

ORD VI-Research Duplex and Wheeler Building, Indianapolis- Summary of Evidence to Date: Temporal Variability in Long-term Mitigation Performance and Before Mitigation: What Causes It?



Presented at EPA 2015 workshop on Long-Term Evidence-Based Protection & Sustainability; in Residential, Commercial and Industrial Buildings

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Duplex Synopsis

Indoor and Ambient Air, Passive Samples

- Locations: ambient; basement & first floor each side
- 131 rounds of VOC sampling: (Jan 2011-Dec 2014): 1-4 week intervals VOCs by Radiellos

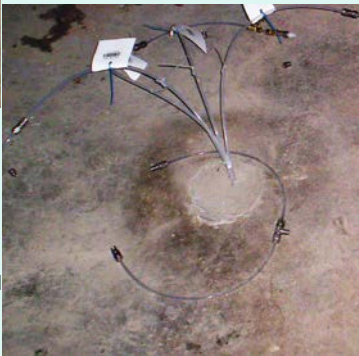
Groundwater

- Multidepth, short screen wells on two sides of duplex
- Single depth well completed through basement



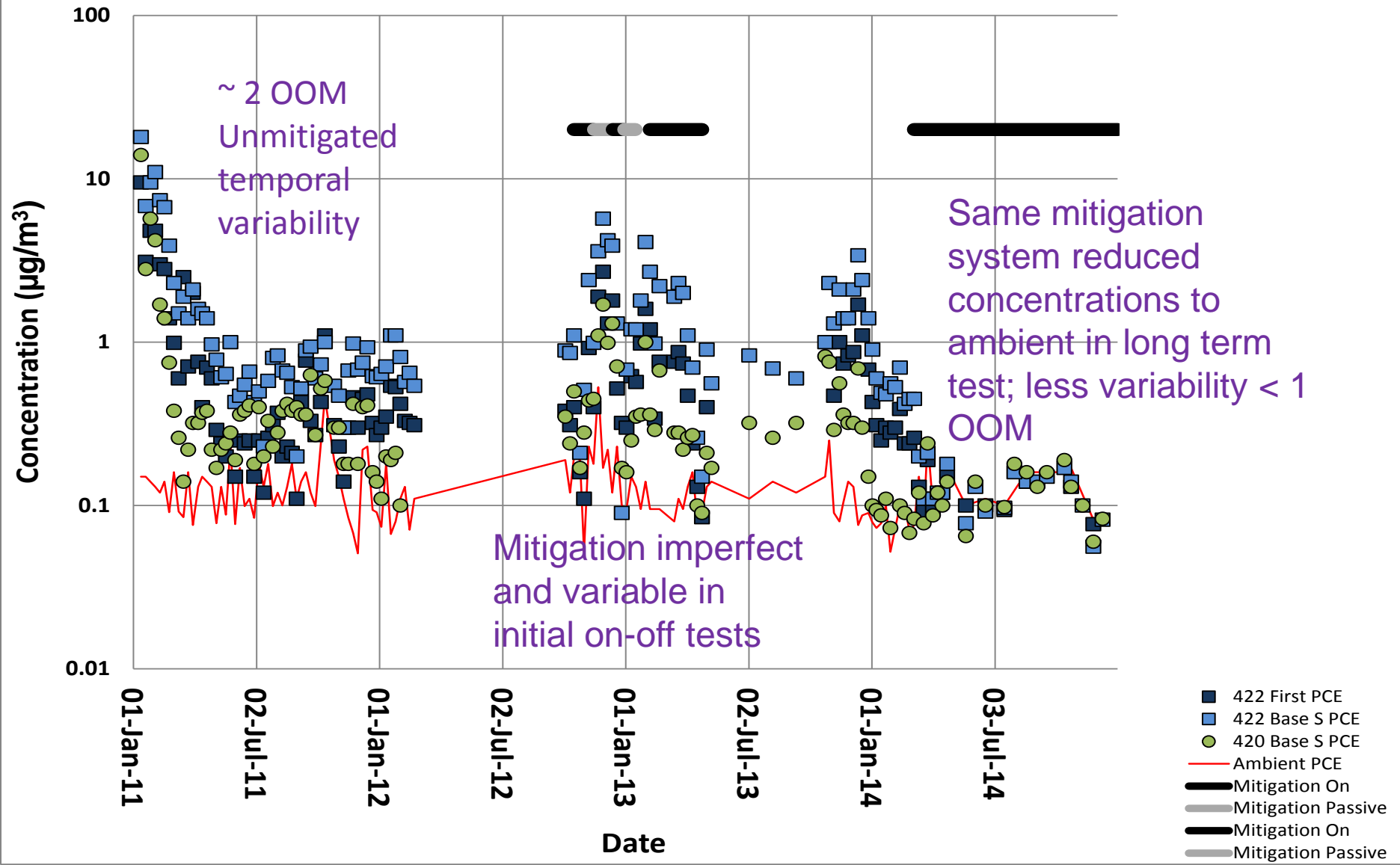
Subslab and Soil Gas, Active Samples

- Five internal soil gas locations, 4 depths each (6, 9, 13, 16.5 ft).
- Five conventional sub-slab locations.
- Four basement wall ports.
- As many as 110 different days of subslab sampling



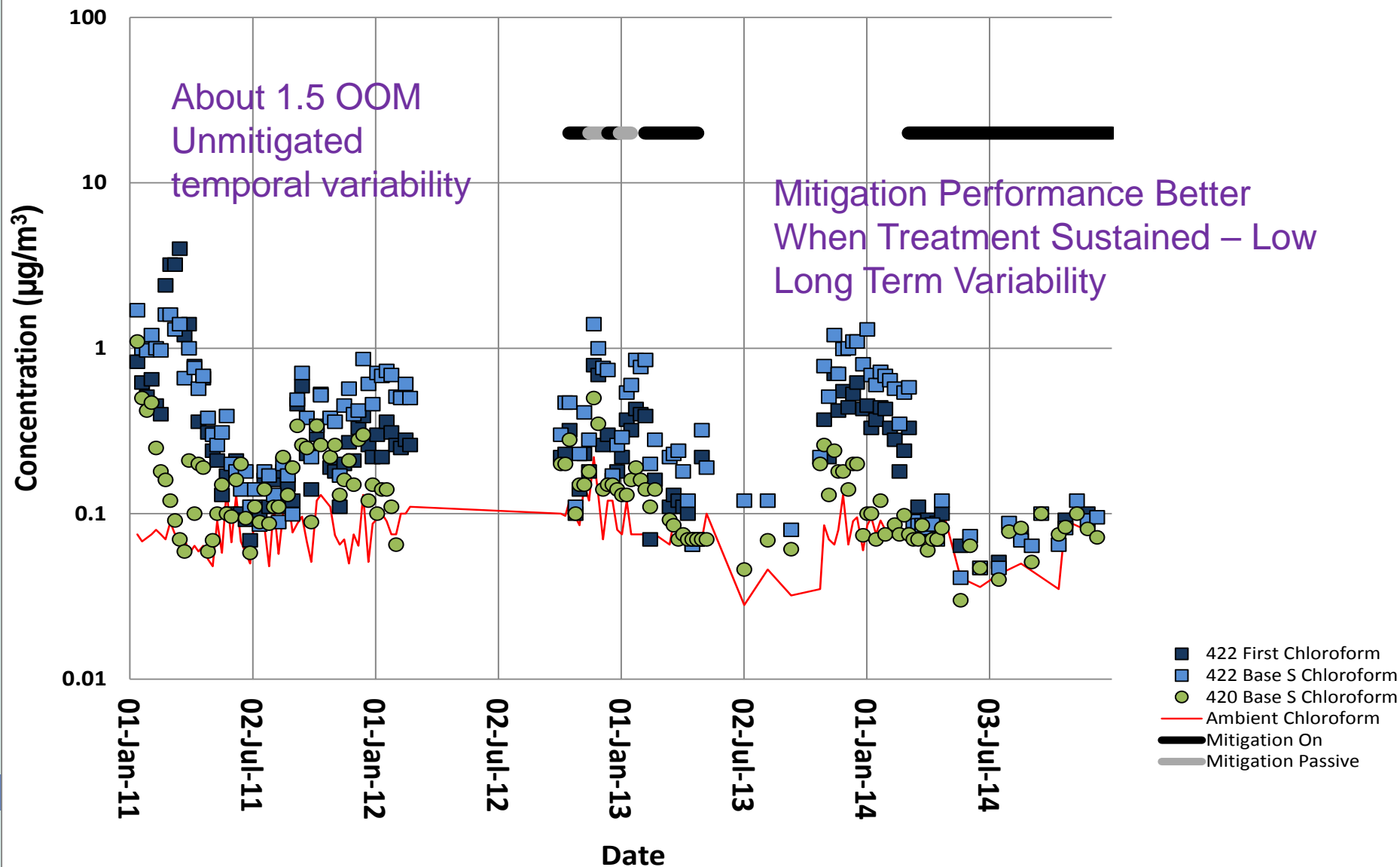
Mitigation Performance and Temporal Variability: PCE

