U.S. EPA Vapor Intrusion Workshop

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

Redfield as an Example of the Possibility of a Soil Gas Safe Community

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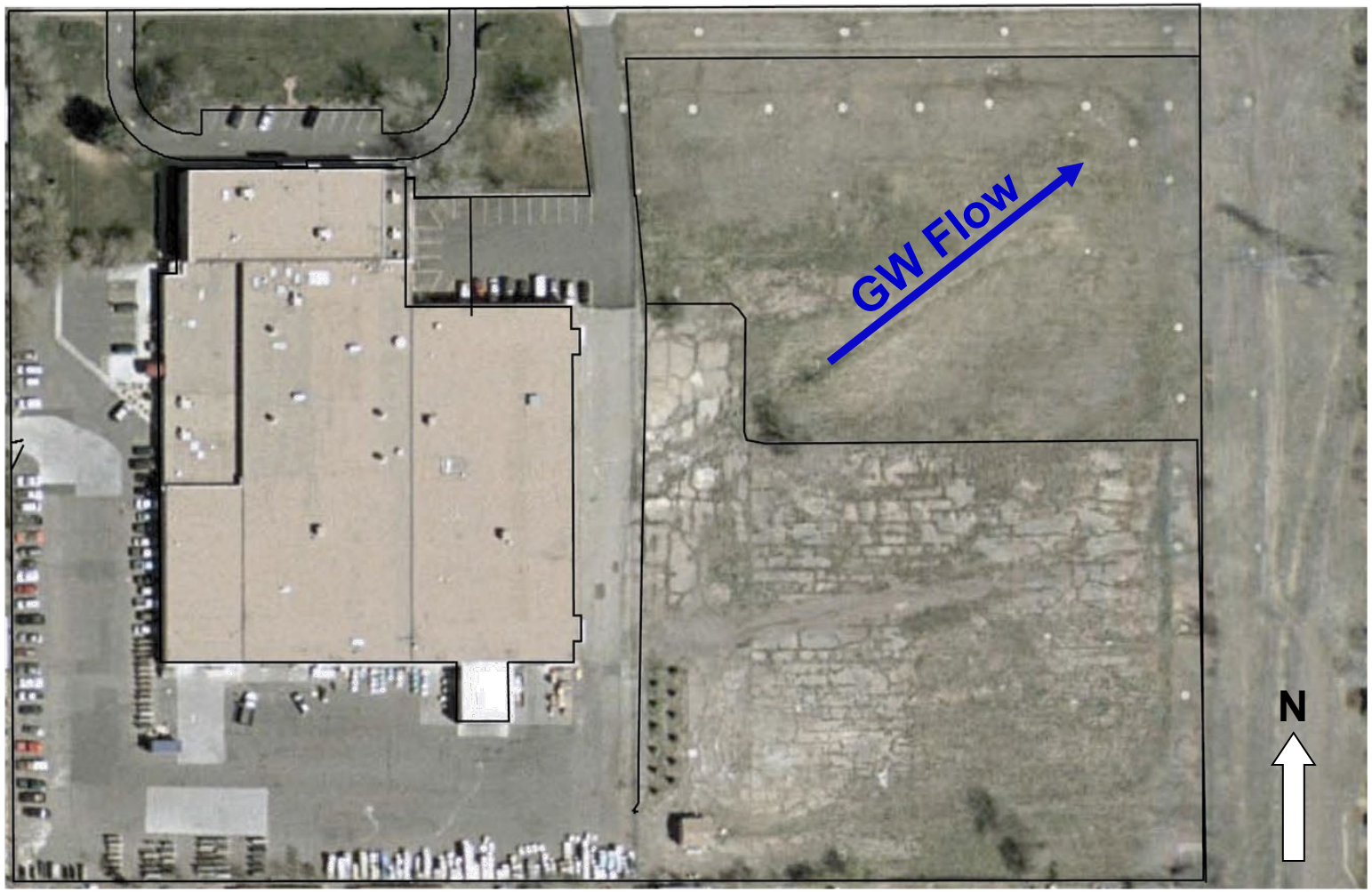
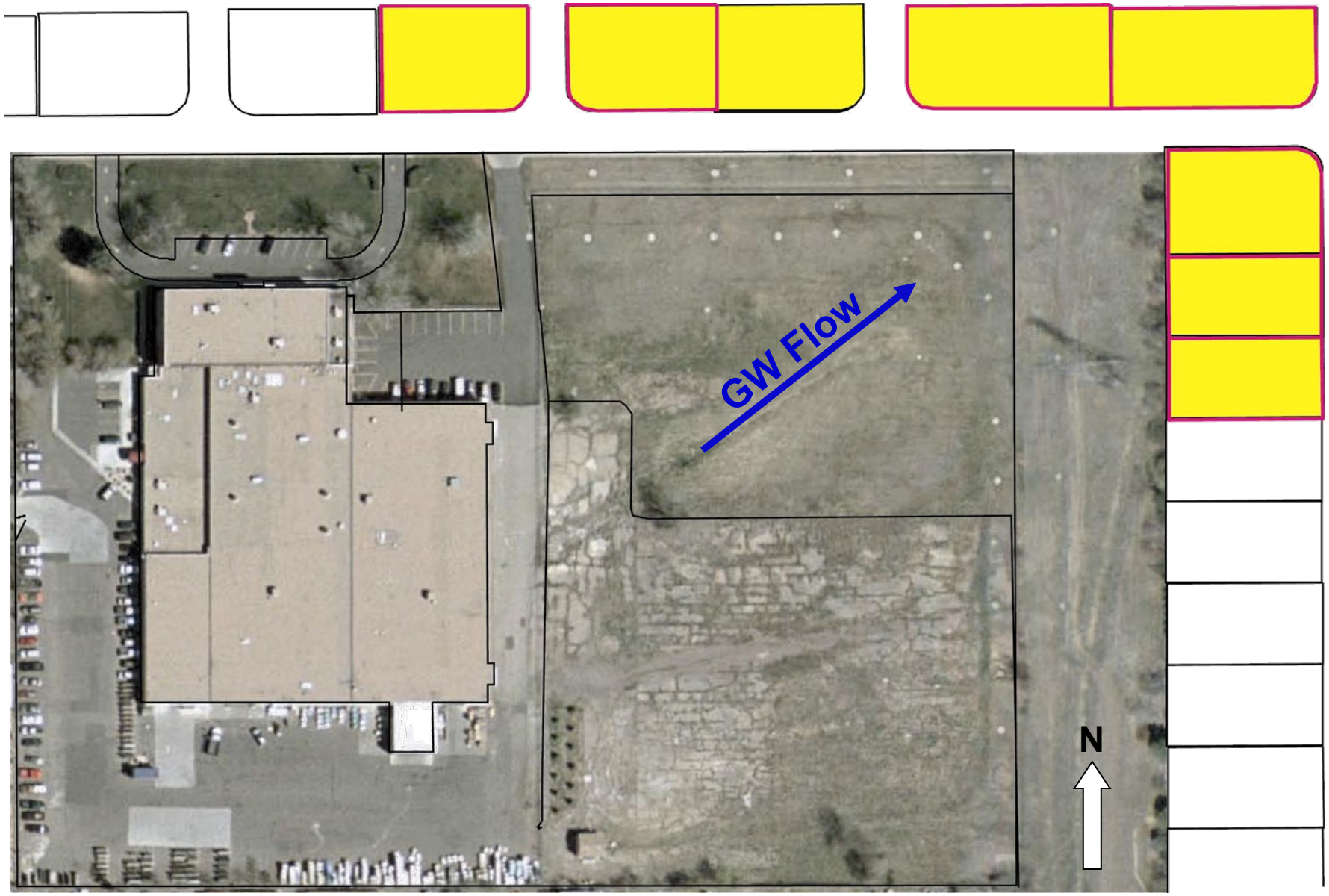
Redfield Site Chronology

