Starting Soon: VIM Session 1

ITRC Resources:
https://itrcweb.org/vapor-intrusion-toolkit

CLU-IN Training Page (slides available):
www.clu-in.org/conf/itrc/vim-1/

Housekeeping

This event is being recorded; Event will be available On Demand after the event at the main training page: www.clu-in.org/conf/itrc/vim-1/

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Advancing Environmental Solutions

VAPOR INTRUSION MITIGATION – A TWO-PART SERIES TRAINING

2026 ITRC VAPOR INTRUSION TOOLKIT

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: US EPA Clean Up Information Network (www.clu-in.org)

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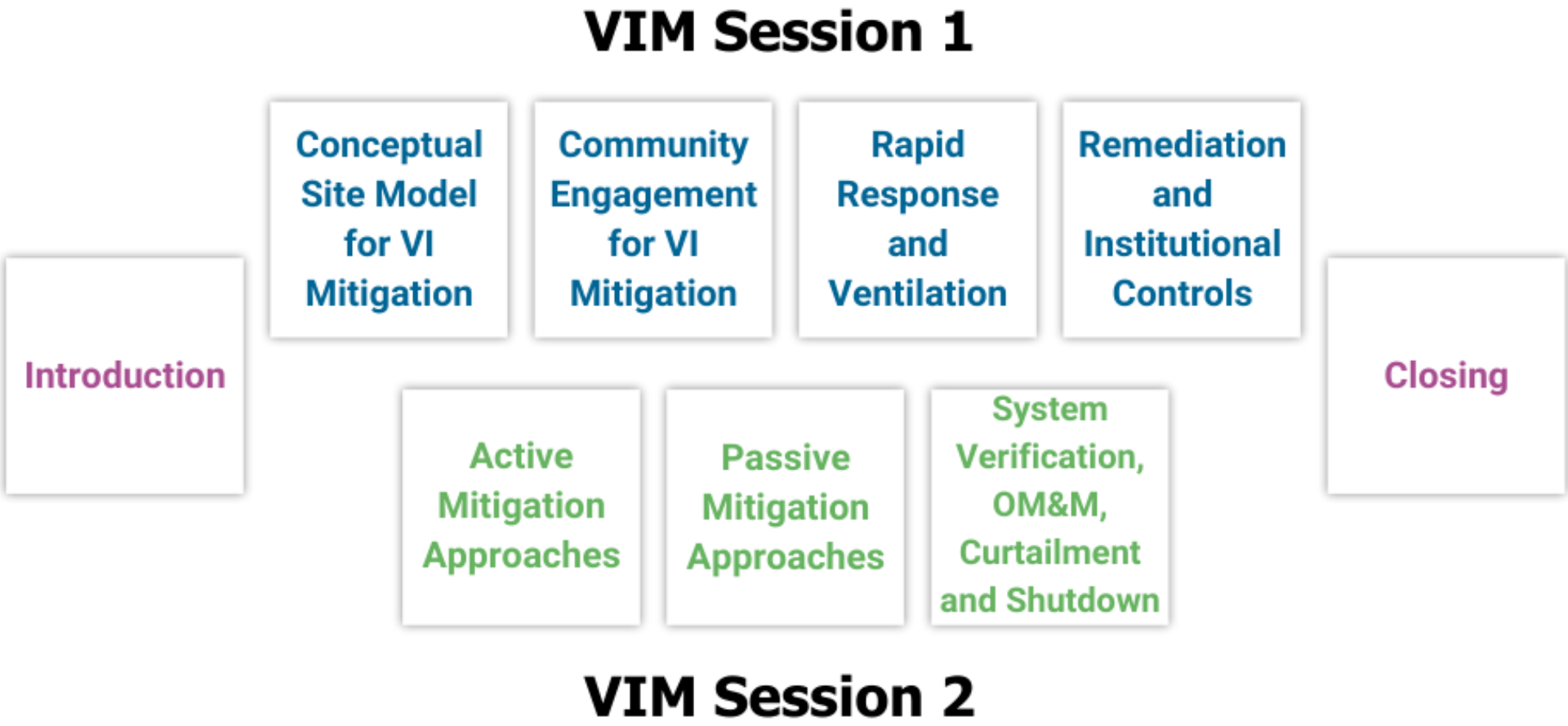
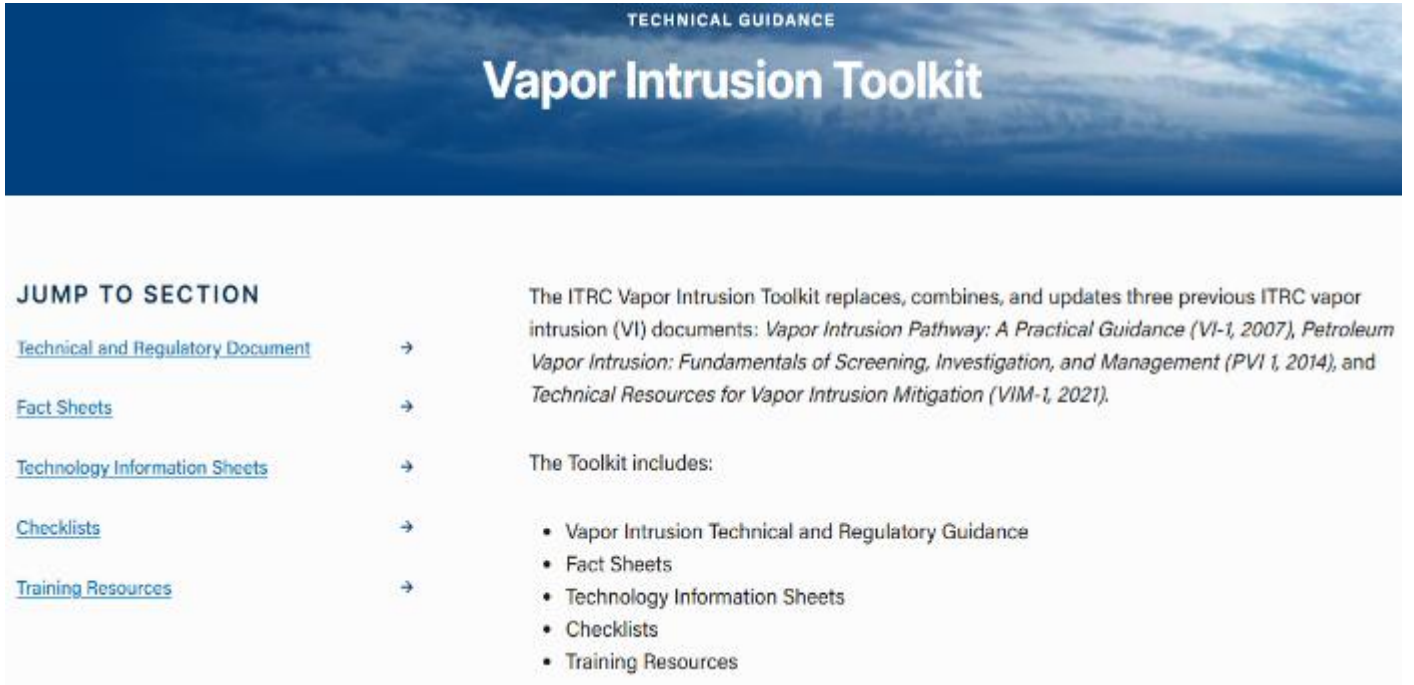
Today's Training Topics – Session 1



ITRC Vapor Intrusion Toolkit

- Compiled ITRC VI guidance into new updated toolkit
  - Vapor Intrusion Pathway: A Practical Guidance (VI-1, 2007)
  - Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management (PVI-1, 2014)
  - Technical Resources for Vapor Mitigation Training (VIM-1, 2021)
- Toolkit provides best practices and most defensible approaches to support VI data driven decision making



VI Mitigation Strategies Information

Tech Reg Chapter 10

Fact Sheets

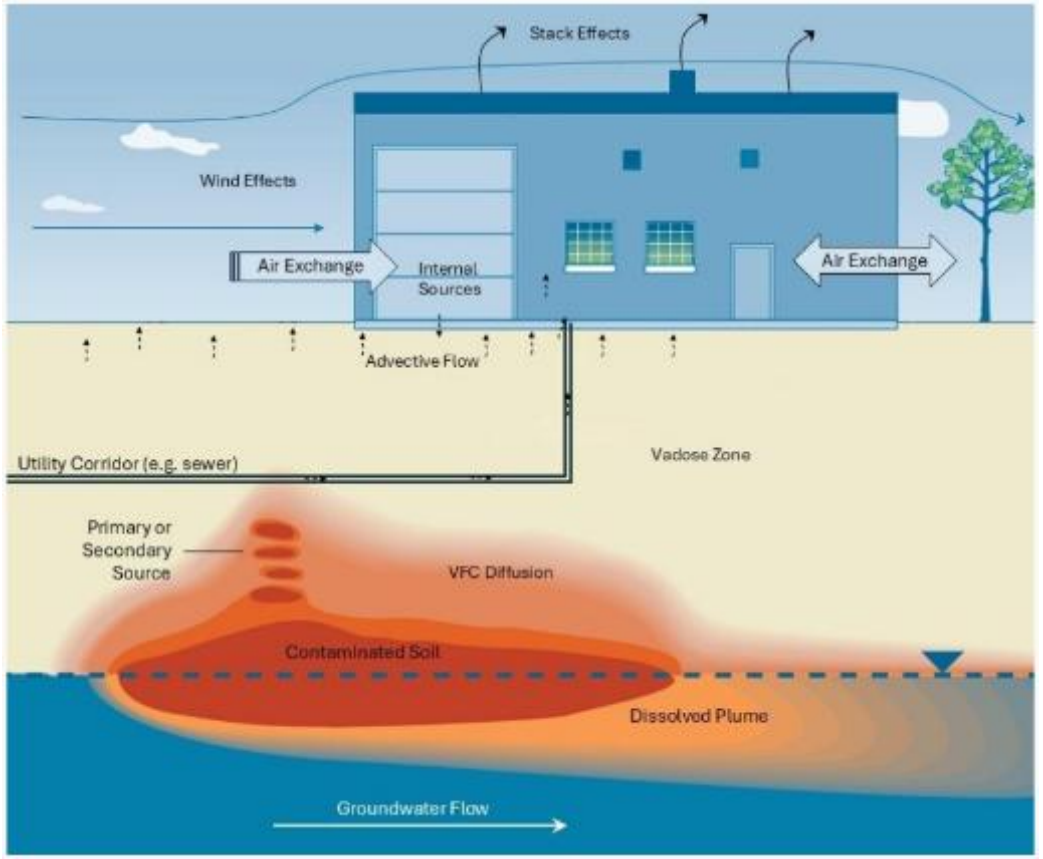
Tech Sheets

Checklists

Plan Outlines in Appendices

What is Vapor Intrusion (VI)

- Contaminants in soil and groundwater can volatilize into soil vapor
- VI occurs when these vapors migrate upward into overlying buildings and contaminate indoor air
- If present at sufficiently high concentrations:
  - These vapors may present a threat to the health and safety of building occupants

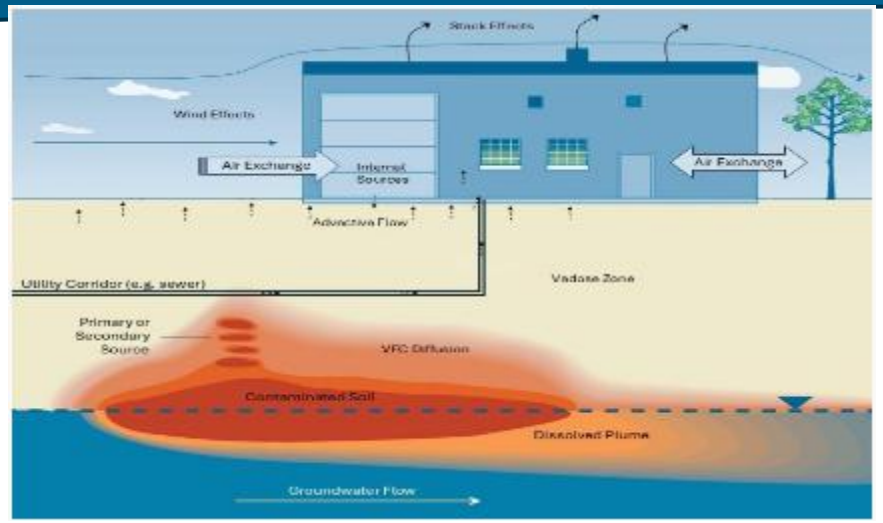


Source: ITRC Vapor Intrusion Toolkit Guidance (VIT-1, 2026)

Different Types of Vapor Intrusion

- Vapor Intrusion addresses vapor-forming chemicals (VFCs)
  - including volatile organic chemicals, semi-volatile organic chemicals, pesticide compounds, elemental mercury, and Per- and Polyfluoroalkyl substances

- Petroleum Vapor Intrusion (PVI)
  - subset of VI that deals exclusively with petroleum hydrocarbon contaminants

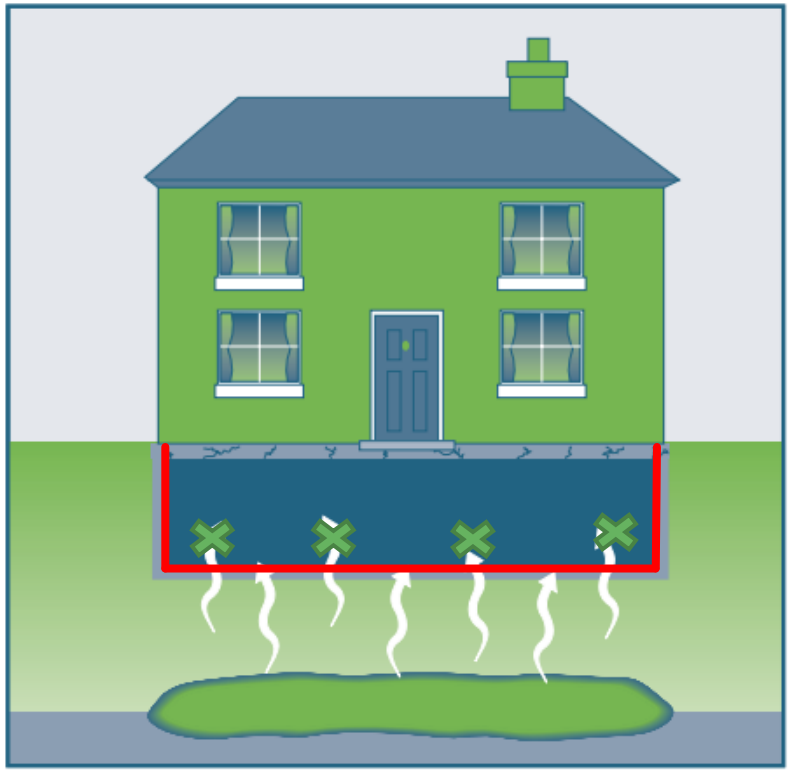


Source: ITRC Vapor Intrusion Toolkit Guidance (VIT-1, 2026)

Source: ITRC Petroleum Vapor Intrusion Guidance (PVI-1, 2014)

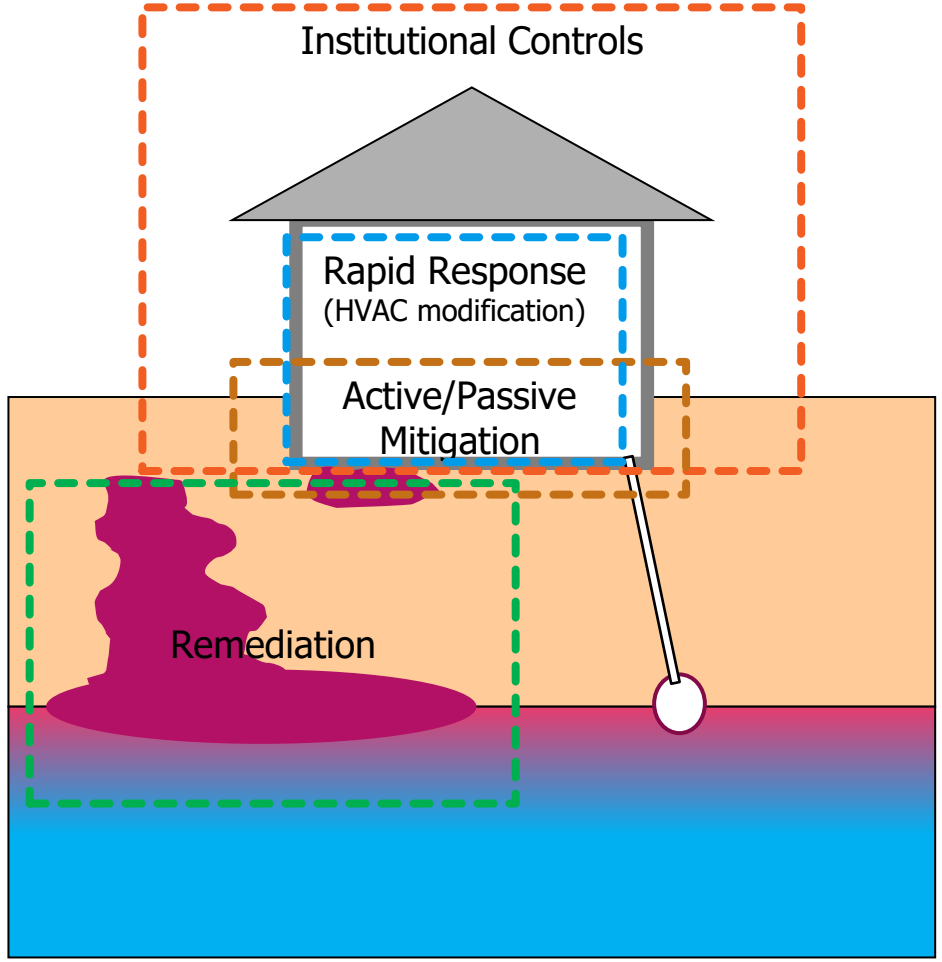
How to Protect from Vapor Intrusion

- Mitigation implemented to reduce indoor air contaminants due to VI below applicable action or screening levels
- Accomplished by
  - Modifying the VI pathway to reduce the mass flux of contaminants entering the building
  - Reducing indoor air contaminant concentrations by removal or dilution



What is VI Mitigation (or Vapor Control)?

