

University of Massachusetts Amherst
Soils, Sediments, and Water



Workshop #13

Critical Exposure Pathways

October 17, 2007

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Workshop Overview

7:00 – 7:40

- CEP Concepts & Process (EC)
- Q&A

7:40 – 8:30

- Vapor Intrusion Pathway (JF)
- Q&A

8:30 – 8:40 **BREAK**

8:40 –9:20

- Regulatory Guidelines & Rules of Thumb (EC)
- Q&A

9:20- 10:00

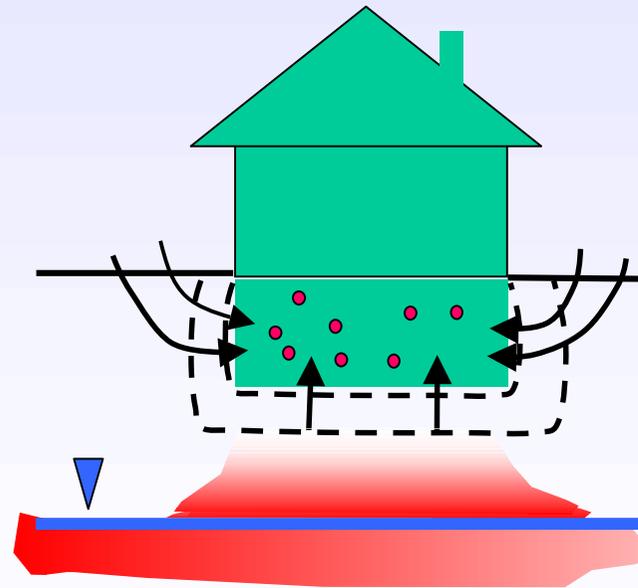
- Technical Guidelines & Rules of Thumb (JF)
- Q&A

CEP Concepts & Process

CEP Definition – 40.0006

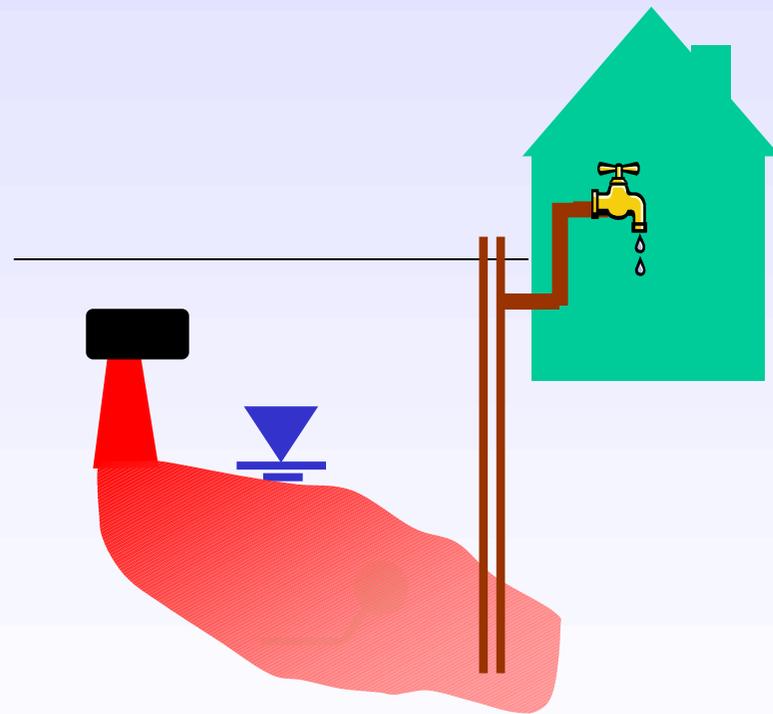
Critical Exposure Pathways mean those routes by which OHM(s) released at a disposal site are transported, or are likely to be transported, to human receptors via:

- (a) vapor-phase emissions of measurable concentrations of OHMs into the living or working space of a pre-school, daycare, school or occupied residential dwelling; **OR**

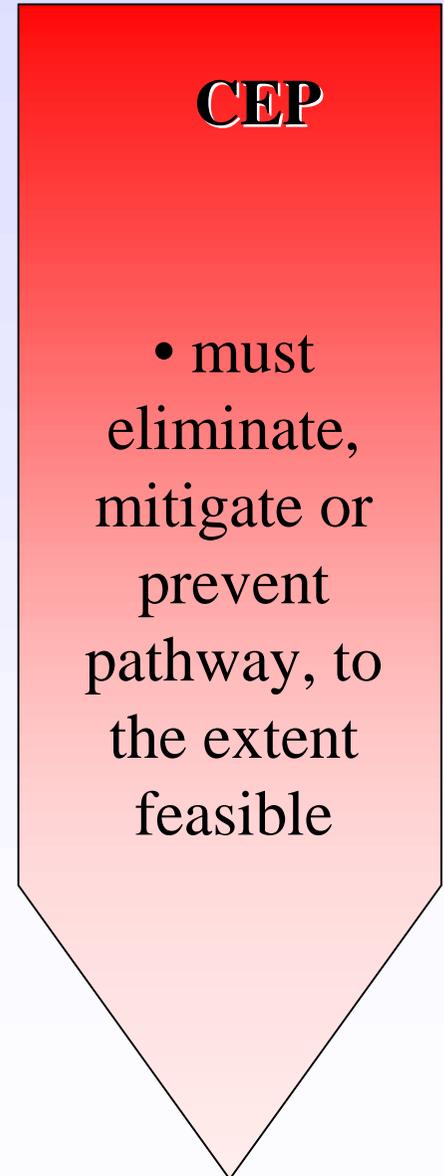


CEP Definition – 40.0006 (cont.)

(b) ingestion, dermal absorption or inhalation of measurable concentrations of OHMs from drinking water supply wells located at and servicing a pre-school, daycare, school or occupied residential dwelling.



Risk and Required Mitigation



Why Do We Care about CEPs?

- CEPs address Exposure Pathways in schools, day cares, and homes, where frequency of exposure is likely high
- Uncertainties in chemical toxicity information and risk characterization
- Sensitive populations (e.g., infants, children, fetal development, compromised immune systems)

Statutory Basis - CEP

Section 3A(g)

Chapter 21E Permanent Solution Requirements

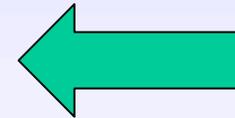
- Achievement of “No Significant Risk” (HI, ELCR)
- Where feasible, a permanent solutions shall include measures to reduce to the extent possible the level of OHM to the level that would exist in the absence of the disposal site (i.e., “background”)

Statutory Basis - Feasibility

Section 3A(h)

Feasibility Criteria

- No technology exists
- **Costs outweigh the benefits**
- Expertise not available
- No available disposal location



Regulatory Requirements – IRAs and CEPs

- 40.0414(3) – IRAs are presumed to require the **elimination and/or mitigation** of CEPs
- 40.414(4) IRAs are presumed to require the **prevention and/or mitigation** of CEPs

These are **REBUTTABLE PRESUMPTIONS**,
based on feasibility

Condition of Substantial Release Migration (SRM) - 40.0006

a condition at a disposal site that includes any of the following:...

(d) releases to groundwater that have been or are within one year likely to be detected in a public or private water supply well;

...

(f) releases to groundwater or to the vadose zone that have or are within one year likely to result in the discharge of vapors into school buildings or occupied residential dwellings.

SRM Condition - Notification

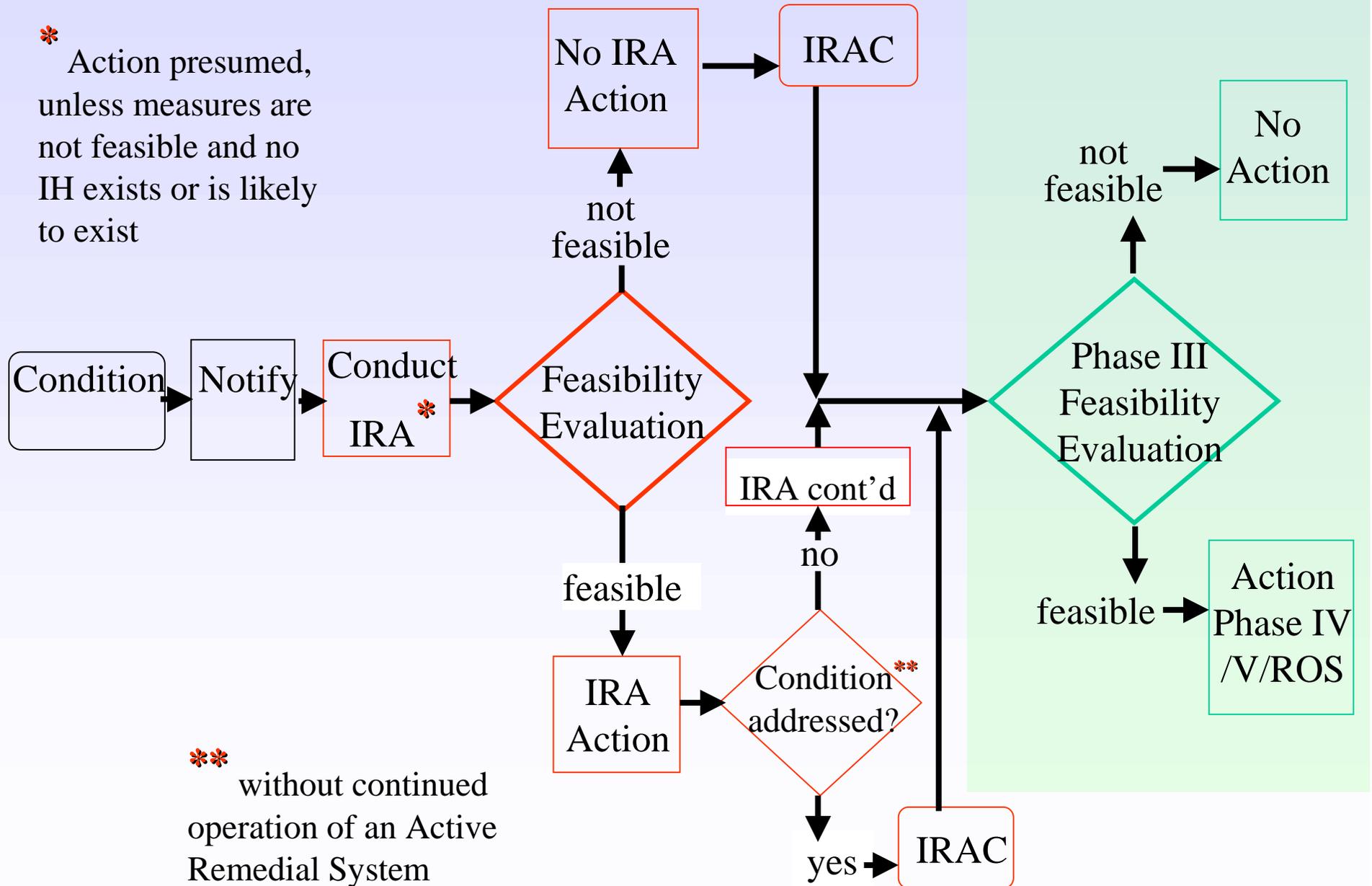
- 72 hour notification condition *
- Requires an IRA

*

where such condition is associated with a release for which notification otherwise is or has at any time in the past been required (40.0313(5))

Life Cycle of a CEP

* Action presumed, unless measures are not feasible and no IH exists or is likely to exist



CEP

- Expedites consideration of cost-effective measures to eliminate, reduce or prevent exposures in schools, day cares and homes from vapors or drinking water
- Front loads the background feasibility evaluation into the IRA where a Critical Exposure Pathway exists

MCP Feasibility Evaluations – 40.0860

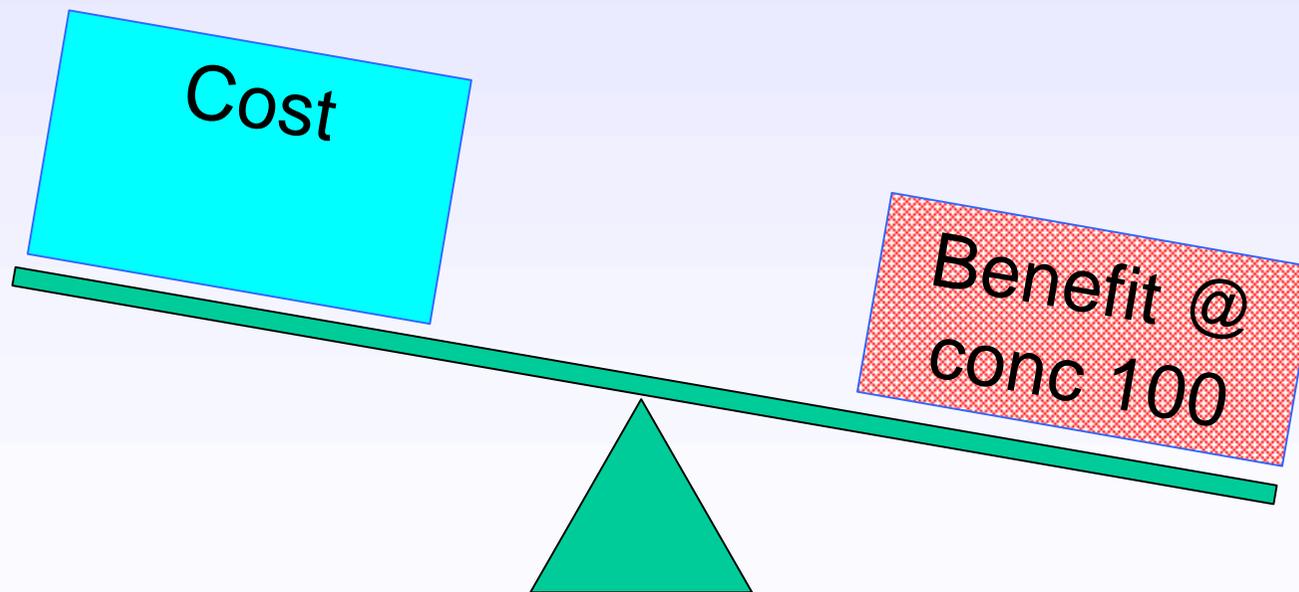
- Selection of Remedial Alternatives
- Permanent Versus Temporary Solutions
- Reducing OHM below UCLs
- **Critical Exposure Pathways**
- Technologies that Reuse, Recycle, or Treat OHM
- Achieving or Approaching Background

Feasibility Considerations

- OHM concentration
- OHM toxicity
- OHM persistence
- Uncertainty in site characterization, complexity of site conditions
- Cost of mitigation alternatives
- Effectiveness of mitigation alternatives
- Timing

