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

## *Opportunities for Communities to Maximize Benefits during Implementation (of SGSC)*

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

# *Soil Gas Safe Communities* (SGSC) Could be built in 3 Phases

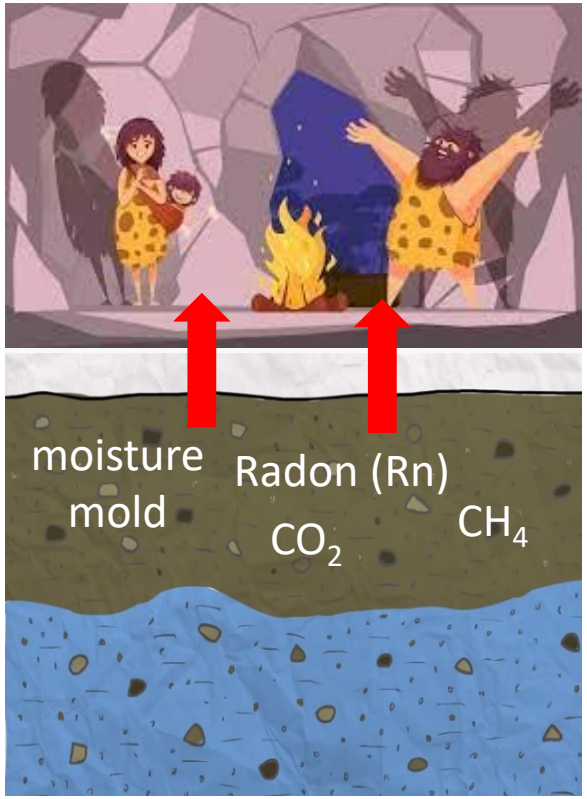
- Phase 1 – Who is “at risk”
- Phase 2 – Probability of Exposures
- Phase 3 – Decisions to Prevent, Or Confirm-&-Manage, Exposures

- 3 Major Players
  - Communities
  - Regulators
  - Responsible Parties/Authorities (RP)

- Each beginning with their own Conceptual Site Models
  - We hope they can converge on a *Soil Gas Safe Community* (reality)

But first a **Public Health Announcement**

**Soil gas / vapor** has been in intruding into 'indoor' air since we lived in Caves



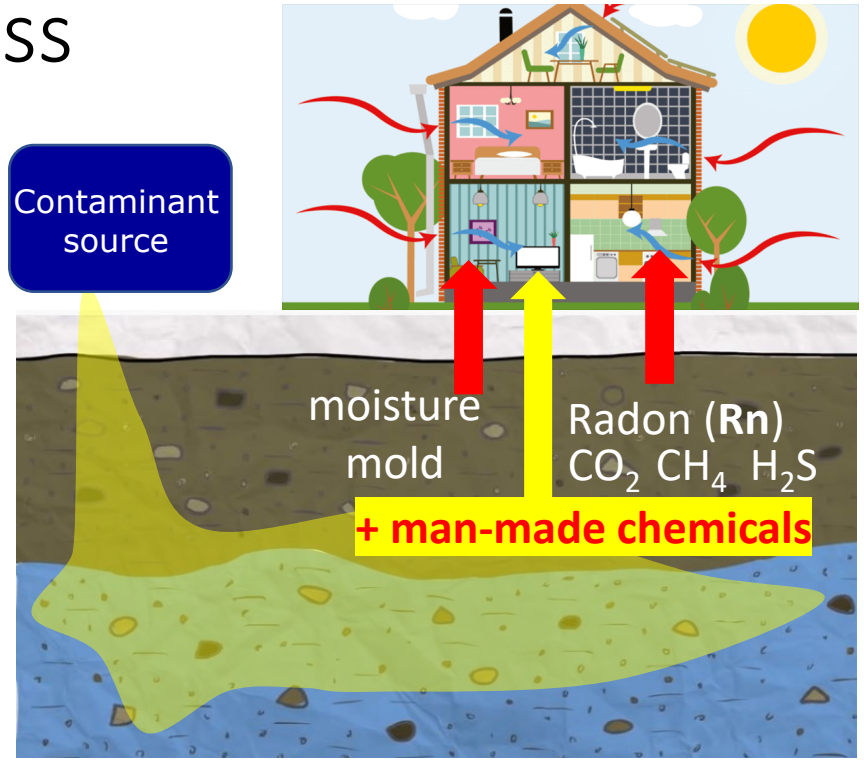

**Big Picture**

***VI Across the Ages***

Generally, **can't**:
**See,**
**Smell,**
**Hear,**
**or**
**Avoid**
**this Intruder**

Conc. **were** minimized by high exchange rates with 'cleaner' outdoor air

Now[1]: Our buildings/homes are increasingly tighter/weatherized for low/lower indoor air/energy loss



