U.S. EPA "State of VI Science" Workshop 2022
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How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create "Soil Gas Safe Communities"

Introduction, Background & Overview

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Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. EPA.

RTI INTERNATIONAL Jacobs Geosyntec consultants

Presentation archived at https://iavi.rti.org/

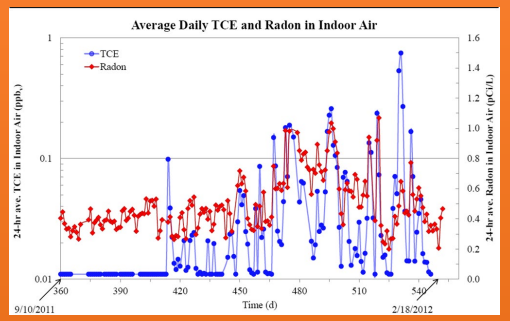
Welcome | Thank you for joining us

- A long history of **participation** and **collaboration** of a large group of experts from the government, academia and consulting
- Today's objective – presenting **research findings** and **perspectives** on the effort of **community involvement** in vapor intrusion data collection, interpretation, and decision-making
- "Soil Gas Safe Community (SGSC)"
  - Effective communication/education and support by scientists and regulators
  - Based on past and ongoing research, and observations
- Looking for YOUR feedback and suggestions to successfully implement the SGSC effort at cleanup sites

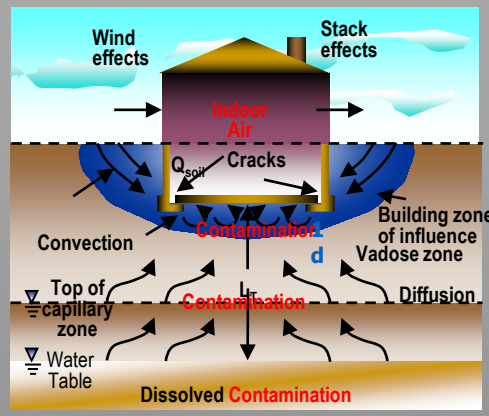
VAPOR INTRUSION

Assessment & Managment

Data Collection & Interpretation



Science & Technology



Regulators & Regulated Community

Impacted Community

Review & Summary – March 2021

EPA-RCRA perspectives on: Environmental Justice & Citizen Scientists (with ITS)

- **VI** = **Temporal** & **Spatial** variability – Many opportunities for **in**equities
  - **Environmental Justice** – many bldgs. screened out (w/o evidence) [bldg.-specific]
  - **Citizen Scientist** (with ITS measurements) – can participate in risk decisions w/ “
  - **Long-term Monitoring** (of **all** buildings ‘at risk’) – can ensure exposure equity (S&T)
  - **‘Soil Gas Safe Communities’** – Celebrates avoidance of all Soil-Gas Intrusion (SGI)
    - **Minimizes opportunities for injustices in exposures** - for populations most likely near CVI sites;
    - i.e., those with disproportionate number of young families with children, who are culturally diverse & economically challenged!

Slide #11 from https://iavi.rti.org/assets/docs/10_Schuver_KC_2021_AEHS.pdf

Today's Sections

Section 1: Overview and Community Involvement

11:00 AM	11:30 AM	Introduction, Background & Overview for 'Soil Gas Safe Communities' (SGSC)	Henry Schuver, Klara Crincoli
11:30 AM	11:45 AM	Redfield as an Example of the Possibility of a Soil Gas Safe Community	Chase Holton
11:45 AM	11:55 AM	Gaffney site as an Example of the Potential for a Soil Gas Safe Community	John Zimmerman, Andrew Weller, Shawn Tisdell
11:55 AM	12:15 PM	Effective Communication: A Tool for Increasing Participation in Communities with Vapor Intrusion Concerns	David Folkes, Seun Akinlotan
12:15 PM	12:45 PM	Panel discussion of 'Soil Gas Safe Communities' concepts and community involvement/Q&A	Lenny Siegel & Kelly Pennell & Alana Lee & Kelly Johnson & John Fitzgerald

Today's Sections

Section 2: Science supporting Soil Gas Safe concepts:

1:00 PM	1:30 PM	Summary of Relevant continuous indicator and tracer (I&T) VI Research: Recently Completed, On-going & Planned	Chris Lutes
1:30 PM	1:50 PM	Methods and Approach for Equivalent Protection Cost Effectiveness analysis of I&T vs. traditional sampling, screening & mitigation approaches	AJ Kondash
1:50 PM	2:30 PM	Results and Interpretation of Sampling Strategy and Equivalent Protection Cost Effectiveness Analyses	Chase Holton & AJ Kondash & Chris Lutes
2:30 PM	3:00 PM	Panel discussion and Q&A section - How might the results of the Equivalent Protection Cost Effectiveness analysis influence Soil Gas Safe Communities (SGSC) decision-making?	Lenny Siegel & Kelly Pennell & Alana Lee & Kelly Johnson & John Fitzgerald

Today's Sections

Section 3: Real world Implementation of Soil Gas Safe Communities

3:15 PM	3:30 PM	Role of area-wide Soil Vapor Extraction (SVE) techniques to achieve equal protectiveness across multiple buildings	Robert Truesdale & Bo Stewart
3:30 PM	3:45 PM	VI Standards and Certifications (Assessment, Mitigation, OM&M, New Construction) by AARST & NRPP	Kyle Hoylman
3:45 PM	4:00 PM	Opportunities for Communities to Maximize Benefits during Implementation	Henry Schuver
4:00 PM	5:00 PM	Planned Research: Overview of SGS Communities Field & Pilot-Community Studies	Brian Schumacher & John Zimmerman & Alan Williams
5:00 PM	5:30 PM	Open Discussion/Q&A for all speakers & panelist – Focus on opinions, recommendations & feedback	

Please submit **comments and questions** through the **chat function**.