- VFC Vapor control can include
  - Source remediation
  - Rapid response
  - Institutional controls
  - Active or passive mitigation (Session 2)



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

General Overview of the VI Mitigation System Process

Community Engagement

Pre-System	System Installation	Post-System Installation	System Curtailment
1. Assessment of Current and Future Site Conditions 2. Technology Selection for Existing/New buildings 3. Develop and Document System Design 4. Plan for System Verification, Curtailment, and System Shutdown	5. Pre-construction Meeting 6. Installation: a. Oversight b. Documentation	7. System Verification: a. Inspection b. Verification Sampling c. Confirming Performance QA/QC 8. Documentation 9. Operation, Maintenance, and Monitoring	10. Assessment of Current and Future Site Conditions 11. Curtailment of System 12. Shutdown System

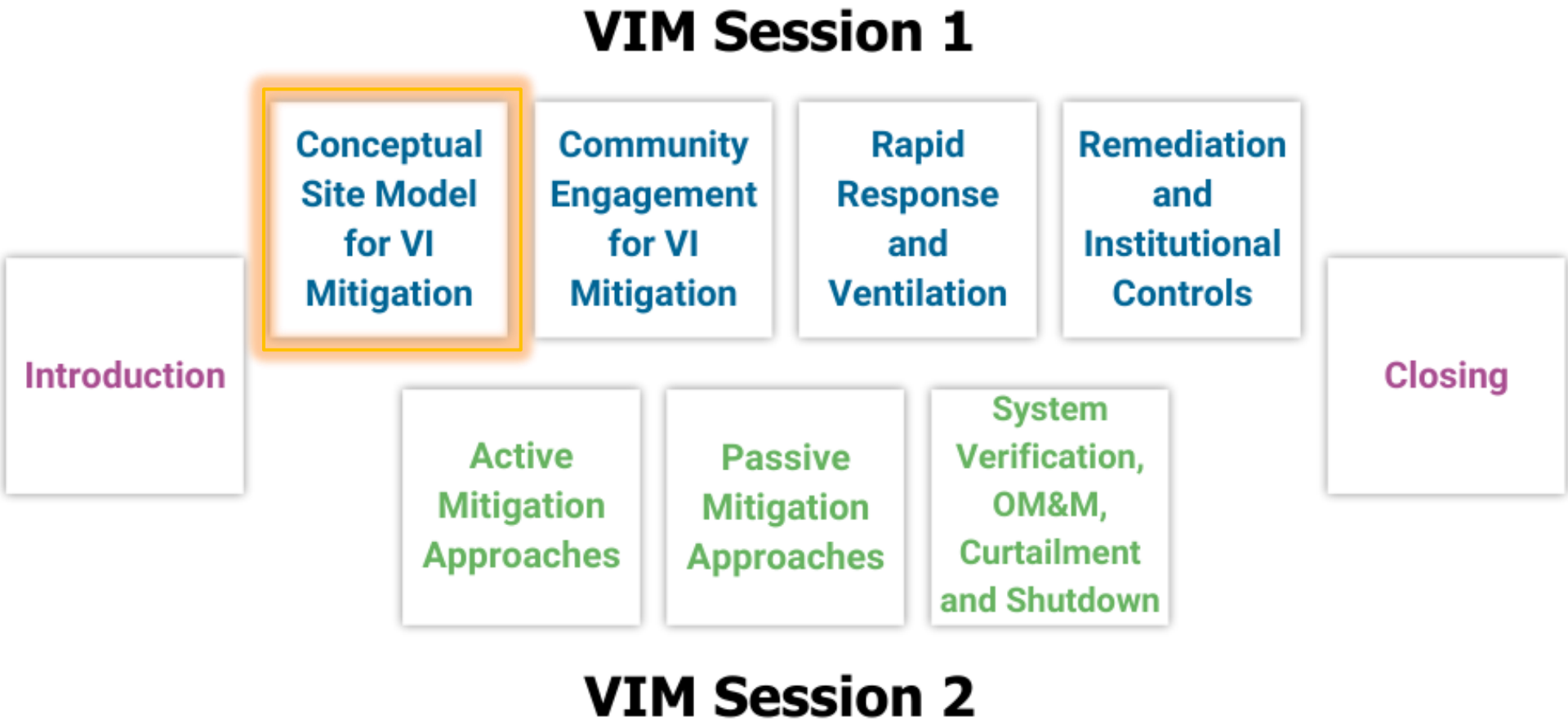
What system is needed?

Is the system installed according to design?

Is the system working?

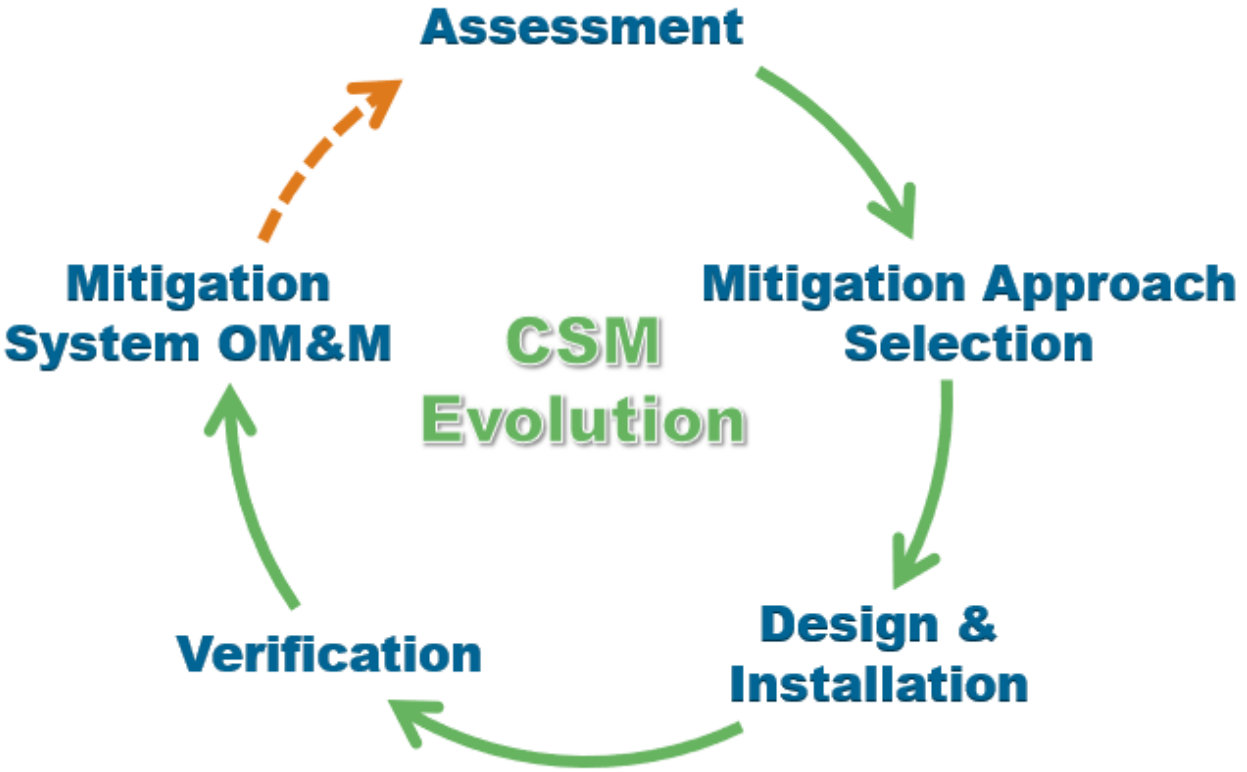
Is the system still needed?

Coming Up Next…



Conceptual Site Model (CSM) for Vapor Intrusion Mitigation

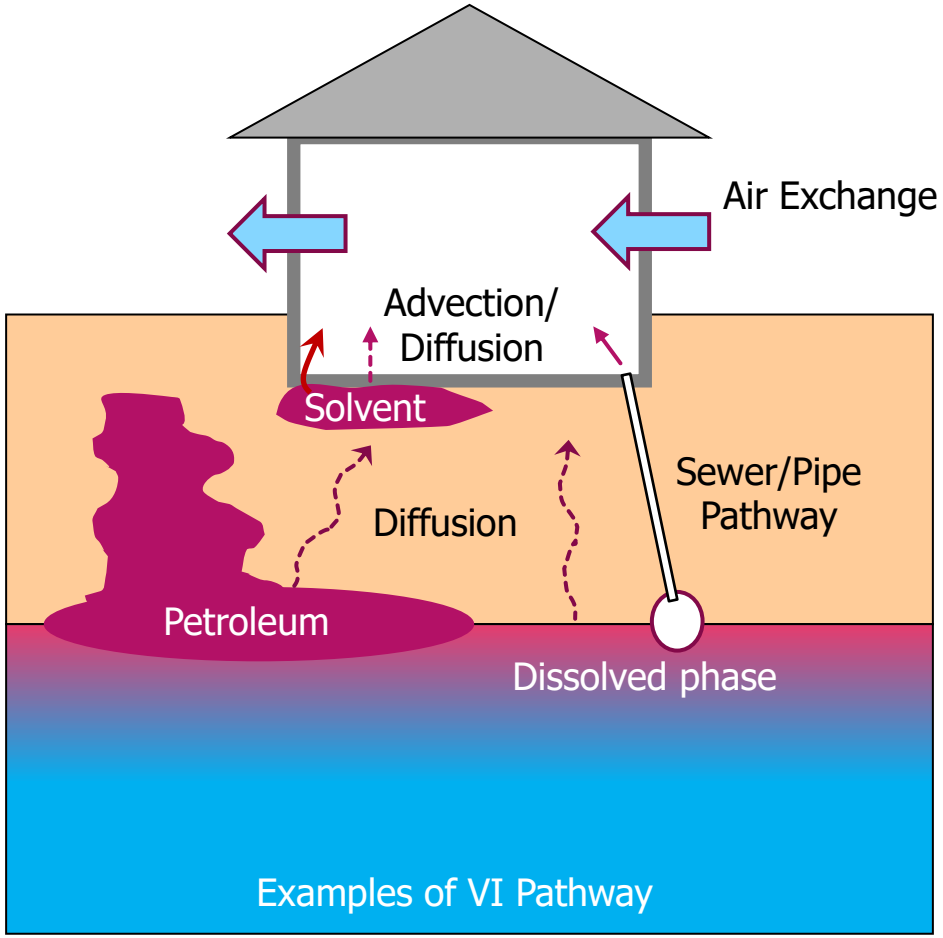
- Understand the importance of a VI "mitigation CSM"
- Identify data needed to enhance the CSM
- Use the enhanced CSM to evaluate mitigation options



Source: Jacobs, 2025. Used with permission.

What is a Mitigation CSM?

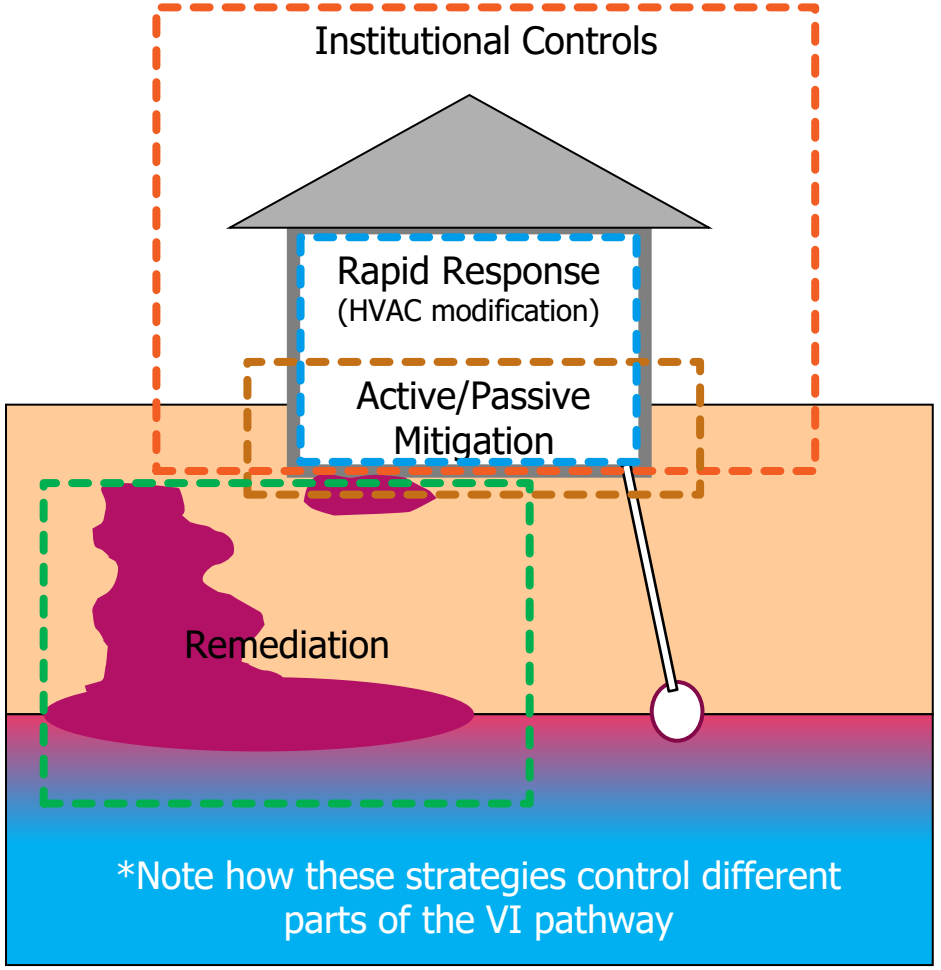
- VI CSM describes the VI pathway
- Mitigation modifies the VI pathway to reduce potential exposure
- A "mitigation-grade" CSM has sufficient information to evaluate mitigation alternatives



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

How can we modify or control the VI Pathway?

