A Graphic Approach to Interpreting Vapor Intrusion Data with Radar Plots

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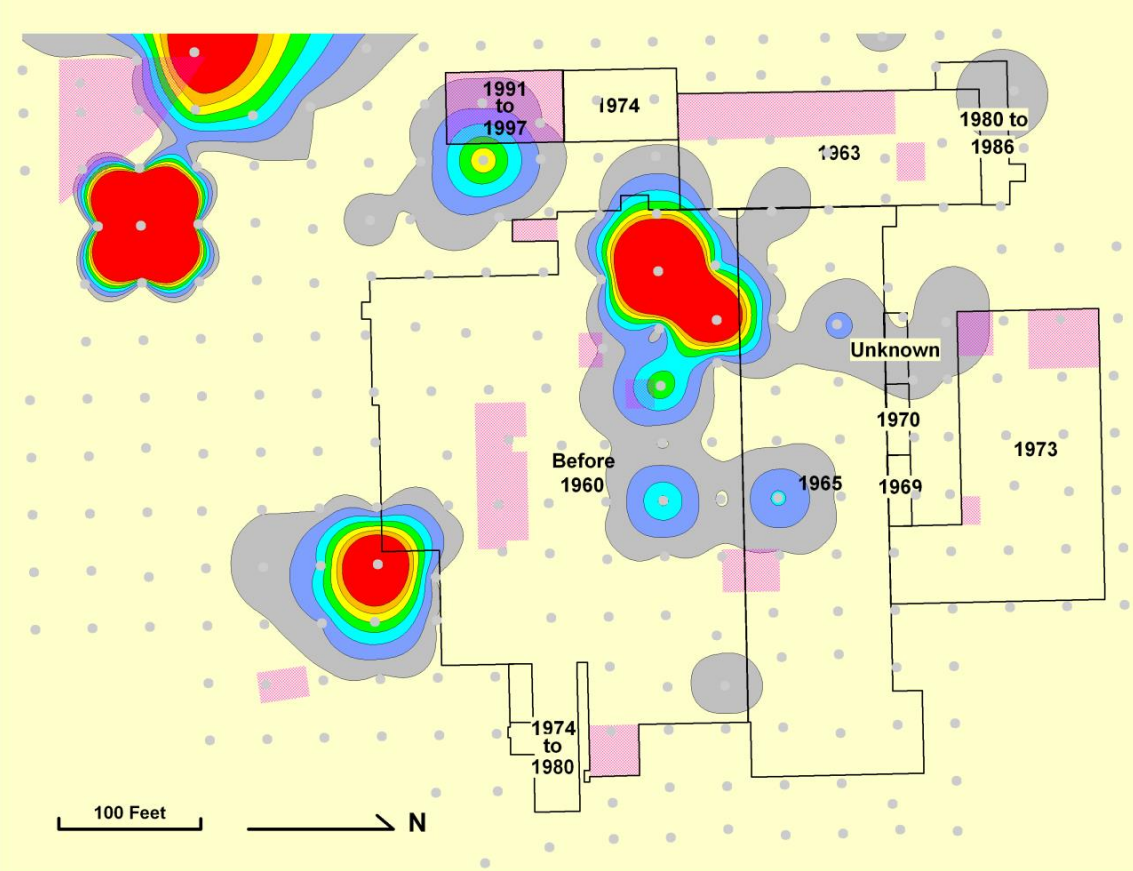
Presented at the
Ohio Brownfield Conference 2014
Columbus, Ohio
April 9, 2014

Cox-Colvin & Associates



Martin (Mort) Schmidt, CPG

Vapor Intrusion Model

CONSISTENT RATIOS

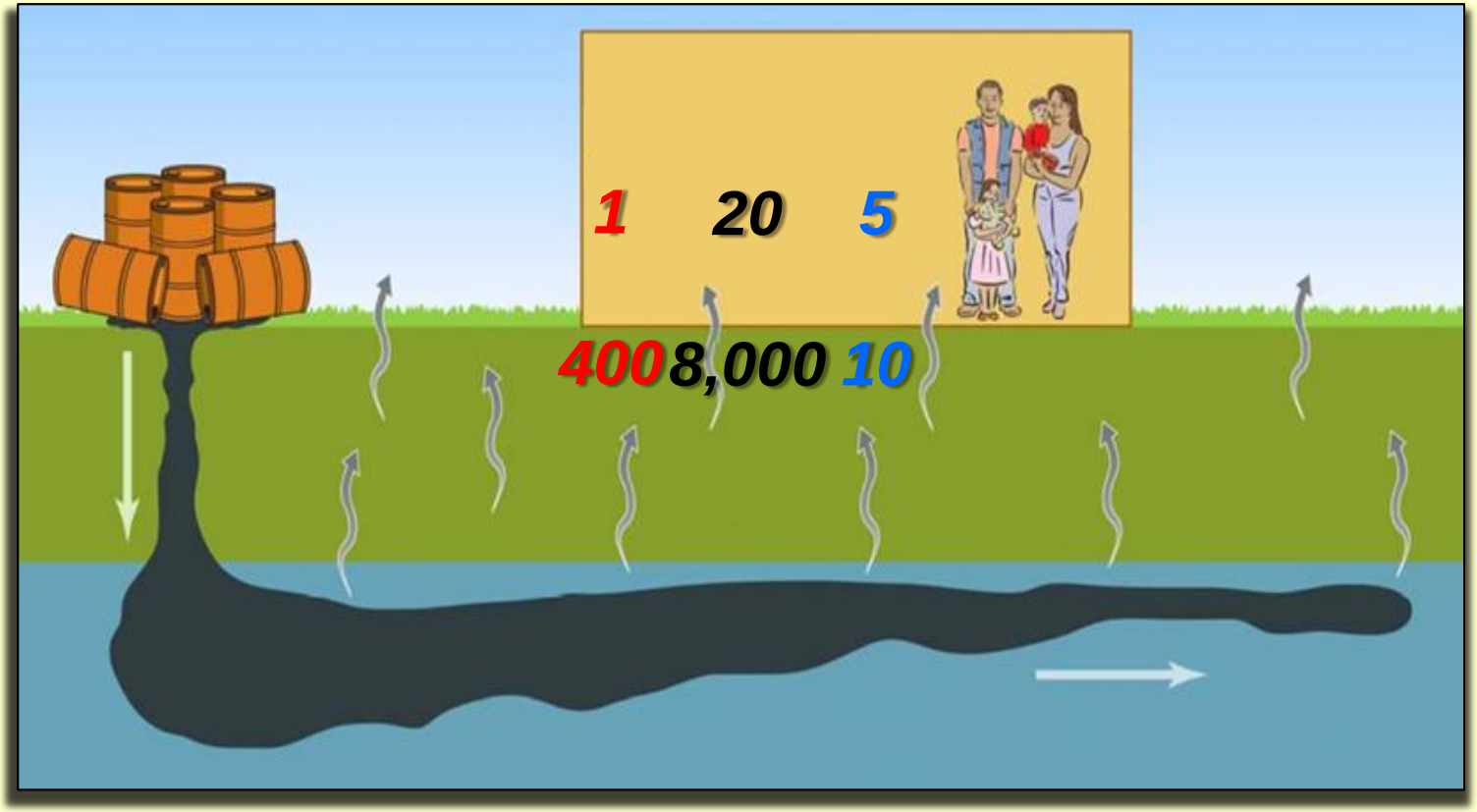
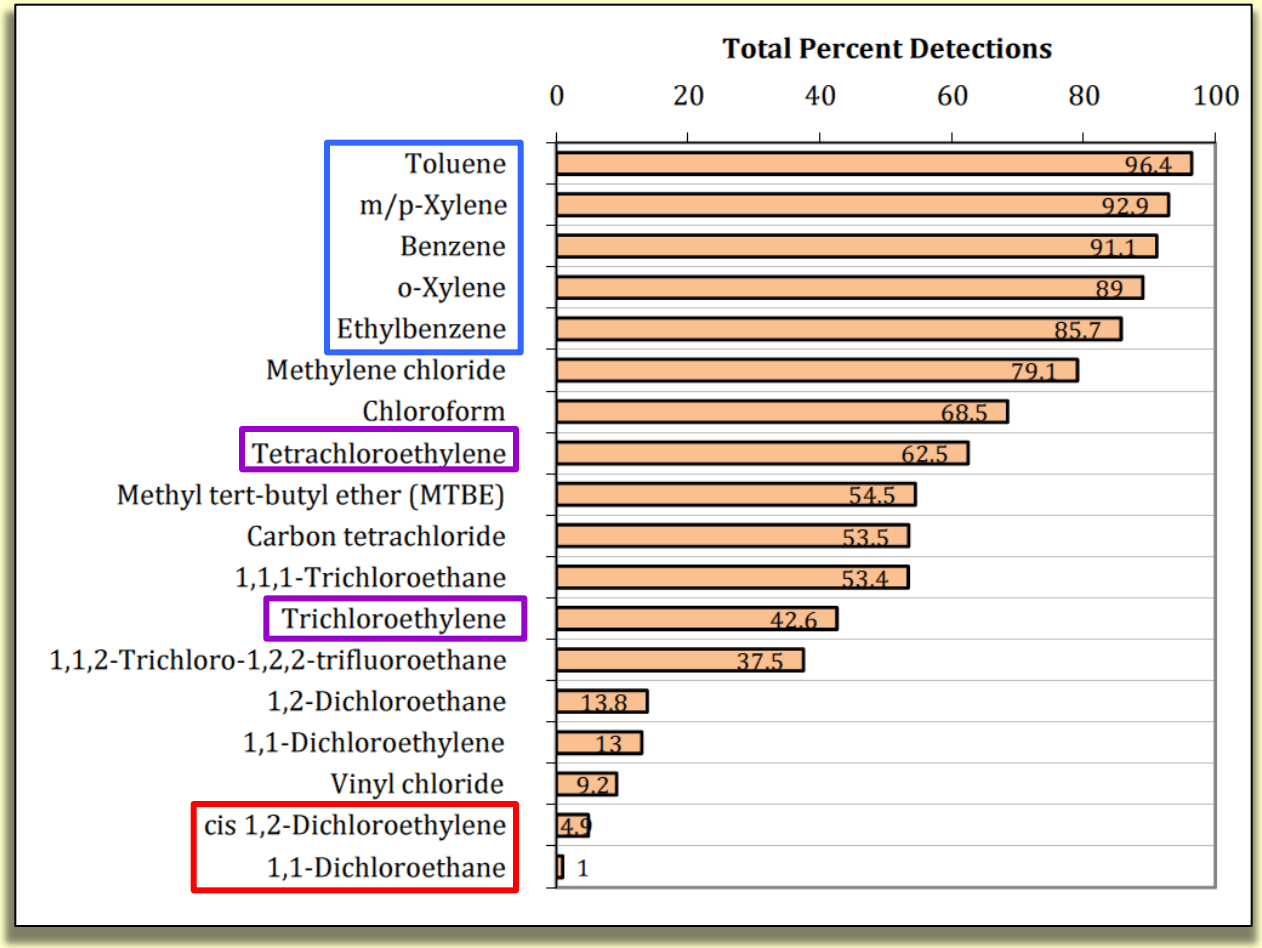