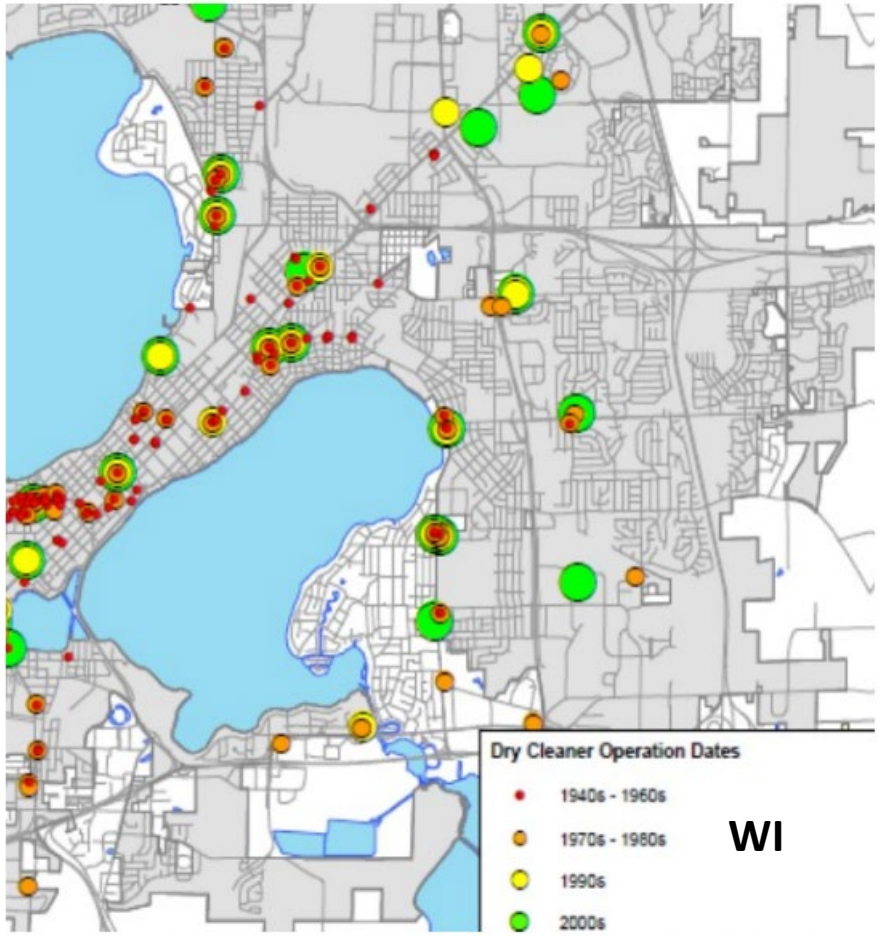

But typically* still allowing soil gas entry – from below

Same natural hazards, but at increasing concentrations as it is 'trapped' indoors longer & Now[2] Petro- *Chloro-* & **Fluoro- +?**

# Soil gas/vapor intrusion was **never good & getting worse** e.g., *chemical*-Vapor Intrusion (cVI) Hazard is Growing[2]

