Evaluation of the Petroleum Vapor Intrusion Risk of Ethylene Dibromide (EDB) and 1,2 Dichloroethane (1,2 DCA)

RemTech

2017

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Background

Petroleum Vapour Intrusion

A subset of Vapour Intrusion, from

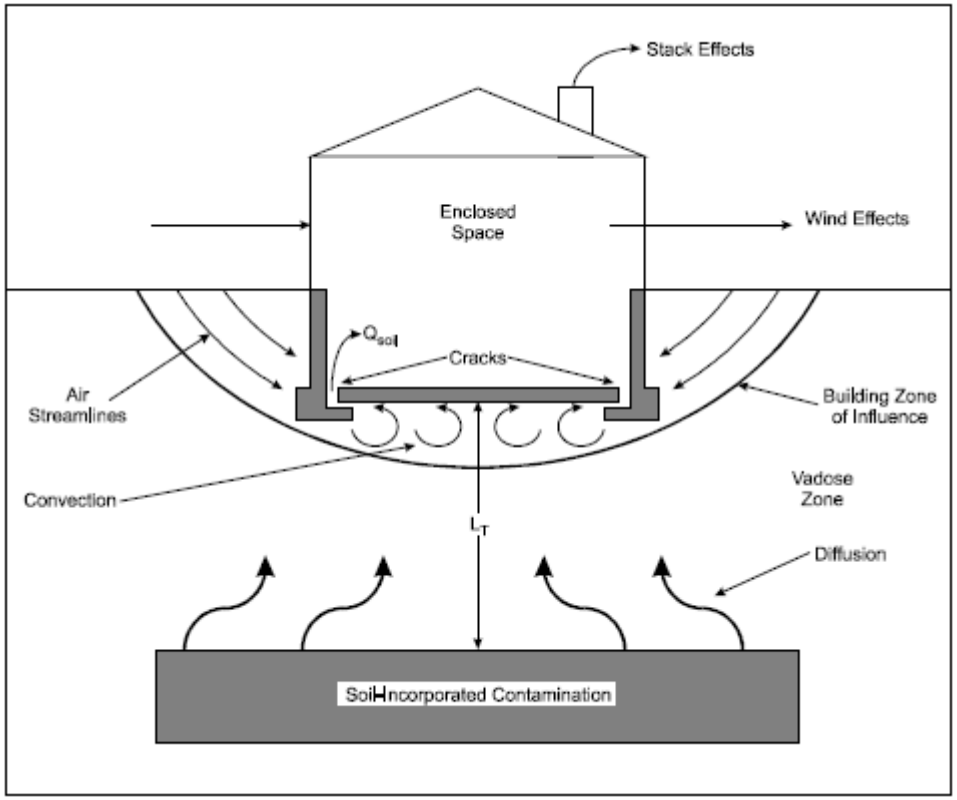
- Light nonaqueous phase liquids (LNAPL) source
- PHC contaminated soil and
- PHC contaminated groundwater

Migration is often limited by microorganisms that are normally presented in soil, which is different than

- Radon and
- Chlorinated solvents vapour

Occurrence of Petroleum Vapor Intrusion

- Documented occurrences of PVI intrusions are rare
- Assessment largely driven by vapour modelling that does not consider biodegradation (J-E model)



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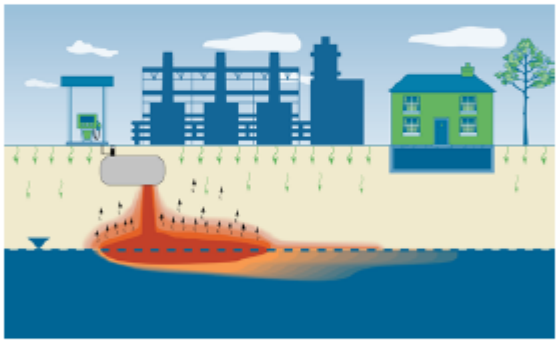
PVI screening distance

Guidance Document

Petroleum Vapor Intrusion

Fundamentals of Screening, Investigation, and Management



October 2014

Prepared by
The Interstate Technology & Regulatory Council
Petroleum Vapor Intrusion Team

United States Environmental Protection Agency

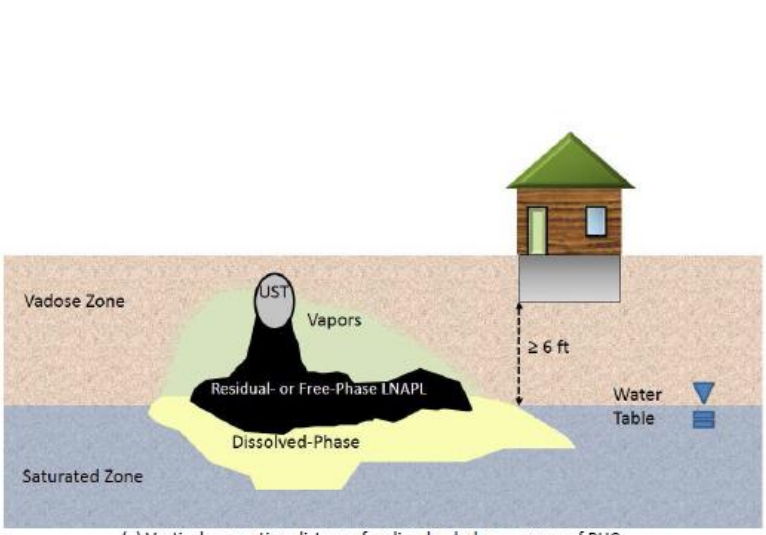
EPA 510-R-15-001

Technical Guide For Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites

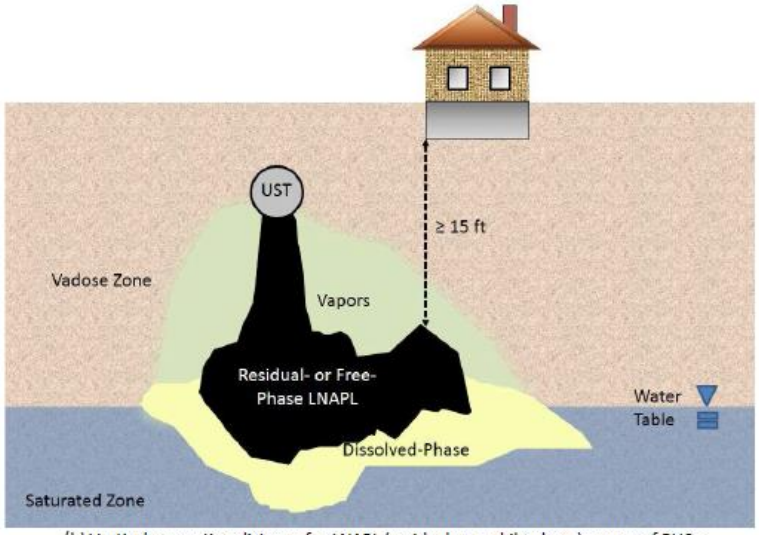
U.S. Environmental Protection Agency
Office of Underground Storage Tanks
Washington, D.C.