Figure Modified After ITRC, 2007

Background VOCs



Ubiquitous In Background

Probably Vapor Intrusion

Figure from USEPA 2011, Background Indoor Air Concentrations, EPA /530/R-10/001

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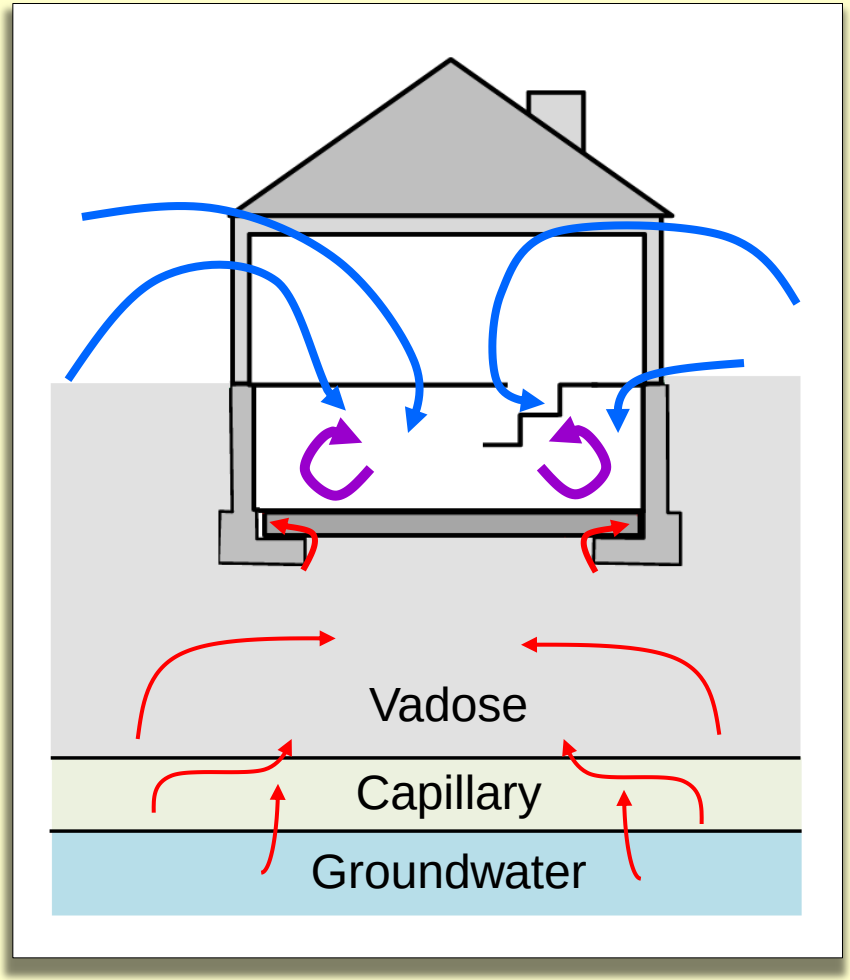
Attenuation Processes



Indoor Air

$$\frac{1.2\ m^3}{244\ m^3} = 0.005$$

$$CI = 0.0012$$

Using EPA 2004 User's Guide defaults

Compare Indoor Ratios to Subsurface

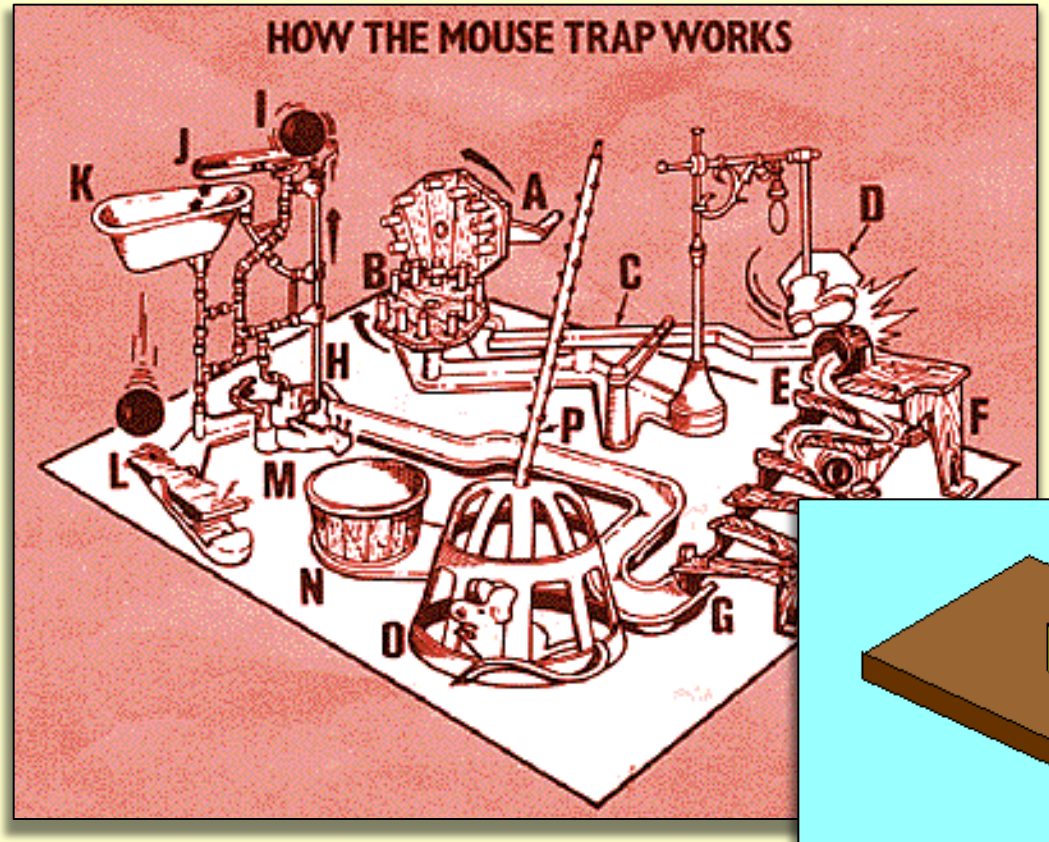
Example:

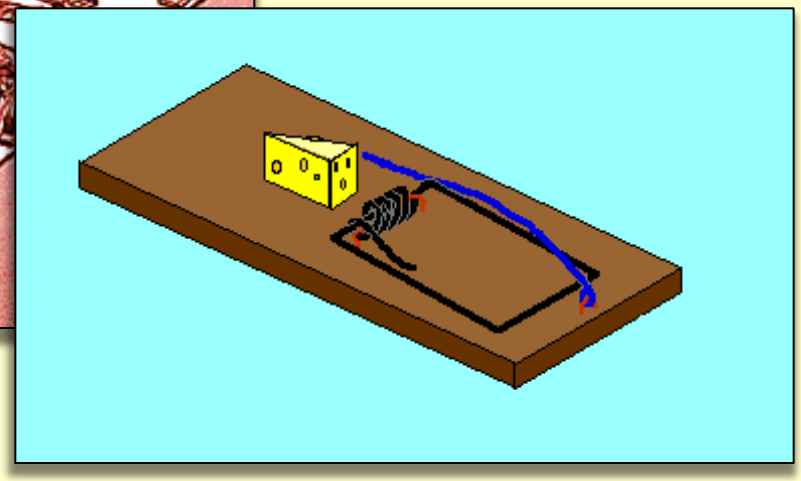
- **TCE is 10 X > PCE in water, soil gas, and/or sub-slab**
- **PCE > TCE in indoor air**
- **It is reasonable to conclude there is an interior (background) source of PCE**

ITRC 2007

Multiple Lines of Evidence (MLE)

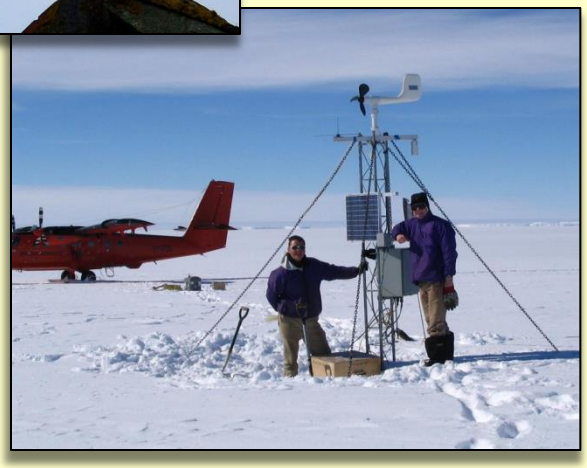
Maybe Something Simpler

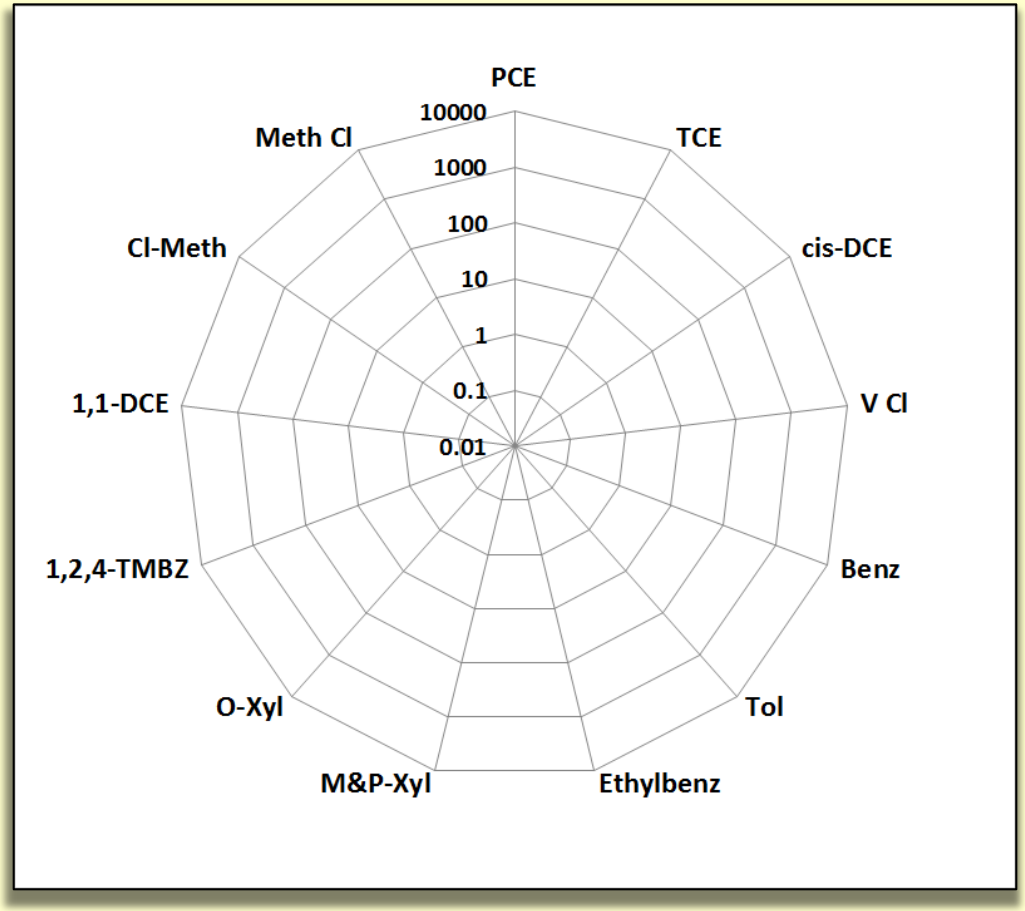




Wind Roses

N
W
E
S




PCE
TCE
cis-DCE
V Cl
Benz
Tol
Ethylbenz
M&P-Xyl
O-Xyl
1,2,4-TMBZ
1,1-DCE
Cl-Meth
Meth Cl
10000
1000
100
10
1
0.1
0.01