Email additional feedback and questions to **indoorairvaporintrusion@rti.org** (up to June 1, 2022)

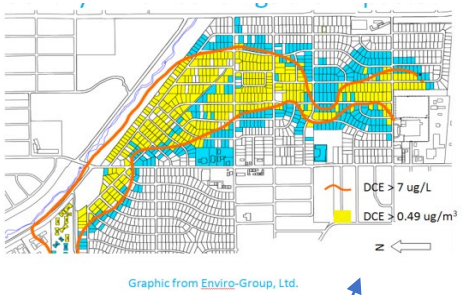
Background* & Overview
Objective: *Explaining the (long) Title*

- Big Picture – Today (News)
  - New Opportunity to ***Test*** SGSC Concepts & Methods for improving VI Protection
    - **Physical** Science/(ITS) **Methods** (Field Trials) (ITS=Indicators, Tracers & *Surrogates*)
    - **Social** Science/**Application** of ITS science methods in **Pilot Communities** interested in being a SGSC
  - Evolving SGSC concepts & considerations – *On-going Discussions*:
    - To *improve* implementation & benefits:
      - Scope of the hazardous/chlorinated-chemical Vapor Intrusion (**cVI**) problem (new & multiple sources)
      - Defining aerial extent/boundaries of SGSC
      - Helping it Grow/Expand
      - Maintaining protection over time
- Bi**gger** Picture (PM) – Soil Gas & Indoor Air (Should Not Mix)
  - **Soil gas** was never good for IAQ, & it is getting Worse (**2x**) – Best to avoid it

*https://iavi.rti.org/assets/docs/10_Schuver_KC_2021_AEHS.pdf for 12 key slides

Henry Schuver, USEPA-ORCR – Personal (RCRA) perspectives

Background, Origin & Purpose of: *Soil Gas Safe Community (SGSC)* concept



- ~2010 observed contrasts between **Redfield**'s[1] & **Typical**[2] VI Assessment
- Apparent **Correlations**:
  - **Higher** % of bldgs[1] **&** # indoor air samples/bldg[1] = **Higher** freq. of VI 'found'
  - **Lower**[2] " " **&** " " " " = **Lower** " " "
    - **&** when ***only a few*** bldgs. are '**found' to have VI** – they '**stick out**'
  - Can be stigmatized as if different/worse than all others (*but probably not)*
- Then possible **Feedback-cycle**

+ 'stepping-out' complications?

  - Occupants seeing earlier bldgs. being stigmatized, don't want that, & do **not** allow sampling
  - Fewer bldgs. get sampled and those that did (& happened to 'find' VI) are ***stigmatized***
  - In ***Un***sampled bldgs. VI Exposures **continue** … potential health impacts

No good 'Options'

- **Keep the Community together** for **More Benefits all-round** w/ **SGSC**

1 – Redfield site Denver Colo. ~**96% *participating*** bldgs. allowing avg. ~**10** indoor air samples **per bldg**. (~50% w/controls)

2 – Commonly **<25%** of bldgs. *targeted* get sampled (< allow), & typically only **2-3** 'random' samples per bldg.

Public Health Protection Needs to be Both: **Effective** & **Low Cost**

- Still most-commonly used methods *appear to be* the **Opposite**:
  - **High Cost** Mostly **Sampling $$*** (tot. of access/prep. for indoor air)
    - &
  - **Ineffective** Sparse ('random'/*un-guided*) indoor **Sampling****
    - At identifying VI exposures (of most concern for health)
      - and thus,
    - Not calling for **Controls** of exposure (that **change health**)

  - We're trying to ***raise the ratio of benefits*** from resources (**$$**) **spent on VI**

  - We'd like the **confidence** & **benefits** of Redfield facility***
    - **More/All** buildings 'sampled' w/ **Indicators & Tracers** (I&T) **But** with ***fewer cVOC samples***
    - **Overall LOWER sampling $$**

*Economic Analysis – later today **Sampling Analysis – later today ***Presentations with details coming

The Agency's ORCR, States & Communities

3) *Would like* ORD to support a large-scale **Pilot** effort involving:

- Physical scientists to confirm the validity of the science and practicality of implementing the approaches above
- Sociologist to help & ensure community members have
  - Easy **Access** to participate & collaborate 'on par' with the RP-decision makers & …
- Economist to compare long-term **Costs** & **Benefits** for:
  - Equally-high levels of **protection** via chemical indoor air sampling **or** controlling[*]SGI; incl.:
    - Long-term on-going protection of SGI/VI continuously documented via Soil Gas Tracer conc. [**]
  - EPA creating a '***Soil Gas Safe Community***' designation (similar to *Energy Star*) to celebrate
    - And minimize Stigma of individual building results

[*See Economic/benefits **modeling analysis** results at 1:30-2:30 (ET) *Very interesting*]
[**Should be tested in soon]

How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- This is a real WORKshop about "How"
- Looking for Feedback/Input; on:
- Proposed Specific:
  - Regulatory-focused concepts/frameworks & decision making – **Panel Discussion**
    &
  - Measurements and Field methods (particularly details by **ORD** in afternoon)

  - **All** feedback/comments/recommendations received by **June 1** will be *studied for incorporation* into full-scale Field studies and Community Pilot(s)

  - 1x Opportunity & We want it to be the very Best it Can Be
    - **With YOUR** experiences, perspectives & comments we **might** be able to ***'Count the Benefits'****

*Comparing disease rates ***before*** *and* ***after*** controlling soil gas intrusion – **'cases avoided'**

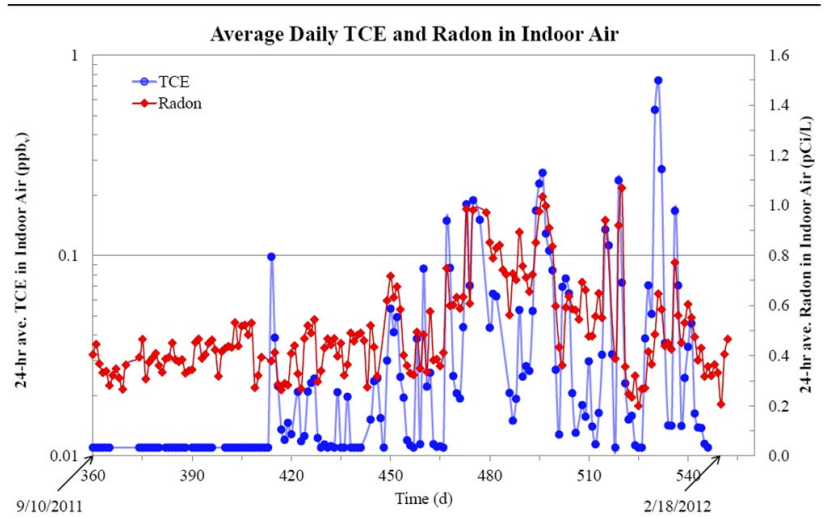
How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- **#1** VI **Challenge**: VARIABILITY (across **Time** & Space) – So we want:
  - Full *Distributions* of frequent/'**continuous'** data (across **Time**) that are;
  - Possible from each & **every building** 'at risk' for VI (i.e., across **Space**)
- Not currently 'affordable' for cVOC/chemical-specific measurements
- Proposing the use of statistically-associated **Indicators** & **Tracers** (I&T)*
  - Differentials (indoor-to-outdoor) *if possible*
    - **Indicators** – of VI **Driving forces** of *flow*** into bldgs.
      - **Temperature**
      - **Pressure**
    - **Tracers** – of the *physical movement* of nearby soil gas intruding into your indoor air
      - **Radon** (Rn) **Conc.** units, *just like we need for* cVOCs (*incl.* indoor mixing & retention)

