

# Lines of Evidence Approach to Vapor Intrusion Issues

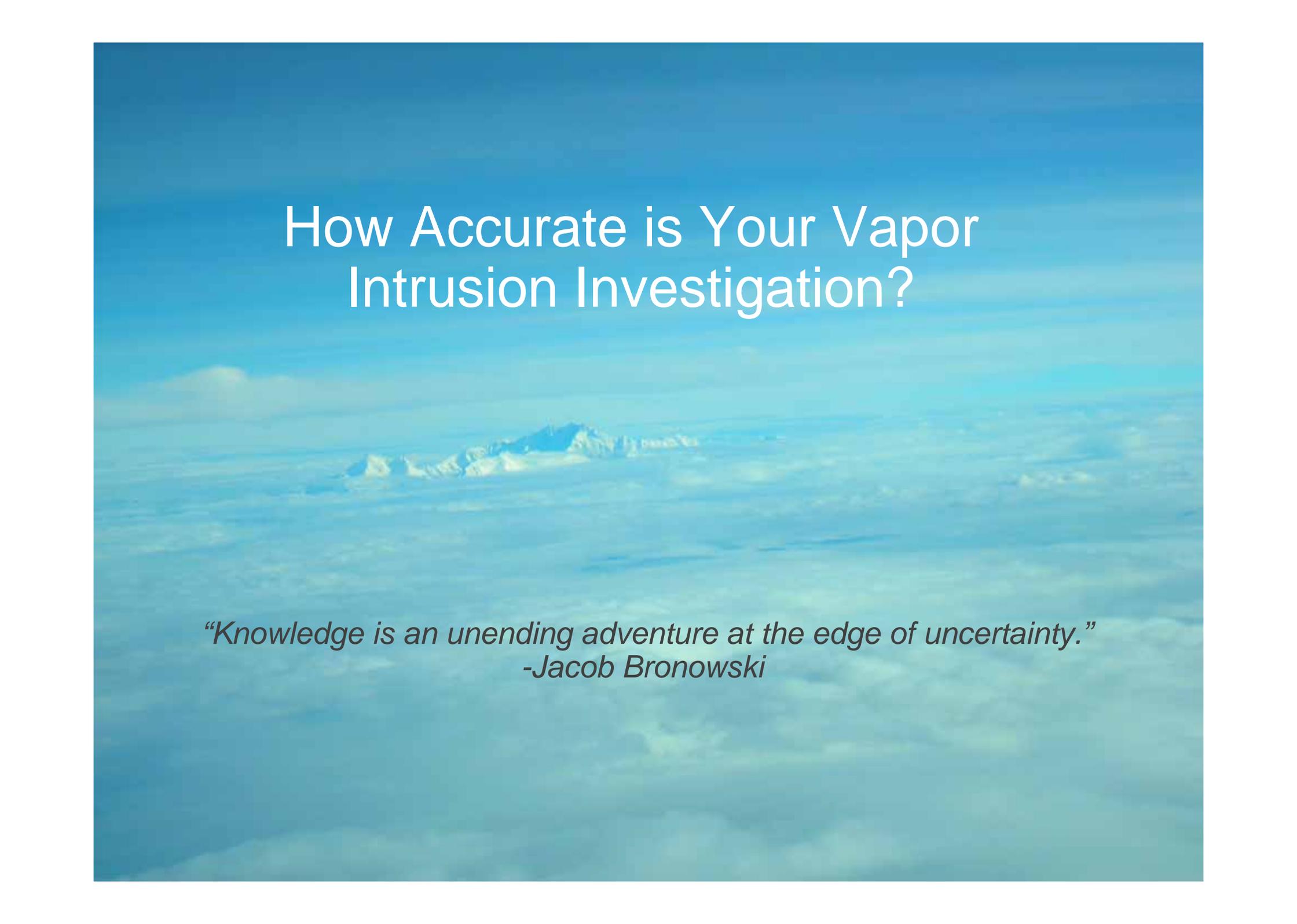
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An aerial photograph showing a range of snow-capped mountains rising above a thick, white layer of clouds. The sky is a clear, bright blue. The text is overlaid on the upper portion of the image.