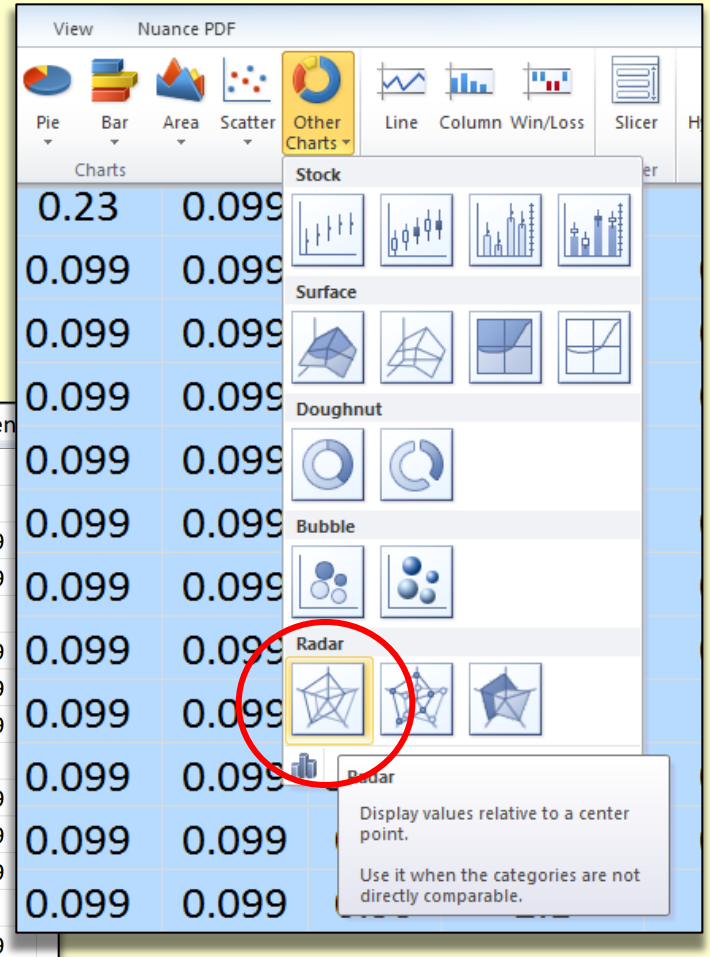
Spreadsheet Application

Columns - Compounds

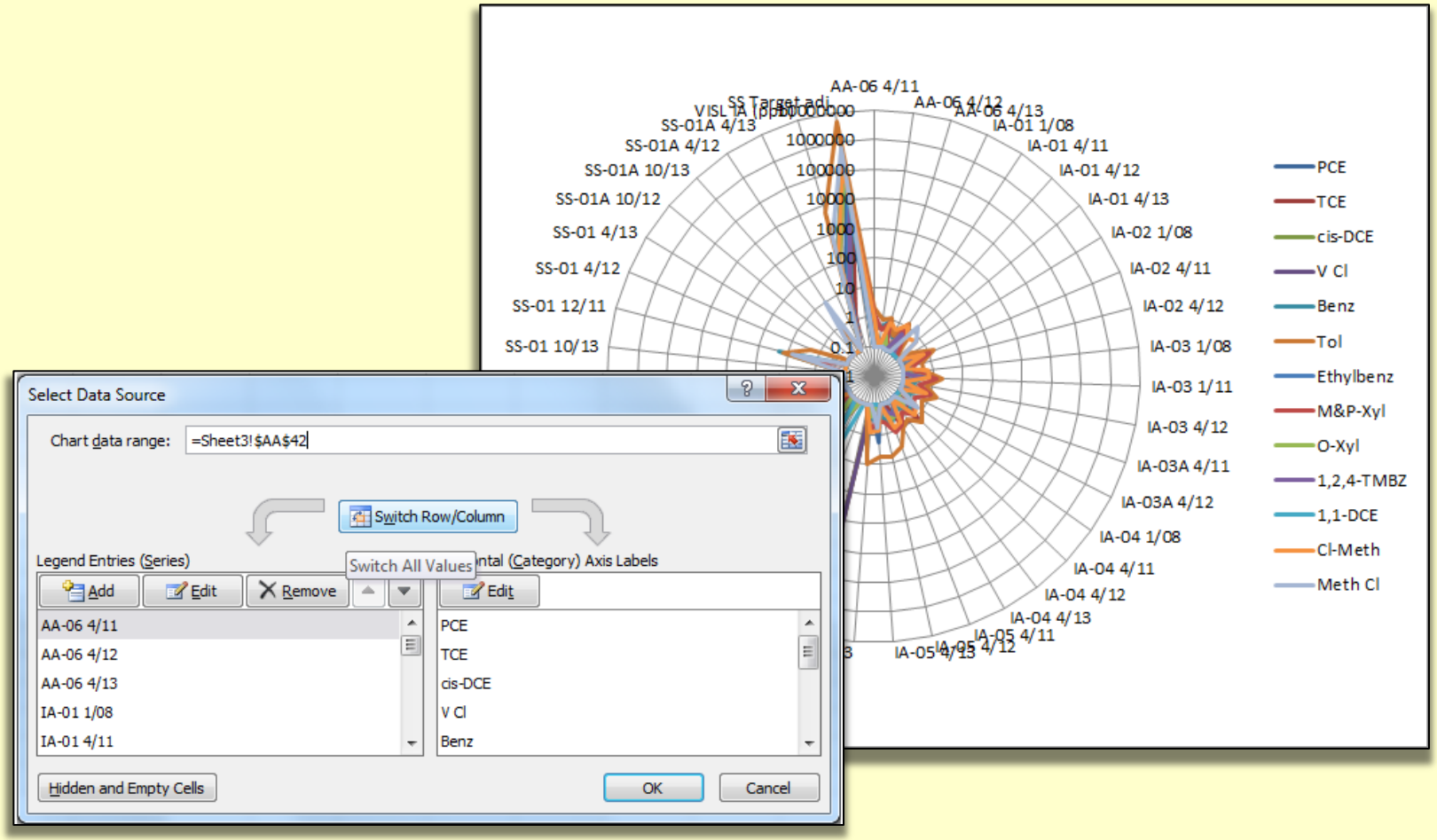
Rows - Samples

ND = 0.099

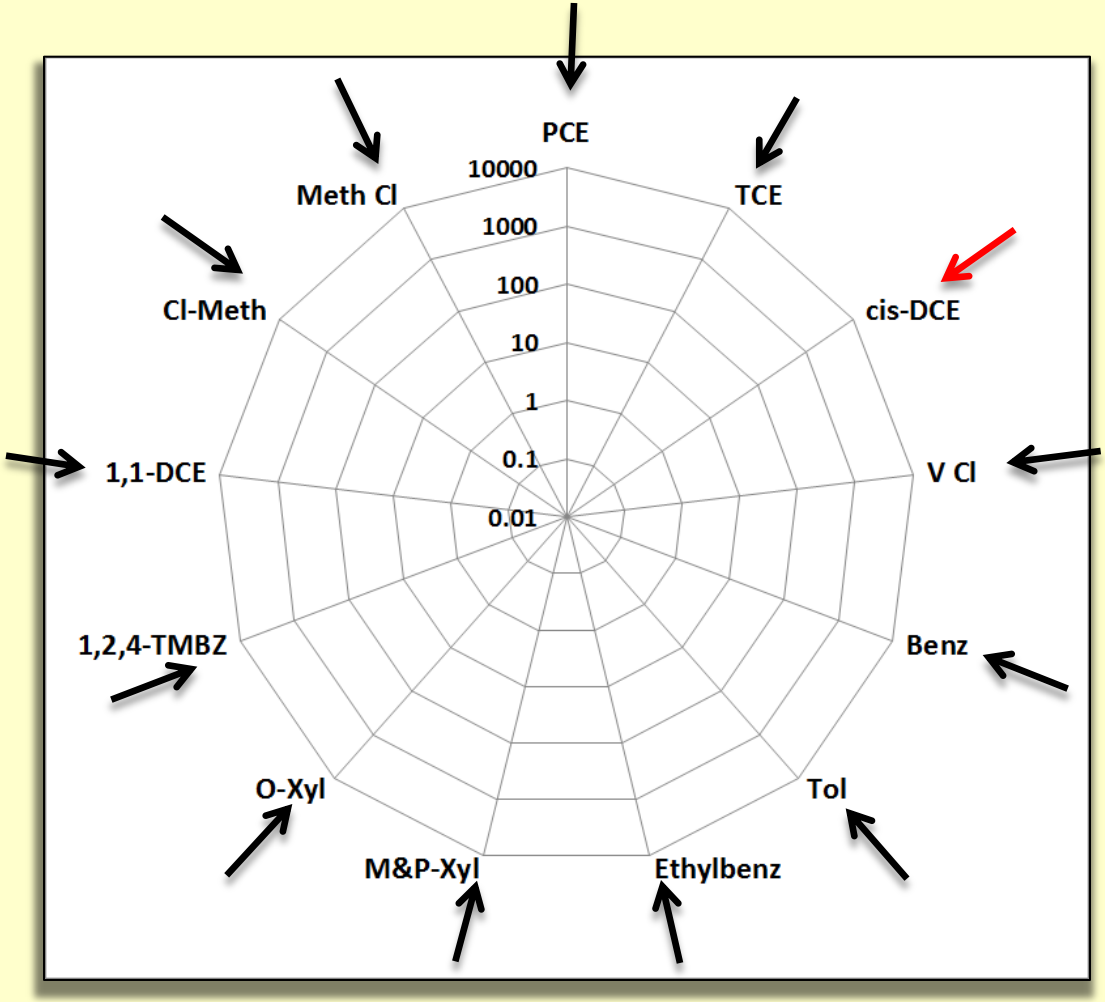
Sample	PCE	TCE	cis-DCE	V Cl	Benz	Tol	Ethylben
IA-04 4/13	0.099	0.73	0.099	0.099	0.27	1.0	0.22
IA-05 4/11	0.099	0.099	0.099	0.099	0.54	3.8	0.32
IA-05 4/12	0.099	0.099	0.099	0.099	0.27	6.4	0.099
IA-05 4/13	1.8	0.099	0.099	0.099	0.25	5.2	0.099
IA-05A 4/13	0.099	0.099	0.099	0.099	0.29	9.6	0.23
SG-01 2/07	0.099	11,000	27,000	19,000	0.099	0.099	0.099
SG-02 2/07	0.099	12,000	1,200	1,200	0.099	0.099	0.099
SG-03 2/07	0.099	20,000	150,000	4,200	0.099	0.099	0.099
SG-04 2/08	0.099	0.099	0.099	0.099	4.1	81	18
SG-05 2/08	5.9	7.5	0.099	0.099	4.2	11	0.099
SG-07 2/08	0.099	0.099	0.099	0.099	0.099	0.099	0.099
SG-10 2/08	0.099	0.099	0.099	0.099	0.35	0.32	0.099
SG-11 4/11	0.099	1.9	4.7	0.099	3.0	8.2	2.4
SG-12 4/11	0.099	0.099	0.099	0.099	0.099	0.099	0.099
SS-01 10/12	0.099	0.099	0.099	0.099	0.099	0.099	0.099
SS-01 10/13	0.099	0.099	0.099	0.099	0.099	0.099	0.099
SS-01 12/11	0.099	0.099	0.099	0.099	20	14	0.099