*Also testing 'Rn-alone' as a **S**urrogate (w/o cVOCs) for decision making (ITS) **Not addressing diffusion, directly

Statistical example: Correlations in the: *Direction* of **Conc. Change** over Time (**+/-**)

- *Indoor* **Rn** & **cVOC**s from VI
- When:
  - *Indoor* **Rn** conc. goes **Up** **cVOC** conc. goes **Up**
    Rn " " **Down** **cVOC** " " **Down**
- How confident are we?
  - Time Series Regression Analysis (complex & costly)
    - EPA Indianapolis Duplex (EID) **99%**
    - Sun Devil Manor (SDM) **99.9%**
      - **10,000** trial **runs** testing the use of these assoc. to **Time** a **few meaningful cVOC samples** – later
- *Magnitude* **Change in *Conc.*** over Time (#/#) is not 1:1, *more complicated*
  - **High** conc. end of distribution
  - **Low** conc. " " "



Occupants *could* monitor intrusion of **soil gas** into their own bldg., with **Rn** meters, ~continuously

- Anyone who has observed a **Rn meter** real-time knows, it changes:
  - Every
    - 15 min.
    - Hour
    - Day
    - Week
    - Month
    - Season
    - Year
    - Decade (Thank you Dr. **Steck** for measuring your new home for **23 years** pre-mitigation!)
  - With such Meters:
- Everyone can 'see' their bldg's soil gas (& if present vapor) intrusion behavior
- Could know if soil gas is intruding ***when*** indoor samples are collected

How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- **#2 Challenge**: Communities have **limited input** to decisions on **Their** risk
- Proposal:
  - **Empower** community members, by providing:*
  - **'All' buildings** with 'continuous' indoor **meters** for **Temp., Press.** & **Rn**;
    - So:
  - Occupants can **observe their bldg.'s variations** in Temp., Press. & **Rn** over *hours-years*
    - They can see how indoor air **sample(s)** from **most** one Day or Week+ can **mean very little**, RE:
      - **Long** term **chronic exposure** risks (like cancer)
        - Or
      - **Short**-term (e.g., 1-day **'peak') exposure** risk (e.g., *in utero*/developmental effects)
    - ***Unless*** the samples are **collected at Times** of **most concern**/representing **most exposures**

*Provided by EPA for this Pilot-Communities concept testing

If we *need to* **sample indoors** for cVOC-VI chemicals; Our Proposal* is Primarily to:

- Allow the collection of **typically 'low' numbers** of indoor cVOC samples
  - for initial/on-going assessments (e.g., **~4/bldg**.)
- But **only *if:***
  - They are **set in a *context*** of <u>more frequent</u> measurements**
    - That can:
      - **Indicate** (VI-**drivers** w/ assoc. observed; e.g., **Temp**. & **Press**.)
      - **Trace** (other components in soil gas that **move with** cVOCs) (e.g., **Rn**)
    - **Shape** of the **distribution** across Time & **Guide** cVOC sampling
      - **Space:** Assess ***all* Bldgs**' for susceptibility to soil gas (pot. cVI) intrusion
      - **Times** *more likely* to represent **some** of upper **50%** of tot. **Exposure**

*to improve VI (under **RCRA)**; **By **Citizen/Community-Scientists** w/ ITS meters in their bldgs.

Quantitative Confidence in Exposure Risks Two *Risk Metrics*: Chronic & Short-term

- **Chronic** risk – is about **long-term average** risk & for confident decisions we use:
- 95th% Upper Confidence Limit on the **Mean** (average) – bare min. 3-7* samples (**variability**)
  - **'95UCL'** of **mean** (**average**) exposure concentration

- **Short-term** risk – is about short-term exposures in periods of vulnerability
  - **R**easonable **M**aximum **E**xposure (**RME; Between 90th - 98th %ile conc.) EPA VIG, 2015
    - *We're using* a **~central-point-estimate** of the range of RME (**95th%ile**) of exposure **concentration**
  - i.e., Conc. *averaged over* the '*period of concern*' for the outcome of concern, e.g.,
  - For short-term/sub-chronic effects, like *in-utero*/Developmental, could be a low as **1 day****

- Summary Note 1: **95UCL** can **> 95th%ile** conc. for small sample # w/ high variability
- Summary Note 2: *Infrequent High Conc. **Peaks** can drive **both**!*

