Vapor Intrusion

Bhooma Sundar

EPA Region 5

Toxicologist

Residential Vapor Intrusion

- Conceptual model of vapor intrusion

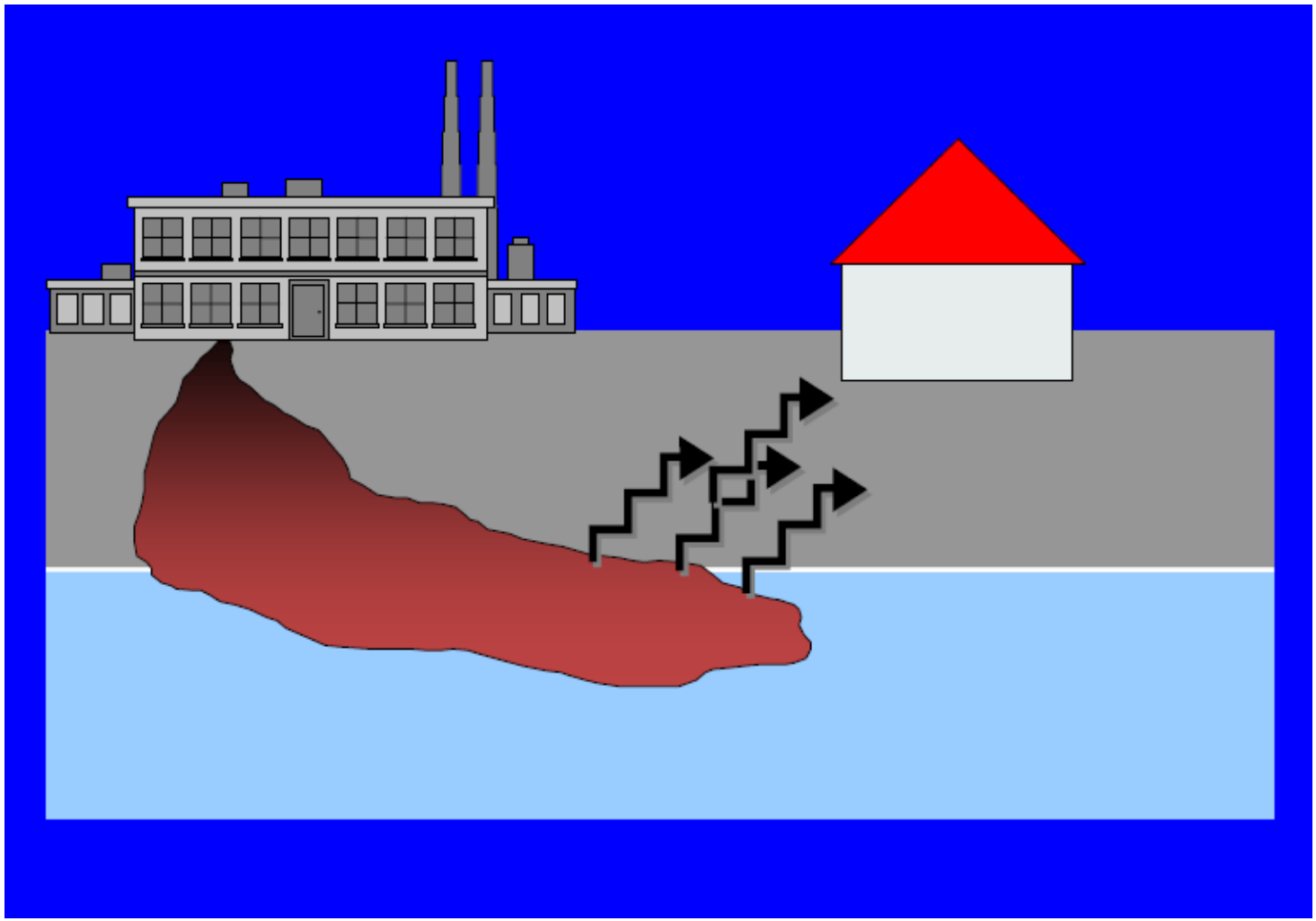
  -What is the problem?

  - How the problem will be identified?

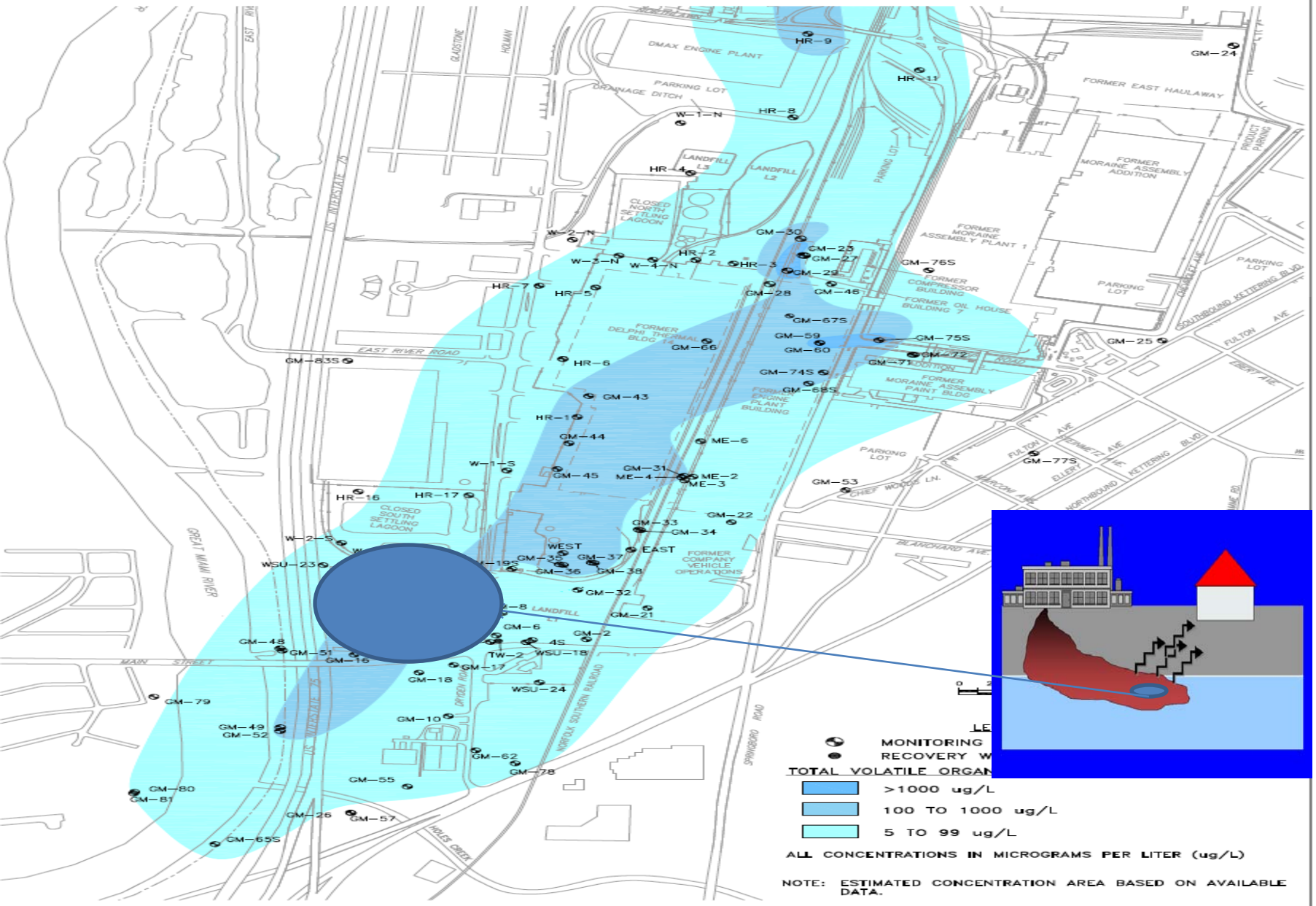
  - If there is a problem, how big it is?