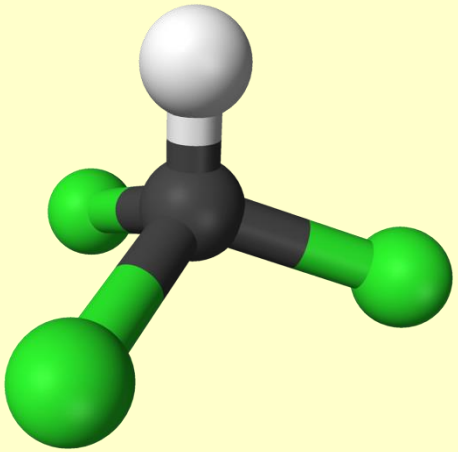
Reverse Columns if Needed



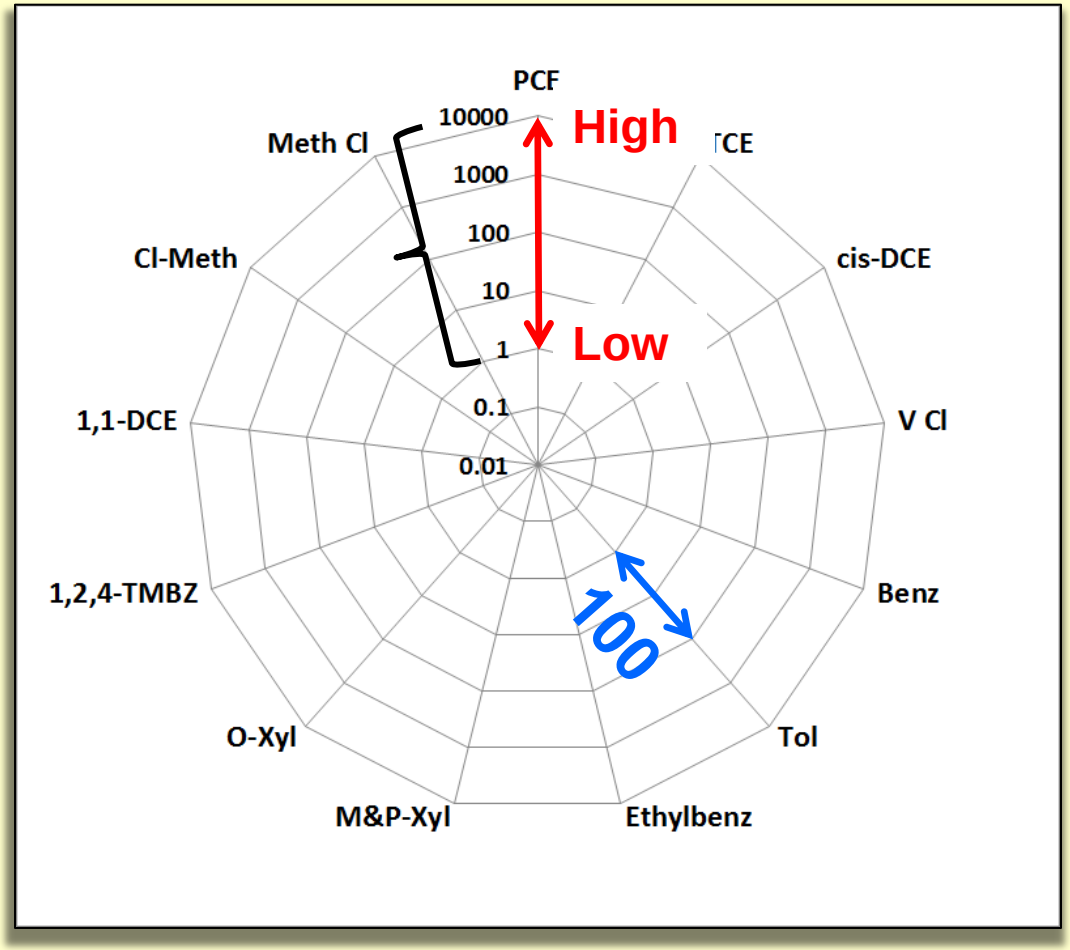
Arrangement of Plots



Spokes are VOCs



Arrangement of Plots



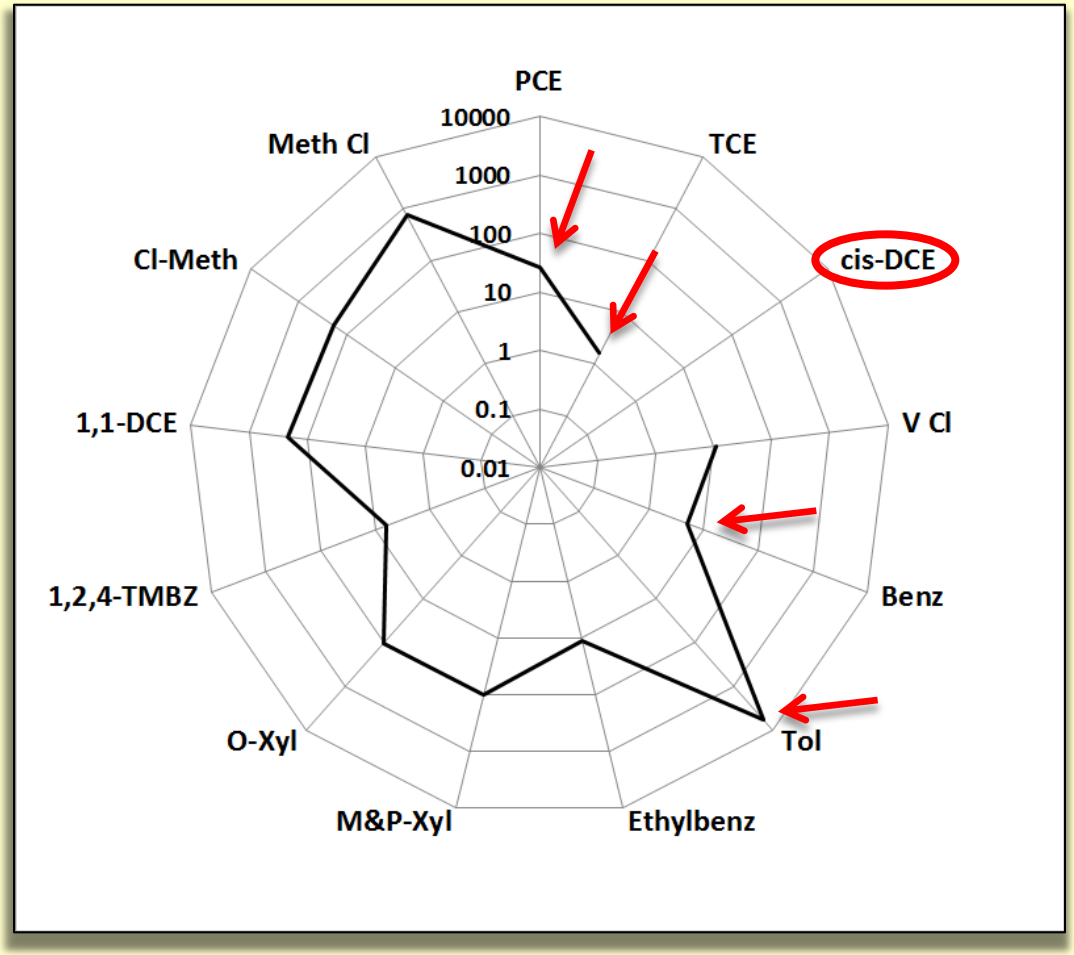
Spokes are VOCs

Distance from center is concentration

Log scale

Each circle is a 10-fold change

Plot of Indoor Air Targets



Vapor Intrusion Screening Level Targets (ppb) Commercial

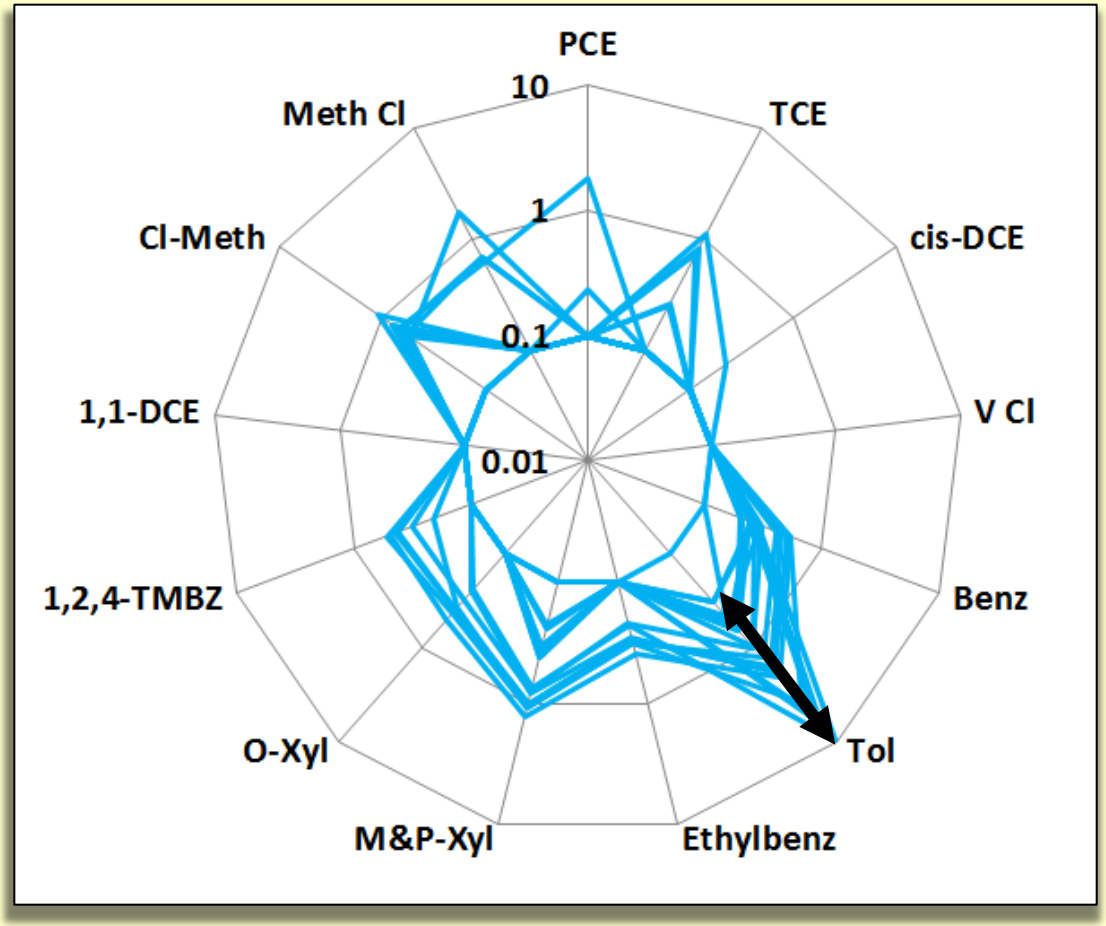
PCE 26

TCE 1.6

Benzene target ~ 1,000 times lower than toluene

cis-1,2-DCE (None)

