



# **Spring 2020 EPA Vapor Intrusion Workshop**

## **Why (When, Where, and How) You Should Monitor Indoor Radon, Differential Temperature & Pressure During Chlorinated Vapor Intrusion Assessments**

### **Introduction and Overview**

**Robert Truesdale, RTI International**

**Geosyntec**  
consultants

engineers | scientists | innovators

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# Monitoring Indicators, Tracers, and Surrogates (ITS) for Chlorinated Vapor Intrusion (CVI) Assessment and Mitigation - Overview

## Fourth EPA workshop on ITS for VI

- Brings in temperature, pressure, and radon data for “new” sites
- New data analyses = new ideas and insights on using ITS measurements as “lines of evidence” for VI

## With new and old ITS data we look at:

- Temporal variability (e.g., seasonality) at several sites
- Spatial variability (e.g., assessing large plumes – or – large buildings)
- Preferential pathways (e.g., new research in Region 9)

# Monitoring Indicators, Tracers, and Surrogates (ITS) for Chlorinated Vapor Intrusion (CVI) Assessment and Mitigation – Workshop Objectives

*We are seeking your experience-based input on the value of specific methodologies for using ITS values in VI assessments.*

Four topic areas (for discussion at end of workshop):

1. Does the evidence support a recommendation to measure ITS during VI investigations?
2. Can ITS be applied for initial site screening, for example, to select buildings or building areas for assessment?
3. Can ITS be used to address the temporal variability of VI?
4. Does the evidence support development of peer-reviewed standard methodologies for ITS measurements and use (e.g., SW 846)?

# Definition Review: Indicator

***Metrics that can indicate elevated potential for chlorinated volatile organic compound (CVOC) exposures.***

Think:

- An indicator in chemistry is a substance whose color varies with acidity or alkalinity.
- An indicator in biology is a species an animal or plant species that can be used to infer conditions of a particular habitat. For example amphibians are sensitive to environmental stress.

***For VI temperature, differential pressure, radon presence can be indicators.***



# Definition Review: Tracer

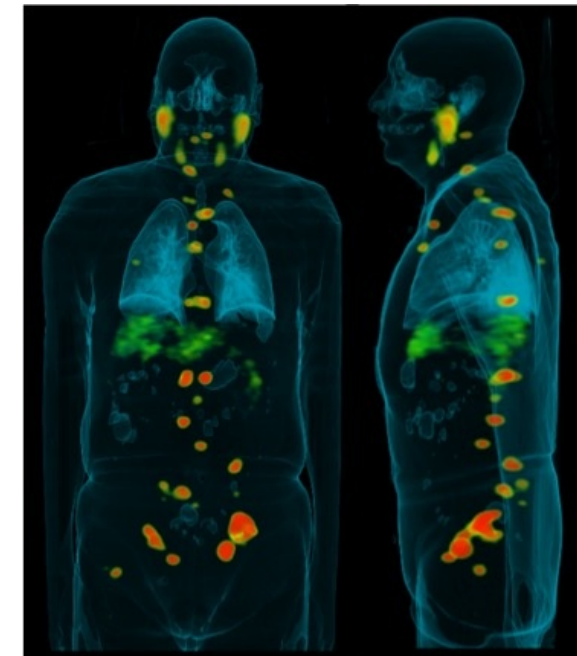
***Easily observable substances that move physically along with the target compounds of interest for VI***



Think:

- In hydrogeology and medicine an identifiable substance, such as a dye or radioactive isotope, that can be followed through the course of a mechanical, chemical, or biological process.

***For VI radon can be a tracer of processes across the slab and into the building.***



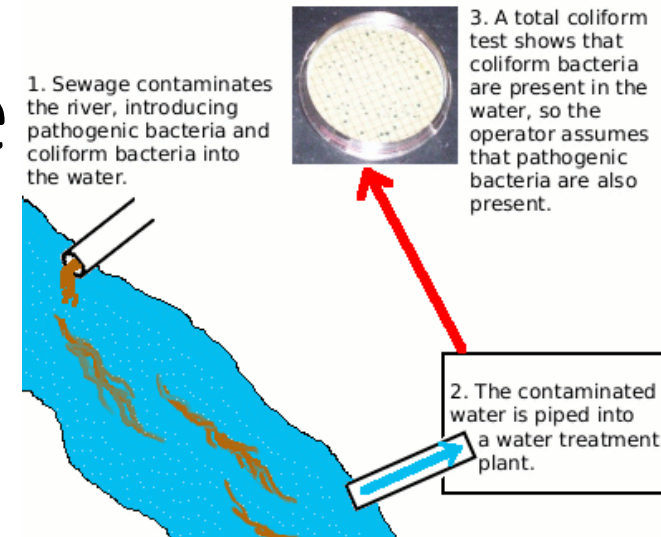
# Definition Review: Surrogate

***Metrics with a quantitative relationship to the target compound for VI, sufficiently accurate to be a substitute.***

“In . . . microbiology and health risk assessment, we have defined surrogates as organisms, particles, or substances *[that]* . . . allow quantification of the degree of exposure” (Sinclair, 2012)