- VFC Vapor control can include
  - Source remediation
  - Active or passive mitigation
  - Rapid response
  - Institutional controls

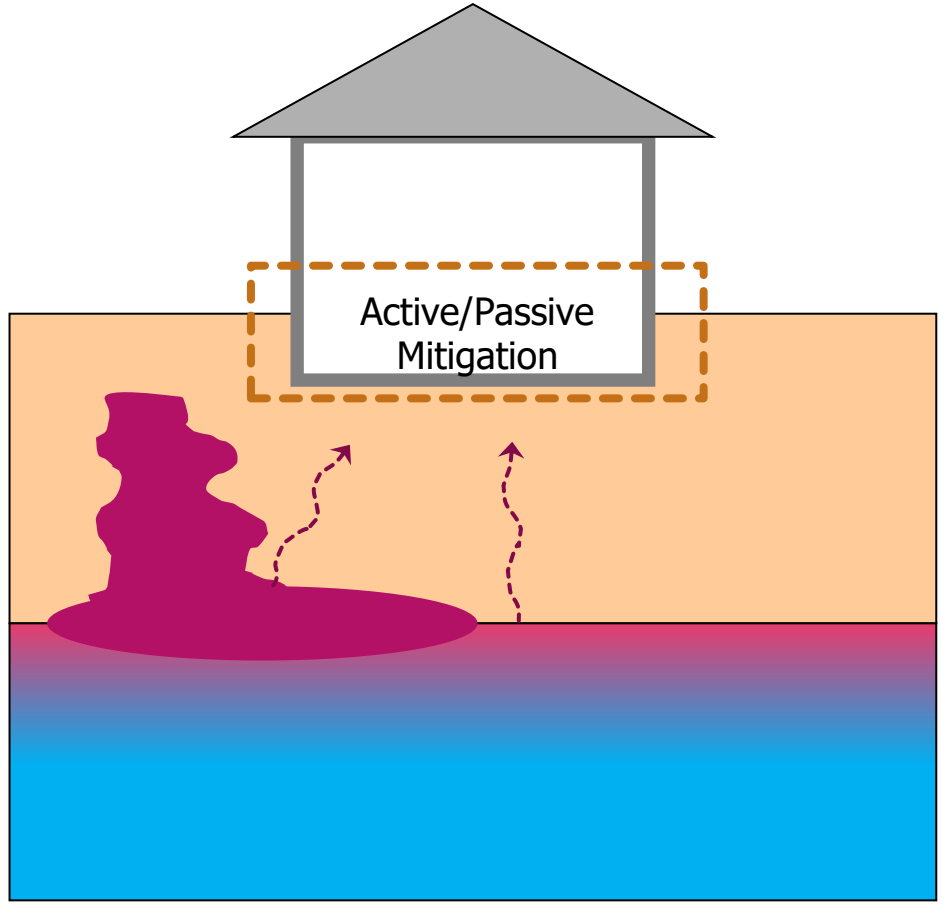


Source: Geosyntec & GSI Environmental, 2020. Used with permission.

Example of additional information needed to evaluate mitigation options

Evaluation of active/passive mitigation options may require additional information concerning:

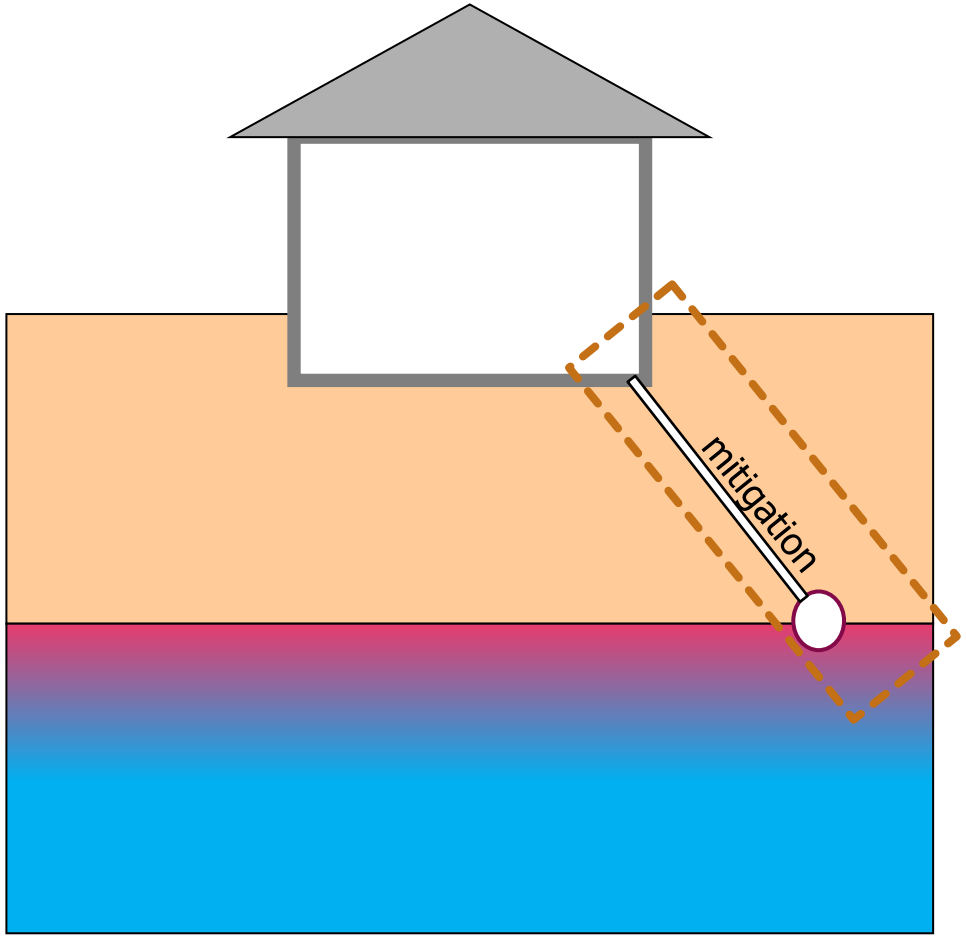
- Sub-slab VFC concentrations
- Sub-slab soil and moisture conditions
- Slab integrity
- Building features that block or short-circuit sub-slab air flow



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

VI Preferential Pathway Considerations

- The CSM should consider the potential for sewer/pipe VI preferential pathways
- Pathways that connect vapor sources to the building can dominate VI
- Mitigation options must control these pathways (potentially in addition to other pathways)



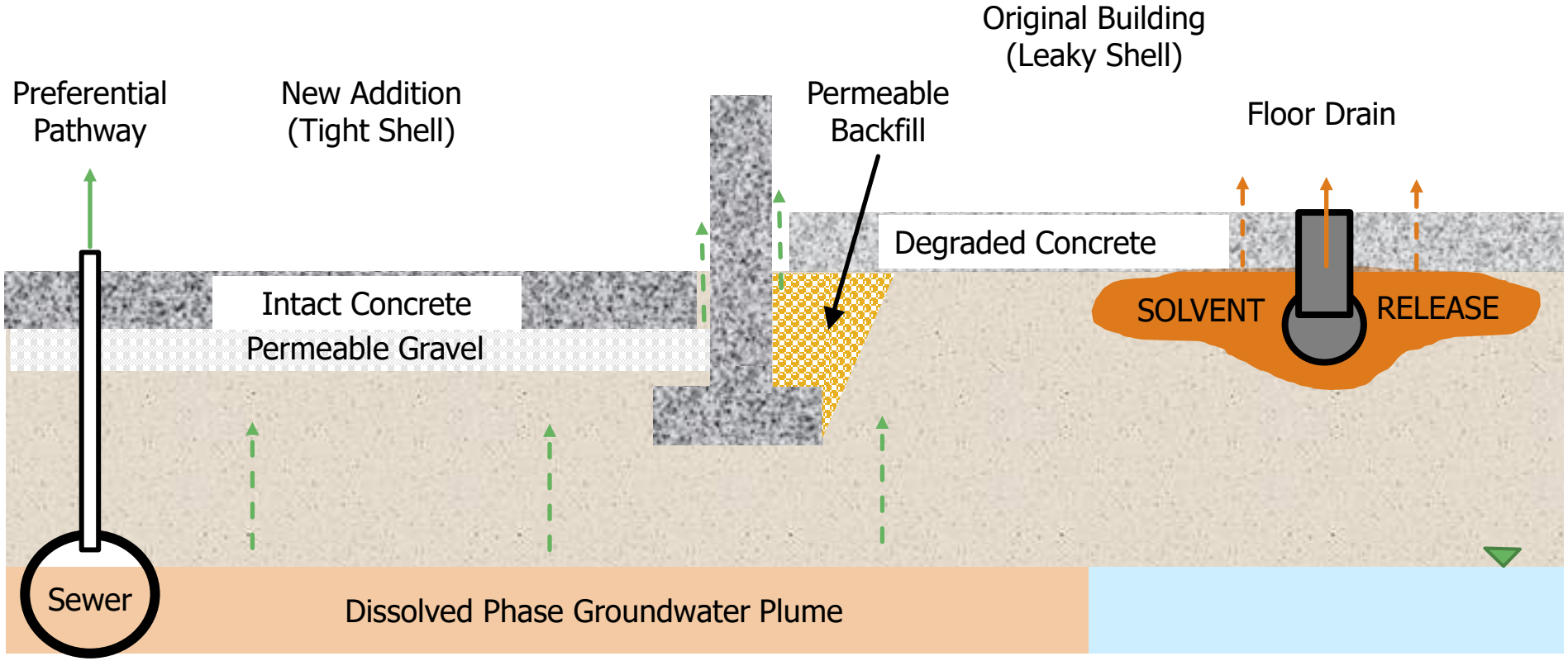
Source: Geosyntec & GSI Environmental, 2020. Used with permission.

Large buildings may have multiple Mitigation CSMs

Example of building with multiple sources, variable pathways, and variable building conditions

Legend

- Advective-controlled pathway
- Diffusion-controlled pathway



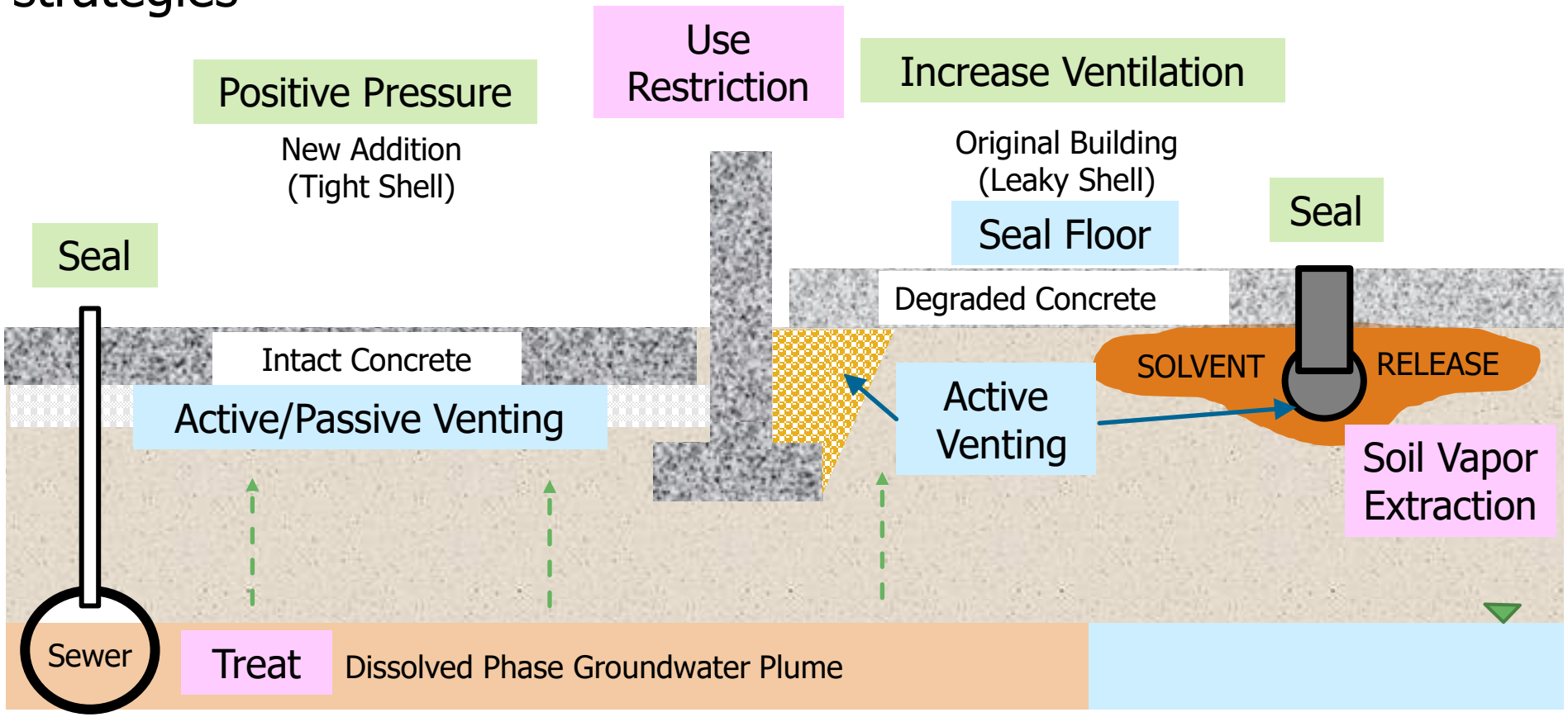
Source: Geosyntec & GSI Consultants, 2020.
Used with permission.

Large buildings may have multiple VI pathways

Multiple Mitigation CSMs may require multiple vapor control strategies

Legend

- Rapid Response and HVAC controls
- Active/Passive Mitigation systems
- Remediation/ICs



Source: Geosyntec & GSI Consultants, 2020.
Used with permission.

CSM for VI Mitigation Checklist

- Supports a systematic site evaluation
- Helps verify understanding of important details
- Facilitates data gaps identification

Excerpt of "Building" Section of CSM Checklist

5. Buildings

Locate and map out existing buildings, identify square footage, and identify areas for potential future construction if known. If multiple buildings are being evaluated, tabulation of the following for each building may be necessary. Also, building additions may need to be evaluated separately. Note that a detailed, building-specific evaluation may not be needed if the VI mitigation effort is focused on the COC source area or pathway outside of the ***building envelope****. In the descriptions below, include references to site reports, as necessary, to support the discussion. Attachments to this checklist with, for example, copies of figures may also be provided.*

5.1 Structure

- Indicate current building use:

☐ Residential

☐ Non-Residential

If non-residential, could future use include residential? ☐ Yes ☐ No
☐ Unknown

Are land use controls (LUCs), use restrictions, institutional controls, or equivalent in place? ☐ Yes ☐ No

Note: If current or future site use is or could be residential, the most conservative state and federal regulations apply for technology selection and design.