Indoor Air PCE (Passive Sampler Data)

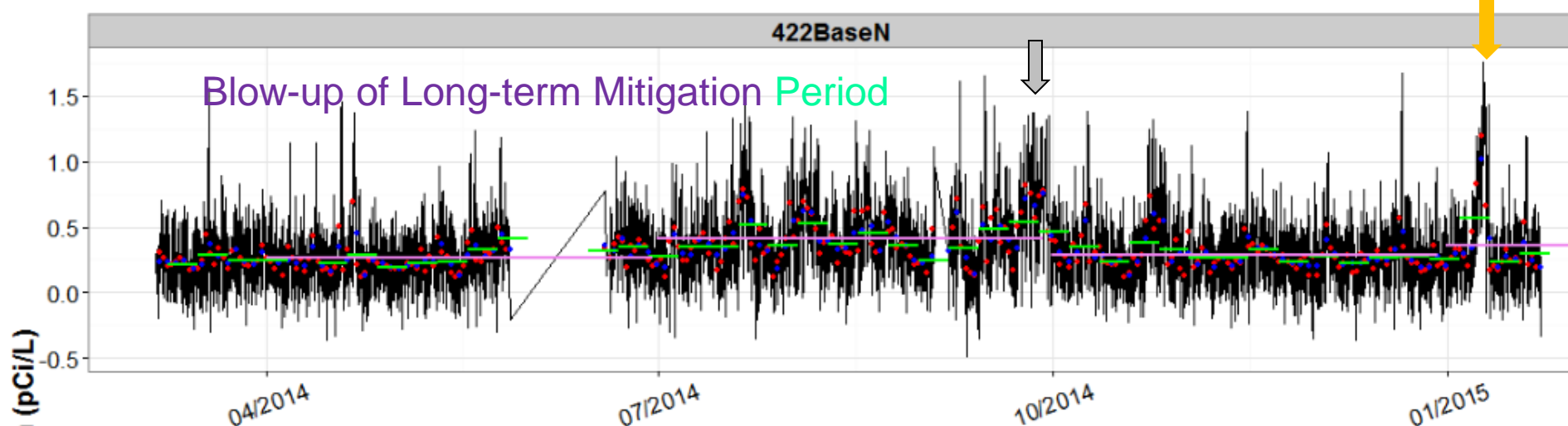
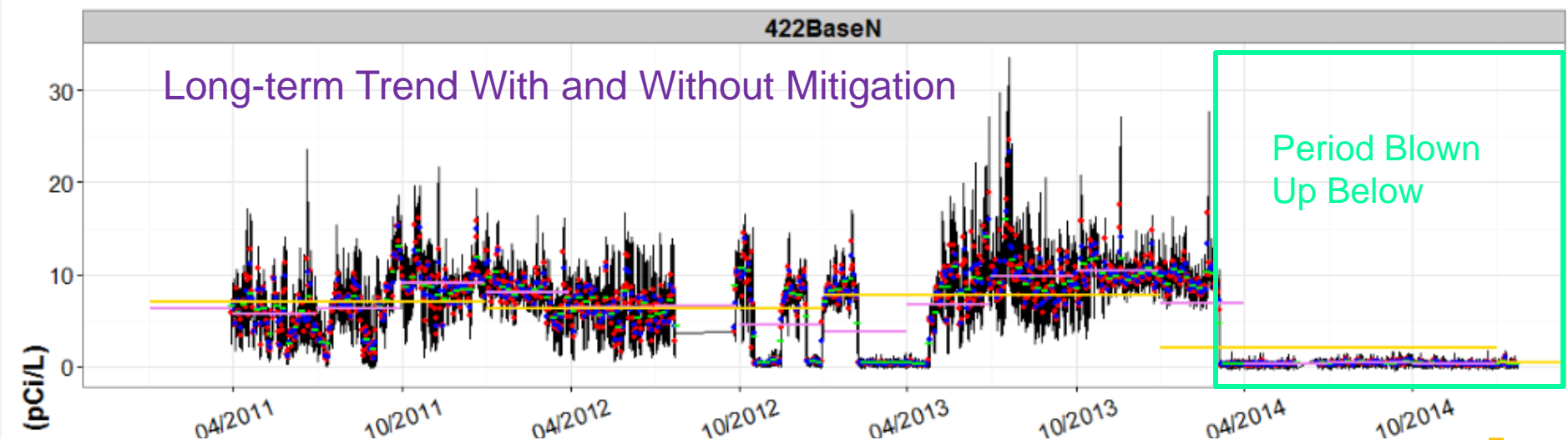


Mitigation Performance and Temporal Variability - Chloroform

Indoor Air Chloroform (Passive Sampler Data)



Temporal Variability With and Without Mitigation – High Resolution Data with Multiple Averaging Times