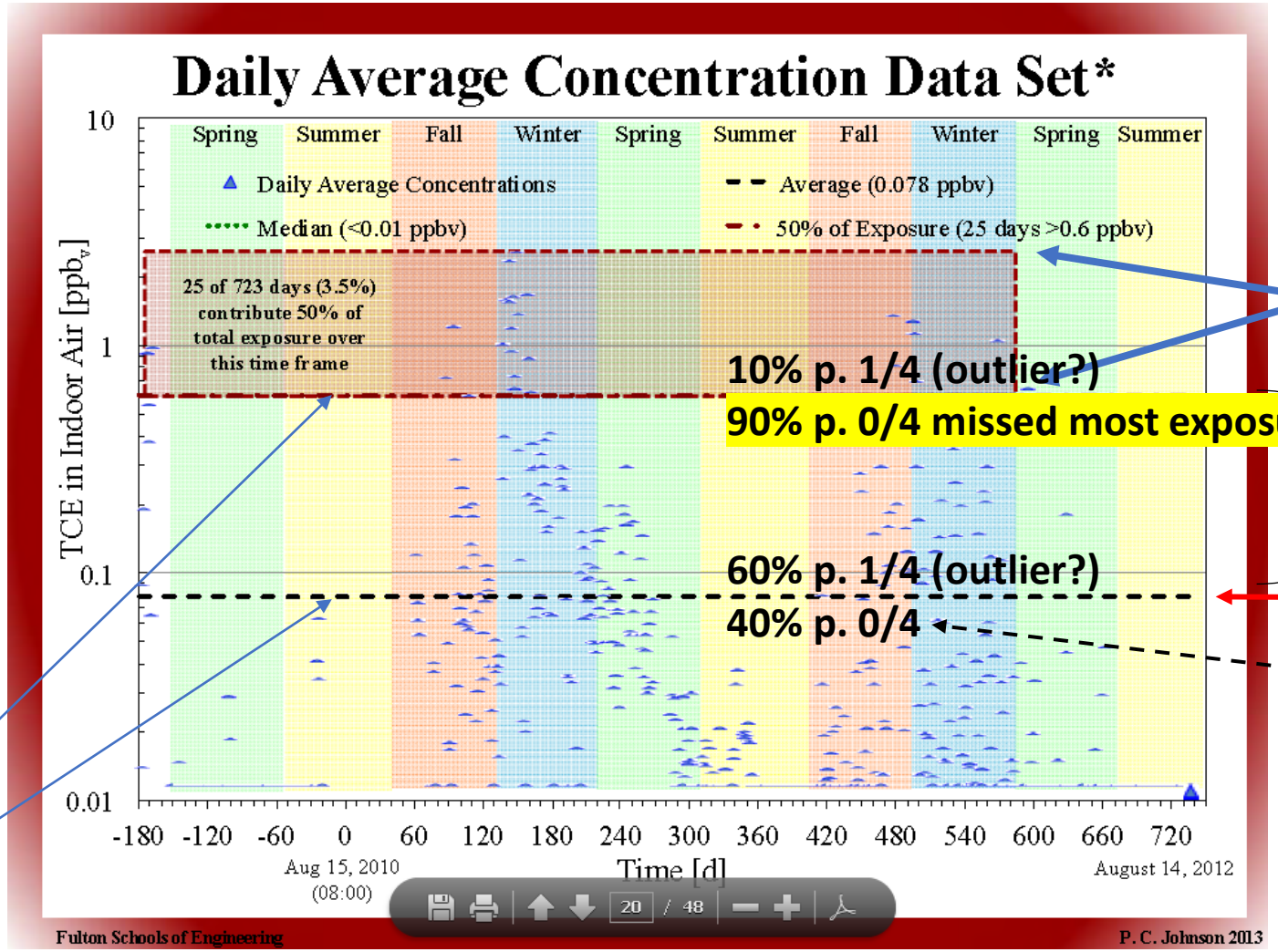
* https://www.nj.gov/dep/srp/guidance/rs/proucl.pdf
**https://www.epa.gov/risk/guidelines-developmental-toxicity-risk-assessment

Continuous measurement of cVI (TCE) at 'Sun Devil Manor'

Sampled cVOCs (TCE) ~continuously for 723 days

A few **Conc.** (points at most ***any*** time) does **NOT** represent **VI Exposure**

VI Distributions/Expos.
Driven by Peaks



Log scale

Assumed collection of 4 samples & text here shows Probability & interpret. for 0 & 1 (out of 4 random samples)
a) >50%ile of **Exposure**
b) > Mean **conc**.

10% p. 1/4 (outlier?)
90% p. 0/4 missed most exposure

60% p. 1/4 (outlier?)
40% p. 0/4

Only 25 days (3.5%) contributed **50%** of the total exposure over ~2 years
[~1 day per month]