- Indicate structure status:

☐ Existing construction

☐ New construction

☐ Potential future construction

See: Checklist – VIM CSM

CSM for VI Mitigation Flow Chart

Receptor

Transport

Source

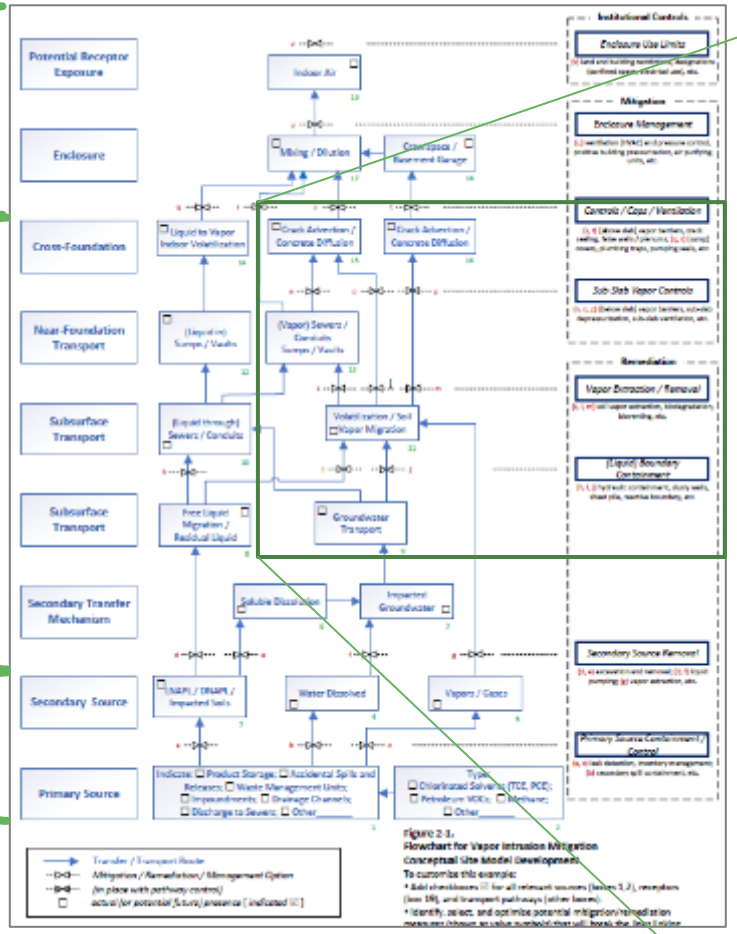
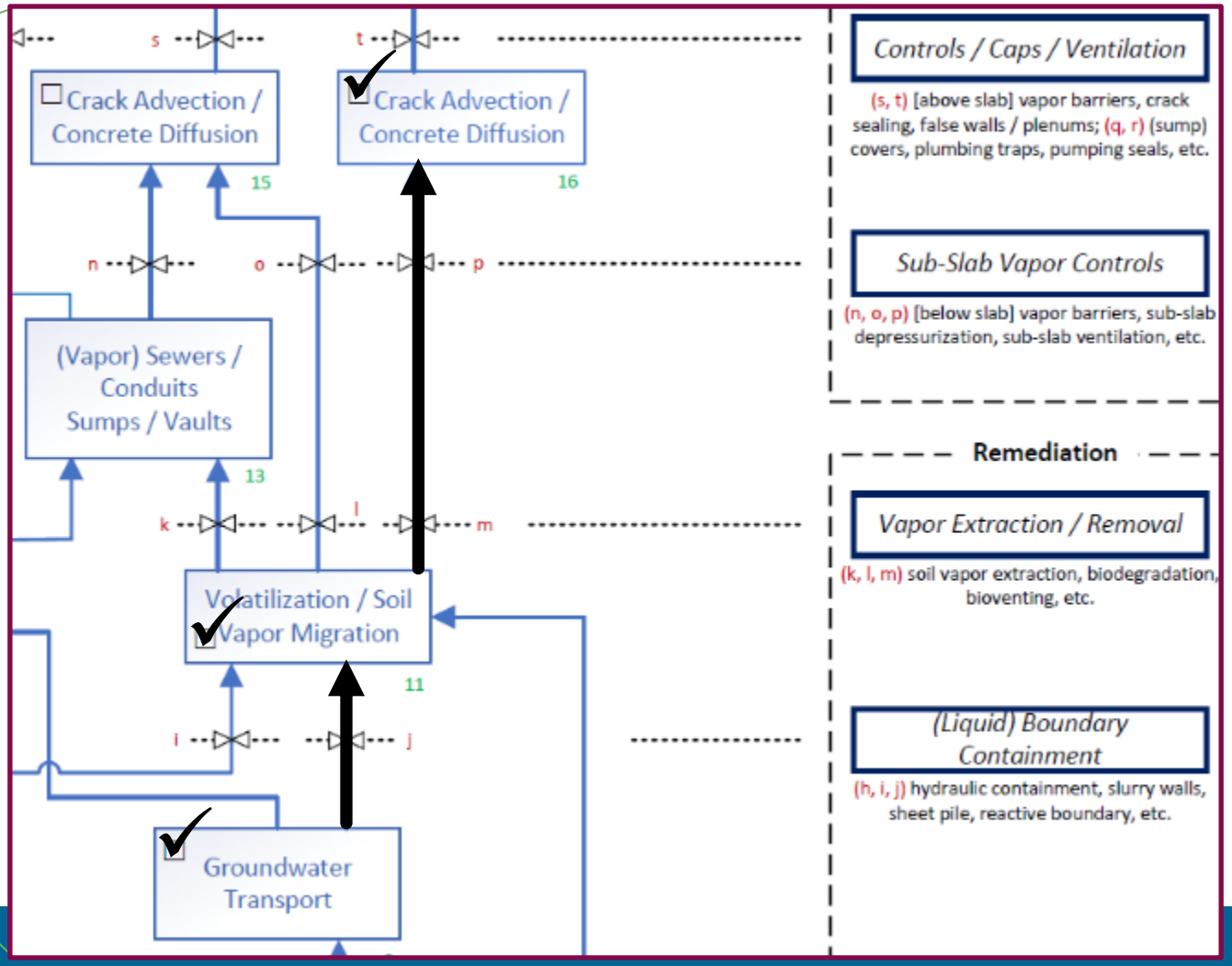


Figure 2-1. ITRC CSM Fact Sheet



Knowledge Check

CSM Summary:

- Occupied slab-on-grade structure with partial crawlspace overlying VFC-containing groundwater
- Sub-slab soil vapor and indoor air sampling indicates complete VI pathway that warrants mitigation
- Sub-slab depressurization system is planned

Why is the **mitigation** CSM incomplete?

A. It does not say if the building is residential or commercial

B. Nah! It is actually complete

C. The CSM does not say if screening levels were exceeded

D. VFC migration through the crawlspace has not been evaluated

E. Temporal variability has not been assessed

Source: Jacobs, 2025, via Copilot. Used with permission.
Copilot prompt: "Can you draw a building with a partial slab on grade and a crawlspace."

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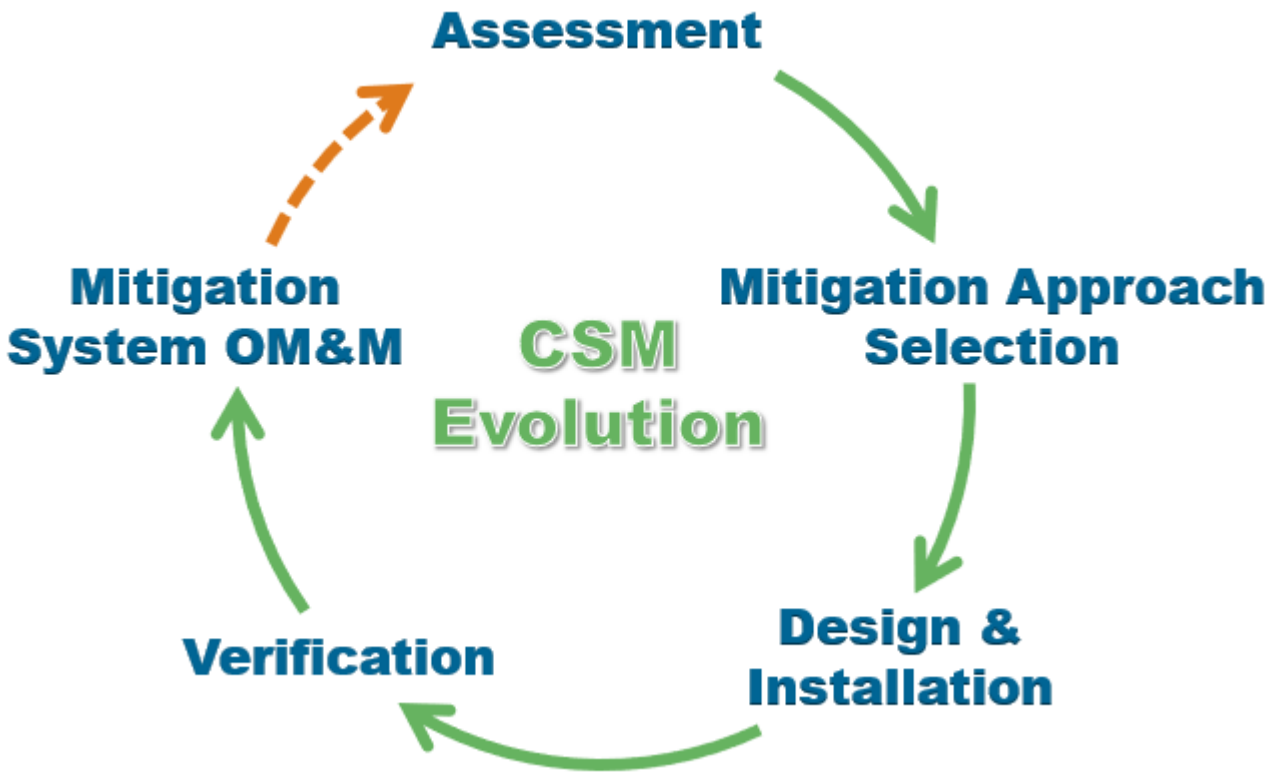
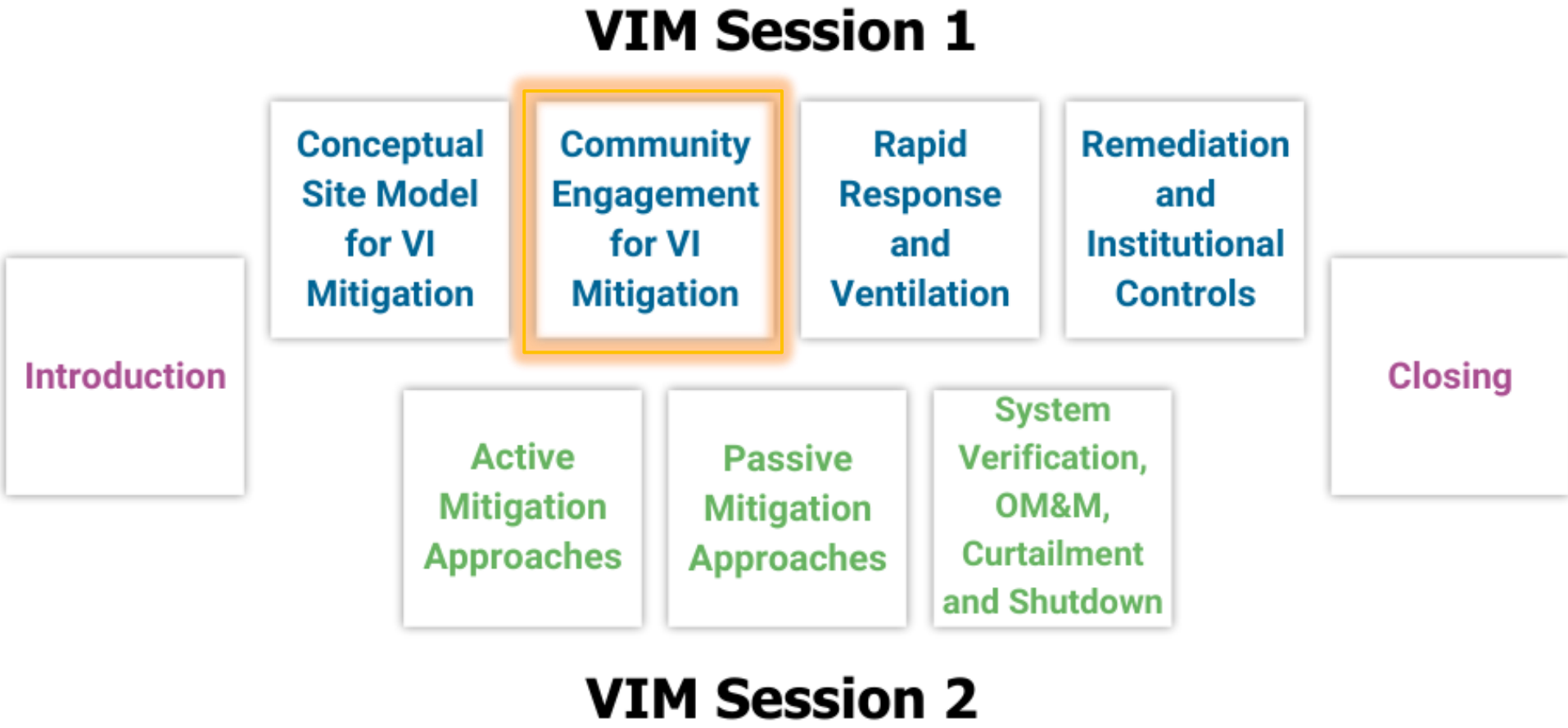
Summary

- VI CSM evolves throughout the life of a project
- "Mitigation CSM" helps to
  - Identify information needed to evaluate mitigation options
  - Support community engagement
- For more information
  - Chapter 4.2 of ITRC VI Guidance
  - VI Mitigation Checklist



Source: Jacobs, 2025. Used with permission.

Coming Up Next…

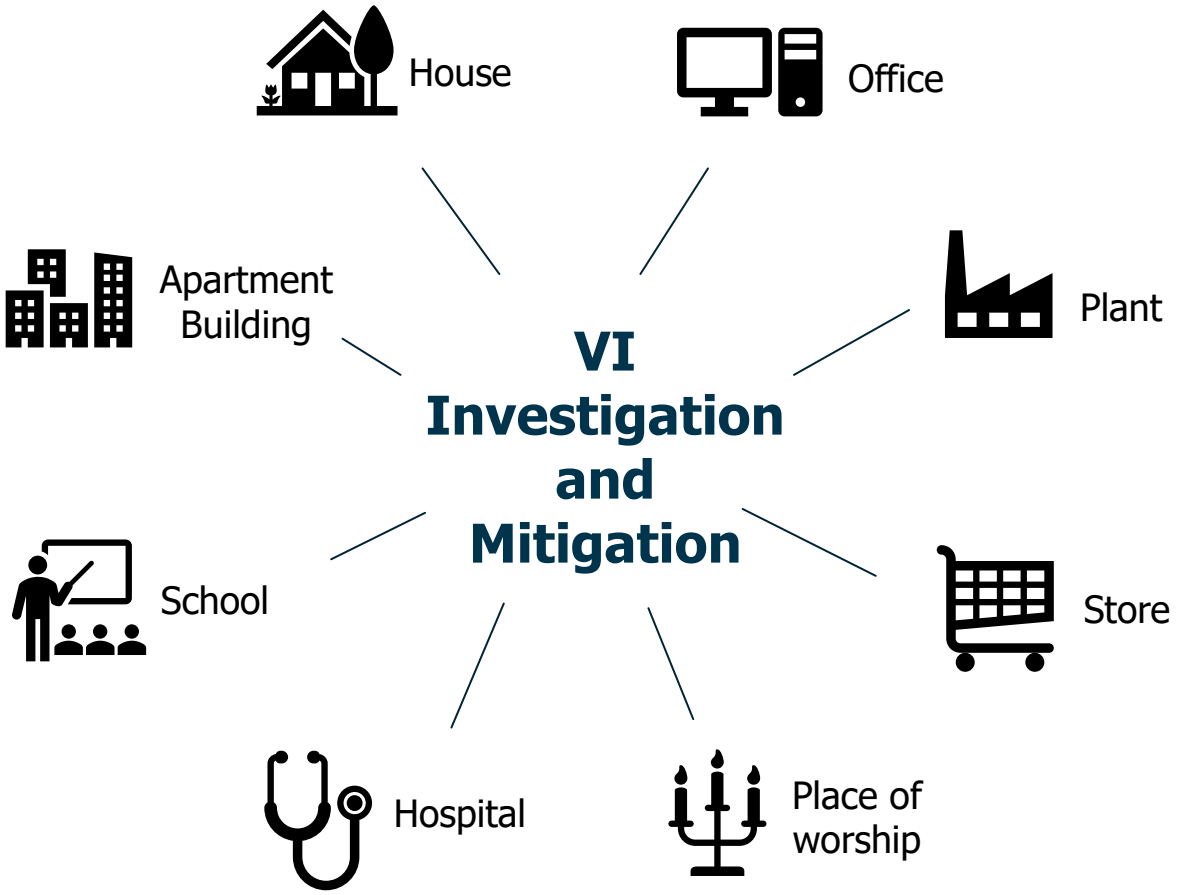


Community Engagement During Vapor Intrusion Mitigation

Source: Pixabay (adapted)