  - If proven to be a problem, how can it be controlled?

Concept of Vapor Intrusion



TOTAL VOLATILE ORGANIC COMPOUND CONCENTRATIONS FOR SHALLOW GROUNDWATER (2008-2010)
MOTORS LIQUIDATION COMPANY
MORAINE, OHIO



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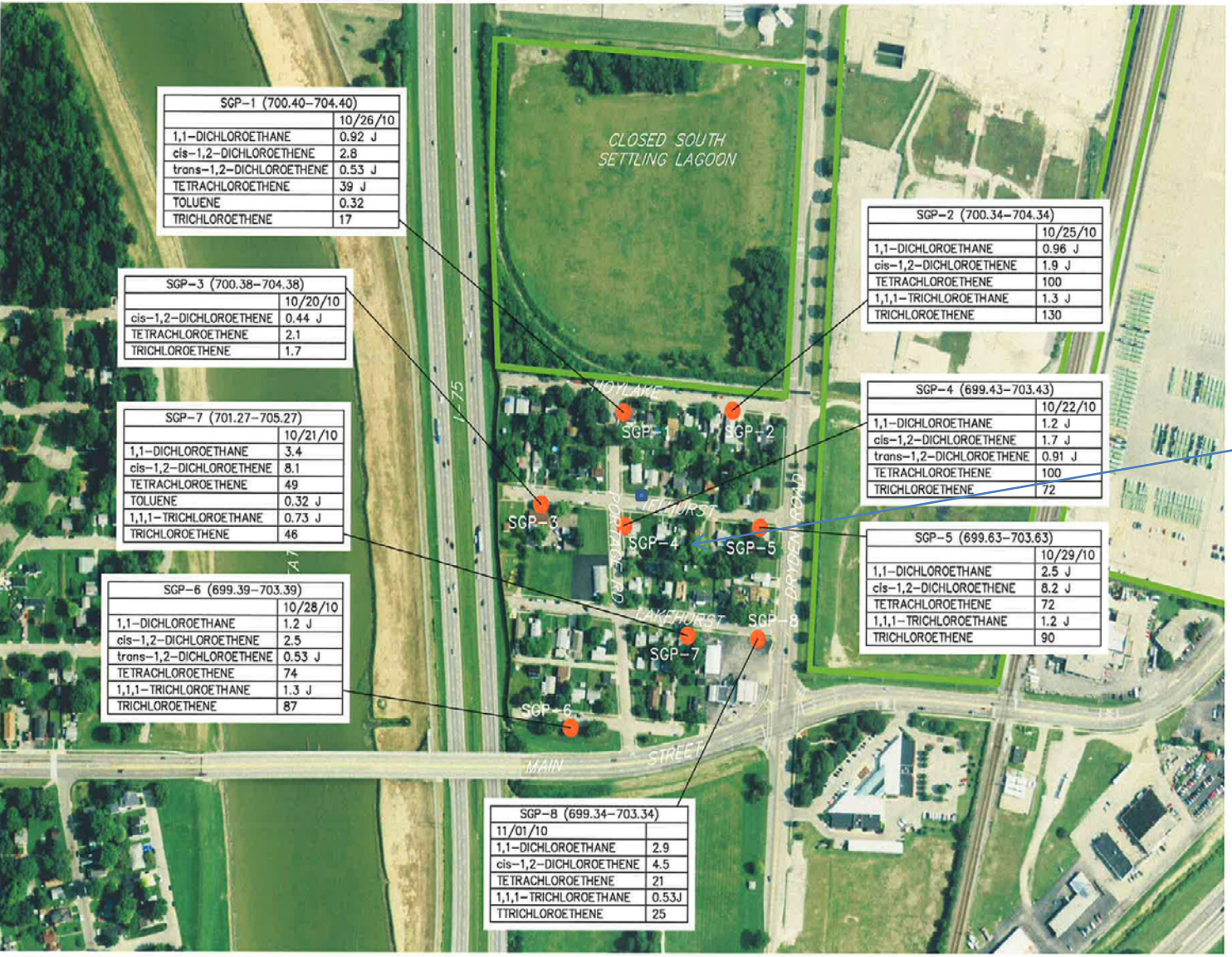


SGP-1 (700.40–704.40)	
	10/26/10
1,1–DICHLOROETHANE	0.92 J
cis–1,2–DICHLOROETHENE	2.8
trans–1,2–DICHLOROETHENE	0.53 J
TETRACHLOROETHENE	39 J
TOLUENE	0.32
TRICHLOROETHENE	17

SGP-2 (700.34–704.34)	
	10/25/10
1,1–DICHLOROETHANE	0.96 J
cis–1,2–DICHLOROETHENE	1.9 J
TETRACHLOROETHENE	100
1,1,1–TRICHLOROETHANE	1.3 J
TRICHLOROETHENE	130

SGP-3 (700.38–704.38)	
	10/20/10
cis–1,2–DICHLOROETHENE	0.44 J
TETRACHLOROETHENE	2.1
TRICHLOROETHENE	1.7

SGP-4 (699.43–703.43)	
	10/22/10
1,1–DICHLOROETHANE	1.2 J
cis–1,2–DICHLOROETHENE	1.7 J
trans–1,2–DICHLOROETHENE	0.91 J
TETRACHLOROETHENE	100
TRICHLOROETHENE	72

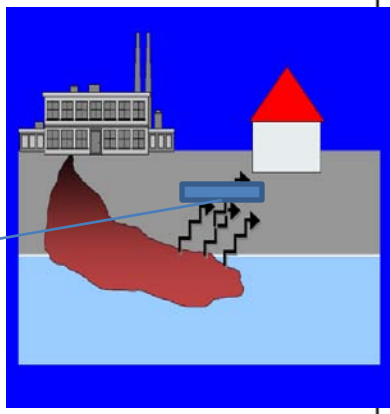
SGP-7 (701.27–705.27)	
	10/21/10
1,1–DICHLOROETHANE	3.4
cis–1,2–DICHLOROETHENE	8.1
TETRACHLOROETHENE	49
TOLUENE	0.32 J
1,1,1–TRICHLOROETHANE	0.73 J
TRICHLOROETHENE	46

