SESSION W-F1 (Clean Up Tract)

Vapor Intrusion Sampling, Analytical, and Assessment

Blayne Hartman, Hartman Environmental Geoscience
Suzie Nawikas, H&P Mobile Geochemistry, Inc.

Notice to Reader:
The following slides are part of a multi-section training presentation given from 8:00am to 12:00pm on Wednesday, 2/5/2020 at the annual CA CUPA Conference in Burlingame, CA. The slides from each session have been combined into one PDF file. See the outline below to help navigate the PDF.

Session Summary: A Vapor Intrusion session to discuss sampling protocols, analytical methods and certifications, as well as the application of attenuation factors and various guidance recommendations. The session will include an interactive class exercise and hand-on demonstrations.

I. **Hot Topics/Intro (PDF Pages 2-15)**
(presentation)
   a. TCE
   b. Sewers
   c. Modeling v. Default Attenuation Factor

II. **Soil Vapor Field Observations (PDF Pages 16-32)**
(presentation)
   a. Installation materials and methods
   b. Sampling protocols and methods, including leak checks
   c. These topics will be covered in slides, and then covered in more detail during the breakout session

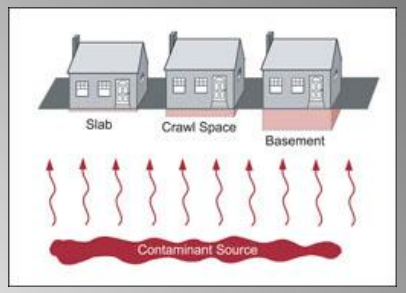
III. **Modern Analytical Techniques (PDF Pages 33-67)**
(Presentation)
   a. Continuous monitoring by TO-14
   b. Field testing versus fixed lab testing
   c. Case Studies
   d. These topics will be covered in slides, and then covered in more detail during the breakout session

IV. **Hands On Sessions to see topics 1 and 2, 20 minutes each, plus switch time**
(Nawikas Breakout Table framework in PDF Pages 68-76)
(Hartman Breakout Table was verbal only, no slides in PDF)
(Breakout Session)
   a. Demonstration of field Installation and sampling practices
   b. Demonstration of continuous monitoring

V. **Attenuation Factors (PDF Pages 77-103)**
(Presentation)
   a. Data Review of ~100 Structures
   b. Focused on Commercial, CA properties

Because the other sections of the training had so much wonderful interaction and questions, we unfortunately did not get to section VI. Thank you to all that participated in this lively training session!

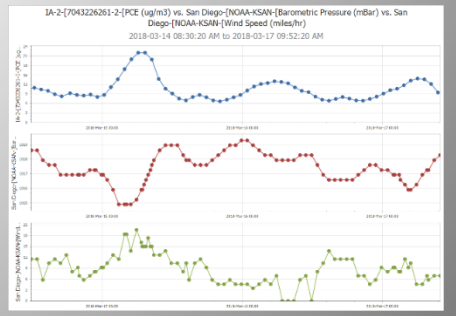
~~VI. **Report Evaluation and Case Study Exercises**~~
~~*(Presentation and Exercises)*~~
   ~~a. What to verify in data reports~~
   ~~b. False positives, false negatives, data flags~~
   ~~c. Analytical Certifications – what the certification entails, where to get certification, how to check, etc.~~
   ~~d. Classroom Exercises with Real Case Studies~~



Vapor Intrusion
Sampling, Analytical, and Assessment

CA-CUPA

February 2020



Presenters

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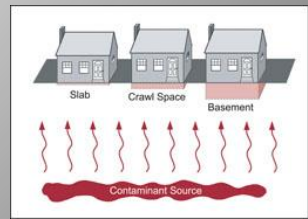
Presentation Topics

- **Hot Topics/Intro** *8:00-8:20, 20 minutes*
- **Soil Vapor Field Observations** *8:20-8:45, 25 minutes*
- **Modern Analytical Techniques** *8:45-9:15, 30 minutes*
- BREAK, 15 minutes
- **Hands On Sessions to see topics 1 and 2, 20 minutes each, plus switch time** *9:30-10:15 (45 minutes)*
- BREAK, 15 minutes
- **Attenuation Factors** *10:30-11:00 (30 minutes)*
- **Report Evaluation and Case Study Exercises** *11:00-11:45*
- *Q&A at the end, but it encouraged throughout the morning!*

Why is VI Such A Concern?

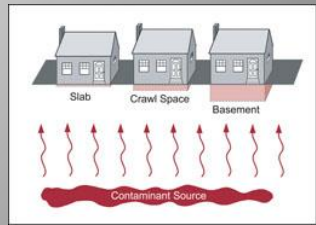
- Long distances (100s of feet)
- Lots of compounds (80+)
- Low screening levels (< 1 ppbv)
- Lots of receptors (people, animals, fruit)

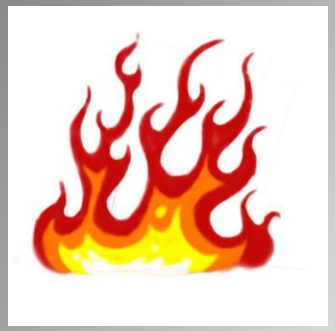
Add it all up & what does it mean…



Topics

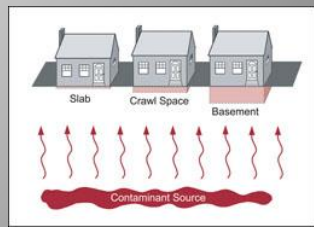
- Short-Term TCE Issue – Latest & Greatest
- Sewers – Really A Concern?
- Modeling – Ok to Use?
- Attenuation Factors – to 0.03 or not to 0.03?
- Passive Samplers – Better to Use?
- Continuous Monitoring – The Future?





The Hottest VI Regulatory Topic

Short Term TCE Exposure



Johnson et al Study (2003)

- Fetal heart malformations observed during 21-day gestational period of Sprague-Dawley rat based on oral exposure.

- To date, fetal heart malformation results not replicated in other studies, including: FIVE TCE rodent/rabbit inhalation studies
  - Carney et al., 2006
  - Dorfmueller et al., 1979
  - Hardin et al., 1981
  - Healy et al., 1982
  - Schwetz et al., 1975

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The Latest TCE Study

- TCE drinking water study designed to mirror 2003 Johnson study completed in summer 2018

Study Conclusion: no treatment-related effects!!

- Results of the study have been accepted by Birth Defects Research and will be posted on the Journal web site soon

- Draft, audited lab report submitted to EPA OPPT in November 2018…no EPA response yet

Sewers

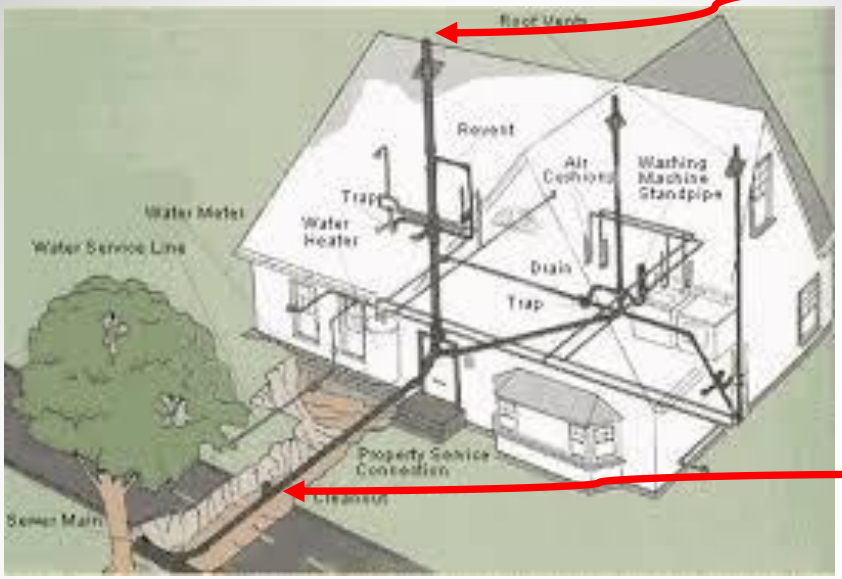
I'll send you to the moon

Vapors from Sewers?

Vapor Intrusion

Sewers

Roof Vents



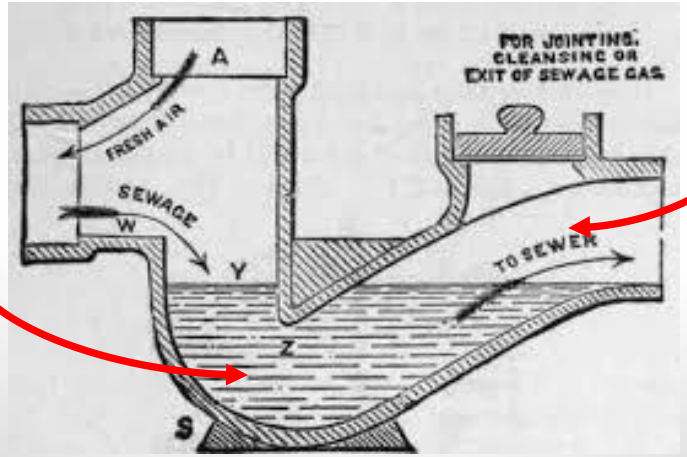
Easy to Sample

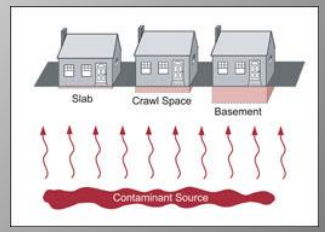
Clean-outs

P-Traps

Easy to Prevent

(Keep Wet)

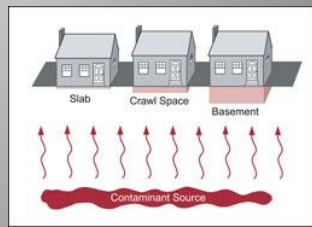




Modeling Getting the Boot

- EPA
- HERO
- NY
- WA
- GA
- MO
- OH
- KS

AF Intended to Replace Modeling



HUMAN HEALTH RISK ASSESSMENT (HHRA) NOTE NUMBER 4

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL (DTSC), HUMAN AND ECOLOGICAL RISK OFFICE (HERO)

ISSUE DATE: May 14, 2019

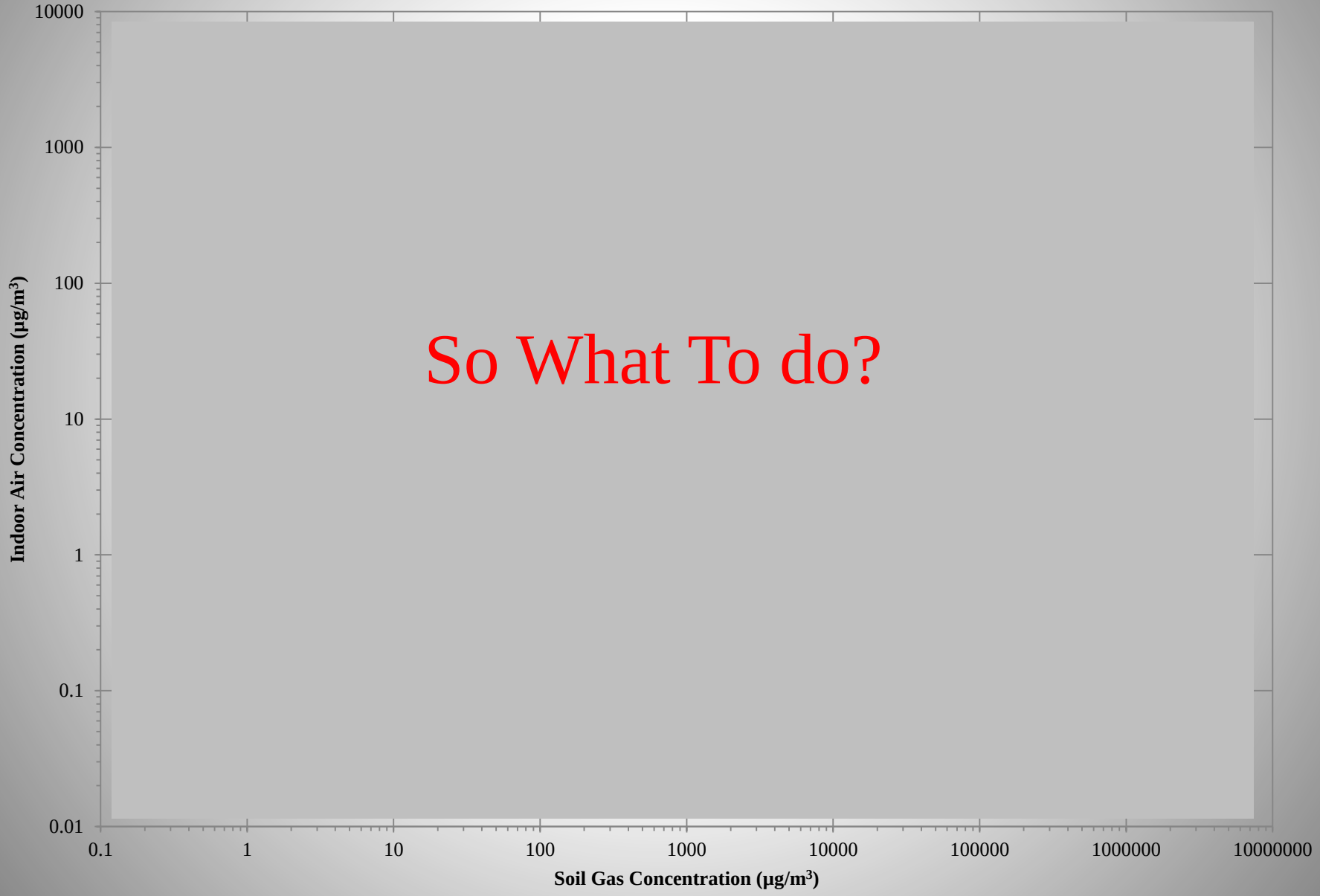
ISSUE: Guidance for Screening Level Human Health Risk Assessments.

D. EVALUATION OF THE VAPOR INTRUSION TO INDOOR AIR PATHWAY

As noted above, the U.S. EPA RSLs and DTSC-SLs do not account for risk and hazard from the vapor intrusion to indoor air pathway. When significant concentrations of VOCs are present, the vapor intrusion pathway often generates the highest cancer risk and hazard index. Therefore, when vapor intrusion is a potentially complete exposure pathway, it is essential that it be included in the screening risk assessment.

Please consult DTSC's vapor intrusion to indoor air guidance for a more detailed discussion of this topic (DTSC 2011a). DTSC guidance recommends that multiple lines of evidence, such as soil gas, indoor air, and groundwater data be used for preliminary screening evaluations of vapor intrusion. Soil gas data provide a direct measurement of the VOCs that may migrate to indoor air. If soil gas data are not available for a given site, a soil gas investigation should be conducted. For sites where groundwater is contaminated with VOCs, DTSC recommends that vapor intrusion to indoor air be evaluated using both soil gas and groundwater data. This recommendation is particularly applicable for sites where groundwater is shallow and there is a large capillary fringe. Technical difficulties in sample collection and preservation of VOCs in soil matrix, as well as uncertainties associated with the use of partitioning equations make soil matrix data less than ideal for estimating vapor intrusion. However, in some cases, there may be no alternative and this should be discussed with the project team prior to conducting the vapor intrusion evaluation. Additionally, please consult your site toxicologist regarding any questions about the use of groundwater data for modeling potential vapor intrusion to indoor air. As discussed above, HERO no longer recommends using the DTSC-Modified soil gas and groundwater J&E models to predict theoretical indoor air concentrations from soil gas and groundwater data and the models have been removed from HERO's website. The J&E models have not been updated and are not based on the most current J&E model spreadsheet tool from U.S. EPA.

EPA Database
Commercial Structures



Hot Topics

Many of these Hot Topics will be woven throughout the presentations this morning

Soil Vapor Field Work Observations

RECOMMENDATIONS FOR SITE VISITS

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NATIONAL ENVIRONMENTAL FIELD ACTIVITIES PROGRAM TNI

Importance of Field Procedures

- Analytical Procedures are well defined, widely accredited, and uncertainty is known
- Field Procedures vary with each contractor, are largely unaudited, and have an unknown uncertainty

We are at a point in our industry where we can and should <u>expect more</u> from the installation and sampling processes

H2P Mobile Geochemistry Inc.

We've come a long way…

THEN: 1997

Screening levels were PPM levels

No defined purge calculations

No leak check

Reusable plastic syringes

Adsorbent tubing, cross contamination, etc.

We would GASP nowadays!

Mobile Geochemistry Inc.

We've come a long way…

Screening levels are at **PPT** levels

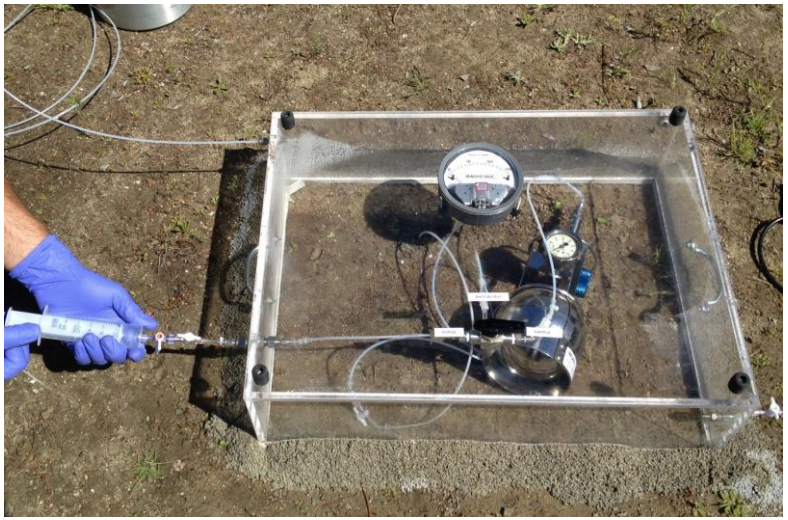
Highly accurate purging, flow rates, vacuum readings, etc.

Liquid leak check thresholds <0.1%, or intense Helium Shroud sampling

Materials and consumables testing

All things that we would have rolled our eyes at in 1997!

NOW: 2020



Mobile Geochemistry Inc.

The Quality of the Data is only as Good as the Quality of the Sample

H&P, INC.

H&P's Mission Statement:

To provide the environmental industry with the highest quality data feasible, using the most updated and proven sampling and analytical techniques.

The H&P team collects over 1,000 soil vapor samples per month

NEFAP CERTIFICATION

H&P is the first and only Field Sampling and Measurement Organization (FSMO) in America to earn Accreditation for Active Soil Vapor Sampling

Cert # L19-655

H&P Mobile Geochemistry Inc.