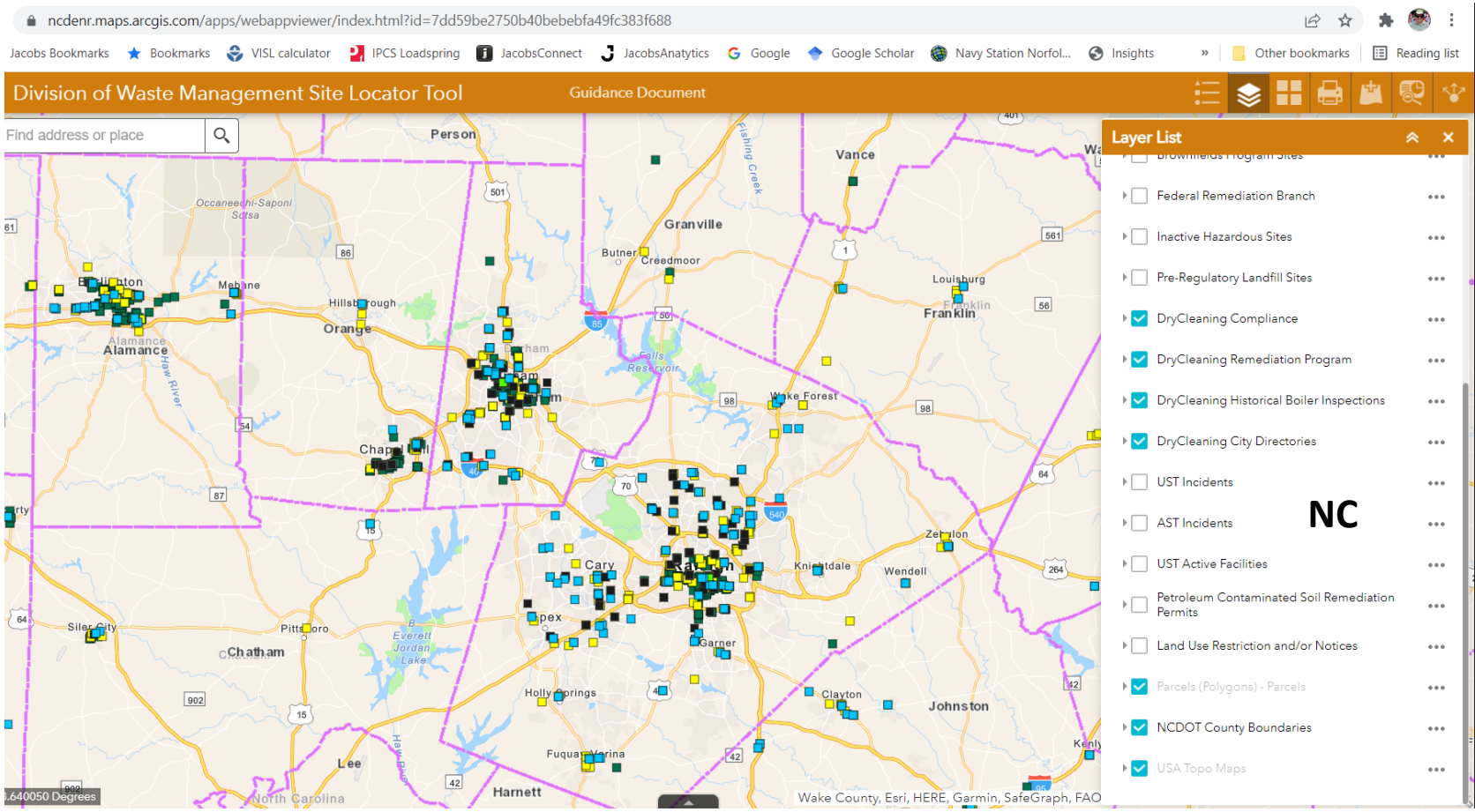
- The list of '***man-made***'/influenced chemical contaminant vapors in soil gas is growing:
  - **Methane** (natural & landfills)
  - **Petroleum**
  - **Dry Cleaner solvents**
  - **Industrial Chlorinated solvent uses – "cVI"** typically subject to cleanup regulations
  - **Mercury –** historical electric lighting manufacturing, now day-care facilities, why?
  - **Pesticides** (Agricultural: fruit fungicides; Residential: termites, ants, grubs, …)
  - Now **PFAS?** (Short-chain (pre-cursors of PFOA/PFOS), e.g., Fluorotelomer alcohols, FTOH)
  - & What's next? e.g., in **New products/wastes**
    - **Fracking (**& **Old un-sealed gas) wells (BTEX+?) indoor vapors** (reported Feb. 24 in BC & ~PA)
- There are **not enough resources** to **address** all the VI risks **we have now**
  - We Need *more* **Cost-Effective methods** to **Assess** and **Manage** VI risks

# Sources of solvents forming vapors are *not everywhere*: ***Just where people live & work*** – 2 Dry Cleaner-only examples




*Example of a GIS map for the City of Madison that identifies the locations of former dry cleaner sites and distinguishes the points based on the dates of operation.*

*Map courtesy of the City of Madison Engineering Division*




Also: **Volatile Organic Contaminants (VOCs) in 47% of urban [groundwater] wells (USGS, 1999)**