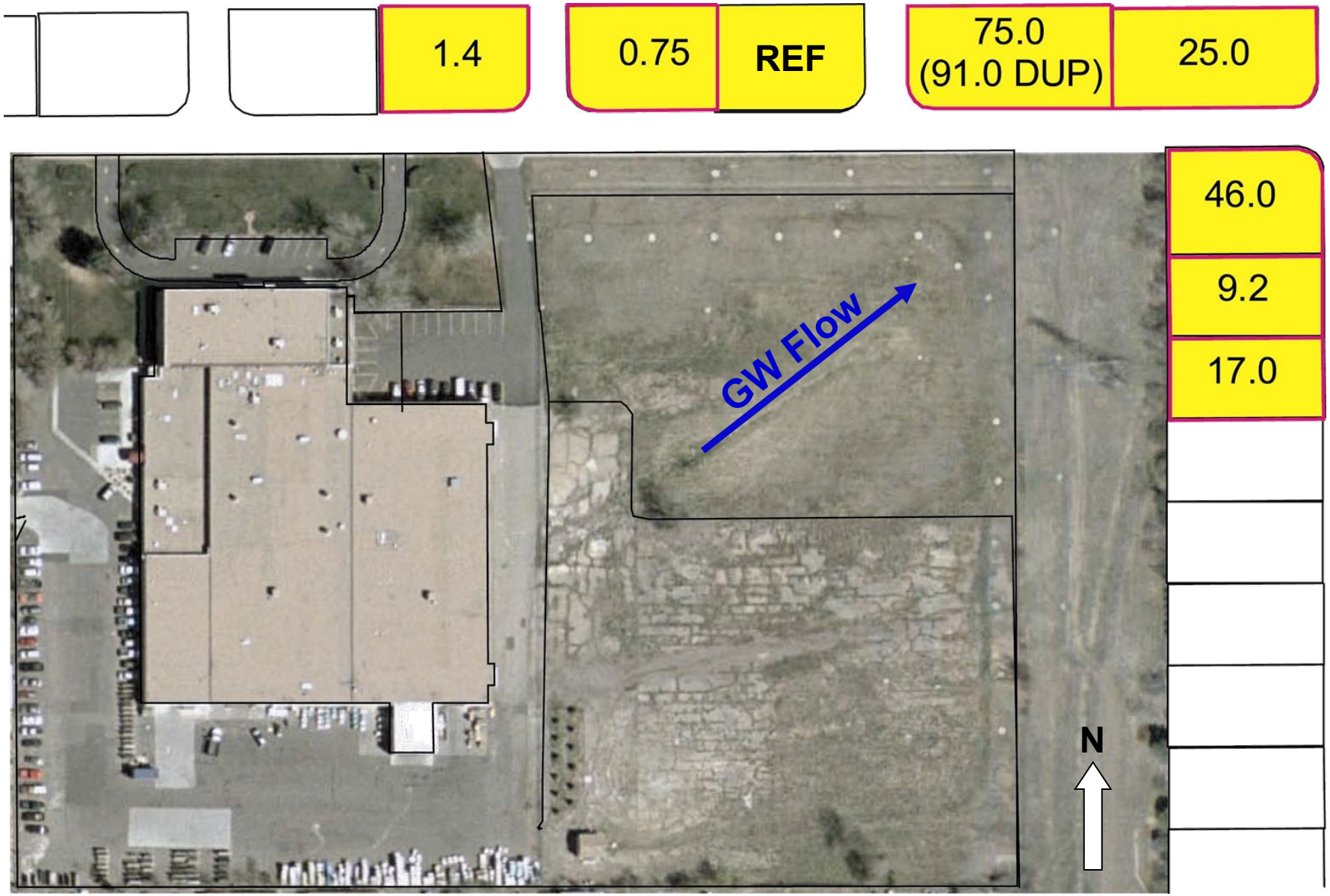
- Various manufacturing operations, 1957 – 1998
- Initial site investigations, 1993 – 1998
- Indoor air testing, 1998 – Present
- Groundwater containment, 1999 – Present
- Off-site groundwater treatment, 2004 – Present

U.S. Geologic Survey, 1993

Redfield Site




GW Flow
N



1,1-DCE (µg/m³)

