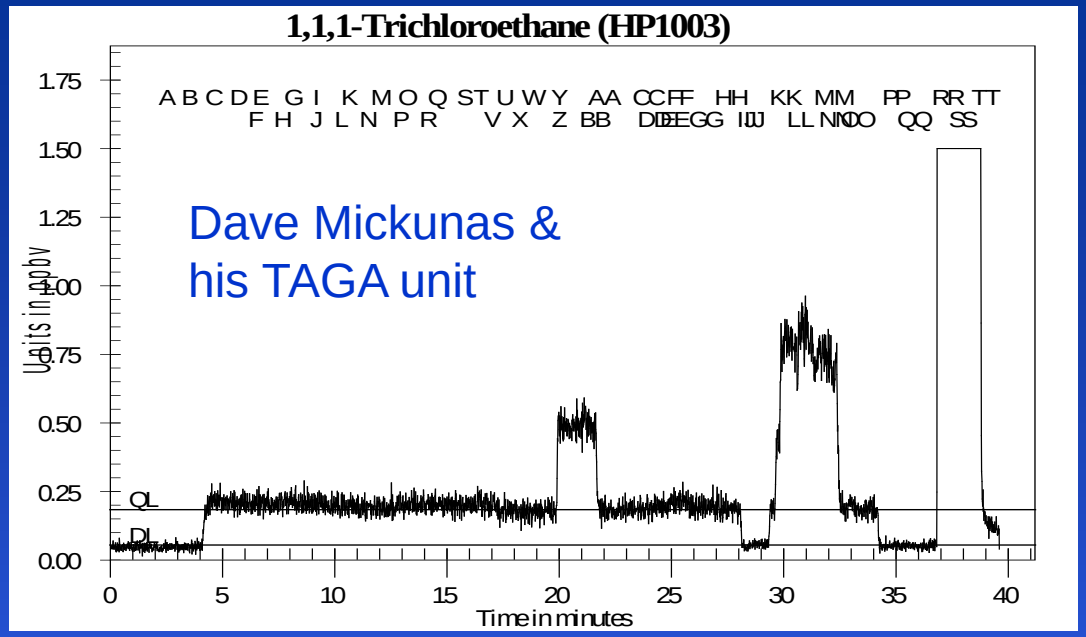
Gerry McDonald NYSDOH

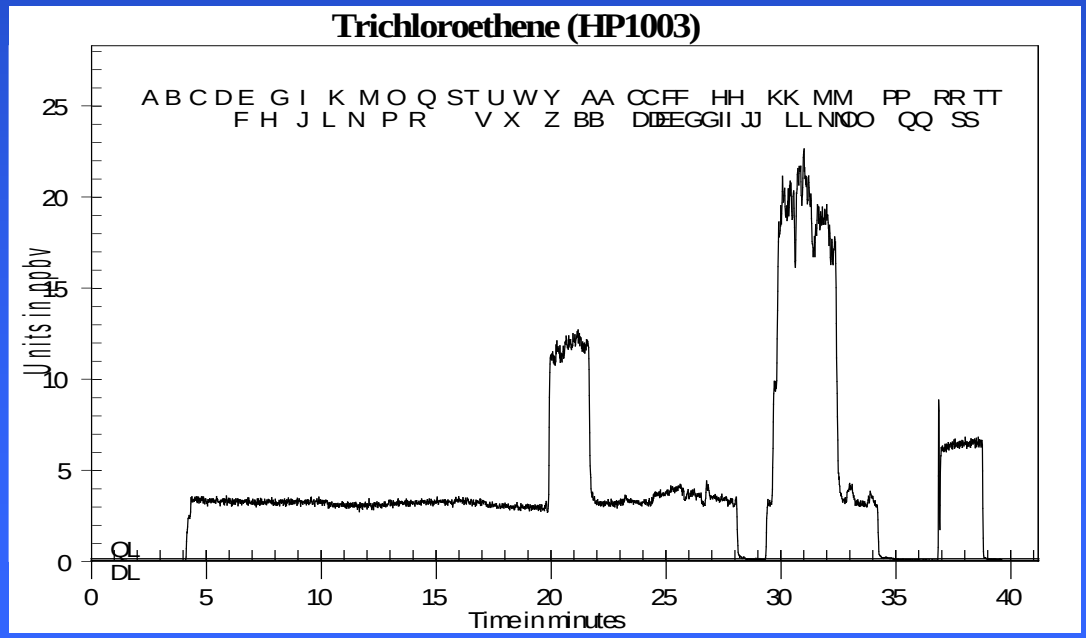
Hapsite GC/MS – DL near lab

Contact: Kathy Baylor, R9

TAGA File Event Summary
File: HP1003 Acquired on 01/26/04 At: 9:17:03
Title: Unit 001