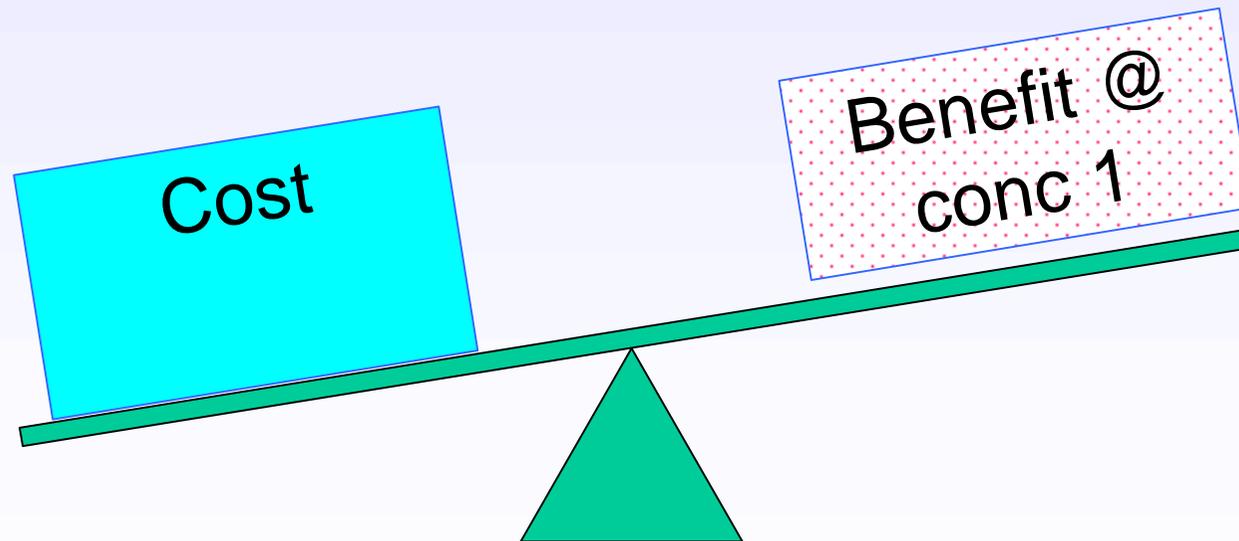
Feasibility Considerations

Critical Exposure Pathways



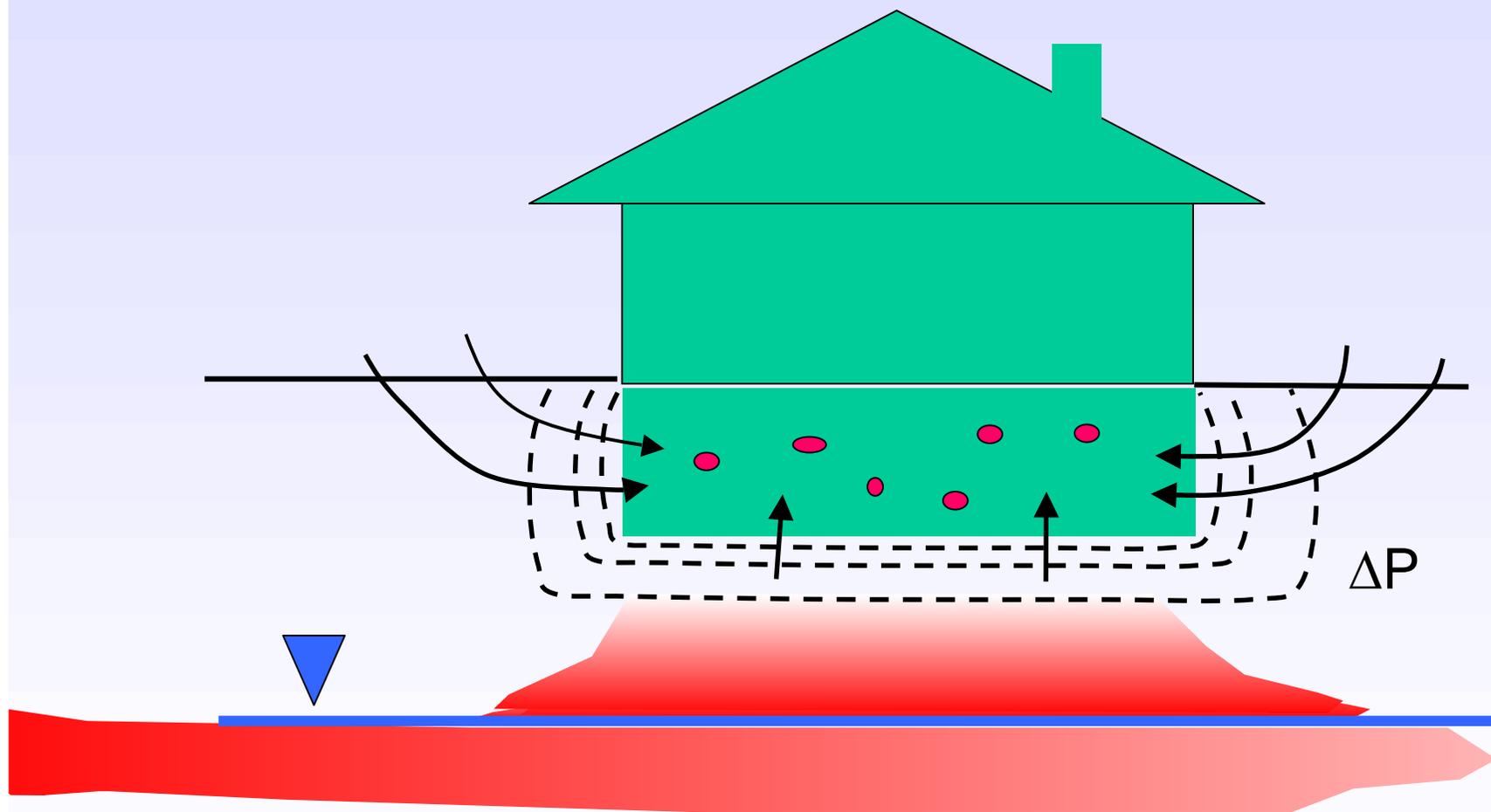
Feasibility Considerations

Critical Exposure Pathways

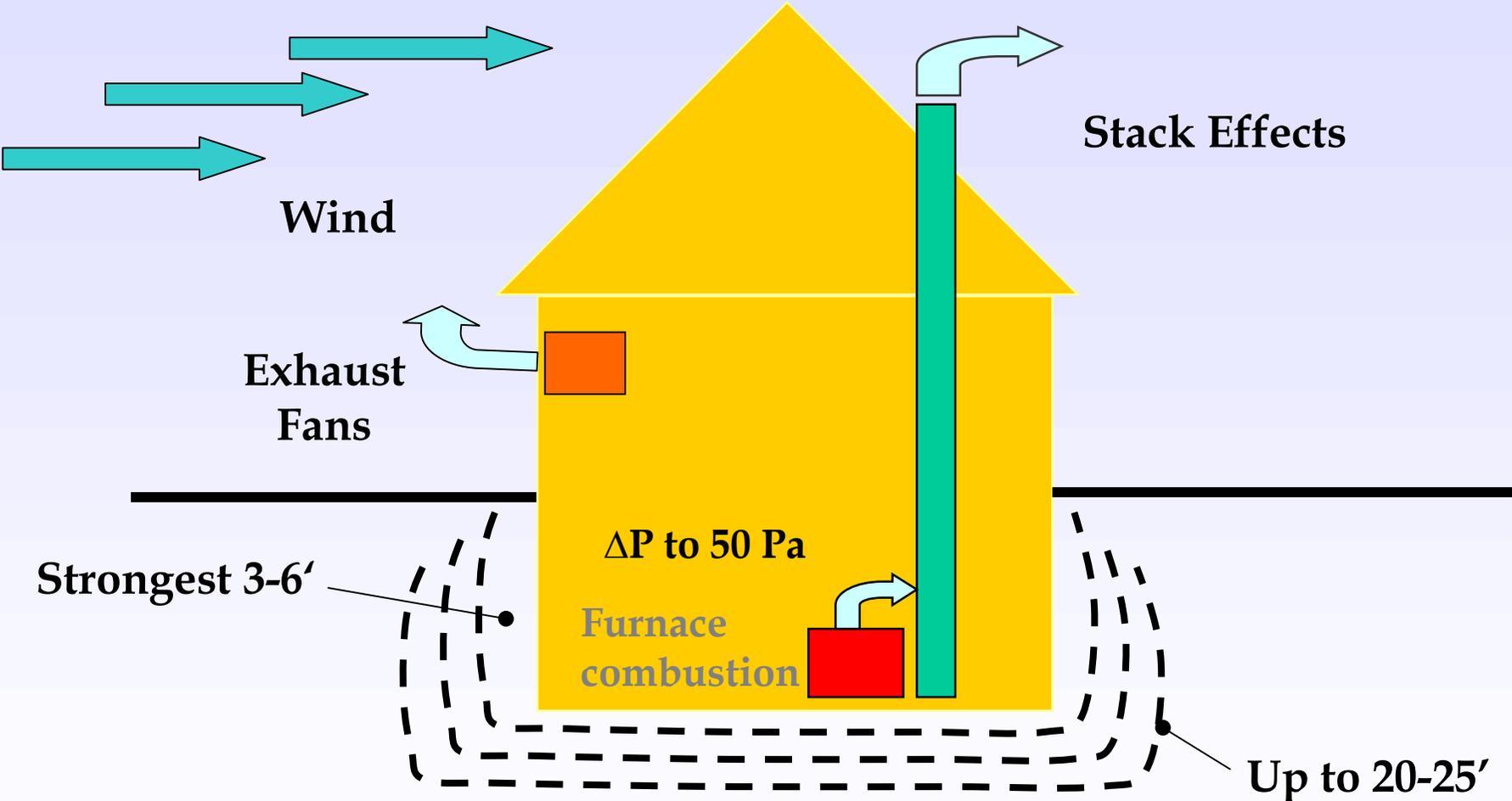


Conceptual Site Model

Vapor Intrusion Phenomenon



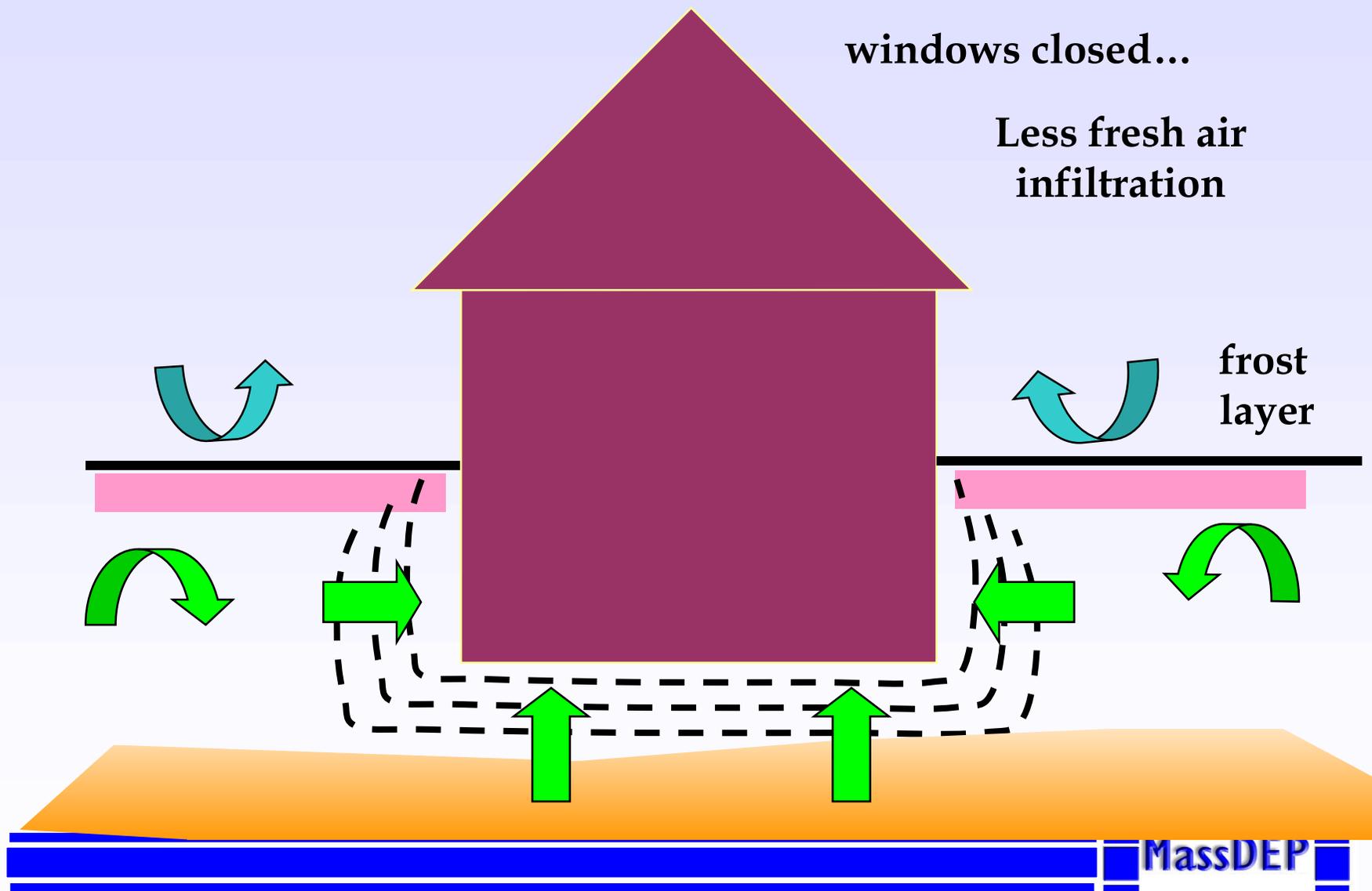
Building Depressurization



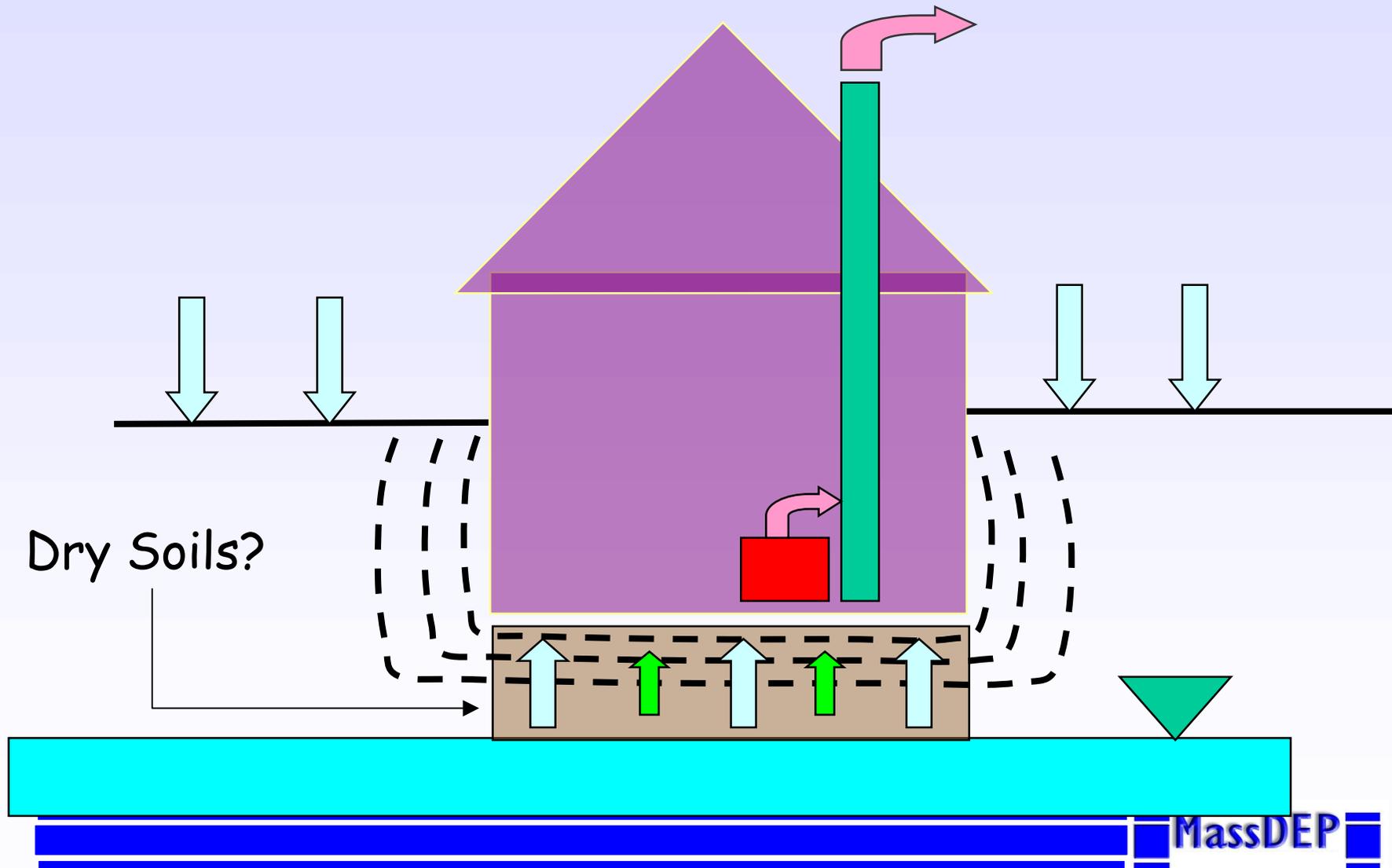
Winter

windows closed...