Installation and Sampling

Soil Vapor Probe Installation

Placement

Materials

Construction Specifications

Tips for Items that aren't necessarily in the DTSC Guidance

Active Soil Vapor Sampling

Procedures

Materials

Leak Check Methods

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Installation Concerns - Placement

1) Field consultant placed the boring based on GPS direction from the office, and didn't have the experience to recognize any problem with the placement

2) Drilling contractor was familiar with soil vapor probe *installation*, but NOT familiar with soil vapor *sampling,* so they didn't think twice.

H&P was tasked with sample collection on this site, and thankfully we were able to influence the consultant to relocate this point before the probe was installed.

Installation Concerns – Rigid Tubing

1) Permanent probes with rigid tubing are susceptible to cracking and kinking over time.

2) H&P is often tasked with probe repair, which typically looks like this. It introduces a lot of new connections and, if not done correctly, creates entry points for leaks.

Teflon tubing isn't all it's "cracked" up to be. Nylaflow has equal analytical qualities and is much more resilient over time.

Installation Concerns – Poor Construction

1) Nested probes – 1’ and 5’ bgs. The top probe was filled with sand to the top, without any bentonite or cement as a seal.

2) The well diagrams in the work plan showed a seal at the top, albeit just a few inches, but this is not how they were constructed. The consultant didn’t know enough to realize that the diversion from the work plan was significant.

H&P was told to “just purge and proceed” as written in the work plan, and significant leaks indicated communication had occurred.

Installation Concerns – Wrong materials

1) Unacceptable probe seal with caulk.

2) H&P was collecting confirmation samples following another consultant. They had already sampled these points, and applied the leak check only to the sample train, not to the probe seal.

Shortcuts and inexperience are never worth the cost savings.

Sampling Concerns – No Leak Check

1) Substitution of a surface seal such as a water dam or mounded bentonite, in place of a leak check compound

2) Common among contractors, and often erroneously described as a leak check method.

Leak prevention techniques are NOT the same as leak check techniques

Sampling Concerns – Reusing Parts

1) Hard to tell in the photo, but the same metal valve and upstream gauge has been used for every sample onsite, quarterly, since 2012.

2) Misconception that it is OK to reuse metal fittings, and underestimating the impact of carryover

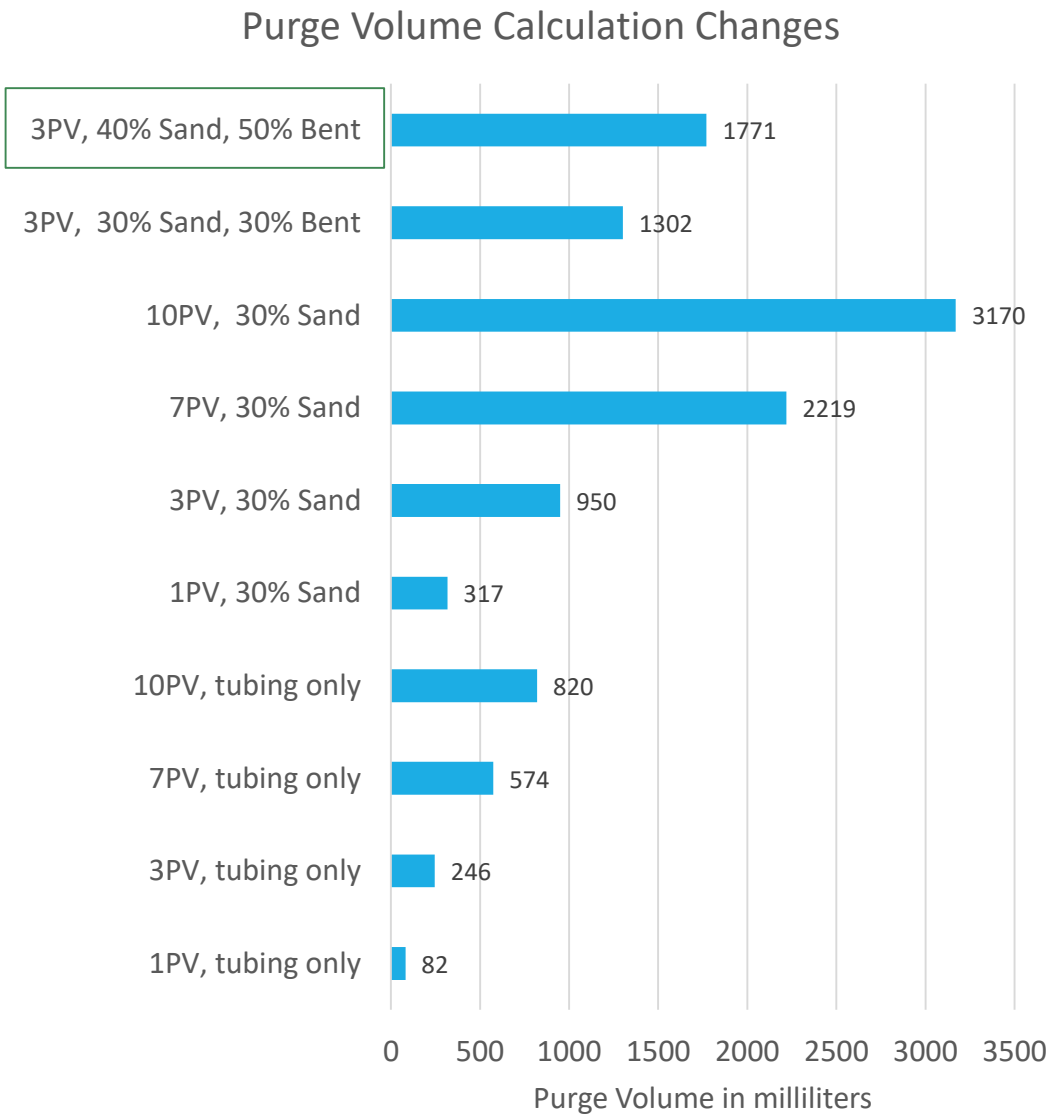
Soil Vapor sampling is not easy, and bad habits, while they can be unintentional, can lead to data issues.

Sampling Concerns – Purge Volumes

Recommended PVs have changed significantly in the past 10 years and can vary between practitioners.

<u>Example Probe:</u>

17’ of ¼” Tubing, 12” sand #3, 6” dry bentonite #16, 2.25” dia boring



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Sampling Concerns – Minimum Flow Rates

"Just get the sample"

"We need data out of this well"

"I don't care how long it takes, just give me some numbers"

This approach leads to unrepresentative samples, many laden with unrecognized leaks.

The industry should agree upon a minimum flow rate at which point active soil gas sampling is no longer representative, and an alternate method (such as passive) should be considered

Sampling Concerns – Unverified Materials

H&P frequently observes various materials being used for sampling, and it is assumed that they are free of VOCs. This is NOT the case, even if MSDS sheets do not indicate VOCs.

Our industry is concerned with lower levels than MSDS sheets are required to describe.

Product photos from amazon.com

Silicon tape can contain ***Benzene, TPH, etc*** *(provided by regulator)*

Mortar Repair and Caulking can contain ***TBA, PCE, TPH, etc***

Modeling clay can contain ***BTEX, PCE, TCE, TMBs, Oxys, Ketones, TPH, etc***

Part of H&P's SOP and certification is that we cannot use anything that we do not test on a regular basis

What is next?

Respect the difficulty that is associated with active soil vapor sampling, and prioritize quality and experience in your soil vapor projects.

Expect MORE from your soil vapor sampling team!

Ask questions, voice suggestions, etc. Just think of the changes that have occurred even in the past 10 years, and where the industry will be in another 10 years!

Table Session

<u>Soil Vapor Probe Installation</u>

Materials (tubing & annular seal hydration)

<u>Active Soil Vapor Sampling</u>

Procedures for Active Soil Vapor (and Sewer)

Materials

Leak Check Methods and Tolerance

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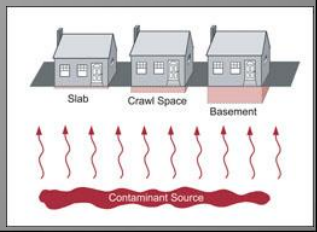
Indoor Air Measurement

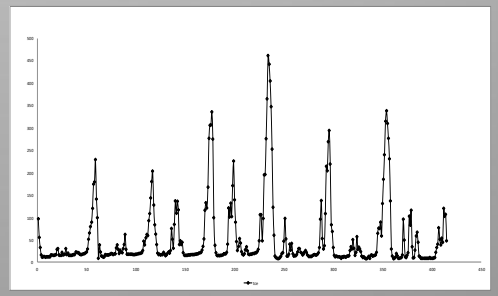
- Pros:
  - Actual Indoor Concentration

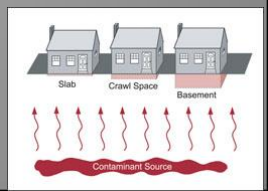
- Cons:
  - Limited data points
  - Where are the compounds coming from?
    - Vapor Intrusion
    - Outside Sources (i.e. exhaust)
    - Inside sources (i.e. household items)



Indoor Air Sampling Methods

- Evacuated Canisters
  - Summa Canister with flow regulator
- Adsorbents with Pump
  - Need a lot of pumps
- Passive Adsorbents
  - Longer collection periods (7 to 30 days)
- Automated Monitoring
  - Much more information

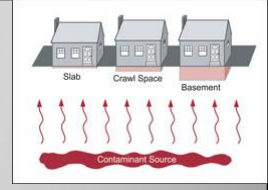




Canisters for Air Sampling

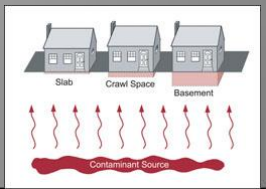
Sizes:
1 to 6 liter

Flow Controllers:
Typically 8hr or 24hr
Now up to 7 days



Long Term Air Sampling
(i.e. 7-30 day sampling periods)

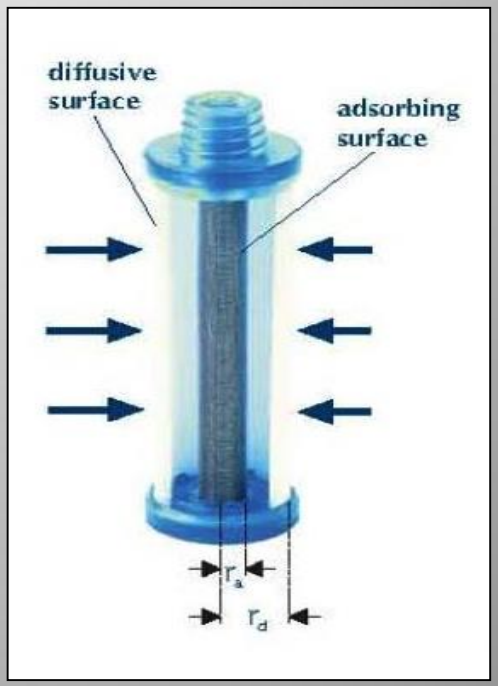
- EPA and CA Regulators leaning toward this approach for IA evaluations
- Pros:
  - Provides an average concentration for a longer period of time
- Cons
  - NO CONTROL over occupants
  - Misses short term occurrences (i.e. TCE)
  - Commercial settings – Cannot simply turn off the collector at night



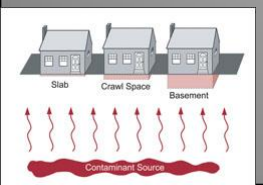
Passive Sampling Media

Diffusion along ends (Beacon Environmental)

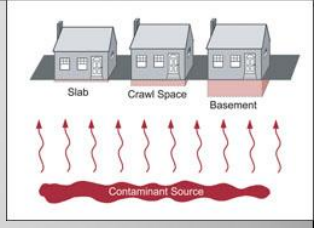
Diffusion on one end pass membrane (Waterloo Sampler)



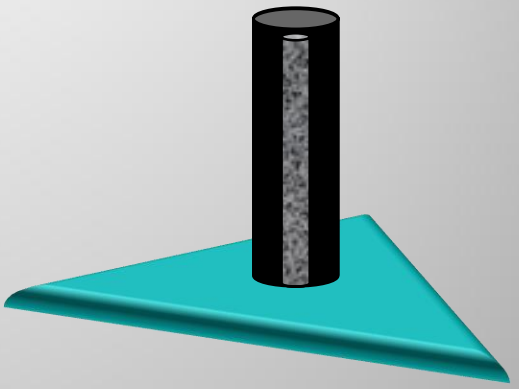
Axial Diffusion (Radiello)



Passive IA Method



$$C = m/Q*t * 1{,}000{,}000$$



C = concentration in ug/m^3

m = mass of analyte in ug

t = exposure time in minutes

Q = experimentally measured sampling rate (ml/min)

Factors Influencing Passive IA Sampler Performance

- Environmental
  - Temperature
  - Relative Humidity

- Type of Sorbent
  - Proper type for COC
  - Proper for sample period

- Expected Concentrations
  - High uptake samplers (axial) for low conc
  - Low uptake samplers for high conc

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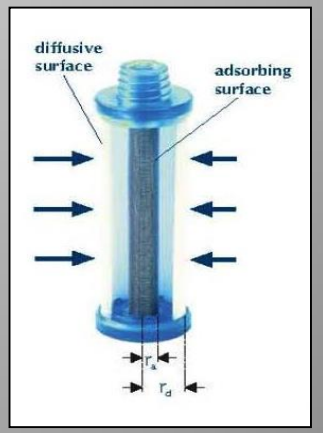
Final Thoughts on Passive Samplers

- Analysis of Samplers
  - Thermal Desorption (could be certified)
  - Solvent Leach (not certified method)

- Canisters
  - Now exist for 7 to 14 day periods
  - Certified method

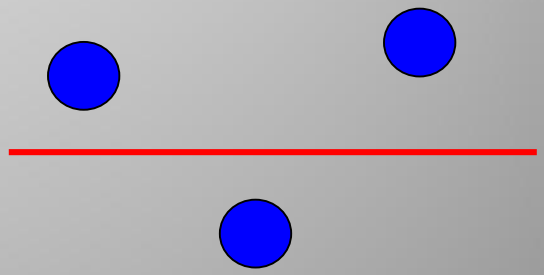


BTW, Remote monitoring of canister vacuums to be available soon

The Fundamental Problem with VI Assessments & Remedies

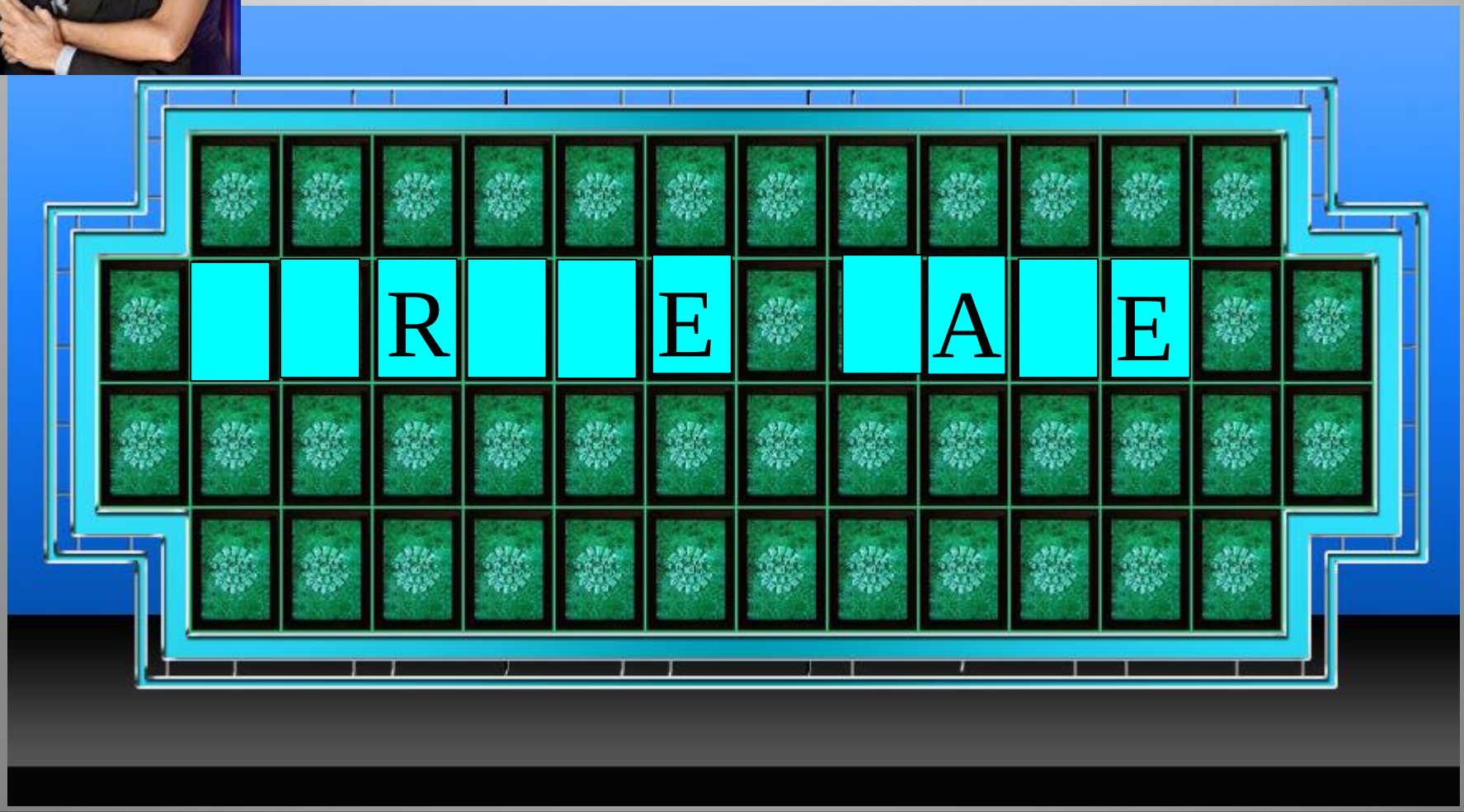
With These:

You Get:



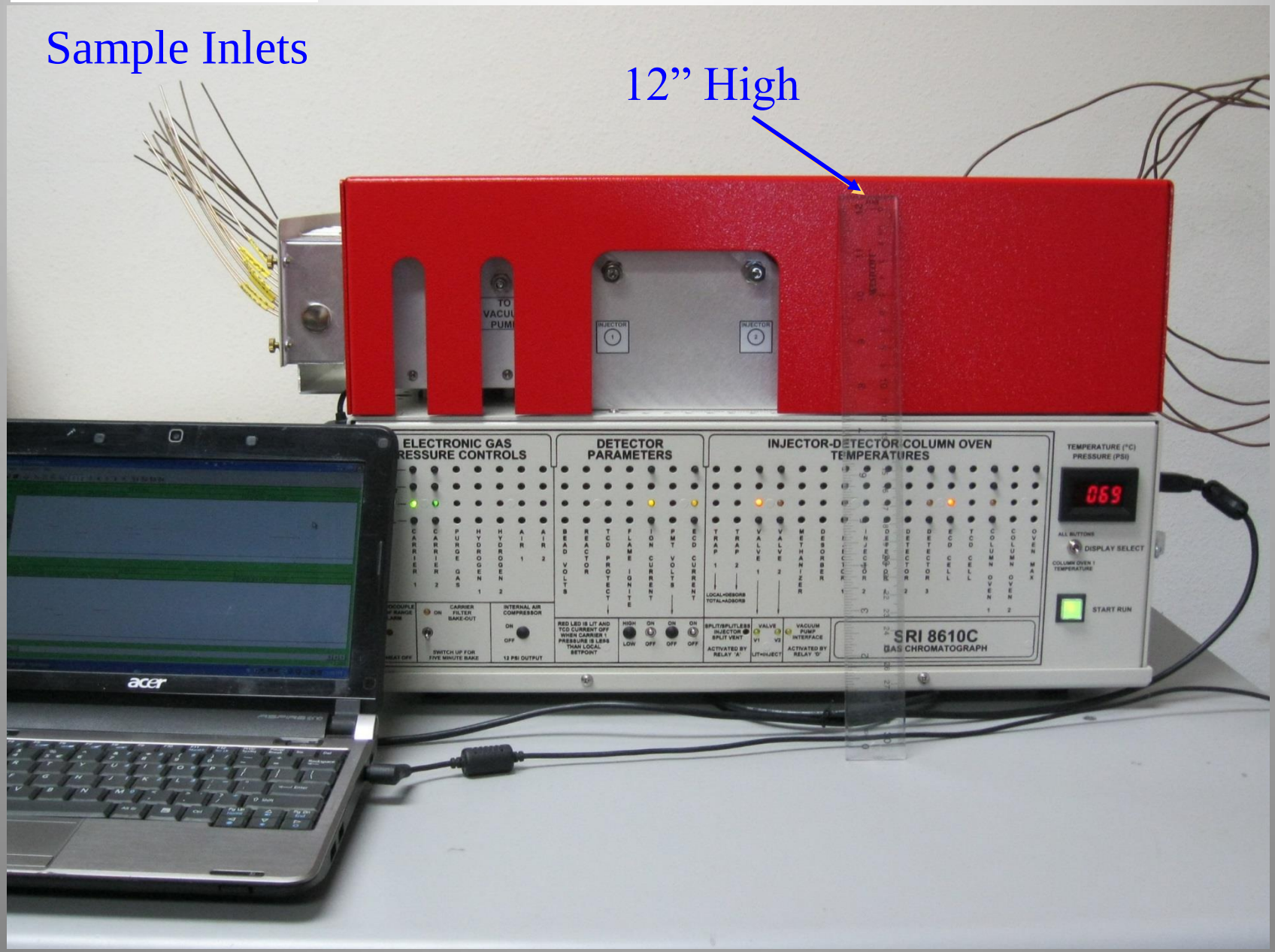

WHEEL
of
FORTUNE

Category: Song



VaporSafe™
VAPOR INTRUSION
ASSESSMENT, MONITORING & RESPONSE SERVICES

Continuous Monitoring System



VaporSafe™
VAPOR INTRUSION
ASSESSMENT, MONITORING & RESPONSE SERVICES

System Capability

- Fully Quantitative!
- Can Reach Ultra-Low Levels (<1 ug/m3) for TCE, PCE, Vinyl Chloride & others
- <10 min Analysis Time for TCE & PCE
- Multiple Sample Locations (16 to 30)
- Very Stable - holds calibration for months
- Real-Time Data On the Web
- Discrete Sampling Mode

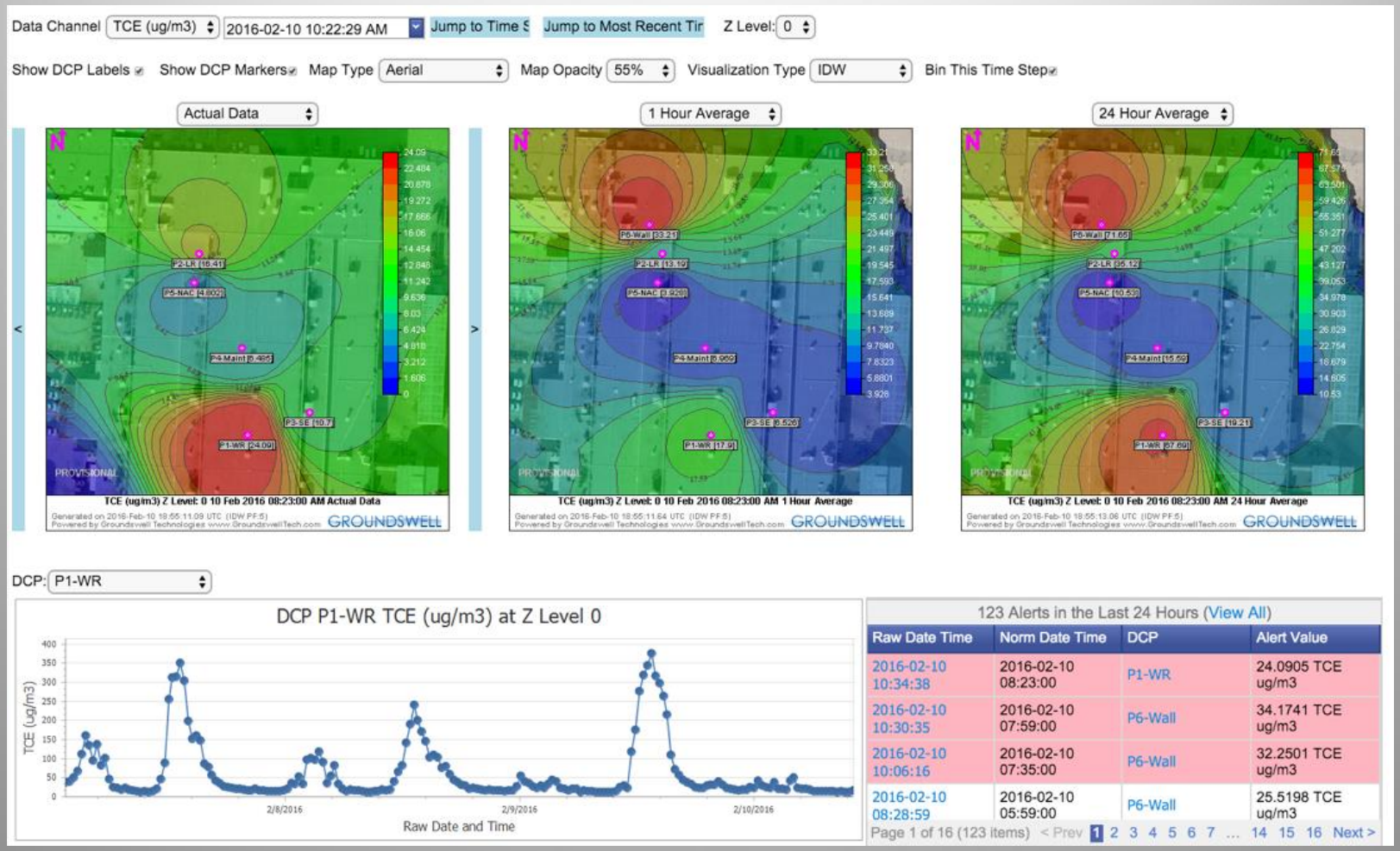
VaporSafe™
VAPOR INTRUSION
ASSESSMENT, MONITORING & RESPONSE SERVICES

Data

VaporSafe™
VAPOR INTRUSION
ASSESSMENT, MONITORING & RESPONSE SERVICES

- Concentrations
- Pressure Differential
- Barometric, Temp., Wind Speed, etc.
- Daily Summary Reports (by e-mail)
- Trigger Relays
- User Friendly Dashboard
  - VOC Conc vs Time
  - Contour/Isopleth Images
  - Moving Averages
  - Plots in Seconds

User Friendly Web-Based Data



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VaporSafe™
VAPOR INTRUSION
ASSESSMENT, MONITORING & RESPONSE SERVICES

System QA/QC

- EPA Method TO-14
- Calibrated with Validated Gas Standards
- Minimum of 5 Calibration Points
- Can Run Calibration Gas Every Cycle of Ports
- Precision on EPA Indy Site: <10% over 100 Days
- Accuracy vs off-site TO-15: 17%

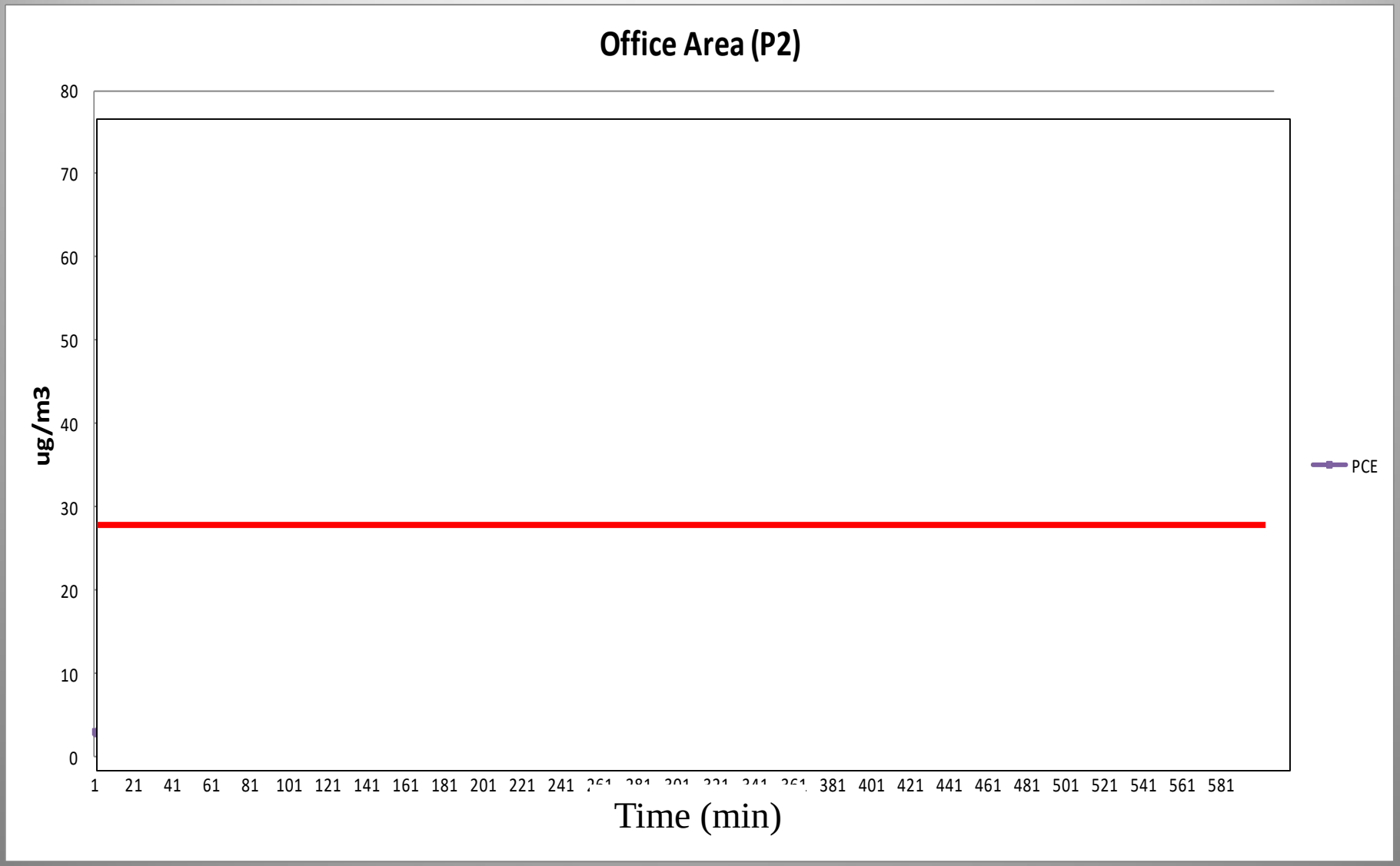
EPA Documented:

https://clu-in.org/download/issues/vi/VI-EPA-600-R-13-241.pdf
(EPA/600/R-13/241 | June 2015 | www.epa.gov/research)