June 2015

PVI Screening Distance –Vertical



(a) Vertical separation distance for dissolved-phase source of PHCs.



(b) Vertical separation distance for LNAPL (residual or mobile phase) source of PHCs.

Figure 6. Vertical Separation Distances Between Source Of PHC Contaminants And Hypothetical Receptor: (a) Dissolved Source, (b) LNAPL Source.

Figures © EPA

PVI Screening Distance – Lateral

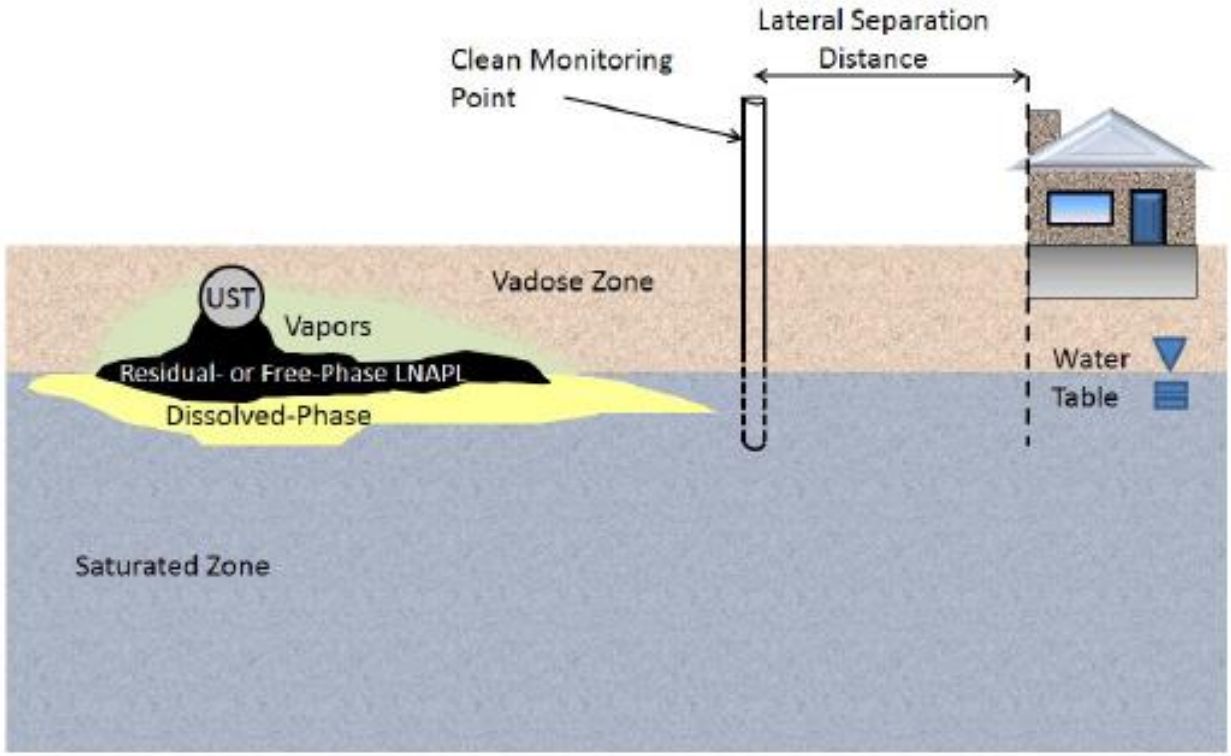


Figure 5. Lateral Separation Distance Between Source Of PHC Contamination And Hypothetical Receptor

Figures © EPA

PVI-Screen Distance – Precluding Factors

- Influence of methanogenesis on oxygen demand - higher ethanol blends of gasoline
- Effect of extensive high organic matter soils (e.g. peat) with potentially high natural oxygen demand
- Reduce oxygen flux caused by certain geological conditions (which are not favorite aerobic microorganisms)
- Fractured rock
- Non UST sites (refinery, terminals) and
- Leaded gasoline sites

Lead Scavengers

Use

- EDB = lead additive; soil fumigant
  - 1,2 DCA = lead active; commercial chemical/solvent, paints, etc.

Chemical Properties

Compound	Henry's Low Constant	Vapor Pressure (mm Hg)	Effective Solubility-Gasoline[a]	Effective Air-phase Saturation (ug/L)
EDB	0.027	11	1,900	51
1,2DCA	0.048	79	3,700	178
Benzene	0.23	95	15,000	3,450

a - Falta, 2004. Ethylene Dibromide and 1,2-Dichloroethane Contamination from Leaded Gasoline Releases, Ground Water Management - Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Assessment, and Remediation Conference, , pp. 252-260

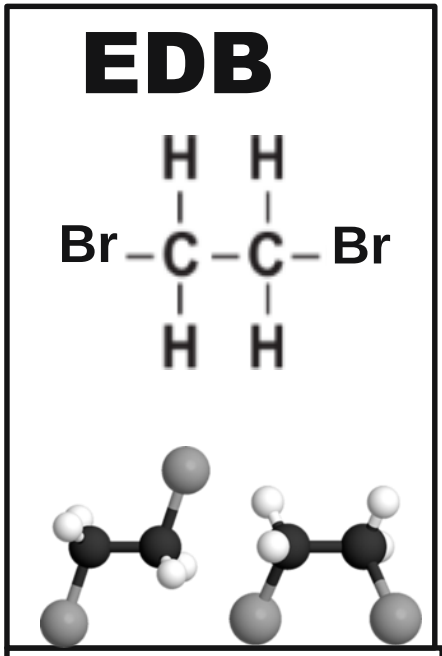
Background: Biodegradation

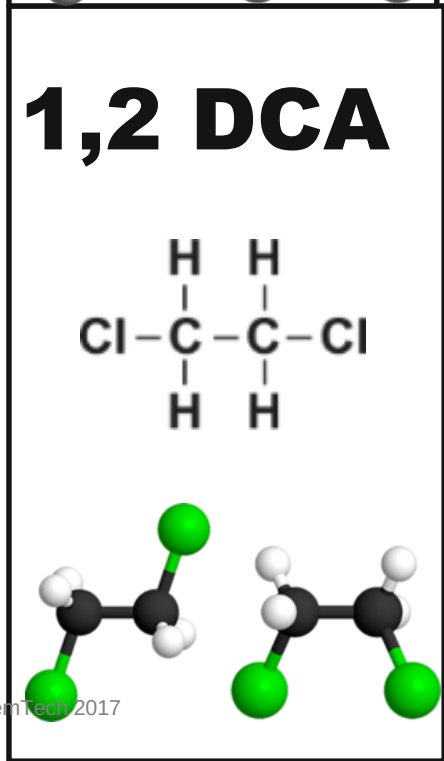
Fate and Transport (in subsurface)