Less fresh air
infiltration



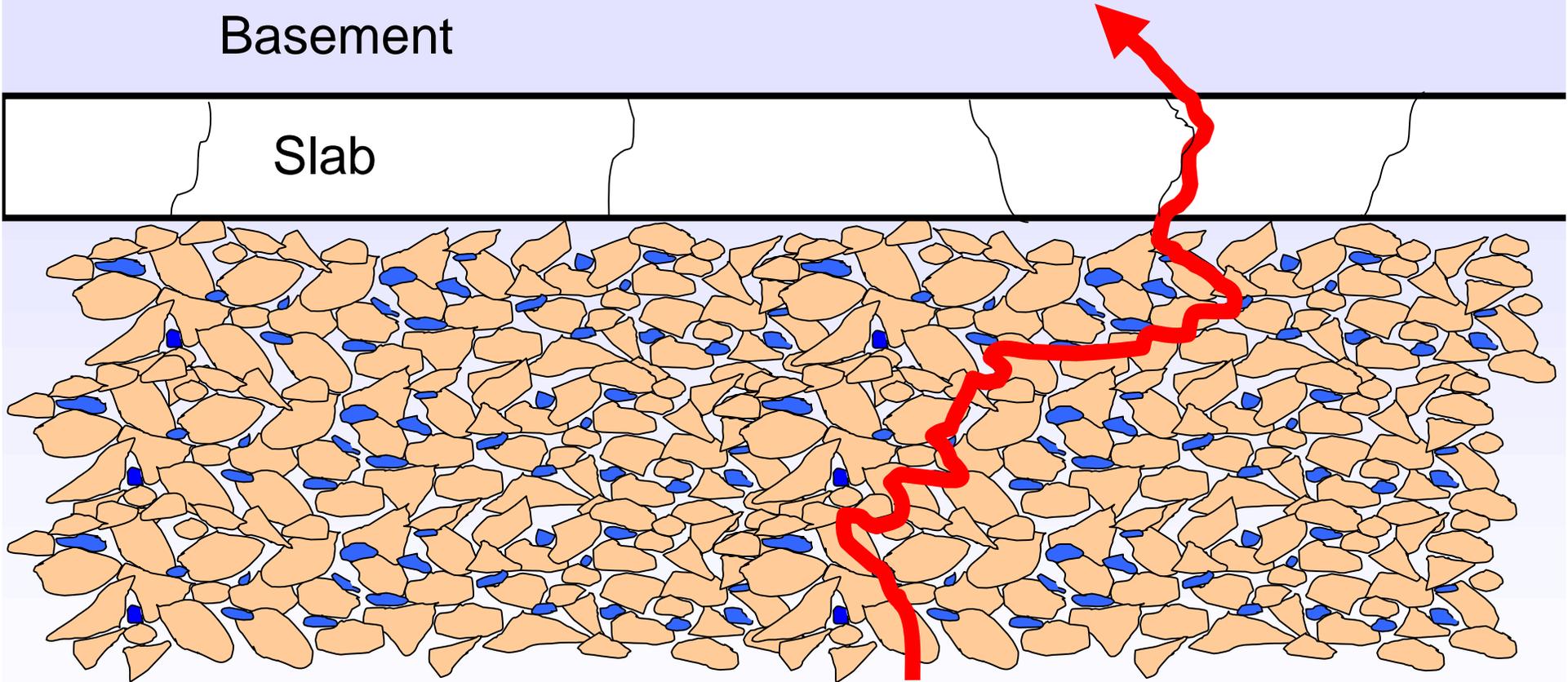
(Water) Vapor Intrusion



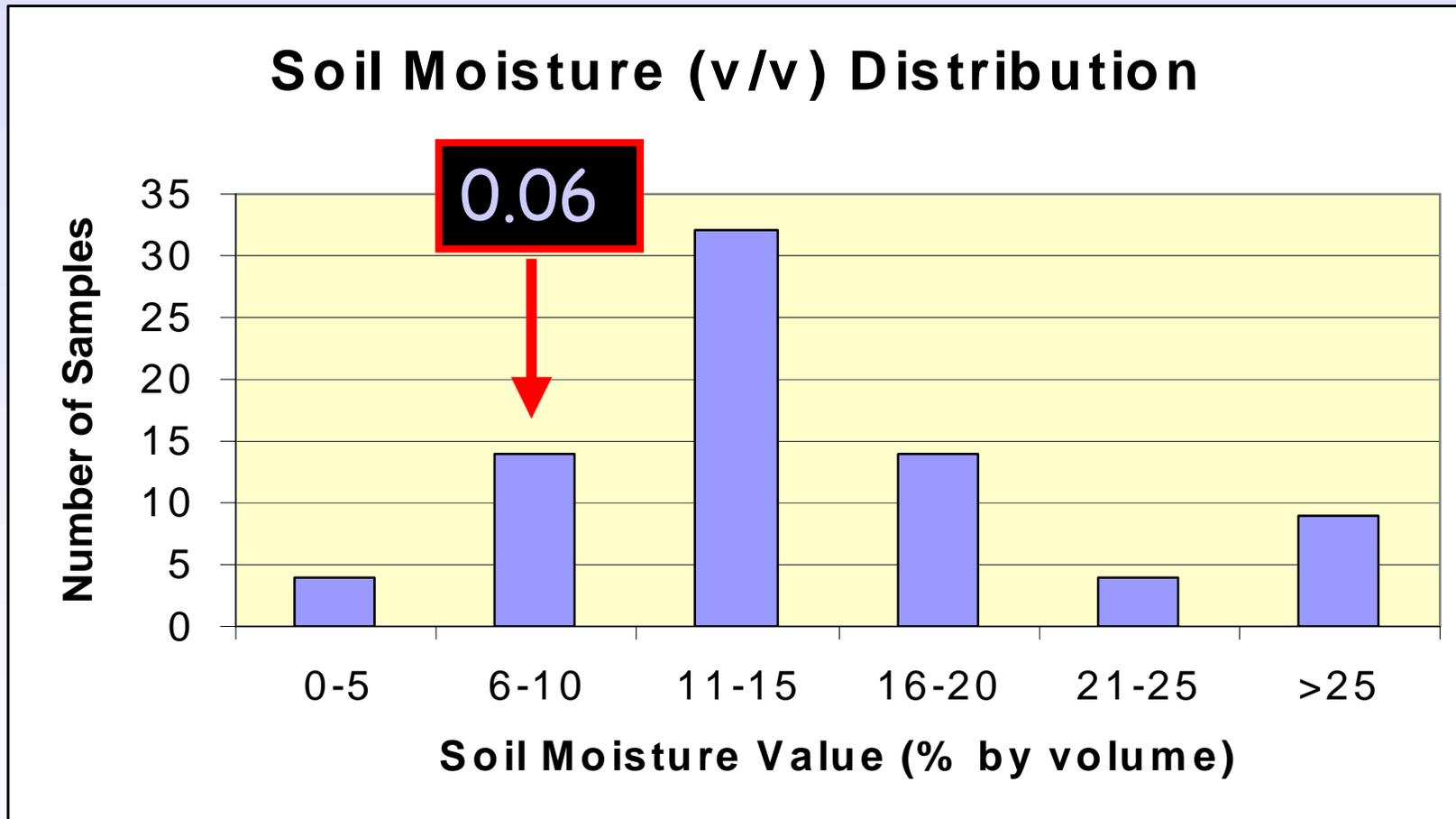
Moisture Considerations

Basement

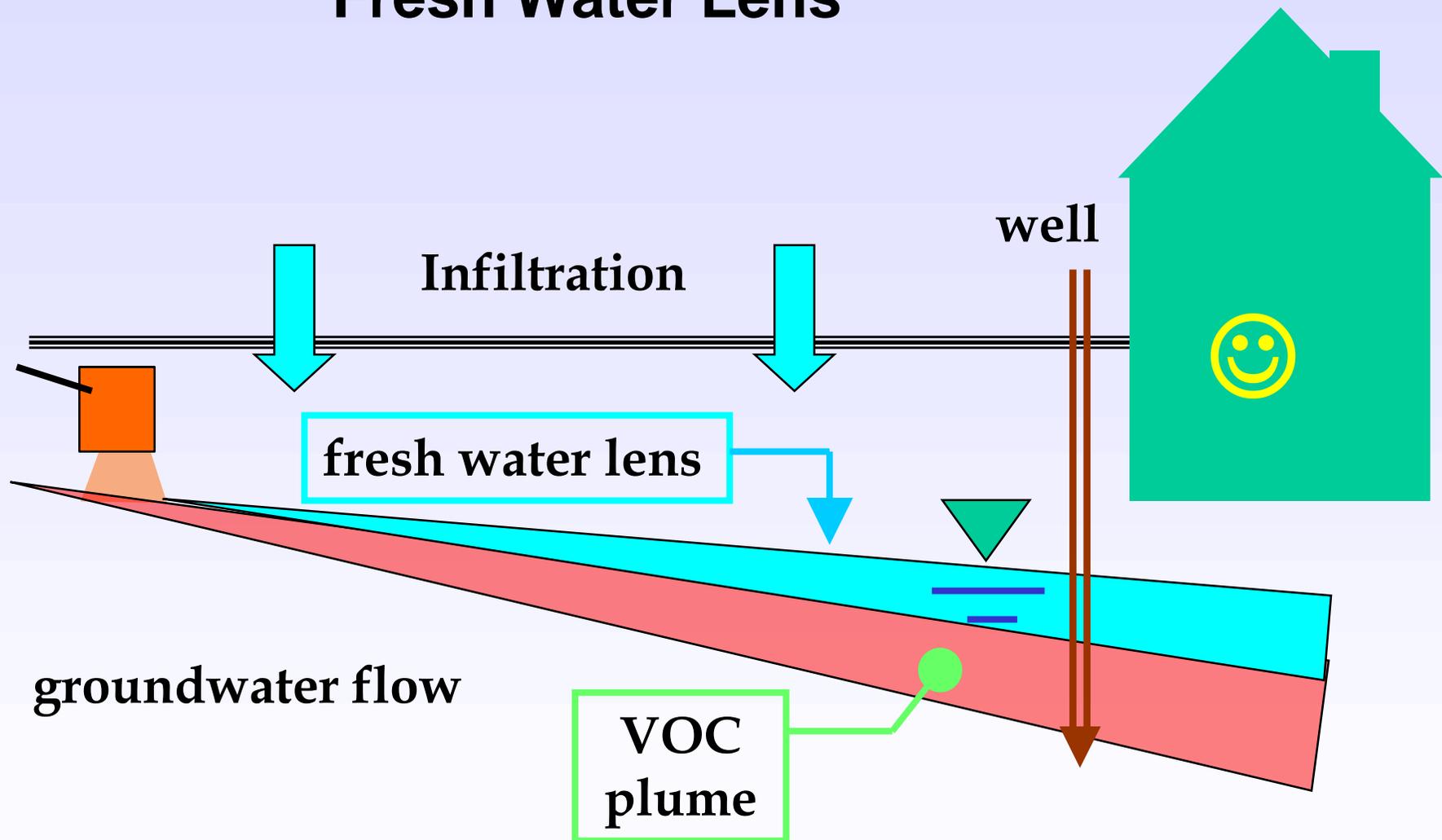
Slab



MassDEP Site Data- Subslab soil samples



Fresh Water Lens



Lines of Evidence Approach

Lines of Evidence

Typical Indoor
Air Conc.