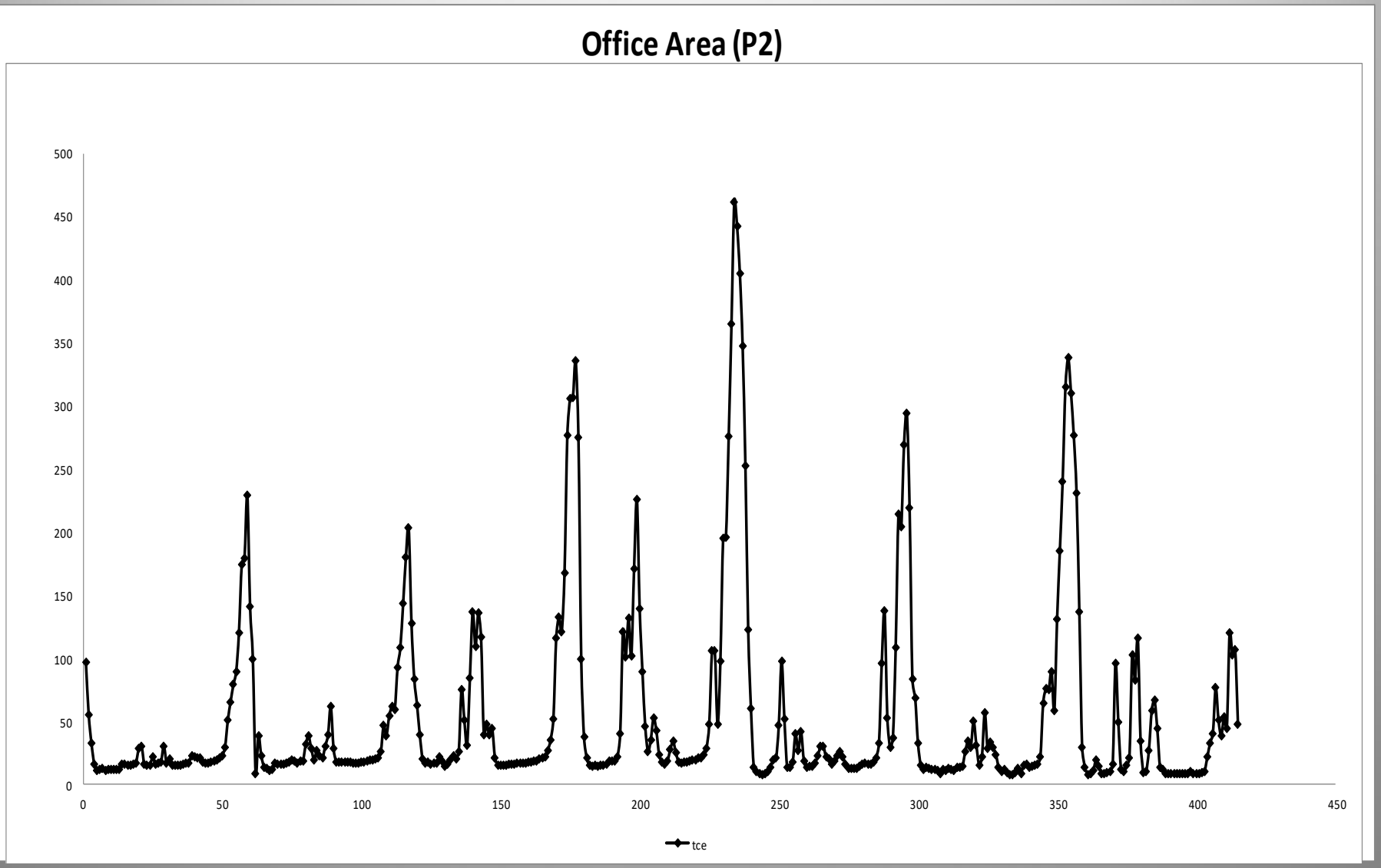
Tubing Runs

Tubing Runs

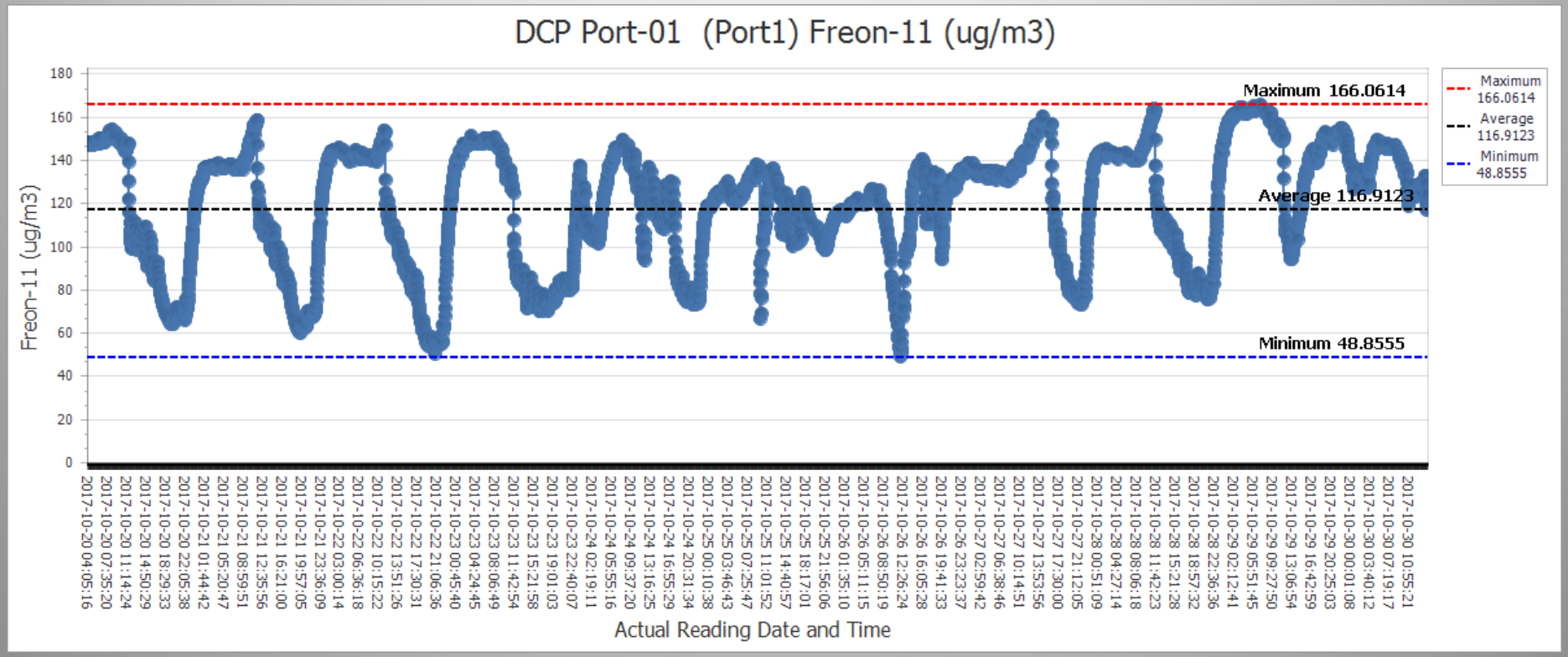
The "Truth" About IA Concentrations



Typical Air Sampling Result



Freon 11 - Office Bldg – 10 Days



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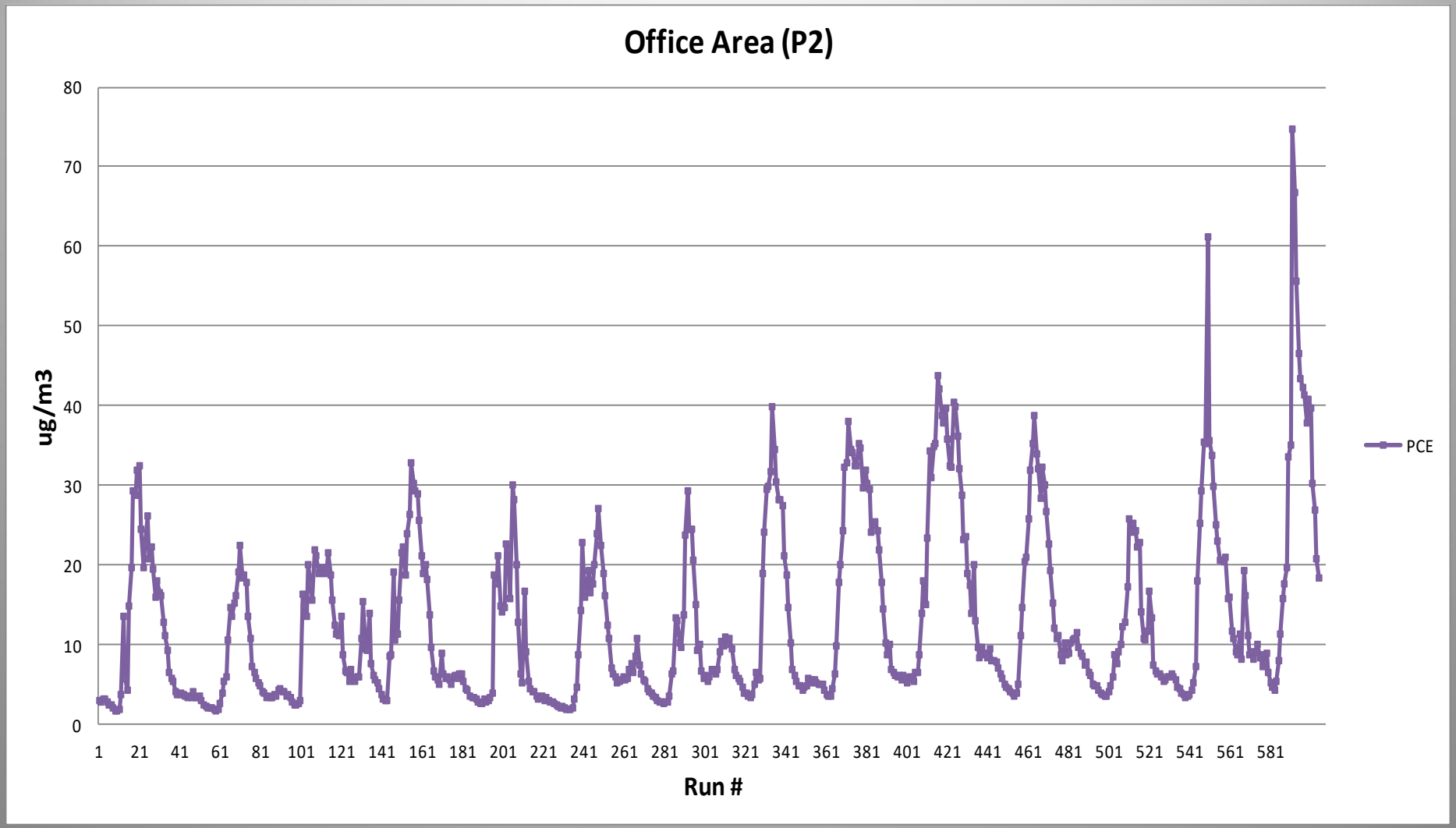
Exposure



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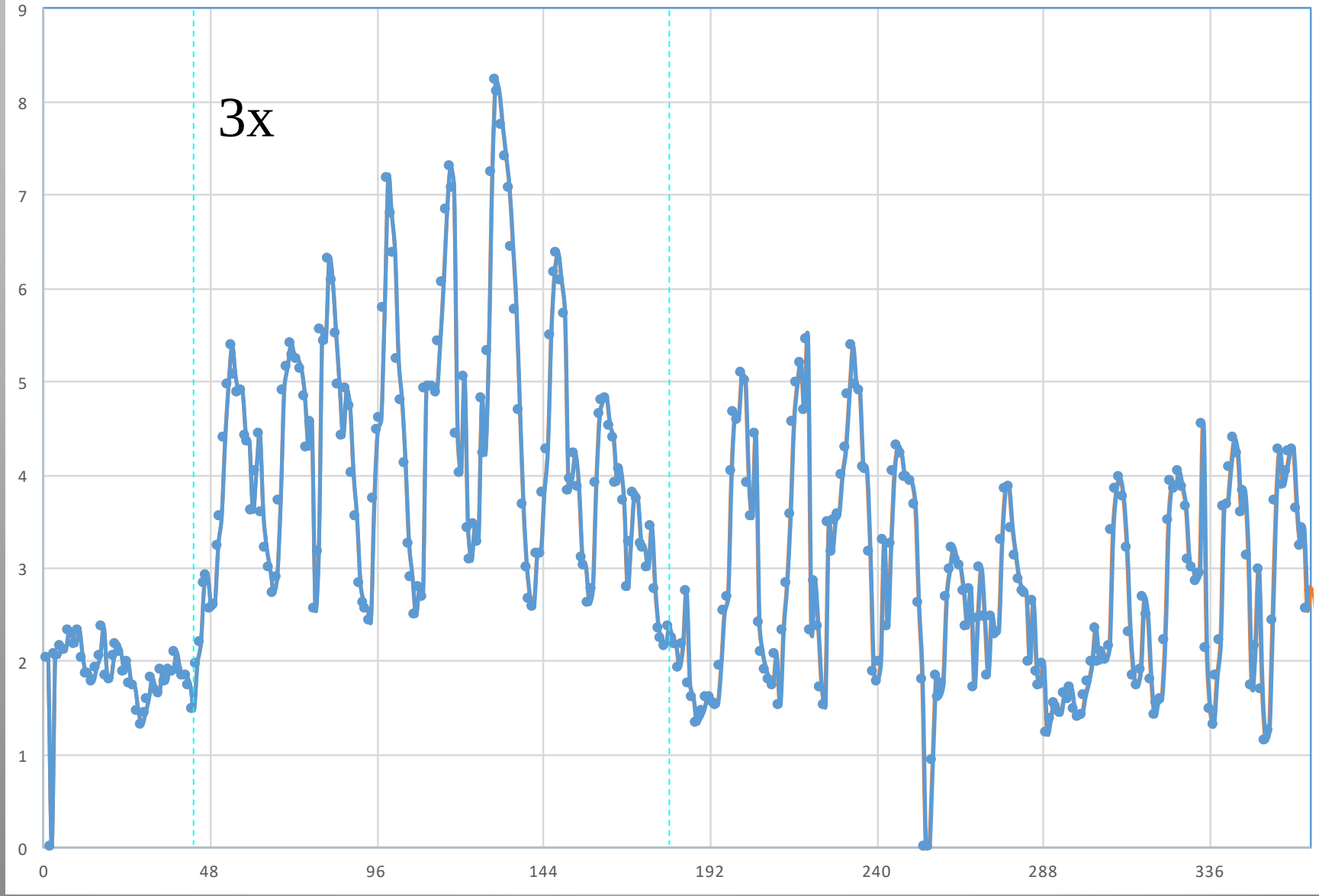
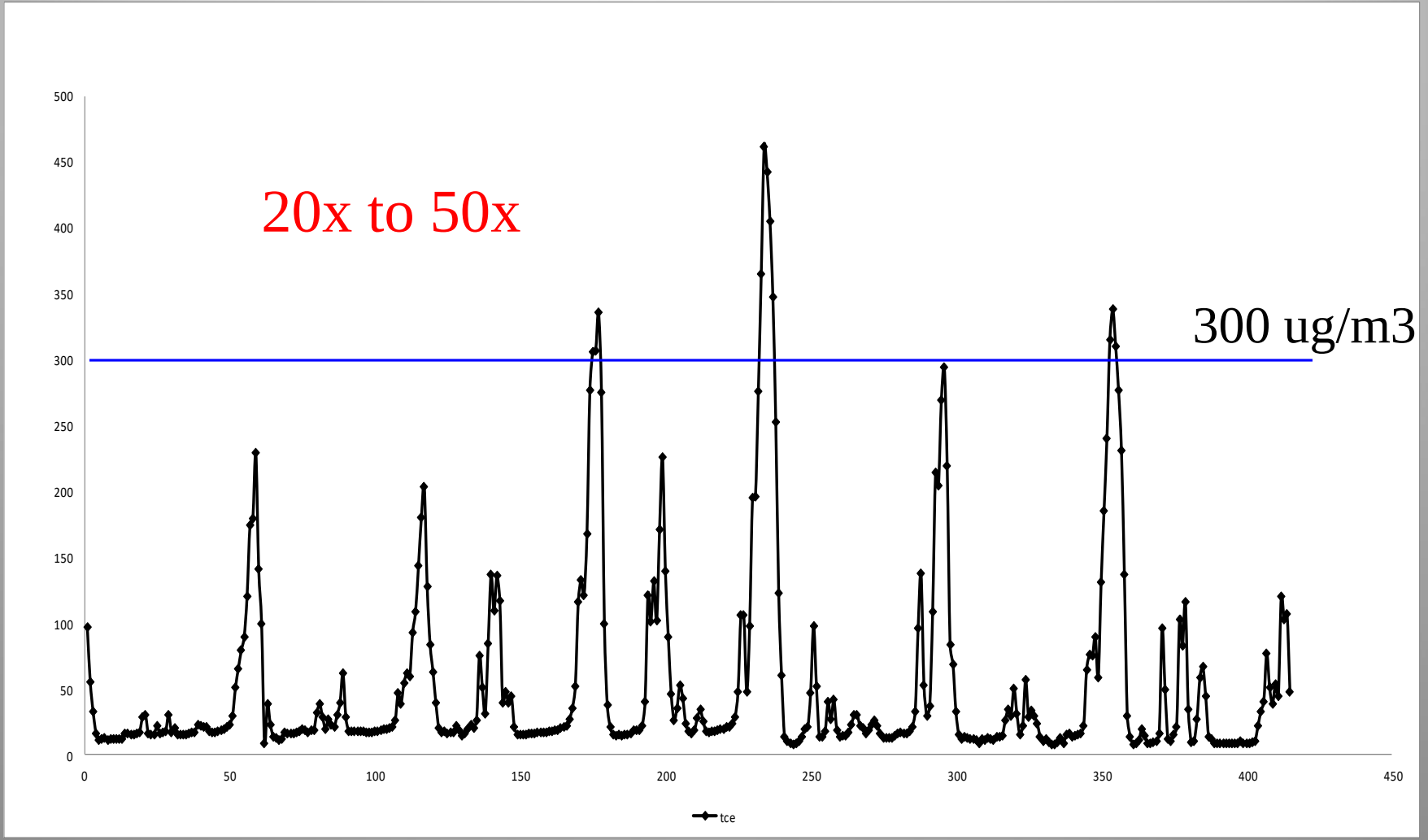
Single Family Residence (Home)



9/12/16 9/24/16 10/16/16

Large Industrial Building



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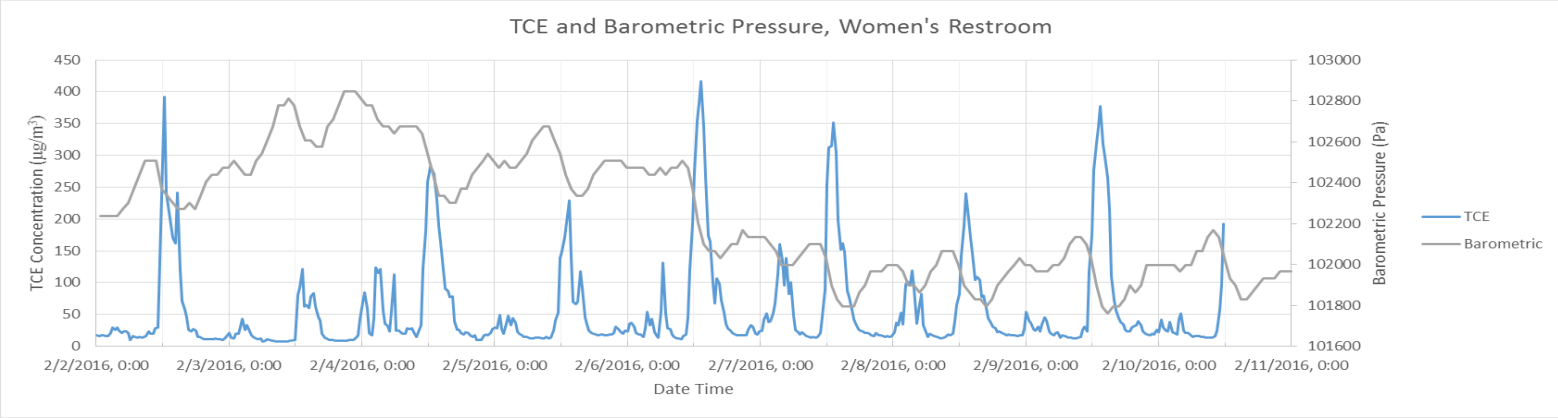
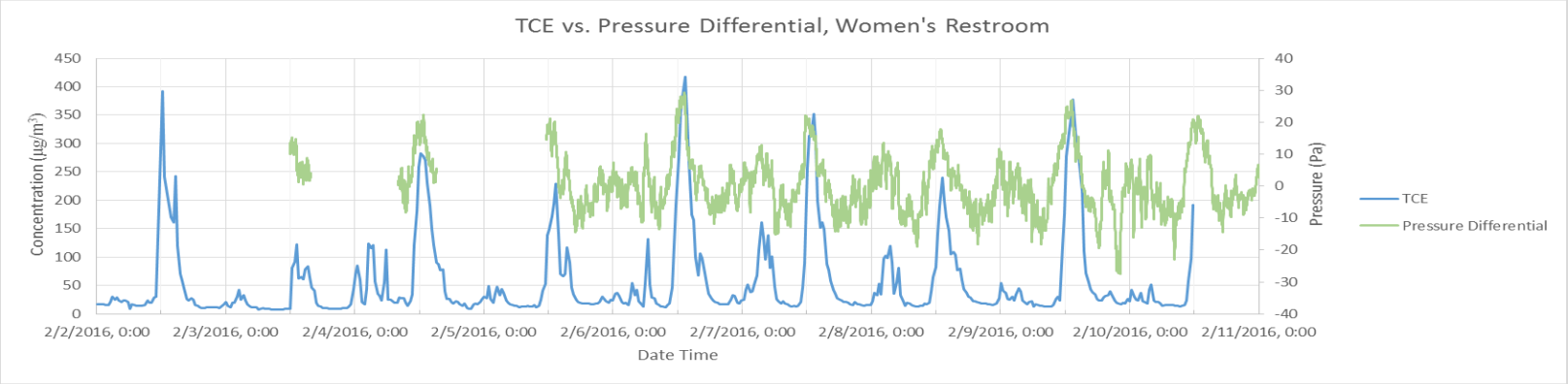
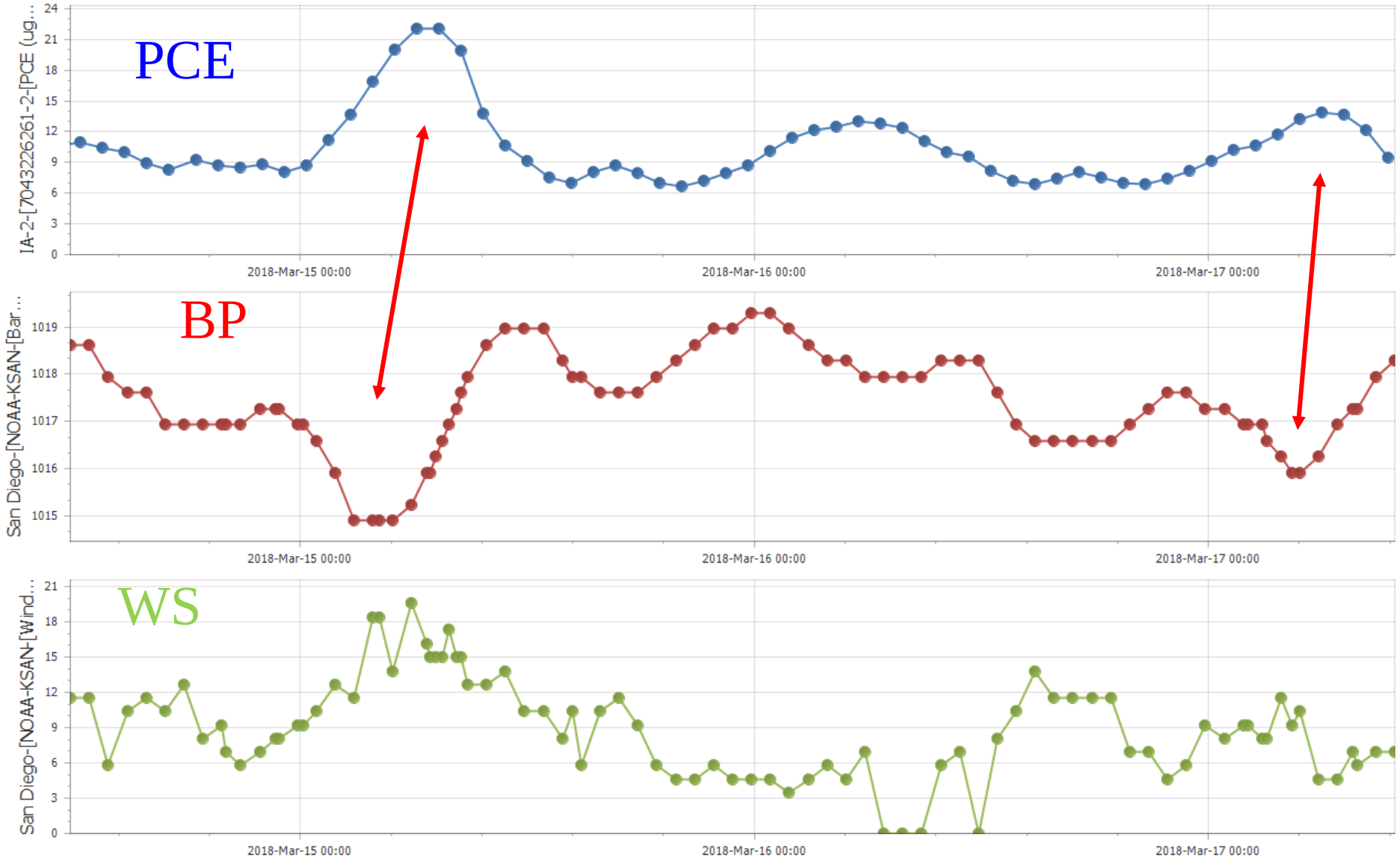
Relationship with Pressure