# Today's **High-Quality** Buildings **Do Not Allow** soil gas/vapor intrusion – they **Stop Exposure**

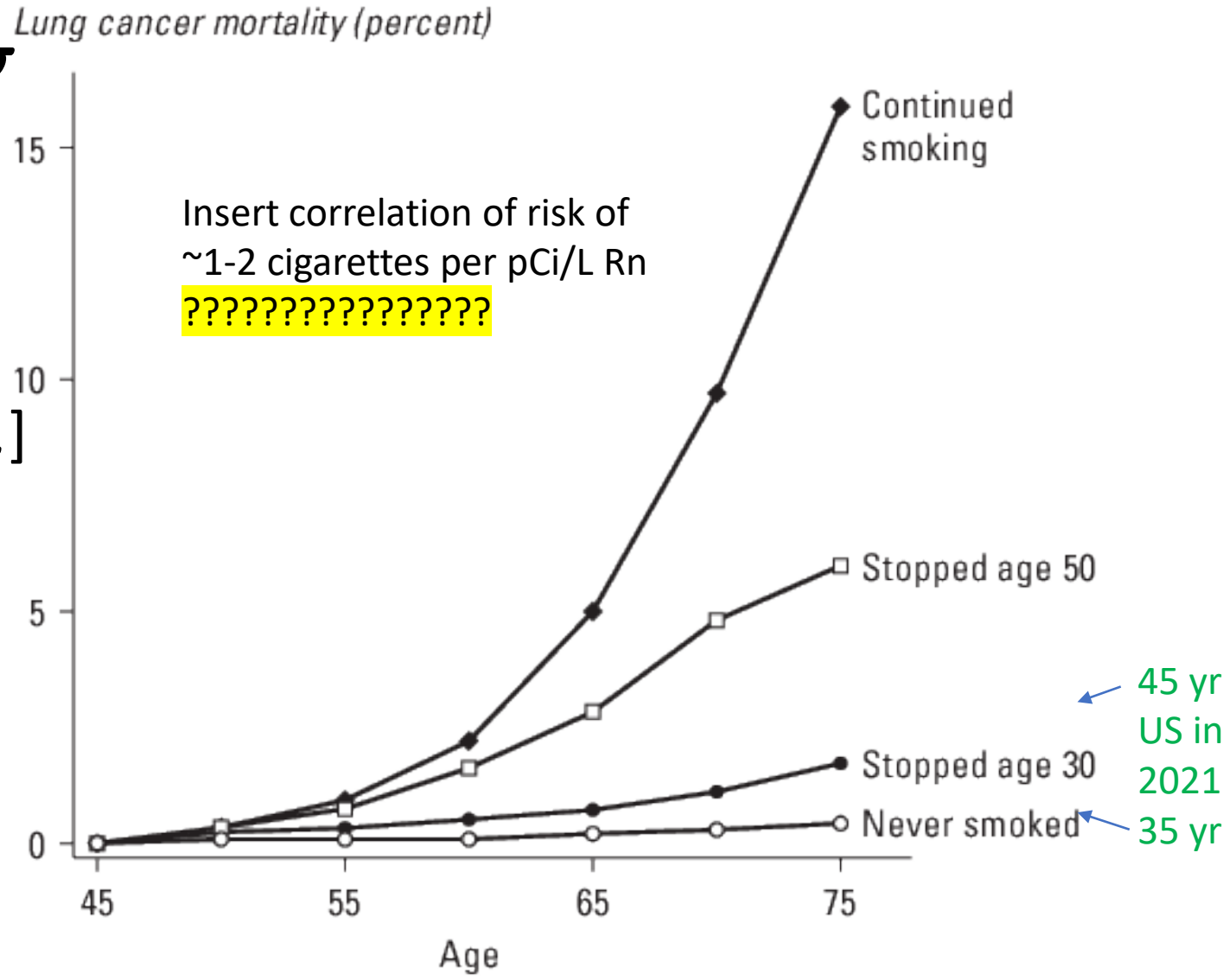
- **Buildings do not have to allow Soil Gas to enter them –** *its social decision*
  - However, most Buildings are still do; because: **They are:**
    - **Designed and constructed to allow Soil Gas to enter**
- The Leadership in Environmental & Energy Design (**LEED**) program
  - Encourages/recognizes/gives LEED credits for new designs & construction that
    - Reduces/Prevents the entry of '**Ground contaminants**'
  - Reference: https://www.usgbc.org/credits/homes-high-rise/v4-draft/eqp4
    - Intent: "To reduce occupants' exposure to radon gas and other **soil gas** contaminants."
  - EPA's Radon(/AARST) & Brownfields programs recommend **Radon/VI resistant** Passive piping in **new construction**
  - EPA has recommended (**since 1993**) the **modification of existing buildings** to 'mitigate'/prevent soil gas intrusion for naturally-occurring **Radon radiation alone**, based on testing, and re-testing **every two years**
    - Radium in soils decaying into Rn is 'forever'
      - Radium "half-life of **1600 years**"

# *Benefits of Stopping Exposure Sooner*

[& it's Never TOO late]

[***Smoking*** ~ *haz. chemical expo.*]

**Stopping Works**: Cumulative Risk of Lung Cancer Mortality in U.K. Males, 1990 rates




*Source:* Peto and others 2000.

# Oct. 21, 2021 *JAMA Oncology*, by Thomson & Cooke; with quotes from 2021 **US** News HealthDay on ***Smoking***

- "new [U.S.] findings underscore the power of quitting as early as possible."
- "Much, however, depended on age -- the age at which smokers both ***started*** [*not typically considered cVI risks*] and quit."
- "The younger people started smoking [~haz. chem. exposure], the greater their risk of eventually dying from cancer. Among those who started **before age 18**, the risk of dying from cancer was increased at least **three**-fold."
- "When people started smoking **before age 10**, their risk of cancer death was **quadrupled** versus lifelong nonsmokers." [*& if from ~birth, cVI in indoor air?*]
- "For people who pick up the habit at a tender age, "it's imperative that they quit as soon as possible," Thomson said.

https://www.usnews.com/news/health-news/articles/2021-10-25/quit-smoking-before-45-wipe-out-87-of-lung-cancer-risk

# Infant Health Data

- TCE plume (70 block) area:
  - ~2615 residents, 1090 births ('78-02)

