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# Risk Management Strategies to Address Vapor Intrusion Assessment and Mitigation Uncertainties

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**Geosyntec Consultants**

25th Groundwater Resources Association Annual Meeting
2016: Groundwater Supply, Quality and Sustainability
The Challenges Ahead
September 29, 2016
Concord, California

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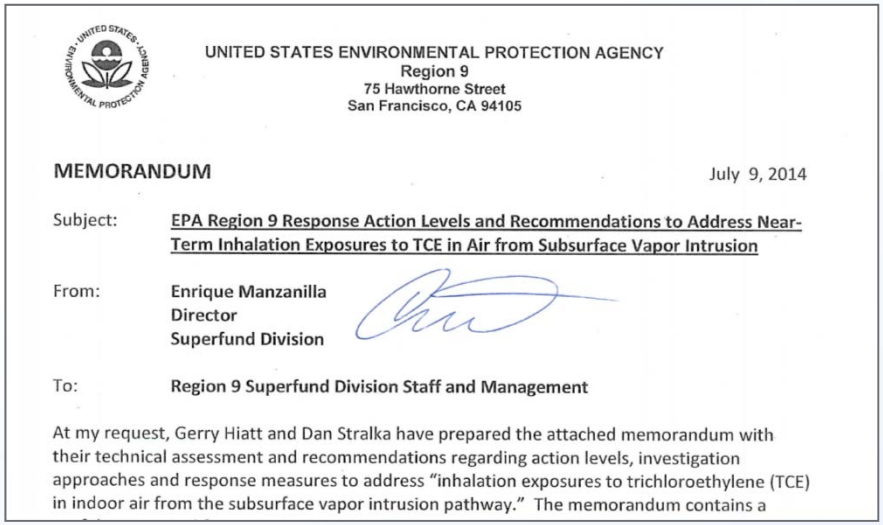
# Short-Term TCE Response Action Levels (RAL)

- USEPA issued TCE toxicity reassessment Sept. 2011
- Strengthened confidence "that TCE is a human carcinogen"
- Identified non-cancer effects
  - Decreased thymic weights (immune system)
  - Toxic nephropathy (kidney)
  - Conotruncal cardiac defects (developmental)
- Some regulatory agencies have proposed short-term action levels



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 9
75 Hawthorne Street
San Francisco, CA 94105

**MEMORANDUM** July 9, 2014

Subject: EPA Region 9 Response Action Levels and Recommendations to Address Near-Term Inhalation Exposures to TCE in Air from Subsurface Vapor Intrusion

From: Enrique Manzanilla
Director
Superfund Division

To: Region 9 Superfund Division Staff and Management

At my request, Gerry Hiatt and Dan Stralka have prepared the attached memorandum with their technical assessment and recommendations regarding action levels, investigation approaches and response measures to address "inhalation exposures to trichloroethylene (TCE) in indoor air from the subsurface vapor intrusion pathway." The memorandum contains a

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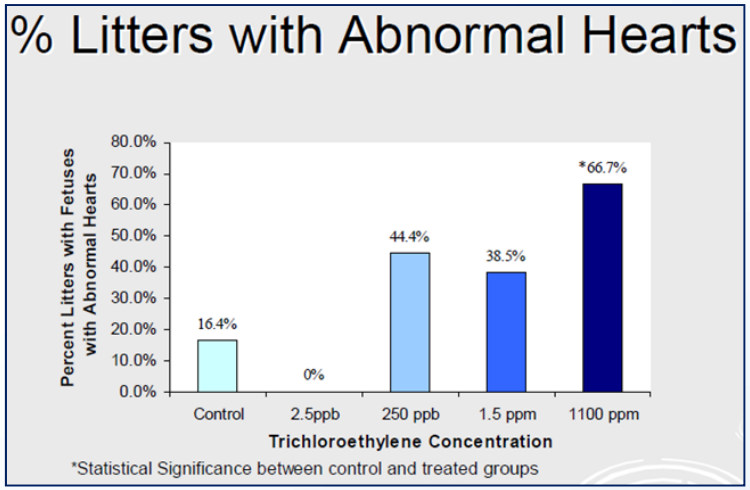
# USEPA Region IX
# TCE Indoor Air Screening Levels

| Exposure Scenario | Urgent RAL ($\mu g/m^3$) | Accelerated RAL ($\mu g/m^3$) | Chronic RSL ($\mu g/m^3$) |
|---|---|---|---|
| Residential | 6 | 2 | 0.48 |
| Commercial (8 hr/day) | 24 | 8 | 3.0 |
| Commercial (10 hr/day) | 21 | 7 | 2.4 |

- Urgent RAL – Urgent Response Action Level based on Hazard Quotient =3
  Implement corrective action immediately
- Accelerated RAL – Accelerated Response Action Level based on Hazard Quotient =1
  Implement corrective action within a few weeks
- Chronic RSL – Chronic Regional Screening Level based on $1x10^{-6}$ target risk level.

# TCE Response Action Levels

- Technical questions have been raised regarding the development of the response action level for TCE
  - Laboratory test procedures
  - Reproducibility of laboratory tests
  - Calculation of acute reference concentration
- Geosyntec/Exponent White Paper discusses deficiencies in proposed action levels
- USEPA has concluded that Johnson (2003) study is suitable for reference value derivation