Community Engagement During Vapor Intrusion

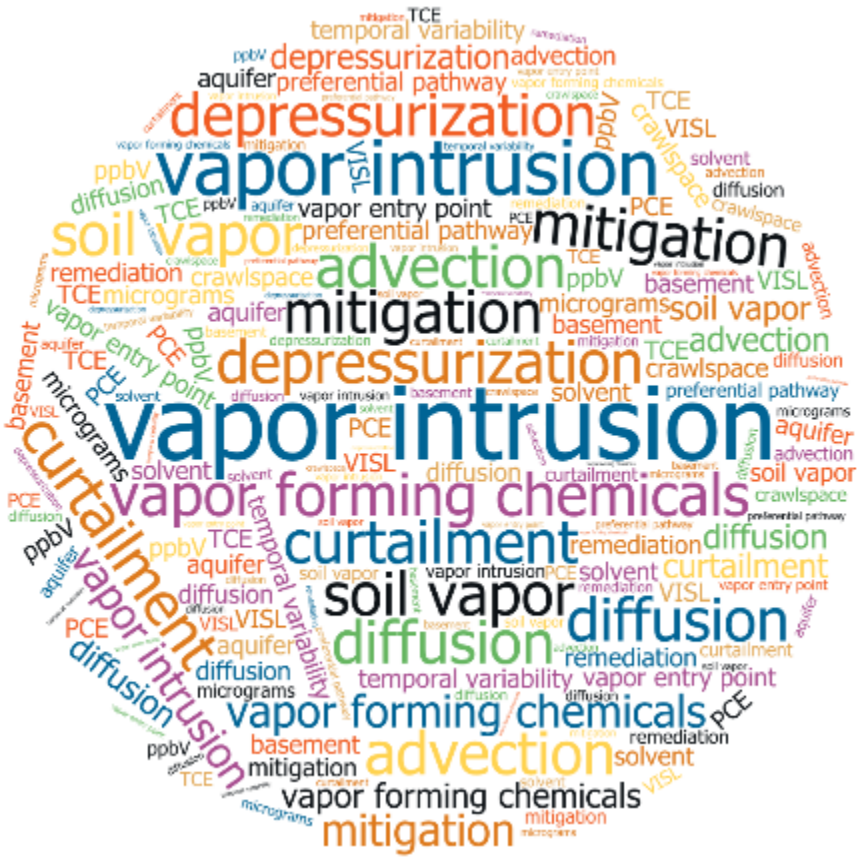
- VI work takes place indoors
- Topic is unfamiliar to the public
- It's about the air we breathe
- Mitigation involves modifications to a building



Key Components of Community Engagement for VI

- Consider outreach early and often
- Be transparent
- Maintain relationships
- Recruit partners
  (e.g., translators, community organizers)
- Listen

Communicating Vapor Intrusion is Complicated



- Unfamiliar words
- Numerous things to measure and compare
- Variability of results
- Background contributions from common consumer products

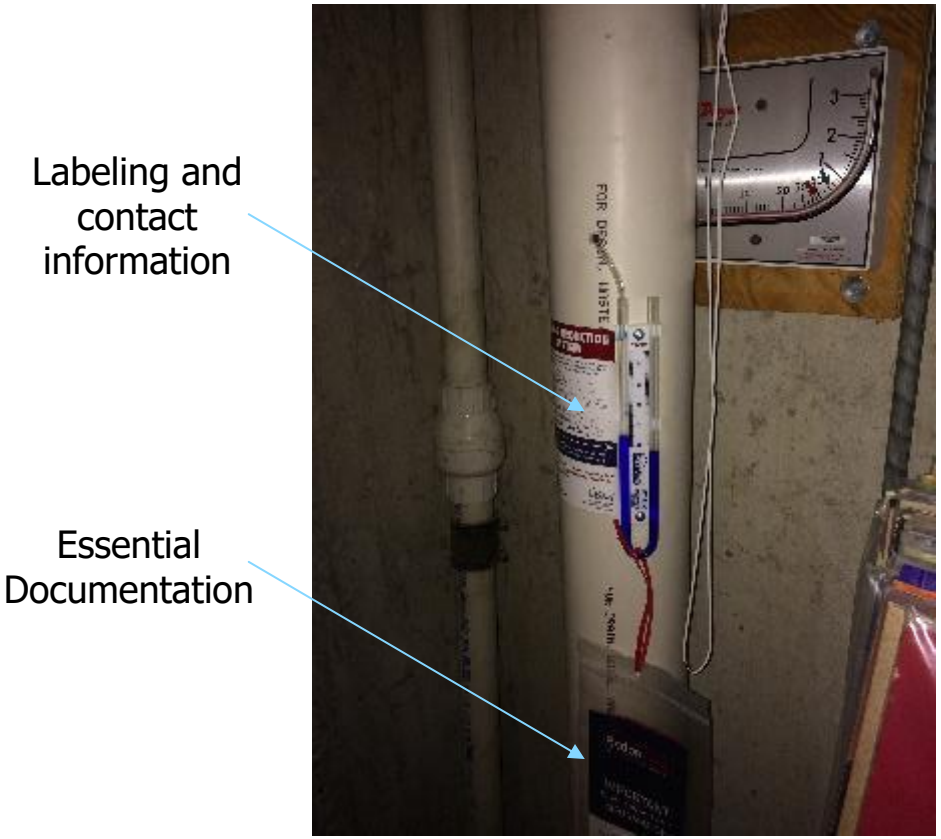
Source: Wordclouds.com

Communicating Vapor Intrusion Mitigation is Complicated

- Use analogies (e.g., radon mitigation)
- Address questions and concerns
- Rely on intermediaries/partners as needed

Communication on Long-Term Management

- Need a plan for communicating:
  - System issues
  - Remodeling work
  - Institutional/engineering controls at property transfer
  - Curtailment strategy
- Provide labeling, contact information, and essential documentation
  - Retain a copy if lost or misplaced



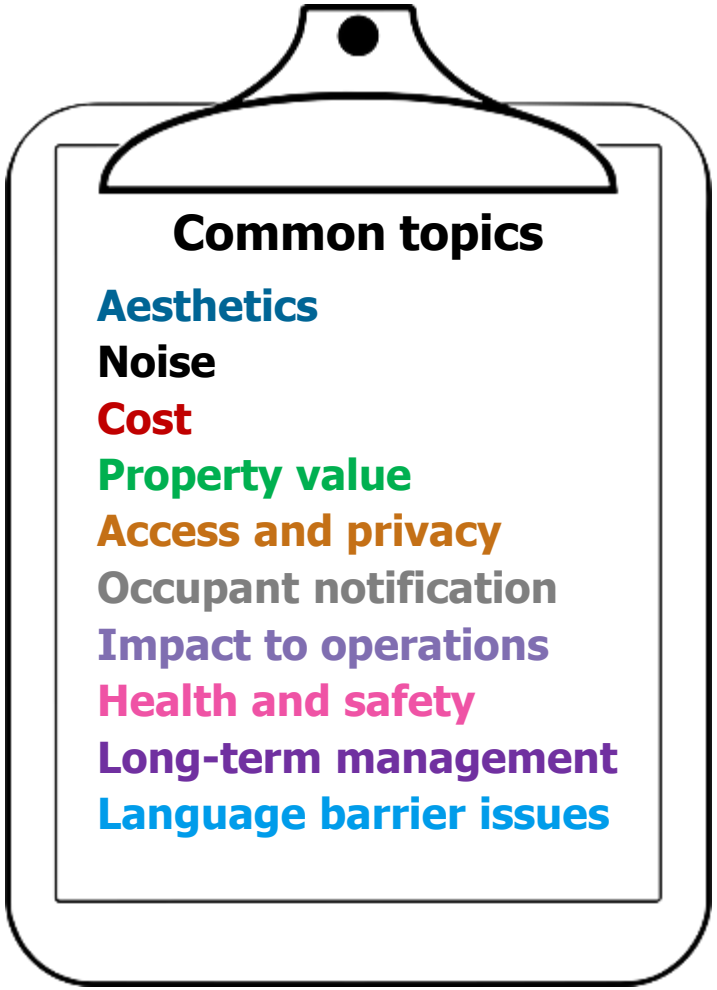
Source: L. Levy, 2020. Used with permission.

Questions from the Public

Source: Pixabay (adapted)

Multiple Communication Tools Needed

- Repeated conversations with same party
- Emphasize that mitigation protects building occupants
- Communicate by multiple methods
  - Group setting
  - Fact sheets
  - Social media
  - One-on-one discussions



Source: Pixabay (adapted)

Communication is Everyone's Job

Every interaction and perception matters

Every stakeholder plays a role in communication

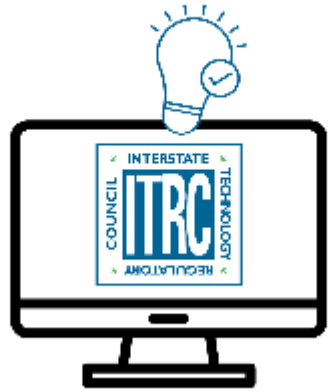
Be mindful of situations where the occupant is not the owner

- Responsible party
- Environmental consultant
  - field staff
- Engineer/mitigation designer
- Mitigation installer
  - field staff, plumber, electrician
- Regulator
- Risk assessor
- Community representative(s)
- Owner/tenant

Knowledge Check

Which statement is **true** regarding community engagement with VI projects?

A. It takes little time and is not much of a workload.
B. Contamination may affect people's health and the project can disrupt their lives/businesses.
C. Only property owners and tenants need to be involved.
D. All investigation and mitigation work can be done from the outside.
E. Engagement with property owners ends after a mitigation system is installed.



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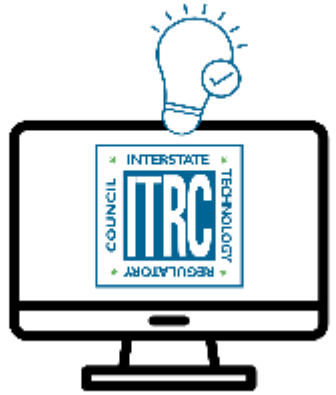
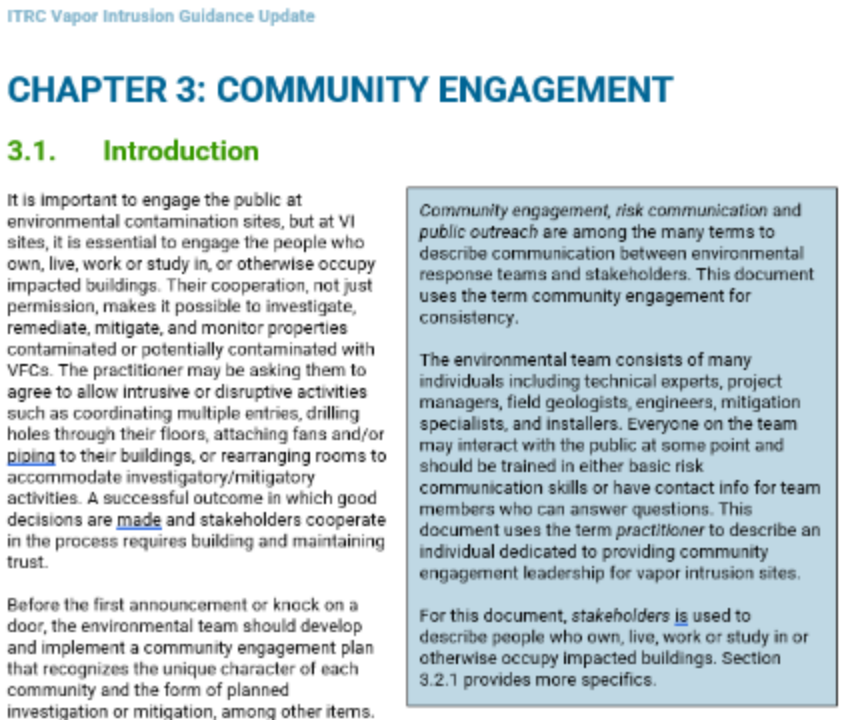


Additional Resources



ITRC Vapor Intrusion Guidance Update

CHAPTER 3: COMMUNITY ENGAGEMENT

3.1. Introduction

It is important to engage the public at environmental contamination sites, but at VI sites, it is essential to engage the people who own, live, work or study in, or otherwise occupy impacted buildings. Their cooperation, not just permission, makes it possible to investigate, remediate, mitigate, and monitor properties contaminated or potentially contaminated with VFCs. The practitioner may be asking them to agree to allow intrusive or disruptive activities such as coordinating multiple entries, drilling holes through their floors, attaching fans and/or piping to their buildings, or rearranging rooms to accommodate investigatory/mitigatory activities. A successful outcome in which good decisions are made and stakeholders cooperate in the process requires building and maintaining trust.

Before the first announcement or knock on a door, the environmental team should develop and implement a community engagement plan that recognizes the unique character of each community and the form of planned investigation or mitigation, among other items.

Community engagement, risk communication and *public outreach* are among the many terms to describe communication between environmental response teams and stakeholders. This document uses the term community engagement for consistency.

The environmental team consists of many individuals including technical experts, project managers, field geologists, engineers, mitigation specialists, and installers. Everyone on the team may interact with the public at some point and should be trained in either basic risk communication skills or have contact info for team members who can answer questions. This document uses the term *practitioner* to describe an individual dedicated to providing community engagement leadership for vapor intrusion sites.

For this document, *stakeholders* is used to describe people who own, live, work or study in or otherwise occupy impacted buildings. Section 3.2.1 provides more specifics.

Chapter 3 Community Engagement
https://itrcweb.org/vapor-intrusion-toolkit

Risk Communication Toolkit

HOME

Welcome

Risk Communication Toolkit

INTERSTATE COUNCIL ITRC TECHNOLOGY REGULATORY

This Interstate Technology and Regulatory Council (ITRC) online document includes a brief overview of risk communication (Section 1), walks through the steps in developing a communication plan and stakeholder outreach activities (Section 4), presents an overview of risk communication concepts (Section 2), and applies these principles in case studies (Section 5) to facilitate risk communication plan development. Section 3.2 includes a summary of the tools included in the appendices (See Section 6 Additional Information) to facilitate risk communication plan development and stakeholder outreach activities. This toolkit is applicable to current, immediate, and emerging environmental issues and concerns. Examples of various tools, as presented in this toolkit, were developed by issue-specific ITRC teams; however, they are generally applicable to environmental issues and concerns. Additional examples will be developed by ITRC teams going forward and linked to the web document in the future. This toolkit will be updated with links to case studies published by future ITRC teams.

A short Risk Communication Toolkit fact sheet summarizing the information in this online document is available.

As part of the PFAS team training videos, a Risk Communication video has been developed. It is posted on ITRC's YouTube channel: https://www.youtube.com/watch?v=HeOaPlp_z5g&feature=youtu.be

Document navigation is provided with the menu on the left, or above on a mobile device.