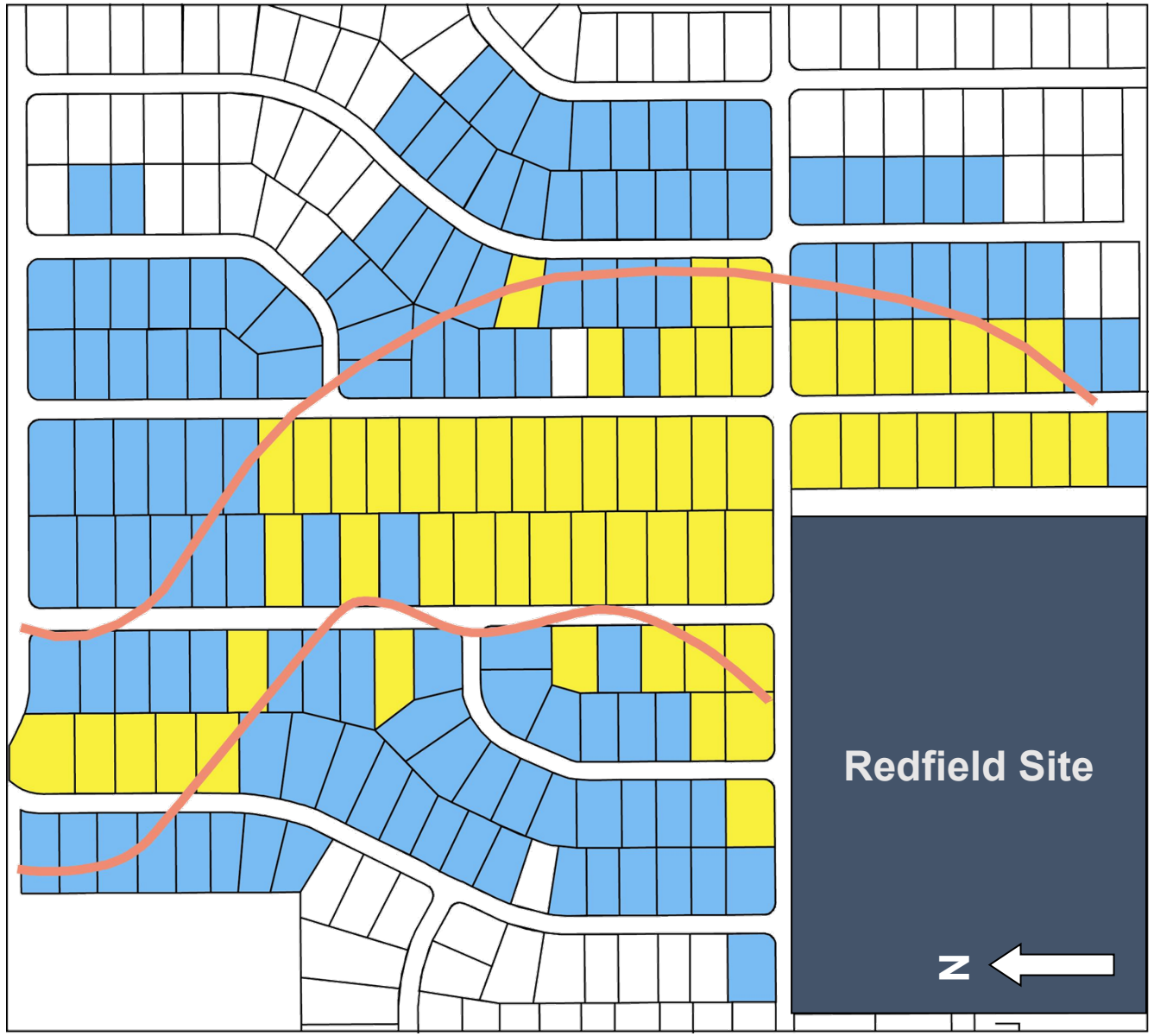
Action level = 0.49 µg/m³

REF = Refused access for testing

Indoor Air Testing Results

1,1-DCE < 0.49 µg/m³

1,1-DCE >= 0.49 µg/m³



Indoor Air Testing Results

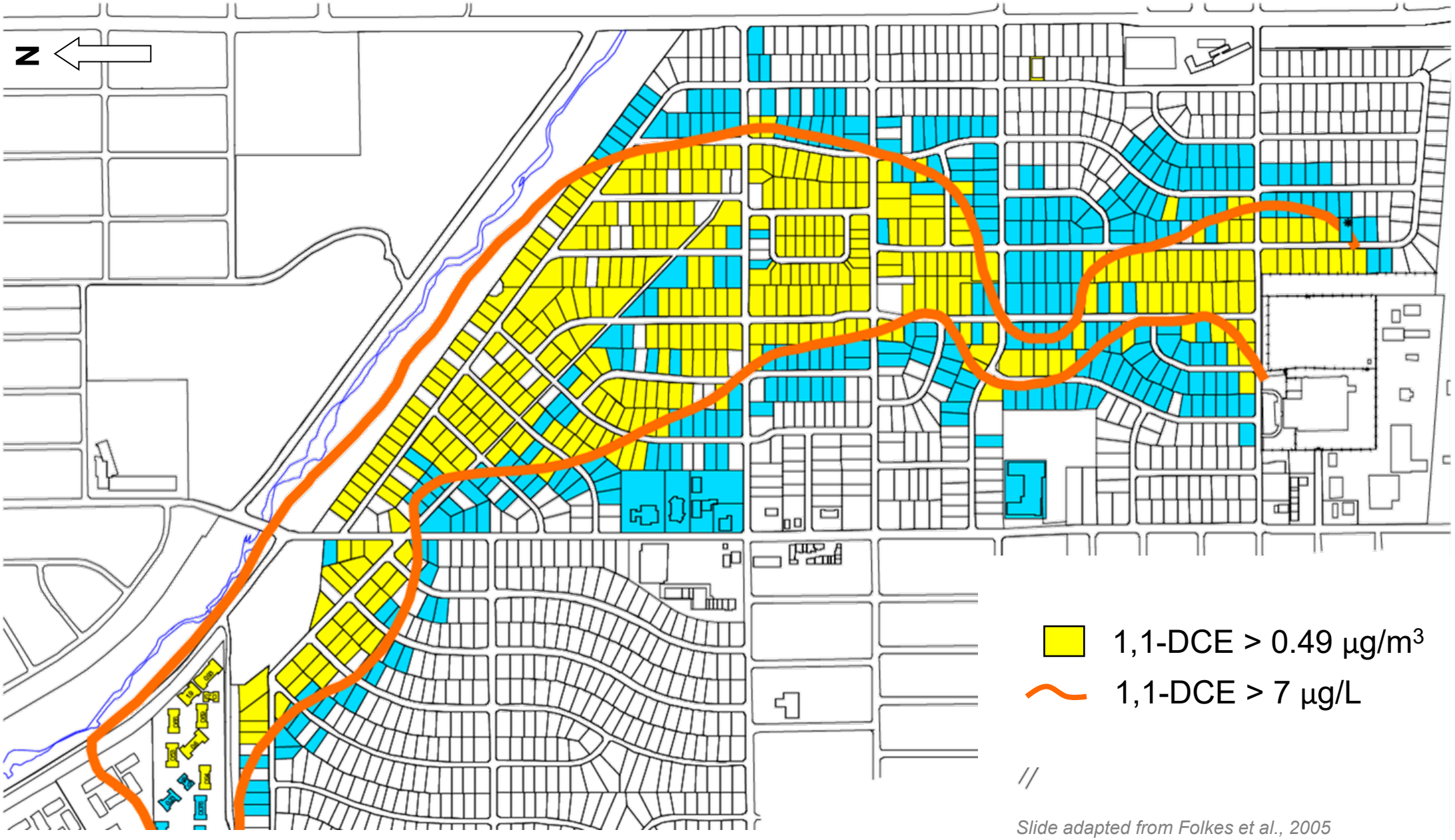
1,1-DCE < 0.49 µg/m³

1,1-DCE >= 0.49 µg/m³

Groundwater Plume

1,1-DCE > 7 µg/L

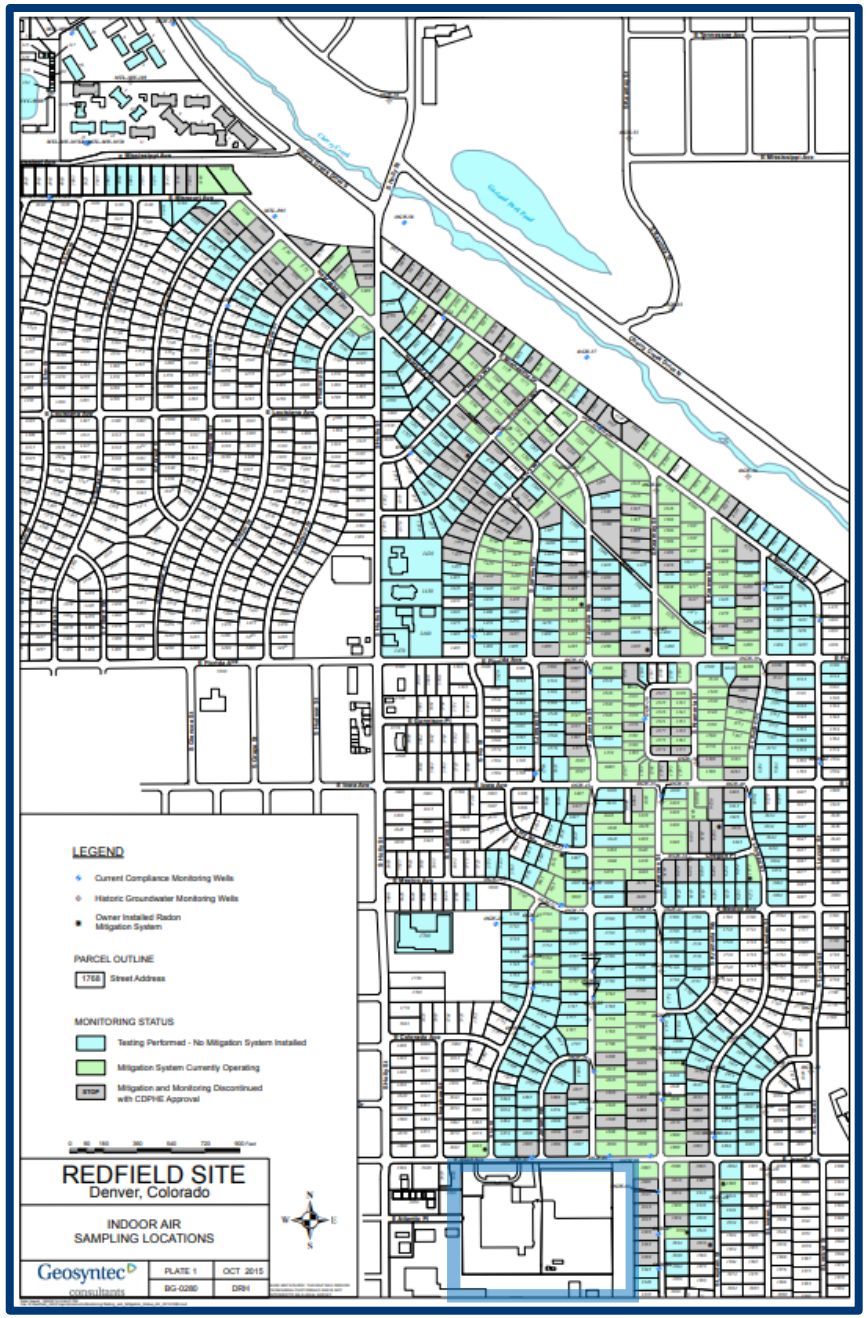
Slide adapted from Folkes et al., 2005



Slide adapted from Folkes et al., 2005

Indoor Air Monitoring Program

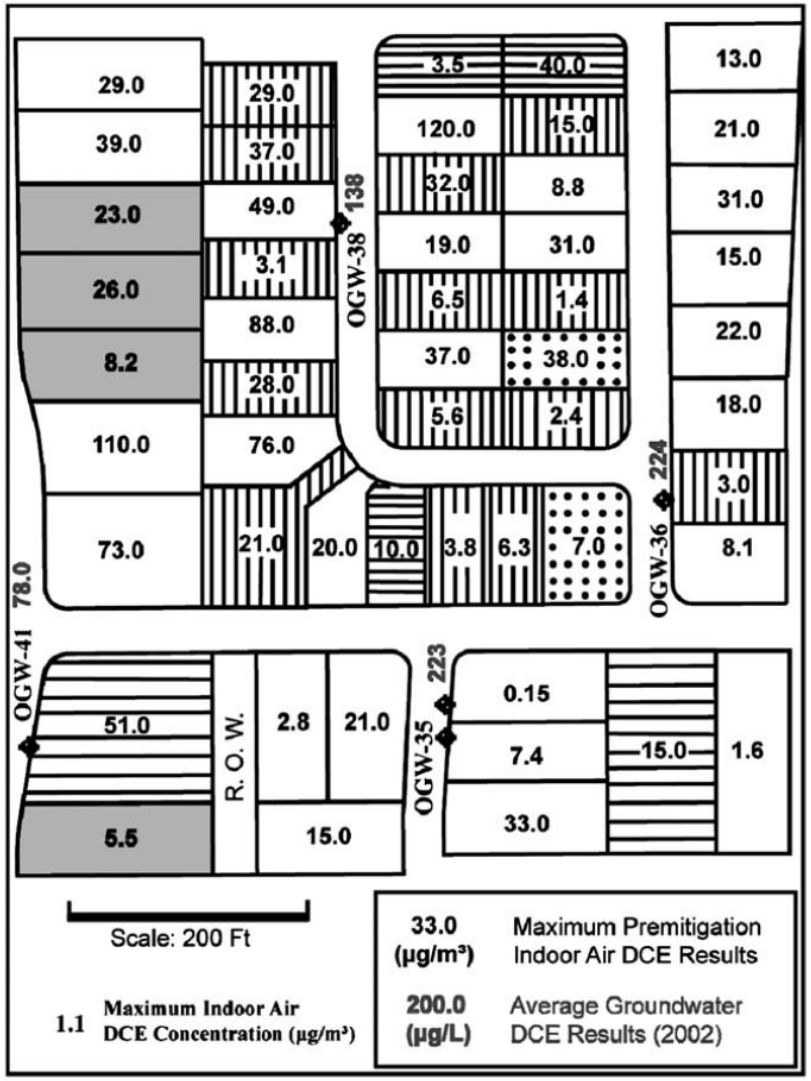
- Indoor air sampling, 1998 – *Present*
  - > 11,500 samples collected
  - > 9,700 indoor air samples
  - > 750 buildings sampled (~99% residential)
  - 387 mitigation systems installed

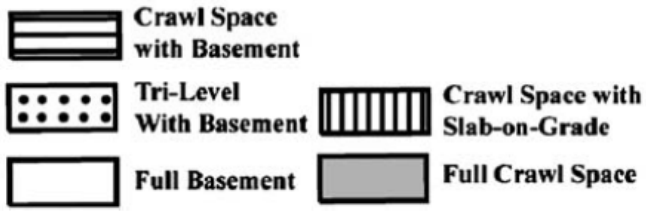


Air Monitoring Program Status Map, 10/2015

Case Study: *Folkes et al., 2009*

- Evaluation of 45 unmitigated homes
  - 2 to 10 years indoor air data (7.8 year average)
  - 715 indoor air measurements
  - Average annual 1,1-DCE indoor air concentration, 0.023 to 0.27 µg/m³