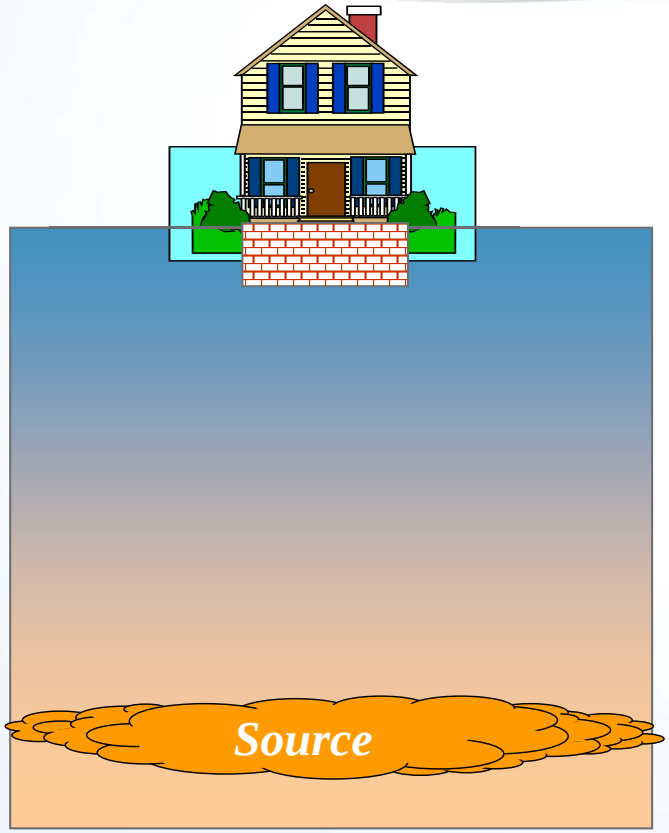



From: Symposium on New Scientific Research Related to the Health Effects of Trichloroethylene, Washington, DC. February 26-27, 2004.

# Implications of Response Action Levels

- Regulatory focus on short-term action levels for TCE affect:
  - Investigation strategy
  - Risk communication
  - Indoor air sampling / building testing
  - Mitigation assessment
- Short-term action levels are similar to chronic screening levels. Impact is on timing of actions, not on general VI corrective action process

# Investigation Approach




Bottom-Up

Top-Down

Indoor Air Evaluation
- Indoor Air Concentrations (TWA, grab, continuous)
- Background Contributions
- Risk Management Decisions/ Mitigation Options

Vapor Intrusion To Building
- Soil Characteristics
- Building Characteristics

Source Characterization
- Groundwater, Soil, Soil Vapor Concentrations

***Need plan to respond to indoor air results before collecting indoor air concentration measurements***

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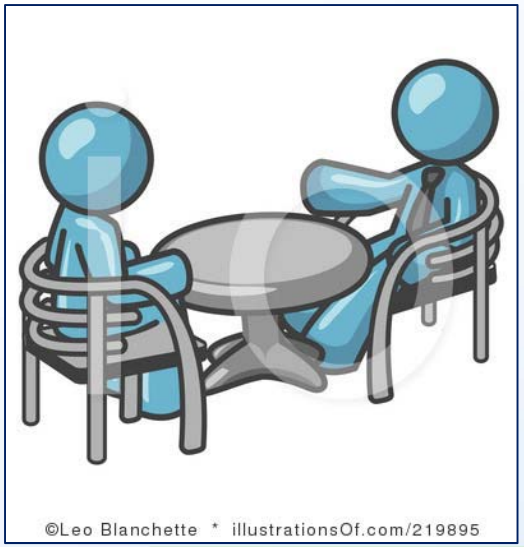
# Risk Communication

- Communication with building occupants is critical
- Before sampling:
  - Explain sampling rationale, methods, and timing
  - Describe common compounds detected in indoor air due to background sources
  - Communicate uncertainties in RALs before sampling
- After sampling:
  - Provide results in timely manner (after data validated)
  - Explain results and follow-up actions (if necessary)
- Consider data confidentiality of results



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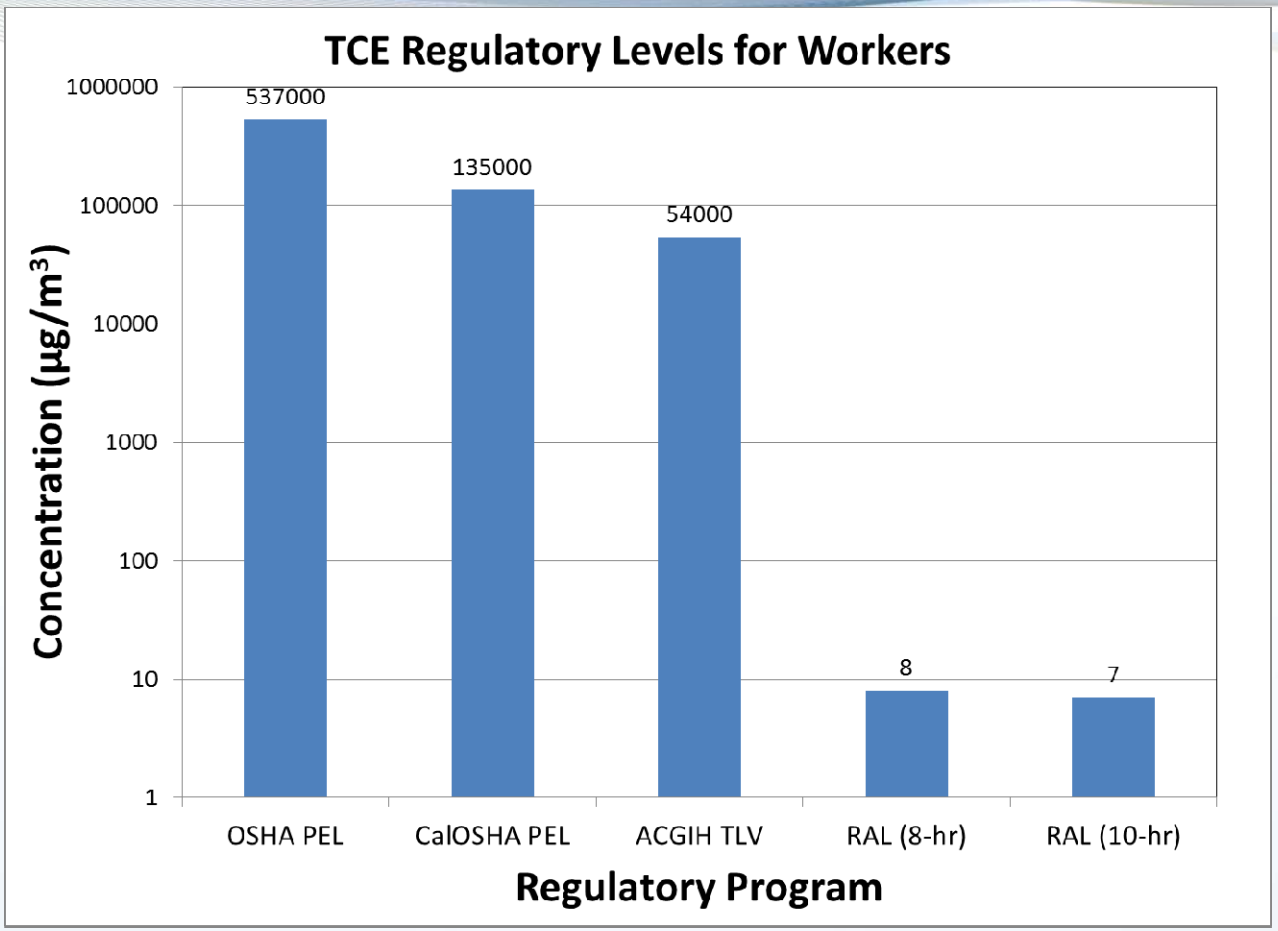
# TCE Regulatory Levels for Non-Residential Scenarios