Publication Date: June 2020

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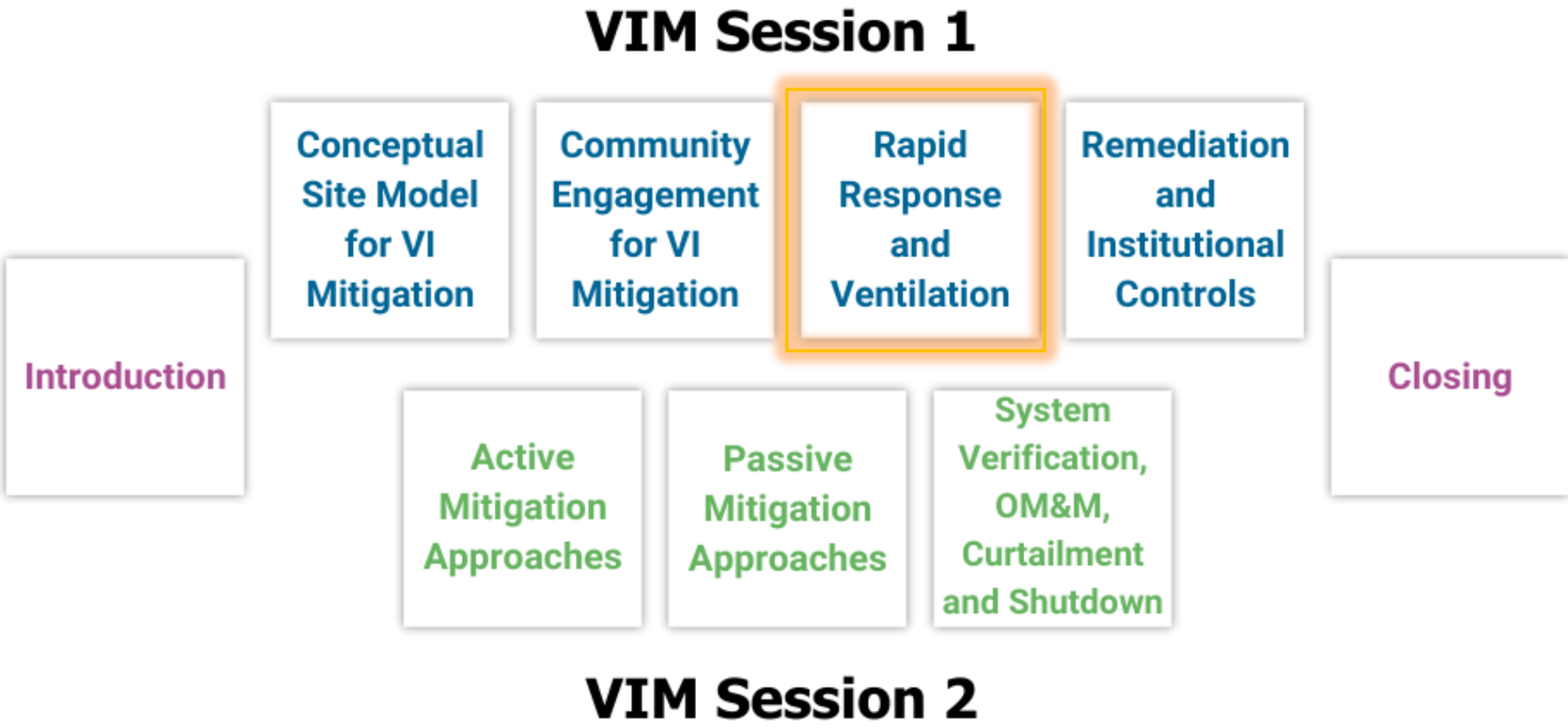
ITRC Risk Communication Toolkit (2020)
https://rct-1.itrcweb.org/

Question & Answer Break

Coming Up Next…



Rapid Response and Ventilation

Not Covered in the Vapor Intrusion Toolkit

Emergency Response Actions

- Evacuate building and immediately contact first responders if:
  - Reports of strong petroleum odors
  - Evidence of combustible, explosive, or oxygen-deficient conditions inside the building

Methane mitigation or hazardous substances that have a high explosive potential

Radon

What is Rapid Response?

- Mitigation implemented within days or weeks of vapor intrusion discovery
- Addresses acute public health risk
- Short term response action
- Applicability and extent based on type of contaminant, indoor air concentration, sensitivity of occupants
- May be different from final response
  - Limited design effort
  - Different verification testing considerations
  - Limited OM&M

Knowledge Check

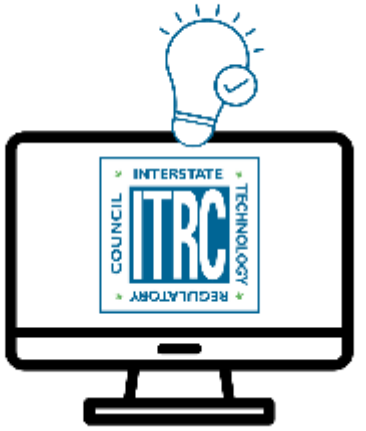
Which of these scenarios could warrant a rapid response?

A. Petroleum vapor intrusion has been documented in a vacant gas station

B. High levels of TCE have been detected in indoor air in a daycare facility

C. TCE levels have been detected slightly above state vapor intrusion action levels in sub-slab vapor beneath an occupied commercial building

D. Benzene has been detected at high levels in soil gas at a vacant lot planned for redevelopment



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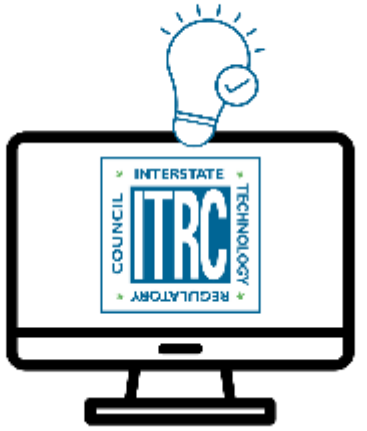


Rapid Response & Ventilation – ITRC Toolkit

- Defines what is a rapid response and when to implement
- Lists administrative and engineering controls for rapid responses
- Discussed in Chapter 1.5, 2.51, 5.23, 10.1 and 10.5 of Guidance
- Separate Tech and Fact Sheet


PREFERENTIAL PATHWAY SEALING AND AD HOC VENTILATION TECHNOLOGY INFORMATION SHEET

Applicability as a method of vapor intrusion rapid response

Overview

INDOOR AIR TREATMENT TECHNOLOGY INFORMATION SHEET

Overview

HEATING, VENTILATION, AND AIR CONDITIONING MODIFICATION TECHNOLOGY INFORMATION SHEET

Overview

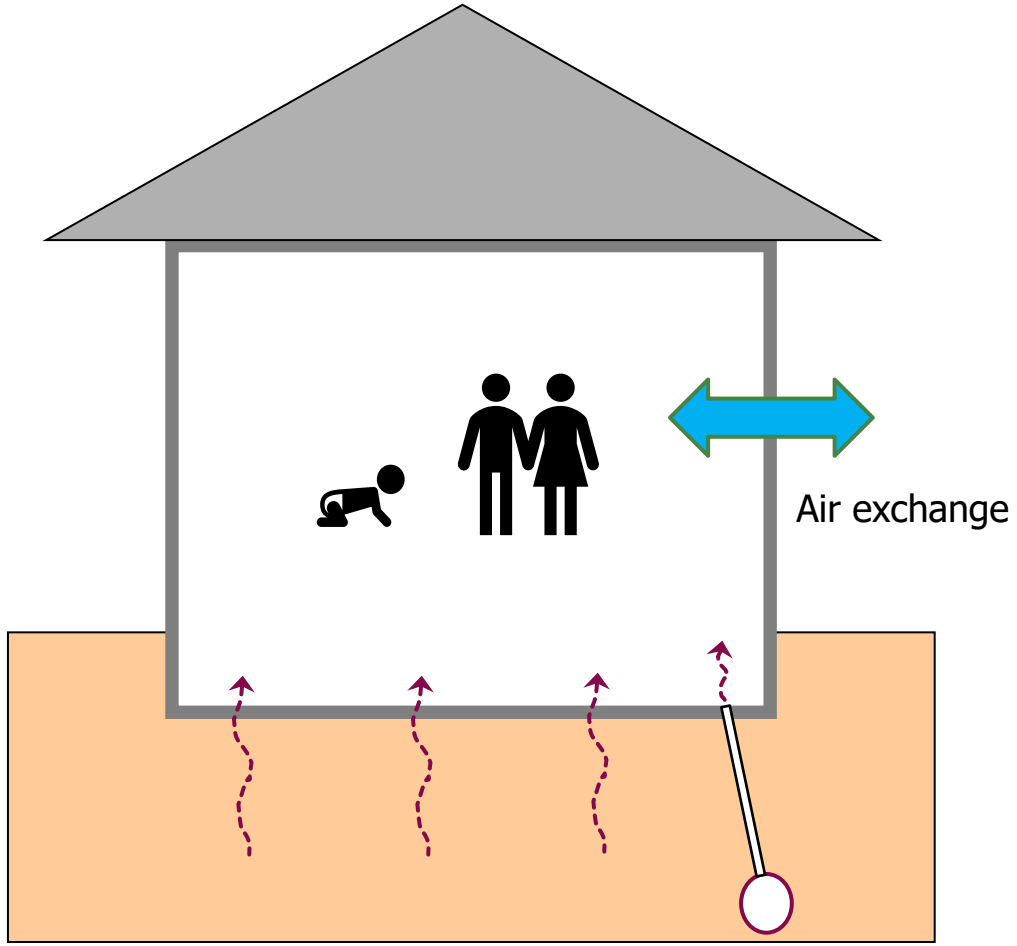

RAPID RESPONSE AND VENTILATION FOR VAPOR INTRUSION FACT SHEET

Rapid response is an interim vapor intrusion (VI) mitigation approach that may be appropriate, under certain conditions (e.g., high contaminant concentrations and

See: Fact Sheet – Rapid Response & Ventilation

Rapid Response Focused on Structure and Occupants

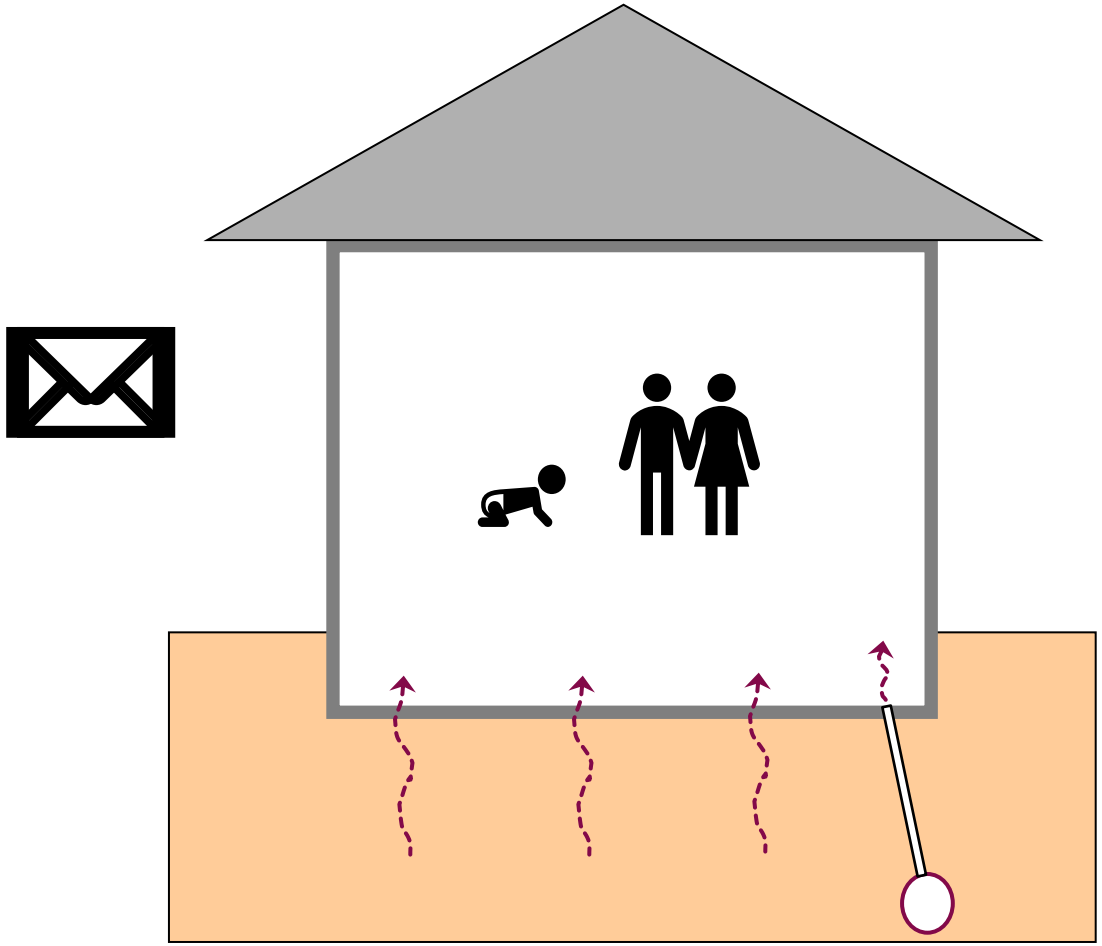
- Building occupants
- Preferential pathways
- Building pressure
- Air exchange rate



Source: Barr Engineering, 2020. Used with permission.

Categories of Rapid Response: Administrative Controls

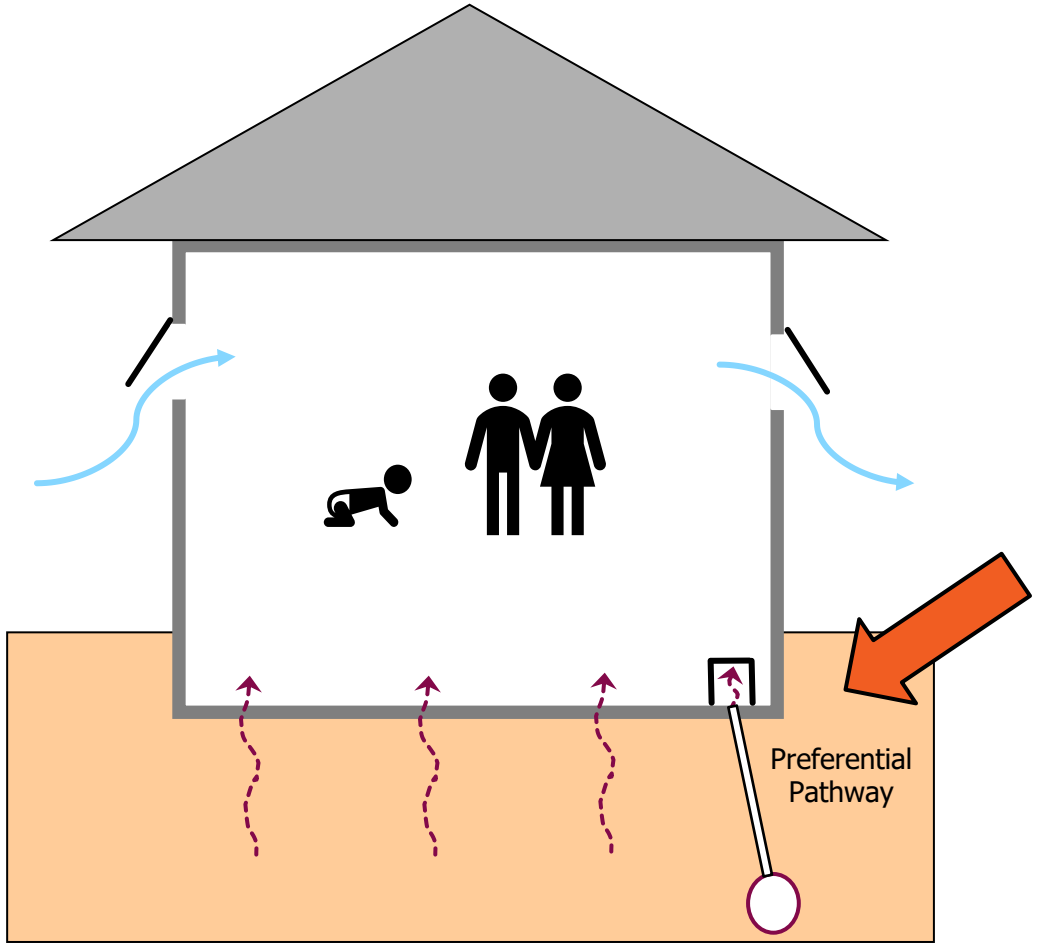
- Notification
- Relocation



Source: Barr Engineering, 2020. Used with permission.