- Aerobic biodegradation
  - EDB: $t_{1/2}$ = days – weeks
  - 1,2 DCA: $t_{1/2}$ = days – > several months

- Anaerobic:
  - EDB: $t_{1/2}$ = months
  - 1,2 DCA: $t_{1/2}$ = months – years; sulfate, methanogenic conditions only

Co-metabolic biodegradation demonstrated (methane), yet biodegradation may be slowed in the field by the presence of other hydrocarbons.





Background: Analytical Methods

Method	1,2 DCA	EDB	Screening Level[a]	
			1, 2 DCA	EDB
Groundwater (μg/L)				
8260B	3	3	5	-
8011		0.01		
Soil Vapour (μg/m^3)				
8260B	100	200	0.4	1
TO 15	4-8	7.5-15		
TO-15 (sim)	0.2	0.4		

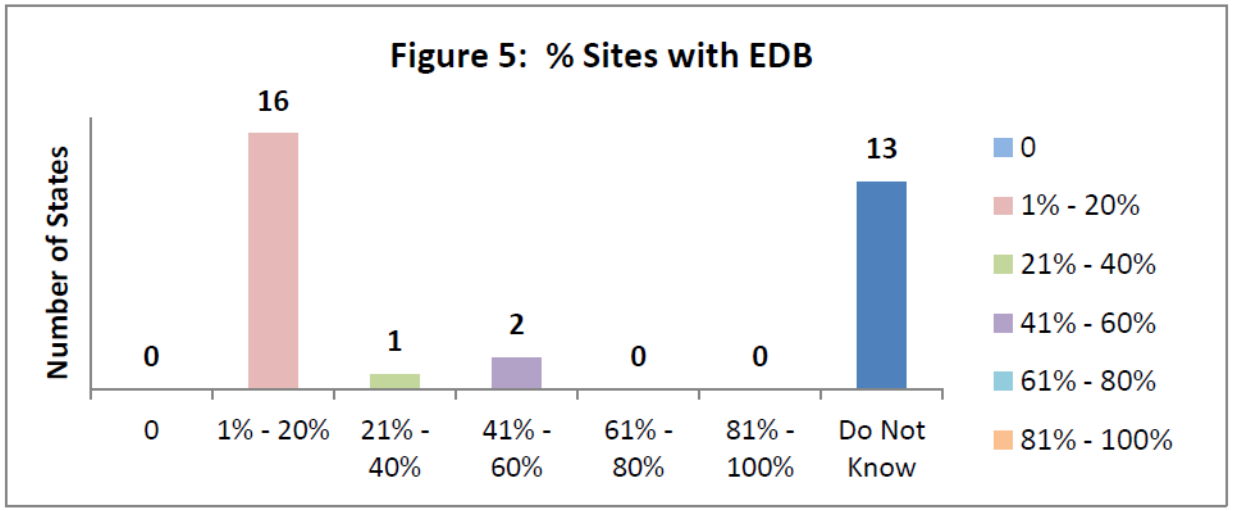
a - contaminated site regulation, British Columbia Ministry of Environment 2014

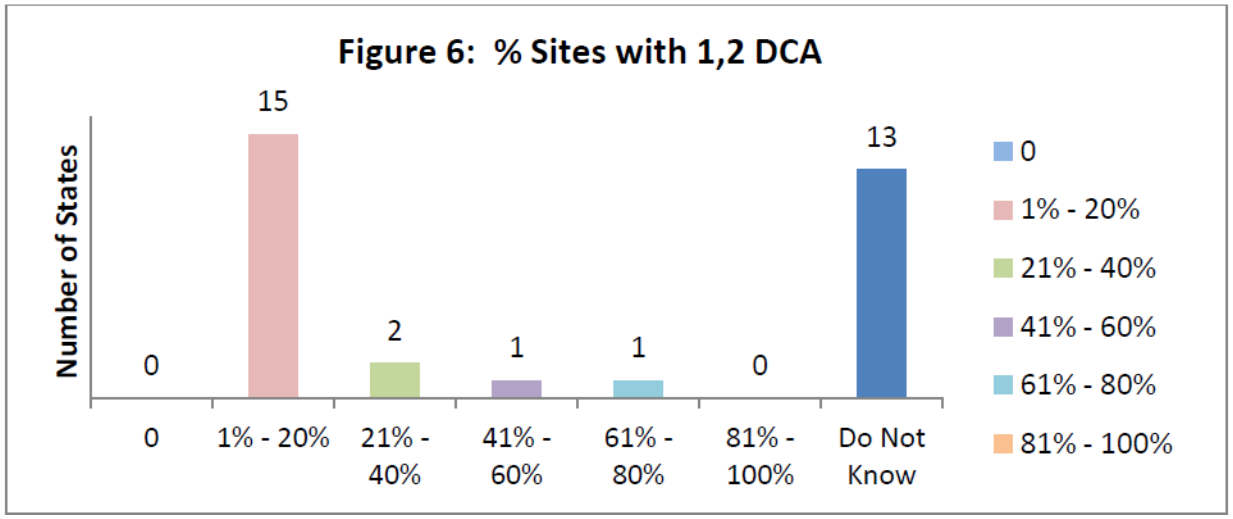
Background: Occurrence (EDB United States)

The distribution of EDB in the sites included in the OUST State Survey is similar to the distribution in South Carolina.