Great deal of variability and uncertainty regarding regulatory levels

Difficult to communicate appropriate responses when there is such disparity between regulatory programs

# Considerations for Indoor Air Monitoring

Regulatory focus on short-term action levels and need for expedient response may affect indoor air sampling strategies

- More difficult to address data with quality control issues (e.g., false positives)
- Temporal variability in indoor air concentrations may lead to requests for more frequent monitoring
- USEPA and DTSC recommending indoor air sampling while HVAC not operating (when practical)

# Considerations for Indoor Air Monitoring (continued)

- Consider longer duration sampling (i.e., passive sampling)
  - Allows for longer time-average samples (e.g., weeks)
  - Consider representativeness for occupational settings
- Expedited decisions require planning before sample collection
  - Develop decision tree for contingency actions
  - Consider whether expedited laboratory analysis is worthwhile

Waterloo Membrane Sampler™

# Real Time Continuous Monitoring

- GC-ECD or HAPSITE GC/MS
  - Analyze for target VOCs
  - ~10 minute sample time
- Building survey to sub-ppbv levels
- Identify preferential pathways, temporal variability or indoor sources

- Screening instrument samples are not consistent with assumptions used for risk-based decision making
  - Use TWA samples to compare to short-term action levels

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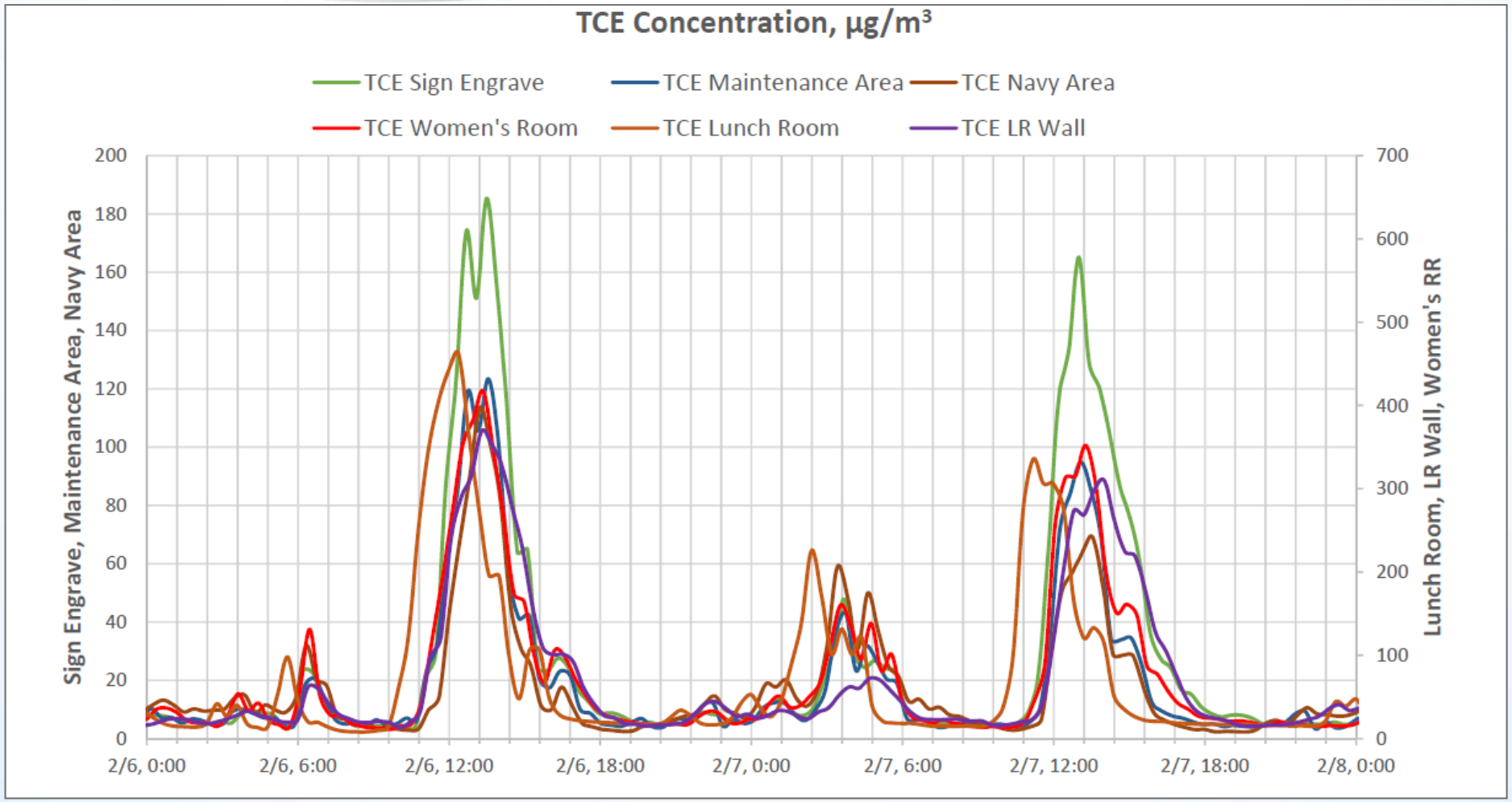
# Real Time Continuous Monitoring Example Data