Flag	Time	Offset Sequence	Description
A	1.6	177	Start of the pre-entry ambient
B	2.6	259	End of the pre-entry ambient
C	3.7	345	Entering the unit
D	4.8	435	Start of the living room
E	5.8	517	End of the living room
F	6.2	547	Start of the bird room
G	7.2	631	End of the bird room
H	7.5	654	Start of the kitchen
I	8.5	735	End of the kitchen
J	8.7	757	Start of the bathroom one
K	9.7	837	End of the bathroom one
L	10.1	864	Start of the bedroom one
M	11.1	945	End of the bedroom one
N	11.3	964	Start of the bathroom two
O	12.3	1044	End of the bathroom two
P	12.6	1071	Start of the bedroom two
Q	13.6	1151	End of the bedroom two
R	13.9	1175	Start of the bedroom three
S	14.9	1256	End of the bedroom three
T	15.6	1317	Start of the computer room
U	16.6	1399	End of the computer room
V	16.8	1415	Start of the family room
W	17.8	1492	End of the family room
X	18.1	1515	Start of the bathroom three
Y	19.1	1598	End of the bathroom three
Z	19.7	1651	Start of the sub-slab closet
AA	20.7	1732	End of the sub-slab closet
BB	21.7	1811	Start of the game room closet
CC	22.7	1893	End of the game room closet
DD	22.9	1910	Start of the game room
EE	23.9	1991	End of the game room
FF	24.2	2015	Start of the storage room
GG	25.2	2096	End of the storage room
HH	26.4	2189	Start of the laundry room
II	27.4	2270	End of the laundry room





Notice TCE is less outdoors than inside and has a maximum in the subslab closet. The ion profiles on the right are continuous updates for 1,1,1-TCA and TCE as the monitoring proceeds through the residence.

1-Day samples (chemicals)
Folkes et al., 2009

- 715 indoor air samples of 1,1-DCE (***24-hr*** samples)
- 45 unmitigated (**low conc**.) homes
- Data from 2 to 10 years (w/ Qtr – annual frequencies)
  - "The [indoor air] normalized [by property annual average conc.] values ranged [max.-min.] from about *10%* (0.1x) … to about *ten times* (10x) the *annual average* of the home"
  - **Range of variation =** 2 orders magnitude **(100x)**
    - 68% of samples w/n **+/-** 2 to 3x of the homes annual mean
    - Winter concentrations tended to be highest and summer was about 50% lower than the annual mean
  - "Short term variability can overwhelm any seasonal trend" [very similar to comment by Rowe 2002]

Summary of Radon Conc. (Bq/m^3) Hubbard et al. 1996 (Sweden)

Sample	Factor	Range	Avg.	Period
1-Day	100x	~8 to 800	yr.	4 yr. ’90-94
2-Week	4.3x	70 to 300	yr.	4 yr. ’90-94
Year	1.3x	180 to 230	-	4 yr. ’90-94

- ~ four year period Nov. 1990 – July 1994

Final findings from TIER 3?