SGP-5 (699.63–703.63)	
	10/29/10
1,1–DICHLOROETHANE	2.5 J
cis–1,2–DICHLOROETHENE	8.2 J
TETRACHLOROETHENE	72
1,1,1–TRICHLOROETHANE	1.2 J
TRICHLOROETHENE	90

SGP-6 (699.39–703.39)	
	10/28/10
1,1–DICHLOROETHANE	1.2 J
cis–1,2–DICHLOROETHENE	2.5
trans–1,2–DICHLOROETHENE	0.53 J
TETRACHLOROETHENE	74
1,1,1–TRICHLOROETHANE	1.3 J
TRICHLOROETHENE	87

SGP-8 (699.34–703.34)	
11/01/10	
1,1–DICHLOROETHANE	2.9
cis–1,2–DICHLOROETHENE	4.5
TETRACHLOROETHENE	21
1,1,1–TRICHLOROETHANE	0.53J
TTRICHLOROETHENE	25

0 150 300 FT



LEGEND

- SOIL–GAS SAMPLING POINT LOCATIONS
- MLC PROPERTY BOUNDARY
- (701.93–705.93) TEMPORARY WELL SCREEN INTERVAL ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- J ESTIMATED VALUE
- ALL CONCENTRATIONS IN MICROGRAMS PER LITER

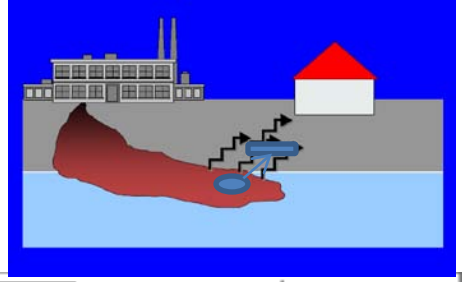
MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

OH000294.0018

GROUNDWATER TABLE SAMPLE RESULTS OF NEIGHBORHOOD SOUTHWEST OF SITE (OCTOBER THROUGH NOVEMBER 2010)

ARCADIS

FIGURE 3



SOUTH SETTLING LAGOON

HOYLAKE COURT

TELHURST COURT

LAKEHURST COURT

OLD SELLARS ROAD

MAIN STREET

PORTAGE ROAD

DIXON ROAD

US INTERSTATE 75

LANDFILL L1

CHURCH

AUTO REPAIR

AUTO REPAIR

GAS STATION

SGP-1 (39J)

SGP-2 (100)

SGP-3 (2.1)

SGP-4 (100)

SGP-5 (12)

SGP-6 (21)

SGP-7 (49)

SGP-8 (74)

SGP-1 (11/10/10)

	15'	11'	6'
Trans-1,2-DCE	12	4.9	<4.5
1,1-DCA	6.6	2.3J	<4.5
Cis-1,2-DCE	8.6	<4.5	<4.5
1,1,1-TCA	23	13	10
Benzene	3.0J	1.3J	2.0J
TCE	620	350	88
Toluene	3.3J	1.8J	8.2
PCE	2,400	970	370
Ethyl Benzene	1.6J	<5.3	2.2J
Xylenes(m,p and o)	5.3J	<10.6	10

SGP-2 (11/11/10)

	15.4'	11'	6'
Trans-1,2-DCE	110	41	5.8J
1,1-DCA	82	28J	6.3J
Cis-1,2-DCE	84J	10J	2.3J
1,1,1-TCA	260	140	77
Benzene	<52	<31	5.9J
TCE	16,000	6,800	2,000
Toluene	<51	<30	21
PCE	36,000	21,000	5,700

SGP-3 (11/09/10)

	19.25'	11'	6'
Trans-1,2-DCE	1.8J	<4.4	<4.5
1,1-DCA	3.0J	<4.5	<4.6
1,1,1-TCA	32	20	5.6J
Benzene	0.8BJ	0.87J	<3.6
TCE	130	70	8.6
Toluene	<4.2	1.0J	2.7J
PCE	120	350	41
Ethyl Benzene	<4.8	<4.9	2.8J
Xylenes(m,p and o)	<9.6	<9.8	17.2

SGP-5 (11/11/10)

	14.8'	11'	6'
1,1-DCA	120	34	<4.5
Cis-1,2-DCE	140	31	<4.4
1,1,1-TCA	340	180	0.57J
Benzene	<38	5.8J	1.1J
TCE	9,700	3,200	<6.08
Toluene	<65	7.3J	5.3
PCE	22,000	12,000	<7.68

SGP-4 (11/10/10)

	16.2'	11'	6'
Trans-1,2-DCE	12	<5.2	<4.4
1,1,1-TCA	40	15	11
Benzene	1.7J	<5.0	1.0J
TCE	1,200	600	160
Toluene	<8.3	<5.8	4.8
PCE	5,600	3,200	880

SGP-7 (11/10/10)

	15.65'	11'	6'
1,1-DCA	37	21	2.0J
Cis-1,2-DCE	15	7.0	<4.6
1,1,1-TCA	73	56	12
Benzene	1.7J	1.8J	6.5
TCE	1,700	1,000	180
Toluene	<8.8	<3.8	25
PCE	4,800	3,400	710
Ethyl Benzene	<10	<8.7	19
Xylenes(m,p and o)	<20	<13.4	89

SGP-8 (11/11/10)

	14.25'	11'	6'
1,1-DCA	210	75	4.4
Cis-1,2-DCE	120	33	<4.4
1,1,1-TCA	290	210	82
Benzene	6.5J	4.9J	1.1J
TCE	3,600	1,600	260
Toluene	<178	<126	1.2J
PCE	11,000	5,800	1,800

SGP-8 (11/11/10)

	15'	11'	6'
Trans-1,2-DCE	1.6J	<4.7	<5.6
1,1-DCA	1.9J	<4.8	<4.7
1,1,1-TCA	130	61	20
Benzene	4.3	<3.8	<3.7
TCE	1,100	270	29
Toluene	18	1.0J	16
PCE	2,750	960	100
Ethyl Benzene	4.3J	0.84J	2.3J
Xylenes(m,p and o)	6.7J	1.0J	9.3

0 60 120Feet

LEGEND

3413 ADDRESS NUMBER

S RESIDENTIAL FOUNDATION STRUCTURE ON SLAB

C RESIDENTIAL FOUNDATION STRUCTURE WITH CRAWL SPACE

B RESIDENTIAL FOUNDATION STRUCTURE WITH BASEMENT

SECONDARY STRUCTURE

NON-RESIDENTIAL STRUCTURE

PARCEL OUTLINE

NOTE: INFORMATION FOR FOUNDATION STRUCTURE BASED ON DATA FROM MONTGOMERY COUNTY AUDITOR WEB SITE (www.mcauditor.org); INFORMATION WILL BE VERIFIED DURING RECONNAISSANCE.