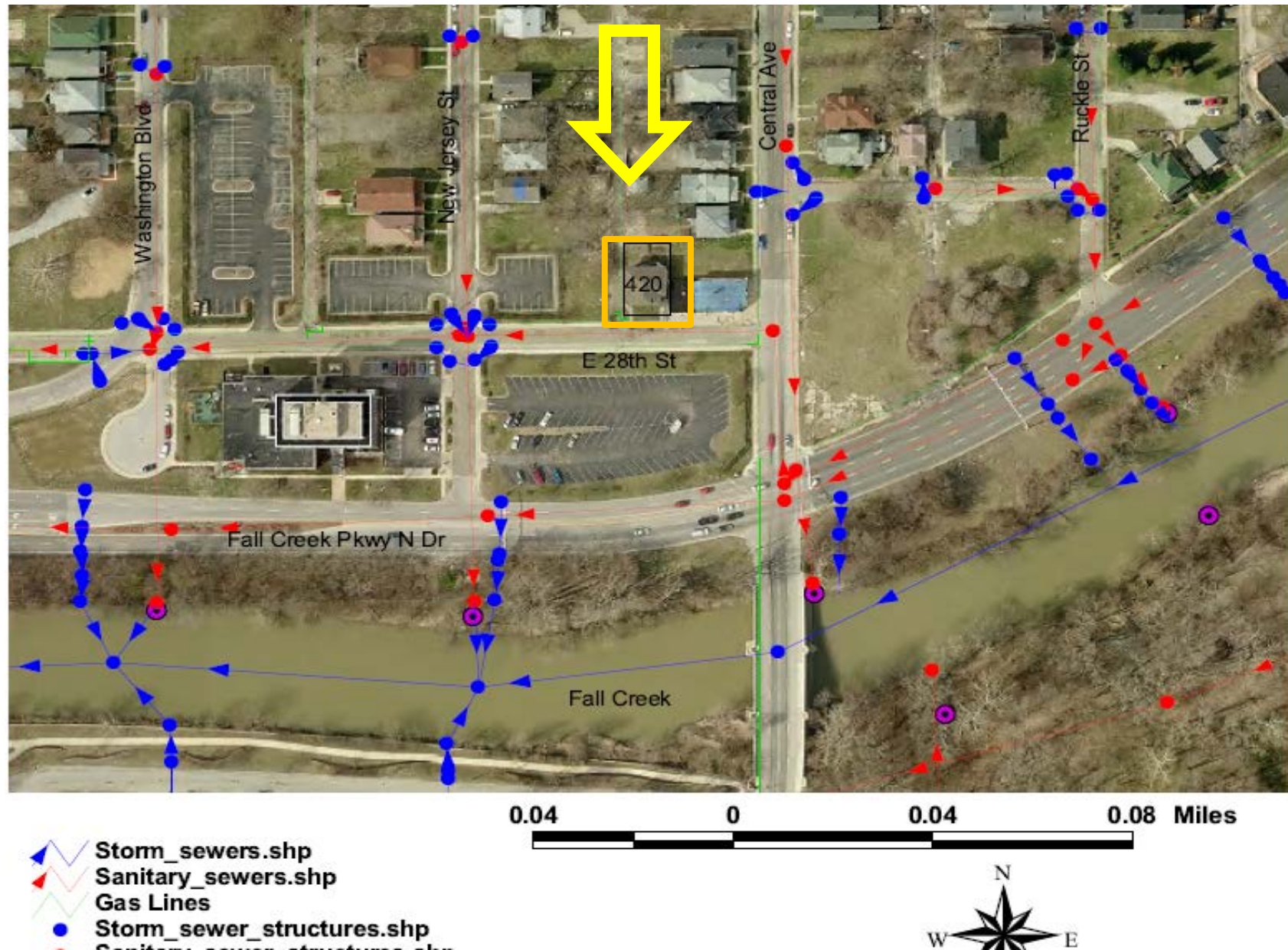
Hourly One Day Two Day Weekly Quarterly Yearly

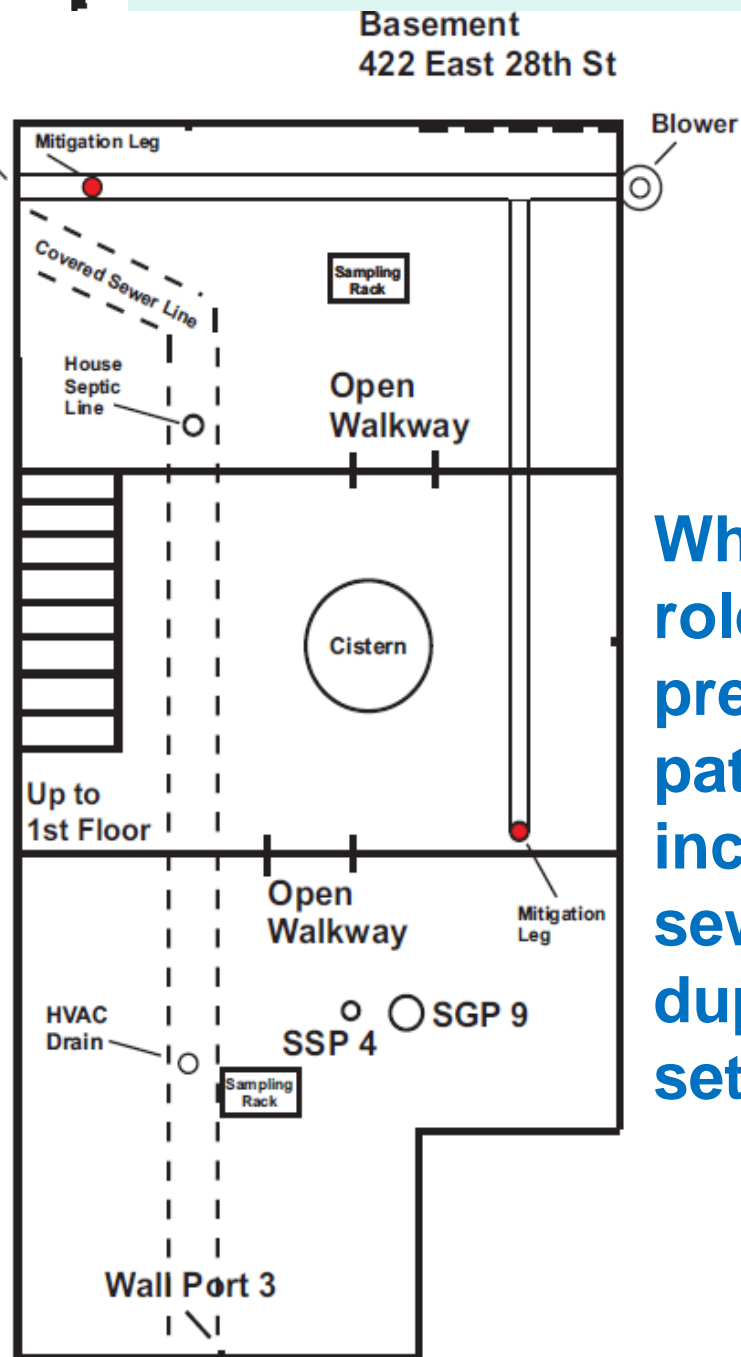
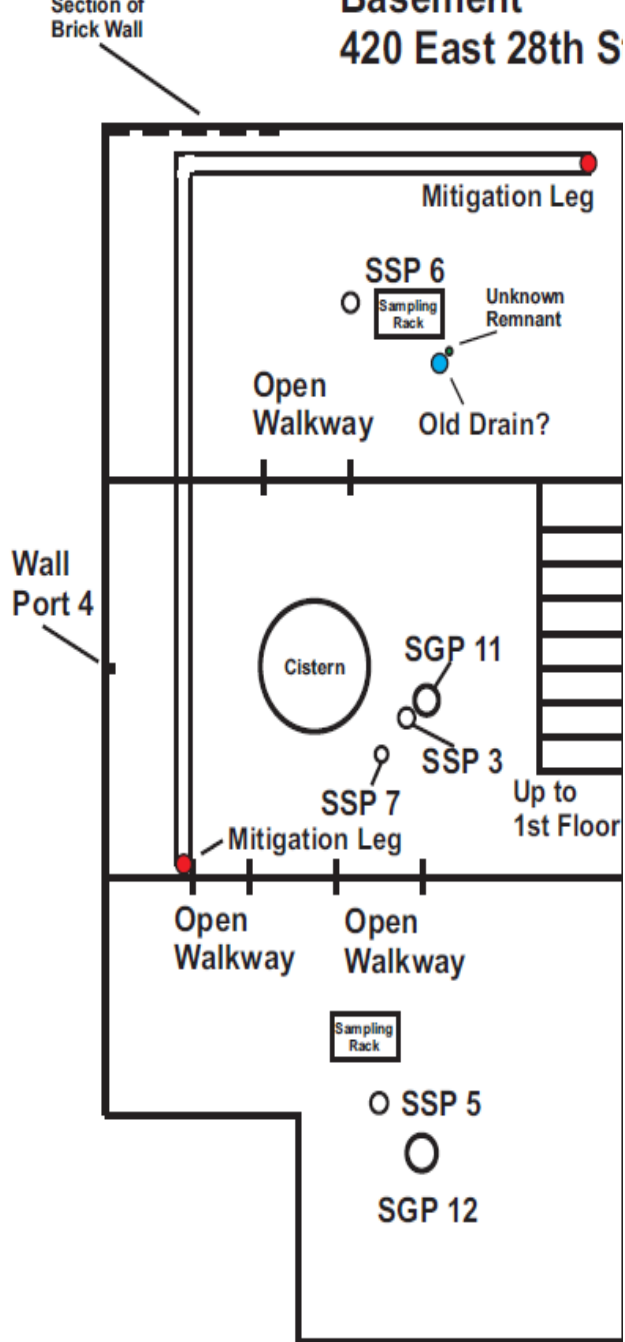
1/7-1/10/15 saw 4 day Radon peak; with daily lows as low as -7 F and wind speeds averaging 18 MPH and Max 32 MPH