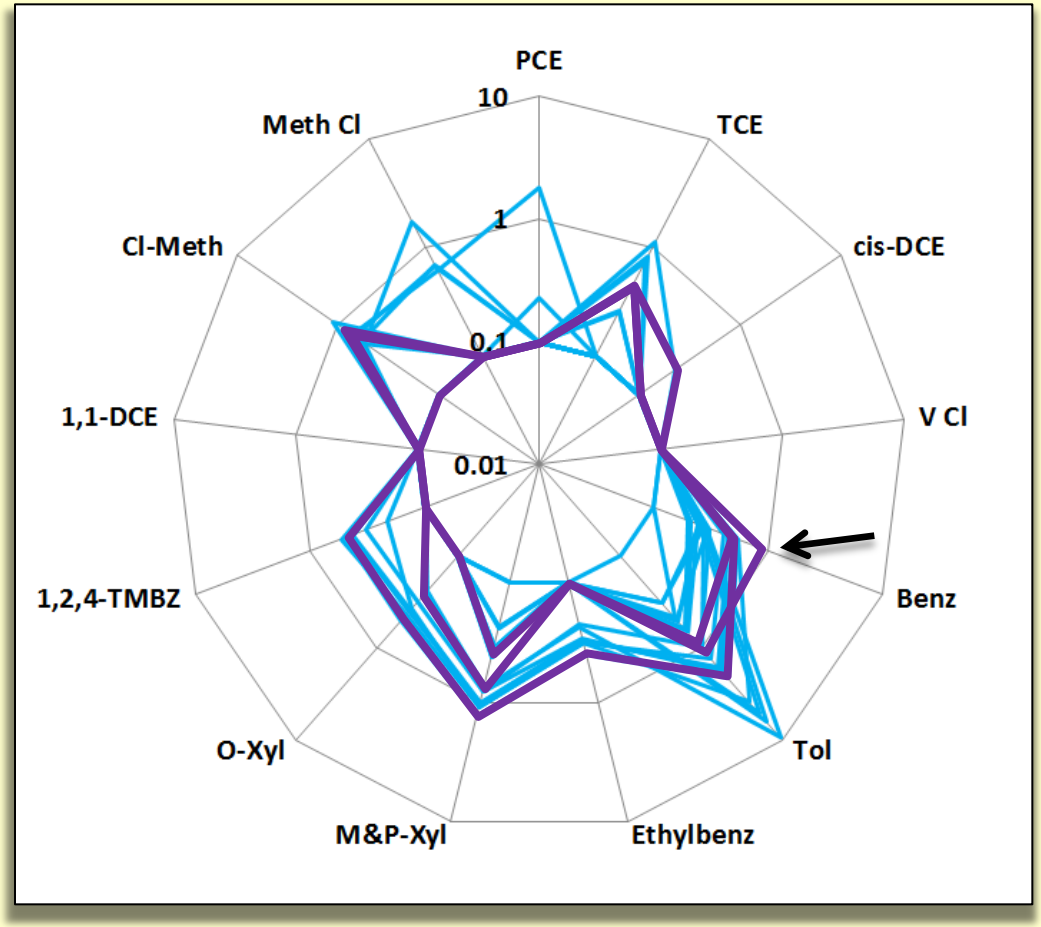
Metal Recycler, Columbus, Ohio



Indoor Air

>10 x variability in Toluene

Metal Recycler, Columbus, Ohio



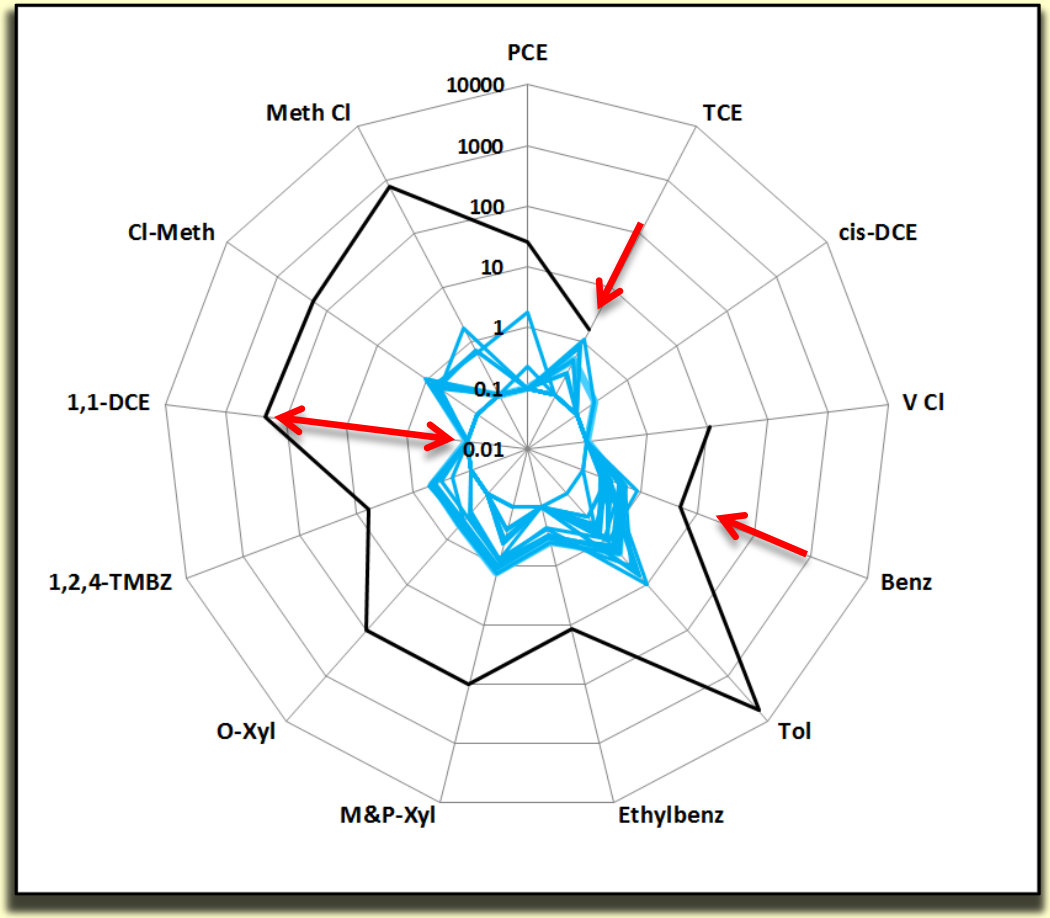
Indoor Air

Ambient Air

Indoor benzene ≤ ambient

Metal Recycler, Columbus, Ohio

VISL Indoor Target Levels



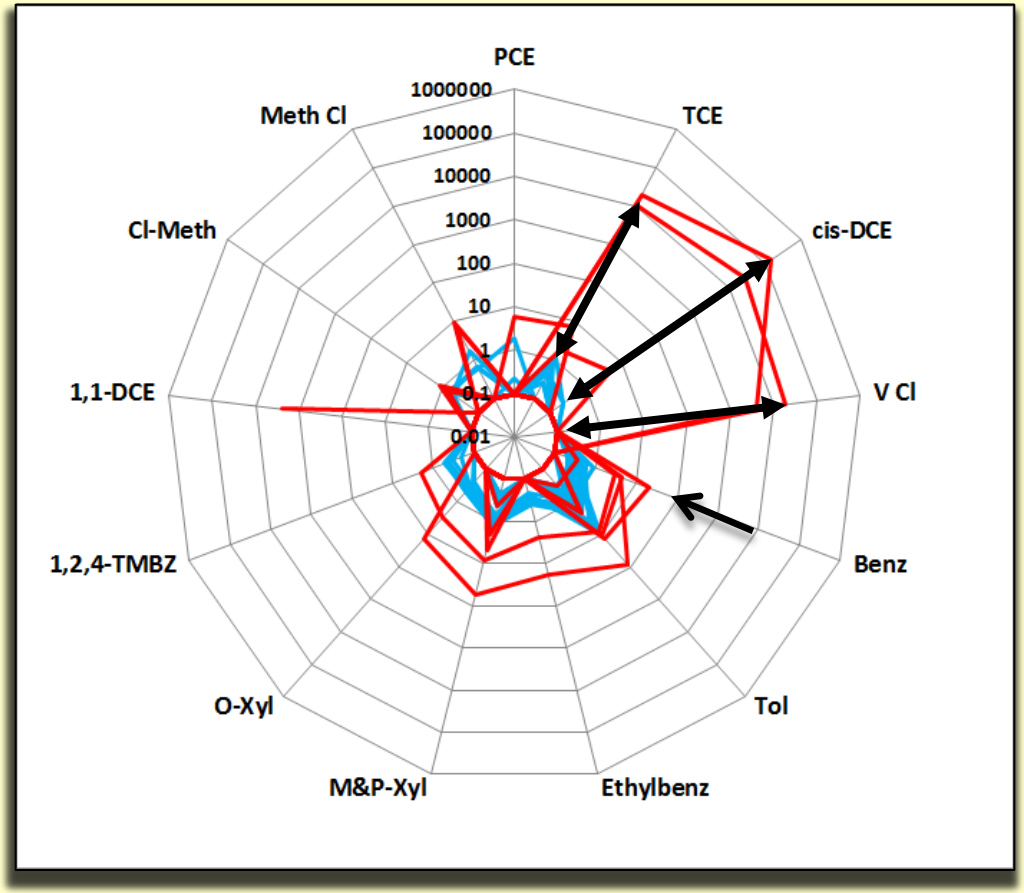
Indoor Air

Most are << Target Levels

Except TCE (& benzene)

Is cumulative risk acceptable?