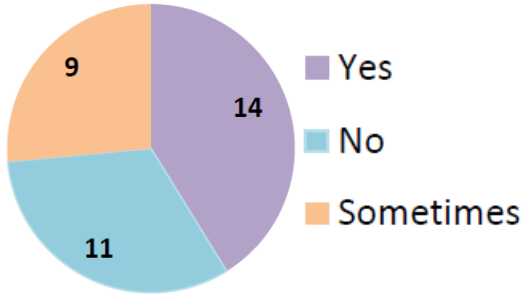
Maximum Concentration at Site	South Carolina (Falta data)	OUST State Survey
	Percent of Sites	
Above 100 µg/L	7%	6%
Above 50 µg/L	11%	10%
Above 1 µg/L	35%	25%
Above 0.05 µg/L	50%	42%

Background: Occurrence in the US

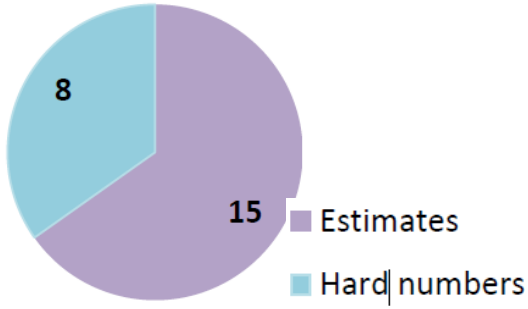




# of states monitoring for lead scavengers

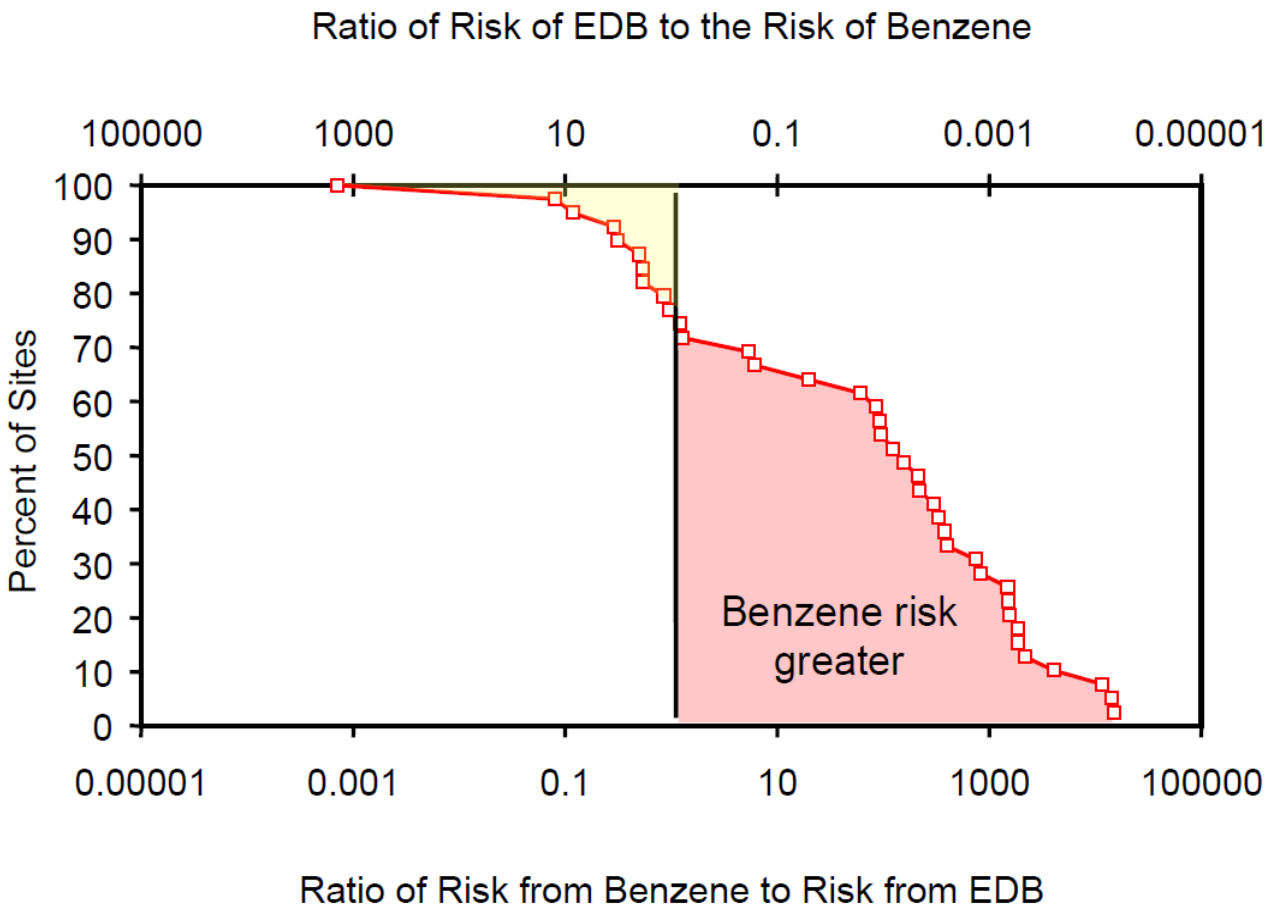


# of states w/ %'s based on estimates or hard data



ASTSWMO, 2014. Lead Scavengers Survey Report: Prepared by LUST Task Force, August 2014.

Background: Risk (EDB)© EPA



Our Study

Background/Initiative

- New methodology developed for PVI site screening
- Method based on use of vertical screening distances
- Method incorporated into ITRC, US EPA OUST, and California Low Threat Tank Closure Policy
- Historical leaded gasoline releases defined as ‘’precluding factor’’ in US EPA OUST & ITRC guidance

Objectives

- Assess PVI risk
- Develop risk-based exclusion distance criteria for use in PVI assessments at petroleum-hydrocarbon release sites based on sound science

Empirical Databases

SNC-Lavalin 139 UST sites – Western Canada	Sites	% of database
Pb scavengers in groundwater (analyzed)	66	47
Pb scavengers > DLs in groundwater EDB = 0.5 μg/L;1,2-DCA = 0.5 μg/L	7	5*