Basement vs.
upper floors

Chemical
Forensics

PID Screening
Cracks/Annular
Spaces/Floor
Drains

Modeling

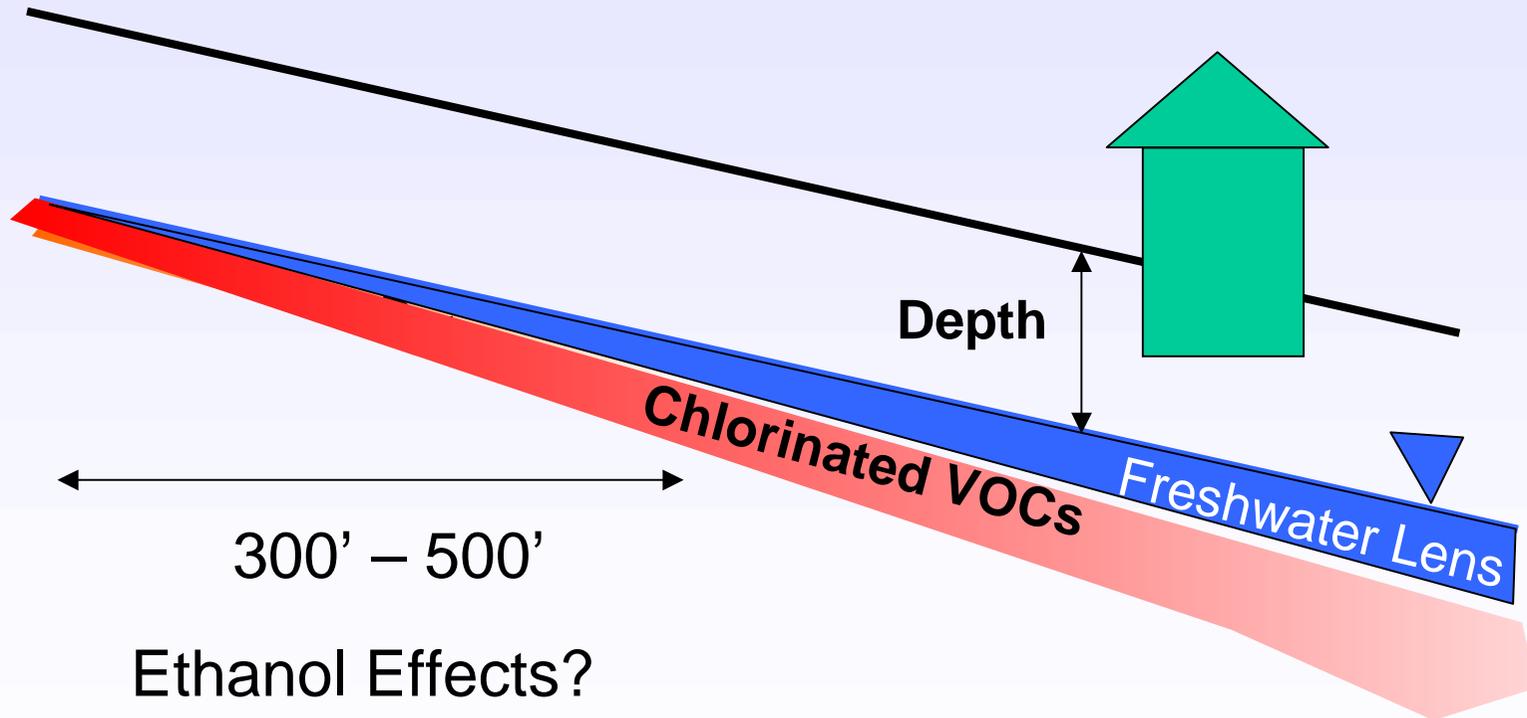
Indoor Air Data

Sub Slab Soil Gas Conc

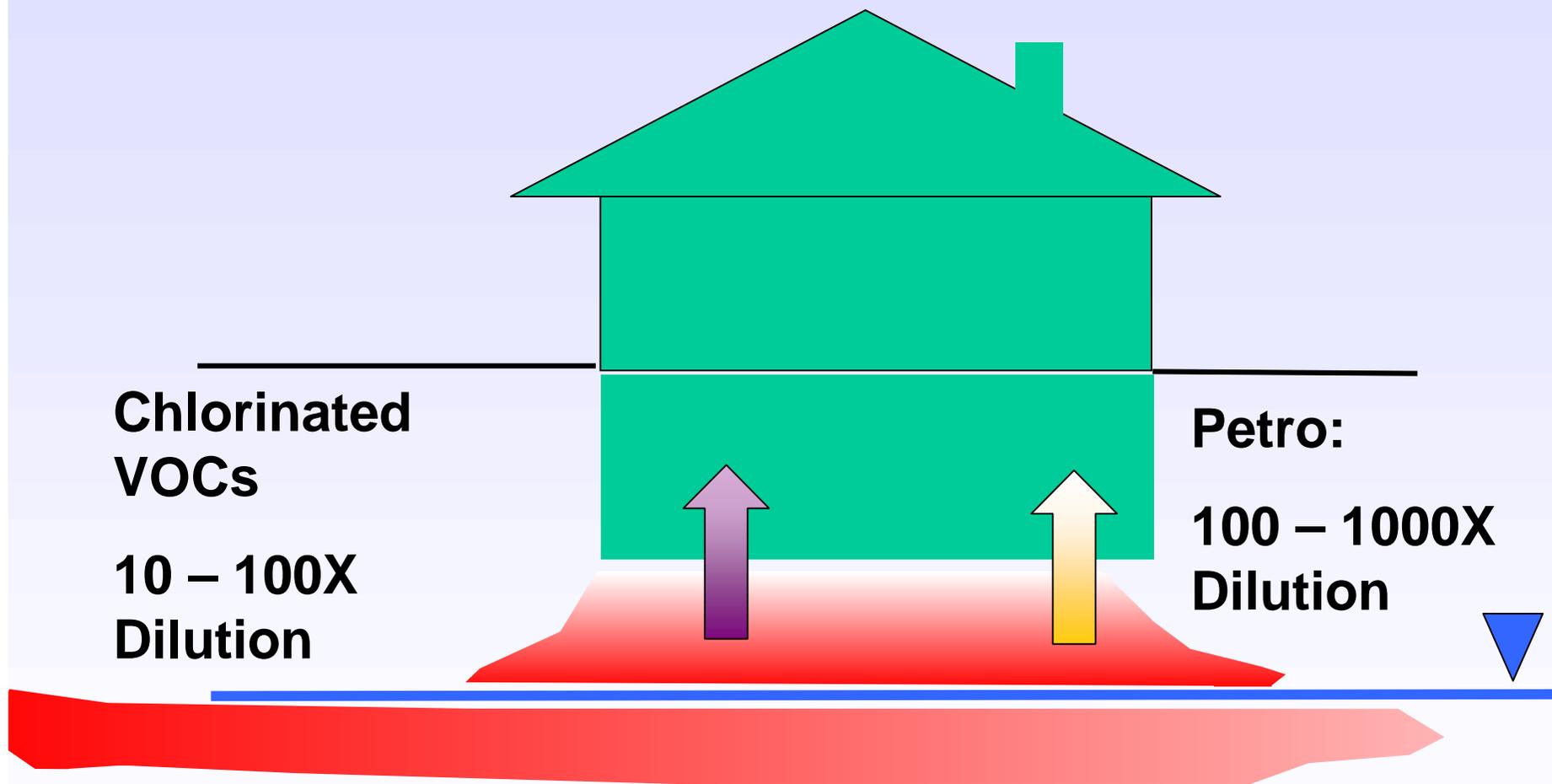
GW concentration

Groundwater

Conc vs GW-2 Std
Type Contaminant
Distances



Sub-Slab Soil Gas Data – Typical Observations



Indoor Air Data

**Typical Indoor
Air Conc.**

**> Published Values?
Use of Chemicals in Building?**

**Basement vs.
upper floors**

**Should be higher in lower
level(s) unless HVAC Issues**

**Chemical
Forensics**

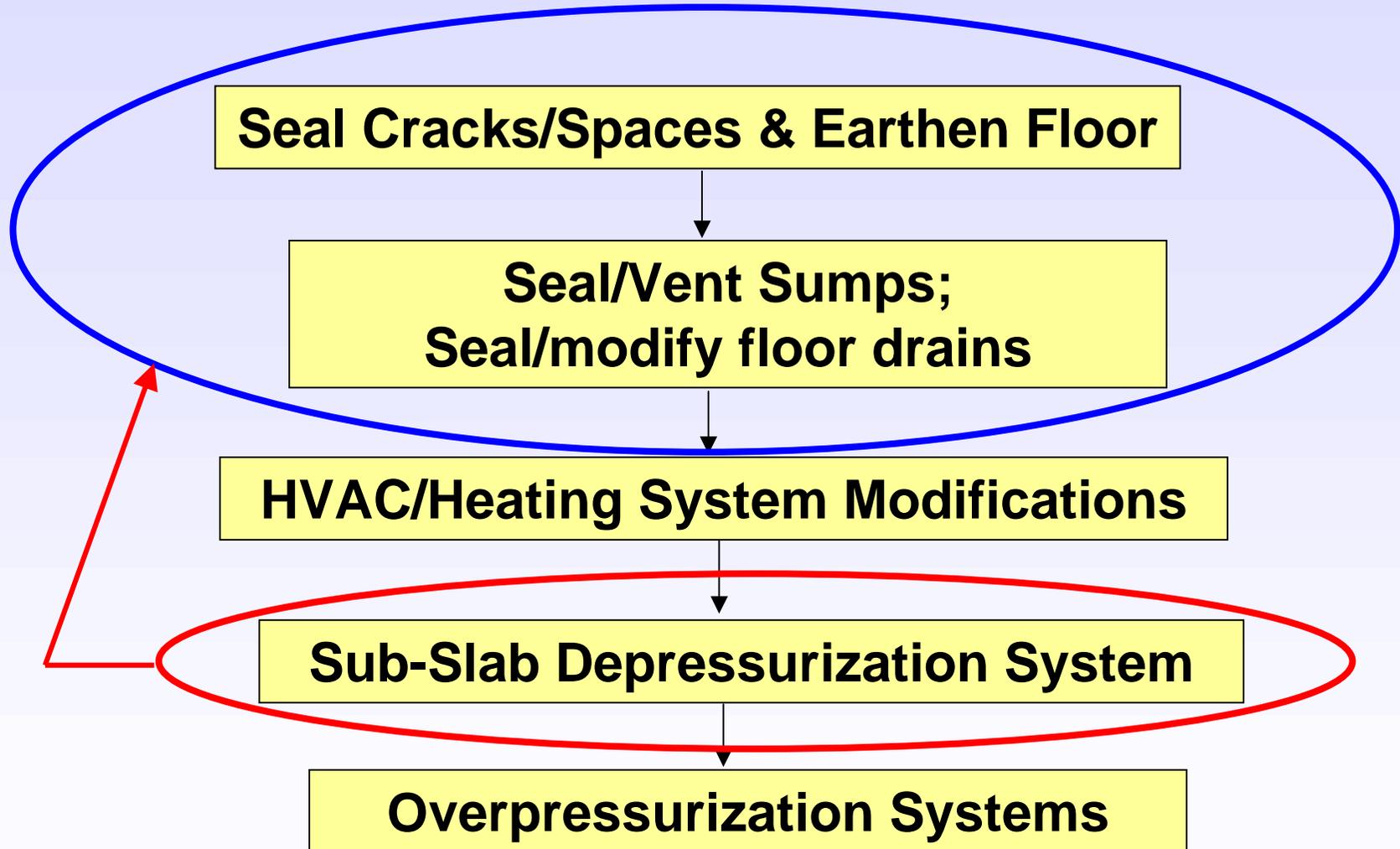
MtBE – Usually not from GW

Petro – Check Chromatograms

**Chlorinated VOCs – Degradation
Products? Cis 1,2-DCE?**

Mitigation

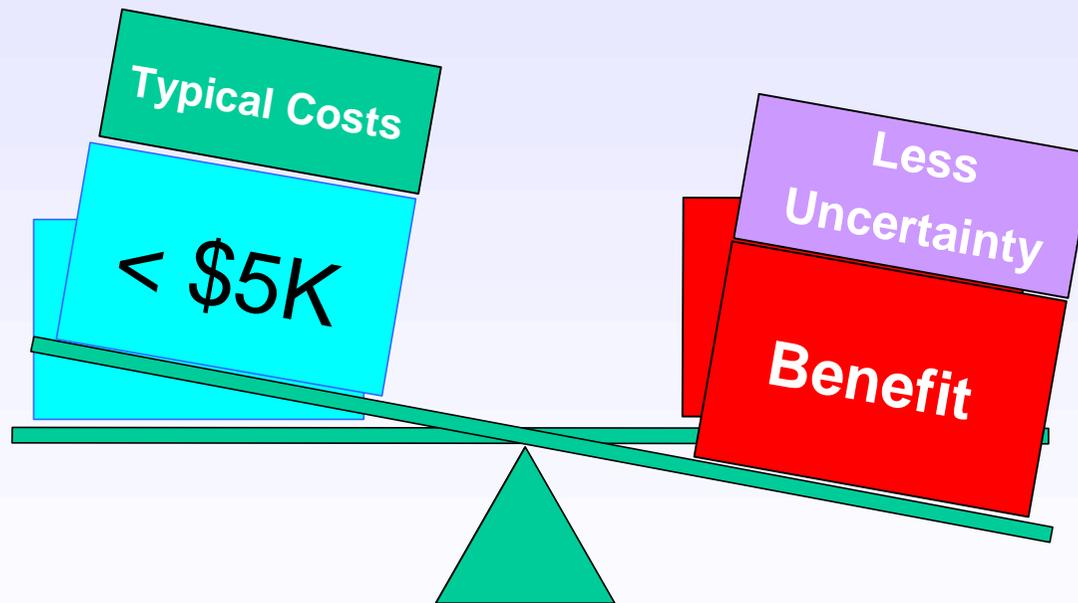
Hierarchy



SSDS



Feasibility of Vapor Intrusion Pathway Elimination



Drinking Water Wells

Two Flavors.....

Private Water Supply Wells

Defined in 40.0006 of MCP:

< 15 Service Connections; or

< 25 People for 60 Days

FOR HUMAN CONSUMPTION
(i.e., not irrigation well)

Public Water Supply Wells

Defined 40.0006 via 310 CMR 22.02:

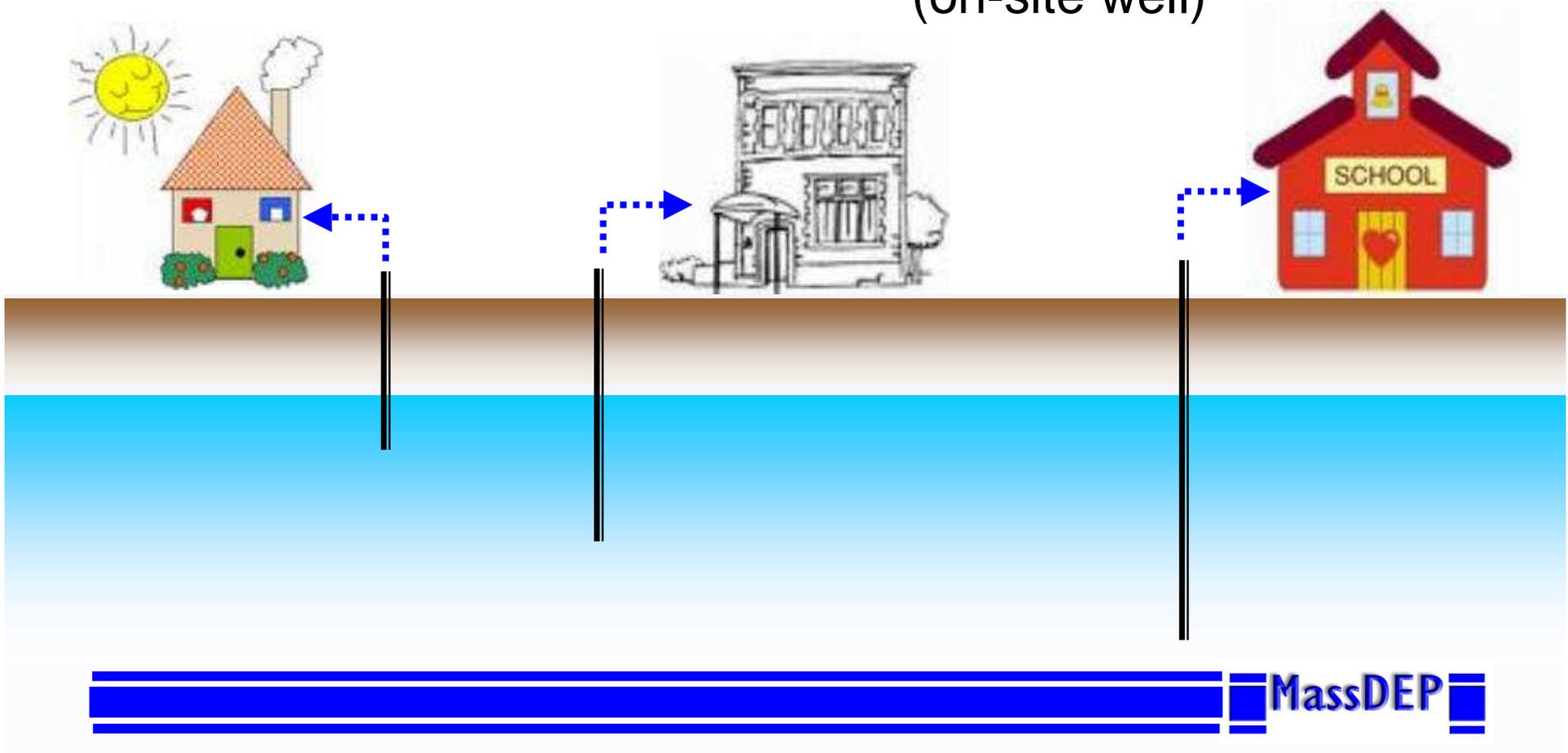
>15 Connections or Servicing >25
Individuals for at least 60 days/year

