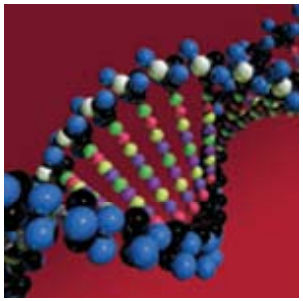
Evaluation of USEPA's Empirical Attenuation Factor Database


Air & Waste Management Association

Vapor Intrusion 2010

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Background

- USEPA introduced the use of default α's for Tier 2 generic screening in its 2002 draft vapor intrusion guidance.
- The 2002 default α's for subslab soil gas and groundwater were based on an USEPA database of empirical α's.
- In 2008, USEPA released an updated database and a draft report suggesting that the new database supports the 2002 default α's.
- In finalizing its vapor intrusion guidance, USEPA is likely to cite the 2008 database and draft report for default α's.
- USEPA has indicated that it may require using default α's for not only generic screening but also for replacement of semi-site-specific screening and site-specific assessment.

Evaluation of the 2008 Database and Draft Report

- Key Questions
  - Is the 2008 database robust enough to derive default α's that can obviate the need for estimating α's that account for site-specific conditions?
  - Are the recommended default α's reasonable for generic screening?

Representativeness of the 2008 Database

- About 90% of the empirical α's are for residential buildings (mostly with basements).
- Most of the subslab and soil gas α's are for coarse- or very coarse-grained soil.
- A vast majority of empirical α's for fine-grained soil are limited to the groundwater α's.
- Almost all of the empirical α's are for chlorinated VOCs (as opposed to BTEX).
- The empirical α's are not broken down by other factors that can strongly influence vapor intrusion, such as the depth of the contaminant source.

Deriving Default α's from the 2008 Database

- USEPA recognized the database included empirical α's that are high-biased by indoor sources.
- In the 2008 draft report, empirical α's were to be excluded from further consideration if:
  - field notes indicated the presence of background sources
  - indoor air concentration was higher than subsurface concentration
  - a chemical's α was inconsistent with other chemicals' α's in a sample
  - indoor air concentration was lower than the 95th percentile indoor air background level or analytical reporting limit
- These criteria eliminated the following percentages of α's:
  - 80% for subslab
  - 64% for soil gas
  - 59% for crawl space
  - 44% for groundwater