# How Accurate is Your Vapor Intrusion Investigation?

*“Knowledge is an unending adventure at the edge of uncertainty.”  
-Jacob Bronowski*

## How Accurate is Your Vapor Intrusion Investigation?

- The goal of any Vapor Intrusion (VI) investigation is to accurately predict whether indoor air quality is being adversely affected by subsurface impacts
- However, several issues can introduce uncertainty in predicting indoor air concentrations related to vapor intrusion, including:
  1. Sampling & analytical methods
  2. Fate & transport prediction from subsurface into building
  3. Indoor/ ambient/ background sources

## How Can We Reduce VI Uncertainty?

- To help reduce this uncertainty, Multiple Lines of Evidence may be considered when evaluating decision points in the vapor intrusion process
- What is the Multiple Lines of Evidence Approach to VI?
  - Uses critical thinking when conducting vapor intrusion investigation
  - Looks at a Site holistically during a vapor intrusion investigation
  - Supplements a traditional screening approach



## Multiple Lines of Evidence – Sampling & Analytical Methods

- Include, but are not limited to:
  - **Fixed gas analysis** in the unsaturated zone to identify whether biodegradation is occurring
    - **Oxygen (O<sub>2</sub>)**: need adequate supply for baseline soil respiration + biodegradation processes
    - **Carbon dioxide (CO<sub>2</sub>)**: biodegradation by-product
  - **Passive soil gas sampling** (e.g., sorbent-based methods for longer time-integrated measurements)
  - **Flux chamber sampling** (e.g., can provide direct information on the flux of constituents from the ground or building surface into indoor air)

# Multiple Lines of Evidence – Fate & Transport Prediction from Subsurface into Building



# Multiple Lines of Evidence – Fate & Transport Prediction from Subsurface into Building

- Include, but are not limited to:
  - Comparison and interpretation of data in a **single medium** or across **multiple media**
    - Single medium (e.g., soil gas at multiple depth intervals; 1<sup>st</sup> floor vs 2<sup>nd</sup> floor indoor air ratios)
    - Multiple media (e.g., subslab to indoor air ratios)
  - Correlation of **soil gas to fixed gases at multiple depth intervals** to identify whether biodegradation is occurring
  - Absence/presence of **indicator chemicals** (e.g., use of radon as tracer gas for determining a site-specific  $\alpha$ )
  - Measuring **cross-slab pressure differentials** (e.g., indoor/outdoor; indoor/subslab)

## Multiple Lines of Evidence – Indoor/ Ambient/ Background Sources

- Include, but are not limited to:
  - Interpretation of **meteorological conditions** during sampling events
    - Wind speed and direction
    - Barometric pressure
    - Precipitation
  - Comparison of **indoor air data to literature values**
  - Indoor air **building survey** checklist
  - Comparison of **indoor air data from multiple floors**

## Benefits of Lines of Evidence Approach

- Gaining acceptance among US Federal (USEPA) and State environmental agencies as a way to identify whether vapor intrusion is an actual concern when initial screening step indicates a concern (e.g., groundwater, deep soil gas concentrations > SLs)
- Instead of a traditional screening approach (e.g., flow diagram with screening steps), more critical thought and investigation goes into characterizing:
  - source
  - migration towards a building
  - potential impacts on indoor air quality from subsurface vs. above-ground source

Put These Pieces Together and...



- Gain comprehensive and holistic understanding of the Site while reducing uncertainty (e.g., Multiple Lines of Evidence)

vs.

- Prescriptive approach of the past which may or may not accurately predict whether vapor intrusion is a concern (e.g., check the box, simple data screen)

## If Still Not Sure Whether VI is a Concern,

- Consider strengthening lines of evidence by:
  - Collecting additional data
    - subsurface media, fixed gases
    - geotechnical parameters
    - building parameters, indoor/ambient conditions
  - Vapor intrusion modeling
  - Completing inventory of building as well as potential ambient air sources in vicinity of Site



# Case Study

## Case Study - Background

- Subsurface crude release located in Texas occurred December 2003
  - release occurred approximately 10-15 feet (3-4.6 m) below ground surface (bgs)
  - release occurred approximately 50 feet (15 m) east of a residence
- Soil samples were collected in 2004, 2006, 2007 to assess subsurface soil impacts
  - showed elevated TPH and BTEX
  - highest BTEX readings @ 14-16 feet (4.3-4.9 m) bgs