Community: Municipal/District Systems

Non Community: Restaurants, Camps,
Golf Courses, **Apartments, Schools**

Critical Exposure Pathway

Non-Community Public Supplies
Residential School
(on-site well)



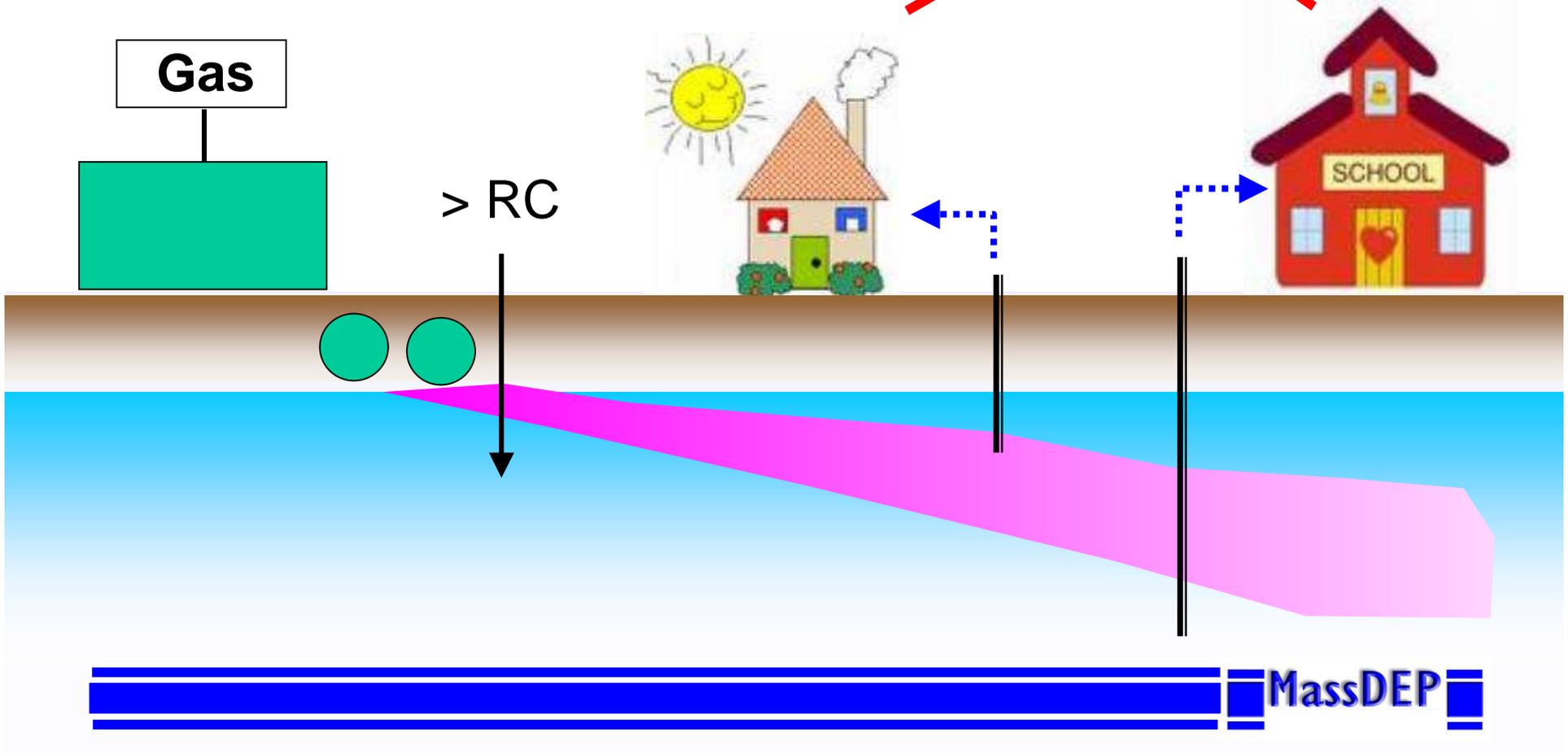
Not All CEPs are Reportable....

CEPs are a sub-universe of Conditions of Substantial Release Migration (SRM)

SRMs require reporting ONLY when associated with a Release that is otherwise Reportable

Reportable
Reportable

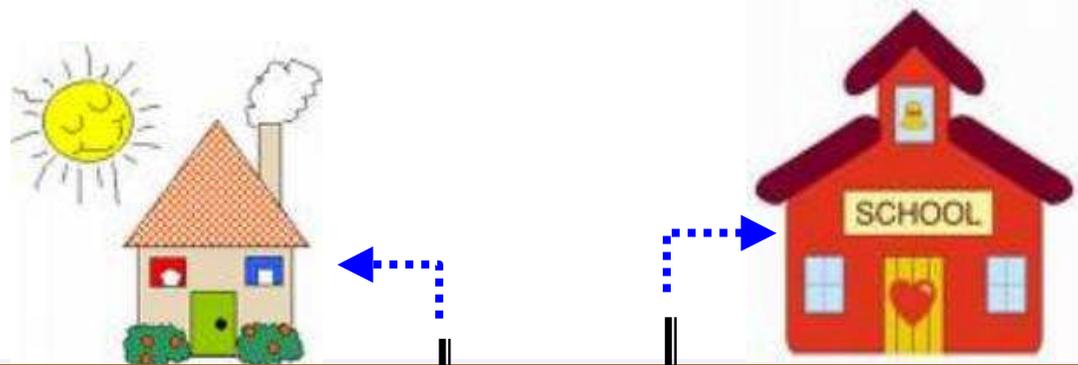
~~MtBE @ 9 µg/L
Unknown Source~~



**Reportable
SRM/CEP**

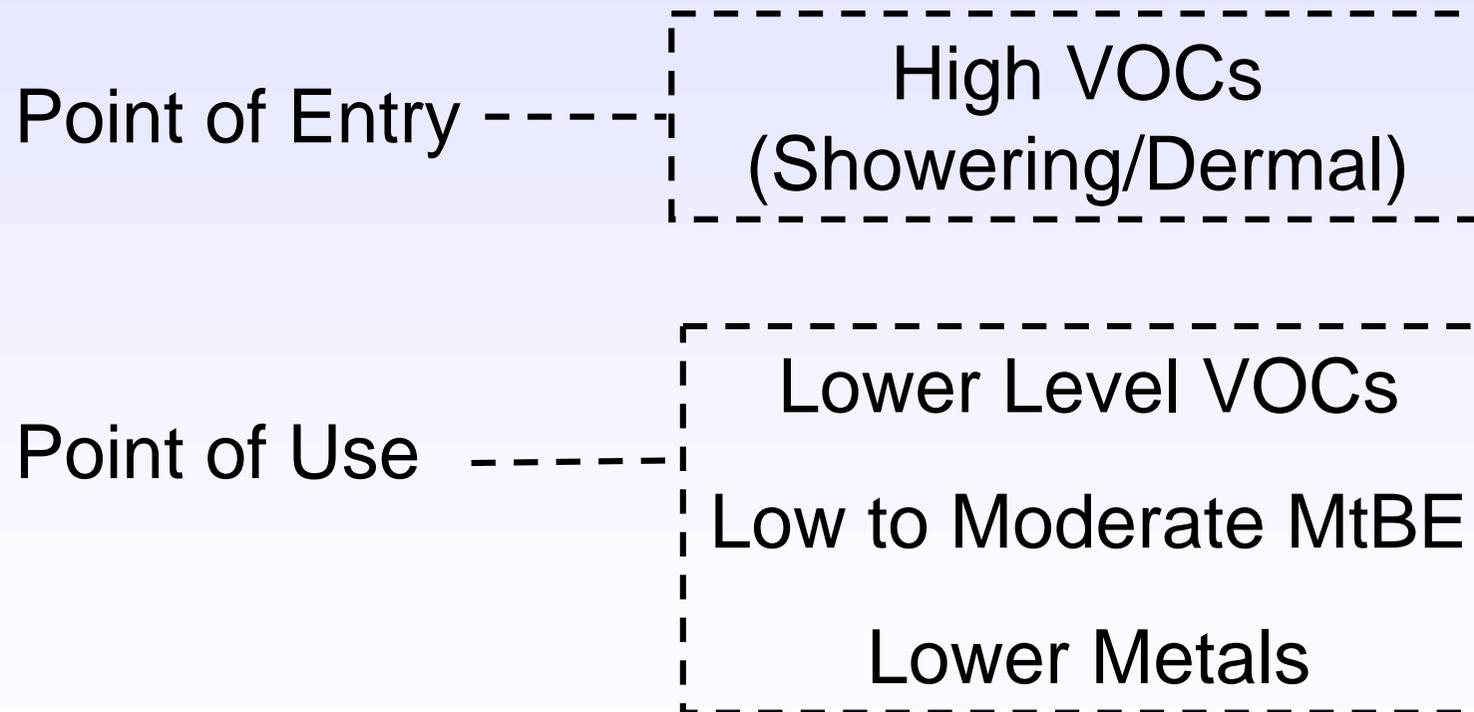
MtBE @ 79 $\mu\text{g/L}$

Unknown Source



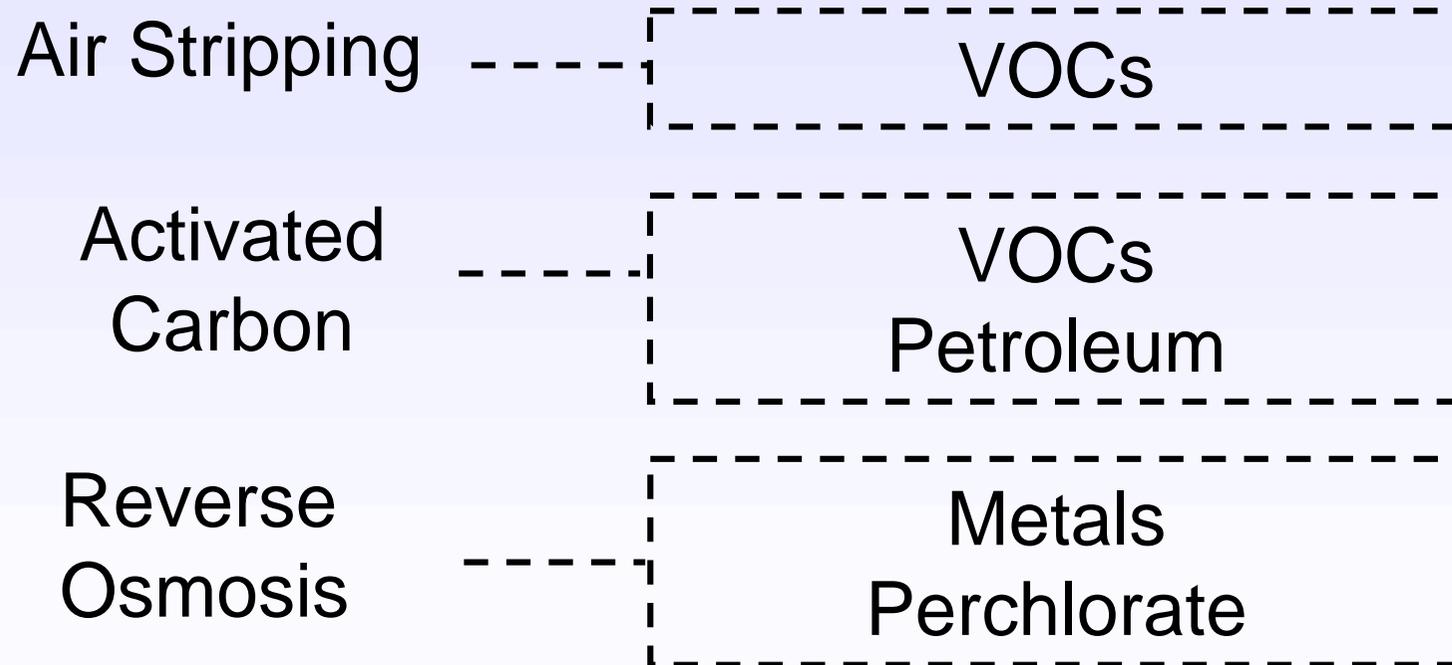
Mitigation

Drinking Water Treatment Systems



Mitigation

Drinking Water Treatment Systems



Mitigation

Drinking Water Treatment Systems

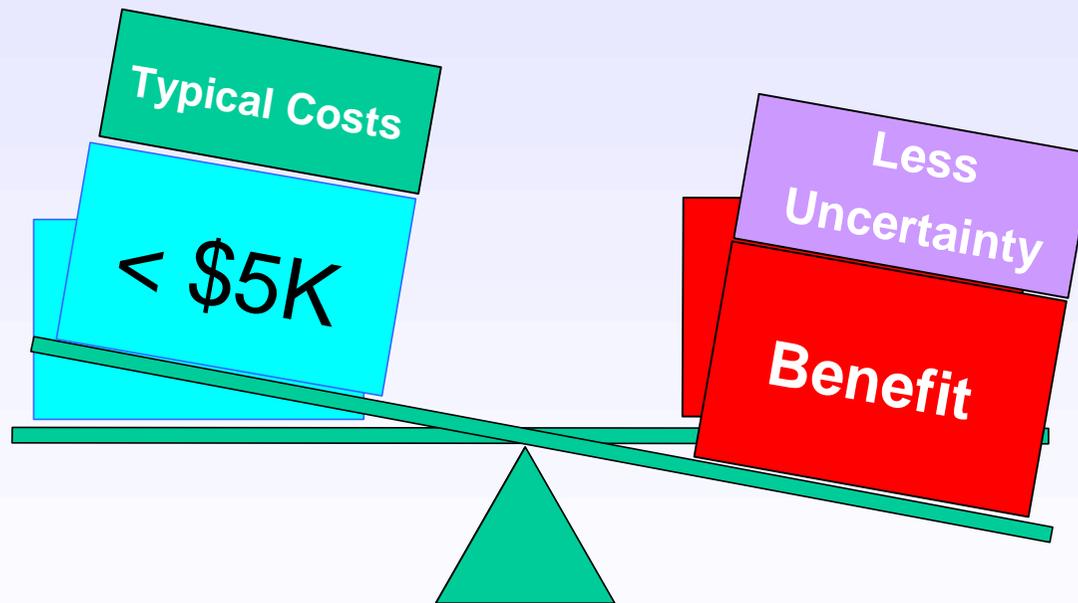
Problem Contaminants (Cost/Benefit Issue):