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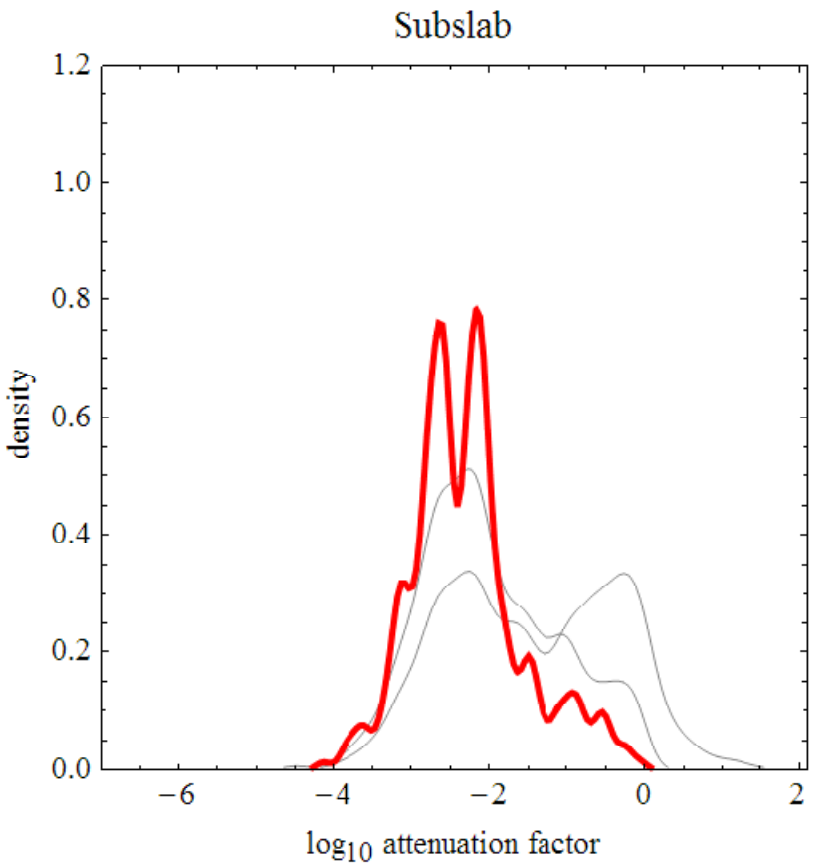
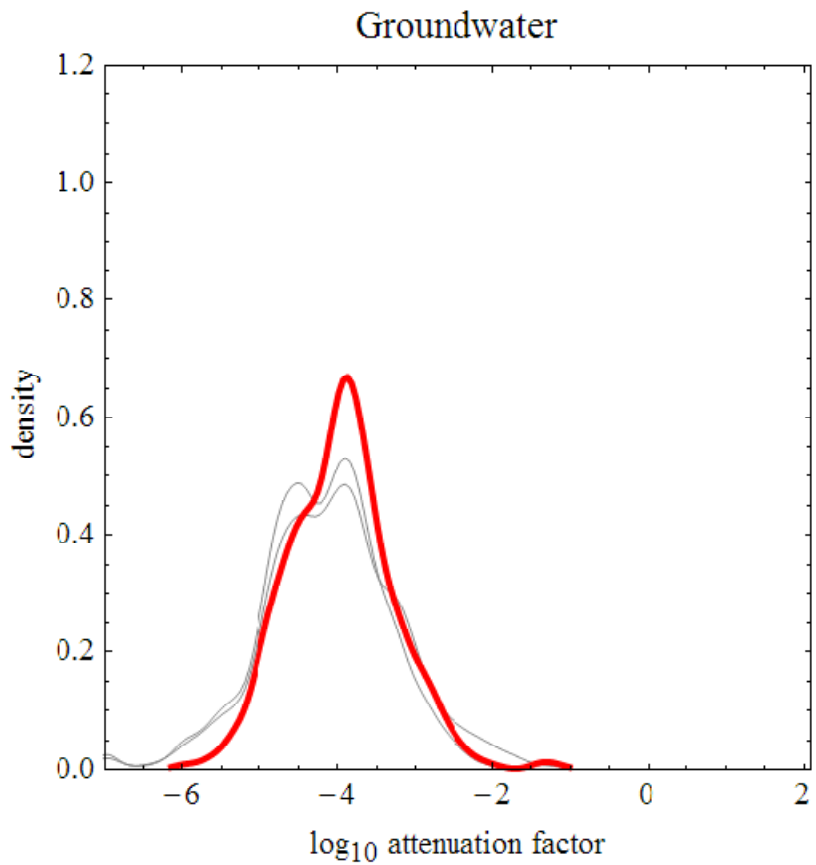
Distribution of α as Background Bias is Reduced





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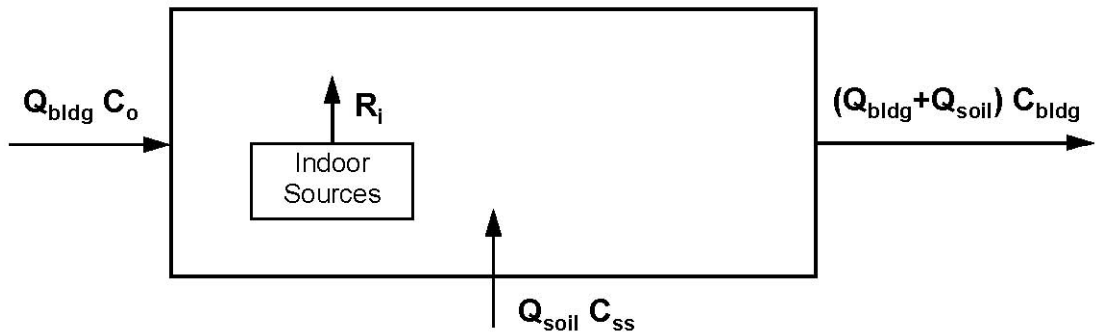
Additional Criterion for Reducing Background Bias

- For the following single-zone, well-mixed indoor space:



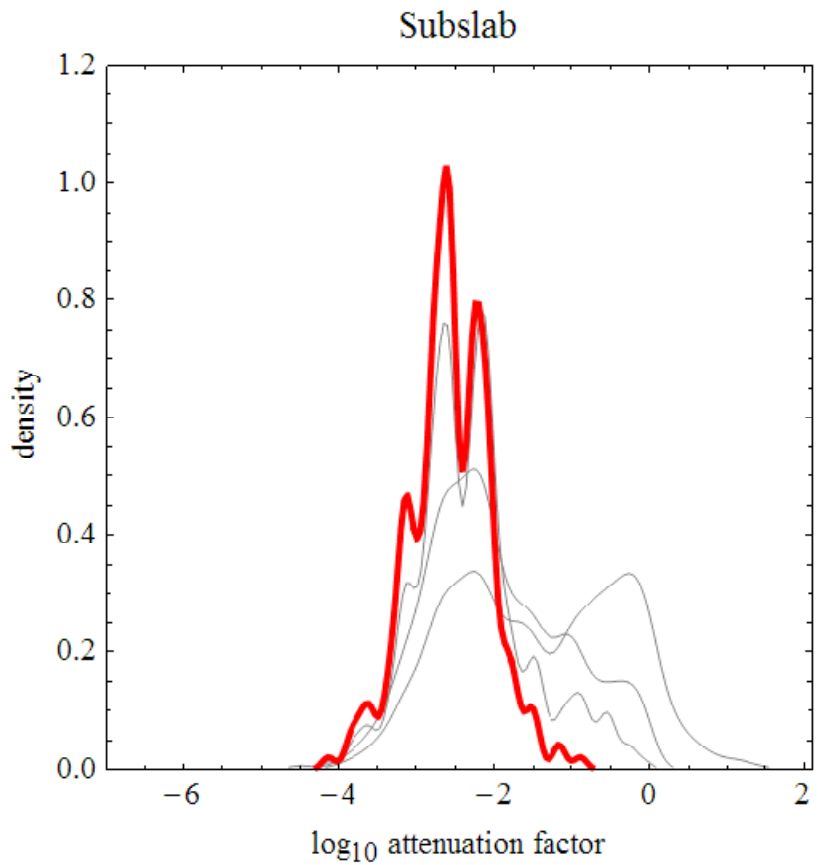
- A mass balance analysis shows that:

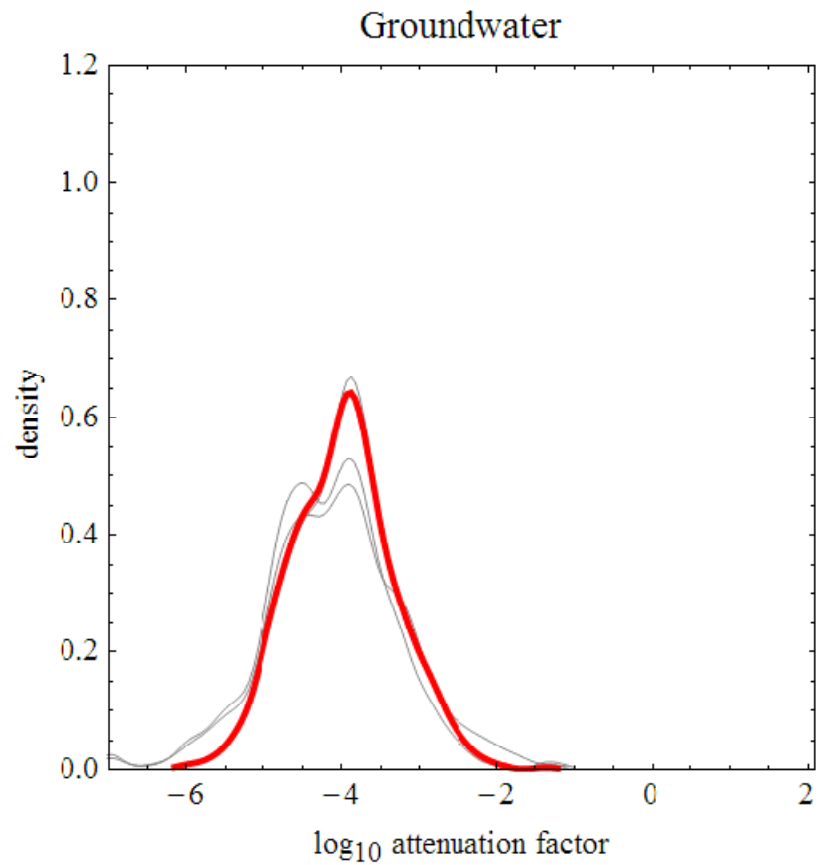
$$\tilde{\alpha}_{ss} \equiv \frac{C_{bldg}}{C_{ss}} = \frac{Q_{soil}}{Q_{bldg}} + \frac{C_i}{C_{ss}}$$

