Vapor Intrusion Guidance Update

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SAC Meeting

January 26, 2011

http://indoorairproject.wordpress.com/

Purpose of Presentation

- To provide you with an overview of the contents of the Guidance Document to assist you in preparing your comments

- Written comments are due March 1, 2011

http://indoorairproject.wordpress.com/

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Reminder

- This guidance document outlines MassDEP's recommendations for best practices that will meet the current regulatory requirements
- Following the recommendations within this guidance document will provide presumptive certainty
- PRPs and their LSPs may meet the regulatory requirements in ways other than those specified in this document, providing that the technical justification for their approach is documented and supported by adequate data

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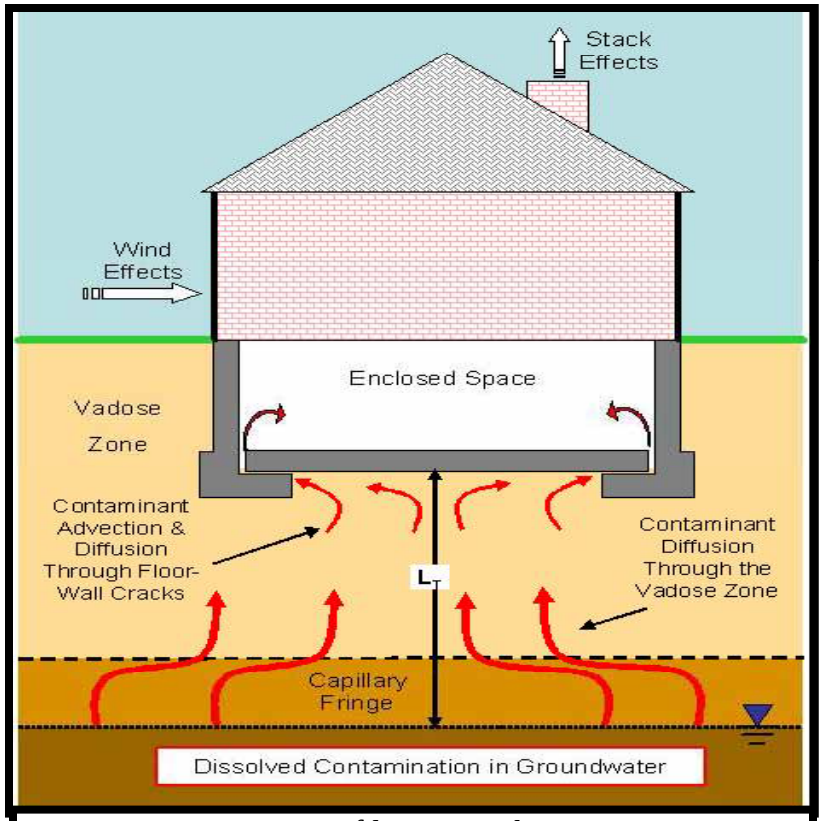
Vapor Intrusion



Vapor Infiltration Pathway

- National Issue
- High Risk Pathway
- Technically Challenging to Assess
- Workgroup's Practical Input Valuable
- Accepting Comments until March 1, 2011

MassDEP is seeking to provide guidance that:

- Is health **protective** of current and future occupants
- Gives current and <u>future</u> property owners and/or developers a **clear** understanding of site conditions where there is a potential for vapor intrusion, and
- Is **practical**, can be applied consistently and provide **certainty** in terms of expectations for MCP compliance

Guidance Table of Contents

Section 1 Introduction

Section 2 Assessment

Section 3 Mitigation

Section 4 Regulatory Framework

Section 5 Communication and Public Involvement at Vapor Intrusion Sites

Section 6 Access

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Guidance Table of Contents

Appendices

I. Indoor Air Threshold Values for the Evaluation of the Vapor Intrusion Pathway
II. Soil-Gas Screening Values (Reserved)
III. Detailed Sampling Procedures
IV. Common Groundwater and Soil Remediation Approaches (Reserved)
V. Guidance of the Design, Installation, Operation, and Monitoring of Sub-Slab Depressurization Systems

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Guidance Table of Contents

Appendices (continued)

VI. References for Other Active Mitigation Systems (Reserved)

VII. Mitigation System Check List

VIII. Use of Activity and Use Limitations (AULs) to Address Future Buildings in Areas of Potential Vapor Intrusion

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Section 1 - Introduction

- Purpose
- Statutory and Regulatory Basis of Policy
- When the Vapor Intrusion Pathway should be evaluated