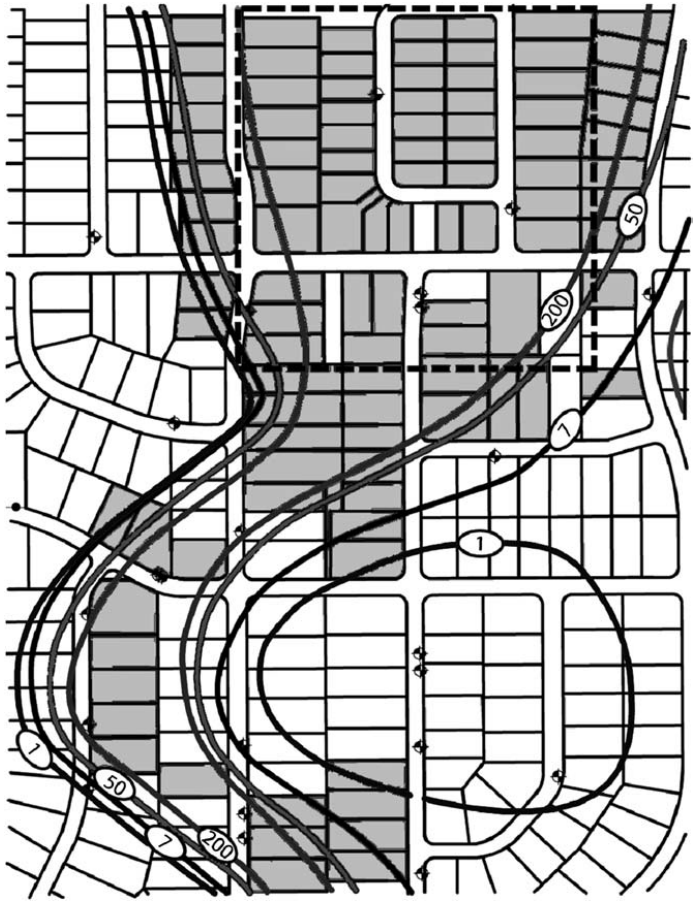




Creating a Soil Gas Safe Community

Key Steps for the Redfield Site

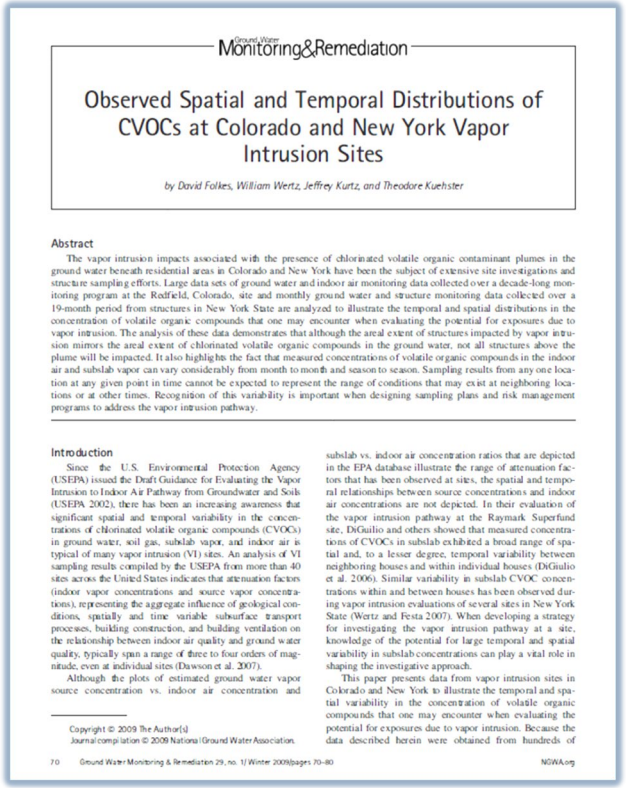
- Initial testing to identify homes requiring mitigation
- Long-term monitoring to avoid false negatives at homes below action levels
- Long-term performance monitoring of mitigated homes



Folkes et al., 2009

References

- Folkes, D., W. Wertz, J. Kurtz, and T. Kuehster. 2009. Observed Spatial and Temporal Distributions of CVOCs at Colorado and New York Vapor Intrusion Sites. *Groundwater Monitoring & Remediation*, *29*(1), 70-80.
- Redfield Site Website; http://www.redfieldsite.org/
- Indoor Air Vapor Intrusion Database; https://iavi.rti.org/workshops.html



Ground Water Monitoring&Remediation

Observed Spatial and Temporal Distributions of CVOCs at Colorado and New York Vapor Intrusion Sites

by David Folkes, William Wertz, Jeffrey Kurtz, and Theodore Kuehster

Abstract

The vapor intrusion impacts associated with the presence of chlorinated volatile organic contaminant plumes in the ground water beneath residential areas in Colorado and New York have been the subject of extensive site investigations and structure sampling efforts. Large data sets of ground water and indoor air monitoring data collected over a decade-long monitoring program at the Redfield, Colorado, site and monthly ground water and structure monitoring data collected over a 19-month period from structures in New York State are analyzed to illustrate the temporal and spatial distributions in the concentration of volatile organic compounds that one may encounter when evaluating the potential for exposures due to vapor intrusion. The analysis of these data demonstrates that although the areal extent of structures impacted by vapor intrusion mirrors the areal extent of chlorinated volatile organic compounds in the ground water, not all structures above the plume will be impacted. It also highlights the fact that measured concentrations of volatile organic compounds in the indoor air and subslab vapor can vary considerably from month to month and season to season. Sampling results from any one location at any given point in time cannot be expected to represent the range of conditions that may exist at neighboring locations or at other times. Recognition of this variability is important when designing sampling plans and risk management programs to address the vapor intrusion pathway.

Introduction

Since the U.S. Environmental Protection Agency (USEPA) issued the Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (USEPA 2002), there has been an increasing awareness that significant spatial and temporal variability in the concentrations of chlorinated volatile organic compounds (CVOCs) in ground water, soil gas, subslab vapor, and indoor air is typical of many vapor intrusion (VI) sites. An analysis of VI sampling results compiled by the USEPA from more than 40 sites across the United States indicates that attenuation factors (indoor vapor concentrations and source vapor concentrations), representing the aggregate influence of geological conditions, spatially and time variable subsurface transport processes, building construction, and building ventilation on the relationship between indoor air quality and ground water quality, typically span a range of three to four orders of magnitude, even at individual sites (Dawson et al. 2007).

Although the plots of estimated ground water vapor source concentration vs. indoor air concentration and subslab vs. indoor air concentration ratios that are depicted in the EPA database illustrate the range of attenuation factors that has been observed at sites, the spatial and temporal relationships between source concentrations and indoor air concentrations are not depicted. In their evaluation of the vapor intrusion pathway at the Raymark Superfund site, DiGuilio and others showed that measured concentrations of CVOCs in subslab exhibited a broad range of spatial and, to a lesser degree, temporal variability between neighboring houses and within individual houses (DiGiulio et al. 2006). Similar variability in subslab CVOC concentrations within and between houses has been observed during vapor intrusion evaluations of several sites in New York State (Wertz and Festa 2007). When developing a strategy for investigating the vapor intrusion pathway at a site, knowledge of the potential for large temporal and spatial variability in subslab concentrations can play a vital role in shaping the investigative approach.

This paper presents data from vapor intrusion sites in Colorado and New York to illustrate the temporal and spatial variability in the concentration of volatile organic compounds that one may encounter when evaluating the potential for exposures due to vapor intrusion. Because the data described herein were obtained from hundreds of

Questions?