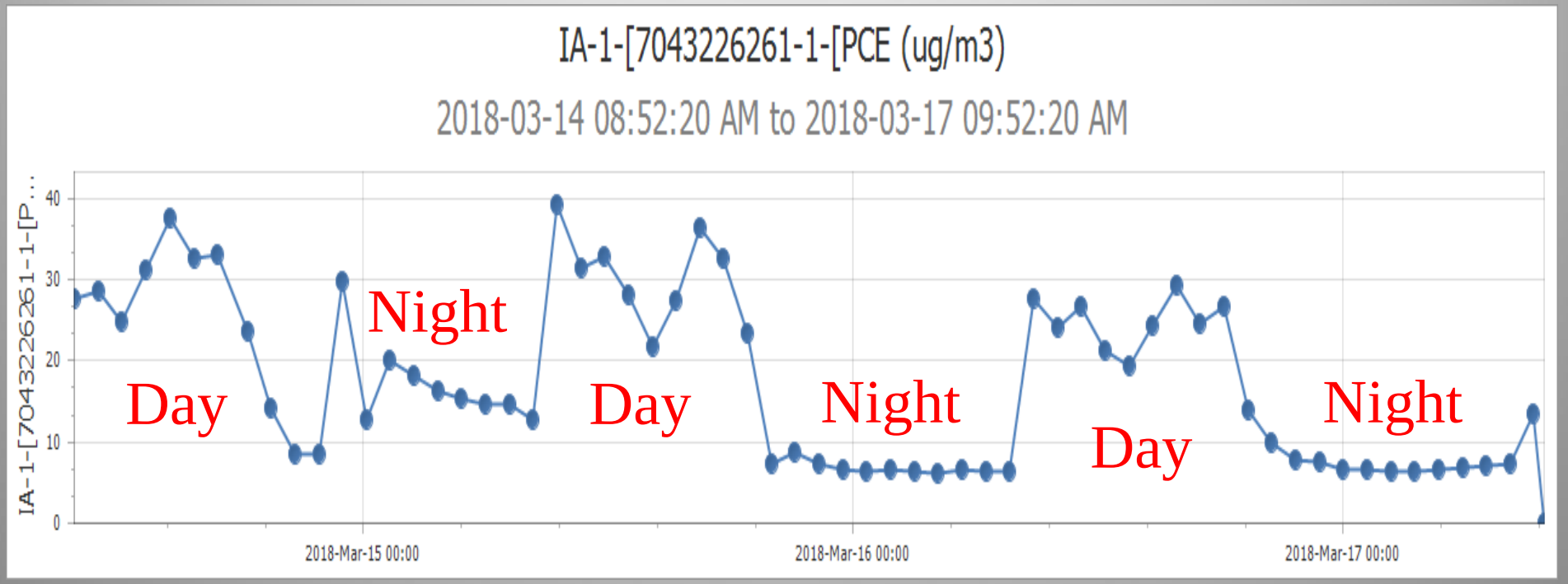


Strong Correlation with Sub-Foundation Pressure
Strong Correlation with Barometric Pressure Change

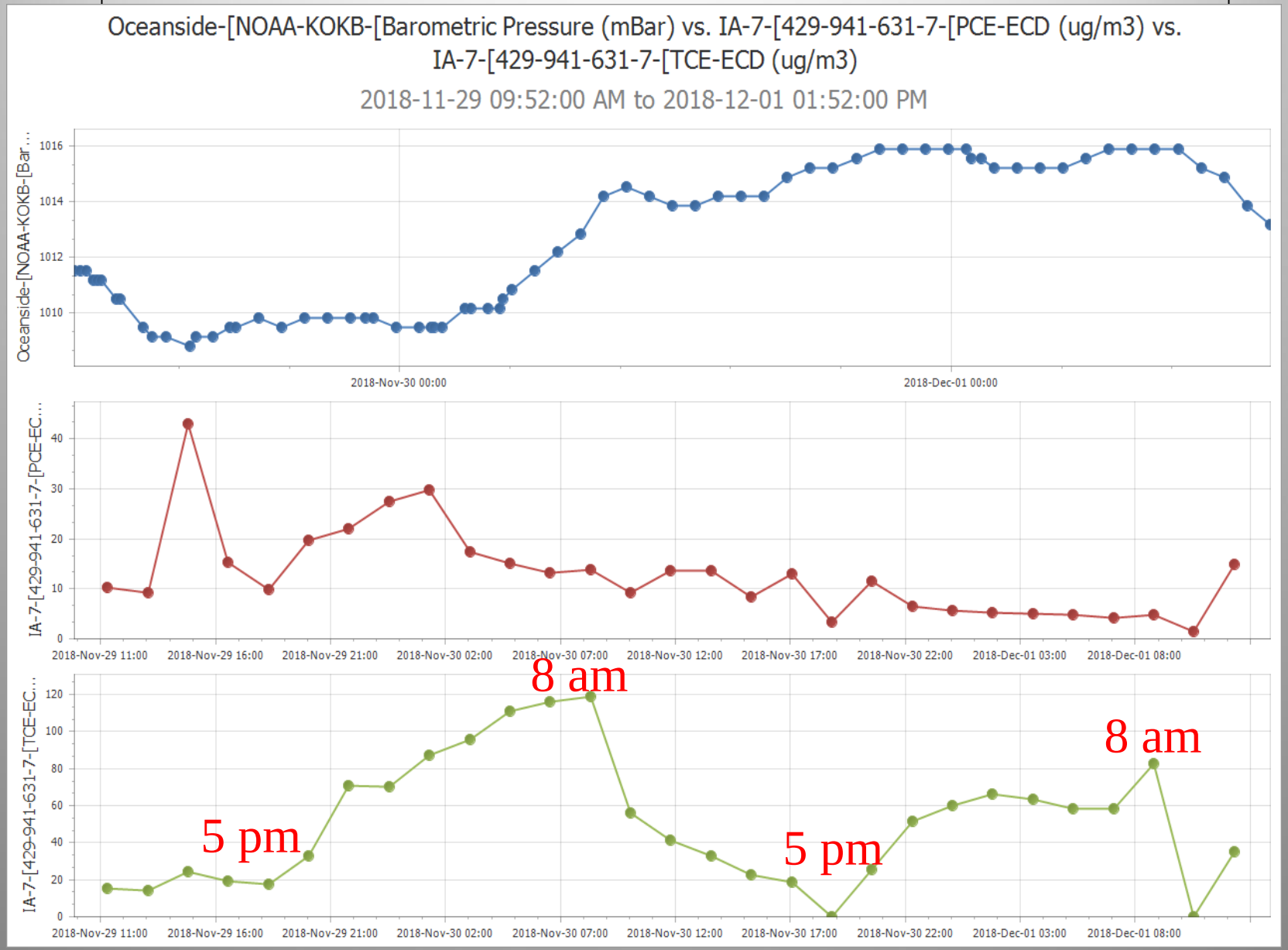
Determining Cause & Effect



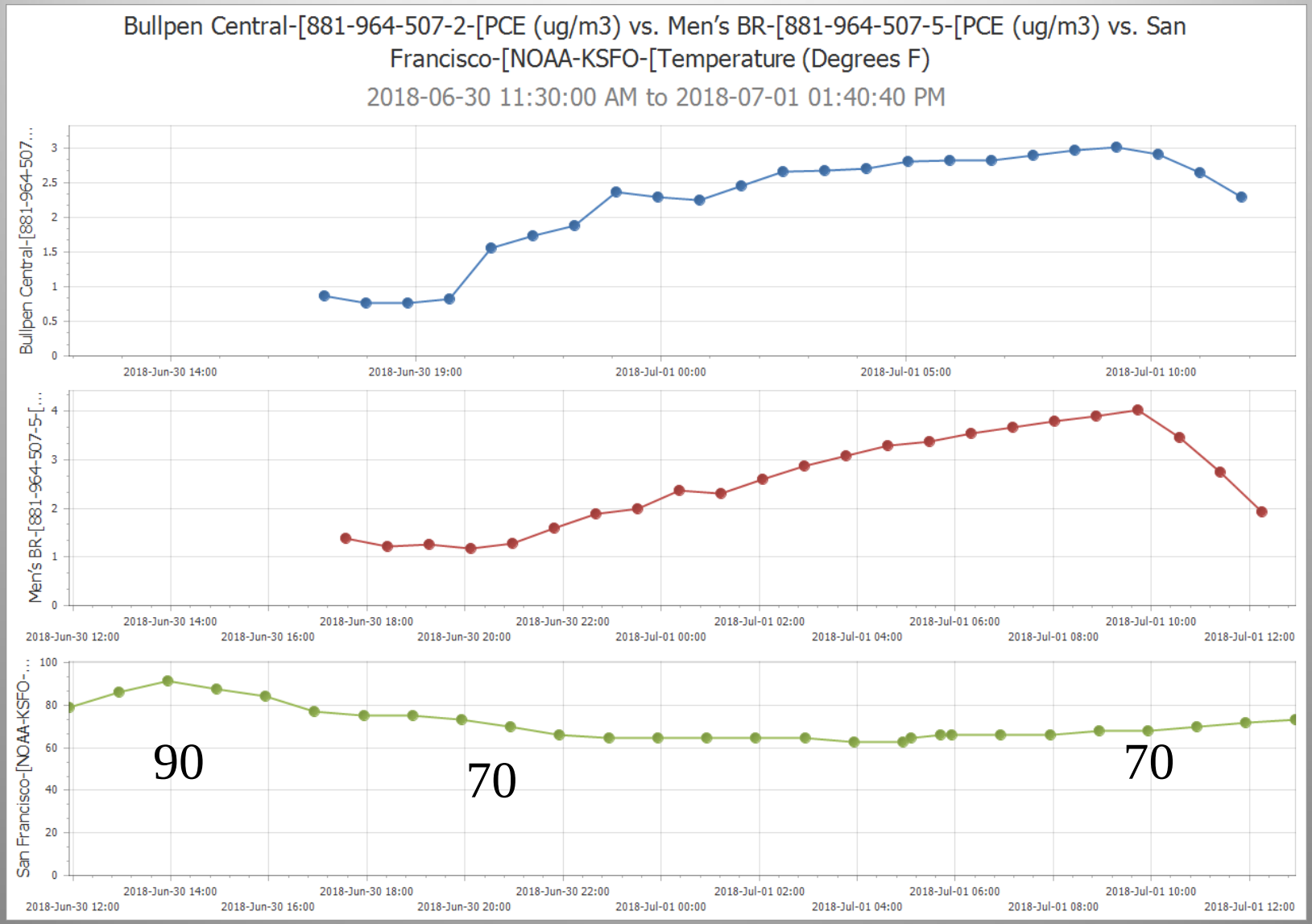
Former Dry Cleaner - Bathroom



Determining Indoor vs VI Source



Correlation with Outdoor Temperature



The Largest Variables

- People
- HVAC
- Sub Foundation Pressure
- Climatic Variables

Assessing Effectiveness of Remedies

- Can Try Various Remedies & See Effects
  - HVAC modifications
  - Fans on/off
  - Air filtration units
  - Sealing sumps & cracks
  - Optimizing vapor recovery systems

Can put VI Issue to Rest in Days Rather than Months or Years!!

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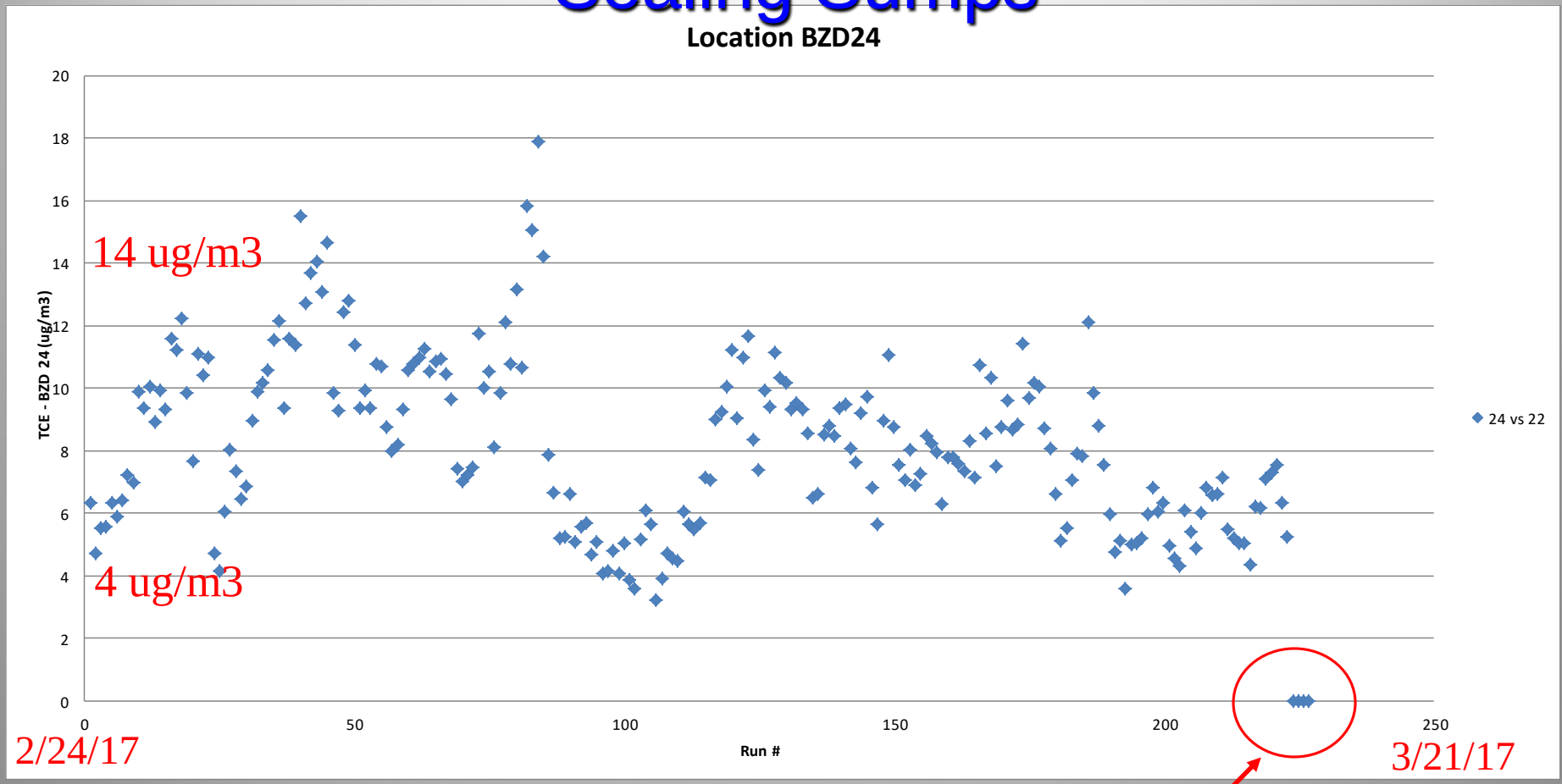
Remedy Effectiveness
Sealing Sumps