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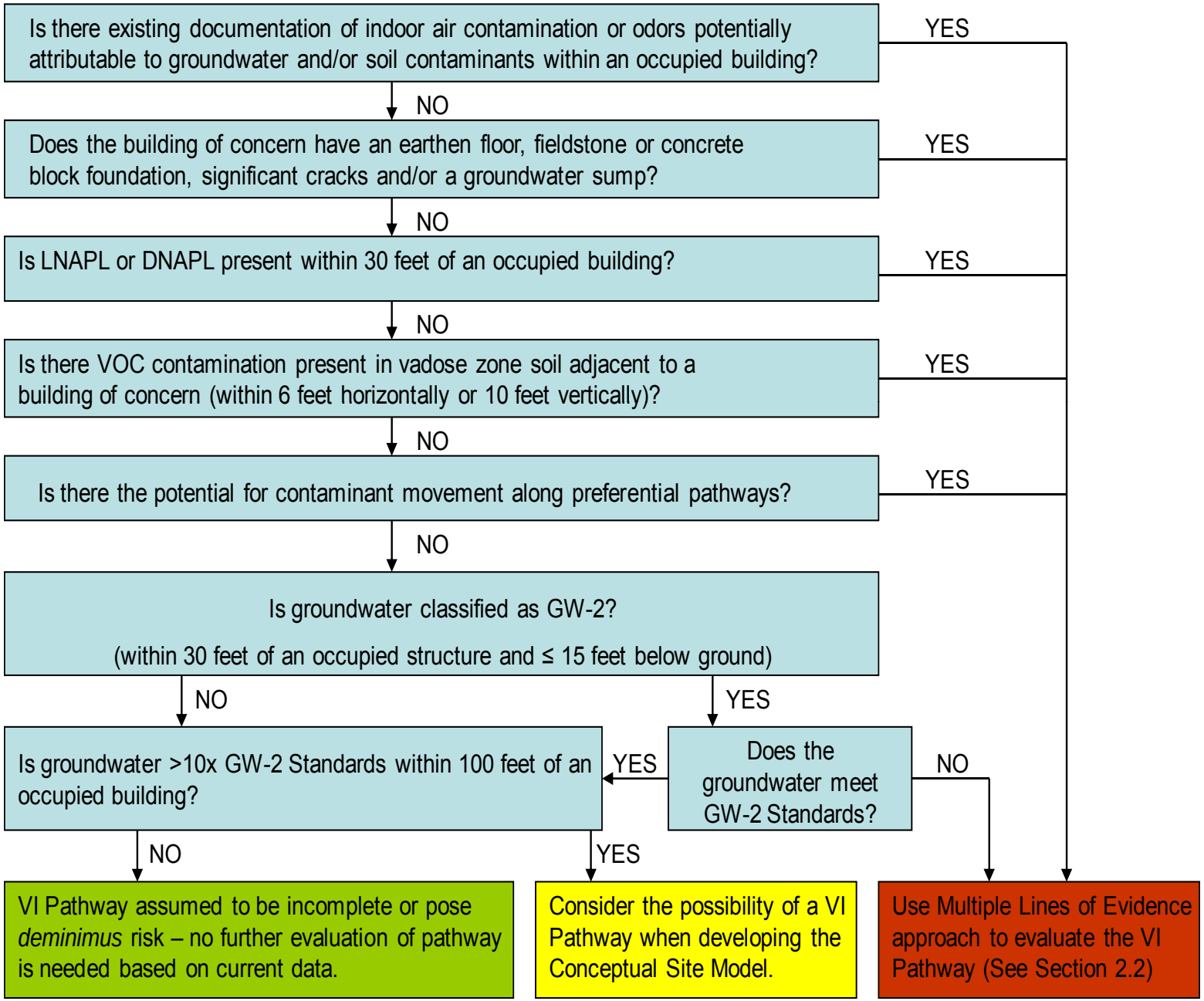
Figure 1-1 Evaluation of Vapor Intrusion



Section 2 - Assessment

- Lines of Evidence
- Sampling Considerations
- Indoor Air Exposure Assessment
- Risk Characterization

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Table 2-1

Interpreting Lines of Evidence – Residential, Schools & Daycares

LINES OF EVIDENCE						
Groundwater Contaminant Levels	<2x GW-2			>2x GW-2		
	AND			**OR**		
Sub-Slab Soil Gas Contaminant Levels#	<50x TV_r (<1000x TV_r)			>50x TV_r (>1000x TV_r)		
	AND			**AND**		
Indoor Air Contaminant Levels	Not Tested	<TV_r	>TV_r	Not Tested	<TV_r	>TV_r
CURRENT PATHWAY?	Not Likely	Not Likely	Possibly†	Likely	Not Likely	Likely
SRM NOTIFICATION?	No	No	Yes	Sample Indoor Air	No	Yes

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Table 2-2

Interpreting Lines of Evidence – Commercial/Industrial

LINES OF EVIDENCE						
Groundwater Contaminant Levels	<2x GW-2			>2x GW-2		
	AND			**OR**		
Sub-Slab Soil Gas Contaminant Levels#	<50x $TV_{c/i}$ (<1000x $TV_{c/i}$)			>50x $TV_{c/i}$ (>1000x $TV_{c/i}$)		
	AND			**AND**		
Indoor Air Contaminant Levels	Not Tested	<$TV_{c/i}$	> $TV_{c/i}$	Not Tested	< $TV_{c/i}$	> $TV_{c/i}$
CURRENT PATHWAY?	Not Likely	Not Likely	Possibly †	Likely	Not Likely	Likely
SRM NOTIFICATION?	NA	NA	NA	NA	NA	NA