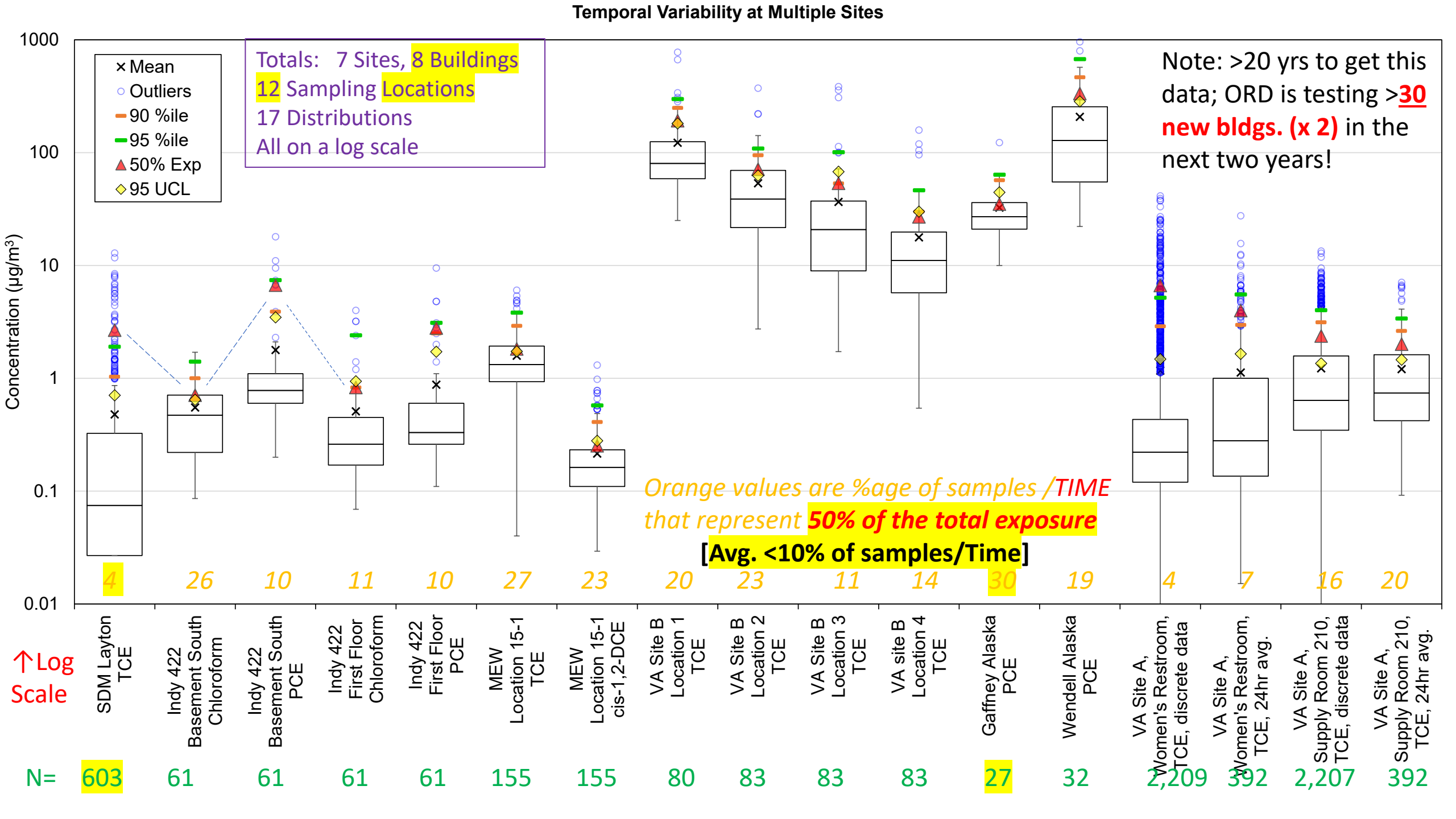
'Upper' 50%' of tot. EXPOSURE

~10x higher screening level

MEAN (Avg.)

Typical Interpretation of 0 out of 4 samples < Avg. means **clean** ?
Can Rn-guiding get us 2/4 here ~50% of the time ?

Dr. Paul Johnson's slide 20/48 - Note audio recording of presentation also available at:
https://iavi.rti.org/attachments/WorkshopsAndConferences/05_Johnson_03-19-13.pdf


Temporal Variability at Multiple Sites
Mean
Outliers
90 %ile
95 %ile
50% Exp
95 UCL
Totals: 7 Sites, 8 Buildings
12 Sampling Locations
17 Distributions
All on a log scale
Note: >20 yrs to get this data; ORD is testing >30 new bldgs. (x 2) in the next two years!
Concentration (µg/m³)
1000
100
10
1
0.1
0.01
Orange values are %age of samples /TIME that represent 50% of the total exposure
[Avg. <10% of samples/Time]
4 26 10 11 10 27 23 20 23 11 14 30 19 4 7 16 20
↑Log Scale
SDM Layton TCE
Indy 422 Basement South Chloroform
Indy 422 Basement South PCE
Indy 422 First Floor Chloroform
Indy 422 First Floor PCE
MEW Location 15-1 TCE
MEW Location 15-1 cis-1,2-DCE
VA Site B Location 1 TCE
VA Site B Location 2 TCE
VA Site B Location 3 TCE
VA site B Location 4 TCE
Gaffney Alaska PCE
Wendell Alaska PCE
VA Site A, Women's Restroom, TCE, discrete data
VA Site A, Women's Restroom, TCE, 24hr avg.
VA Site A, Supply Room 210, TCE, discrete data
VA Site A, Supply Room 210, TCE, 24hr avg.
N= 603 61 61 61 61 155 155 80 83 83 83 27 32 2,209 392 2,207 392

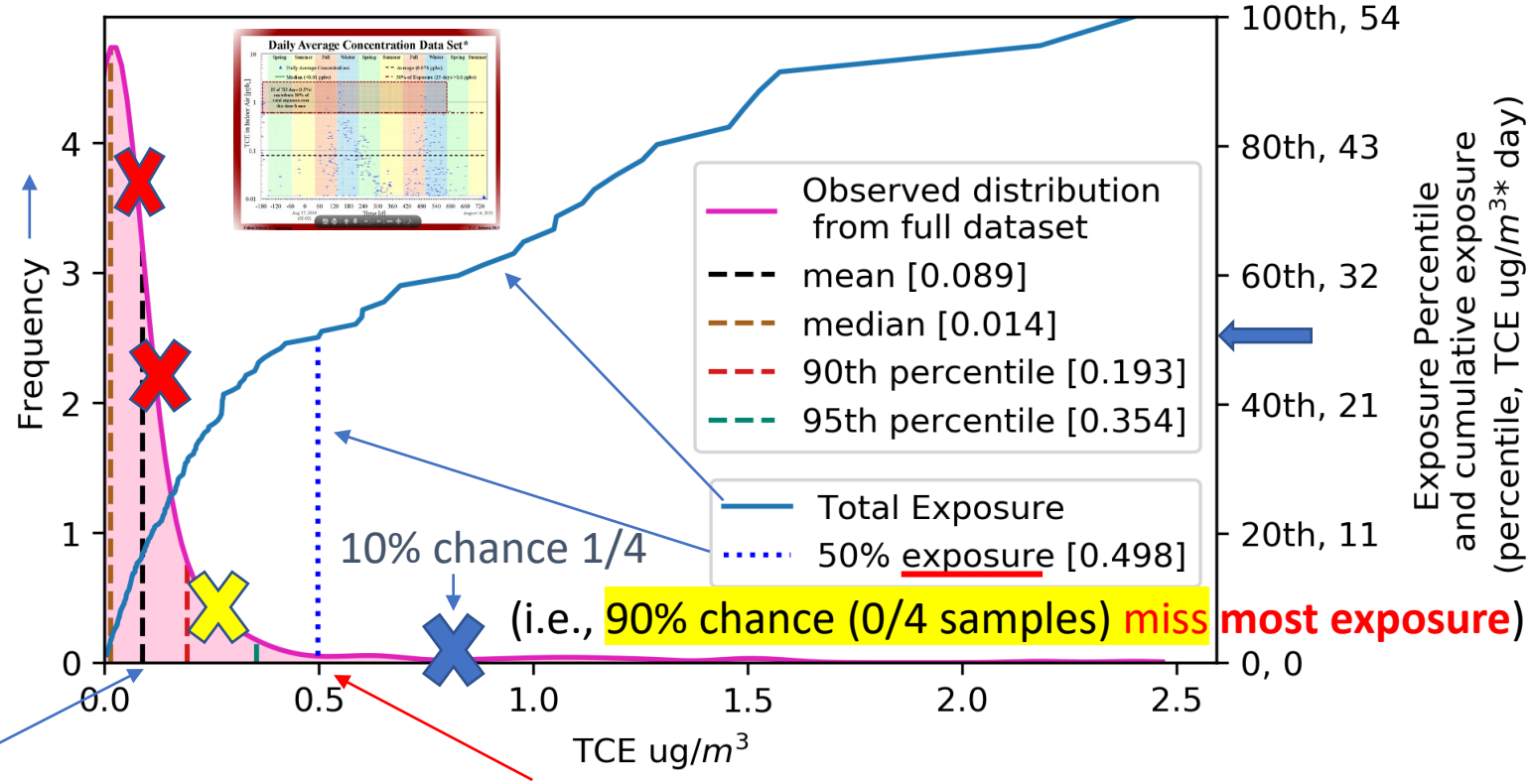
Sampling '*non*-Normal' dist. of VI conc. in indoor air to represent ~Avg. *cumulative (total)* Exposure is NOT easy