Thank you,

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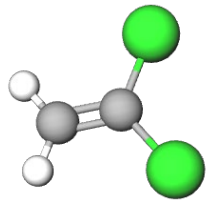
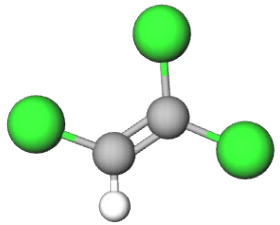
Back-up Slides

Screening Levels vs. Time



1,1-DCE
1,1-Dichloroethylene

0.46 µg/m³ → 0.49 µg/m³ → 5.0 µg/m³ → 7.3 µg/m³

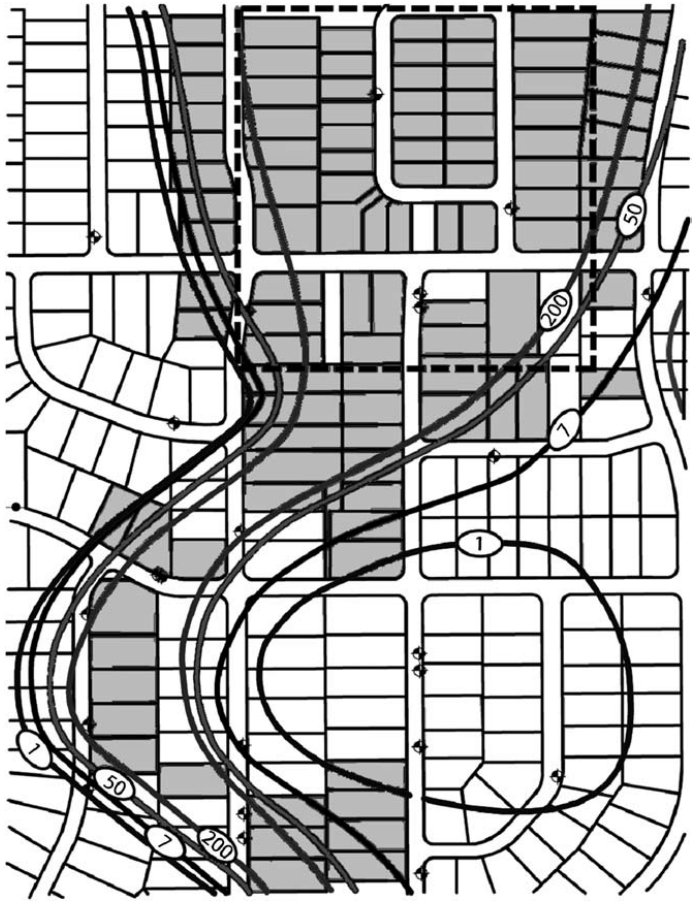


TCE
Trichloroethylene

0.8 µg/m³ → 2.1 µg/m³

Site Background

- VOC impacted groundwater plume (**1,1-DCE**, 1,1,1-TCA, TCE)
- Variable geology; sand, silt, clay, weathered sedimentary rock
- Variable depth to groundwater (< 3’ to 50’)
- On- and off-site groundwater treatment