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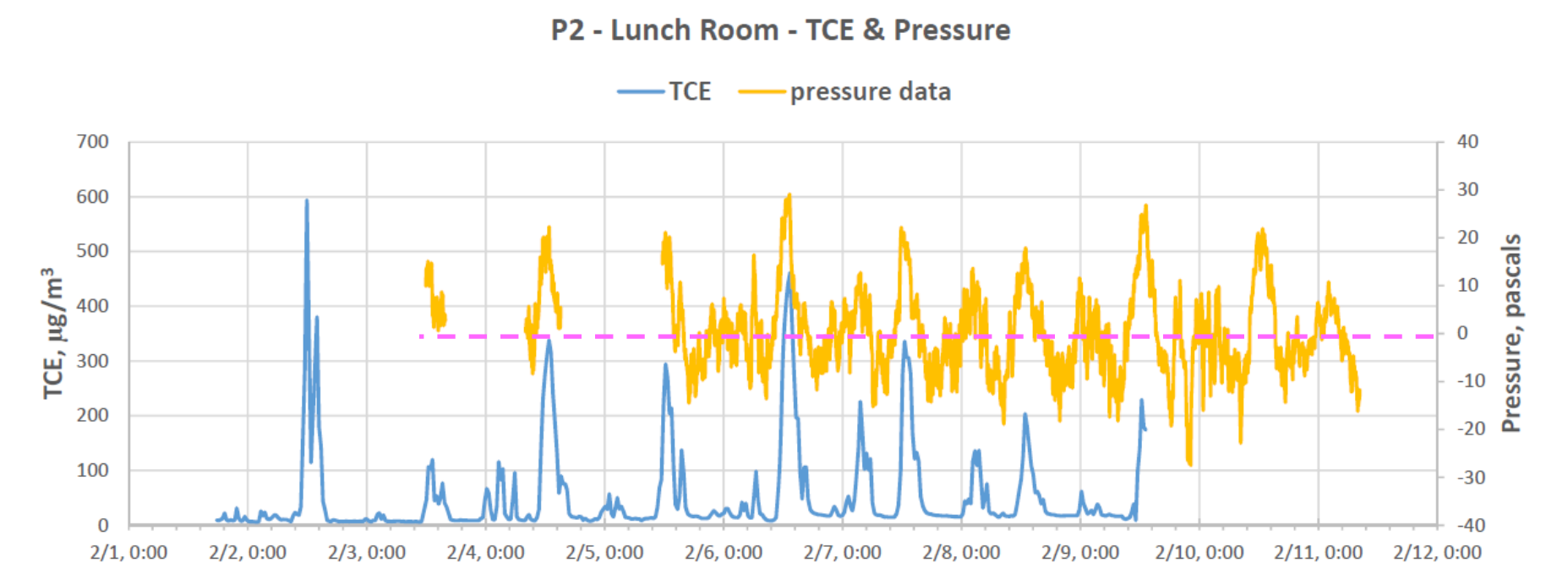
# Real Time Continuous Monitoring Example Data



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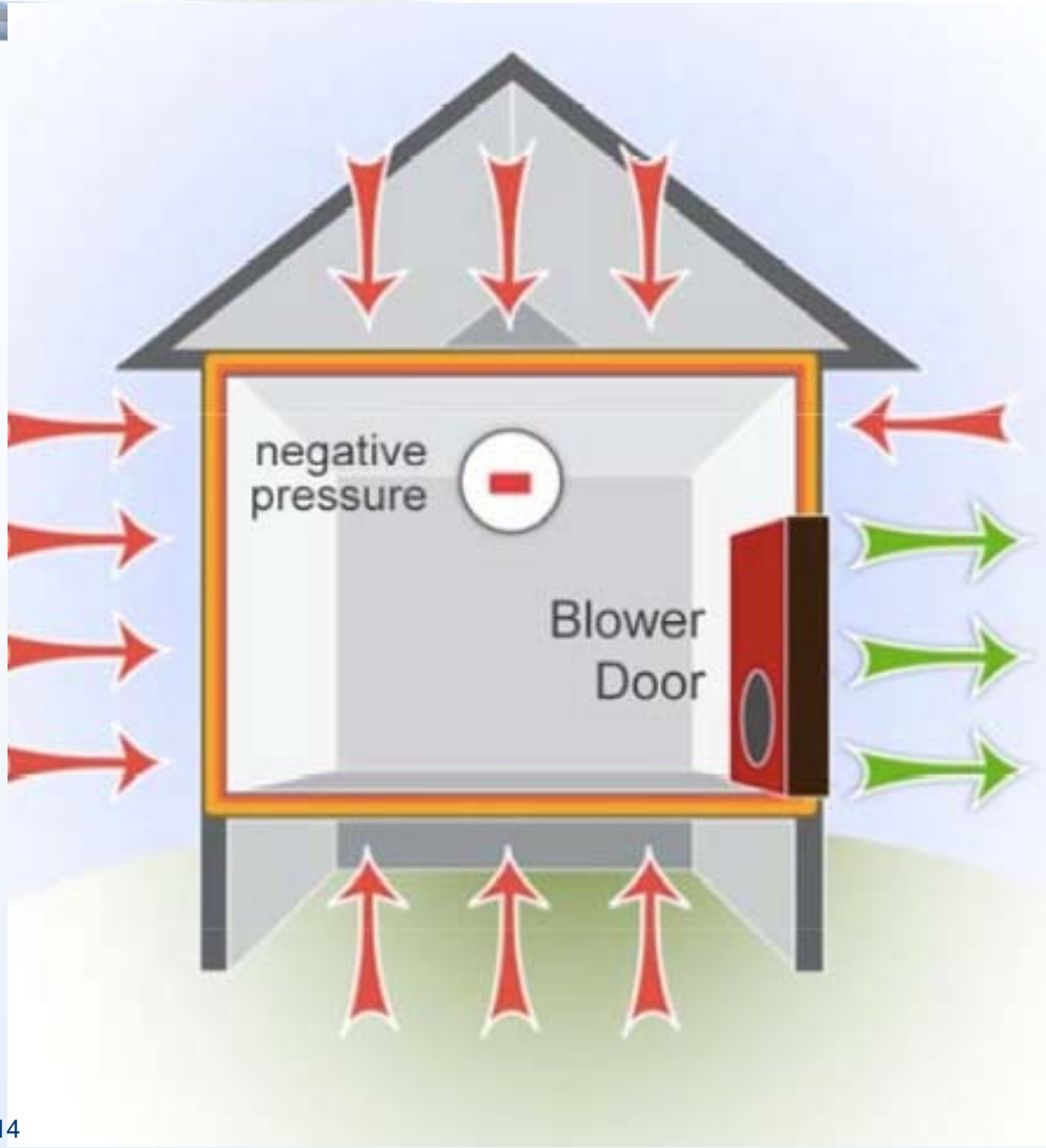
# Building Pressure Control