One of 12 Locations with similar relationships

Sun Devil Manor, Layton Utah, Daily Data Exposure Curve
Date range: 2010-08-15 to 2012-08-21
Sample Count: 603

If we could *ONLY* get a **couple** of samples from the upper ½ of exposure you'd have **a chance** of representing Avg. **exposure**.

Peer review:
"*a very lucky sample … too optimistic*"



Avg. (mean) Conc. 0.089 ug/m3 Avg. (50%) **Exposure** 0.498 ug/m3 [**5.6x higher**]

Because:
very **infrequent**
very **high conc.**
make up **50%** of the **total *cumulative* EXPOSURE**
&
***If you* miss them You can't represent the Average or Peak EXPOSURE**

So how can we guide sampling times to find these?

How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- **Regulator-teams** will (*for this study*):

- *Work with* the RP/authorities & consultants **to Ensure** they:
  - **Identify ALL** buildings that are w/n 'proximity' '**at risk**' of VI due to their/a VI source
  - **Sample soil gas *nearby*** (e.g., <6 ft) **'all' bldgs.** for **cVOCs** to know ***if*** the cVI chemicals are adjacent to each bldg.
- Provide 'Community-Scientist' **Training** to help community members:
  - who are interested in the science behind ensuring their own safety from cVI
  - **Interpret** the meaning of the ITS data they have been observing/collecting
    - &
  - **Decide when** they might be **most concerned/interested** in indoor cVOC-VI **sampling**
    - & (***if*** needed/wanted and if practical)
  - **Know How** they could **collect their own** indoor air cVOC **sample(s)** for VI
    - At the **most appropriate Time**

How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- Communities with their ***own Evidence*** & support of Regulator-teams:
  - Could '***bring to the table***' and show:
  - **THEIR own Evidence** & **Perspectives*** to RP/Author. decision-makers
    - Regarding **THEIR own Exposures**
- For example, this could include:
  1) **R**eminder (to RP/Auth.) – Our **Bldg.** *still* **'overlies'** your cVOC-VI source & is **'at risk'** for cVI**
  2) **R**eminder – The **Soil Gas *nearby*** (our home/office/bldg.) **contains** your **cVI chemicals****
  3) **O**ur **ITS Evidence shows** the same **nearby soil gas *is* intruding** into our **Indoor Air****
     e.g., **Levels** of the **Tracer** of **soil gas entry (Rn)** are **> Outdoors**, by up to **___ x times*****
  4) **W**e'd prefer you **control/remove** the (now) cVOC-contaminated **soil gas** *around our* **bldg.**/soils
     Or
  5) **Sample** our indoor air – at the **Time** of **our choosing**; e.g.;
     a) e.g., At times when soil/conduit gas intrusion is known (via elevated ITS levels) **to be 'turned on')** &
     b) Continue **'as needed'** over 'all' **future** times, while our bldgs. remain '**at risk**'; overlying your **cVI source******

*Hypothetical examples here
**If evidence shows it is/does
***cVI can be x^2 (compared to Rn)
****meters will be monitoring for more elevated cond.

This approach can address the:
Two Basic Tenets of Environmental Justice*

- Equal **Protection**
  - from 'risky' exposures** [now only getting '*spotty*' protection]
    - e.g., due to *un-recognized* **Spatial** & **Temporal** variability

- Equal **Access** to *meaningful* **participation**
  - And fair *representation* in **risk decisions**
    - e.g., **Spatial** (bldg.-bldg.) variability
      - (i.e., almost un-tested/un-studied)***
  - Functional Theme: *Minimizing the Opportunities for **In**justice* (in exposures)

*Little & Pennell *Measuring Vapor Intrusion: From Source Science Politics to a Transdisciplinary Approach* (Environ. Sociology, 2016)
**Subject to regulatory (e.g., RCRA) authority for Corrective Action
***Very difficult to get access to study new bldgs. in detail – ORD plans for a major step forward – later today

How Vapor Intrusion Data Measured by Communities and Supported by Regulators Can Create *"Soil Gas Safe Communities"*

- **When** the **Majority** (>50%) of the Bldgs. *still* 'at risk' for cVI - within a neighborhood boundary* can show they have **on-going evidence**** that:
  - **With- or with-Out** engineered vapor **controls,** they:
- **Qualitatively – Do NOT** have a **Complete pathway** for VI **exposure**, because:

  1) cVI **chemicals are NOT present** in **soil**/conduit **gas** surrounding their buildings *or*

  2) Soil/conduit **gases** are **NOT intruding** into indoor air (e.g., **>> outdoor**, Rn background), *or*

  3) cVOC-VI **chemicals are NOT Detected** in indoor air, ***Or***

  Although a '**Complete**' Pathway for (*unavoidable indoor*) Exposure … cVOC ≠ **Pb, Rn**
- ***If*** **__# ~OK – *Confident* No Unacceptable Conc.** (> **__#**) *in* our indoor air, from cVI

  i.e., From **Times** when soil/conduit gas **intrusion** is **known** to be **'turned on'** (via ITS, e.g., **Rn**)
  - ***If*** Can **show** this 'on-going' evidence of protection;** they are a ***Soil Gas Safe Community***

*To be discussed **For as long as they remain 'at risk' i.e., 'above' a cVOC-VI source(s)