Categories of Rapid Response: Engineering Controls

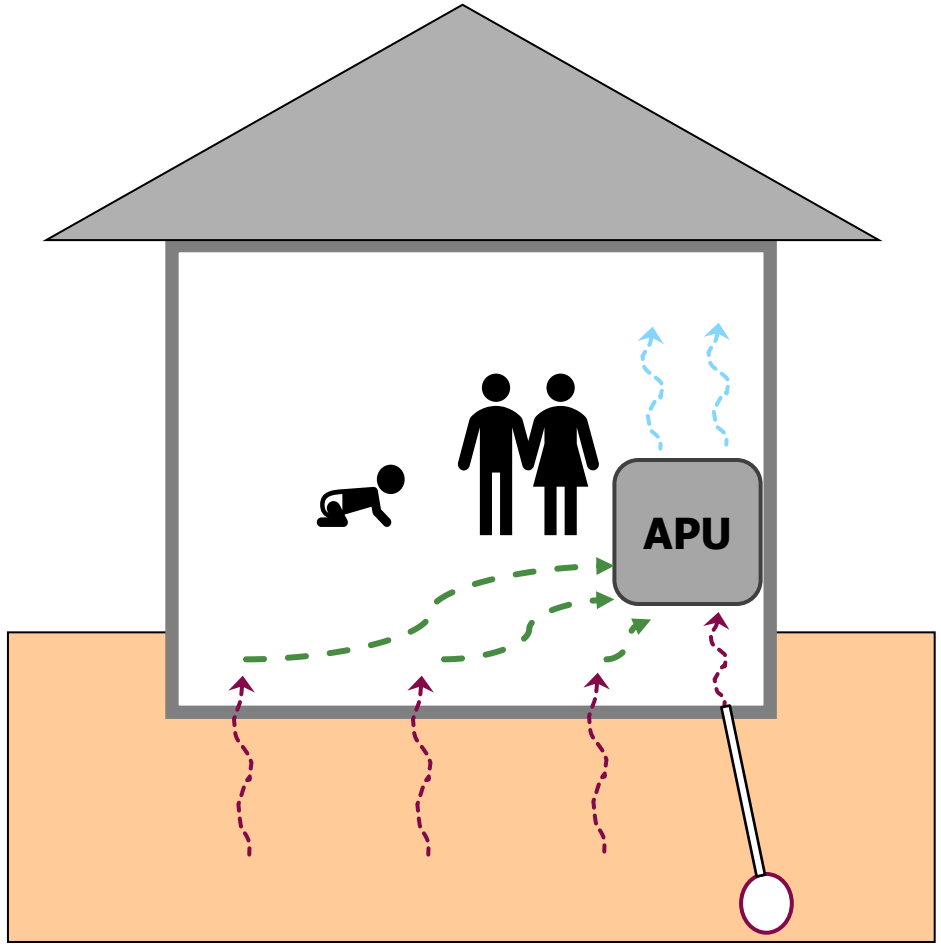
- Preferential pathway sealing
- Ad hoc ventilation



Source: Barr Engineering, 2020. Used with permission.

Categories of Rapid Response: Engineering Controls

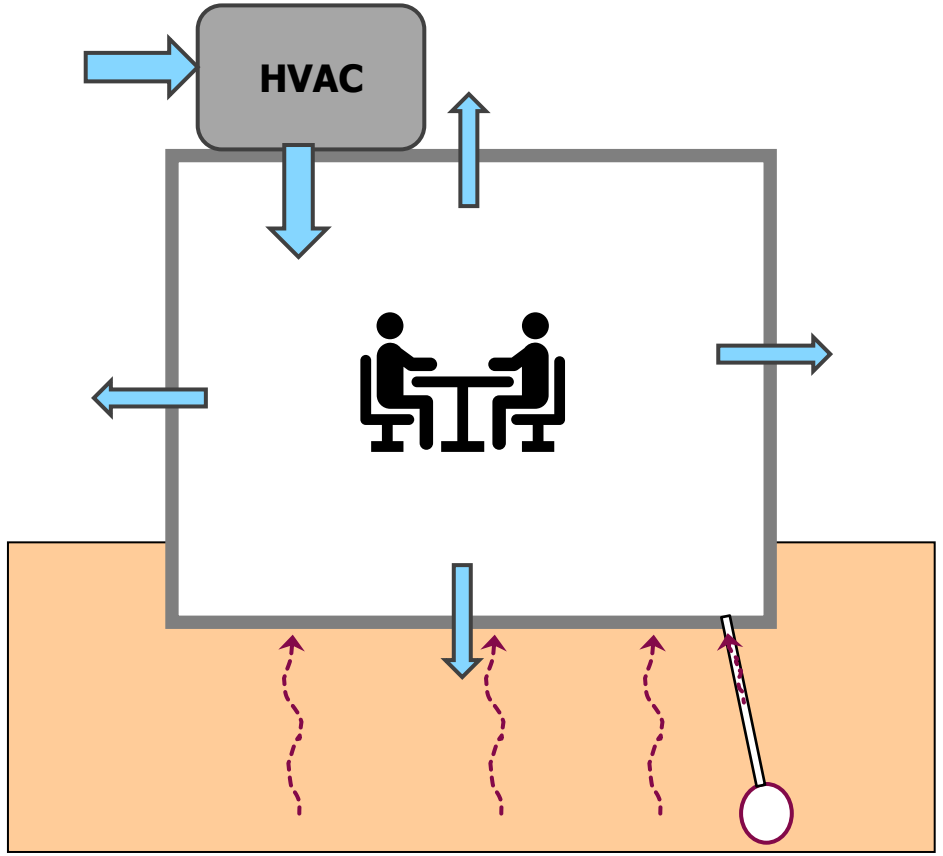
- Preferential pathway sealing
- Ad hoc ventilation
- Indoor air treatment



Source: Barr Engineering, 2020. Used with permission.

Categories of Rapid Response: Engineering Controls

- Preferential pathway sealing
- Ad hoc ventilation
- Indoor air treatment
- HVAC modification

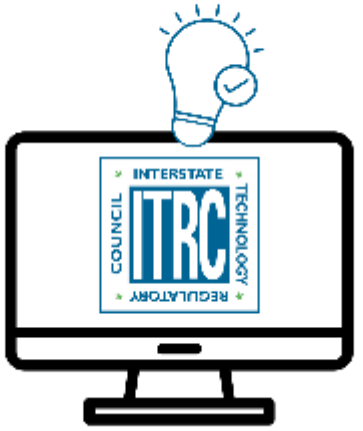


Source: Barr Engineering, 2020. Used with permission.

Knowledge Check

Which of the following are administrative controls? (Check all that apply)

A. Notification
B. Ad Hoc Ventilation
C. Relocation
D. Indoor Air Treatment
E. HVAC Modification



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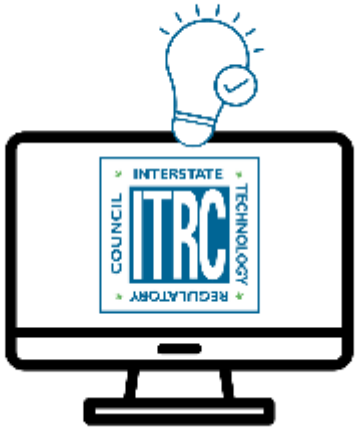
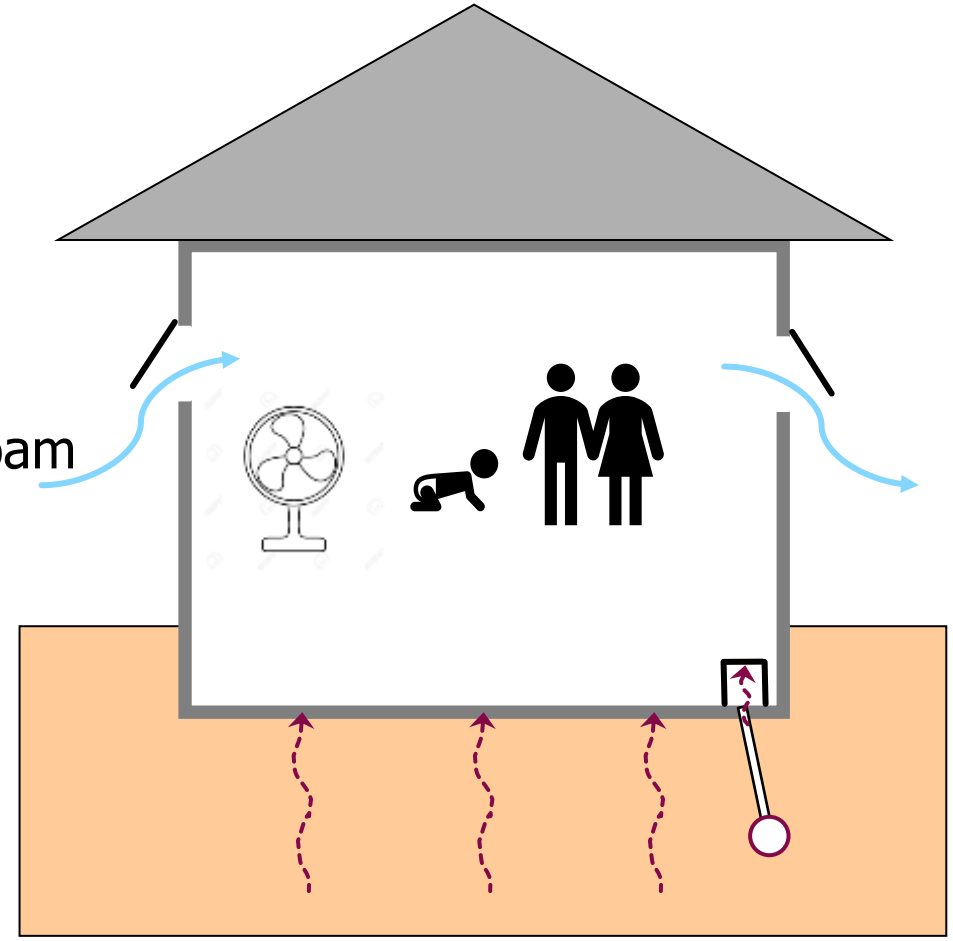


Tech Sheet – Preferential Pathway Sealing – Overview

- Advection vs. Diffusion
- Preferential pathway sealing blocks advection
  - Benefits long-term mitigation
  - Variety of caulks and sealants can be used
  - Cracks and openings > ½-in should be filled with a foam backer prior to sealant application
  - Sumps can be fitted with vapor-tight lids
  - Piping and electrical penetrations seals with non-permanent caulk (e.g., silicone)



Source: Barr Engineering, 2020. Used with permission.

Preferential Pathway Sealing – Components

Source: Sanborn, Head & Associates, Inc.

Sealant applied to floor gap

Source: L. Levy, Jacobs Eng.

Sealed floor sump

Source: Barr Engineering Co.

Add water or mineral oil to dry drain

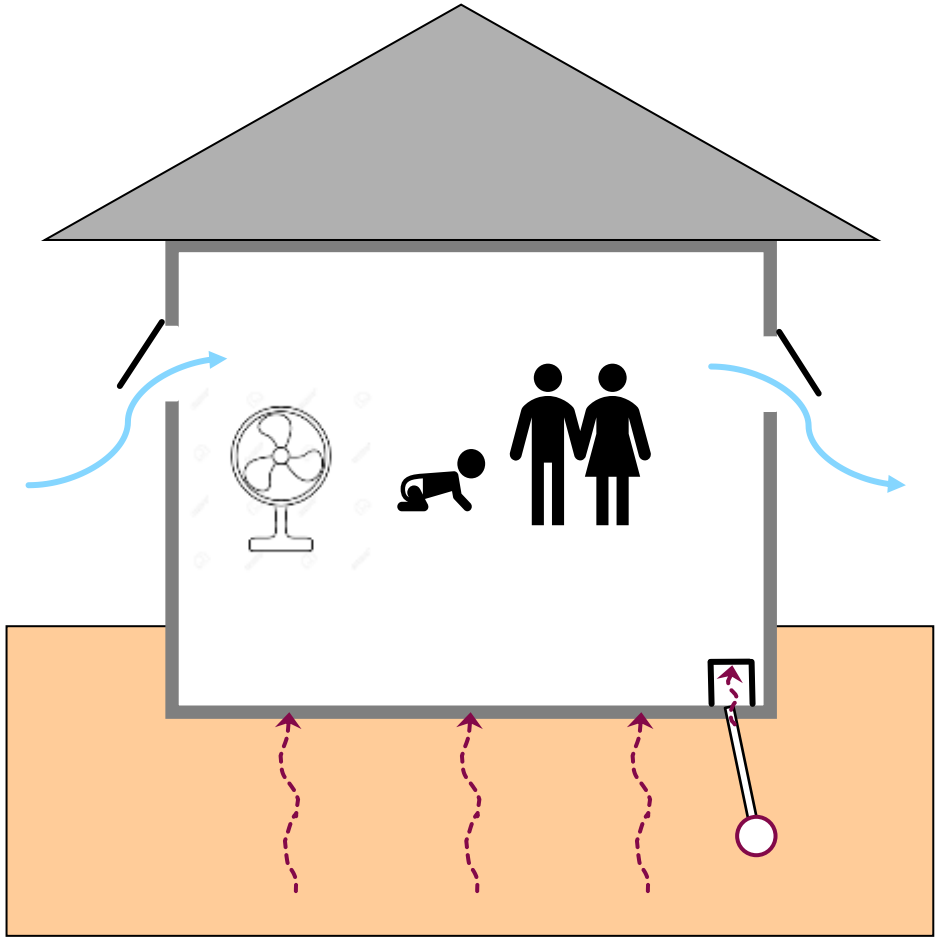
Tech Sheet – Ad Hoc Ventilation – Overview

- Ad hoc ventilation = dilution
  - Weather dependent
  - Changes that can be made immediately, easily, and

    do not require special skills or training
  - Adjusting a building's HVAC system to increase fresh air

    intake
  - Requires understanding of air exchange rates

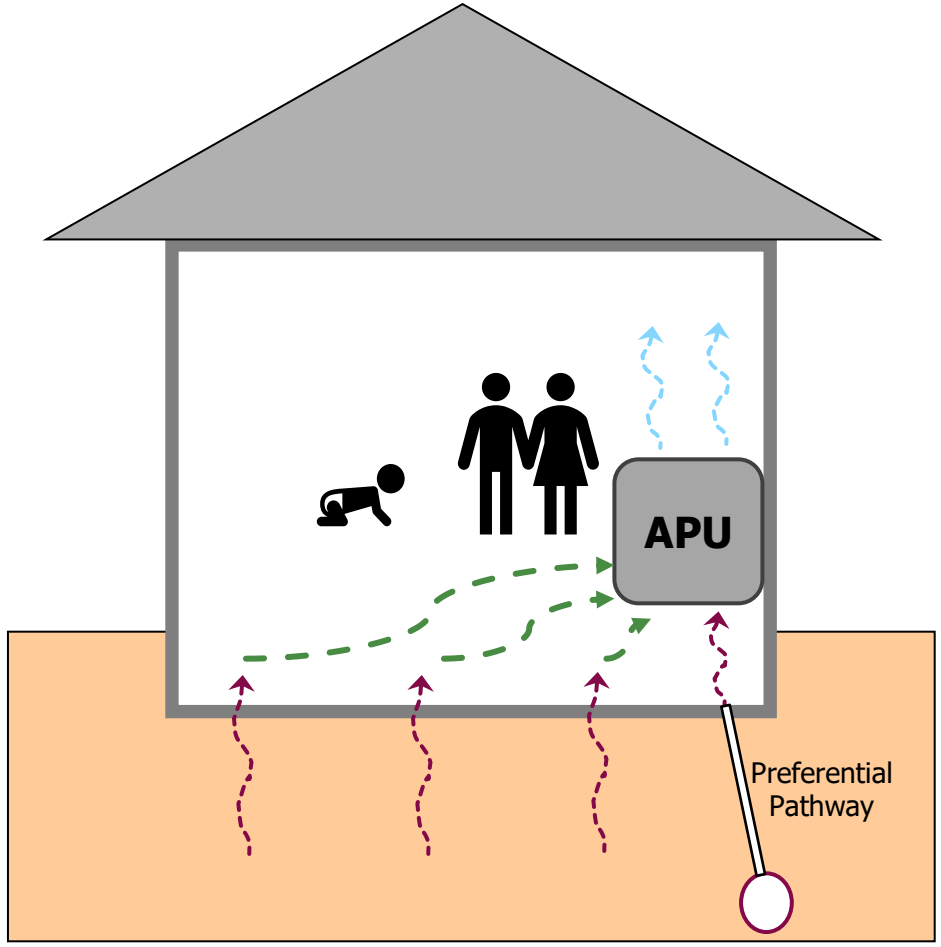
    and soil vapor entry rate and location



Source: Barr Engineering, 2020. Used with permission.