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Table A.1 Residential Threshold Values

Chemical	CAS No.	TV_r		Basis for Value
		µg/m³	ppbv	
ACETONE	67-64-1	91	38	90th%
BENZENE	**71-43-2**	**2.3**	**0.72**	**50th%**
BROMODICHLOROMETHANE	75-27-4	**0.14**	**0.021**	cancer risk
BROMOFORM	75-25-2	2.2	0.21	cancer risk
BROMOMETHANE	74-83-9	**0.6**	**0.15**	90th%
CARBON TETRACHLORIDE	56-23-5	**0.54**	**0.086**	50th%
CHLOROBENZENE	108-90-7	2.3	0.50	Reporting Limit
CHLOROFORM	67-66-3	1.9	0.39	50th%
DIBROMOCHLOROMETHANE	124-48-1	**0.10**	**0.012**	cancer risk
DICHLOROBENZENE, 1,2- (o-DCB)	95-50-1	**0.72**	**0.12**	90th%
DICHLOROBENZENE, 1,3- (m-DCB)	541-73-1	**0.6**	**0.10**	90th%
DICHLOROBENZENE, 1,4- (p-DCB)	106-46-7	**0.5**	**0.083**	50th%
DICHLOROETHANE, 1,1-	75-34-3	0.8	0.20	Reporting Limit
DICHLOROETHANE, 1,2-	107-06-2	**0.090**	**0.022**	cancer risk
DICHLOROETHYLENE, 1,1-	75-35-4	0.8	0.20	Reporting Limit
DICHLOROETHYLENE, CIS-1,2-	**156-59-2**	**0.8**	**0.20**	**Reporting Limit**
DICHLOROETHYLENE, T-1,2-	156-60-5	0.8	0.20	Reporting Limit
DICHLOROMETHANE (MeCl)	75-09-2	5.0	1.4	cancer risk
DICHLOROPROPANE, 1,2-	78-87-5	**0.13**	**0.028**	cancer risk
DICHLOROPROPENE, cis, 1,3-	10061-01-5	**0.60**	**0.13**	cancer risk
DICHLOROPROPENE, trans, 1,3-	10061-02-6	**0.60**	**0.13**	cancer risk
DIOXANE, 1,4-	123-91-1	**0.59**	**0.16**	cancer risk
ETHYLBENZENE	100-41-4	7.4	1.7	90th%
ETHYLENE DIBROMIDE	106-93-4	**0.011**	**0.0014**	cancer risk
HEXACHLOROBUTADIENE	87-68-3	**0.11**	**0.010**	cancer risk
METHYL ETHYL KETONE	78-93-3	12	4.1	90th%
METHYL ISOBUTYL KETONE	108-10-1	2.2	0.54	90th%
METHYL TERT BUTYL ETHER	1634-04-4	39	11	90th%
METHYLNAPHTHALENE, 2-	91-57-6	8.0	1.4	Reporting Limit
NAPHTHALENE	91-20-3	**0.61**	**0.12**	non-cancer risk
C5 to C8 Aliphatics	NOS	58	NA	50th%
C9 to C12 Aliphatics	NOS	68	NA	50th%
C9 to C10 Aromatics	NOS	**10**	NA	non-cancer risk
STYRENE	100-42-5	1.4	0.33	90th%
TETRACHLOROETHANE, 1,1,2,2-	79-34-5	**0.041**	**0.0060**	cancer risk
TETRACHLOROETHYLENE	**127-18-4**	**1.4**	**0.21**	**50th%**
TOLUENE	108-88-3	54	14	90th%
TRICHLOROBENZENE, 1,2,4-	120-82-1	**3.4**	**0.46**	90th%
TRICHLOROETHANE, 1,1,1-	71-55-6	3.0	0.55	90th%
TRICHLOROETHANE, 1,1,2-	79-00-5	**0.15**	**0.027**	cancer risk
TRICHLOROETHYLENE	**79-01-6**	**0.8**	**0.15**	**90th%**
VINYL CHLORIDE	75-01-4	**0.27**	**0.11**	cancer risk
XYLENES (Mixed Isomers)	1330-20-7	20	4.6	non-cancer risk

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Table A.2 Commercial/Industrial Threshold Values