NY *wisely* used **block-wide** assessments & mitigation

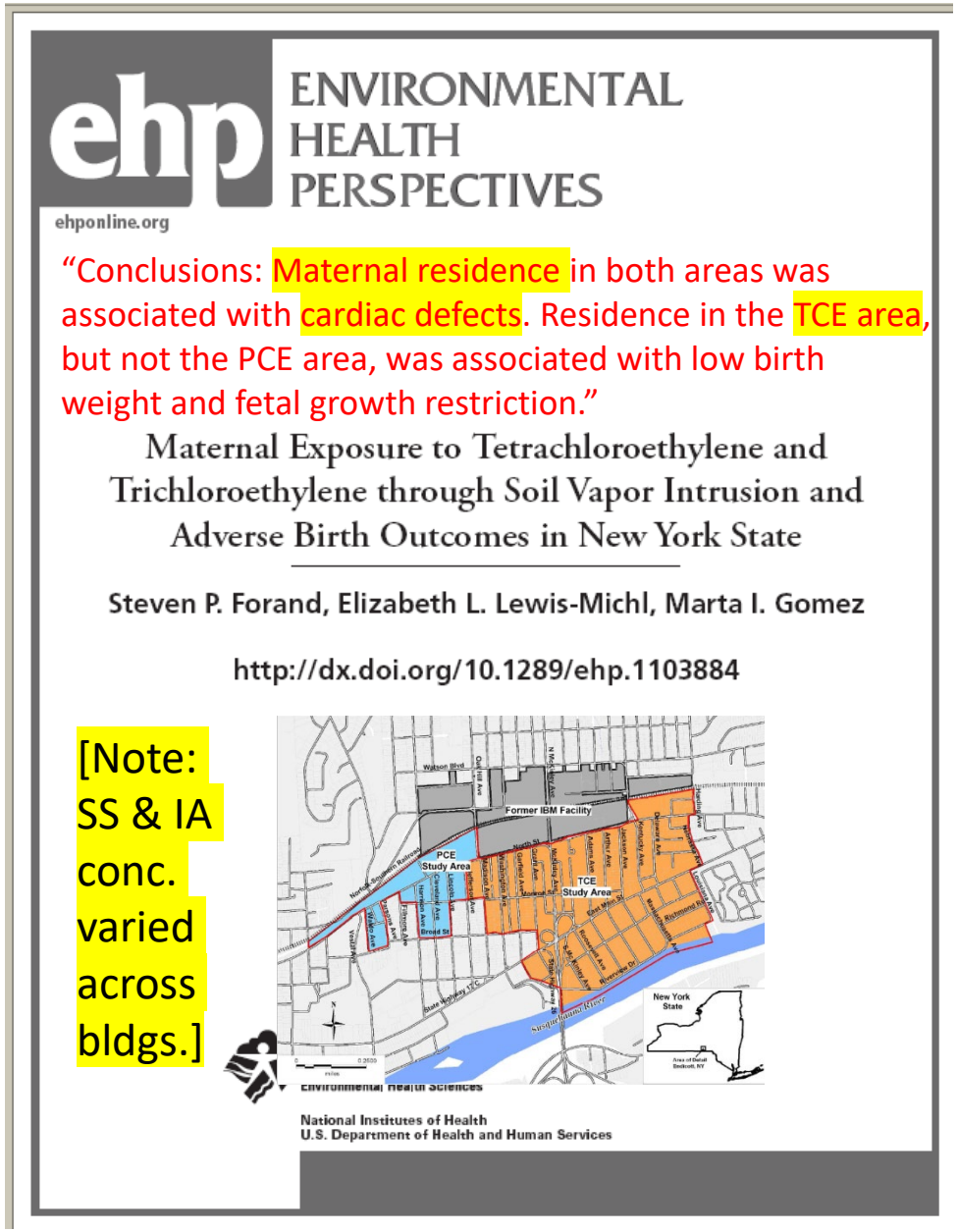
248 events

>95% CI (in NY)

(~1/4 births)

4/4 children's exposure to cVI started ~birth & only stopped when/w Controls

- 117 Small for gestational age
  - RR = **1.23** (95% CI = 1.03-1.48)
- 76 Low birth weight
  - RR = **1.36** (95% CI = 1.07-1.73)
- 37 Term low birth weight
  - RR = **1.68** (95% CI = 1.20-2.34)
- 15 Cardiac defects
  - RR = **2.15** (95% CI = 1.27-3.62)
- 3 Conotruncal* defects
  - RR = **4.91** (95% CI = 1.58-**15.24**)


ehp ENVIRONMENTAL HEALTH PERSPECTIVES

ehponline.org

"Conclusions: Maternal residence in both areas was associated with cardiac defects. Residence in the TCE area, but not the PCE area, was associated with low birth weight and fetal growth restriction."

Maternal Exposure to Tetrachloroethylene and Trichloroethylene through Soil Vapor Intrusion and Adverse Birth Outcomes in New York State

Steven P. Forand, Elizabeth L. Lewis-Michl, Marta I. Gomez

http://dx.doi.org/10.1289/ehp.1103884

[Note: SS & IA conc. varied across bldgs.]



National Institutes of Health
U.S. Department of Health and Human Services

* "abnormal formation of the outflow tracts of the heart"

(RR) Rate Ratios relative to the rest of NY state (excluding NYC) – elevated? (by many VI sites)

http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.1103884

# Summary
# Soil gas is Never Good (for IAQ*)

- If you want to know ***how Bad*** – **Sample** it
- If you want ***Less*** of it – **Avoid** it (physical Controls) & Improve health sooner

- Generally **$** are **limited**;
  - RP, Fed./State Gov. (w/ or w/o a "Super" fund), Developers, Private owners, Everyone
- For 1x **$** you can **Sample** *(for cVI)* **or** ~**Avoid** *it (**all** soil gas **hazards**)*
  - If you choose to **Sample** – don't waste it on *arbitrarily-timed* samples (esp. **Low** Rn)
  - For <**3%** of typical (*limited*-cVOC *range*) '1x' **sample cost** – **Rn** gives continuous info. yrs.
    - Occupants could **use Rn info** to help decide best use of the 'remaining' **97%** of 'that' same 1x**$**
    - **Don't sample too much**; likely **$** spent **sampling**, **reduces $** for **Controls**

*Maybe moisture & cooling in extreme hot/dry climates?