Frequently Asked Questions about Duplex Study

- What is the role of preferential pathways, including sewer lines, in this data set?
- Are the features of this duplex and other well studied cases “typical” of the US housing inventory?
- Is the VOC mass observed entering the duplex primarily from groundwater or vadose zone sources?
- Why do chloroform and PCE differ at this site, in terms of sources and VI behavior?
- What is the spatial and temporal variability of the observed attenuation factors?

What is the role of preferential pathways, including sewer lines, in duplex data set?





1'

What is the role of preferential pathways, including sewer lines, in duplex data set?



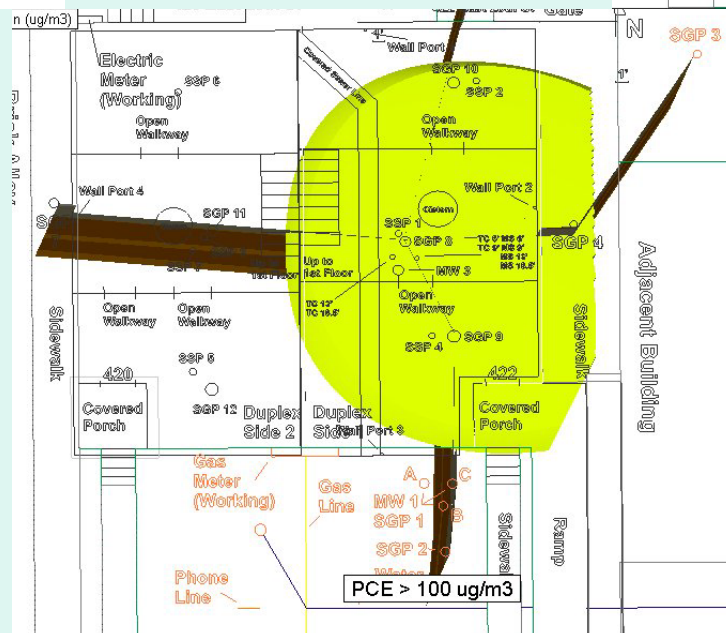
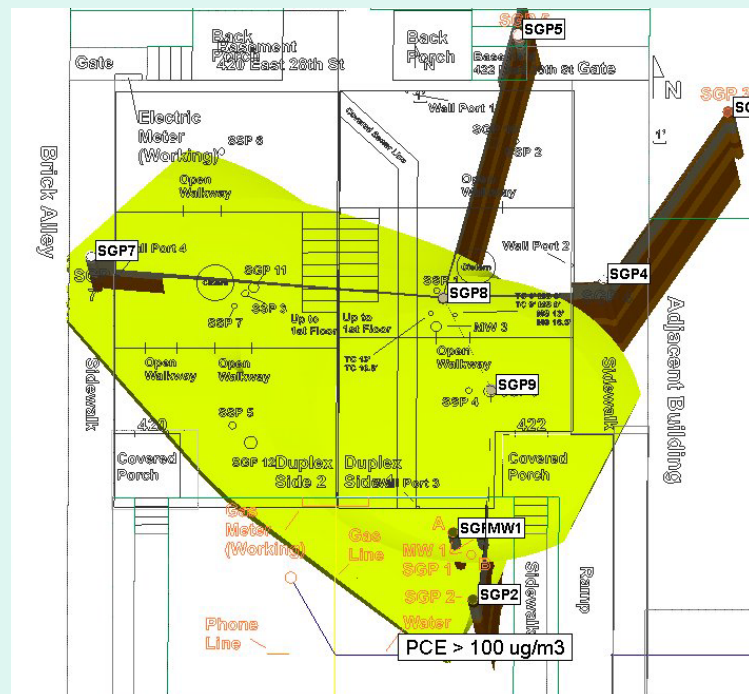
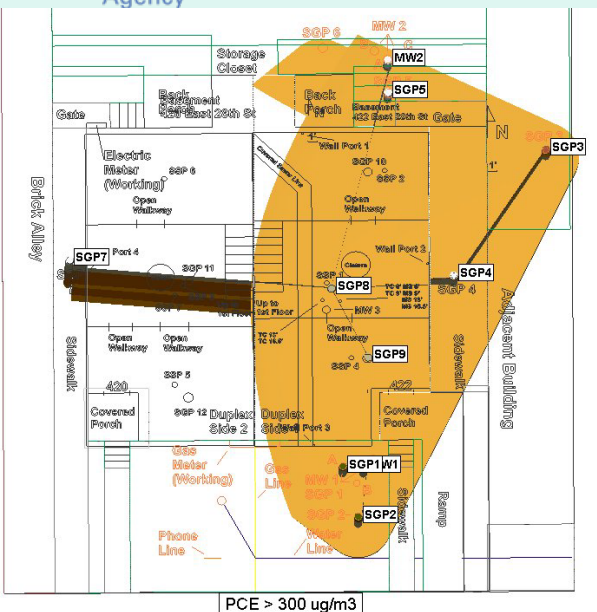
United States
Environmental Protection
Agency

PCE Soil Gas Spatial Distributions

January
2011

August
2011

December
2011



What is the role of preferential pathways, including sewer lines, in duplex data set?