Chemical	CAS No.	$TV_{c/i}$ µg/m³	$TV_{c/i}$ ppbv	Basis for Value
ACETONE	67-64-1	230	98	Non-cancer Risk
BENZENE	**71-43-2**	**11**	**3.4**	**90th%tile TIAC**
BROMODICHLOROMETHANE	75-27-4	0.19	0.029	Cancer Risk
BROMOFORM	75-25-2	3.1	0.30	Cancer Risk
BROMOMETHANE	74-83-9	1.5	0.37	Non-cancer Risk
CARBON TETRACHLORIDE	56-23-5	0.86	0.14	90th%tile TIAC
CHLOROBENZENE	108-90-7	5.8	1.3	Non-cancer Risk
CHLOROFORM	67-66-3	3.0	0.62	90th%tile TIAC
DIBROMOCHLOROMETHANE	124-48-1	0.14	0.017	Cancer Risk
DICHLOROBENZENE, 1,2- (o-DCB)	95-50-1	58	9.7	Non-cancer Risk
DICHLOROBENZENE, 1,3- (m-DCB)	541-73-1	58	9.7	Non-cancer Risk
DICHLOROBENZENE, 1,4- (p-DCB)	106-46-7	1.5	0.25	90th%tile TIAC
DICHLOROETHANE, 1,1-	75-34-3	150	37	Non-cancer Risk
DICHLOROETHANE, 1,2-	107-06-2	0.13	0.032	Cancer Risk
DICHLOROETHYLENE, 1,1-	75-35-4	58	15	Non-cancer Risk
DICHLOROETHYLENE, CIS-1,2-	**156-59-2**	**31**	**8.2**	**Non-cancer Risk**
DICHLOROETHYLENE, T-1,2-	156-60-5	20	5.1	Non-cancer Risk
DICHLOROMETHANE (MeCl)	75-09-2	11	3.1	90th%tile TIAC
DICHLOROPROPANE, 1,2-	78-87-5	0.18	0.039	Cancer Risk
DICHLOROPROPENE, cis, 1,3-	10061-01-5	0.85	0.18	90th%tile TIAC
DICHLOROPROPENE, trans, 1,3-	10061-02-6	0.85	0.18	Cancer Risk
DIOXANE, 1,4-	123-91-1	0.83	0.23	Cancer Risk
ETHYLBENZENE	100-41-4	290	67	Non-cancer Risk
ETHYLENE DIBROMIDE	106-93-4	0.011	0.0015	Cancer Risk
HEXACHLOROBUTADIENE	87-68-3	460	0.42	90th%tile TIAC
METHYL ETHYL KETONE	78-93-3	1500	500	Non-cancer Risk
METHYL ISOBUTYL KETONE	108-10-1	880	220	Non-cancer Risk
METHYL TERT BUTYL ETHER	1634-04-4	880	250	Non-cancer Risk
METHYLNAPHTHALENE, 2-	91-57-6	15	2.6	Non-cancer Risk
NAPHTHALENE	91-20-3	2.7	0.53	90th%tile TIAC
C5 to C8 Aliphatics	NOS	330	NA	90th%tile TIAC
C9 to C12 Aliphatics	NOS	220	NA	90th%tile TIAC
C9 to C10 Aromatics	NOS	44	NA	90th%tile TIAC
STYRENE	100-42-5	6.0	1.4	Cancer Risk
TETRACHLOROETHANE, 1,1,2,2-	79-34-5	0.059	0.067	Cancer Risk
TETRACHLOROETHYLENE	**127-18-4**	**4.1**	**0.62**	**90th%tile TIAC**
TOLUENE	108-88-3	1500	380	Non-cancer Risk
TRICHLOROBENZENE, 1,2,4-	120-82-1	58	7.9	Non-cancer Risk
TRICHLOROETHANE, 1,1,1-	71-55-6	1500	280	Non-cancer Risk
TRICHLOROETHANE, 1,1,2-	79-00-5	0.21	0.038	Cancer Risk
TRICHLOROETHYLENE	**79-01-6**	**6.0**	**1.1**	**Cancer Risk**
VINYL CHLORIDE	75-01-4	0.39	0.16	Cancer Risk
XYLENES (Mixed Isomers)	1330-20-7	29	6.7	Non-cancer Risk

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Comparison of Residential and Commercial/Industrial Threshold Values

Chemical	TV_r		$TV_{c/i}$		Basis for Value
	µg/m³	ppbv	µg/m³	ppbv	
Tetrachloroethylene	1.4	0.21	4.1	0.62	r: 50th tile TIAC c/i: 90thtile TIAC
Trichloroethylene	**0.8**	**0.2**	6.0	1.1	r: 90thtile TIAC c/i: cancer risk
cis – 1,2-dichloroethylene	**0.8**	**0.13**	31	8.2	r: cancer risk c/i: 90thtile TIAC
Benzene	2.3	0.72	11	3.4	r: 50th tile TIAC c/i: 90thtile TIAC

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Table 2-3

Conditions for Sampling Indoor Air

Parameter	Most Conservative Conditions	Least Conservative Conditions
Season	Late winter/early spring	Summer
Temperature	Indoor 10°F > than outdoors	Indoor temp < outdoor temp.
Wind	Steady, > ~5 mph	Calm
Soil	Saturated with rain	Dry
Doors/Windows	Closed	Open
Heating System	Operating	Off

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Table 2-4

Recommended Indoor Air Exposure Assumptions

Site Use/Receptor	Exposure Duration	Exposure Frequency	Exposure Period
Residential/Homebound Adult	24 hours per day	365 days per year	30 years, 5 years for IH Evaluation
Commercial/Industrial Worker	8 hours per day	250 days per year	30 years, 5 years for IH Evaluation