SOIL-GAS SAMPLING POINT LOCATION

(21) GROUNDWATER TABLE PCE CONCENTRATION IN ug/L

SOIL-GAS CONCENTRATIONS

SGP-11 (11/11/10)	SAMPLE IDENTIFICATION (DATE)
11'	DEPTH IN FEET
cis-1,2-DCE	cis-1,2-DICHLOROETHENE
trans-1,2-DCE	trans-1,2-DICHLOROETHENE
1,1-DCA	1,1-DICHLOROETHANE
1,1,1-TCA	1,1,1-TRICHLOROETHANE
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
J	BELOW LABORATORY DETECTION LIMIT; ESTIMATED VALUE
B	METHOD BLANK DETECTION

ALL SOIL-GAS CONCENTRATIONS IN MICROGRAMS PER CUBIC METER AND PRESENTED IN TABLE 3

PCE GROUNDWATER TABLE CONCENTRATIONS

- >100 ug/L TETRACHLOROETHENE
- 50 TO 100 ug/L TETRACHLOROETHENE
- 5 TO 50 ug/L TETRACHLOROETHENE

ALL GROUNDWATER TABLE CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L) AND PRESENTED IN TABLE 2

MOTORS LIQUIDATION COMPANY
MORAINE, OHIO

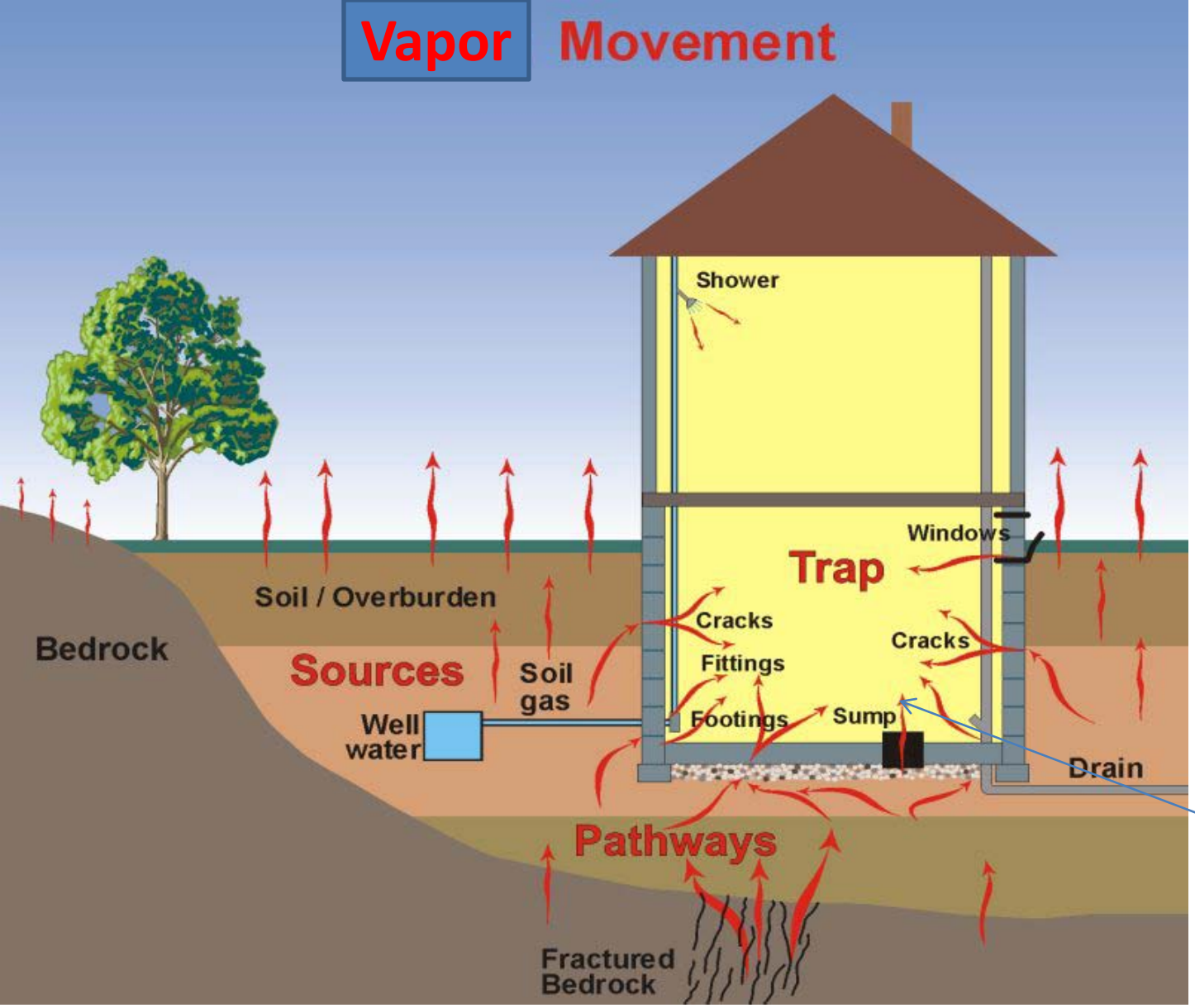
OH000294.0018

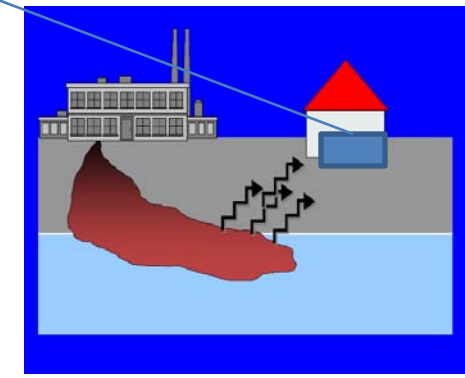
SOIL-GAS SAMPLE RESULTS AND PCE GROUNDWATER TABLE PLUME IN NEIGHBORHOOD SOUTHWEST OF SITE (OCTOBER-NOVEMBER 2010)