- **Sewer lines and laterals appeared to play some role in contaminant fate and transport in this system.**
- **Sewer lateral running beneath the basement floor was buried and cemented over sometime after the floor's original construction. PVC drain lines join this lateral from the plumbing on both sides of the duplex. The HVAC unit drains condensation into a floor grill leading to the lateral. A nonfunctional water line enters the house from the south.**
- **Elevated concentrations of PCE and chloroform were present in the headspace of sewer gas but primarily in one leg.**
- **Their role as a direct entry pathway were minimized through sealing drains.**

What is the role of preferential pathways, including sewer lines, in duplex data set?

- Helium tracer suggest easy horizontal migration toward the building over distances of up to 20 ft and rapid vertical migration from 13 ft to 6 ft bls at the injection cluster; typically within 2 days, with and without mitigation.
- Ground penetrating radar (GPR) results suggest that the concrete slab varies from 0.5 to 0.7 ft in thickness with an irregular undulating contact with the underlying fill material and resulting gaps where soil gas may pool or move preferentially. This suggests the concrete was not pored on flattened fill material.

What is the role of preferential pathways, including sewer lines, in duplex data set? – Results before drain sealing

Passive Drain Sampling Data April 13–April 21, 2011 ($\mu\text{g}/\text{m}^3$)

Location	Chloroform	TCE	PCE
422 laundry drain – 1st floor	320	5.6	310
422 bathroom—in sink	1.2	0.089	1.4
422 basement floor drain (near furnace)	0.65	0.091	1.7
420 bathroom—in sink	1.5	0.054	0.96
420 laundry room drain in floor	1.6	0.087	2.6

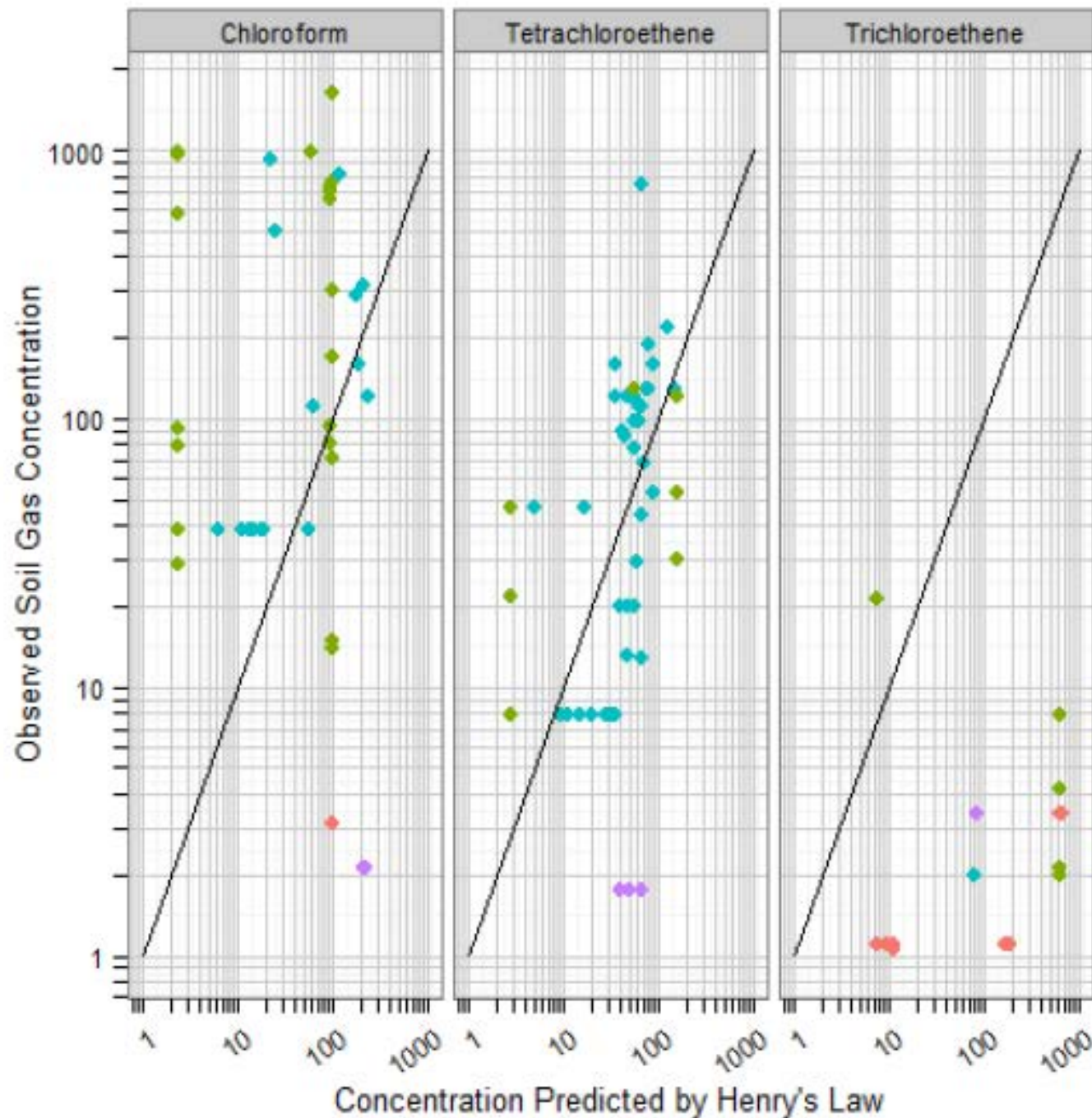
Are the features of this duplex and other well studied cases “typical” of the US housing inventory?

Compare Indianapolis Duplex and Sun-devil Manor to the 2013 American Housing Survey results (% of 128K units):

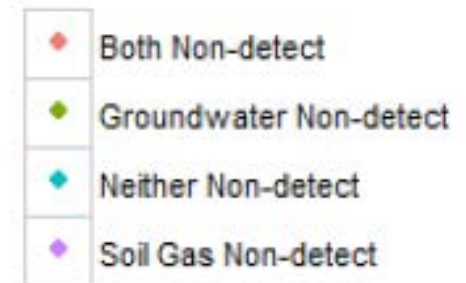
- Location
 - Duplex - Central city (30%)
 - Sun-Devil – In MSA but not central city (50%)
- Public Sewer - both Duplex and Sun Devil – yes (81%)
- Units in structure
 - Duplex- 2 – 4 (8%)
 - Sun-Devil = 1 detached unit (65%)
- Construction date – Median in U.S. is 1975
 - Duplex (Pre 1915) – Pre 1919 is 7% of housing stock
 - Sun Devil (1991) – 1985 to 1995 is 12% of housing stock

Are the features of this duplex and other well studied cases “typical” of the US housing inventory?