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Section 3 - Mitigation

- VOC Source Elimination or Control
- Indoor Air Pathway Mitigation
- Active Mitigation Systems
- Alternative Mitigation Approaches
- Mitigation Maintenance and Monitoring
- Closure Sampling

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Table 3-1- SAMPLING REGIMENS FOR ACTIVE MITIGATION SYSTEMS AND PASSIVE MEASURES IMPLEMENTED TO ADDRESS THE VAPOR INTRUSION PATHWAY

	ACTIVE SYSTEMS	PASSIVE MEASURES		COMMENTS
RECOMMENDED USE	Active systems, specifically mitigation systems, are the recommended method to address the vapor intrusion pathway particularly if an Imminent Hazard or Significant Risk exists	Passive measures (such as passive venting systems, sealing cracks and concrete walls and floors, sealing the annular spaces around utilities, and sealing sumps) may be an alternative to active SSD systems when the subsurface contaminant concentrations are low. Passive measures are not recommended for Imminent Hazards or Significant Risk.		
NUMBER OF DAYS TO ALLOW SYSTEM TO EQUILIBRATE	Sample indoor air approximately seven days after system start up.	Sample indoor air approximately seven days after the measures are implemented.		
SAMPLING TO DEMONSTRATE EFFECTIVENESS	Once a pressure differential across the floor is established conduct at least one round of indoor air sampling during the heating season. If it is determined that the system is effectively reducing the indoor air contaminant concentrations the differential pressure can then be used to monitor system effectiveness (see below).	**Sampling regimen depends on concentration of contaminants in the groundwater, sub-slab-soil soil gas and/or indoor air PRIOR to system installation:**		**If any sampling to demonstrate effectiveness indicates that the system installed or measures taken are not effective, either augment and/or modify the system or select another approach to achieve the goals of the response actions. These measures should be implemented immediately and re-sampled following these guidelines.** **If the sampling to demonstrate effectiveness indicates that the system is effective, the system should be monitored following the guidelines outlined in the maintenance monitoring section.**
		If GW Conc. > GW-2 and < 2X GW-2 **and** **Sub-slab Soil Gas Conc. < 50X TVs[1., 2.]** **and** **Indoor Air Conc. < 2X appropriate TVs[2]:** Conduct at least two rounds of sampling in the first year after the measures are implemented, with one round conducted during heating season.	**If GW Conc. >2X GW-2** **and/or** **Soil Gas Conc. > 50X TVs[1.,2.]** **and/or** **Indoor Air Conc. > 2X appropriate TVs[2]:** Quarterly indoor air sampling in the first year after the measures are implemented.	
MAINTENANCE MONITORING	Differential pressures across the sub-slab can be used to demonstrate system effectiveness. If the sub-slab pressure differential is equal to or greater than it was when the indoor air sampling indicated that the concentration of contaminants in the indoor at were at or below the appropriate TVs, it can be assumed that the system is working properly. Annual checks for pressure drops and fan operation should be conducted until site closure.	**Sampling regimen depends on concentration of contaminants in the groundwater, sub-slab-soil soil gas and/or indoor air PRIOR to system installation:**		**If the maintenance monitoring indicates that the system installed or measures taken are not effective, either augment and/or modify the system or select another approach to achieve the goals of the response actions. These measures should be implemented immediately and re-sampled following these guidelines.**
		If GW Conc. > GW-2 and < 2X GW-2 **and** **Sub-slab Soil Gas Conc. < 50X TVs** **and** **Indoor Air Conc. < 2X TVs:** Indoor air samples should be collected once every two years during the heating season until site closure.	**If GW Conc. >2X GW-2** **and/or** **Soil Gas Conc. > 50X TVs** **and/or** **Indoor Air Conc. > 2X TVs:** Indoor air samples should be collected annually during the heating season until site closure.	

NOTES:

1. If sub-slab soil gas samples cannot be collected due to site conditions (shallow groundwater), the decisions should be based on groundwater concentrations (inferred or directly measured) and indoor air concentrations.
2. The appropriate threshold values (TVs) should be used for the expected exposure scenarios, whether residential or commercial/industrial (refer to Section 2 of the text).

Active Systems

Recommended Use

Active systems, specifically mitigation systems, are the recommended method to address the vapor intrusion pathway particularly if an Imminent Hazard or Significant Risk exists

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Active System Monitoring

Sampling to Demonstrate Effectiveness

Once a pressure differential across the floor is established, conduct at least one round of indoor air sampling during the heating season. If it is determined that the system is effectively reducing the indoor air contaminant concentrations, the differential pressure can then be used to monitor system effectiveness

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Active System Monitoring

Maintenance Monitoring

- If sub-slab pressure differential equal/greater than it was when the indoor air sampling indicated that the indoor air concentrations were at/below TVs, then system is assumed to be working properly
- Annual checks for pressure drops and fan operation should be conducted until site closure