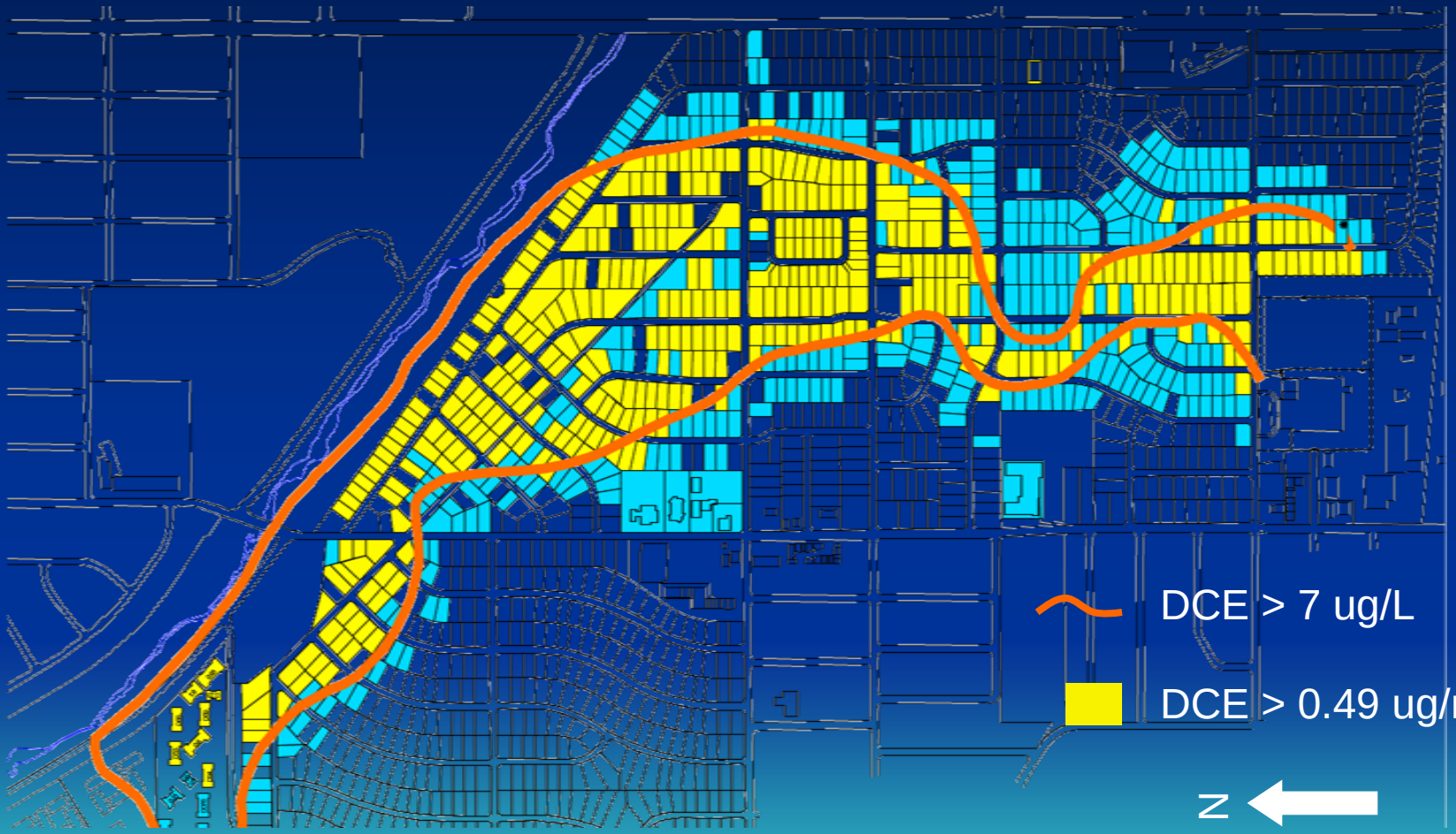
- Finally, the 2002 Draft Vapor Intrusion Guidance allows a site-wide decision to be made based on the measurement, or estimation, of indoor air concentrations in a *relatively* ***few*** *representative* ***buildings***.

- However, experiences since 2002 have indicated that vapor intrusion is *much more building-specific than appreciated in 2002*.

  – For example, observations have shown that **adjacent buildings** overlying similar subsurface contaminant concentrations can have **very different indoor air concentrations**, based on various factors, due to vapor intrusion. [See next slide]