- Foundation (survey is % of single family for this variable):
 - Duplex, Basement (full or partial basement = 42%)
 - Sun-Devil – Concrete Slab Split Level (slab = 34%)
 - Crawl space (22%)
- Heating – Both Forced Hot Air – (64%)
- Cooling
 - Duplex – window units (21%)
 - Sun-Devil – central air (65%)
- Physical Problems – 5% of units have moderate to severe problems in one census category
 - Duplex – Moderate upkeep problems
 - Sun Devil – no problems

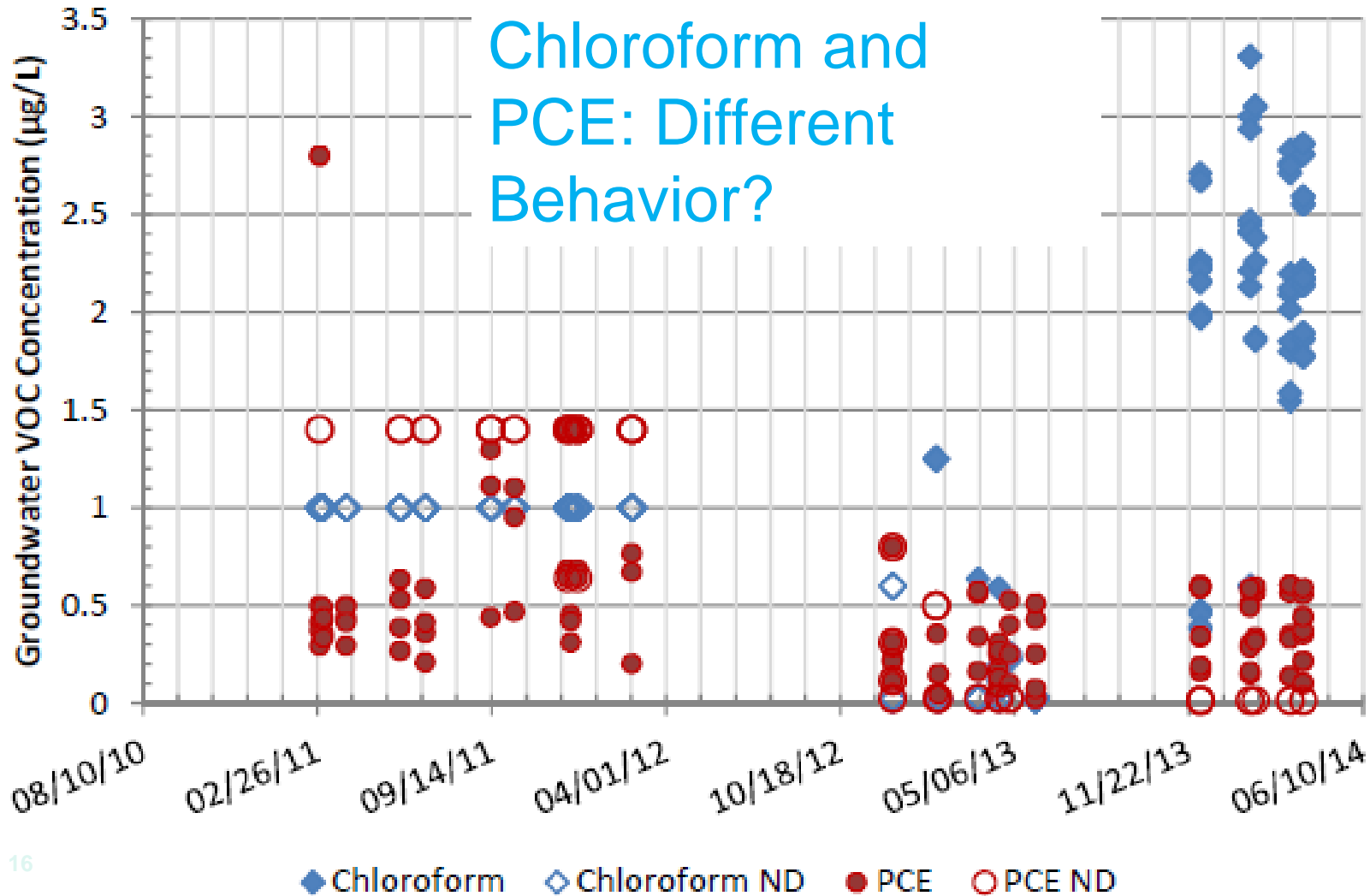


Is the VOC mass entering from groundwater or vadose zone sources?:
Henry's Law Comparison

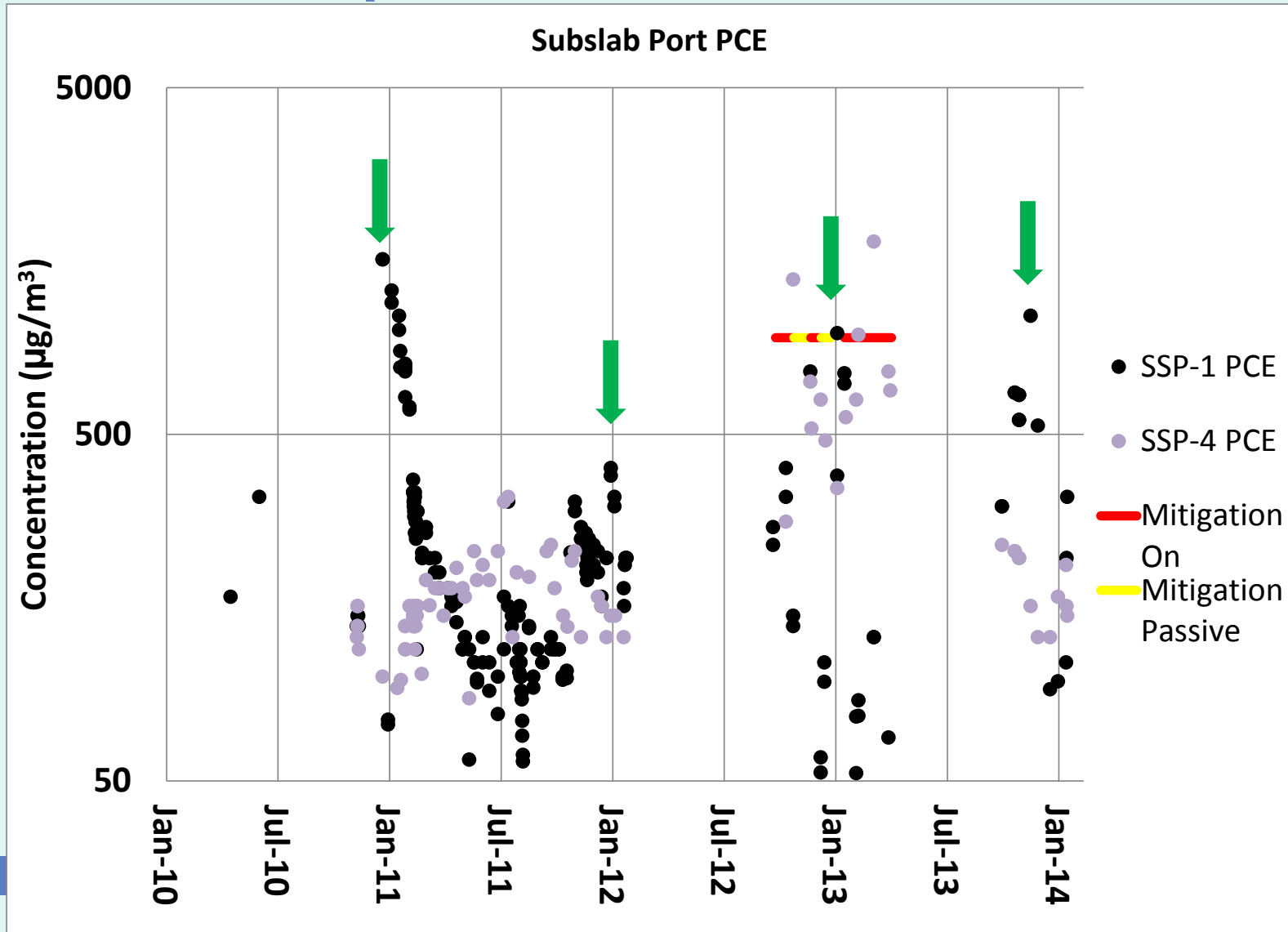


Chloroform and PCE: Different Behavior?