Passive Venting Systems

Recommended Use

- Passive venting systems may be an alternative to active SSD systems when the subsurface contaminant concentrations are low. Passive venting systems are not recommended for Imminent Hazards or Significant Risk

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Passive Venting Monitoring

Sampling to Demonstrate Effectiveness depends on contaminant concentrations measured prior to mitigation

Low Concentrations:

GW greater than GW-2 and less than 2 X GW-2;

Sub-slab Soil Gas Concentration less than 50 X TVs; **and**

Indoor Air Concentration is less than 2 X appropriate TVs

High Concentrations:

GW greater than 2 X GW-2;

Sub-slab Soil Gas Concentration greater than 50 X TVs; **and**
Indoor Air Concentration is greater than 2 X appropriate TVs

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Passive Venting Monitoring

Sampling to Demonstrate Effectiveness

Low Concentrations:

Conduct at least two rounds of sampling in the first year after the measures are implemented, with one round conducted during heating season

High Concentrations:

Quarterly indoor air sampling in the first year after the measures are implemented

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Passive Venting Monitoring

Maintenance Monitoring

Low Concentrations:

Indoor air samples should be collected once every two years during the heating season until site closure

High Concentrations:

Indoor air samples should be collected annually during the heating season until site closure

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Site Closure

Certainty and Protectiveness for sites with Vapor Intrusion (AKA how to RAO if you've dealt with CEP)

- Source eliminated or controlled
- No Significant Risk
- Enough data to demonstrate that indoor air really is NSR
- AULs as needed to ensure future protectiveness

What is enough data?

To demonstrate that an active system is no longer required to mitigate the vapor intrusion pathway MassDEP recommends a minimum of **three rounds of indoor air sampling collected over two years**, with two rounds collected during the heating season, *with the sub-slab system off*

The system should be turned off for at least seven prior to sampling days to allow for equilibration

If it can be demonstrated that No Significant Risk has been achieved without the system operating, the system can be shut down

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Section 4 – Regulatory Framework

- Reporting Obligations
- Immediate Response Actions
- Critical Exposure Pathway (CEP)
- Numerical Ranking System
- MCP Closure
- Future Buildings

Risk and Required Mitigation

Risk

Imminent Hazard

• must promptly eliminate

No Substantial Hazard

• must achieve for a Temporary Solution

No Significant Risk

• must achieve for a Permanent Solution

Background (No Vapor Intrusion Pathway)

• must achieve or approach, to the extent feasible, for a Permanent Solution

CEP

Eliminate, mitigate or prevent pathway, if feasible

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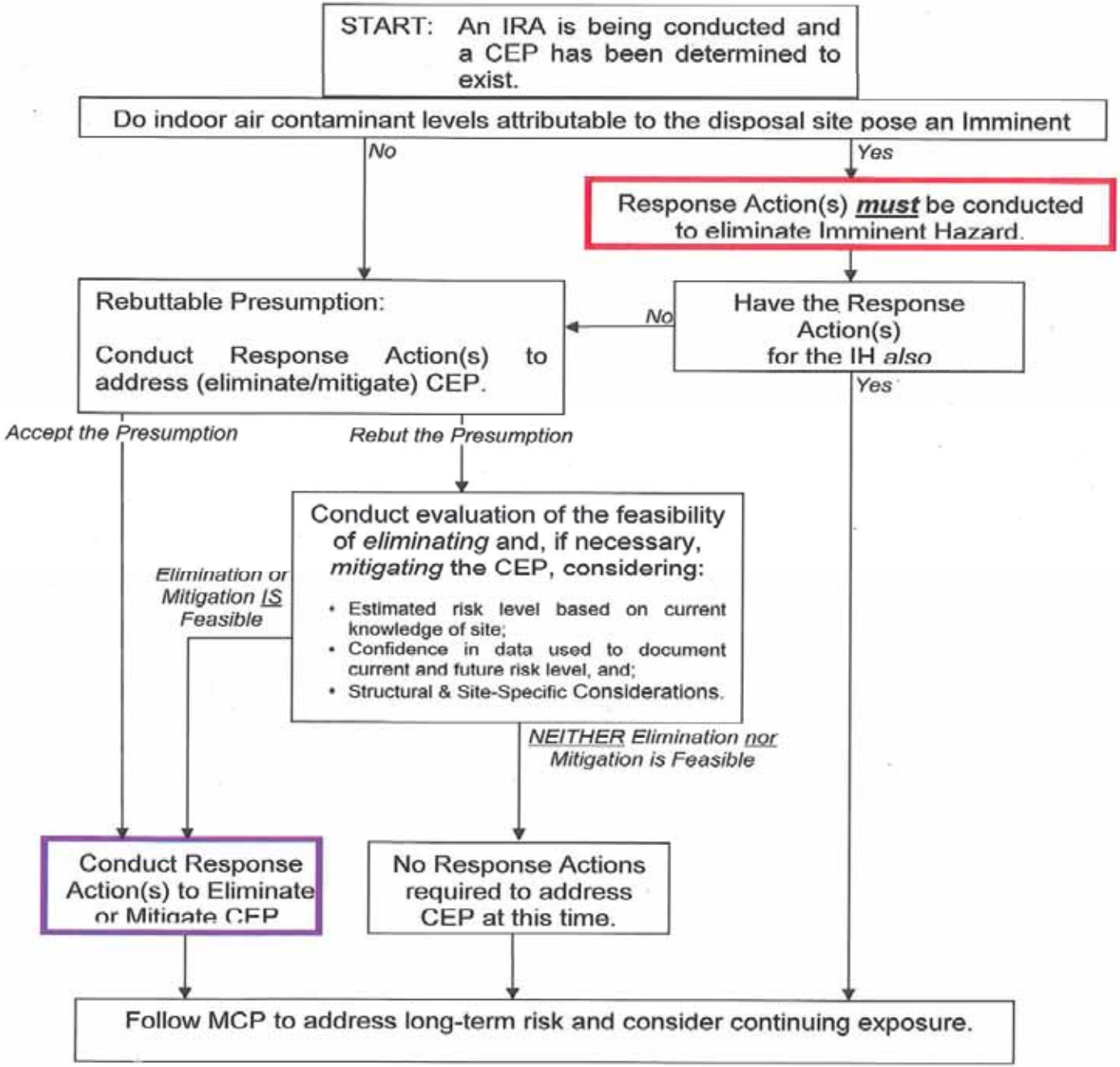
Addressing CEP from Vapor Intrusion