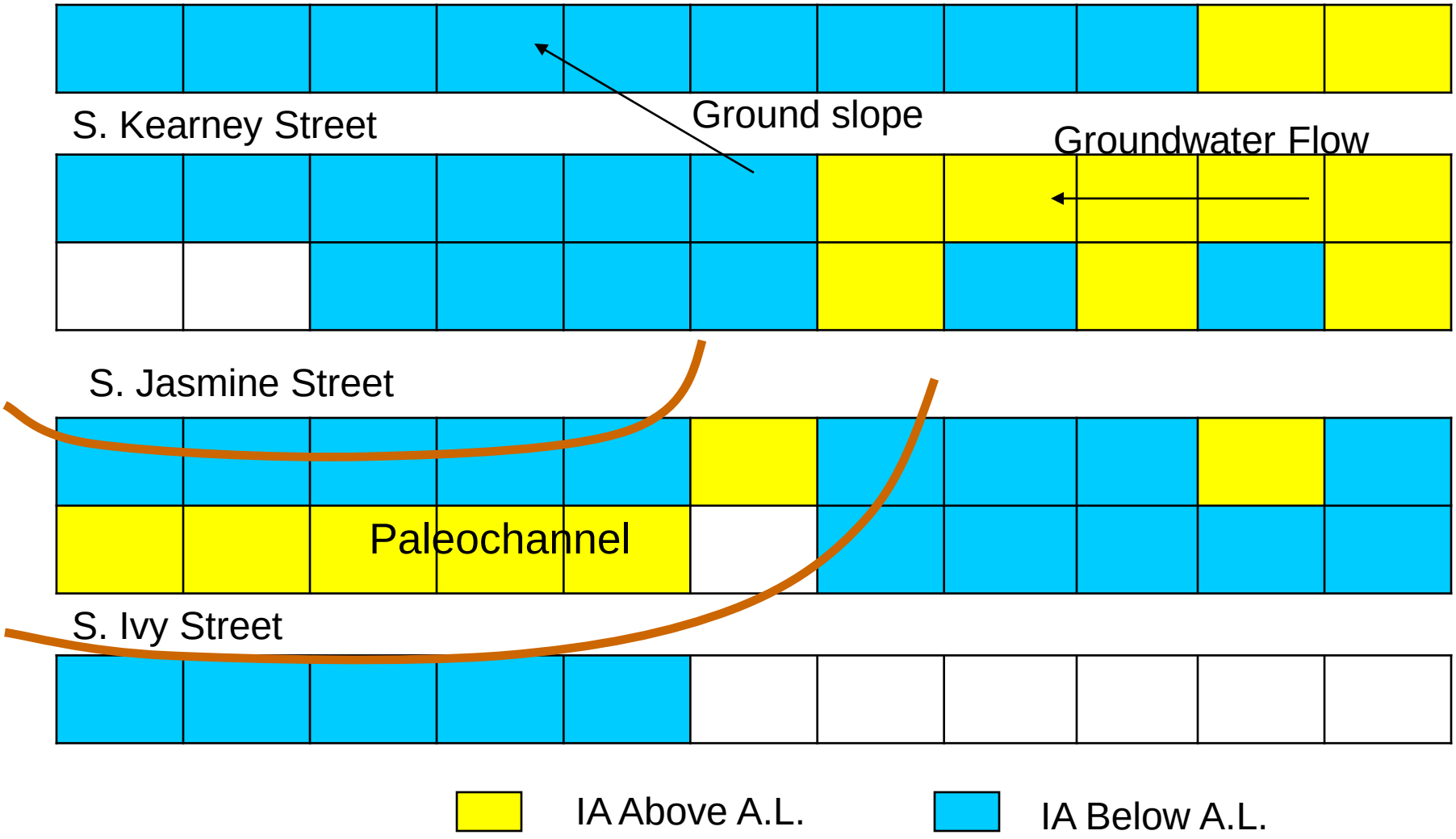
- While the approach described in the 2002 Draft Vapor Intrusion Guidance would generally remain appropriate and valid ***if*** the ***few sampled buildings*** were ***fully representative*** of all current and future buildings, this portion of the guidance will likely ***be updated*** to increase the confidence that the approach fully addresses ***building-by-building*** variability.

Extent of Impacts



EnviroGroup Limited
The Environmental Solutions Company

Redfield Site (1,1-DCE)



Slide by David Folkes, EnviroGroup, Inc.

Findings for the Appendices?

- The appendices to the 2002 Draft Vapor Intrusion Guidance include technical specifics and updates will be made for much of the technical information contained in the appendices.

- Also Appendix H (***Community Involvement Guidance****: Recommendation for What to Do If You Have a Neighborhood Needing Indoor Air Sampling Due to Subsurface Vapor Intrusion*) **will be updated and expanded**.

  - EPA views improving public outreach in neighborhoods surrounding vapor intrusion sites as a critical component of finalizing the Vapor Intrusion Guidance.
    »
  - Although the current Appendix H language remains valid, it is general, limited (e.g., is only focused on community involvement in the indoor air sampling phase), and not as specific to vapor intrusion sites as it could be.

  - EPA is considering—and will be soliciting EPA regional, state, and public input on—how to restructure and expand the community involvement components of the 2002 Draft Vapor Intrusion Guidance to be more specific to community involvement at vapor intrusion sites, including vapor intrusion–specific guidelines for effective risk communication, and available resources, outreach products and tools for public outreach at vapor intrusion sites.

A Summary of the 2002 Review

– Much of it is appropriate for its scope & purpose

– Updates could be made to:

- Chemical-specific details & definition of vapor source-areas (the VI site) & documentation for future buildings
- Use of SLE approach in Tier 2, & both Generic & Semi-site-specific Modeled attenuation factors for Soil Gas
- More - MLE, buildings types & preemptive mitigation
- Flexible timing (& duration) of external & indoor sampling
- Decision making & managing ‘background’ (w/ MLE, +)
- Address site-wide variability, incl. temporal & Bldg-by-Bldg
- Meaningful participation by all affected stakeholders

Questions?

Thank You

www.epa.gov/oswer/vaporintrusion