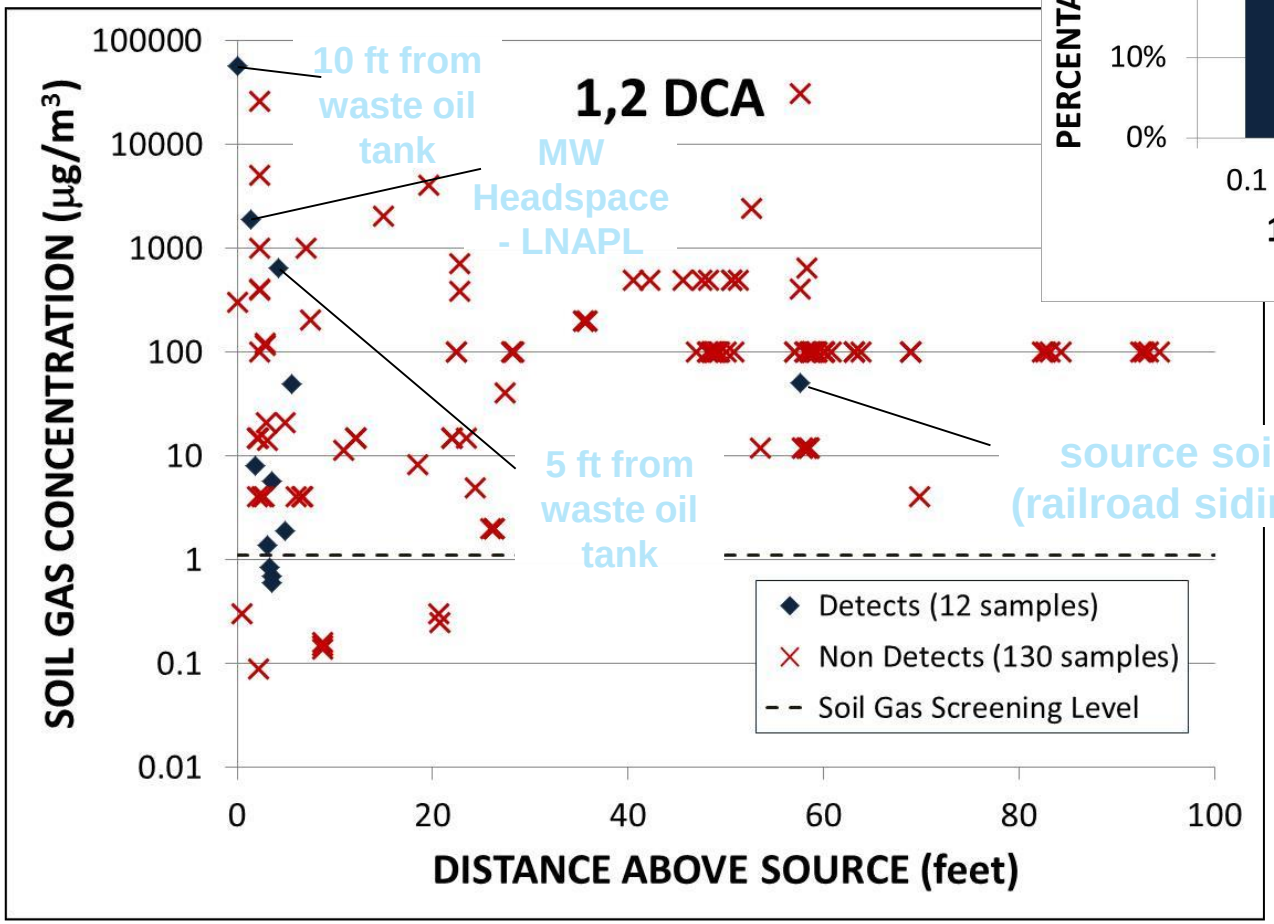
Geotracker Database

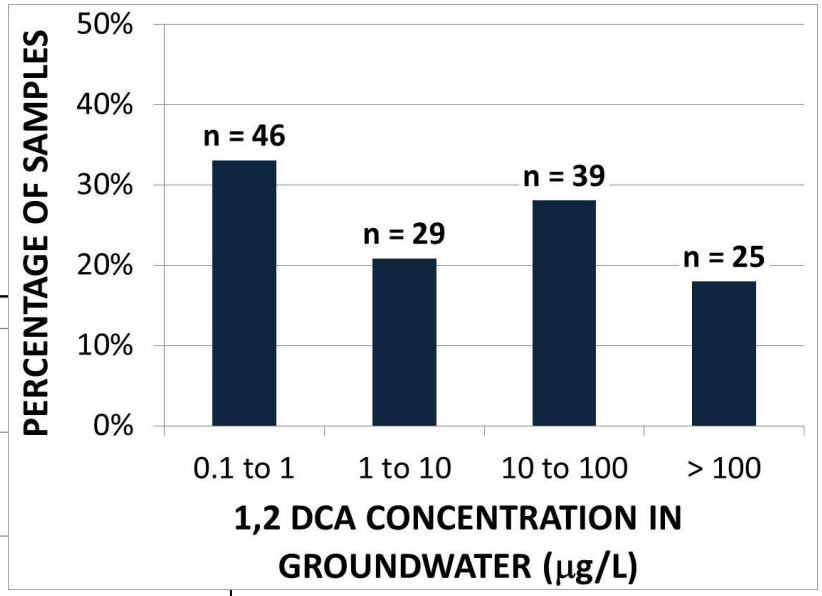
Area Name (25)	#Total Sites (extracted)	GW L.S. analyzed	Soil Gas L.S. Analyzed	Both	Paired points
Alameda	767	109	51	10	3
Butte	102	6	3	1	0
Contra Costa	277	48	29	9	0
Orange	796	796	156	156	36
Riverside	351	352	65	65	0
SanLuisObispo	158	158	3	3	0
Frensno	209	209	14	14	0
Salano	750	686	62	51	0
SantaCruz	173	173	18	18	0
Shasta	40	32	2	1	0
Sutter	42	37	3	3	0
Tuolumne	43	38	8	7	0
Kings	49	36	12	10	1
Lake	46	28	2	1	0
Los Angeles	2,161	255	114	12	3
Mariposa	22	12	2	2	0
Merced	150	150	33	33	0
Napa	115	115	8	8	0
Sacramento	395	40	34	4	0
SanBernardino	211	27	11	5	0
SanDiego	1,000	170	68	2	0
SantaBarbara	352	88	10	1	0
Sonoma	457	81	15	4	0
Ventura	390	59	10	3	0
Yuba					
Total	**9,056**	**3,705**	**733**	**423**	**43**

Database Development: General Elements

- Groundwater and soil gas concentrations
- Soil gas sampling method (vapor probe, monitoring well head space)
- Soil type (presence of fractured rock)
- Surface cover (asphalt, open, building)
- Source type (LNAPL, dissolved)
- Water-table elevation
- Facility type (UST, industrial)
- Sampling dates
- Presence of fractured rock (excluded)
- Vertical separation distances
- Lateral offset (source, monitoring well)
- Method (detection limits)
- Site operational history (releas pre-1986, operation pre-1986)
- QA/QC (including leak testing, no on-going remediation, GW well screened across water table)