# Is **VI** missing a **Clear Message**; & **Too focused** on *bldg.-specific* risks, based on highly-*precise* (costly) samples, at *arbitrary* times**?**

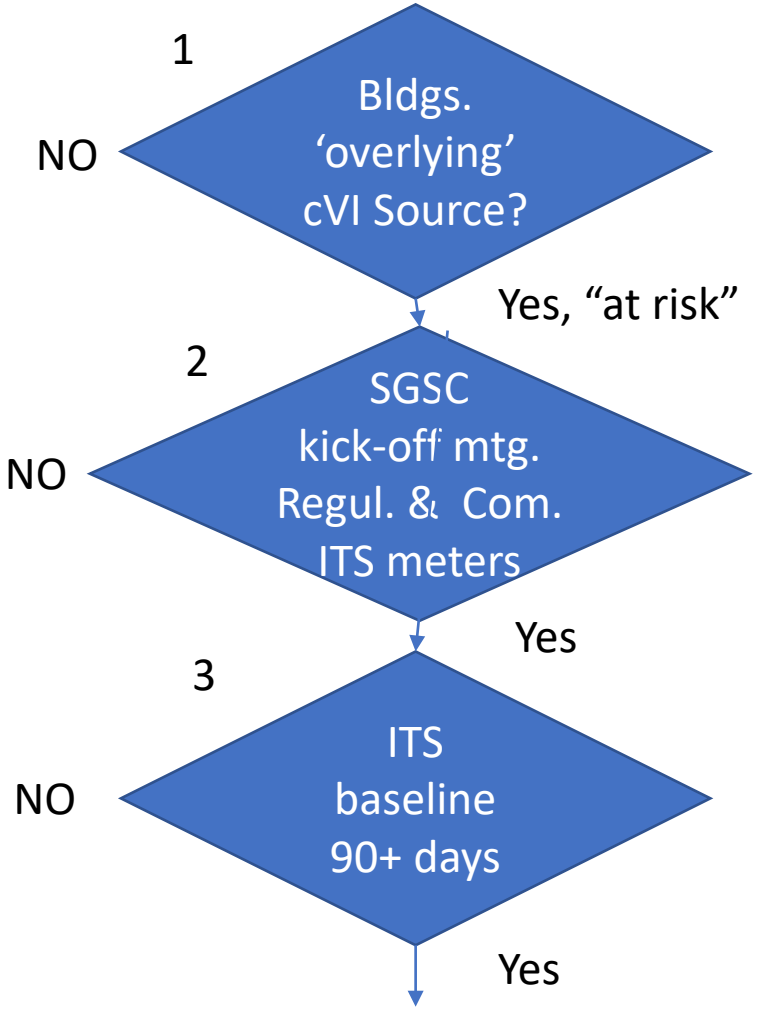
- ***Perhaps***: e.g., look at how the very successful $GW_{ing}$ cleanup program was run:
  - While $Groundwater_{ingestion}$ risks were much simpler – they still used ***observable probabilities*** and ***awareness*** as public health tools, e.g.,:
  - While $GW_{ing}$ ***risks*** were addressed in the 'Human Exposure' EI* a **2nd** EI was needed:
- **Groundwater** (*Media*)
  - **'Migration of Contaminated Groundwater Under Control'** (Dissolved & NAPL)**
    - **Extent** & **movement** of haz. **contamination** in ground-**water media** (for **potential** exposure)
    - To ***track changes in the quality of the environment*** [**G**overnment **P**erformance & **R**esults **A**ct]
      - Where awareness, exposure controls &/or remediation may be needed/appropriate
  - ***If*** **we had an EI for Vapor**, e.g., ***Migration of Contaminated Near-surface Soil Gas Under Control*** **…**
    - I think there would be (far) **less cVI exposures today**, i.e., **Power of a Clear Message** … SGSC ?

*RCRA's EI guide/documentation forms were created for all ~2500 High-priority facilities in 1999, & is being *tracked* **today**