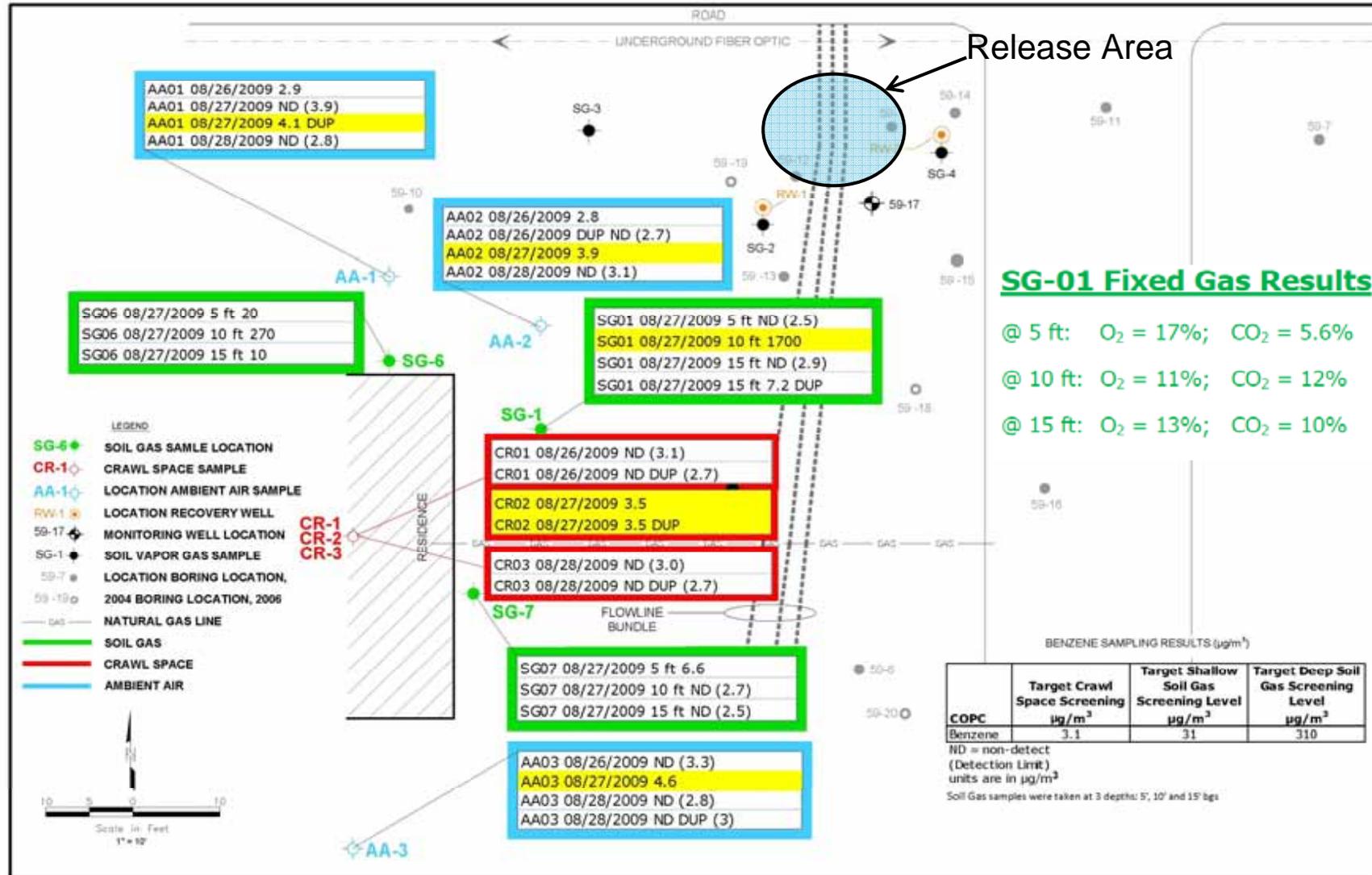
## Case Study – Background (continued)

- Soil gas samples collected in 2007 for BTEX at 5, 10, 15 ft (1.5, 3, 4.6 m) bgs
- Highest benzene soil gas reading
  - 910,000 ug/m<sup>3</sup> @ 10 ft (3 m) bgs near release site
  - exceeds benzene deep soil gas SL (310 ug/m<sup>3</sup>)
- Lowest benzene soil gas reading
  - <59 ug/m<sup>3</sup> @ 5 ft (1.5 m) bgs near residence
  - Although non-detect, detection limit exceeds benzene shallow soil gas SL (31 ug/m<sup>3</sup>)

## Case Study – 2009 Investigation

- Conducted 3-day sampling event in August 2009 to refine data characterization:
  - Collected soil gas samples between release site and residence at multiple depths 5, 10, 15 ft (1.5, 3, 4.6 m) bgs
  - Analyzed all 2009 soil gas samples for fixed gases
    - O<sub>2</sub>, CO<sub>2</sub>, CH<sub>4</sub>
  - Collected crawl space samples below the residence
  - Collected ambient air samples upwind and downwind of the residence
  - Collected meteorological information all 3 days

# Benzene Sampling Results



## Case Study - Conclusion

- Although initial soil gas data analysis showed concentrations in excess of benzene's screening level, additional lines of evidence subsequently proved that vapor intrusion was not a concern for the nearby resident.
- By using the multiple lines of evidence approach at this Site, the initial suggestion that subsurface impacts were adversely affecting indoor air quality was disproved and remedial action was not required.

Obrigada  
Thank You

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