***For VI radon can be used a surrogate for quantifying the percentage of soil gas in indoor air.***

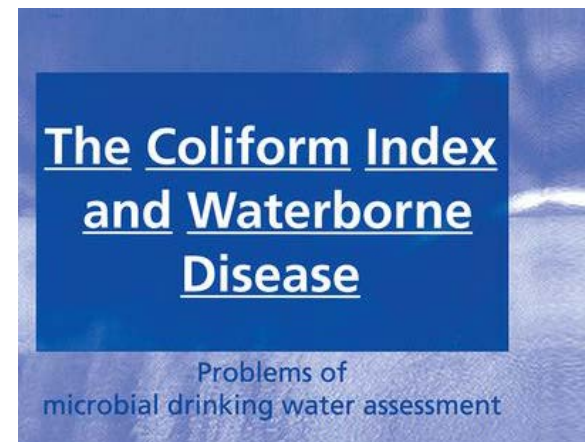
Sinclair, Ryan G., Joan B. Rose, Syed A. Hashsham, Charles P. Gerba, and Charles N. Haas. "Criteria for selection of surrogates used to study the fate and control of pathogens in the environment." *Applied and environmental microbiology* 78, no. 6 (2012): 1969-1977.



Images from:

<https://water.me.vccs.edu/course/s/ENV295Micro/lesson9b.htm>

<https://images.tandf.co.uk/common/jackets/amazon/978041921/9780419218708.jpg>





# New EPA Fact Sheets on Measuring ITS

- EPA Fact Sheets for measuring ITS (2-4 pages, introduced in 2019 Fall Workshop):
  - *Monitoring radon as a VI tracer or surrogate*
  - *Measuring pressure as a VI indicator*
  - *Measuring temperature as a VI indicator*
- *Fact sheets are being finalized (they are ready for use)*
- *Describe how to measure ITS parameters in the context of a VI investigation*
- *Include example instruments, references for further information*

<https://iavi.rti.org/workshops.html>

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### Monitoring Radon as a Vapor Intrusion (VI) Tracer or Surrogate

**What is Radon and Why Measure it at a Volatile Organic Compound (VOC) Contaminated Site?**

- Radon is colorless, odorless, naturally occurring gas that is a common component of soil gas.
- Radon has few indoor sources, and thus is a relatively unique tracer of soil gas intrusion into buildings, following the same pathway to indoor air as soil gas and with very similar mechanisms as VOCs in soil gas.
- Radon exposure poses very substantial carcinogenic hazards in and of itself, so reducing radon is a valuable side benefit of mitigating the VI pathway (for more information, see <https://www.epa.gov/radon/health-effects-radon>).
- Radon is measured in picocuries per liter (pCi/L) or becquerels per cubic meter (Bq/m<sup>3</sup>); 1 pCi/L is equal to 37 Bq/m<sup>3</sup>.
- EPA recommends mitigation of residences with radon levels greater than 4 pCi/L and considers radon levels between 2 and 4 pCi/L.

**Where to Measure Radon?**

- Radon can be monitored with these methods in crawlspace, ambient, entry pathway, and indoor air.
- Select indoor locations to represent the zones in which exposure likely occurs, such as treated occupied basements and first floors.
- Ambient radon in outdoor air can be an important comparison because outdoor radon can vary significantly from indoor radon levels. Estimates of ambient air radon in the United States averages 0.4 to 0.7 pCi/L with concentrations ranging from less than 0.01 to 1.5 pCi/L. Radon in ambient air is higher at night over land than over oceans. Radon seasonality in outdoor air depends on wind direction and speed.
- Monitoring of crawlspaces and air in preferential pathways (for example wall cavities) can provide information on soil gas entry. Radon surveys can be used to identify entry points such as cracks in the foundation.
- Radon is likely to be detectable in soil gas almost everywhere in the United States, but concentrations are not always high enough to be clearly observable after attenuation into indoor air are most likely in medium to high risk radon zones (Zones 1 and 2 in <https://www.epa.gov/sites/production/files/2015-07/documents/zonemap.pdf>).
- Very roughly, high risk radon zones are likely to have soil gas radon greater than 1,350 pCi/L, medium risk radon zones range from 270 to 1,350 pCi/L (Lewis and Houle, 2009).