***(**Not** Vapor)*

# SGSC Phase 1 – Who is “at risk”

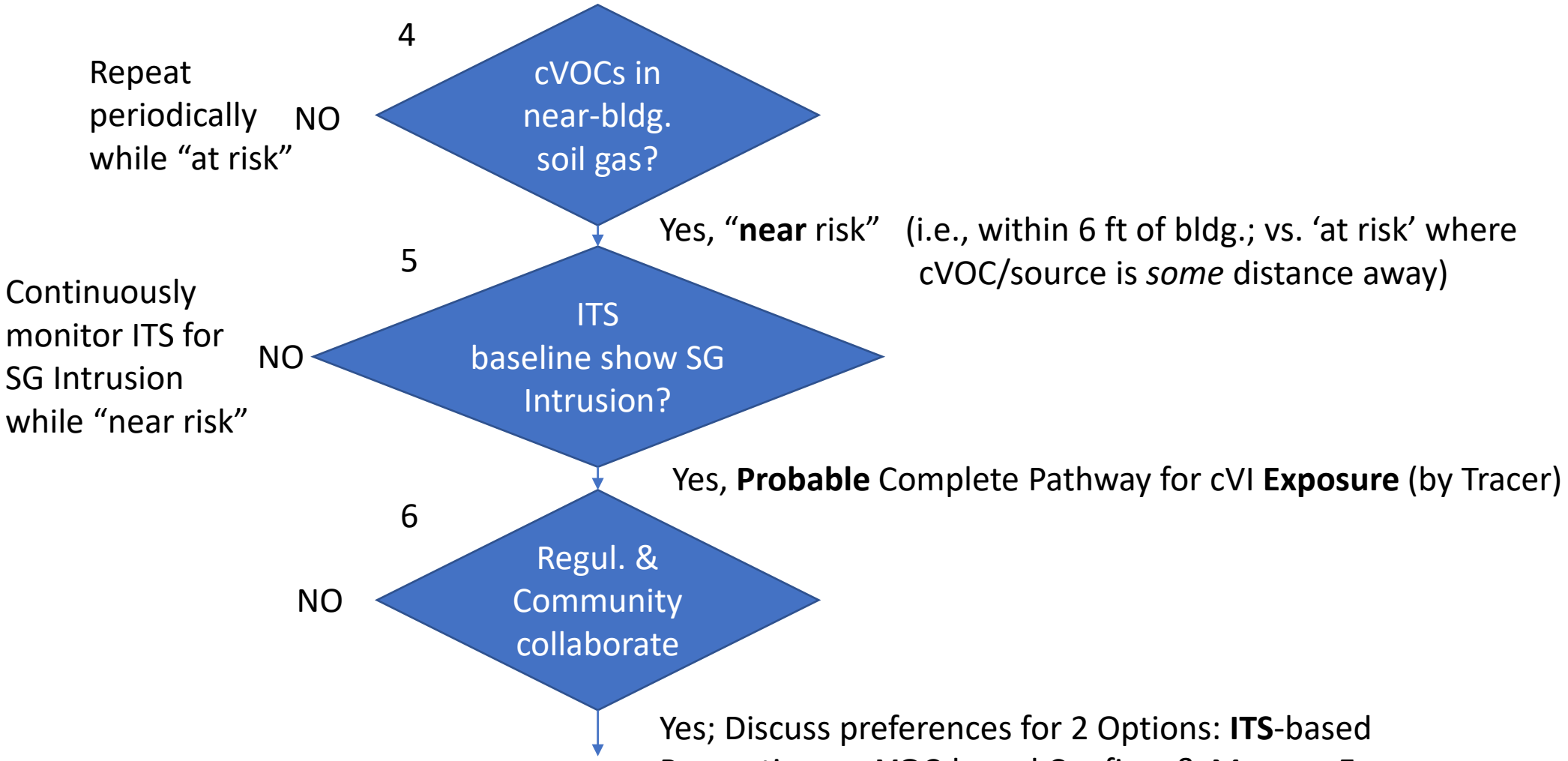
*If* was in past;
should go through
~1x  Step 4
(in next slide).



# SGSC Phase 1 – Who is “at risk”

- 1) RP – **Characterizes** nature & **extent** of cVOCs **source area** for VI & Presents Community w/ Map of bldgs. ‘at risk’ of VI now (& in past)
- 2) RP&R – Seek participation by all bldgs. ‘at risk’ – for possible ***Soil Gas Safe Community***-wide designation; & **provides** them **ITS** meters
- 3) C – Participating bldg. occupants using meters to **measure ITS** metrics continuously for **90+ days** (& use *90-day rolling* dataset in future?)