Seal Sumps

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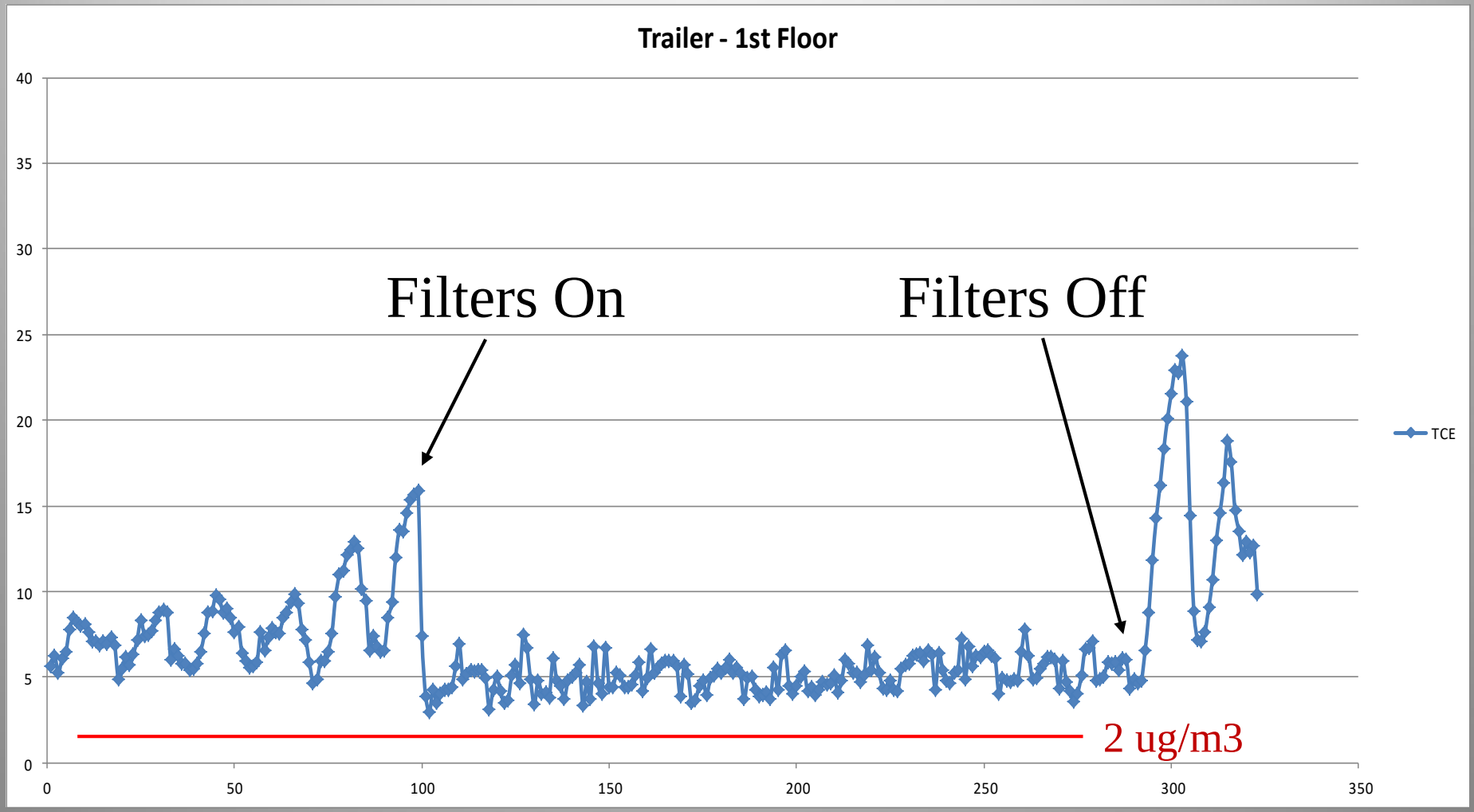
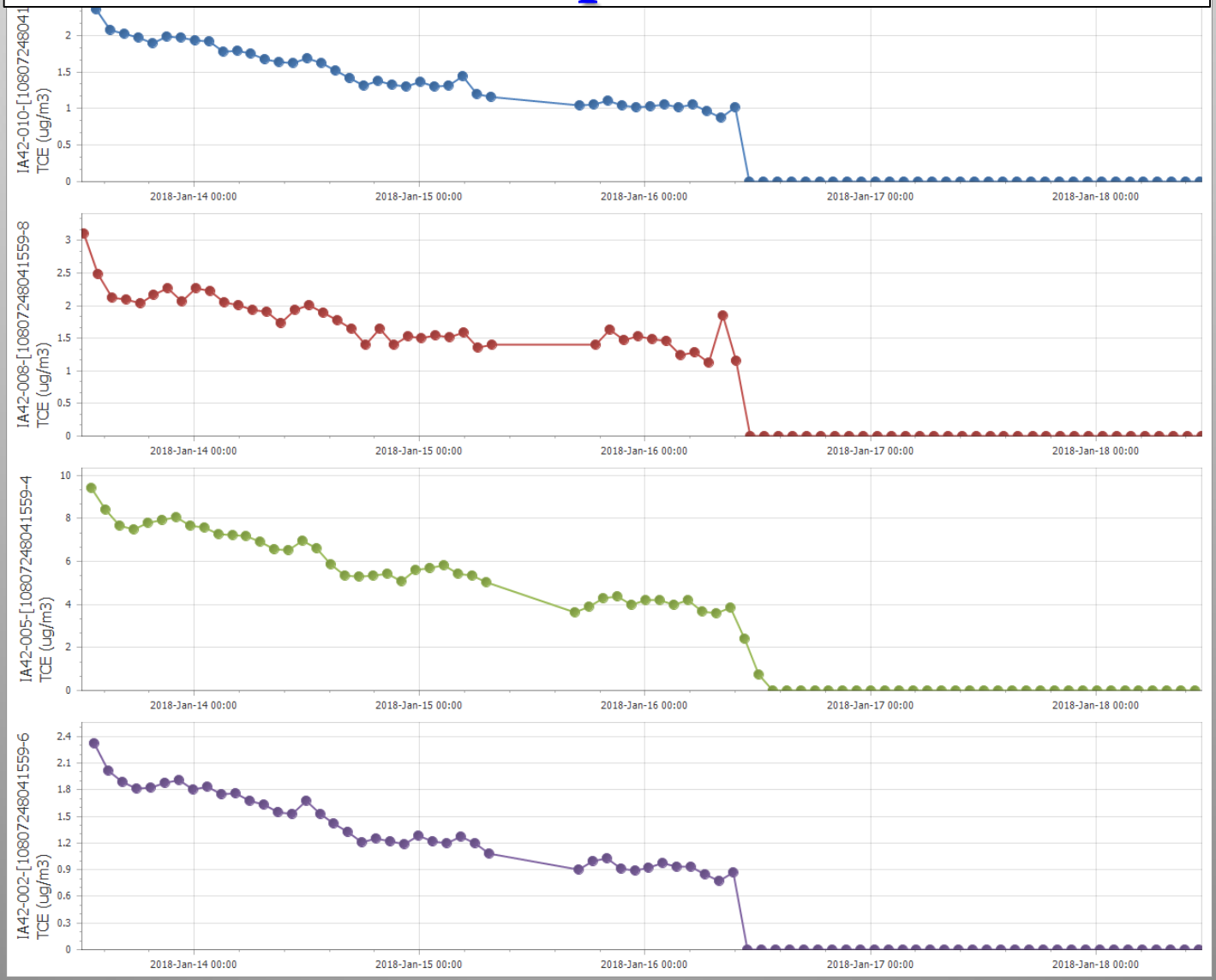
Remedy Effectiveness
Air Filtration Units



Remedy Effectiveness
Sub-Slab Depressurization



Summary

- High Resolution Data Gives Pattern
- Pattern = Opportunity
- Opportunity to:
  - Differentiate Indoor vs Subsurface Source
  - Find Cause & effects
  - Determine best remedy
  - Evaluate effectiveness of mitigation systems
  - Evaluate effectiveness of remediation systems

Within Days!

Table Session

<u>Soil Vapor Probe Installation</u>

Materials (tubing & annular seal hydration)

<u>Active Soil Vapor Sampling</u>

Procedures for Active Soil Vapor (and Sewer)

Materials

Leak Check Methods and Tolerance

H2P Mobile Geochemistry Inc.

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

Nylaflow®, polyetheretherketone (PEEK), and Teflon® are recommended tubing materials for soil vapor sampling. Low-density polyethylene (L-D PE) should not be used due to decreased performance relative to other tubing types in both off-gassing of VOCs inherent in the tubing structure (contribution to background) and for decreased recovery (reactivity). Reduced recovery of naphthalene has been observed when using Nylaflow® tubing with small sample sizes.

Teflon or Nylaflow Tubing?

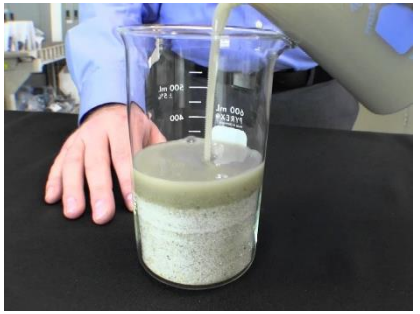
- The two most commonly requested tubing types
- The Advisory leads readers to conclude that Nylaflow is inferior to Teflon for Naphthalene (Hayes)
- Other recovery studies that simulate typical soil vapor sampling practices indicate that there is not a significant difference between the two tubing types for Naphthalene in particular. *Data review in process and findings to be presented at a future date.*
- For longevity in permanent probe construction, 1/8” Nylaflow is more flexible and performs better coiled within a well box than the more rigid 1/4” Teflon.

Tubing Types

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

3) Annular Seal. The composition of the annular seal is a function of the long-term use of the soil gas well, as follows:

Hydration of Bentonite to Create an Annular Seal



- Advisory suggests to hydrate the annular seal material at the surface then pouring into the boring, rather than hydrating in lifts.
- Practical experience with Leak Testing and Vacuum Testing has shown that hydration in lifts creates an excellent seal between probe depths and to the surface.
- Hydration of bentonite and/or neat cement bentonite mixtures at the surface create an acceptable temporary seal, but do not remain air tight over time.
- Vapor probes are NOT water wells. The 2” annular seal and composition do not hve to be the same.

Annular Seal Hydration

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

probes, sample collection containers should be less than or equal to one liter to avoid excessive air removal, avoiding the possibility of ambient air entering the subsurface

Considerations for Sample Volumes >1 Liter

- Advisory recommends sample volumes of 1 Liter or less in multiple sections, but lower SLs require larger volumes for some labs.
- IF sampling with a 6L canister is performed, additional checks should apply
  - ✓ Shut-In Test (i.e. equipment vacuum test) of 60 seconds may not suffice for a canister that is now going to take 30 minutes to fill.
  - ✓ To maintain the concentration of the tracer gas at the surface, either check the helium levels frequently, or reapply the liquid multiple times (i.e. every 10 min)
  - ✓ Particularly for subslab, the zone of influence may include additional points of entry for ambient air not addressed by the leak check compound.

Sample Container Size

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

4.2.2.1 LEAK CHECK COMPOUNDS (LIQUID)

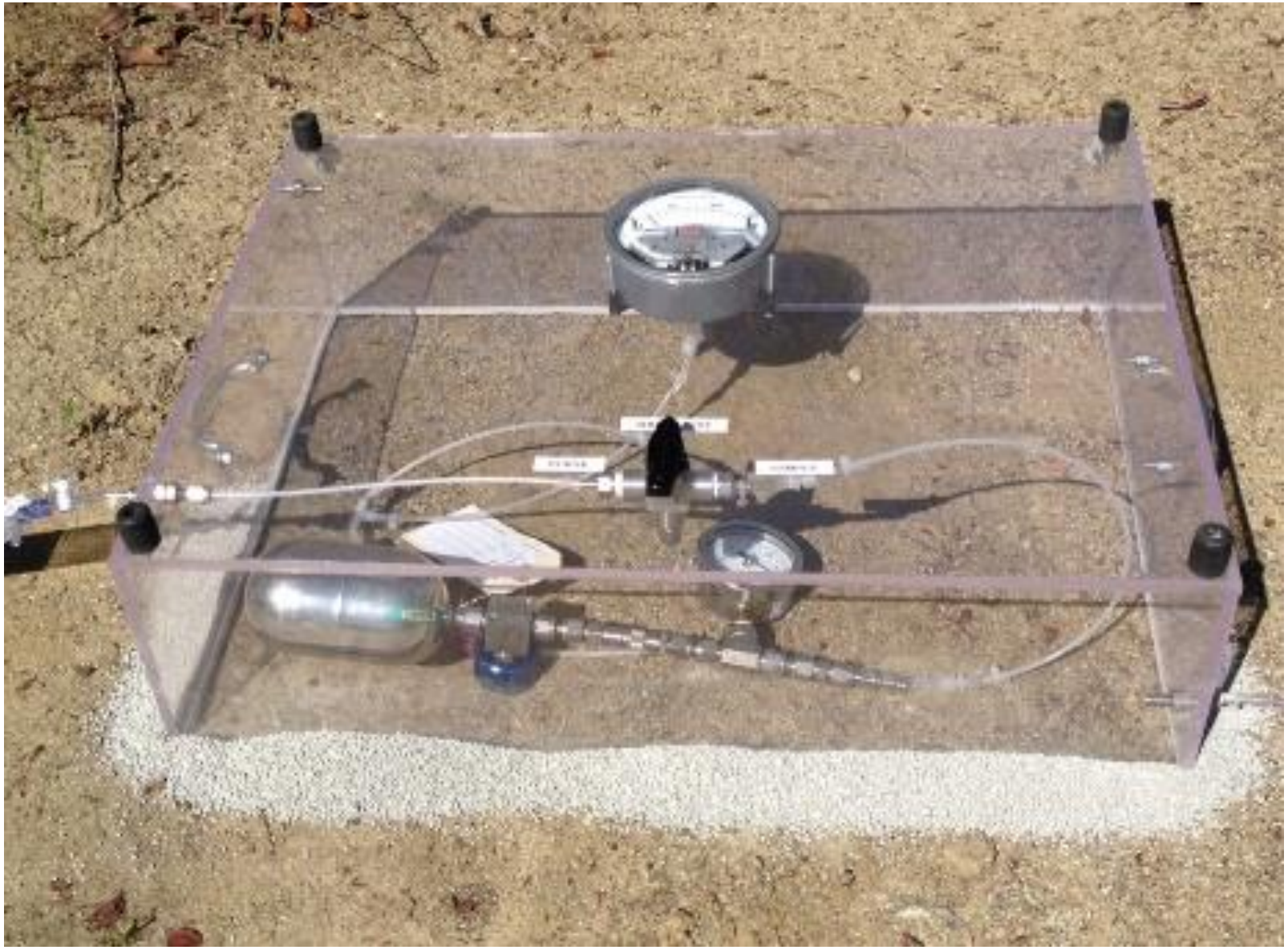
detections of the leak check compound at the reporting limit of the target analytes. If the concentration of the leak check compound is greater than or equal to 10 times the reporting limit for the target analyte(s), then corrective action is necessary as discussed

4.2.2.2 LEAK CHECK COMPOUNDS (GASEOUS)

are described in Appendix C. An ambient air leak up to 5 percent is acceptable if quantitative tracer testing is performed by shrouding.

Evaluation of Leak Check Compounds

- Extremely different tolerances for the two different methods of performing leak checks
  - **Gaseous Tolerance is 5%**
  - **Liquid Leak Tolerance is below 1%** - *Multiple studies and field tests show that the surface concentrations of liquid tracers are 1,000,000+ ug/m3. With RLs typically ranging from 5-100 ug/m3, estimated thresholds of 10x the RL are 0.005% - 0.1%*
- Sliding scale approach toward the liquid leak check threshold leads to more leniency on sites which have higher reporting limit goals, as well on samples that require dilutions.
- Leakage (i.e. communication) is common with subslab samples, leading practitioners to use the shroud application method to obtain higher thresholds.
- Not all projects include a budget to analyze the summa canister for the gaseous compound.



Certification of Active Soil Vapor Sampling

NEFAP (National Environmental Field Activities Program) is a program for the accreditation of **FSMOs** (Field Sampling and Measurement Organizations)

Why would an organization become accredited?

- Demonstrate competence in sampling and field measurement
- Provide consistent and reliable sampling and measurements

Why use an accredited organization?

- Same reason you would use a certified analytical laboratory - confidence, accountability, etc.
- Competitive advantage using a certified organization for sampling

Mobile Geochemistry Inc.

Certification of Active Soil Vapor Sampling

What does being certified entail?

- ✓ Standard Operating Procedures (that meet criteria)
- ✓ Formal Corrective Action and Resolution process
- ✓ Official Field Sampling Training Program
- ✓ Performance Testing (bi-annual) and uncertainty budgets
- ✓ Field Audits (annual) of sampling procedures and supplies
- ✓ Equipment and Materials tracking
- ✓ Control Charts for all field instruments

Please feel free to contact me with questions or suggestions regarding active soil vapor sampling!

Suzie Nawikas
H&P Mobile Geochemistry, Inc.
suzie.nawikas@handpmg.com
Direct Office: 760-290-4851

H&P Mobile Geochemistry Inc.

SUB-SLAB TO INDOOR AIR ATTENUATION FACTORS DETERMINED FROM RADON DATA

CALIFORNIA DATABASE REVIEW

SUZIE NAWIKAS

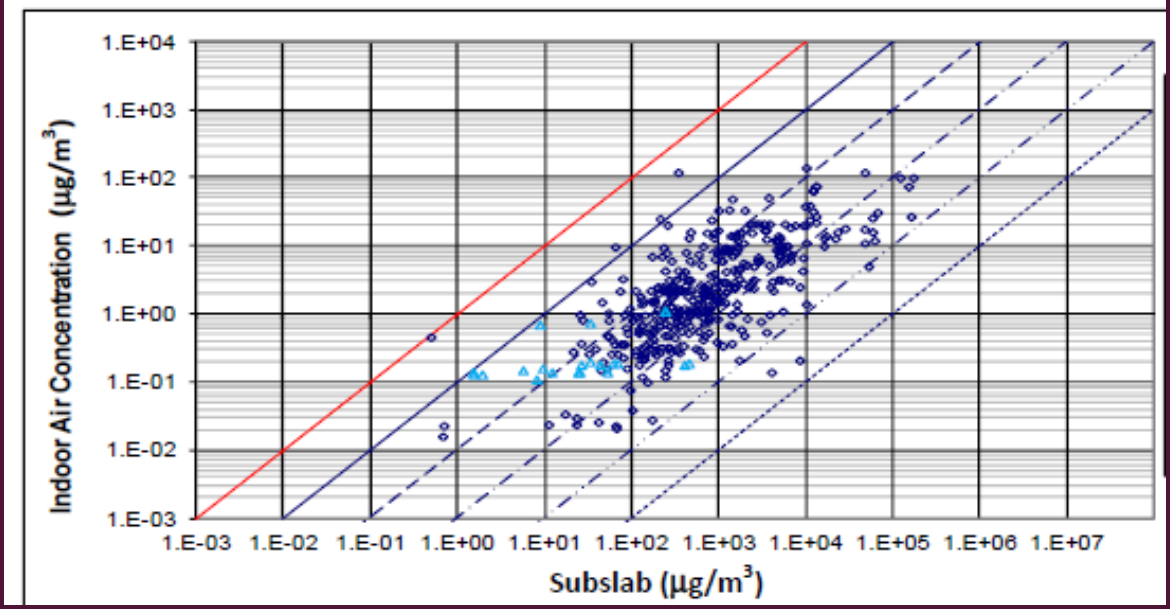
H&P INC, CARLSBAD, CA

CUPA | Burlingame, CA | Feb 5, 2020

EPA'S VAPOR INTRUSION DATABASE

Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and **Residential** Buildings
(EPA 530-R-10-002, March 16, 2012)

THE DEFAULT SOIL GAS 0.03 α

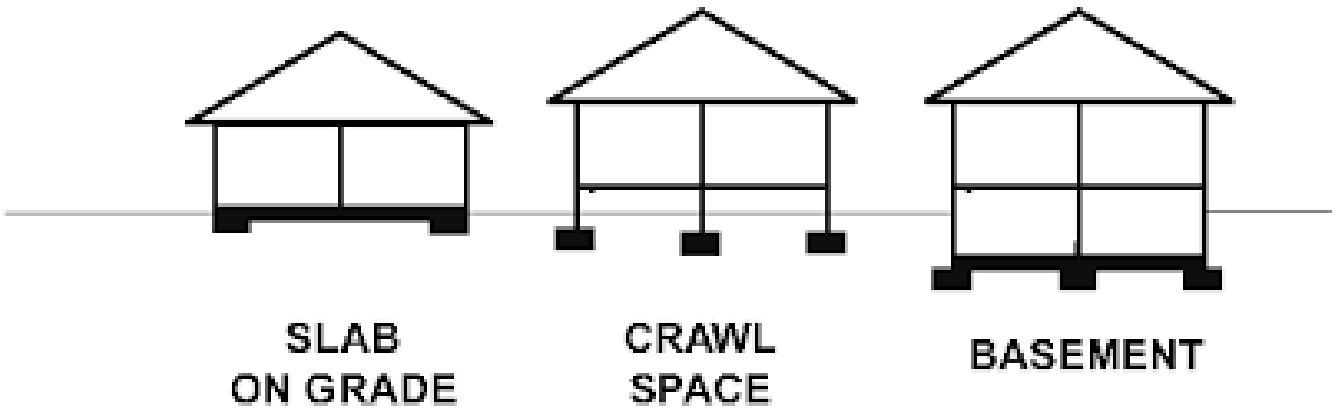


HARTMAN ENVIRONMENTAL GEOSCIENCE

SHOULD WE BE USING 0.03?