- Measure indoor air concentrations under different building pressure conditions
- Negative pressure = induced vapor intrusion
- Positive pressure = inhibited vapor intrusion
- Measurements are not representative indoor air concs.

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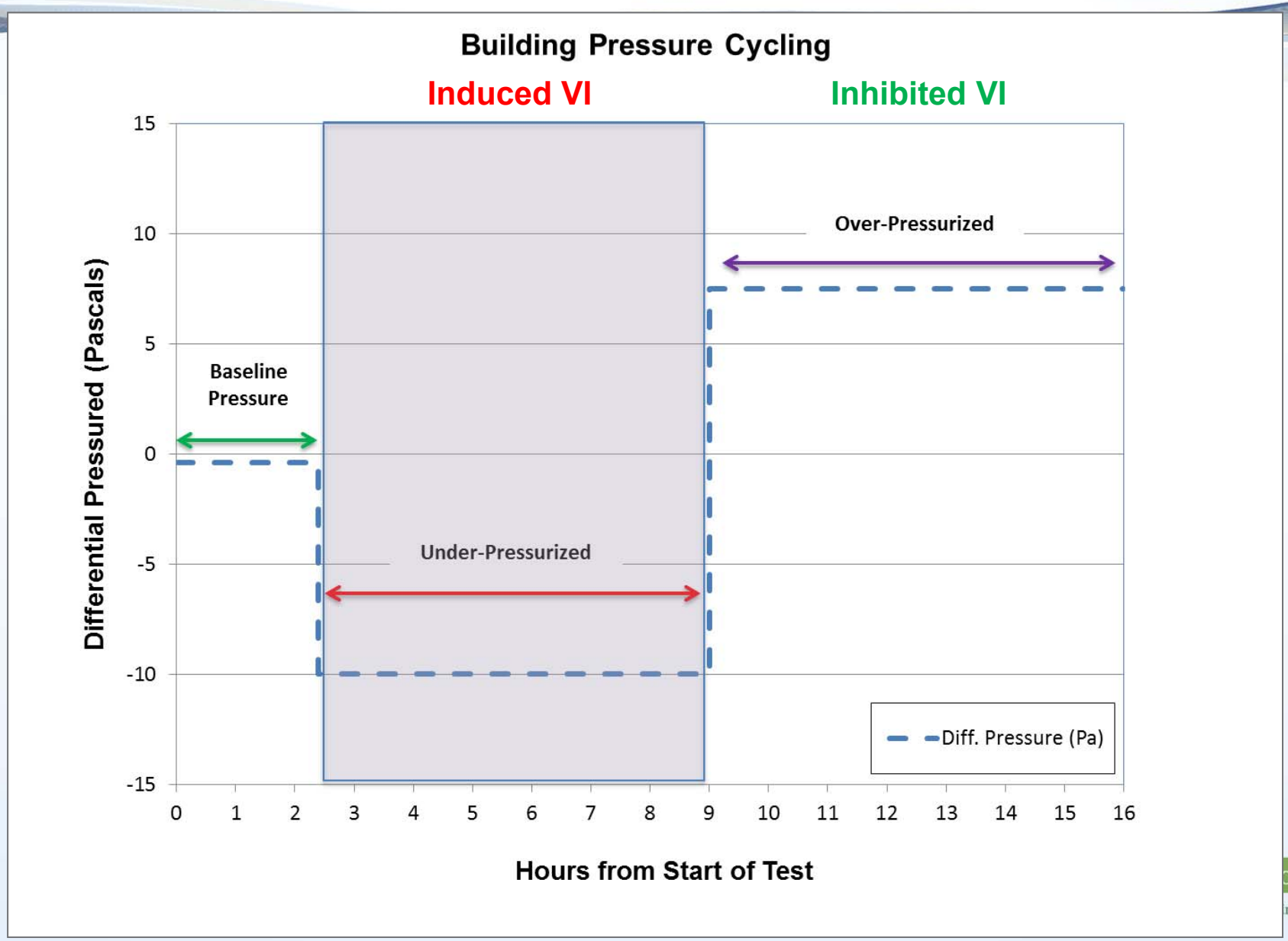
# Building Pressure Cycling Concept