MtBE

Ethanol



Feasibility of Drinking Water Pathway Elimination



Regulatory Guidelines & Rules of Thumb

When to be Concerned about a Possible Vapor Intrusion Pathway

- Site conditions, events
- Complaints of odors
- Saturated soils, NAPL beneath or immediately adjacent to the structure
- Groundwater concentrations > GW-2 standards within 30 feet of building foundation, groundwater depth 15 feet or less

Groundwater Concentrations < GW-2

Generally, further investigation of indoor air pathway and CEP issues is not warranted

Exceptions

- Odors, OHM likely attributable to groundwater contamination observed in structure
- Earthen floor, field stone foundation, and/or groundwater sumps with COC chlorinated contaminants
- NAPL/saturated soils within 30 feet of structure

When to be Concerned About a Possible Drinking Water Well Impact

- Groundwater OHM plume proximate (500 feet) to a water supply well that serves a school, day care, or residence
- Potential migration in bedrock to well
- MtBE or chlorinated contaminants

“Measurable Concentrations” in Drinking Water

- 8000 series are appropriate for determining the presence of OHM in the course of investigating the extent of the disposal site
- 500 series (lower detection limits) should be used for drinking water well and tap samples

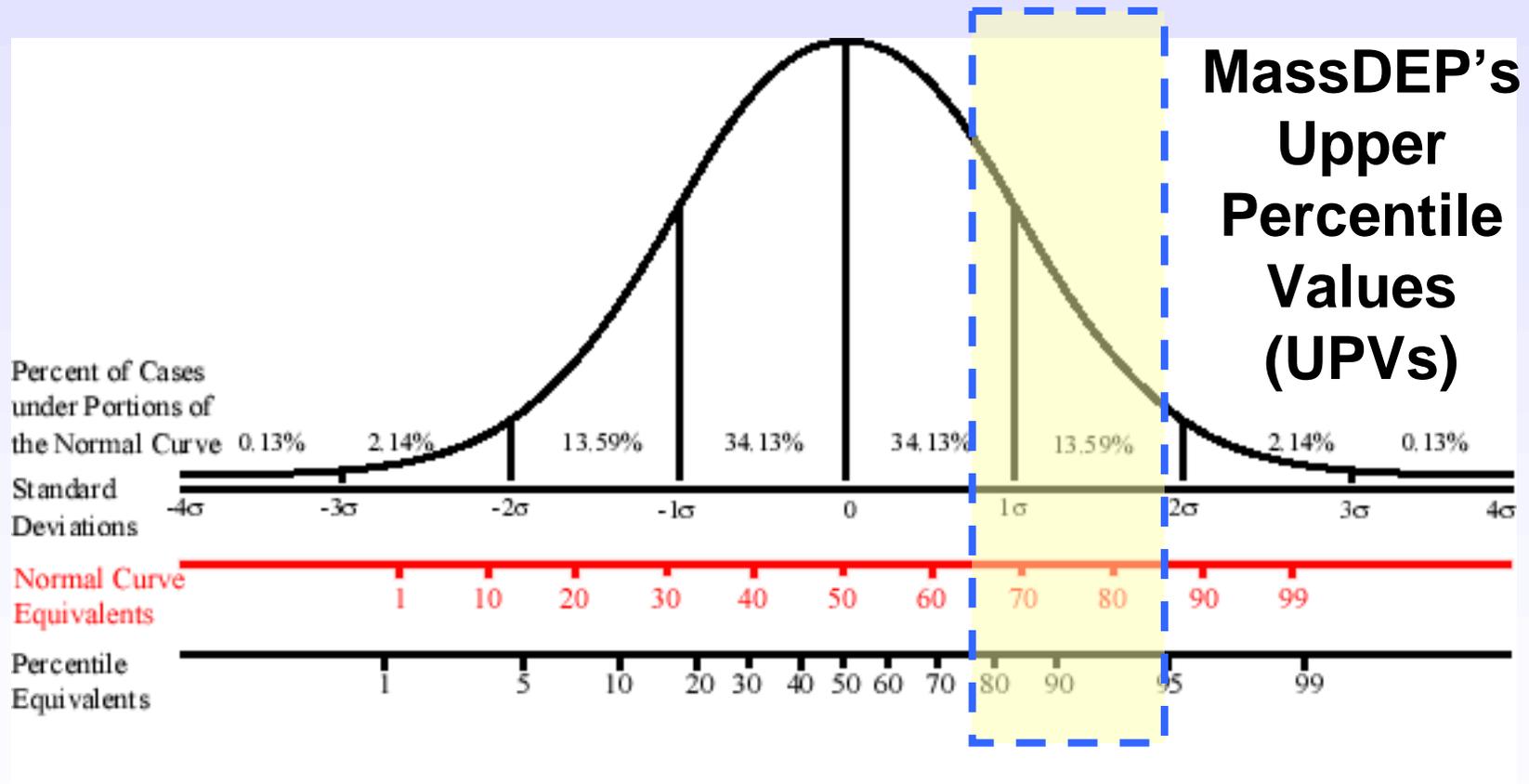
“Measurable Concentrations” in Indoor Air

- OHM conc. attributable to the disposal site at or above the Reporting Limit for commonly used air testing methods (TO-15/APH) with commonly reported method detection limits
- OHM conc. distinguishable from indoor air levels absent vapor intrusion (e.g., chemicals from household products and building materials)

Typical Indoor Air Concentrations

= levels of OHMs that can be found in any building, absent a vapor intrusion pathway

Typical Indoor Air Concentrations



Regulatory Guidance

Upper Percentile Values (UPV) and CEPs

Generally, if conc. is below listed UPV

- Can assume indoor air pathway does not exist
- Can terminate CEP evaluation

Exception OHM where UPV is at a level of significant risk ($HI > 0.2$ $ELCR > 1 \times 10^{-6}$)

- Evaluate additional Lines of Evidence

Regulatory Guidance

Upper Percentile Values (UPV) and CEPs

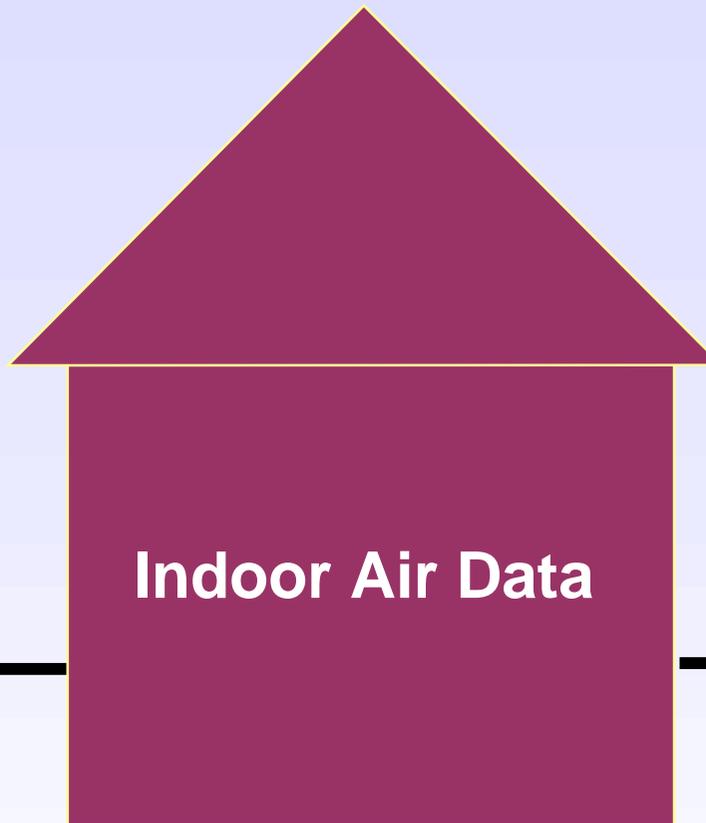
If conc. is above UPVs

- Evaluate additional Lines of Evidence

Lines of Evidence

TO-15/APH
Typical Indoor
Air Conc.
Basement vs.
upper floors
Chemical
Forensics

PID Screening
Cracks/Annular
Spaces/Floor
Drains



Modeling

Sub Slab Soil Gas Conc

GW concentration



CEP Feasibility Guidance

- Low Level Drinking Water Well Contamination
- Owner-Occupied Residential Properties

CEP Feasibility Guidance

Low Level Drinking Water Well Contamination
MtBE concentrations 5 ug/l or less

“Categorically Infeasible” to
eliminate, mitigate or prevent CEP
due to chemical-specific issues,
including treatability

CEP Feasibility Guidance

Owner-Occupied Residences where concentrations do not pose a Significant Risk

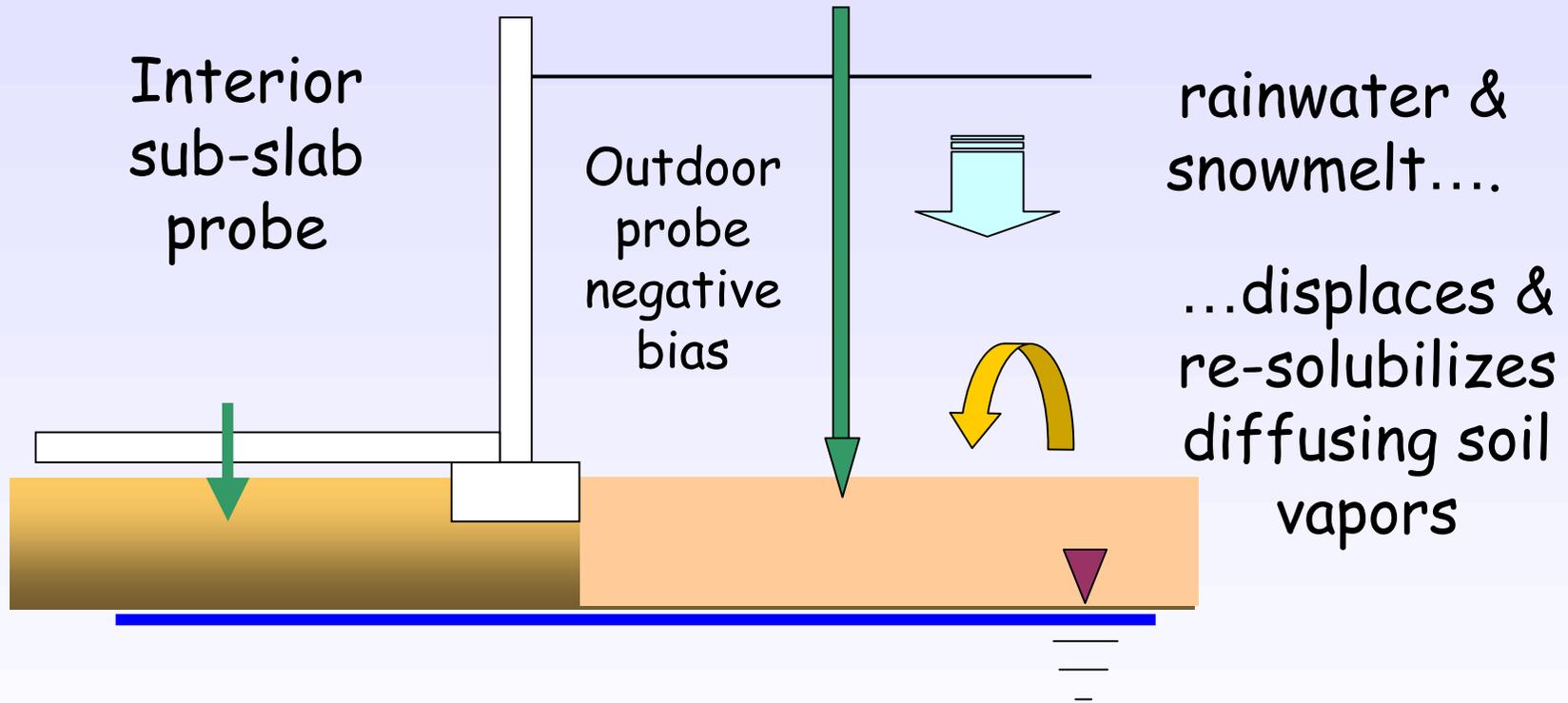
Owner May Decline Measures to address CEP (i.e., owner determines benefits do not justify costs)

CEP Feasibility Documentation

- Description of the Critical Exposure Pathway (CSM)
- List of measures evaluated to prevent, eliminate or mitigate the CEP
- Estimated costs of measures and explanation of how costs were determined
- Description of basis for determining measure(s) feasible or infeasible