Metal Recycler, Columbus, Ohio



Indoor Air

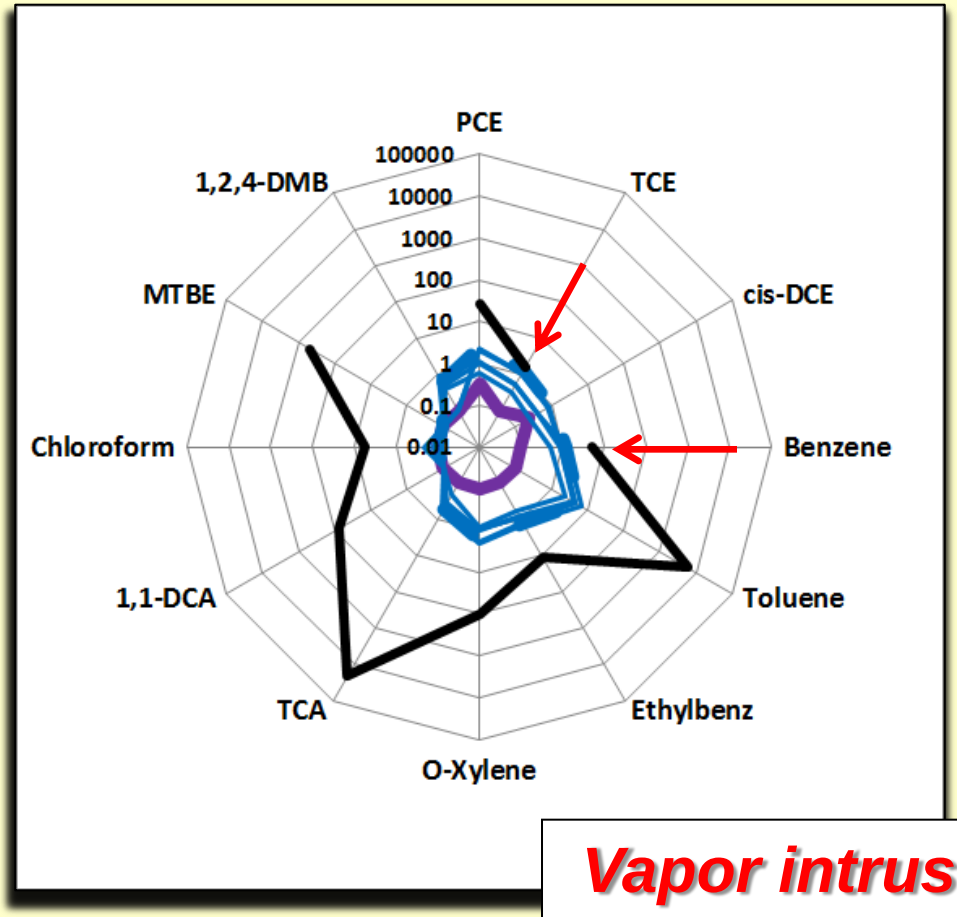
Soil Gas

Soil gas TCE & VC >> indoor & indicate VI origin

Cis-DCE shows attenuation = 1/100,000

Benzene from soil gas is minimal

PCE Source, Central Ohio



October 2011

Indoor Air

Indoor Air Dupe

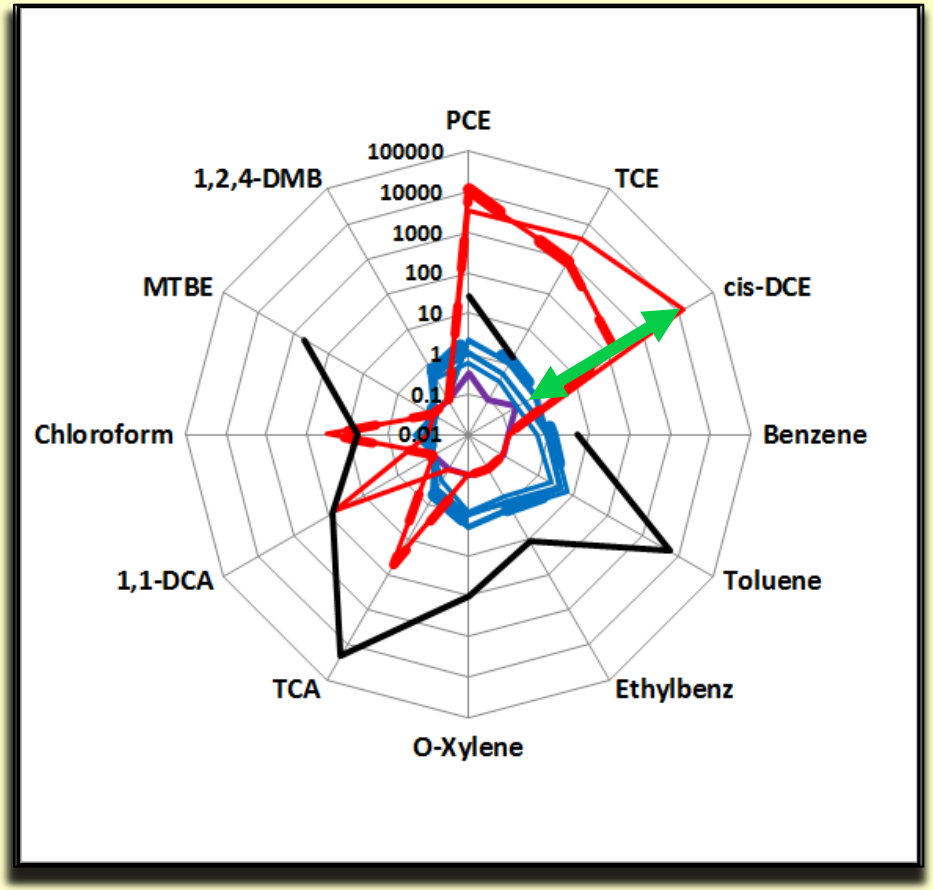
Ambient Air

VISL Indoor Target

TCE, benzene, (& chloroform) concerns

Vapor intrusion or background?