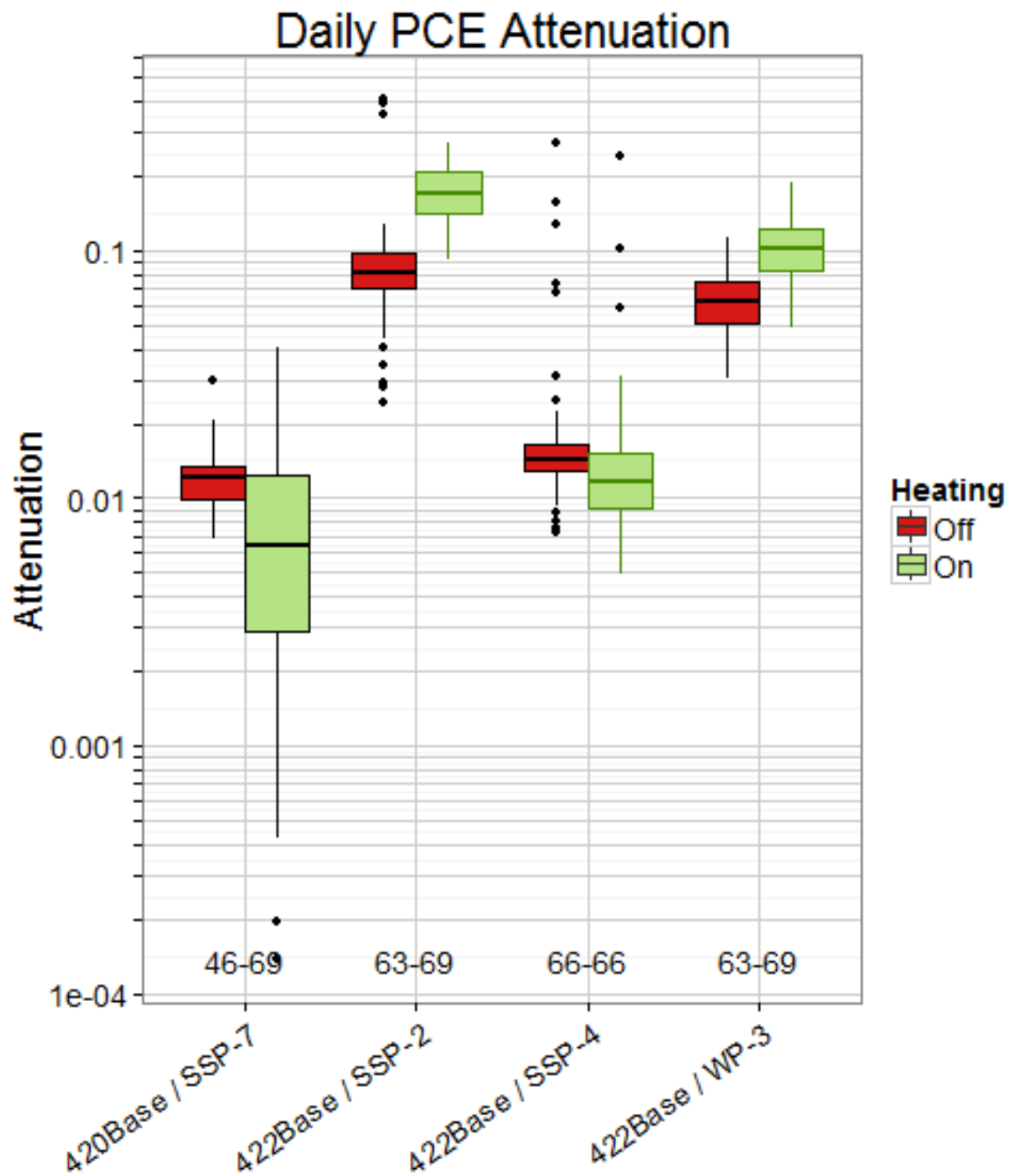
Is the VOC Mass Entering Primarily From Groundwater or Vadose Zone Sources?: Groundwater Time Sequence



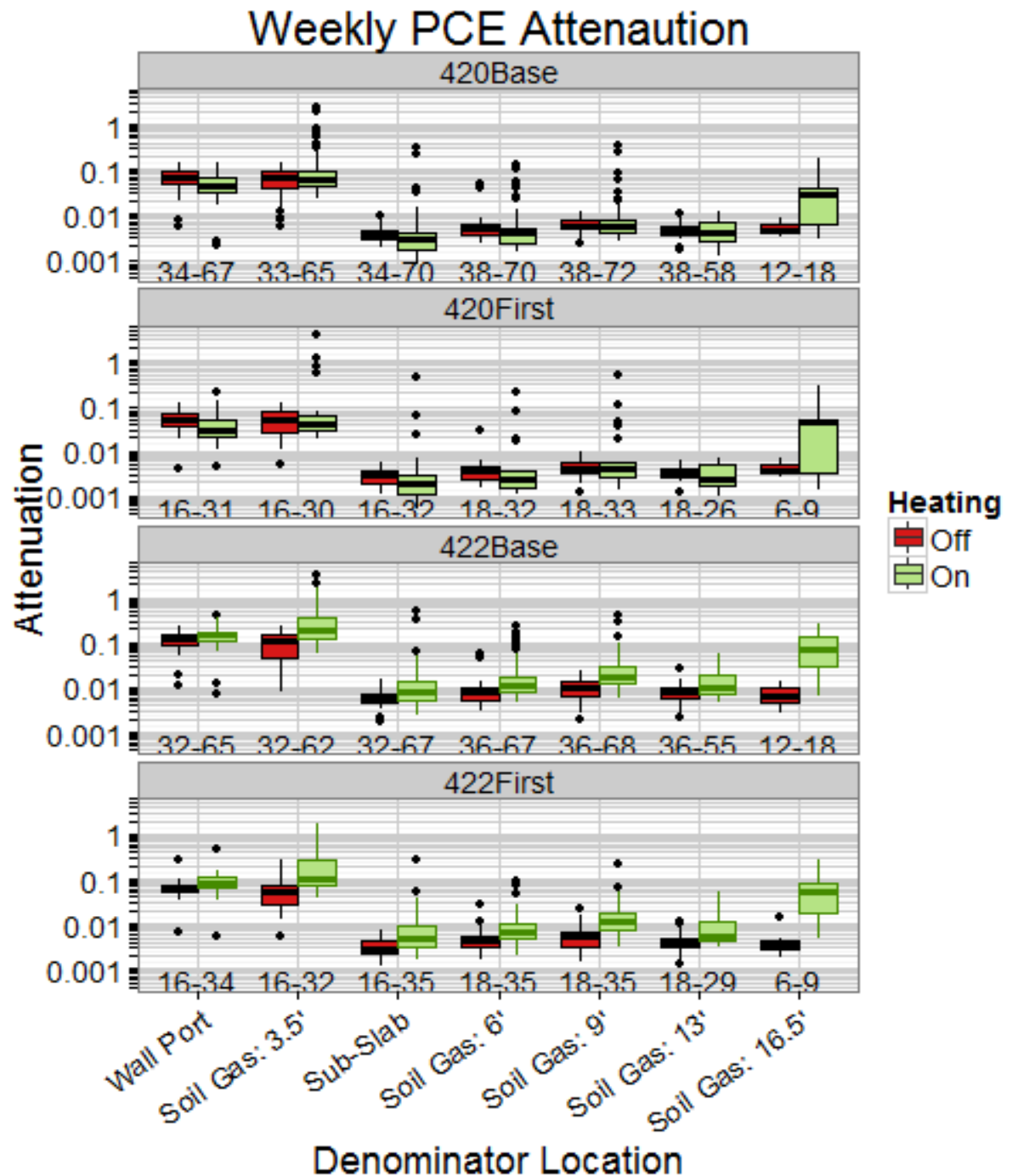
Is VOC Mass From Groundwater or Vadose Zone?: Soil Gas Time Sequence