Future Buildings
Statement of the Problem

At a disposal site with VOCs in groundwater above the GW-2 Standards and no current building, how do we ensure that future development is protective against vapor intrusion?

Future Buildings
Statement of the Problem

Compound	GW-2	GW-3
PCE	50 ug/l	30,000 ug/l
TCE	30 ug/l	5,000 ug/l
Cis-1,2-DCE	100 ug/l	50,000 ug/l
benzene	2000 ug/l	10,000 ug/l

Future Buildings

- Design and siting
  - Building situated away from area of contamination
  - Garage on lowest level
  - Building elevated above ground
- Tiered engineering solutions depending on contaminant levels
  - Vapor barrier with certified installation, +/- sub-slab system, +/- monitoring

Protecting Occupants of Future Buildings: *Examples of **Possible** Off-Ramps*

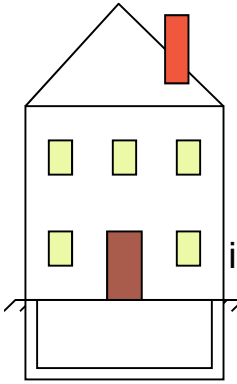
A "Low"

MCP Closure:

- A-2 or B-1 RAO
- No AUL
- (assumes all other requirements are met)

gw **<** GW-2

Time



Building Construction

- Unrestricted Use
- No MCP requirements

ia *Not sampled*

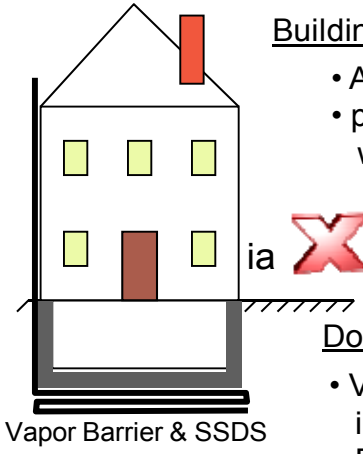
B "Elevated"

MCP Closure:
(assumes all other requirements are met)

- A-3 or B-2 RAO (includes AUL)
- **A-2 or B-1 (with potential future notification obligation)**
- **RAO VI (possible future option?)**

gw **< 10** x GW-2

Time



Vapor Barrier & SSDS

Building Construction

- AUL Applies
- post-RAO RAM with submittals

ia *Not sampled*

Documentation

- VB & SSDS installed meeting Performance Stnds (TBD)

(assumes unchanged gw conditions)

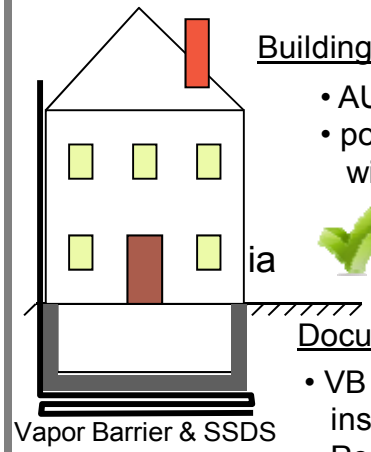
C "High"

MCP Closure:
(assumes all other requirements are met)