PCE Source, Central Ohio



Soil Gas

Duplicate shows good replication

Sub-slab PCE, TCE, DCE >> indoor suggest VI

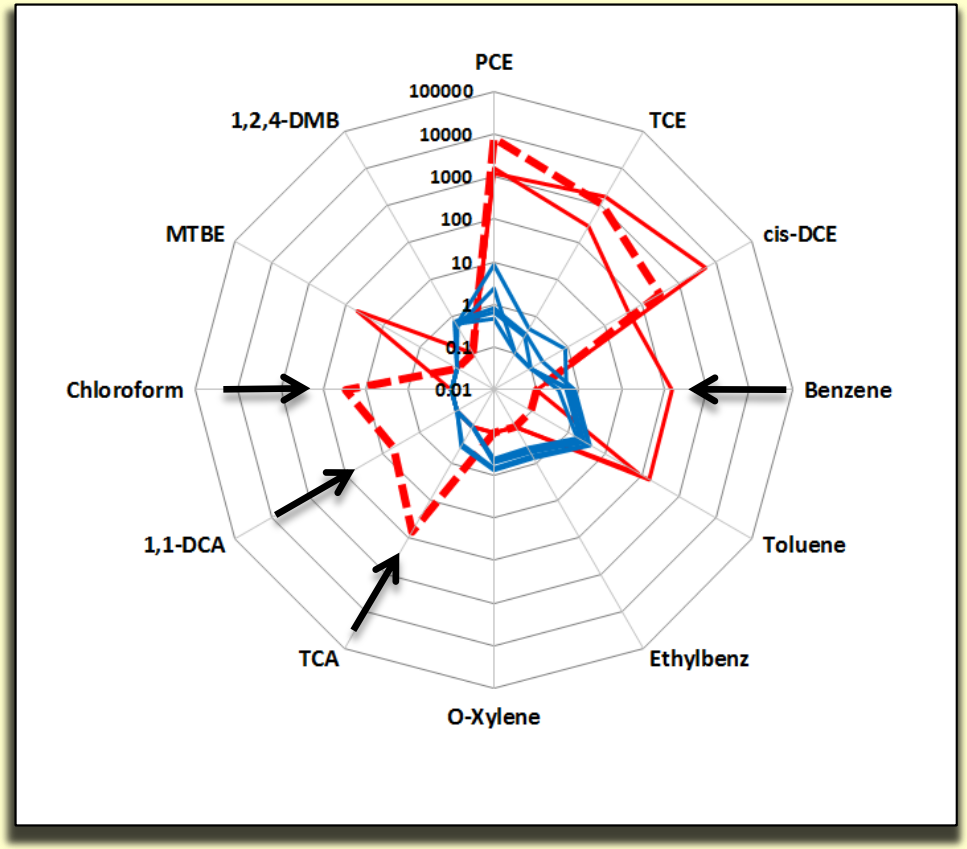
Cis-DCE shows 0.0001 attenuation

Indoor Air

Ambient Air

VISL Indoor Target

PCE Source, Central Ohio



Different lab
September 2011

Duplicate soil gas via tee fitting

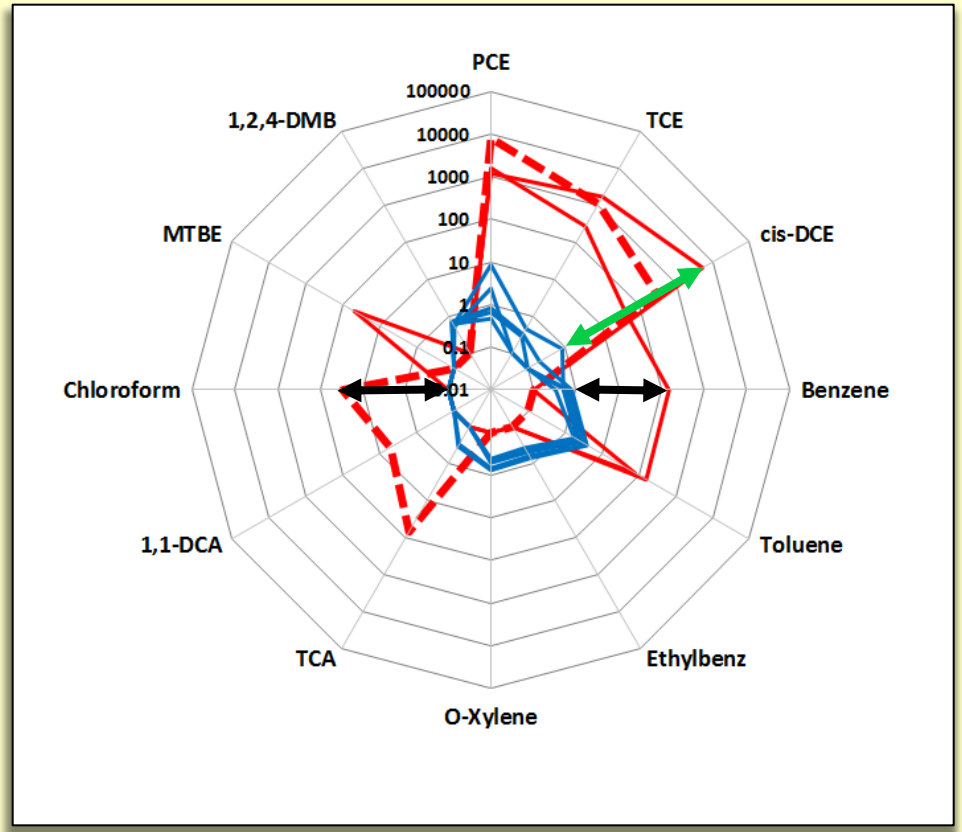
Poor repeatability

Soil gas > Indoor air

Cumulative risk

Soil Gas
Indoor Air

PCE Source, Central Ohio



Cis-DCE shows attenuation of 0.0001

Lower benzene & chloroform ratios

Benzene & chloroform not vapor intrusion

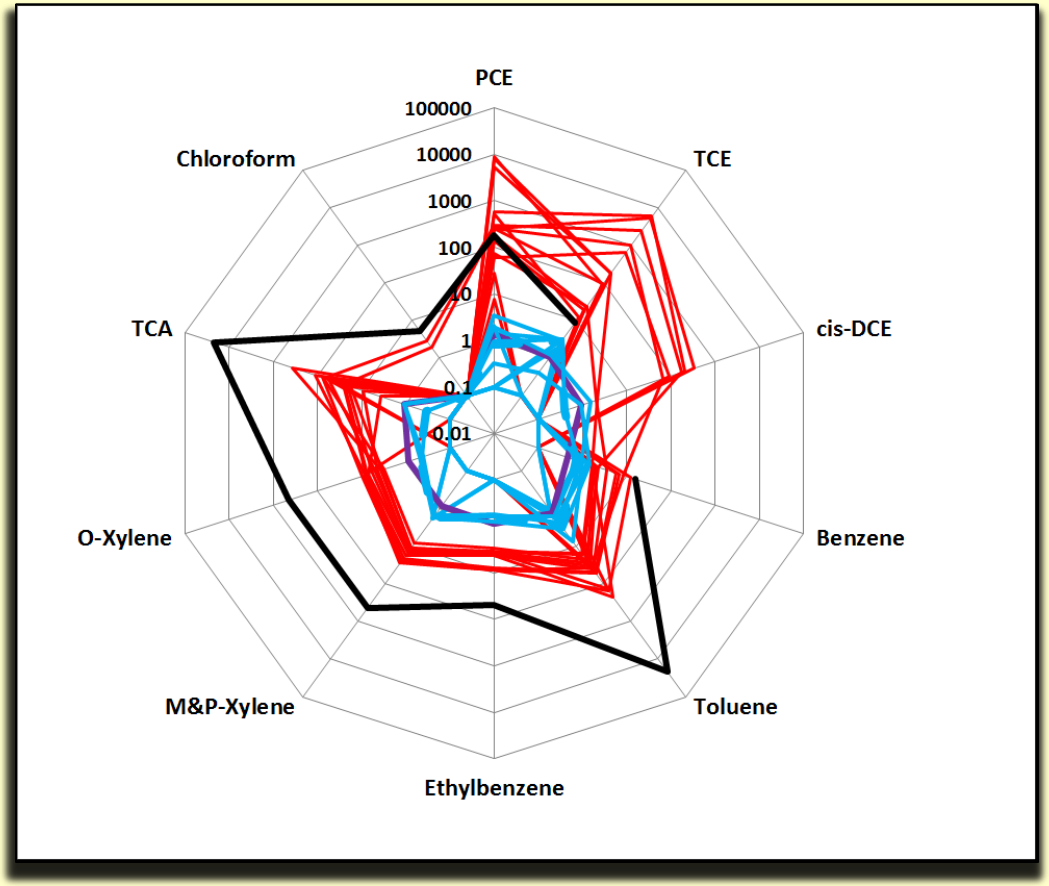
Soil Gas
Indoor Air

Advantage of Radar Plots

- ✓ ***Simplifies comparison of multiple data sources***
- ✓ ***Reduces need for calculations***
- ✓ ***Made quickly***
- ✓ ***Made with conventional software***
- ✓ ***More obvious than numerical results***
- ✓ ***Could potentially become a standard approach***

QUESTIONS?

PCE Source, Mansfield Ohio



Is anything close to target level?

Are TCE or benzene from ambient air?

Are TCE or benzene from soil gas?

What is subslab AF?

Indoor Air Target Levels

Indoor Air

Ambient

Soil Gas