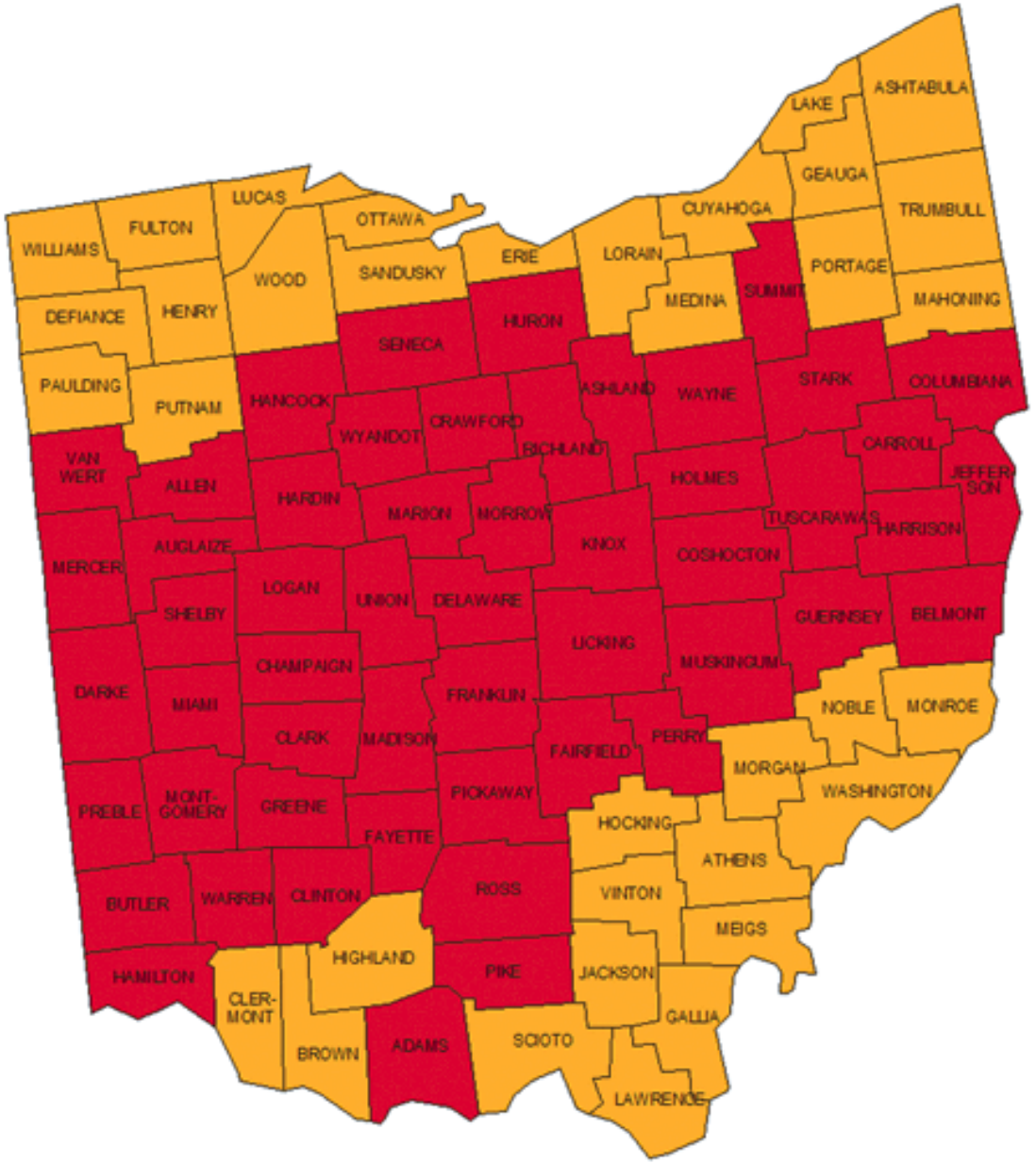
ARCADIS

FIGURE 5

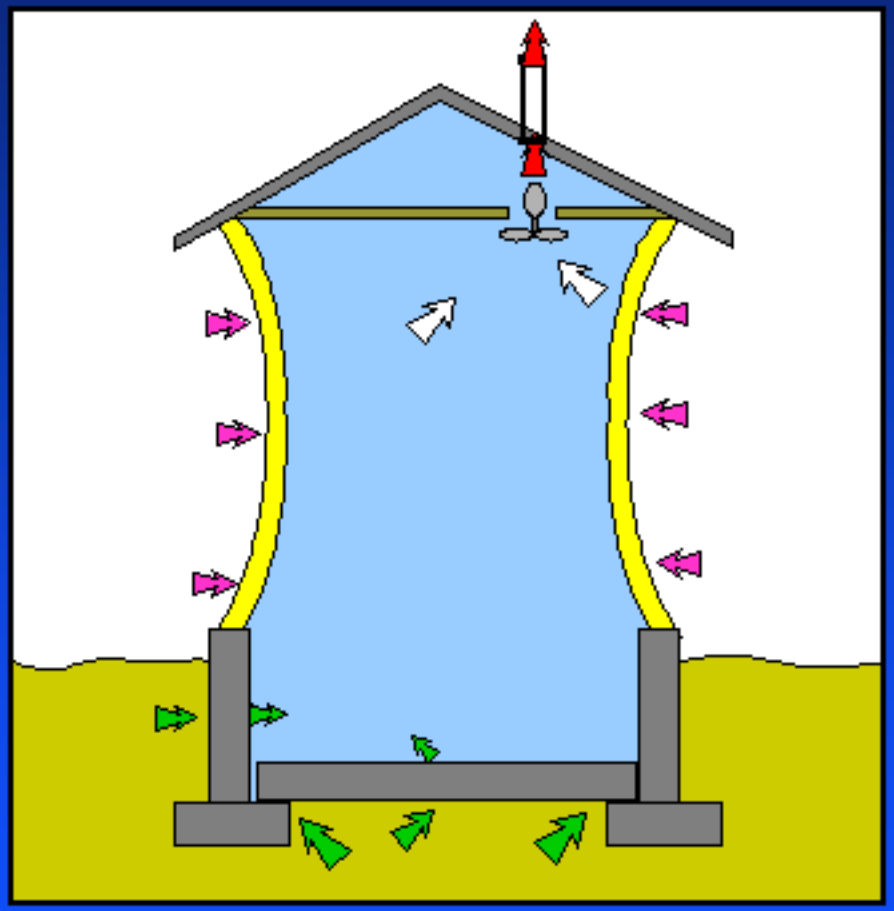
Vapor Movement



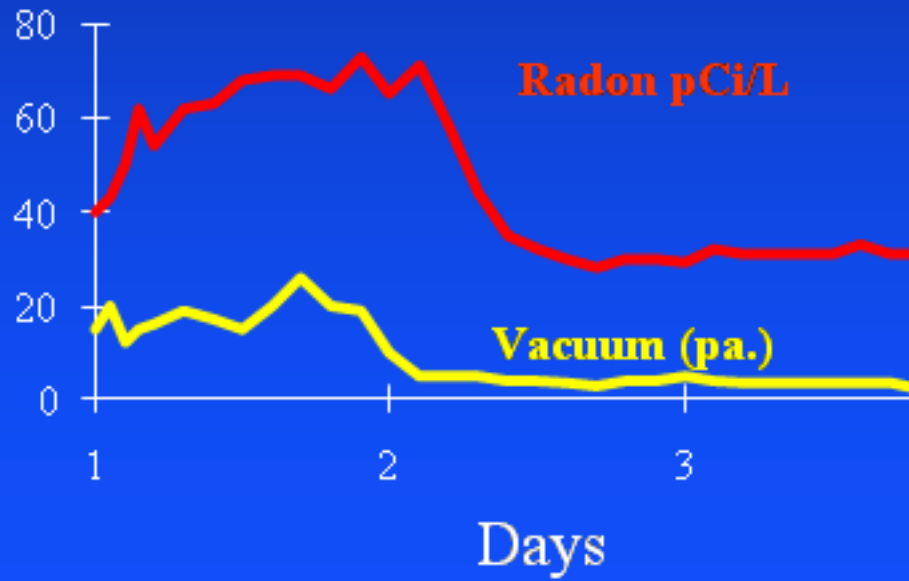


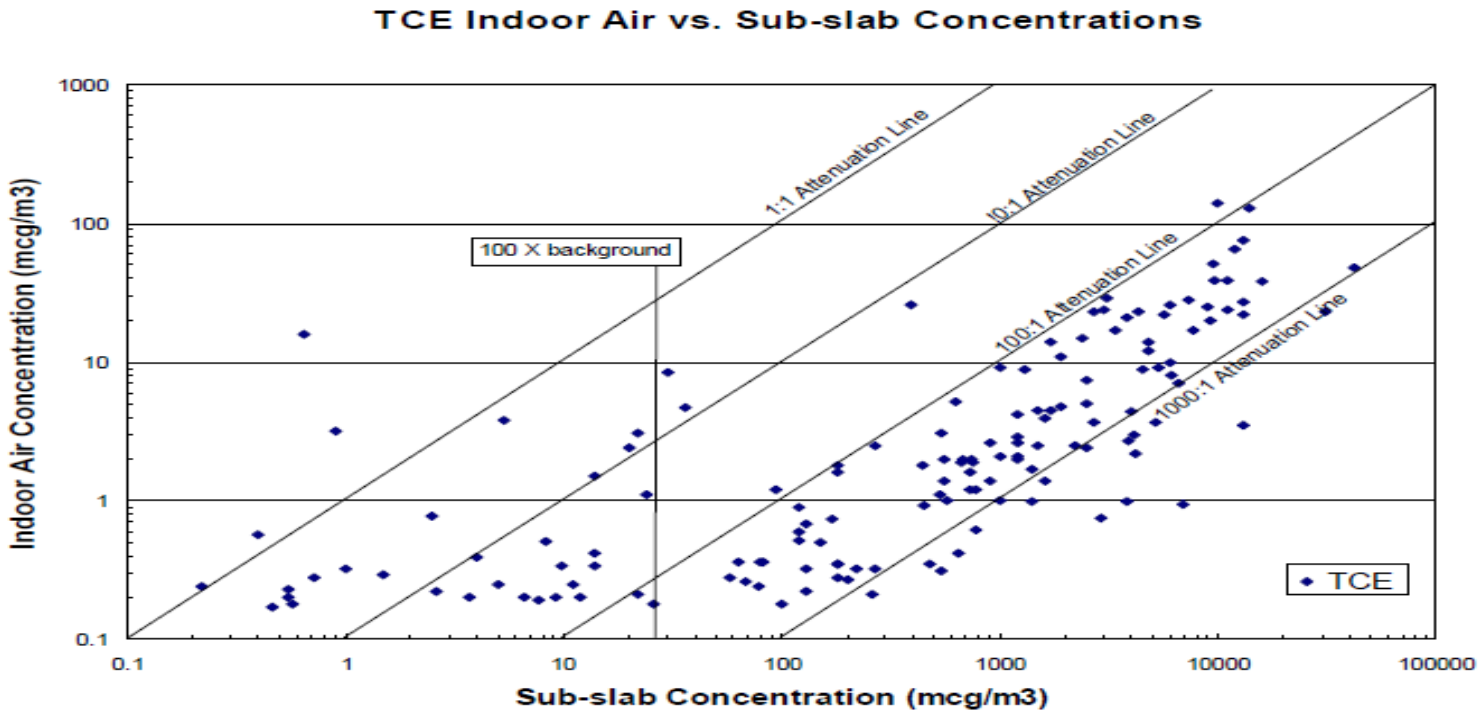

ASHTABULA
LAKE
GEAUGA
TRUMBULL
CUYAHOGA
PORTAGE
MAHONING
LORAIN
MEDINA
SUMMIT
ERIE
SANDUSKY
OTTAWA
LUCAS
WOOD
FULTON
WILLIAMS
HENRY
DEFIANCE
PAULDING
PUTNAM
SENECA
HURON
HANCOCK
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
WAYNE
STARK
COLUMBIANA
CARROLL
JEFFER SON
VAN WERT