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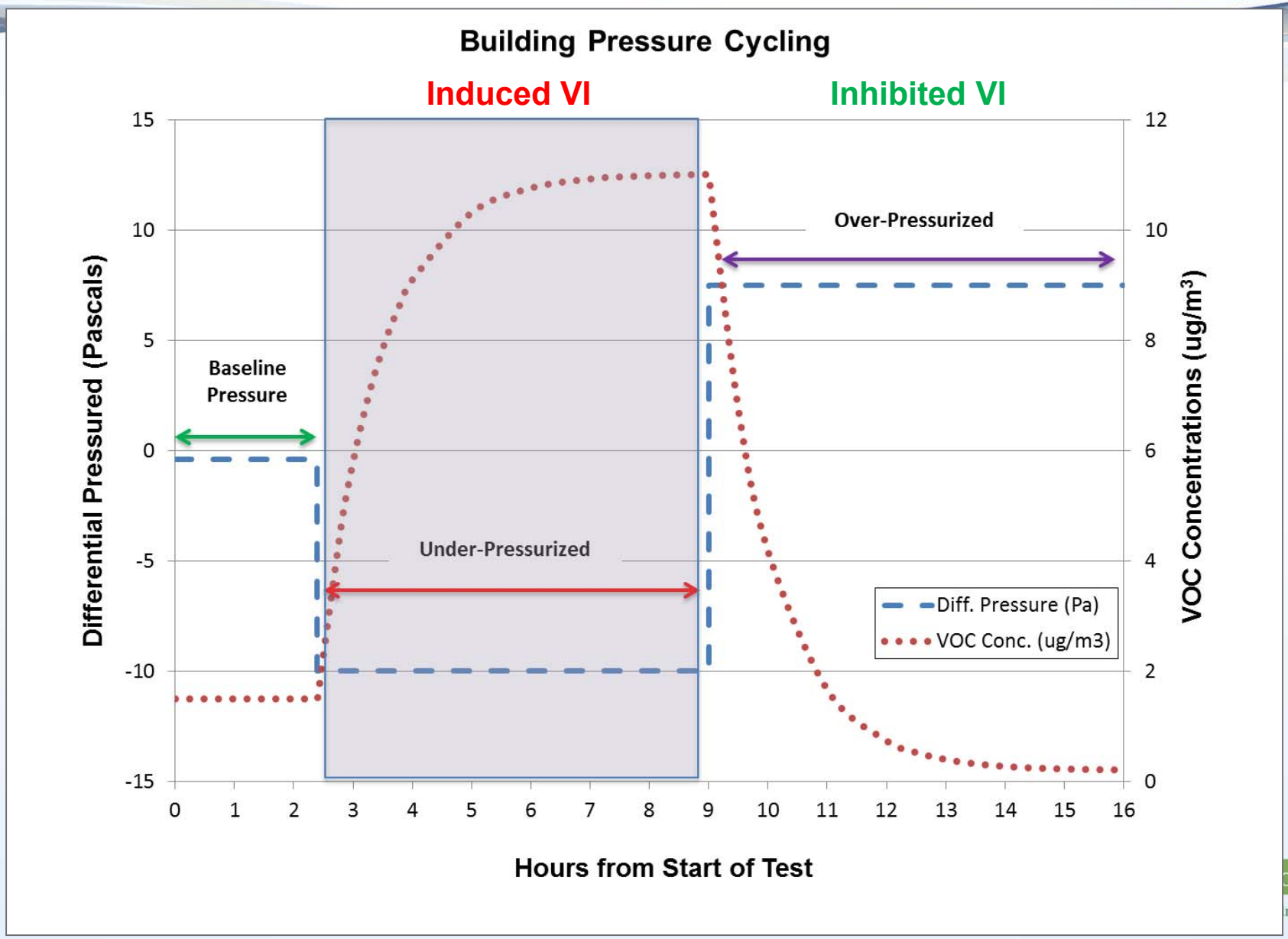
# Building Pressure Cycling Concept
# Evidence of Significant VI



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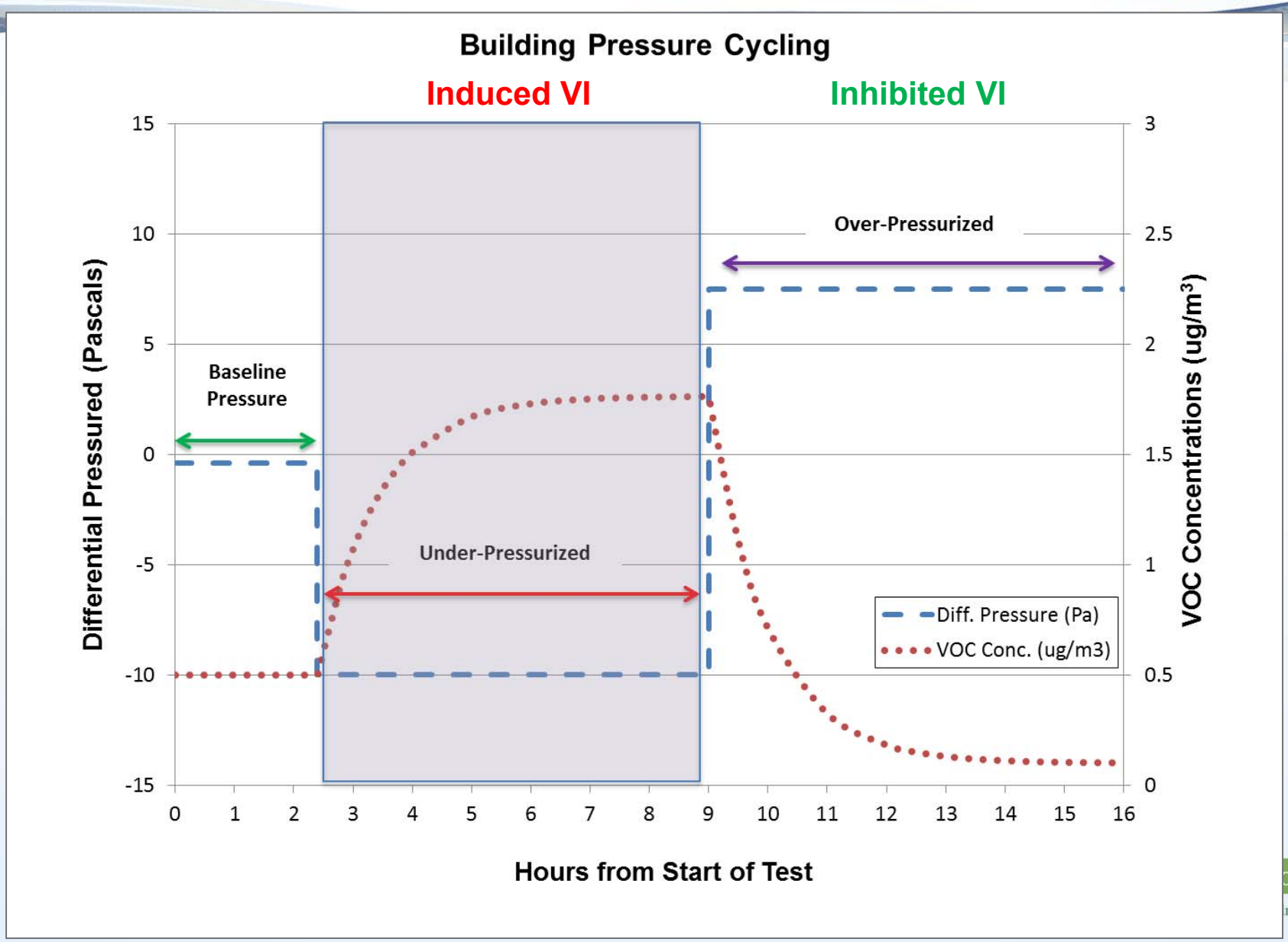
# Building Pressure Cycling Concept
# Evidence of Minor VI