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### Measuring Pressure (Differential and Barometric) as a Vapor Intrusion (VI) Indicator

**What Pressures?**

- Differential pressure ( $\Delta P$ )—Difference in pressure between two points in space (indoor/outdoor or indoor/subslab).
- Change in barometric pressure ( $\Delta BP$ )—Pressure in the atmosphere (indoor and outdoor), change in BP over time is most important (Figure 1).
- Normal changes in BP can be quite large and create pressure differentials across the building envelope if all else is equal (Figure 2). A regular diurnal variation of up to 300 pascals (Pa) is common and weather fronts can cause BP to change by 1,000 Pa over several days.
- Falling BP leads to vapors flowing out of the ground as pressures seek to equalize, but with a time delay.
- Wind loads and stack effects are also important causes of BP variations.

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### Measuring Temperature as an Indicator for Vapor Intrusion (VI) Studies

**What Temperatures?**

Measure or estimate indoor temperature ( $T_i$ ), outdoor temperature ( $T_o$ ), and differential temperature ( $\Delta T$ ) using the formula  $\Delta T = T_i - T_o$ . For example, if inside = 75°F, outside = 30°F, then  $\Delta T = 45^\circ\text{F}$ .

**Where to Measure Indoor Temperature?**

In the main living space—definitely. Ideally also in the basement/crawlspace and attic.

**Where to Measure Outdoor Temperature?**

At a location near the house sheltered from direct sun or use your local weather station.

**When to Measure Temperature?**


At least hourly is a good start—temperature has a diurnal and seasonal cycle. It typically does not change more than a few degrees per hour.

- In comparison studies temperature should be measured at least as frequently as your volatile organic compound (VOC) or radon data are. So, for studies using 24-hour Summa canisters, the average temperature for the day is the bare minimum.

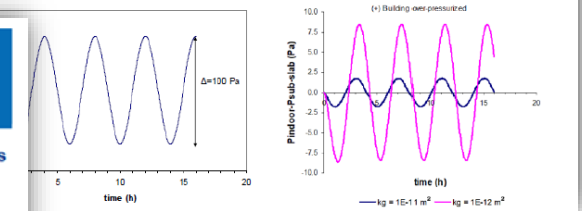
**With What?**

- Inexpensive digital temperature loggers are widely available and cost less than \$100 per location (e.g., <https://www.microlog.com> and [www.onsetcomp.com](http://www.onsetcomp.com)). Some pressure instruments give temperature as well.

**Power interruptions and daylight savings time.** When selecting temperature-monitoring equipment for long-term projects, determine ahead of time how those devices will react to power outages and time changes due to daylight savings time. These events can affect the accuracy of dateline stamps, especially when comparing data streams coming from multiple independent devices.



- Historical outside temperature data for thousands of locations are cataloged either for specific period or normal values (<https://www.ncdc.noaa.gov/cdo-web/>, <https://www.wunderground.com/history/>, <https://www.ncdc.noaa.gov/cdo-web/stattools/select-location>).



# Workshop Website

For Abstract, Agenda, Bios, Acronym List, and ITS Fact Sheets:

<https://iavi.rti.org/workshops.html>

-or-

[iavi.rti.org](https://iavi.rti.org), click on “Workshops and Conferences”

(presentations to be available there by end of March)



# Monitoring Indicators, Tracers, and Surrogates (ITS) for Vapor Intrusion (VI) Assessment and Mitigation – *Today's Speakers:*

- U.S. Environmental Protection Agency
  - Henry Schuver, Office of Resource Conservation and Recovery (ORCR)
  - Brian Schumacher, Office of Research and Development (ORD)
  - Bhooma Sundar, Region 5
  - Alana Lee, Region 9
- Jacobs
  - Chris Lutes, Loren Lund, Keri Hallberg
- Geosyntec
  - Chase Holton
- Groundswell
  - Mark Kram
- RTI International
  - A.J. Kondash, Robert Truesdale

(See full bios at: <https://iavi.rti.org/workshops.html>.)



# Spring 2020 EPA Vapor Intrusion Workshop

Why (When, Where, and How) You Should Monitor  
Indoor Radon, Differential Temperature & Pressure  
During Chlorinated Vapor Intrusion Assessments

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EPA Vapor Intrusion Workshop, March 17, 2020; – <https://iavi.rti.org/workshops.html>