ALLEN
HARDIN
MARION
MORROW
KNOX
HOLMES
TUSCARAWAS
HARRISON
AUGLAIZE
MERCER
LOGAN
UNION
DELAWARE
LICKING
COSHOCTON
GUERNSEY
BELMONT
SHELBY
CHAMPAIGN
MUSKINGUM
DARKE
MIAMI
FRANKLIN
NOBLE
MONROE
CLARK
MADISON
FAIRFIELD
PERRY
MORGAN
WASHINGTON
PREBLE
MONT-GOMERY
GREENE
PICKAWAY
FAYETTE
HOCKING
ATHENS
BUTLER
WARREN
CLINTON
ROSS
VINTON
MEIGS
HIGHLAND
PIKE
JACKSON
HAMILTON
CLER-MONT
BROWN
ADAMS
SCIOTO
GALLIA
LAWRENCE

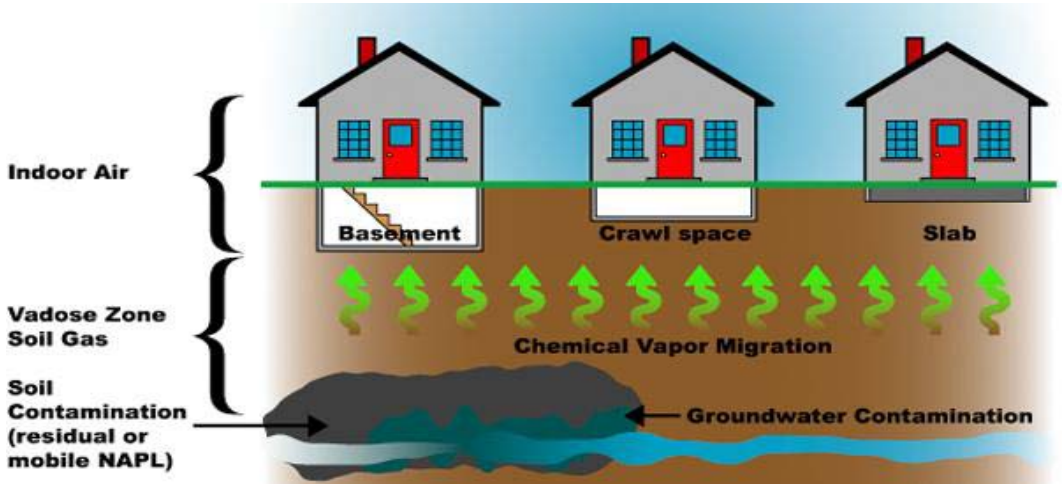
How Is Vapor Drawn Into A Building?