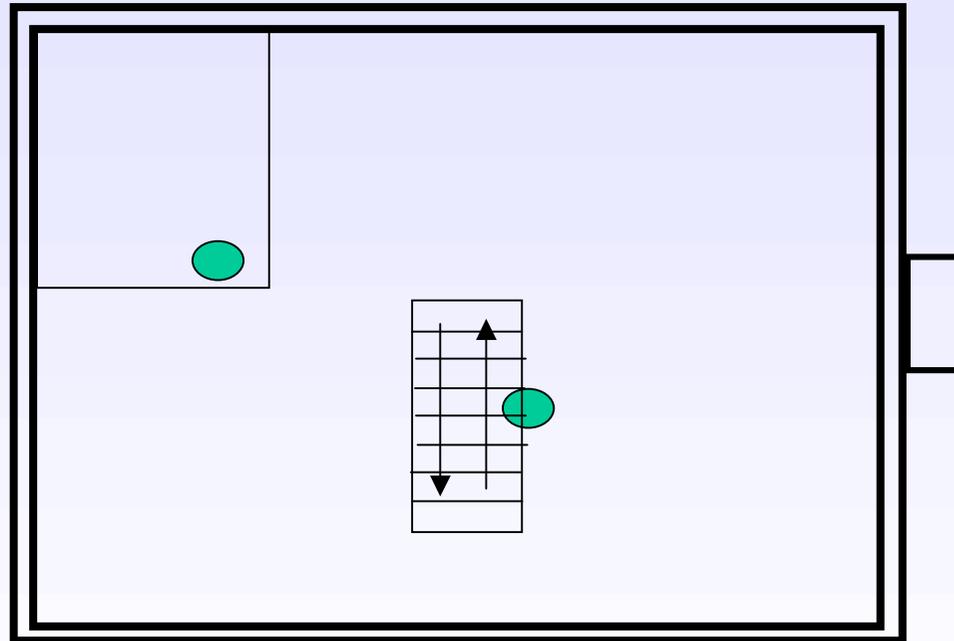
Technical Guidelines and Rules of Thumb

Soil Gas Investigations - Placement

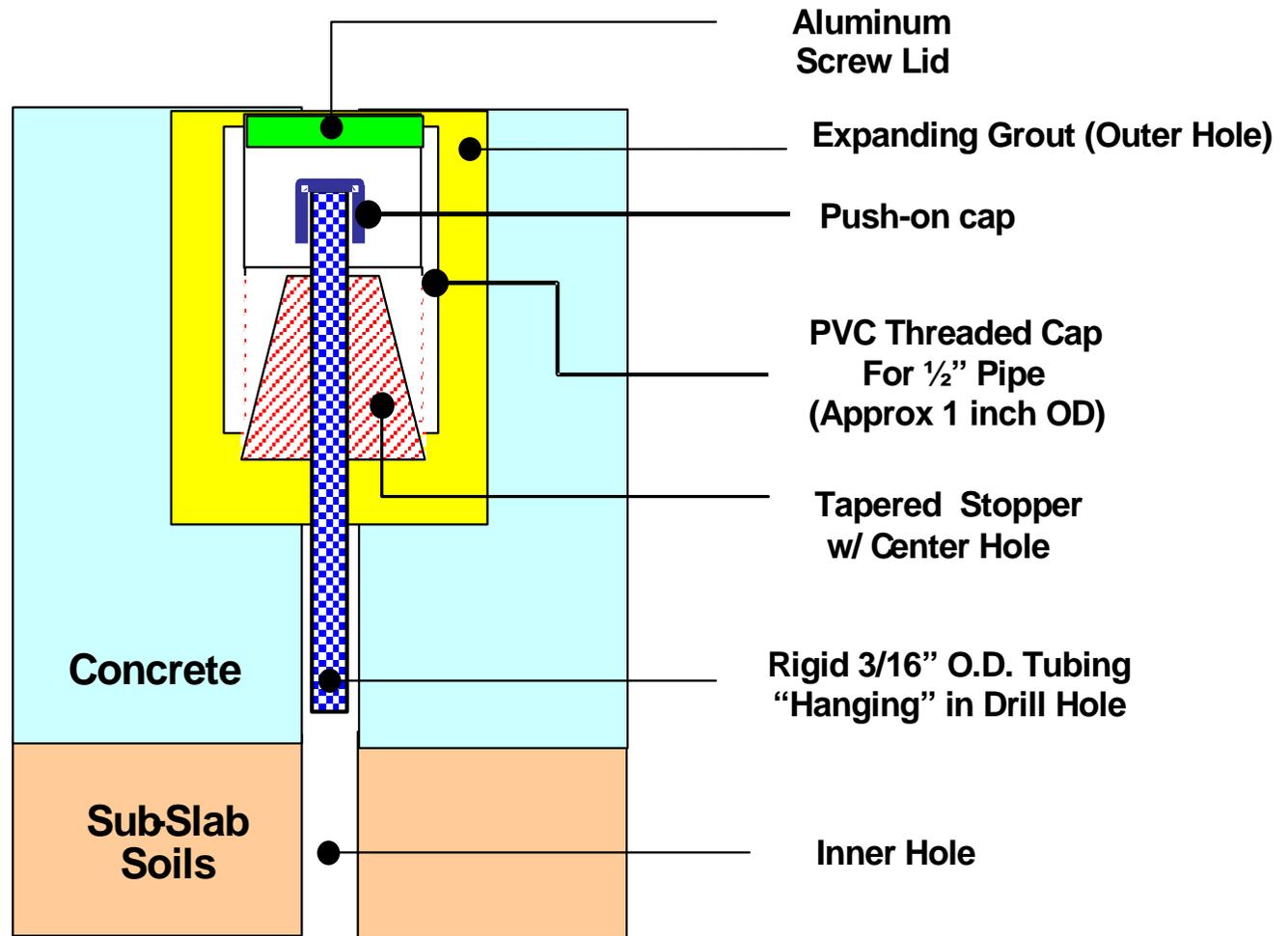


Sub-Slab Probes

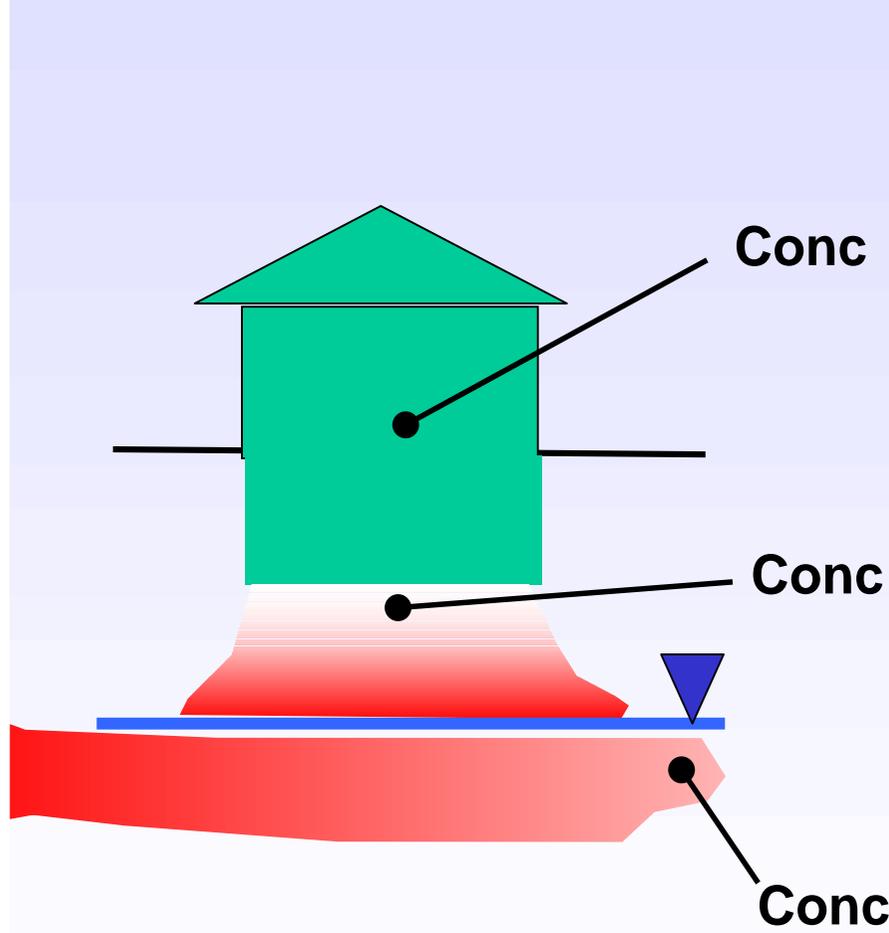
Minimum of
2 in normal
sized home



Example Soil Gas Probe Construction

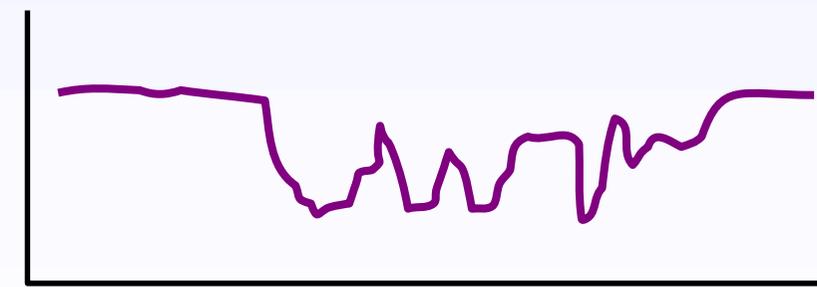
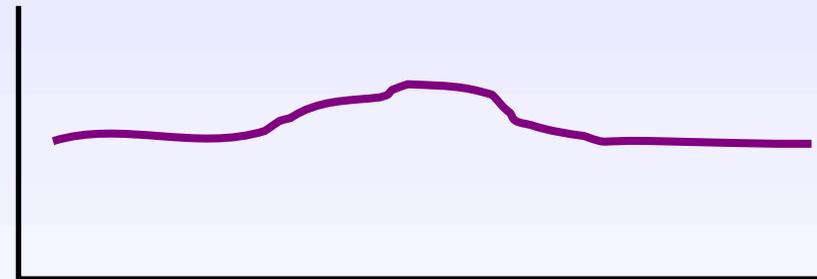
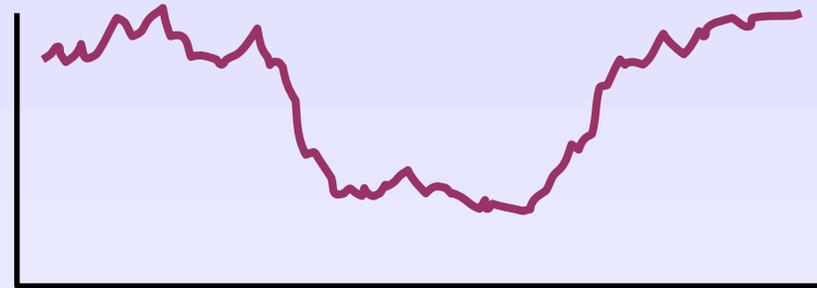