'Soil Gas Safe' – Label/Name & the *Big Picture*

- We've have been *warned*/cautioned
  - by Communication Experts
    - Involved in major EPA labelling efforts, e.g., Energy Star
- ***'Soil Gas Safe'***
  - ***Is NOT common or familiar term – for most members of the public****
  - ***May not be the best label – for this effort***
- *Your Suggestions are welcomed:*
  - But; we believe part of the value here is **Education****

*Except to Geologist, who like it

** **Everyone** should know ***soil gas*** was never any good to breathe; & it's getting worse;

Public Health Awareness

Help Stop Soil Gas Intrusion from Lowering IAQ

- Unquestionable some public health benefits – will follow (Rn 'alone')

  never is w/ cVI

  - **Whenever** cVI samples are collected (from Indoor air):

  - There is going to be **some amount** of **soil gas (Rn*)** in that indoor air

    - Do you **want** that to be **Unknown, Low, Avg., or High?**

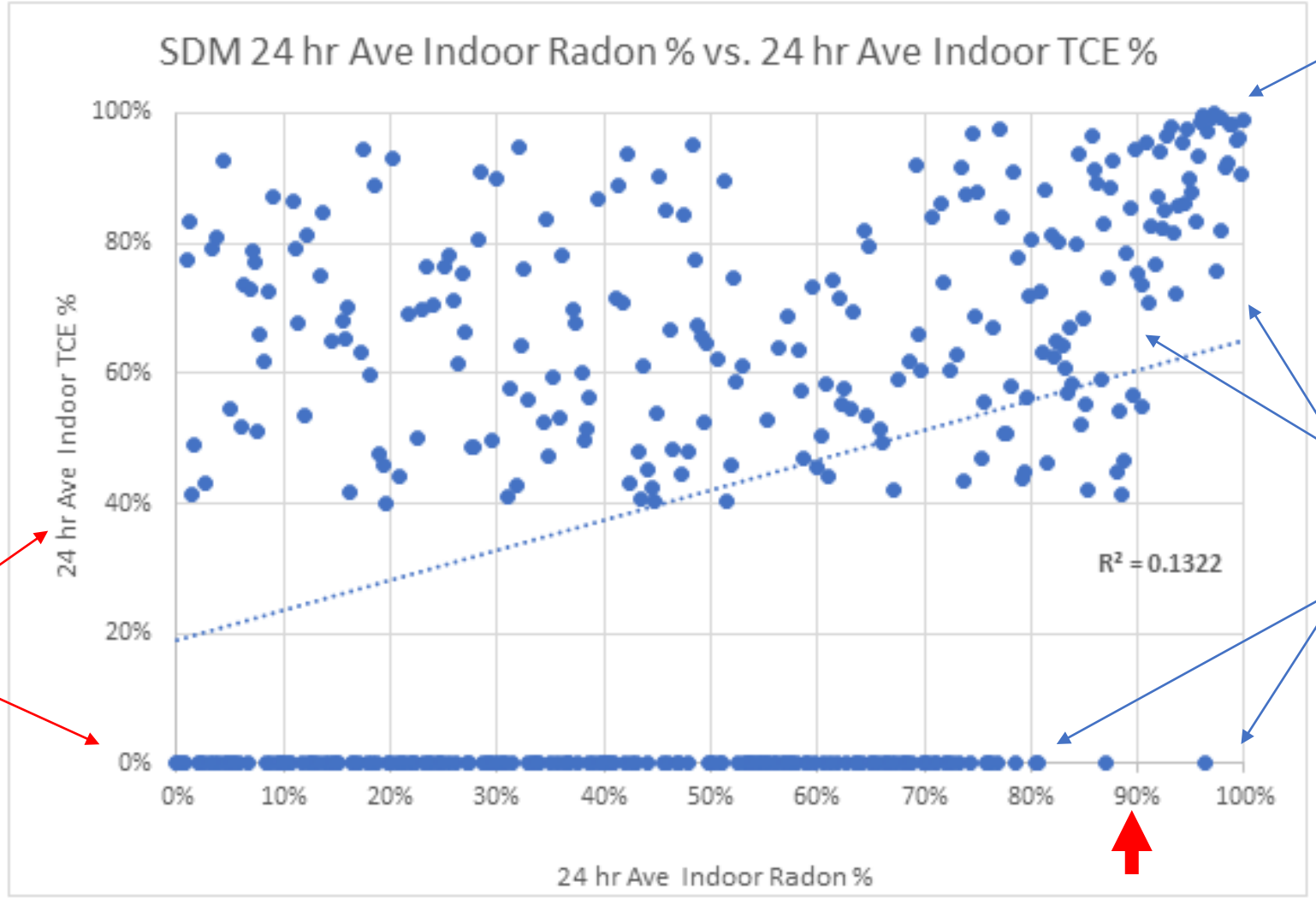
      - Personal recommendations**:

- **Avoid** collection of cVI indoor air **samples** when soil gas intrusion (**Rn**) is '**Low**'***

* That can be correlated with the **Conc.** of **the** soil gas marker/***Tracer*** **Rn** in the indoor air
** Given what we 'know' today
**for your building's natural range of indoor Rn levels (e.g., <90th%ile of bldg-specific distribution)

Calculated Percentiles (rank order distributions; *not* conc. scale) – w/o Re: sequence/time

Calculated Percentiles (%iles), <u>including</u> No-Detected (ND) values



~ 40% of the TCE levels are Non Detected

The **highest levels** of Rn & TCE are **most closely associated –** & **that's useful!**

When >90th%ile Rn, almost all TCE levels >70th%ile & up to 100th%ile (Highest TCE levels)

At >80th%ile Rn near-lack of ND levels;

*Regression line for correlation – **over all**; But we only really care about the highest*