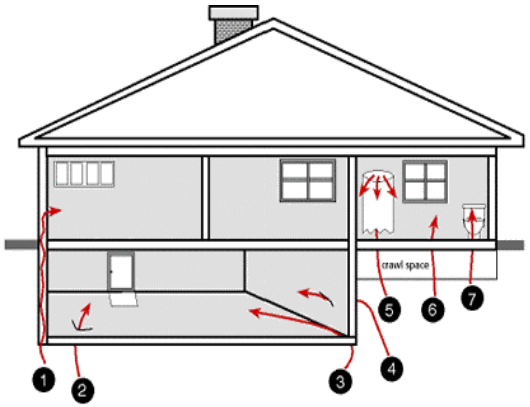


- Vacuum
  - Exhaust systems
  - Thermal stack effects

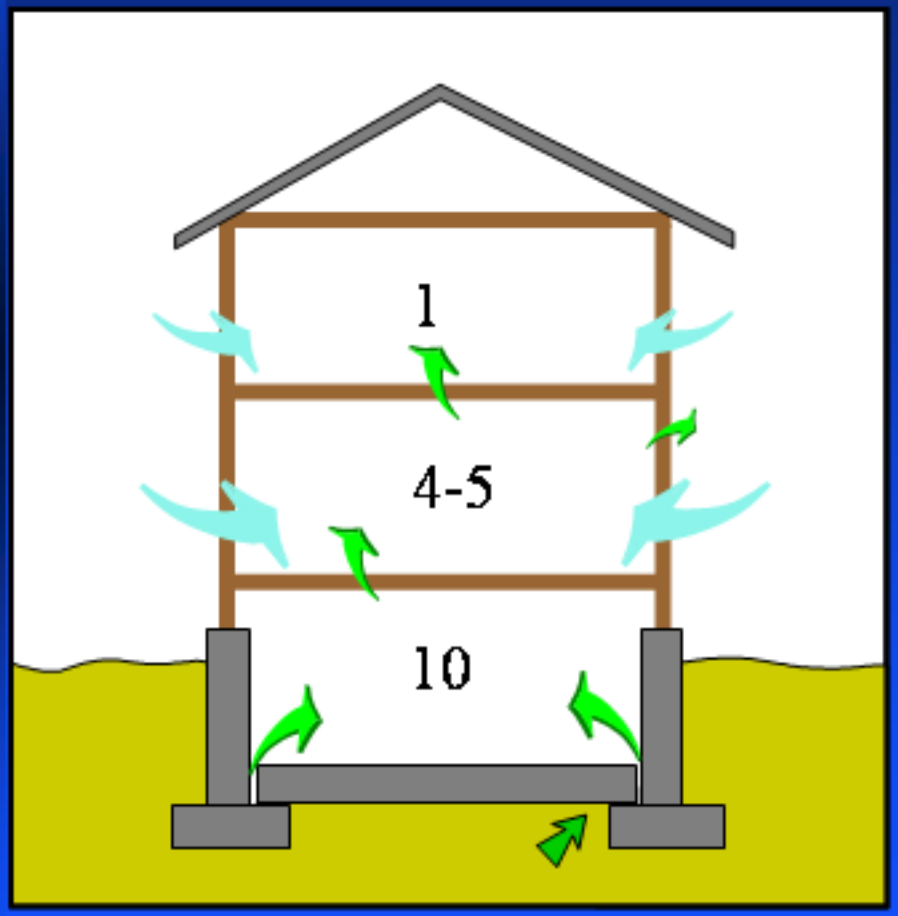



TCE Indoor Air vs. Sub-slab Concentrations
Indoor Air Concentration (mcg/m3)
Sub-slab Concentration (mcg/m3)
1000
100
10
1
0.1
0.1
1
10
100
1000
10000
100000
1:1 Attenuation Line
10:1 Attenuation Line
100:1 Attenuation Line
1000:1 Attenuation Line
100 X background
TCE


Indoor Air
Vadose Zone
Soil Gas
Soil
Contamination
(residual or
mobile NAPL)
Basement
Crawl space
Slab
Chemical Vapor Migration
Groundwater Contamination


crawl space
1
2
3
4
5
6
7

Radon/TCE/PCE distribution



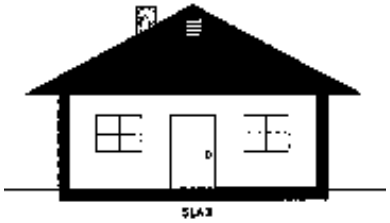
- Radon enters from beneath foundation and travels upw
  - Diluted with outdoor air infiltrating building
- If radon is less than 4 pCi/L lower level, one can say wi reasonable confidence that upper floors are also less th pCi/L.

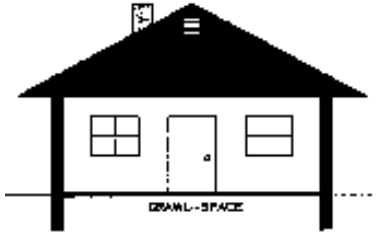
Indoor Air Sources

Source	Benzene	Toluene	Ethylbenzene	Xylene	Styrene	Trimethylbenzene	Naphthalene	Trichloroethene	Trichloroethanes	Perchloroethene	Chlorobenzene	Decane
Latex Paints	X	X				X						
Alkyl Paints										X	X	
Carpets	X	X			X	X						
Glued Carpets	X	X			X	X					X	X
Wood Burning		X		X	X	X	X					
Foam Board											X	
Paint Removers		X										
Spray Products				X								
Adhesives/Tapes		X			X			X				X
Room Deodorants											X	
Tobacco Smoke	X	X	X	X	X							
Gasoline/driving	X	X		X	X	X						
Solvents		X	X						X			
Dry Cleaning										X		

From *Hers et al., 2001. The use of indoor air measurements to evaluate intrusion of subsurface VOC vapors into buildings, J. Air & Waste Manage. Assoc. 51:1318-1331.*