What is the spatial and temporal variability of attenuation factors?: Daily (On-line GC Data)



What is the
spatial and
temporal
variability of
attenuation
factors?:
Weekly
(Passive
Sampler and
TO-17 Data)

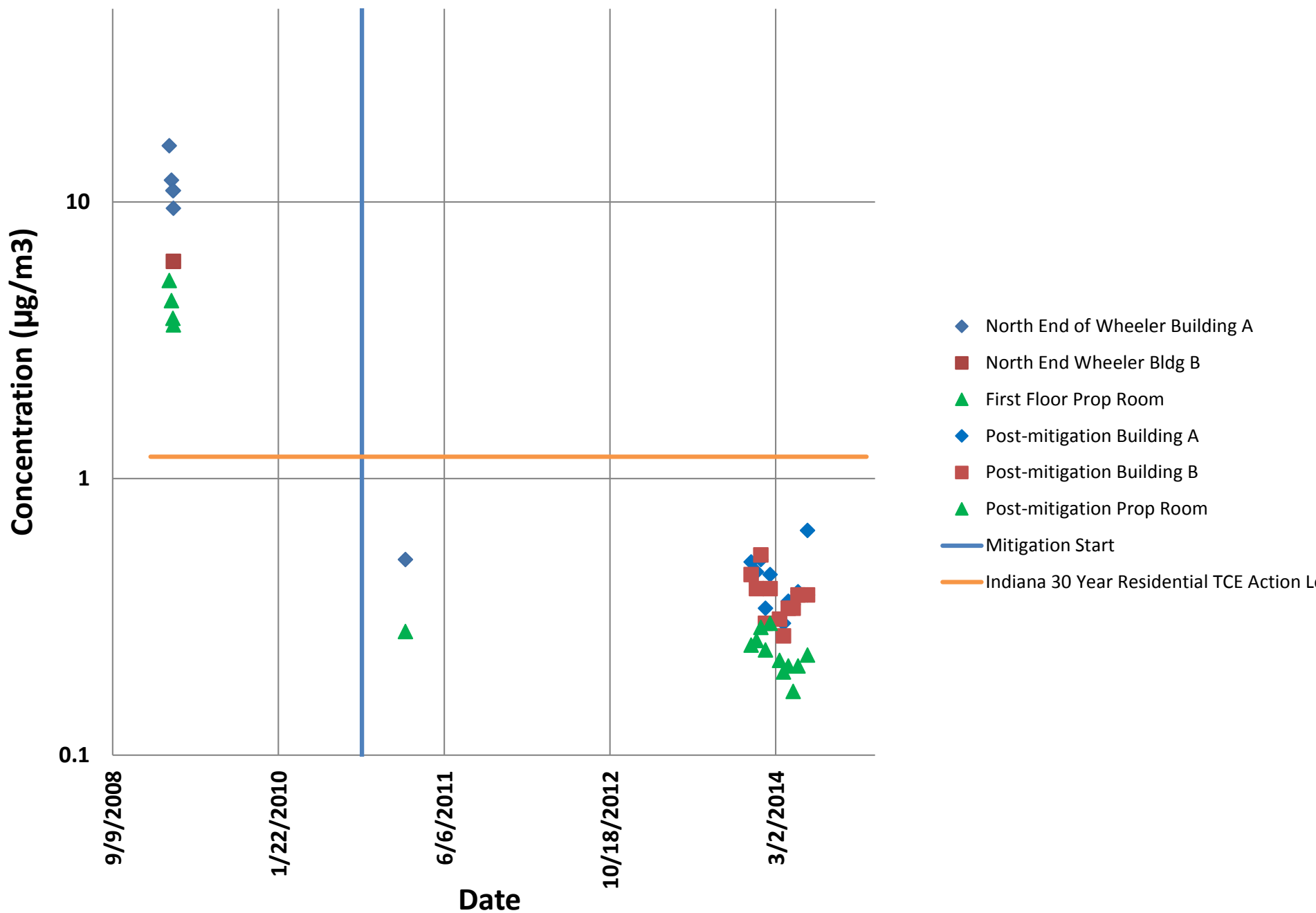


Wheeler Building Mitigation: History

- 100,000 square foot building
- Industrial facility from 1911 until 1995.
- Renovations into live-work lofts, office space and a theater.
- EPA Research measurements 2009
- Sealing and SSD mitigation system was installed in 2010 – designed to address highest concentration portion.
- Subslab VOCs a mix of releases here and upgradient. Premitigation subslab up to 12,000 $\mu\text{g}/\text{m}^3$ TCE
 - Regulator required one round of initial proof of effectiveness through VOC testing and differential pressure, then system operation by owner



TCE in Indoor Air at Wheeler Building, Pre- and Post-mitigation



More Available: Four Reports

- Fluctuation of Indoor Radon and VOC Concentrations Due to Seasonal Variations EPA/600/R-12/673; September 2012 (Been Available)
- Assessment of Mitigation Systems on Vapor Intrusion: Temporal Trends, Attenuation Factors, and Contaminant Migration Routes under Mitigated and Non-mitigated Conditions; EPA/600/R-13/241 (Release expected 3/15)
- Simple, Efficient, and Rapid Methods to Determine the Potential for Vapor Intrusion into the Home: Temporal Trends, Vapor Intrusion Forecasting, Sampling Strategies, and Contaminant Migration Routes EPA/600/R-14/397 (Release expected 3/15).
- Future plan will focus on peer reviewed papers – first two on Long Term Mitigation and Improved Passive Sampler Performance

Contact and Acknowledgements

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