EPA's 2012 Conclusions from the VI Database Analysis:

- Residential Buildings with Basements (95th): **0.03**
- Residential Buildings with Slab-on-Grade (95th): **0.01**
- USEPA 2015 Guidance = default of **0.03** for all structures regardless of construction or use, and all subsurface VOC sources, regardless of depth



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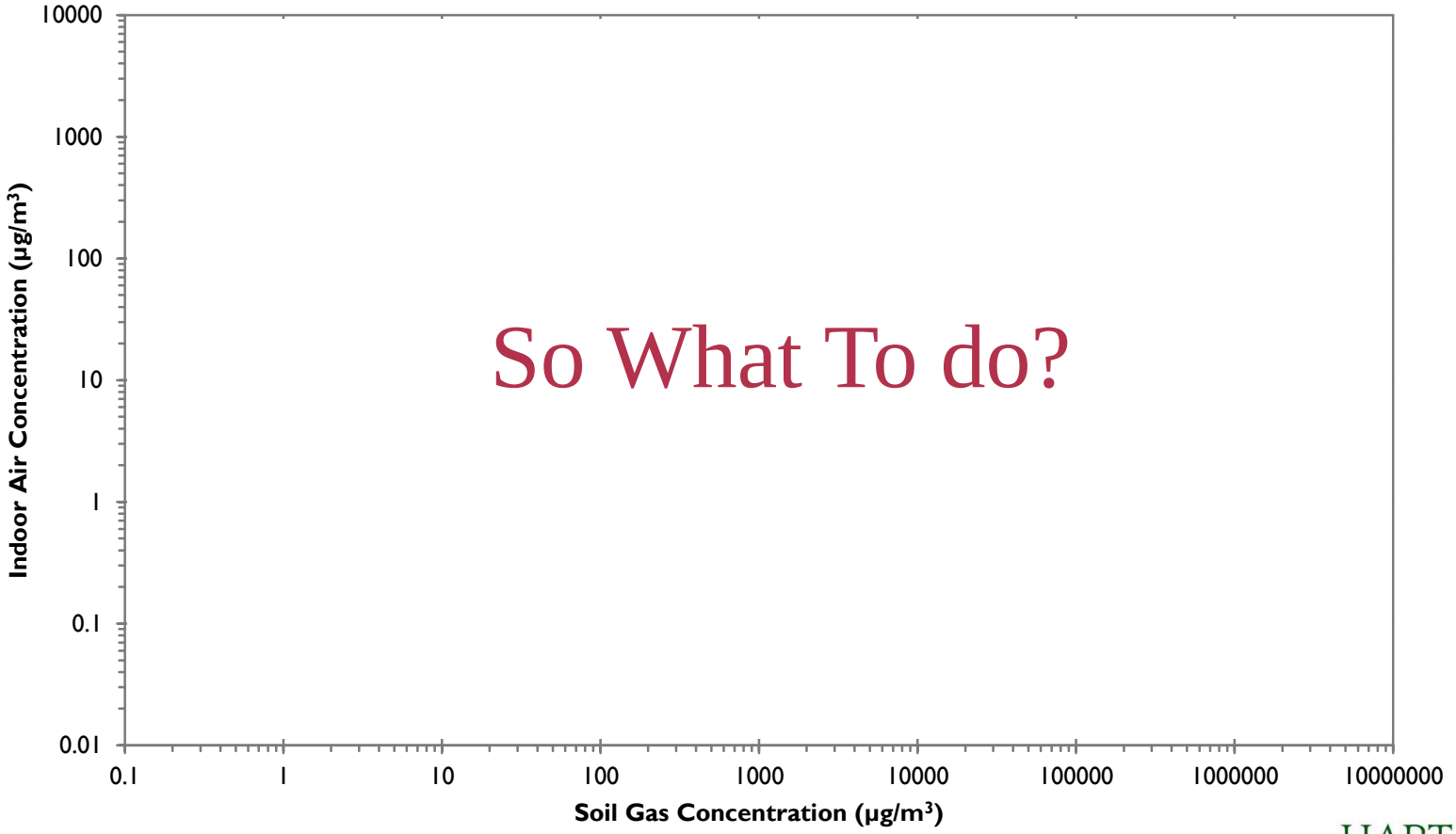
ENVIRONMENTAL GEOSCIENCE

SHOULD WE BE USING 0.03?

EPA's 2012 Commercial Database:

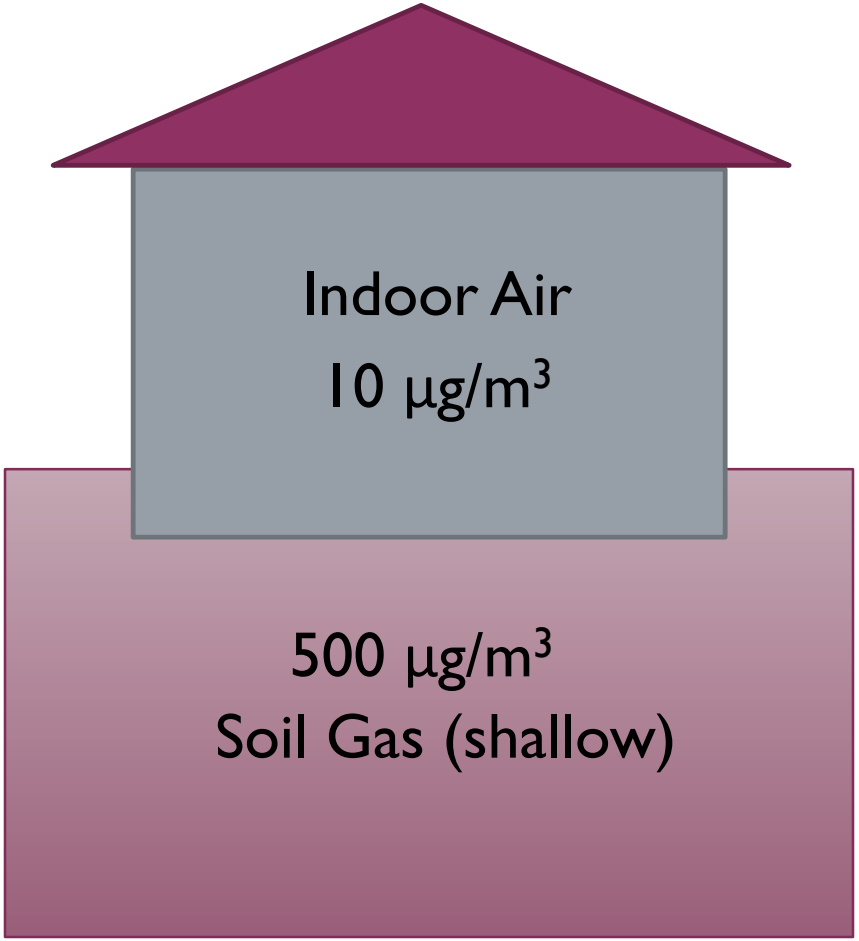


HARTMAN
ENVIRONMENTAL GEOSCIENCE

AGENDA

- Introduce a NEW dataset that adds some variety in the form of building type
- The Development, Structure and Content
- Screening Criteria for Evaluation
- Discussion of Assessments
- Ideas for Future Assessments

ATTENUATION FACTOR (α)



$\alpha_{sg} = C_{indoor}/C_{sg}$

Alpha = 10/500

Alpha = 0.02 (shallow soil gas)

HARTMAN
ENVIRONMENTAL GEOSCIENCE

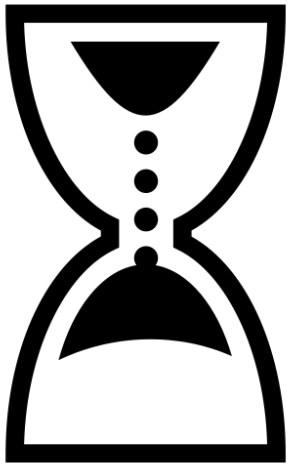
DATA FOR ATTENUATION FACTORS

Attenuation Factors can be derived by comparing:

- VOC results (i.e. BTEX, PCE/TCE, etc)
- Radon results

Radon data does not have significant background sources. The most significant source of radon in an indoor air space is from attenuation from the subsurface (USEPA).

H&P'S RADON DATABASE



- Radon has been used for the past 10+ years to develop slab specific attenuation factors for use in modeling
- H&P has access to electronic records from radon data that we've either collected or facilitated since 2010, from which Radon information can be pulled
- Upon release of the USEPA default 0.03 AF, and the current state of uncertainty in CA, we decided it was time to get the information together!

SITES IN THE USEPA AF DATABASE

Empirical data from over 900 buildings at over 40 sites from across the country

(Majority of data from a few sites in CO and NY)

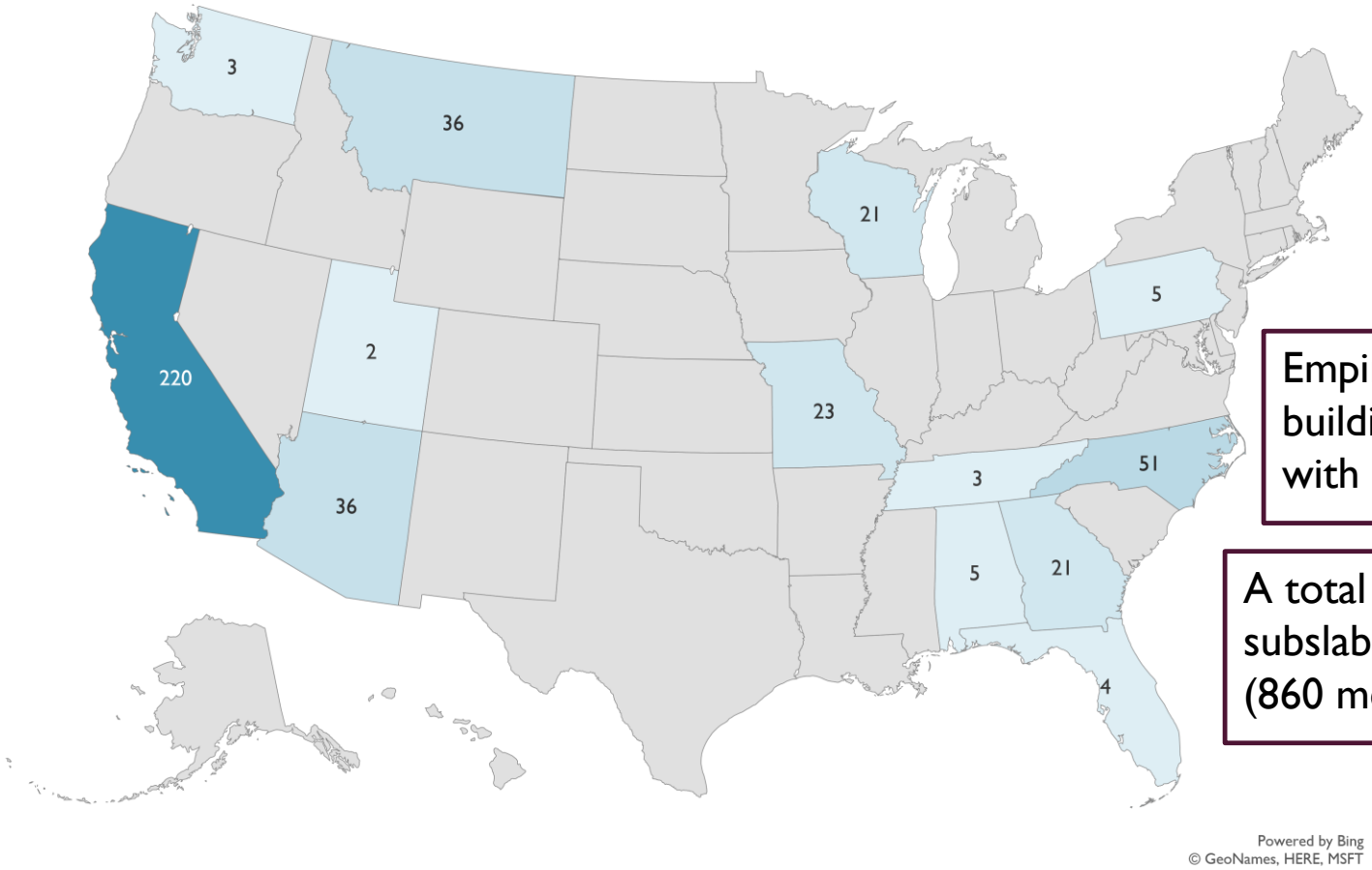
Paired indoor air and sub-surface data used to calculate empirical attenuation factors

(Only 15 of the 40 sites have direct subslab to air measurements)

USEPA, 2012. EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Compounds and Residential Buildings

Slide courtesy of Robbie Ettinger, Geosyntec

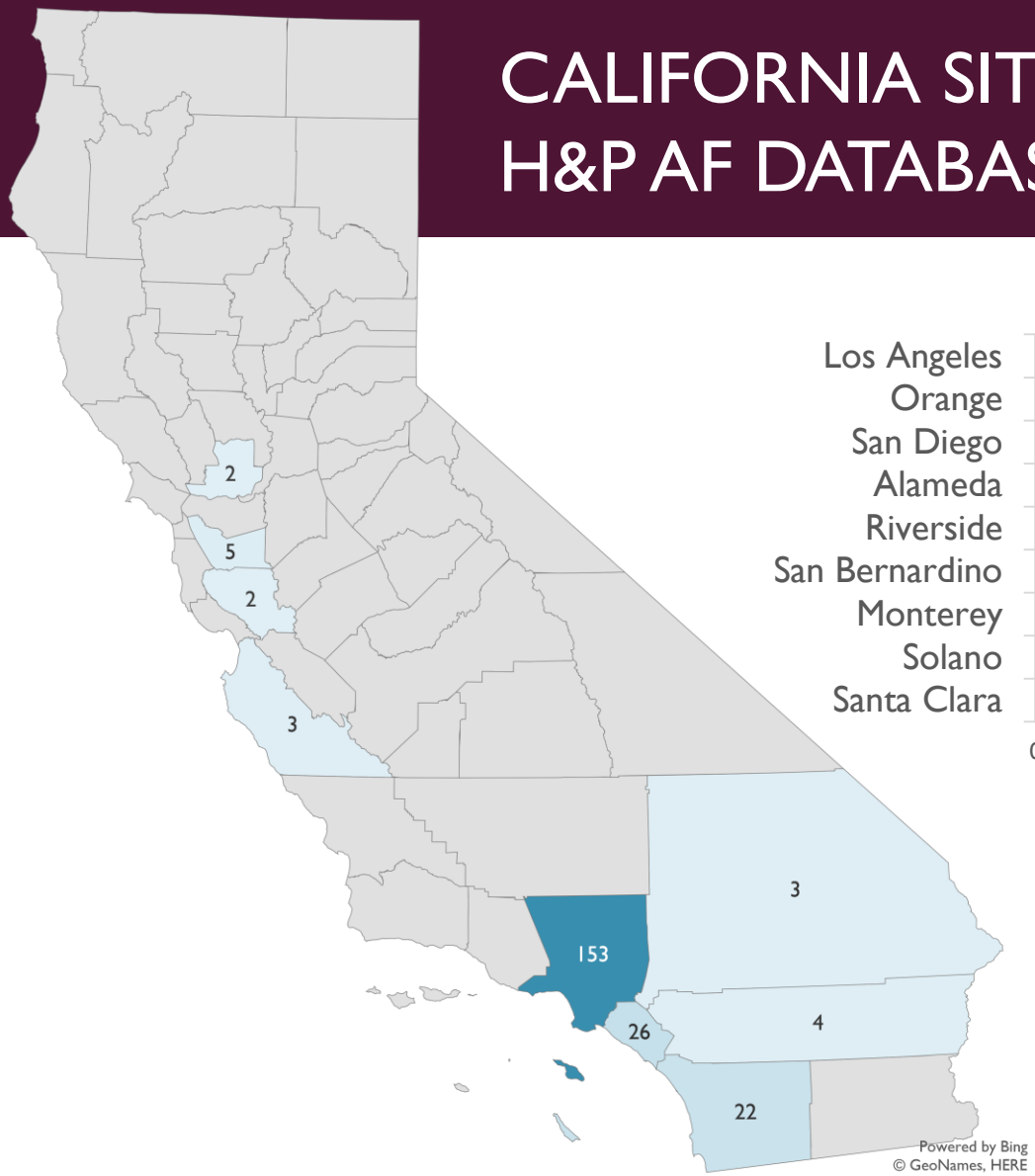
SITES IN THE H&P AF DATABASE

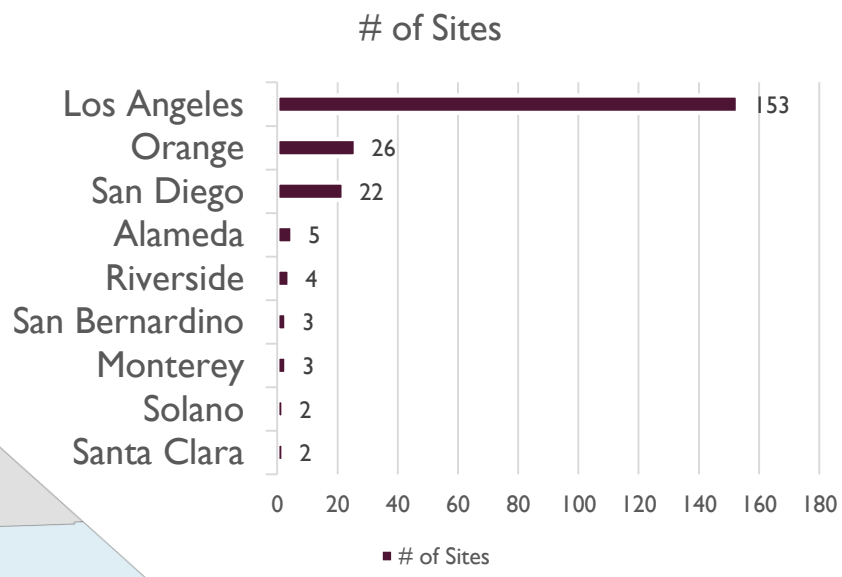


Empirical data from 158 buildings from 13 states, with a majority in CA.

A total of 430 direct subslab to indoor air pairs (860 measurements)

CALIFORNIA SITES IN THE H&P AF DATABASE





A total of 220 direct subslab to indoor air pairs (440 measurements), from 84 commercial buildings

ATTENUATION FACTOR DATABASE COMPARISON - STRUCTURE

USEPA Database (2012)

- Majority Single Family Residential
- Majority basement construction
- Includes groundwater, deep soil gas, subslab, and air data
- Utilizes VOC concentrations, with an effort to diminish the effect of background air concentrations

H&P Database (2019)

- Mostly Commercial Structures
- Primarily slab-on-grade
- Includes only direct subslab to indoor air pairs
- Utilizes Radon concentrations, which do not have the complication of background air concentrations

ATTENUATION FACTOR DATABASE COMPARISON – SAMPLING CRITERIA

USEPA Database (2012)

- Does not have a method for verifying sampling QA/QC information, other than a general overview of the sampling plan
- Attenuation Pairs included must be within proximal distance to one another (no set distance), and collected within 48 hours to a few weeks of one another

H&P Database (2019)

- Weighs heavily on sampling QA/QC steps, such as leak testing, shut-in testing, and purging are verified and included in the data evaluation
- Attenuation Pairs included must be collected in the same area, and within 4 hours of one another

UNIQUE DATA ASSESSMENT – SAMPLING AUDIT

Sampling QA/QC is the UNIQUE Criteria in H&P's Attenuation Factor Database

The ability to examine specific sampling parameters, then compare and/or eliminate poor quality samples

Why? If a subsurface sample is diluted (i.e. leakage), then the AF is biased high

SCREENING CRITERIA FOR DATA EXCLUSION

Removal of Data Points in the H&P Database...