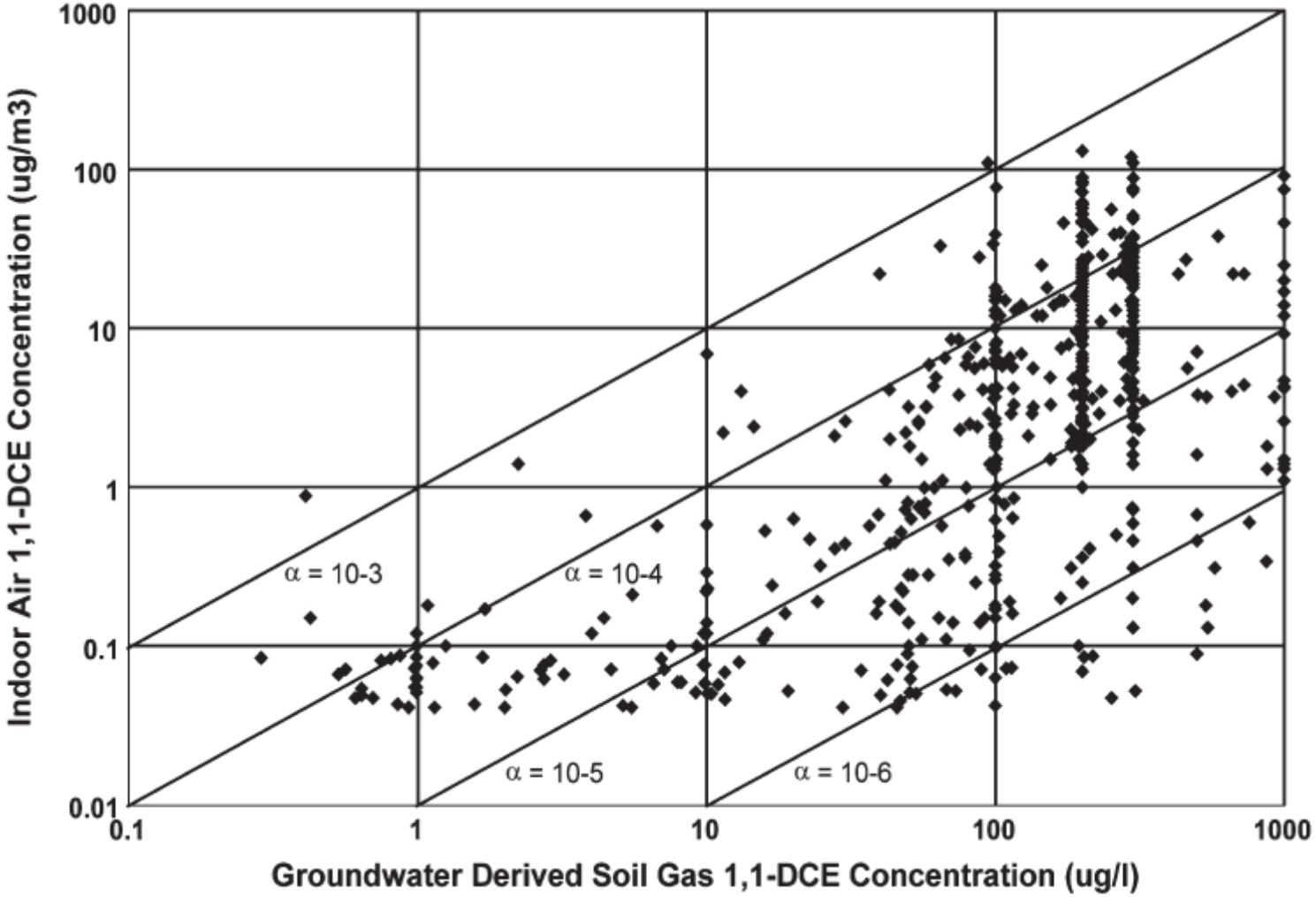
Folkes et al., 2009

Site Background

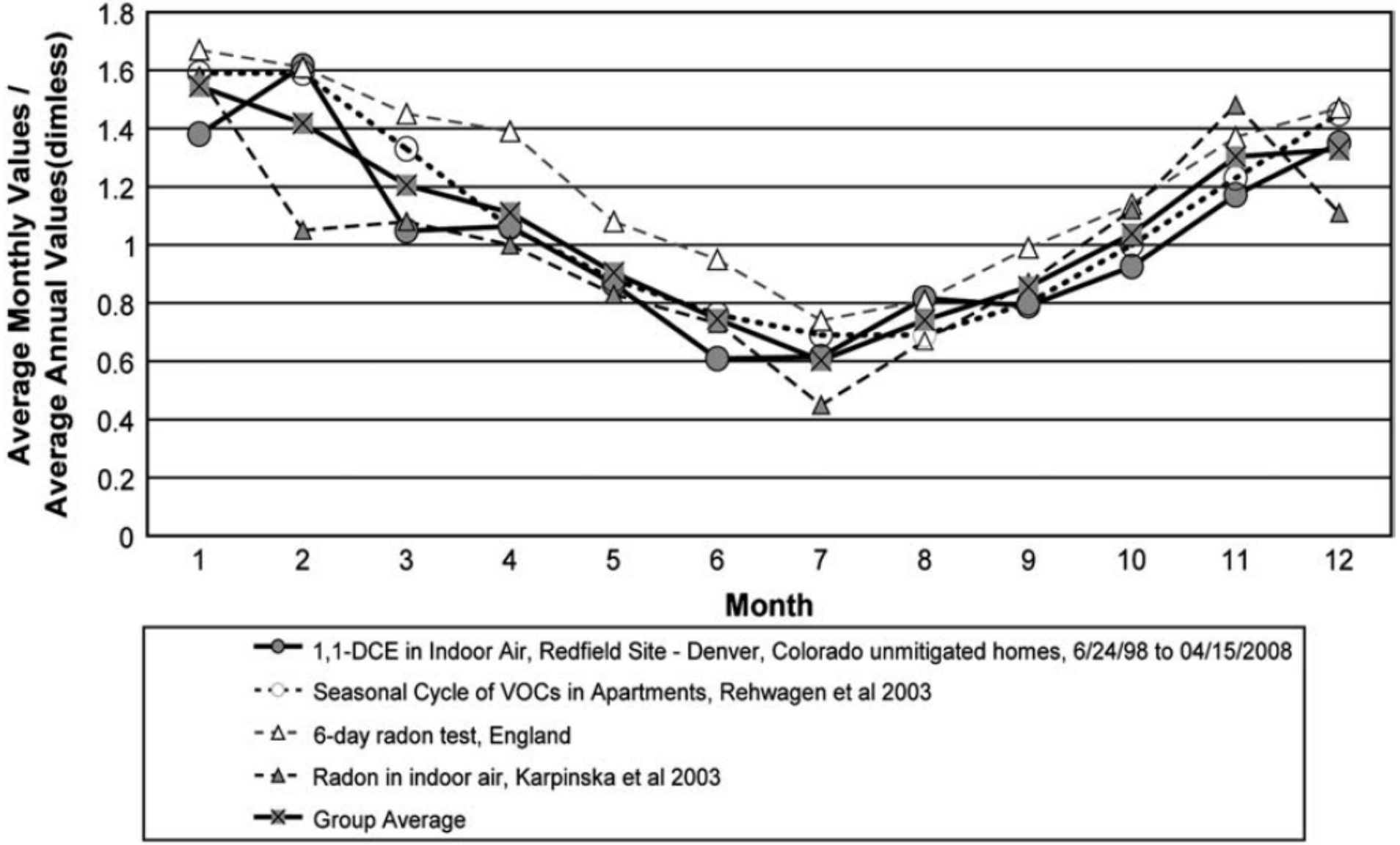
- Variable building construction and characteristics
- Homes mainly constructed in 1950s, mostly forced air heating; however, a variety of building construction and HVAC types are observed across the site

Google Earth, 6/1993

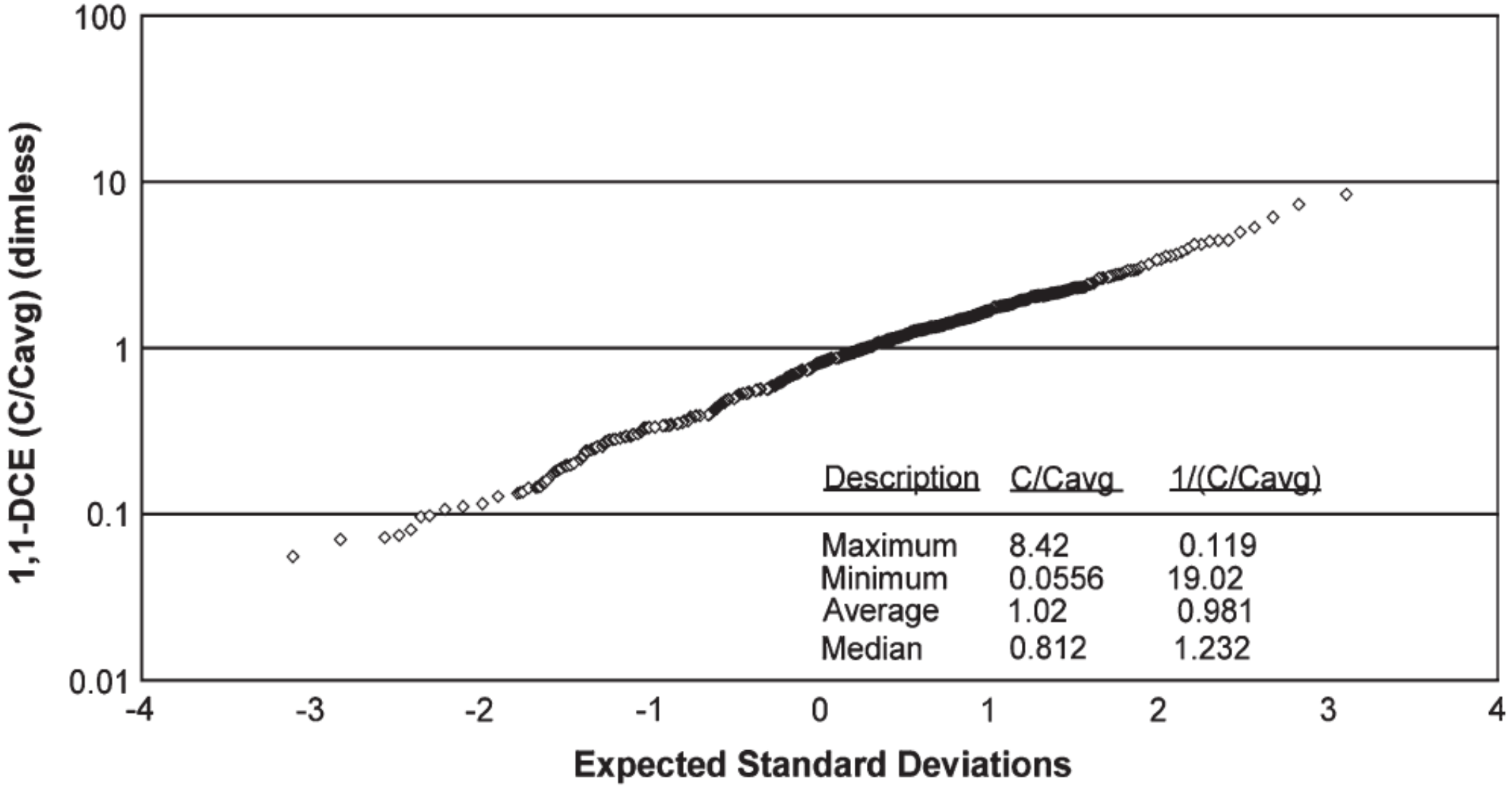
Case Study: *Folkes et al., 2009*



Groundwater derived soil gas concentration versus pre-mitigation indoor air concentration of 1,1-DCE (*1998-2003*)