When to Sample

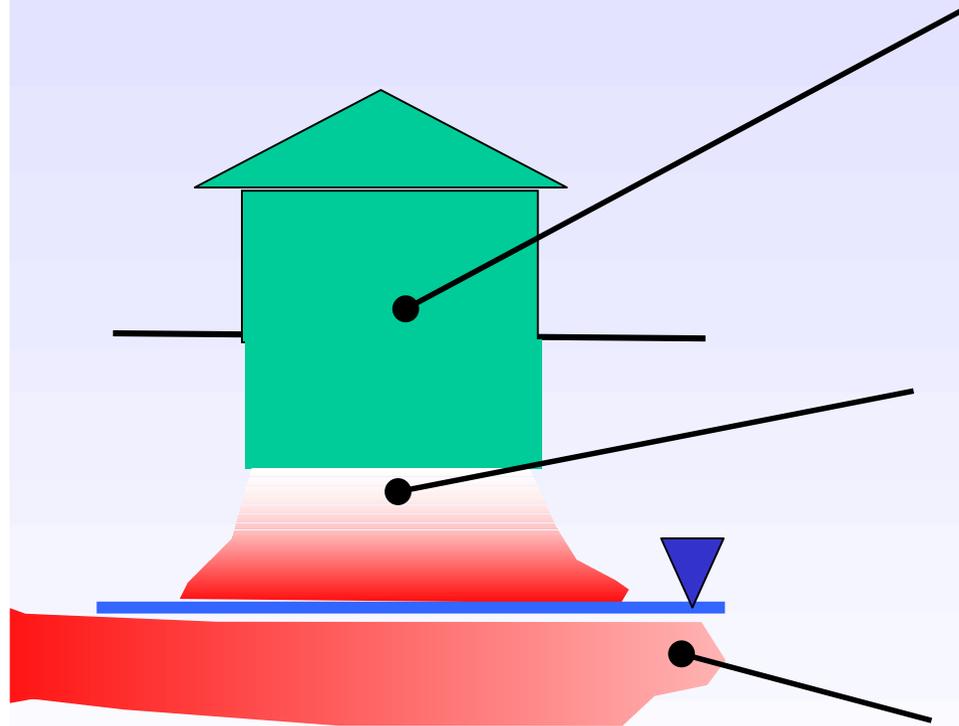


January

December



How to Sample

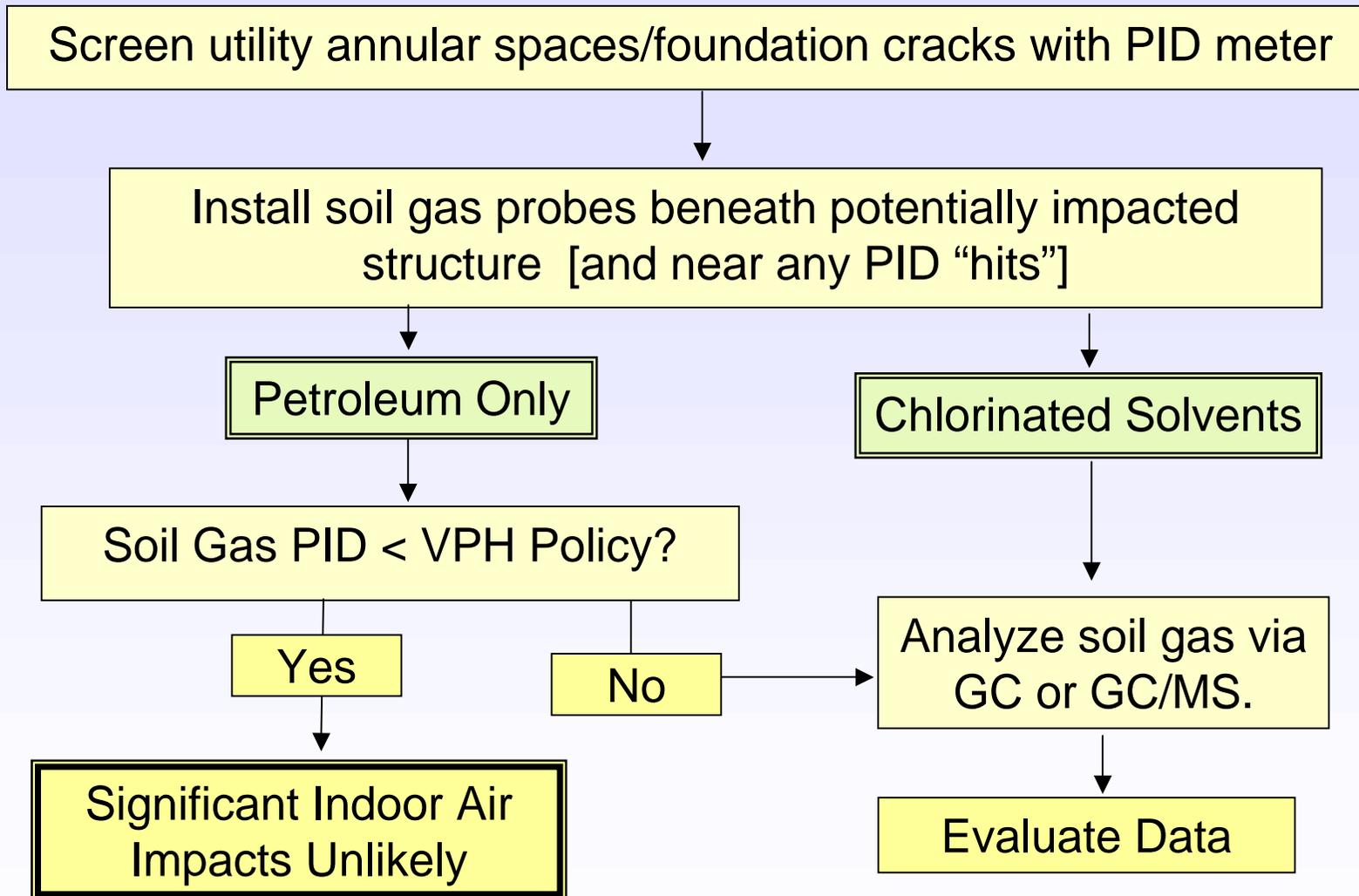


**TO-15 or APH
Summa Canister
4 hour TWA
Consider Outdoor Sample**

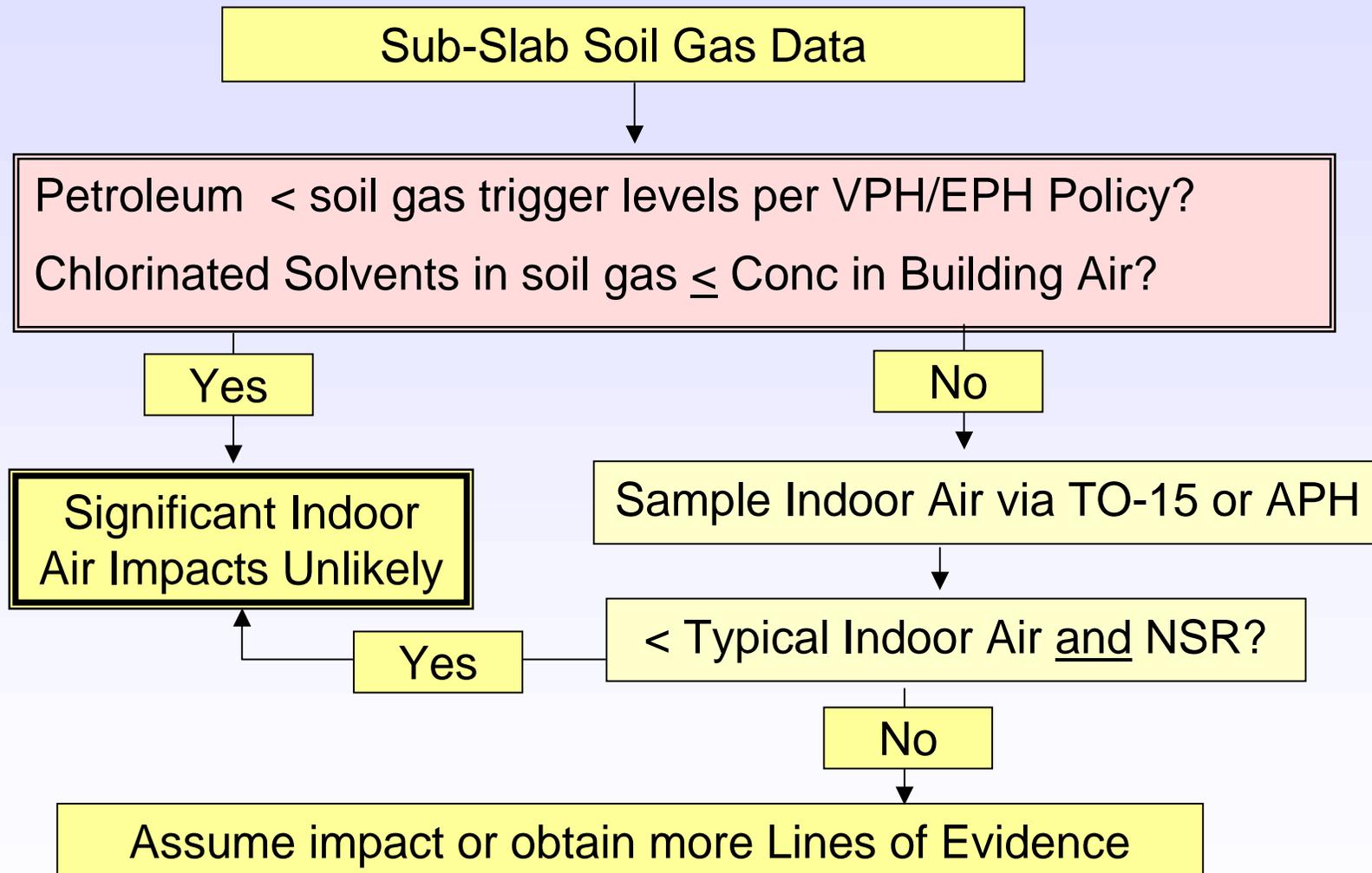
**At least two probes
Grab PID/GC/Summa
Purge 5 probe volumes
Sample rate 100–200 mL/min**

**Water Table Interface Well!
Antecedent Precip?
4+/- Rounds (Chlor VOCs)**

Assessing Lines of Evidence



Assessing Lines of Evidence



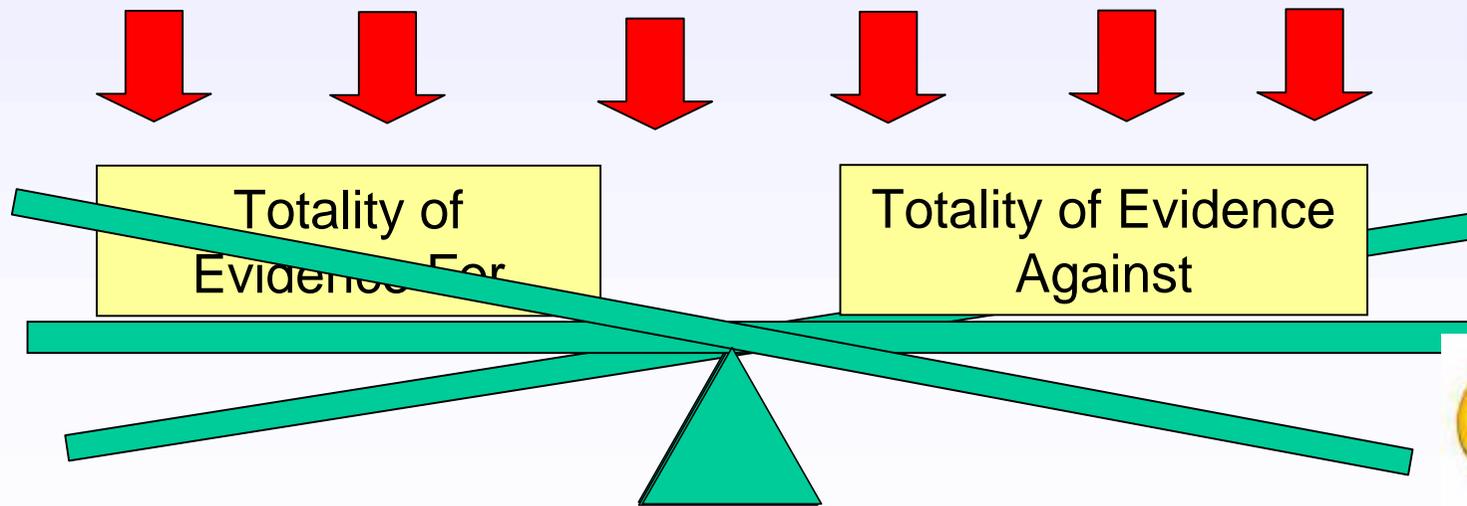
Assessing Lines of Evidence

More Lines of Evidence...

Chemistry of Air Samples:
Breakdown products
In-building sources
Outdoor air quality
Fresh vs weathered petro
Basement vs upper floors

Modeling
Johnson & Ettinger
Site-specific inputs

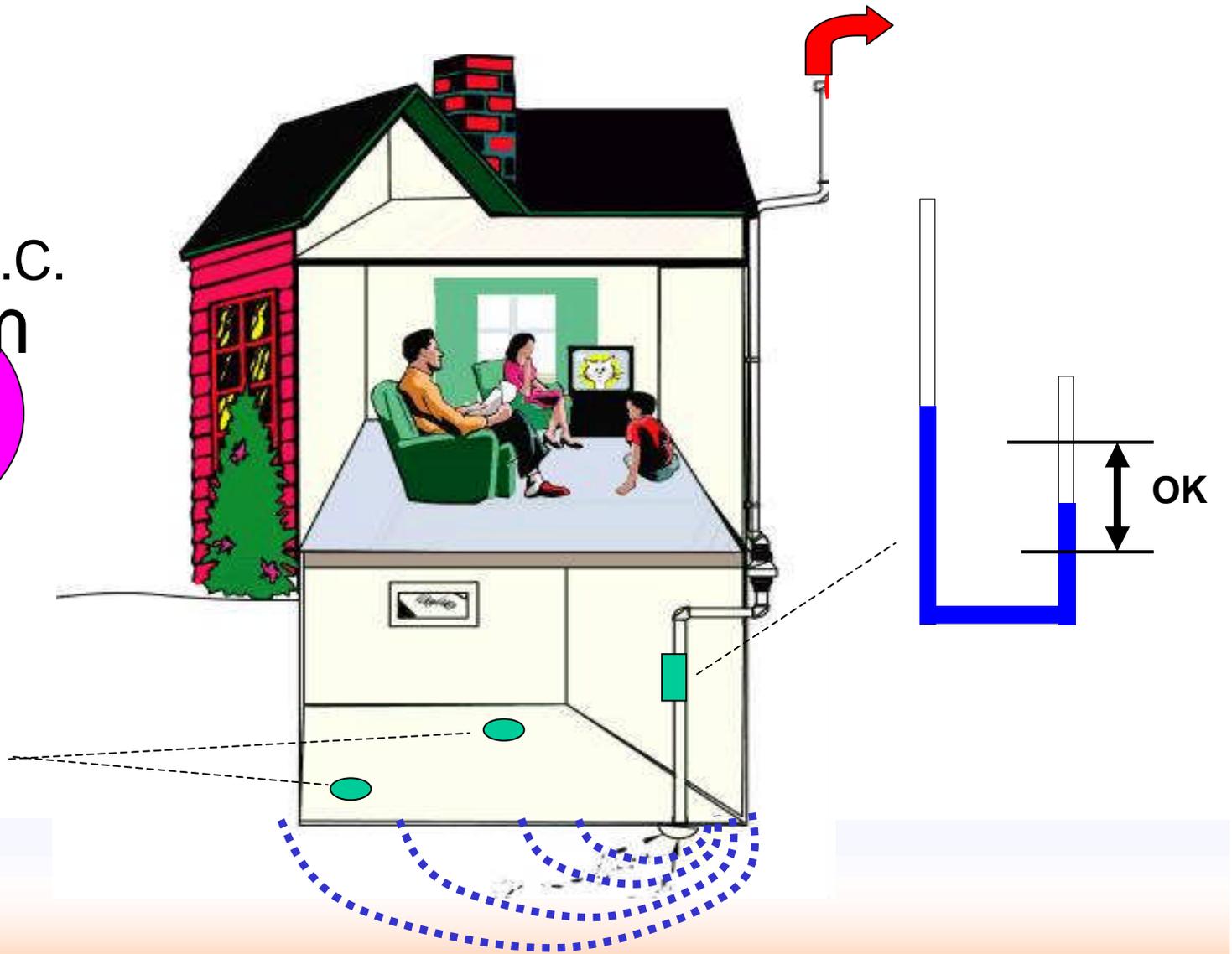
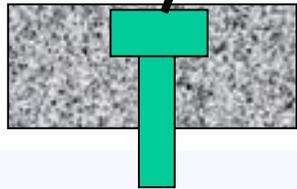
Conceptual Site Model



Sub Slab Depressurization Systems

SSDS

- 0.005" W.C.
Bottom
Line



SSDS

Typical Design Features

Fan outside home or in attic

Terminate with 180° Elbow 2' above Roof

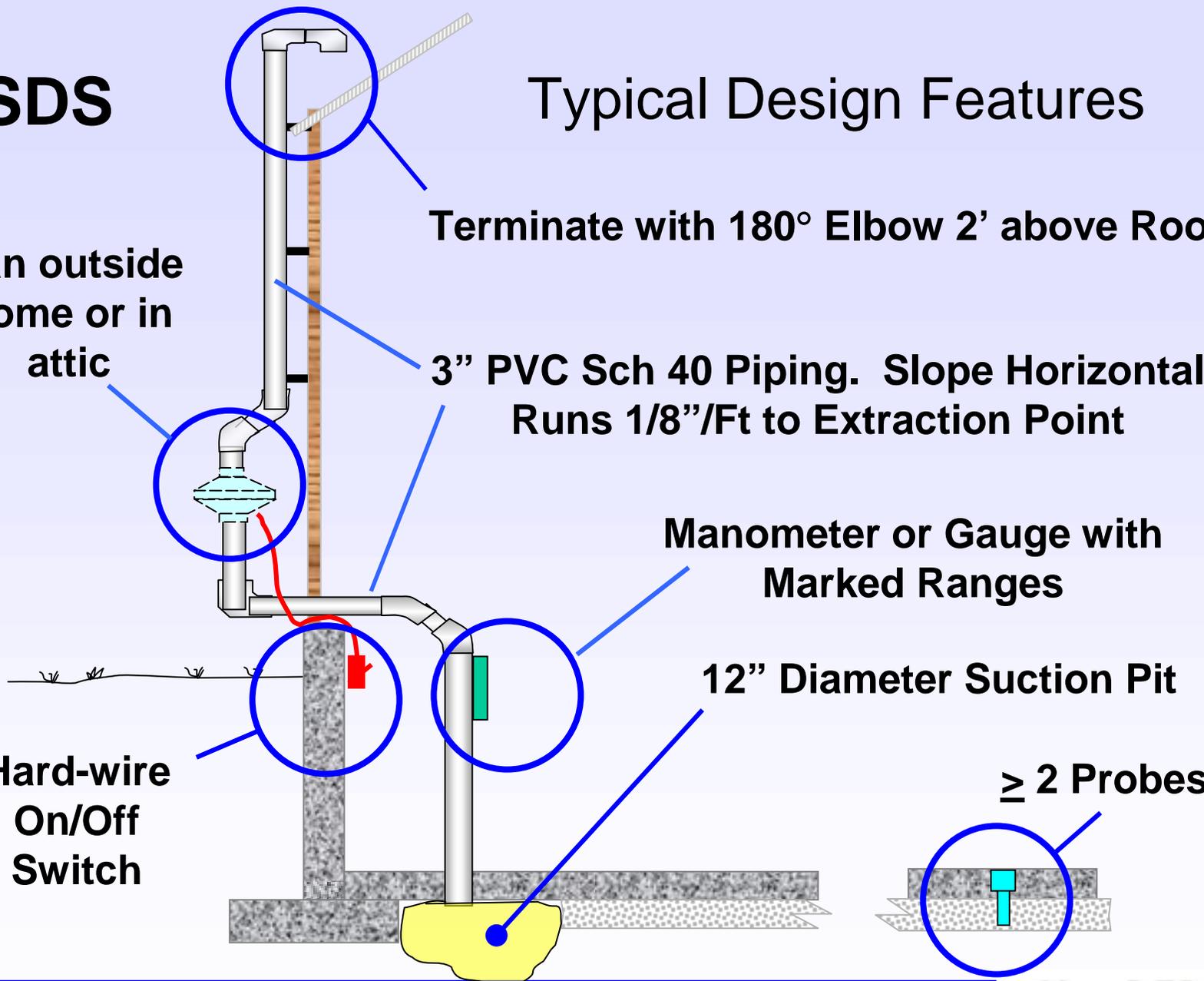
3" PVC Sch 40 Piping. Slope Horizontal Runs 1/8"/Ft to Extraction Point

Manometer or Gauge with Marked Ranges

12" Diameter Suction Pit

Hard-wire On/Off Switch

≥ 2 Probes



SSDS – Concerns & Considerations

Discuss placement/construction/operation with bldg occupants

Seal cracks/voids/earthen floors (VOC-free sealants!)

Seal and vent sumps (provide access to sump pumps)

Seal or ensure integrity of floor drains

Consider pre-design diagnostic tests

Consider back- drafting concerns

SSDS

Startup

Document negative pressure in at least two sub-slab probes

Document reduction in indoor air contaminants within 2-4 weeks

Instruct building occupants to periodically check extraction pressure

O&M

Confirm operation of system and negative pressure at extraction point.

Submit Remedial Monitoring Report.

Periodic Air Testing (every 1-2 years)