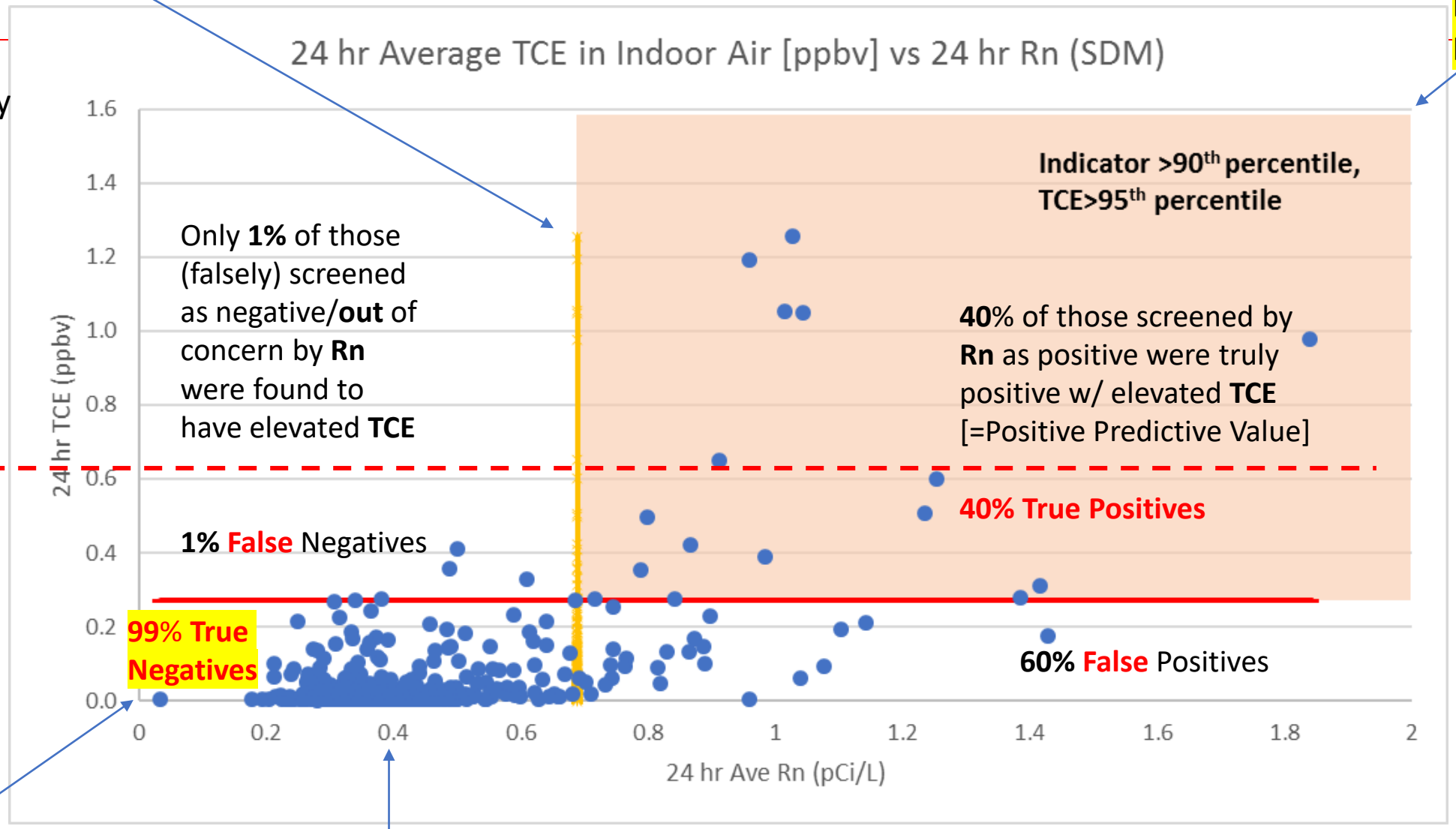
Sampling for TCE **when** the **Rn** level is <80th%ile gives a >**40% probability (~1/2)** of finding a **ND TCE value!**
You **need to know** the **building's %ile** of **Radon** conc. **when chem. sample is collected** to **understand** what chemical conc. found represents. **If sampling when Rn was >80th%, or even better >90th%, you *could* find much higher TCE levels**

90th%ile Indoor Radon as Indicator of TCE – Sun Devil Manor

Primarily *drain-pipe/conduit* VI

Low Rn after mitigation may be low $ high quality verify effectiveness of controls/ mitigation

High Rn & High TCE



40% of the data 'Indicated', by Rn, to have higher TCE conc. were found to have higher TCE

50%ile of Exposure Rn 100% True Negatives i.e., VERY Confident

Low Rn & Low TCE **TODAY'S FOCUS**

National outdoor Rn background

Would you rather have 1% or 60% screening errors?
Use the '**LOW** '**Rn** to predict **LOW** TCE with **99% Confidence**!

Limitations & Uncertainties ~ *for the High side*

Good correlations of **High Rn** & **High cVI** observed in many bldgs.

- Radon intrusion is **very similar** to chemical **once they have entered** the 'man'-built environment, but not in the subsurface – Work in Progress: e.g.,
- Origin and **Source** of Rn & Chemicals ***in the subsurface*** can differ:
  - **Location** of the *source* – esp. relative to openings into building – maybe not =
    - Very little building-specific mapping of Rn in sub-slab soil gas (that I know of)
      - Rn & cVOCs can have **Different Distributions/Loc., Pathways, & Access to openings** to buildings
  - **Strength** of *source*/flux rates
    - Rn gas comes from naturally distributed Radium minerals within rocks/soils (not-mobile)
    - Rn is generated by constant radioactive decay you can set your watch by it
    - cVOCs in the subsurface can be **Orders of Magnitude higher** here or there and
    - Vary in location/conc. with time (mobile) with groundwater/soil-gas/vapor transport
- Long-term Stewardship – Testing needs to start soon
  - If Rn levels remain 'Low' = Protected from cVI?

This is an **Opportunity**
Supported by **EPA resources**

- For:
  - **Communities**
    - High/Research-Quality cVI Exposure Assessments (ORD QA/QC plans, … etc.)
  - **EPA ORD & Cleanup Programs**:
    - Field testing ‘guidance’ for Improving cVI Protection
  - **Regions** & **States**
    - Helping assess cVI cases/facilities with unknown potential, sooner than otherwise
- Prioritizing:
    - Communities with EJ concerns
    - Communities ‘trapped’ in VI-probable real estate by economic constraints
    - Communities with concerns their VI assessment too slow or RP trust issues
    - Resource-limited cases that would not be addressed in a timely manner otherwise
    - Cases where there is a long history of possible past VI (& other pathway) exposures

  - Contact: Brian Schumacher & John Zimmerman., cc: Schuver & Crincoli

Thank You