Case Study: *Folkes et al., 2009*



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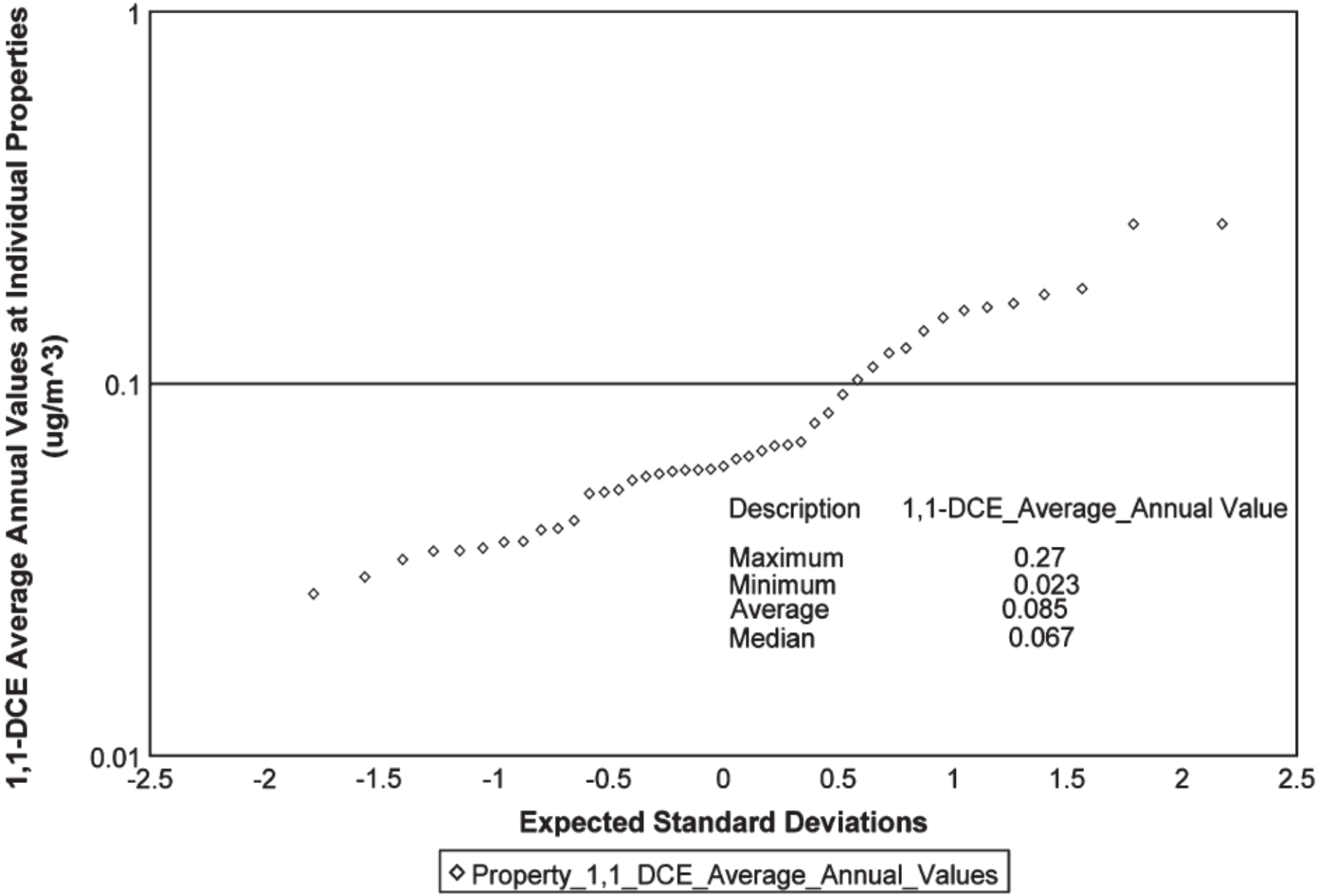

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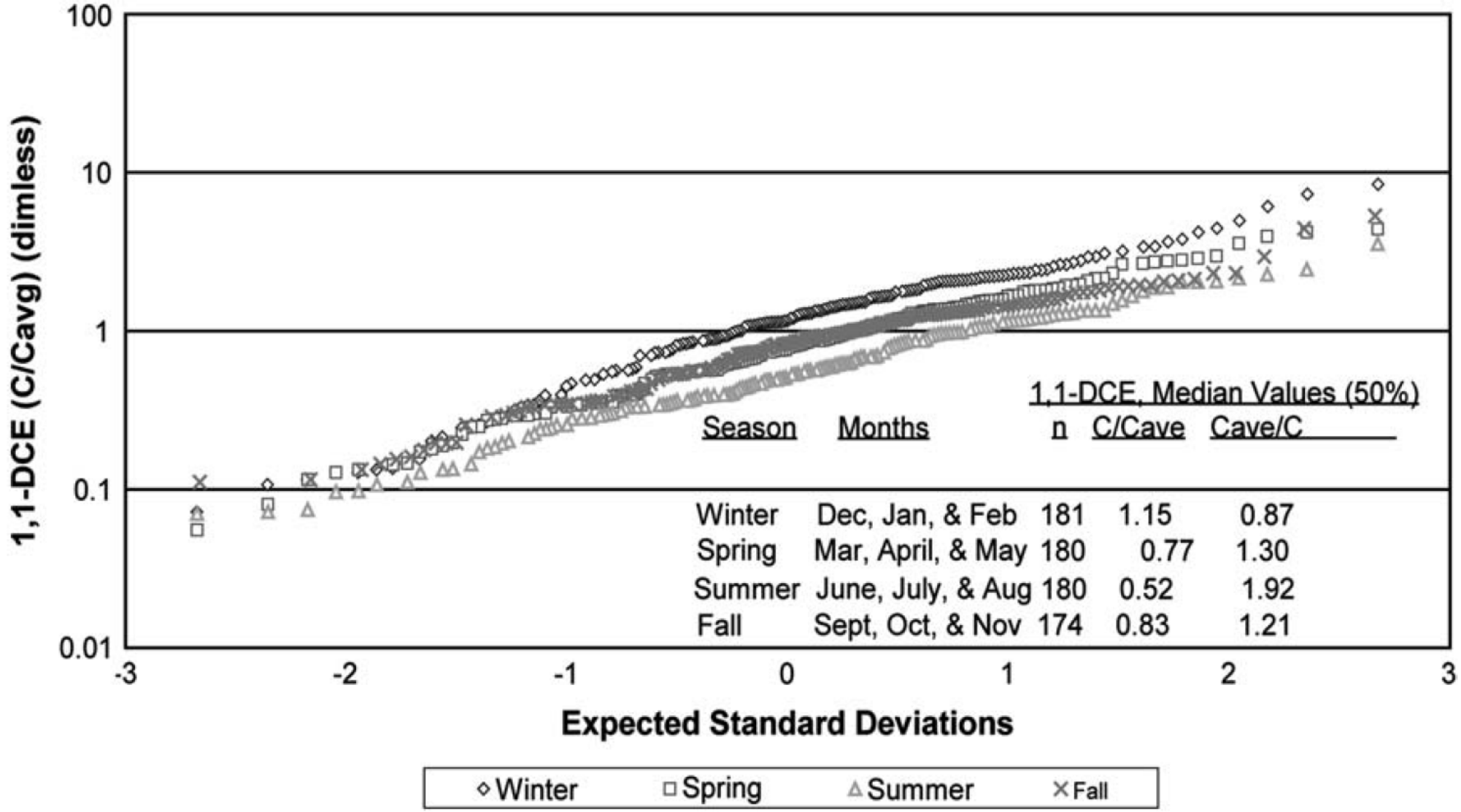

Case Study: *Folkes et al., 2009*