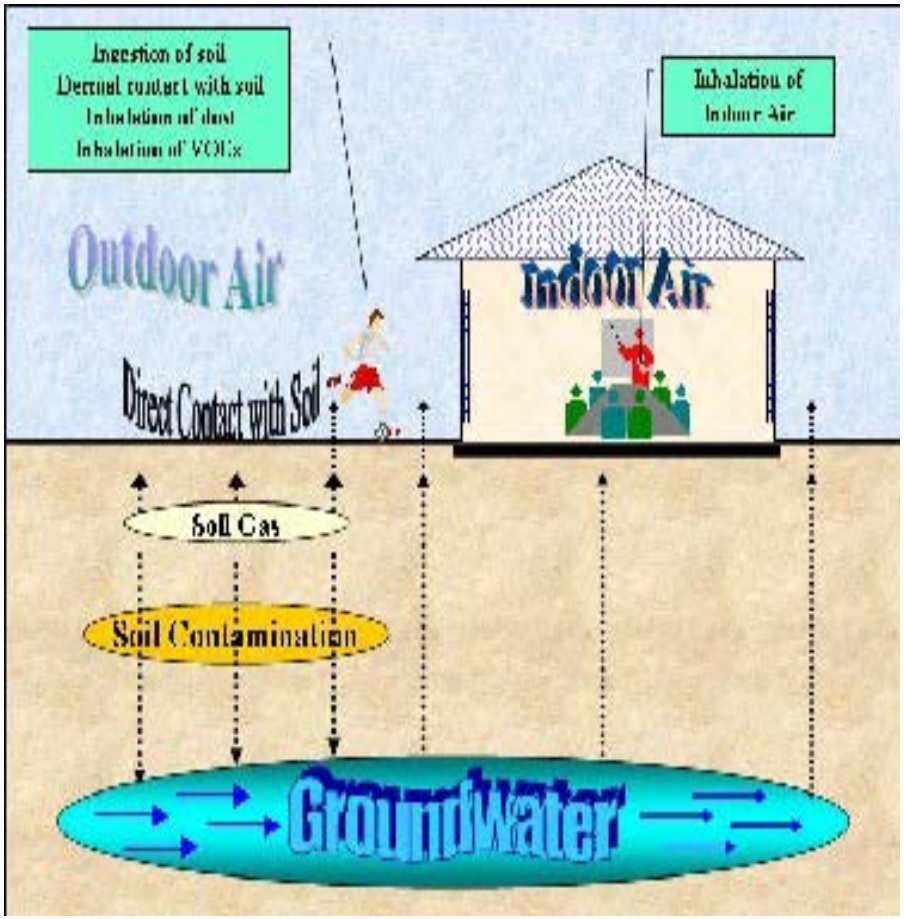
Riverview VI
Sampling Work Plan





- **Full or partial basement**
  - One sub-slab sample (below floor)
  - One indoor air sample from basement (breathing space)
  - One indoor air sample from first floor
- **Slab-on-grade**
  - One sub-slab sample
  - One indoor air sample from first floor
- **Crawl space**
  - One indoor air sample from crawl
  - One indoor air sample from first floor

Definition of Risk



Risk

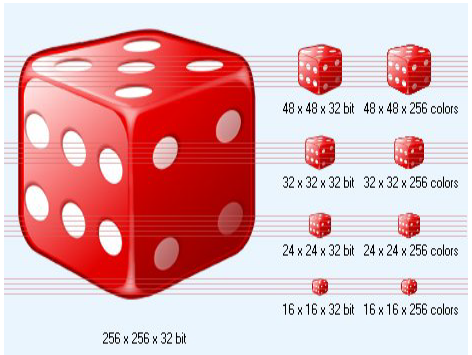
Exposure X Toxicity

Probability for Health Adverse Effects

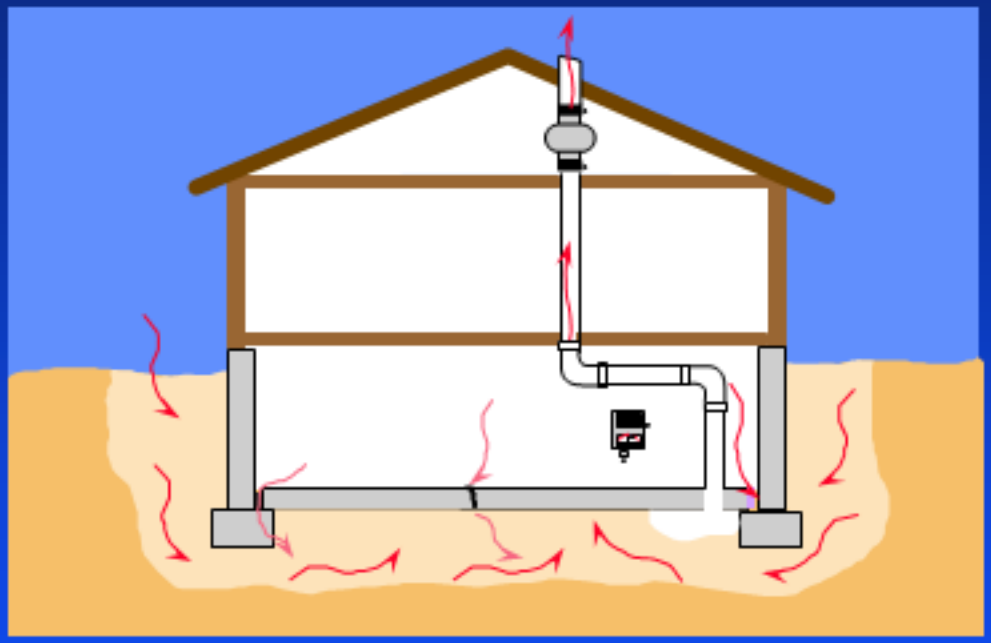
Person	Home	Exposure Characteristics
-Genetics -Lifestyle -Occupation -Nutrition	-Age of the Home -Foundation Type -Indoor air quality - Number of levels	-How long ? -How much ? -How often ?

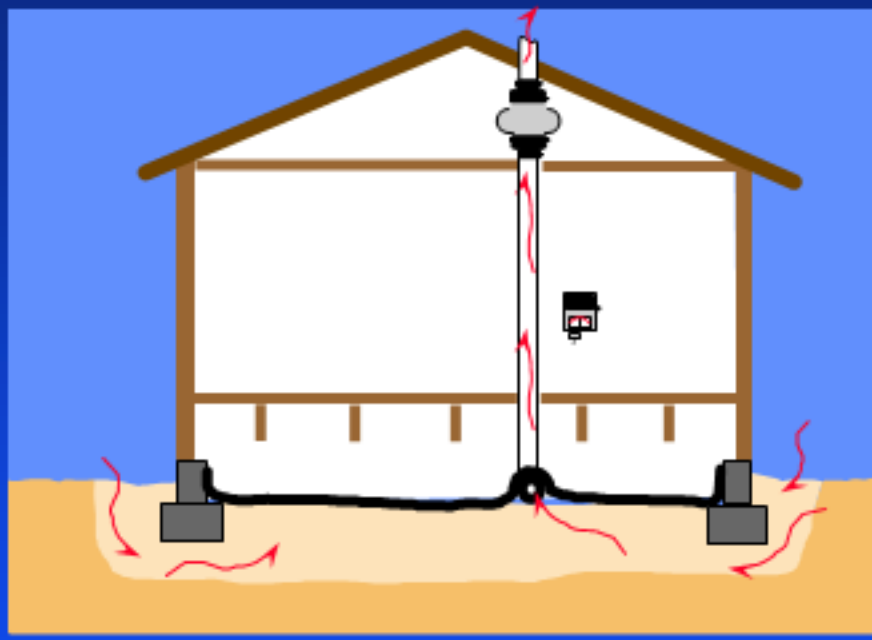
Probability for adverse effects :

Radon 1 in 1000 = 4 pci TCE 1:1000 = 5370 ug/m3 (OSHA)
EPA Residential Action Level: TCE : 1 in 100, 000 = 12.2 ug/m3
PCE: 1 in 100,000 = 4.1 ug/m3



Homes With VI Concerns Can Be Fixed!





Active soil depressurization is a means of creating a vacuum beneath a slab or plastic sheet and collecting the radon before it enters a building.

VI Mitigation Works!