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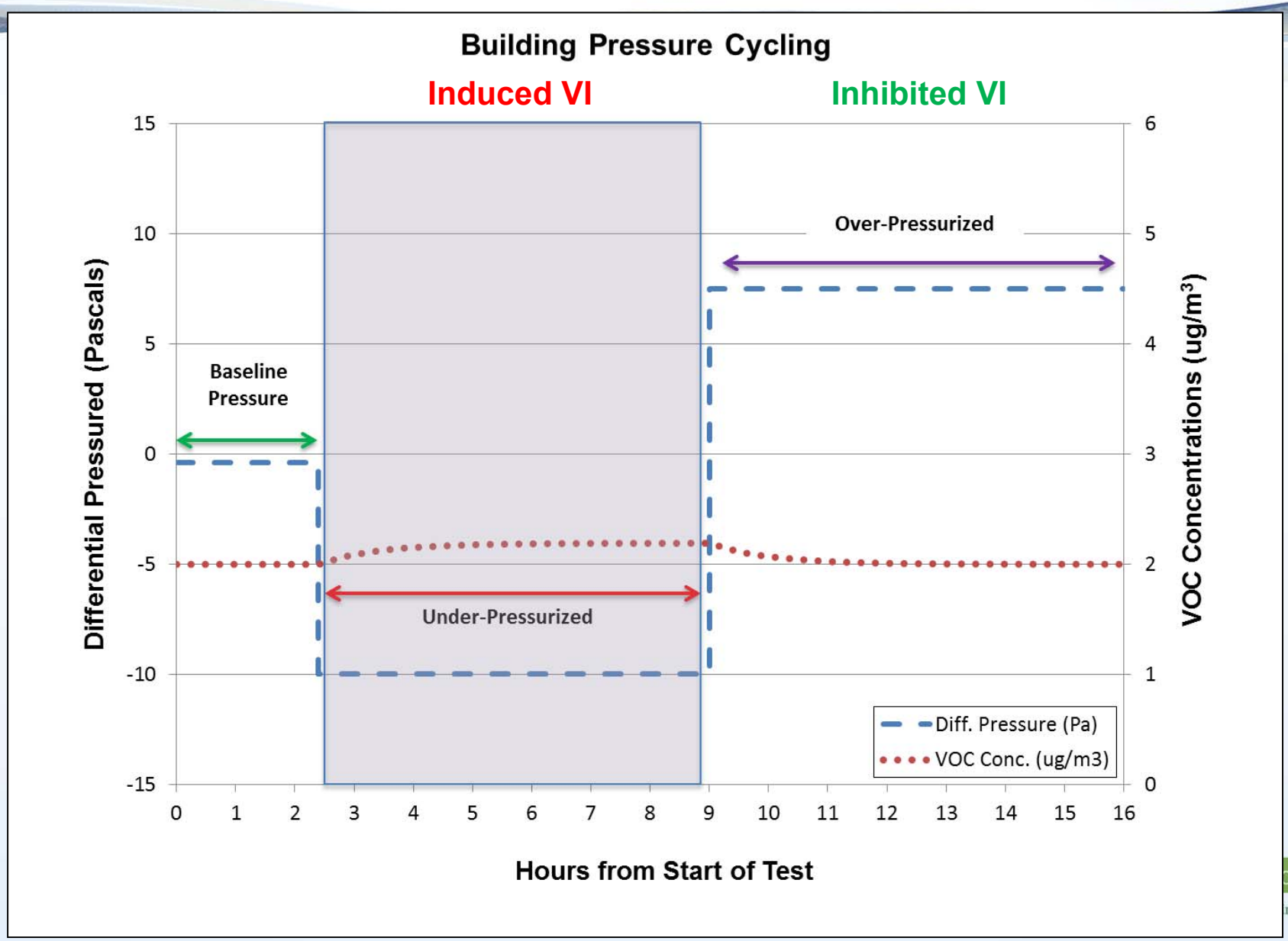
# Building Pressure Cycling Concept
# Evidence of Significant Background Source



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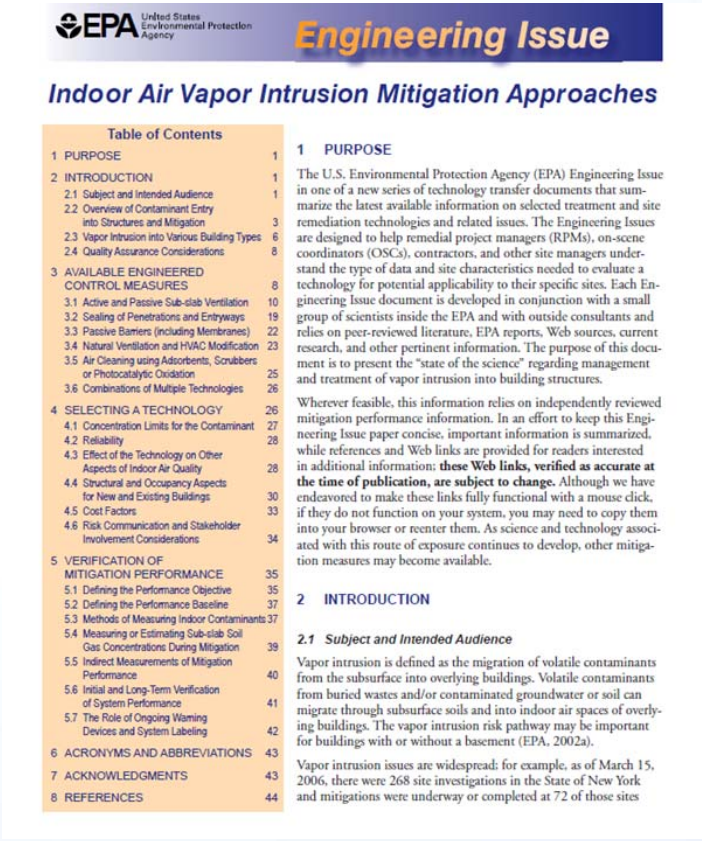
# Supplemental Data for Risk-Based Decision Making