1,2 DCA: All Data

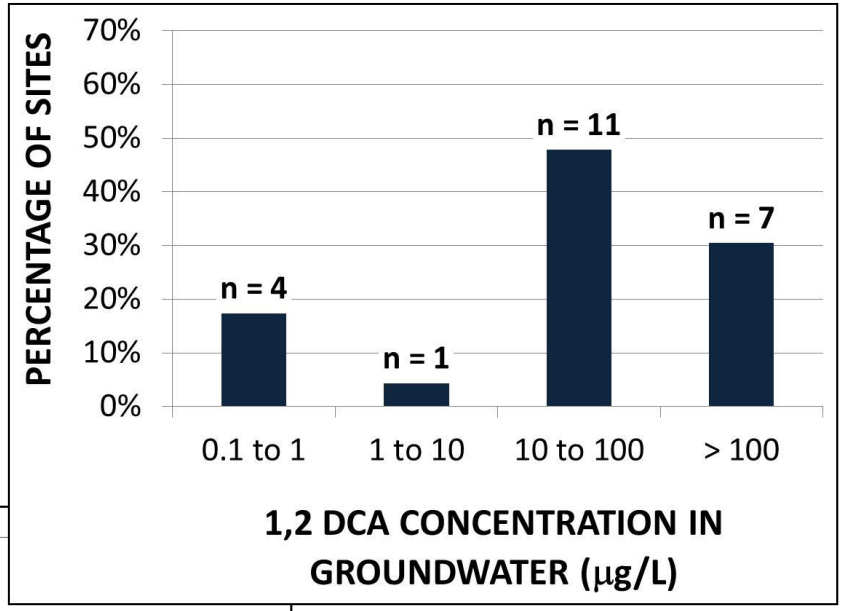


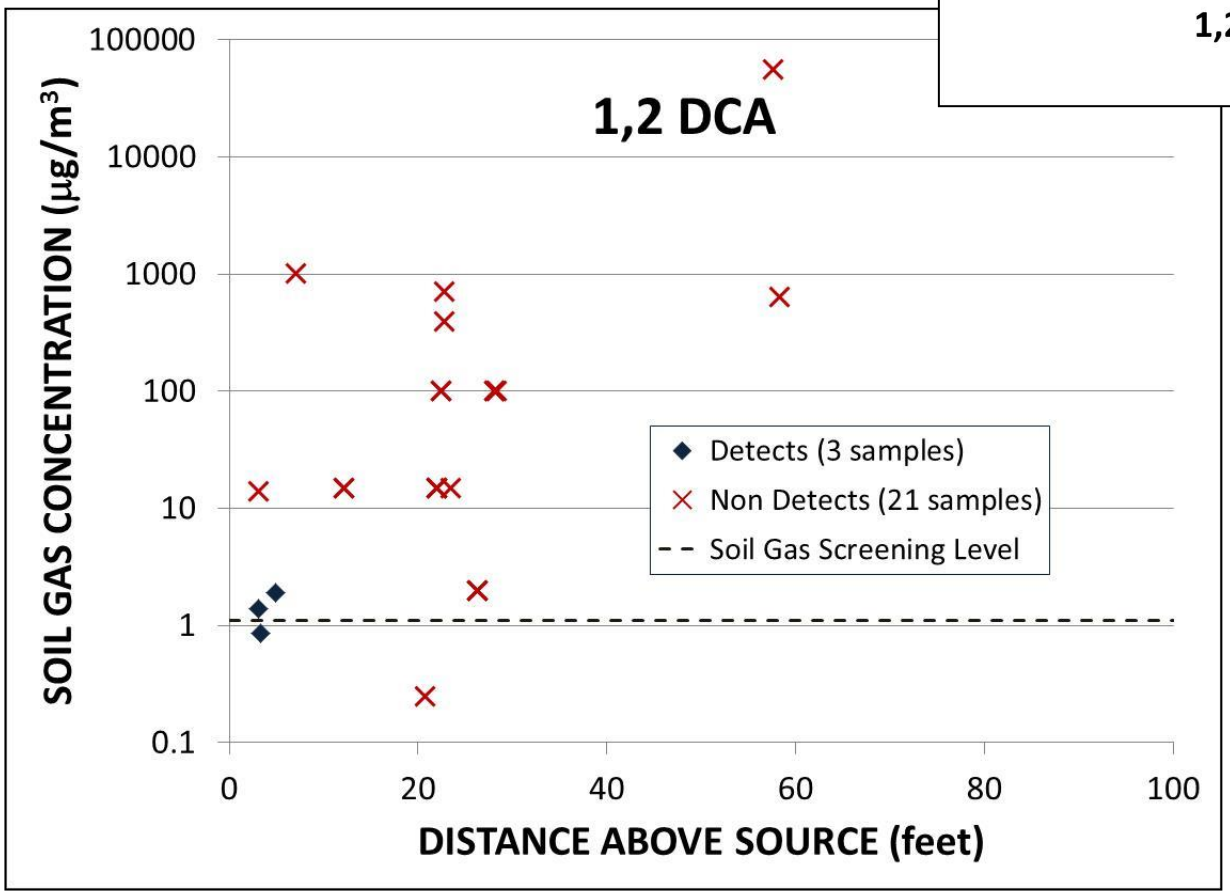


1,2 DCA: Paired Data

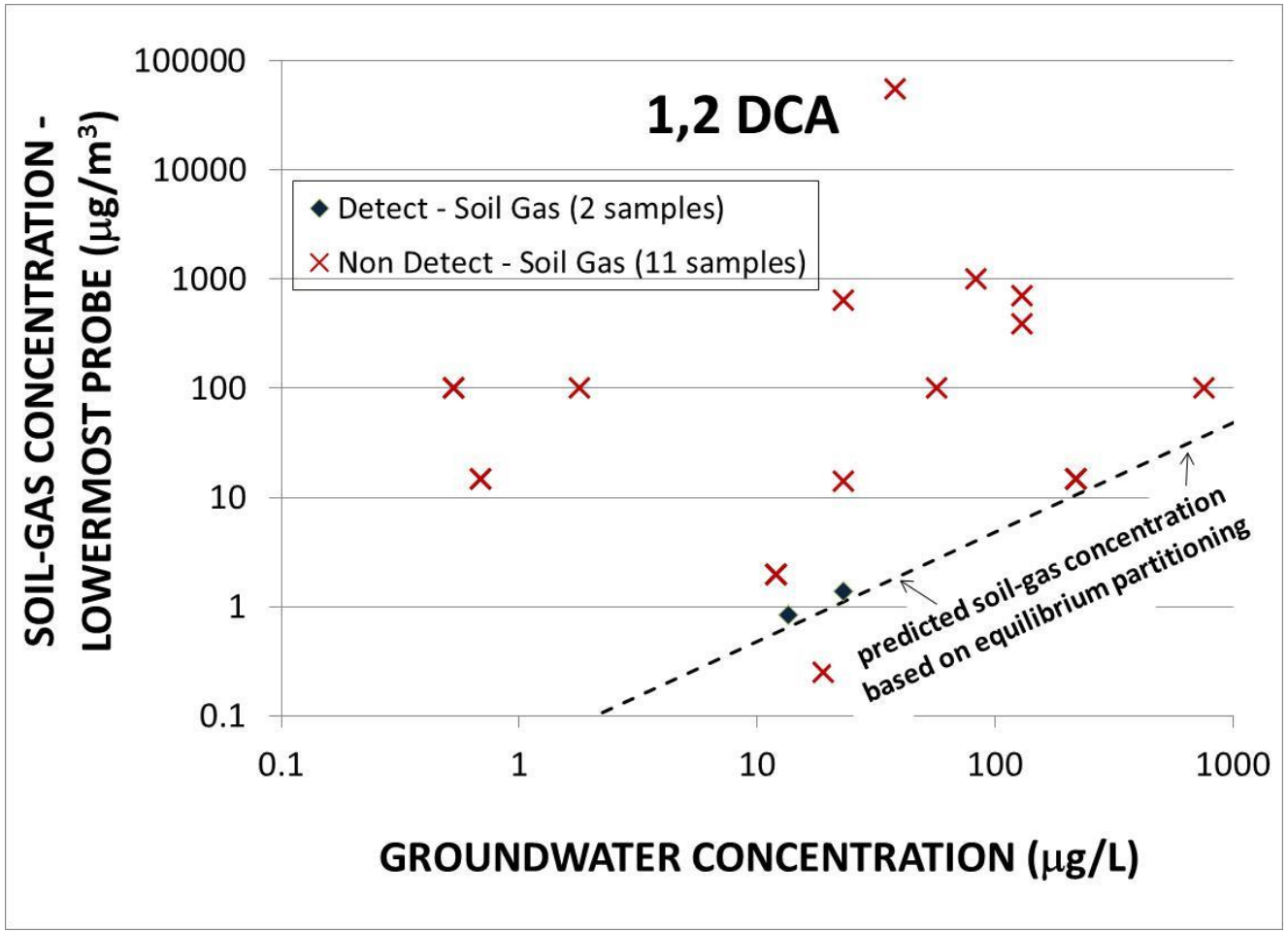
PAIRED DATA

- < 30 days between sample events
- < 30 ft between sample locations
- vapour probe only
- > 10 ft from source areas (waste-oil tanks)