- A-3 or B-2 RAO (includes AUL)
- **A-2 or B-1 (with potential future notification obligation)**
- **RAO VI (possible future option?)**

gw **> 10** x GW-2

Time



Vapor Barrier & SSDS

Building Construction

- AUL Applies
- post-RAO RAM with submittals

ia *sampled*

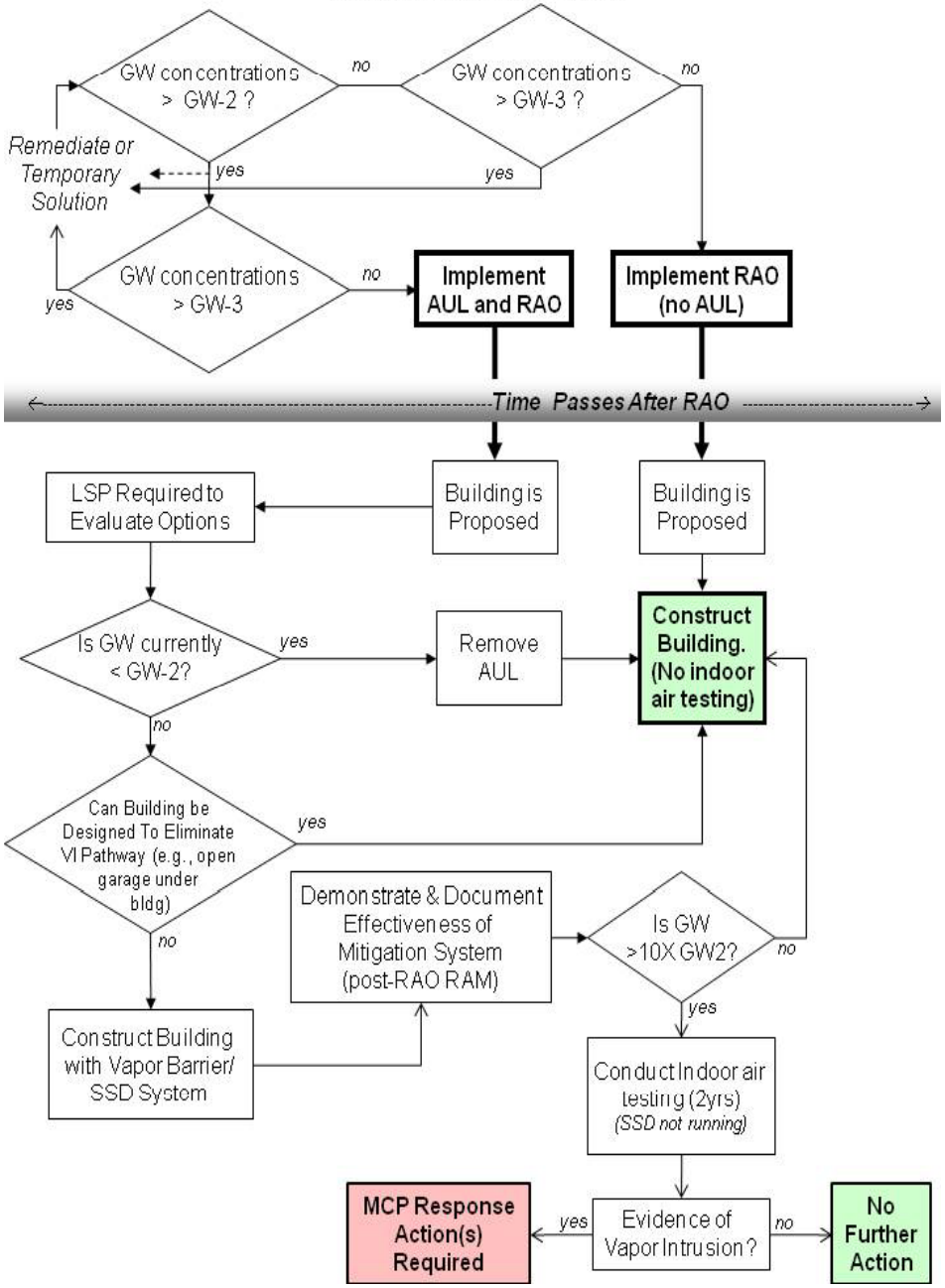
Documentation

- VB & SSDS installed meeting Performance Stnds (TBD)
- 2 yrs indoor air sampling results (consistent with existing bldg requirements)

(assumes unchanged gw conditions)

Protecting Future Buildings

in Areas of Potentially Significant Vapor Intrusion but No Current Building
(Assumes Site is Not in GW-1 Area)



Types of Barriers & Performance Standards

- Types of vapor barriers
  - Liquid Boot®
  - Geoseal™
  - Polyguard
  - Cupolex ®
  - Others?
- Performance Standards
  - Indoor air sampling
  - Sub-slab soil gas
  - ASTM Methods
    - Smoke testing
    - other?

Section 5 – Public Involvement

- MCP Requirements for Notification to Property Owners
- Public Notification and Involvement
- Public Involvement Plan Designation
- Optional Public Involvement Activities

Section 4 – Obtaining Access

- Not much to say about this….

Next Steps

- Accepting written comments until March 1, 2011
- Organize comments and prepare written responses
- Meet with external workgroup to discuss comments and responses
- Finalization of Guidance
- Training

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http://indoorairproject.wordpress.com/