Additional Criterion for Reducing Background Bias

- Indoor sources will inflate subslab α's by 2X or more when C_i/C_{ss} equals or exceeds Q_{soil}/Q_{bldg}.
- Using USEPA-recommended assumptions for a residential building with basement, Q_{soil}/Q_{bldg} is approximately 0.003.
- This is similar to a ratio of 0.0016 that has been derived for radon entry into single-family homes.
- This means C_{ss} should be approximately 300X higher than C_i to minimize background bias on empirical subslab α's.

Further Reducing Background Bias Using “300X” Criterion





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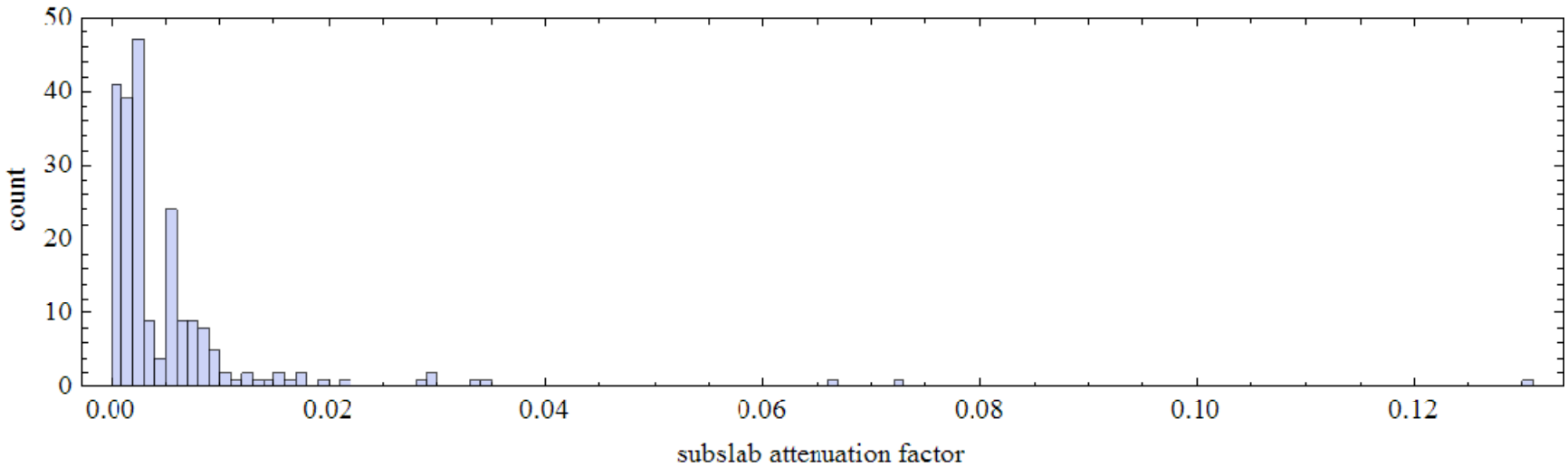
Remaining Empirical Subslab α's



- Review of these 217 α's showed that 97 have confounding factors or other characteristics that indicate a potential for background bias.
- These α's include 19 outliers (higher than $Q_{0.75}$+1.5*IQR).
- USEPA's default α of 0.1 is at the 99.5th percentile.

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Key Points

- The 2008 database has a very limited number of empirical α's for nonresidential buildings, fine-grain soil, or petroleum hydrocarbons.
- In deriving default α's, USEPA had to exclude most of the empirical α's in the database to minimize background bias.
- We found that empirical α's for residences will be inflated unless they are based on subsurface concentrations that are at least 300X higher than indoor background levels.
- USEPA's default subslab α of 0.1 is based on empirical α's that include many with C_{ss}/C_i ratios much less than 300.
- USEPA's default groundwater α of 0.001 does not have this problem.