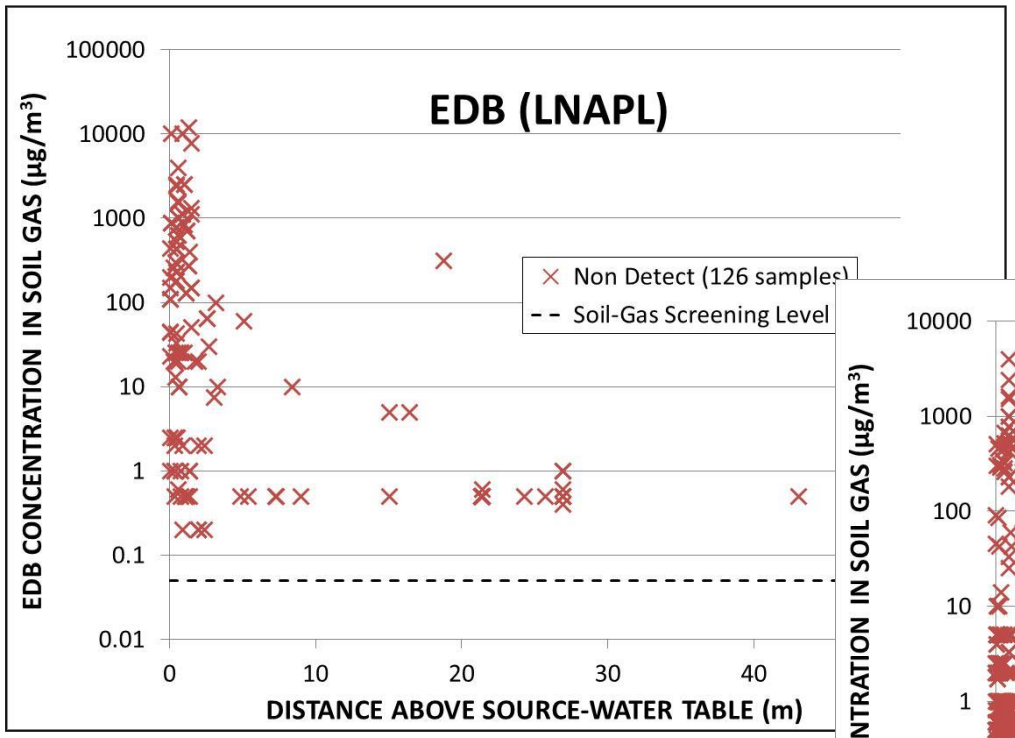


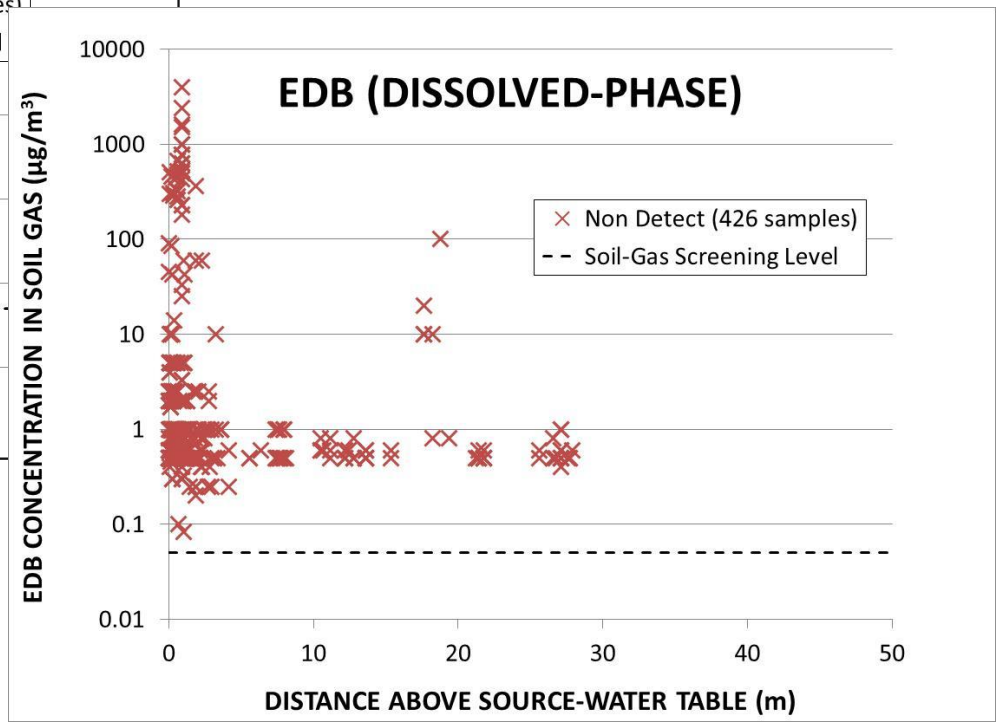


1,2 DCA: Paired Data

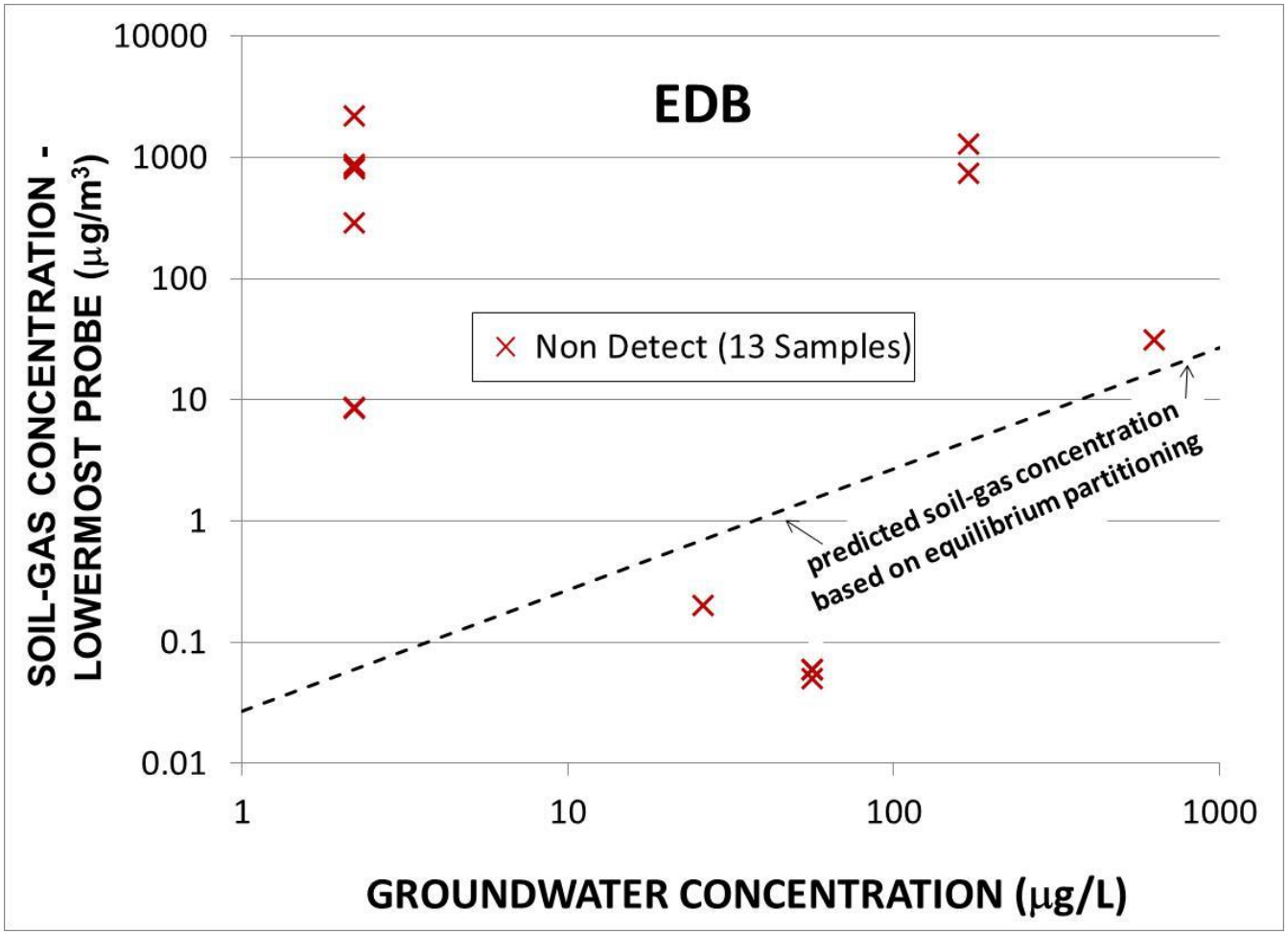


EDB: All Sites with Historical Use of Leaded Gasoline





EDB: Paired Data



Conclusions

- Inability to assess screening distances
  - Lots of ND data (method DLs and RLs above soil-gas screening levels, especially for EDB)
  - Few representative soil-gas/groundwater data pairs

- Empirical data indicate limited PVI risk
  - Aerobic biodegradation – rates similar to benzene
  - Volatility – lack of occurrence in groundwater
  - Results consistent with empirical studies (limited detections of hydrocarbons in soil-gas above dissolved-phase sources)

Acknowledgements

Matthew Lahvis, Ph.D.,
Team Lead Soil and Groundwater
(Shell Projects and Technology US)

Janice Paslawski, Ph.D., P.Eng.
Director, Risk Assessment Centre of Excellence
(SNC-Lavalin)

Values that guide us

Our values keep us anchored and on track. They speak to how we run our business, how we express ourselves as a group, and how we engage with our stakeholders and inspire their trust.

Teamwork & excellence
We're innovative, collaborative, competent and visionary.

Customer focus
Our business exists to serve and add long-term value to our customers' organizations.

Strong investor return
We seek to reward our investors' trust by delivering competitive returns.

Health & safety, security and environment
We have a responsibility to protect everyone who comes into contact with our organization.

Ethics & compliance
We're committed to making ethical decisions.

Respect
We consistently demonstrate respect for all our stakeholders.