# SGSC Phase 2 – Probability of Exposures

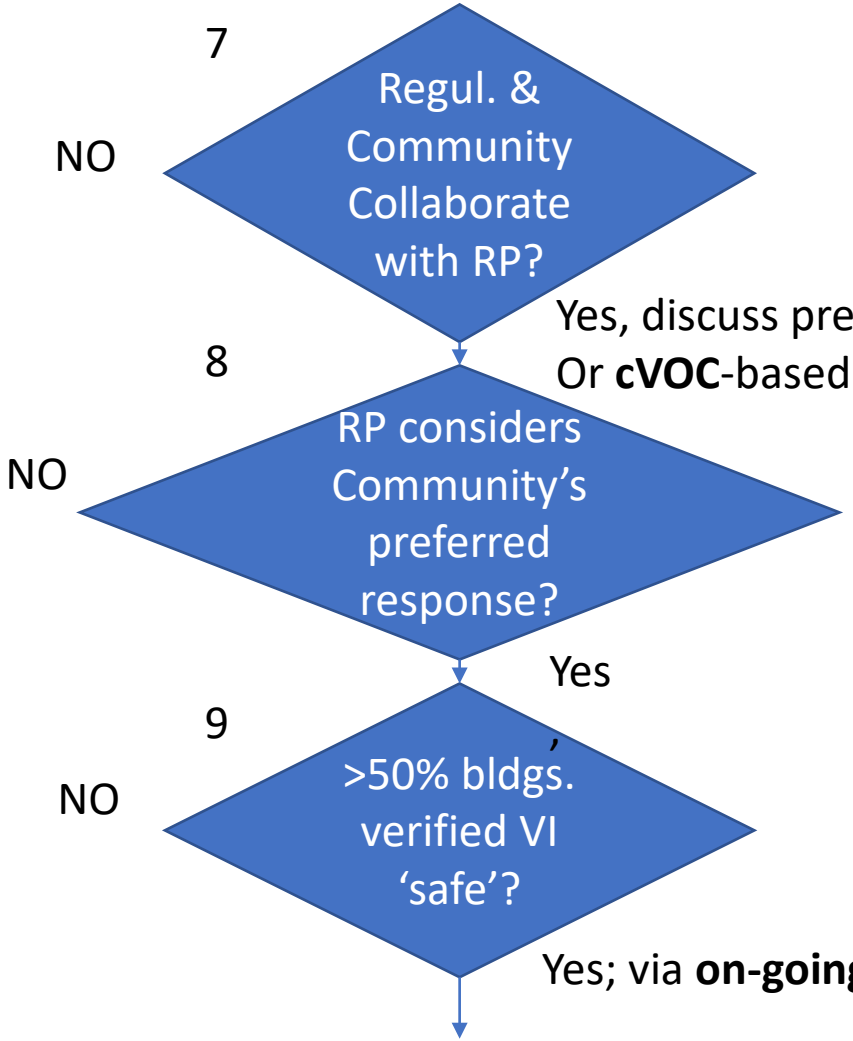


# SGSC Phase 2 – Probability of Exposures

- 4) RP – Sample for cVOCS in *near-bldg.* **soil gas**/conduit vapor (e.g., 30-day passive) (samples/side w/n 6 ft of bldg.)* to identify those "near risk"
  - Presents Detection map results to Community (& pot. Conc. data/map to individuals)**
- 5) C/R – Citizen-Community Scientists (w/ regulators help) interpret ITS levels for '**~complete**' VI pathway for exposure in their bldgs., &
- 6) Collaborate on **their** preferred* response (to probable VI exposure)
- 7) R – Collaborate between RP & Community (w/data) on deciding the most appropriate Response for each Bldg. (w/ ~Complete VI pathway), & possible Community-wide action(s))

*USEPA Air/Superfund guidance 1992 **for Privacy

# **Decisions:** ITS-based **Preventing** Exposure, Or **cVOC**-based **Confirm-&-Manage** Exposure




Yes, discuss preferences for two Options: **ITS**-based **Preventive**, Or **cVOC**-based **Confirm-&-Manage** Exposure

Yes; via **on-going** measurements (ITS **or** cVOC) **w/ or w/o controls**

# SGSC Phase 3 – Decisions to Prevent Exposures, Or Confirm-&-Manage Exposures

8) RP: Considers near-bldg. soil gas, ITS data & **occupant/community preferences**, costs & liabilities in making Response decisions to conduct either: **ITS**-based Preventive or **cVOC**-based Confirming Track):

**If Complete-by tracer (probable cVI exposure)**

**Preventive/Proactive ITS Track**

- a) Pre-confirmatory/ Proactive Vapor Controls/ Mitigation to reduce/prevent soil/conduit gas intrusion &
- b) Long-term verification of controls effectiveness by on-going I&T level monitoring; ***Unless***, cVOC source conc. *near bldg*. >100x applicable soil gas Screening Criteria; then cVOC samples for LTS as long as "at risk"

**Confirm cVI Exposure & Manage Track**

- a) On-going indoor cVOC sampling (I&T guided ) to Confirm no unacceptable exposure; under 'natural' conditions* or
- b) If Unacceptable conc. Confirmed – Mandatory vapor Controls/ Mitigation w/ On-going cVOC sampling (guided by I&T) to verify long term effectiveness (LTS)*

*for as long as "at risk", i.e., while the cVI source remains

# Summary of “No” Exits/Off-Ramps

1) No-Even if no longer considered to be “at risk” from ‘deep’ source consider seeking ~**1x** *near-bldg*. soil gas sampling to verify no possibly residual near-bldg. ‘sources’

4) No-If **only** “at risk’ – cVOCs not yet detected in surrounding near-bldg soil gas

- Periodically re-verify no cVOCs in **near-bldg soil gas** as LTS while “at risk”
  - BTW If many ~= *Migration of cVOC Contaminated Near-Surface Soil Gas Under Control*
- Continue to monitor ITS for levels for ‘baseline’ understanding of bldgs.’ intrusion behavior

5) No-If “at risk” & nearby **soil gas** contains cVOCs, but ITS shows no intrusion

- Continuously monitor ITS **for** levels exceeding those indicating/assoc. w/ **Intrusion**
  - Pay particular attention after bldg. operational or structural changes & weather events

# Thank You (again)