- Continuous Real-Time Monitoring
  - Identify if temporal conditions are affecting vapor intrusion
  - Assess locations/areas for vapor intrusion
  - Collect data that may be used for mitigation system design
- Building Pressure Control
  - Assess if additional monitoring to assess temporal variability is warranted
    - Data indicates background sources
    - Induced VI data are below action levels
  - Compound ratio analysis / tracers
  - Compound-specific stable isotope analysis (CSIA)

# Expedited Response Actions

- Potential Response Actions:
  - Source removal
  - HVAC modifications to increase ventilation or change building pressure
  - Indoor air purification
  - Occupant relocation
  - Barriers to chemical entry
    - Pathway sealing
    - Sub-slab depressurization
    - Sub-slab or crawl space venting
    - Aerated flooring
  - Remediation
- Consider timing, effectiveness, and duration when selecting mitigation measure(s)



EPA United States Environmental Protection Agency

**Engineering Issue**

***Indoor Air Vapor Intrusion Mitigation Approaches***

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## 1 PURPOSE

The U.S. Environmental Protection Agency (EPA) Engineering Issue in one of a new series of technology transfer documents that summarize the latest available information on selected treatment and site remediation technologies and related issues. The Engineering Issues are designed to help remedial project managers (RPMs), on-scene coordinators (OSCs), contractors, and other site managers understand the type of data and site characteristics needed to evaluate a technology for potential applicability to their specific sites. Each Engineering Issue document is developed in conjunction with a small group of scientists inside the EPA and with outside consultants and relies on peer-reviewed literature, EPA reports, Web sources, current research, and other pertinent information. The purpose of this document is to present the "state of the science" regarding management and treatment of vapor intrusion into building structures.

Wherever feasible, this information relies on independently reviewed mitigation performance information. In an effort to keep this Engineering Issue paper concise, important information is summarized, while references and Web links are provided for readers interested in additional information: **these Web links, verified as accurate at the time of publication, are subject to change.** Although we have endeavored to make these links fully functional with a mouse click, if they do not function on your system, you may need to copy them into your browser or reenter them. As science and technology associated with this route of exposure continues to develop, other mitigation measures may become available.

## 2 INTRODUCTION

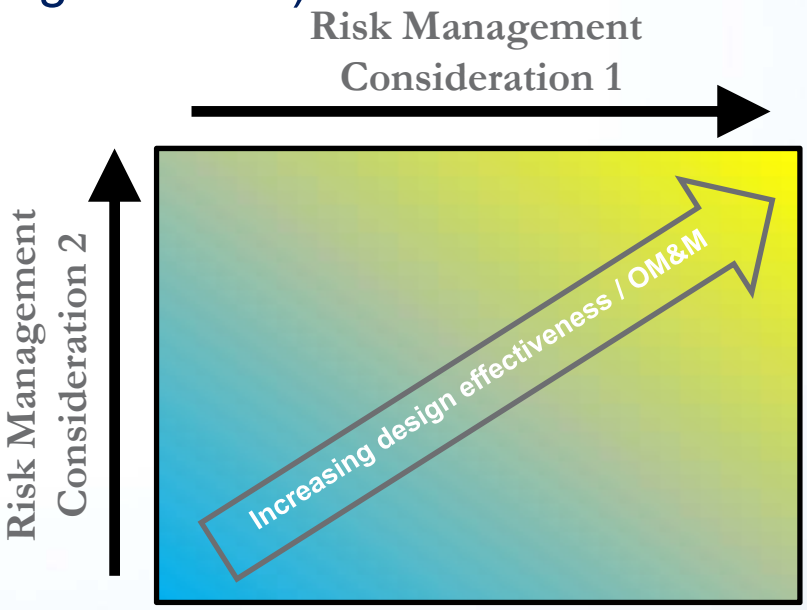
### *2.1 Subject and Intended Audience*

Vapor intrusion is defined as the migration of volatile contaminants from the subsurface into overlying buildings. Volatile contaminants from buried wastes and/or contaminated groundwater or soil can migrate through subsurface soils and into indoor air spaces of overlying buildings. The vapor intrusion risk pathway may be important for buildings with or without a basement (EPA, 2002a).

Vapor intrusion issues are widespread: for example, as of March 15, 2006, there were 268 site investigations in the State of New York and mitigations were underway or completed at 72 of those sites

# Vapor Intrusion Mitigation System Considerations

- Design
  - Implementability (e.g., new vs existing structure)
  - Effectiveness
- O&M Requirements
  - Electrical costs
  - Equipment upkeep
- Monitoring Requirements
  - Requirements to demonstrate effectiveness
- Cost Considerations
  - Installation costs may be much less than monitoring costs
- Other Issues
  - Impacts to building occupants (i.e., aesthetics, costs)
  - Business/public perception/litigation risk management



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# Summary

- Regulatory focus on TCE short-term action levels will likely lead to more frequent indoor air sampling.
- Potential short-term effects of TCE exposure are uncertain and communication of results can be confusing to building occupants
- Methods to address difficulties in evaluating vapor intrusion for TCE
  - Improved risk communication
  - Well thought out investigation strategies
  - Vapor mitigation options that consider site-specific conditions
- Have a strategy to deal with the results before hitting the field