- If leaking subslab conditions were documented on the sampling logs, which could bias the subsurface concentrations low
- If radon activity was not detected in either sample (zero result)
- If the attenuation factor was less than 0.00001 (1/100,000)
- If the subsurface radon concentrations were <50x the expected indoor air background for radon, which is 0.4 pCi/L (modeling the EPA's data screen for subsurface VOCs sample exclusion)

DATA ASSESSMENT – THE FUN PART!

MANY WAYS TO ASSESS THE DATA

Mimic the USEPA evaluations for comparison, as well as the database compiled by Geosyntec and others using CA specific data.

Examples:

1) Descriptive statistics
2) Frequency Plots
3) Cumulative Probability, etc

BUT, the first answer that everyone wants to see…

What is the resulting Attenuation Factor??

THE BIG QUESTION WITH THE BIG ANSWER

But, what if H&P's Database AF is *higher* than 0.03?

It isn't…
Phew!

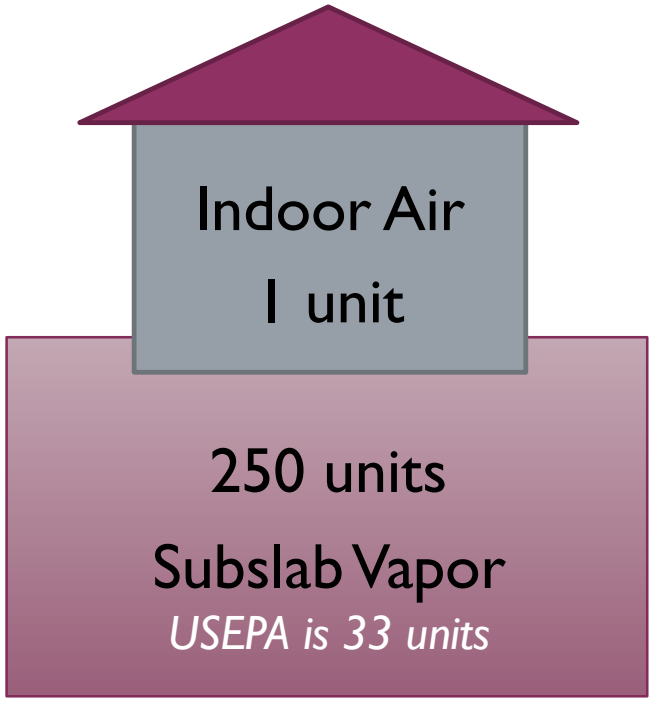
Source: Alternative Press

DATA ASSESSMENT – CALIFORNIA COMMERCIAL

The Attenuation Factor (95th) from H&P's Radon Database for Commercial California:

α 0.004

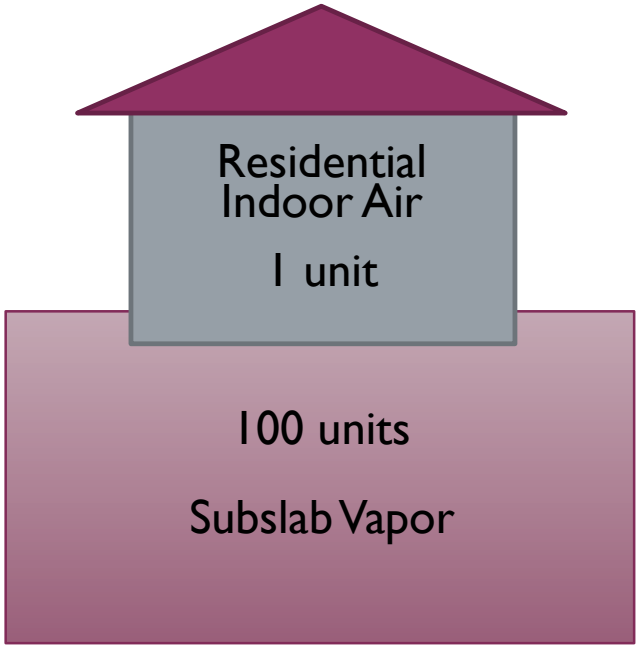
50th = 0.0003 (1/3,333)
75th = 0.001 (1/1,000)
90th = 0.002 (1/500)



DATA ASSESSMENT – NATIONWIDE RESIDENTIAL

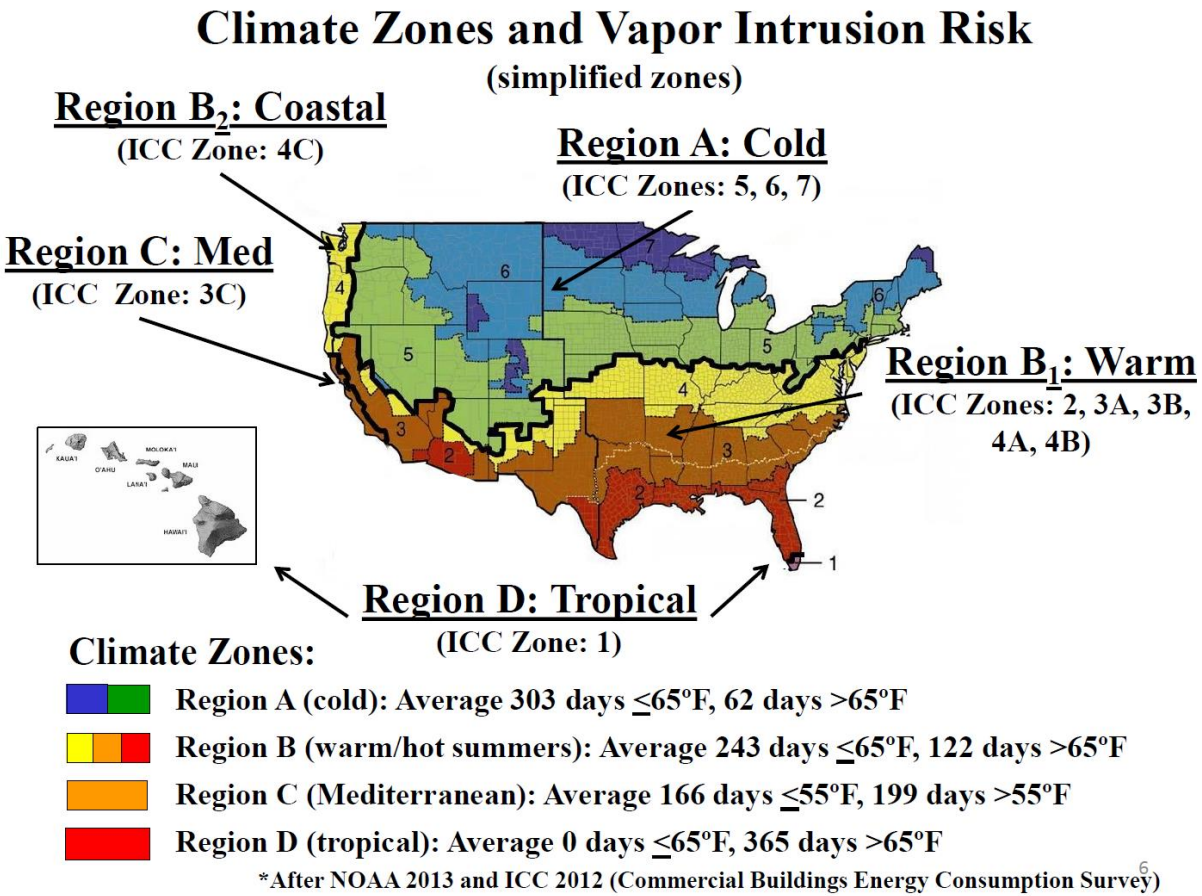
The Attenuation Factor (95th) from H&P's Radon Database *Residential Nationwide*:

α 0.01



Same Attenuation Factor as EPA's 2012 slab-on-grade conclusion

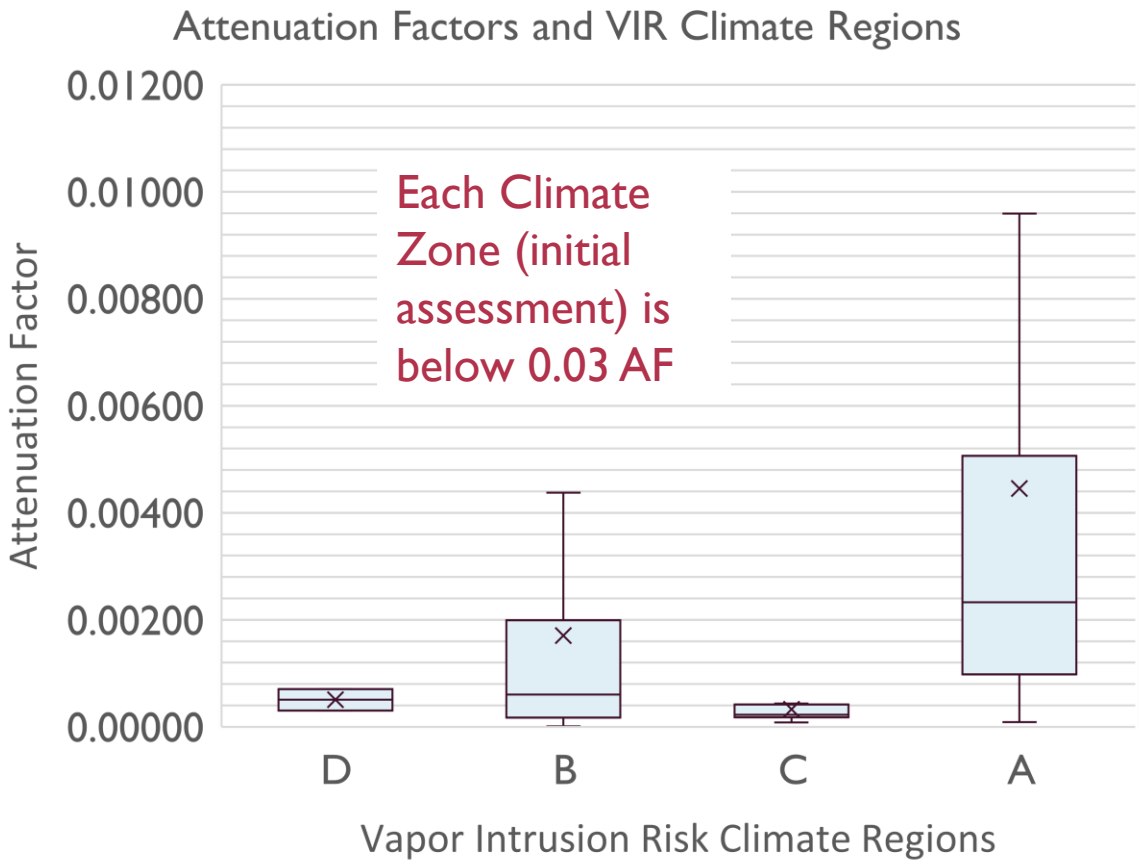
FUTURE ASSESSMENT - CLIMATE ZONE



One of the goals is to evaluate the AF with regards to climate zones, and reach out for data in zones where there is not equal representation

Slide Courtesy of Roger Brewer, AEHS 2017

FUTURE ASSESSMENT – CLIMATE ZONE



Vapor Intrusion Risk Climate Zones
A: Cold Climate
B: Warm/Hot Summer
C: Mediterranean
D: Tropical

More to be done:

- Filter data by building use
- Obtain more data for under-represented zones

LIMITATIONS AND ADVANTAGES OF H&P'S RADON ATTENUATION DATABASE

ADVANTAGES:

- Robust Sampling Details
- Purging Information
- Equilibration
- Leak Check Information
- Shut-In Test
- No background sources to contend with (vs a dataset which relies on VOC data)

LIMITATIONS:

- Inherent variability with subslab concentrations
- Unknown Foundation Type
- Unknown Building Size*
- Unknown Contamination Type (i.e. petroleum or solvent)*

**May be retrieved from H&P records, possibly*

IDEAS FOR DATA EVALUATIONS

We are just starting to evaluate this data set, so please share your ideas!

Do you have sites that could be included?

More Angles to Evaluate

Additional Fields to Consider

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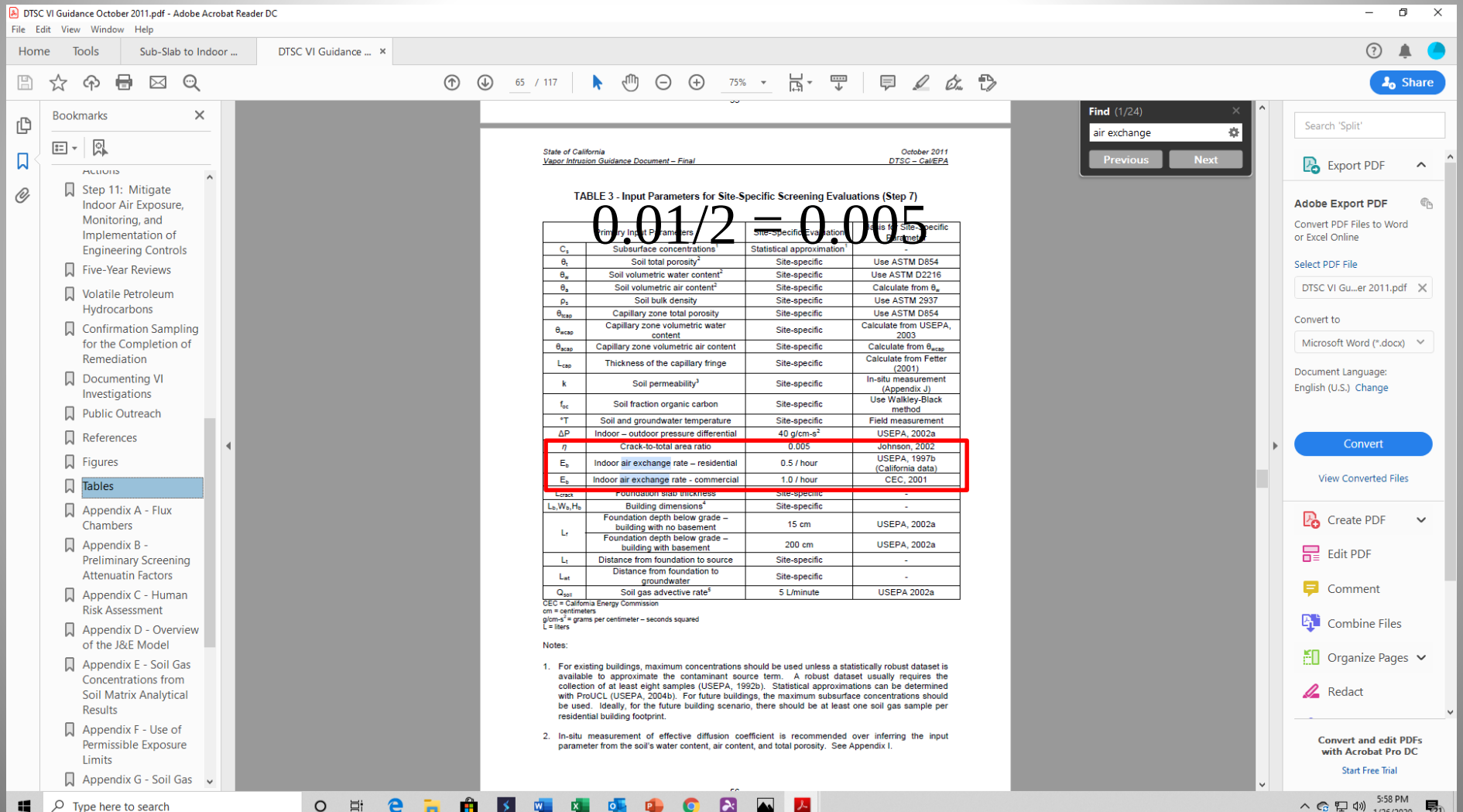
760-804-9678
Suzie.Nawikas@handpmg.com

Adjustment of Residential AF to Commercial

AF for Slab-on-Grade Residences: 0.01



California empirical AF results are substantially lower than USEPA results

Statistic	USEPA Database (Sub-slab)	California Database (Sub-Slab and Soil Vapor)
Maximum	9.4E-1	9.3E-3
95th %ile	0.026	0.002
75th %ile	0.0068	0.0005
50th %ile	0.0027	0.00012
25th %ile	1.5E-3	3.5E-5
Minimum	2.5E-5	1.0E-7

HARTMAN ENVIRONMENTAL GEOSCIENCE

Slide courtesy of Robbie Ettinger, Geosyntec

Commercial AF Comparison

- Hartman Adjustment for Exchange Rate: 0.005
- Nawikas Study: 0.004
- Ettinger 2019: 0.002*

* Residential Structures also

HARTMAN
ENVIRONMENTAL GEOSCIENCE

NOTES AND REFERENCES

- All Radon measurements performed by Dr. Doug Hammond using alpha scintillation counters built by Applied Techniques (Model AC/DC-DRC-MK10-2)
- All samples collected into polymer gas bags (e.g. SKC or ESS tedlar bags)
- USEPA. EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings. Office of Solid Waste and Emergency Response. EPA 530-R-10-002. March16, 2012.
- USEPA. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air Office of Solid Waste and Emergency Response. OSWER Publication 9200.2-154. June 2015.
- Brewer, R. Nagashima, J., Rigby, M., Schmidt, M., O'Neill, H. Estimation of Generic Subslab Attenuation Factors for Vapor Intrusion Investigations.
- Thomas E. McHugh, Douglas E. Hammond, Tim Nickels & Blayne Hartman (2008) Use of Radon Measurements for Evaluation of Volatile Organic Compound (VOC) Vapor Intrusion, Environmental Forensics, 9:1, 107-114, DOI: 10.1080/15275920801888491
- Robert A. Ettinger, Steve Luis, Nadine Weinberg, Todd McAlary, Gina Plantz, Helen E. Dawson & Jeff Sickenger (2018) Empirical Analysis of Vapor Intrusion Attenuation Factors for Sub-Slab and Soil Vapor – An Updated Assessment for California Sites. Presented at the Vapor Intrusion, Remediation, and Site Closure Conference December 5-6, 2018 Phoenix, AZ