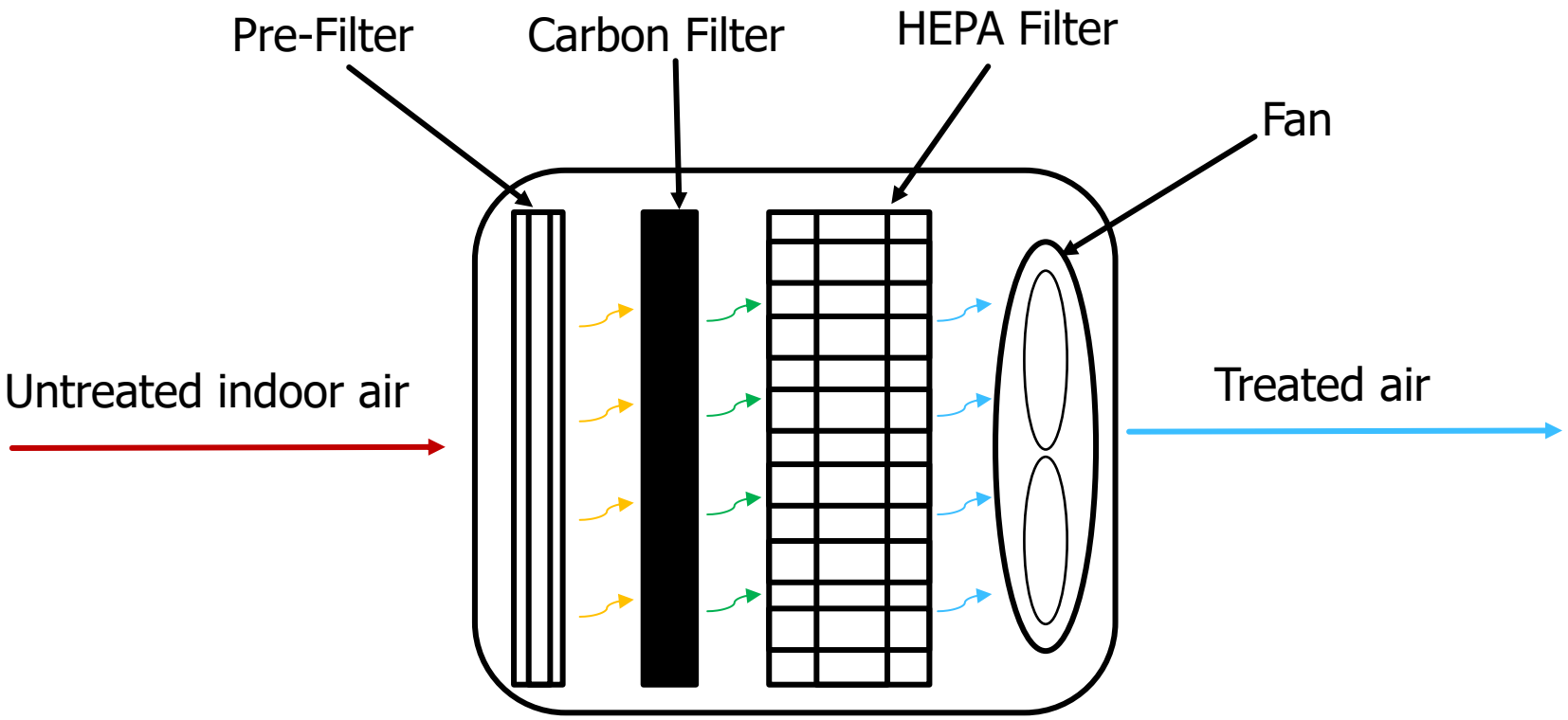
Tech Sheet – Indoor Air Treatment – Overview

- Implemented via air purifying units (APUs)
- Treats air inside building through circulation & filtration
- Section & size based on target VFCs and size of space to be treated
- Subject to human interference
- Must be sized correctly
- Follow-up verification testing/performance monitoring may be warranted
- Types of APUs include adsorption-based, photocatalytic oxidation, ozone generating, or chemisorption



Source: Barr Engineering, 2020. Used with permission.

Tech Sheet – Indoor Air Treatment – Components



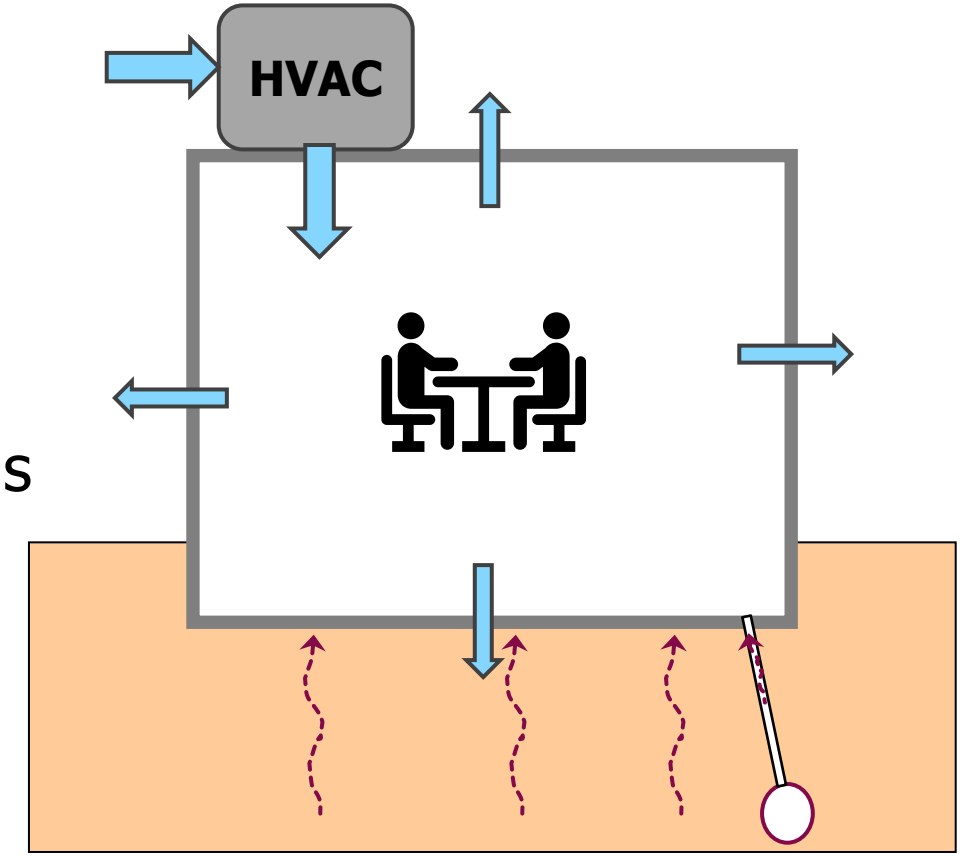
Example adsorption-based APU

Source: Sanborn, Head & Associates, 2021. Used with permission.

Figure 1. Indoor Air Treatment Technology Information Sheet.
Sources: Jacobs Engineering Group, U.S. Navy, used with permission.

Tech Sheet – HVAC Modification – Overview

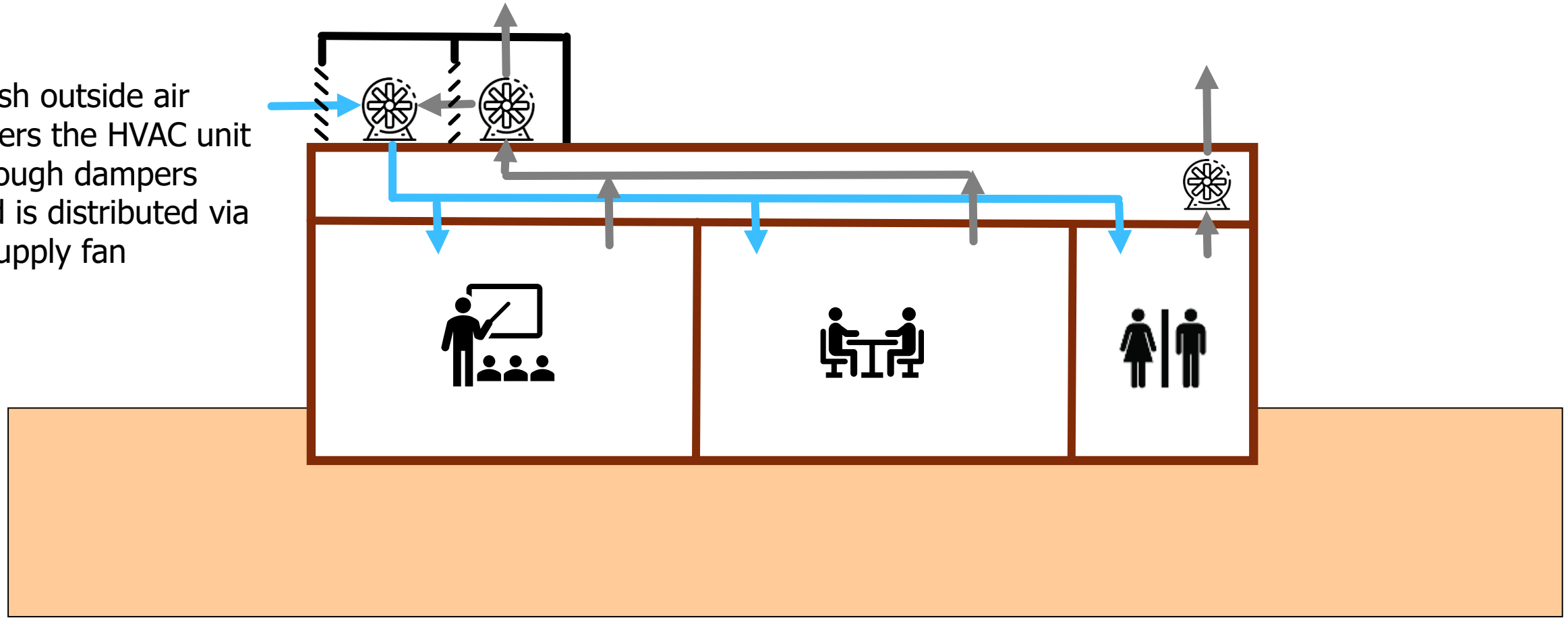
- Increase air exchange rate
- Increase building pressure
- Can supplement other mitigation methods
- Most suitable for commercial/industrial buildings
- Building-specific



Source: Sanborn, Head & Associates, 2020. Used with permission.

Tech Sheet – HVAC Modification – Components

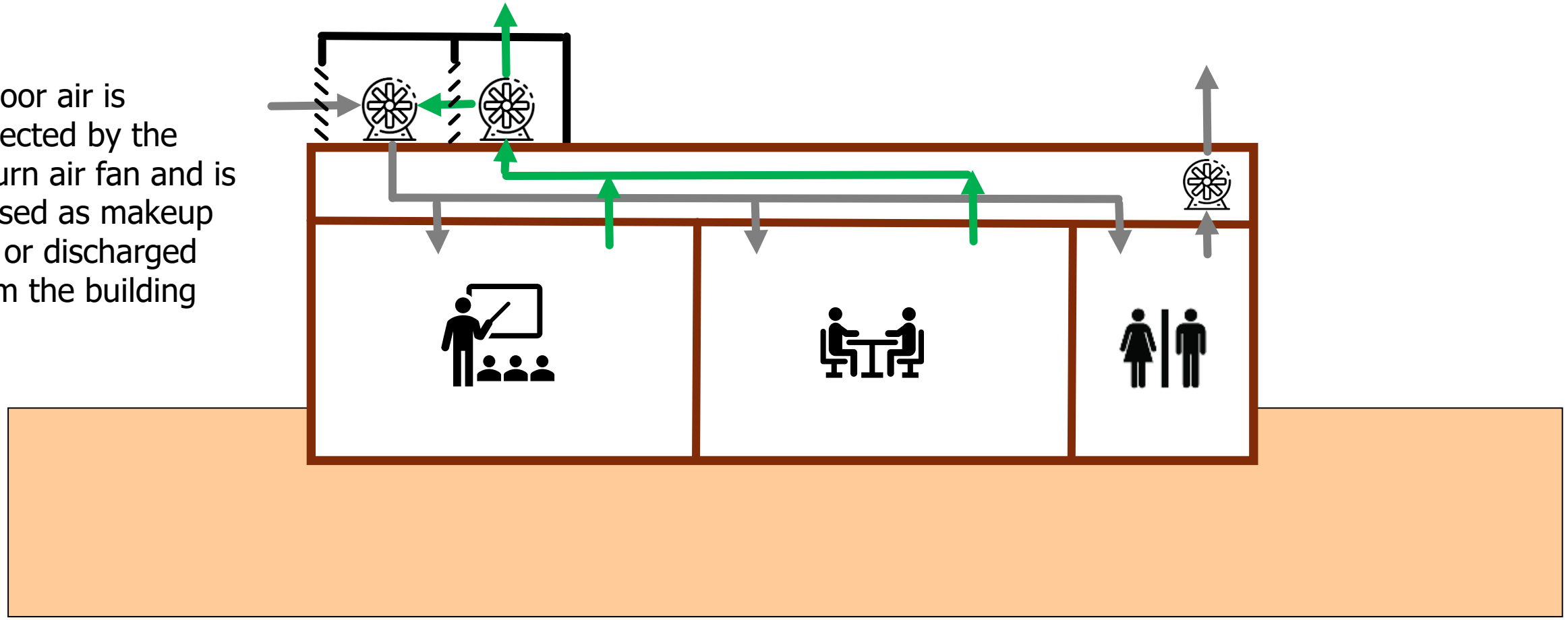
Fresh outside air enters the HVAC unit through dampers and is distributed via a supply fan



Source: Sanborn, Head & Associates, 2020. Used with permission.

Tech Sheet – HVAC Modification – Components

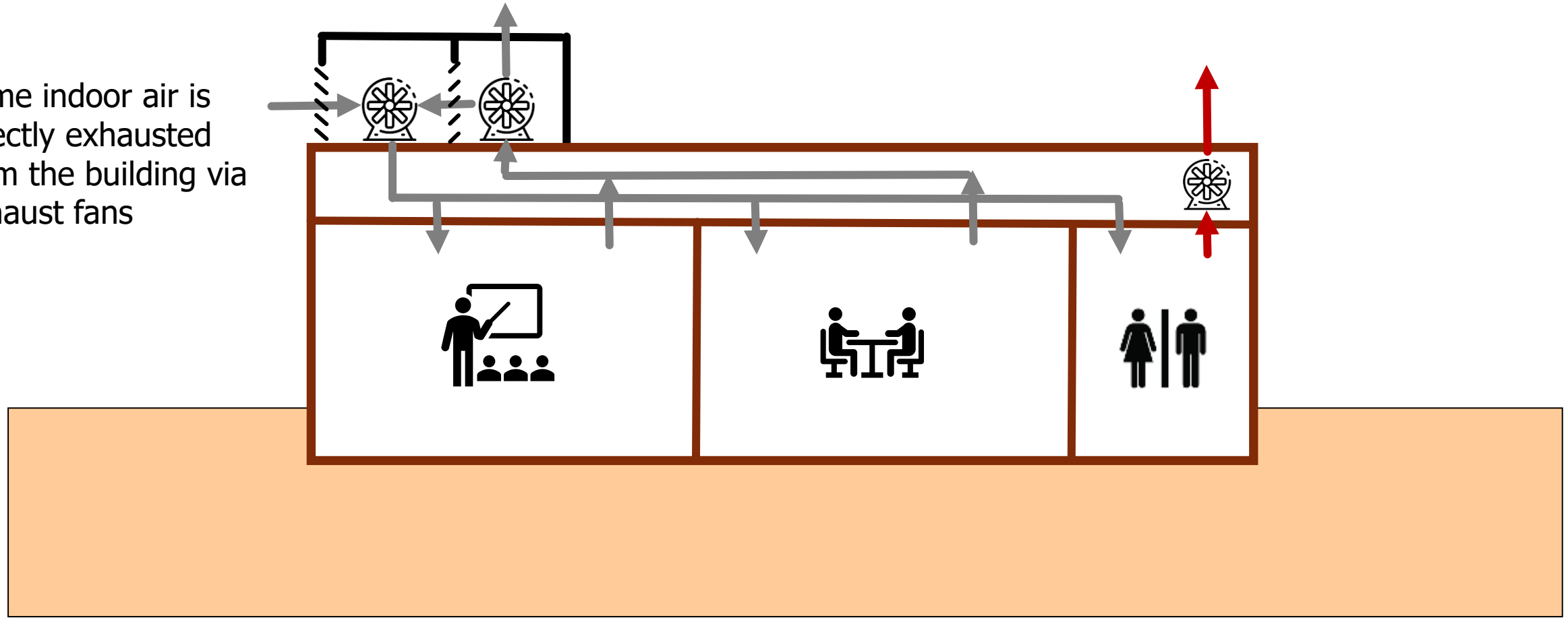
Indoor air is collected by the return air fan and is reused as makeup air, or discharged from the building



Source: Sanborn, Head & Associates, 2020. Used with permission.

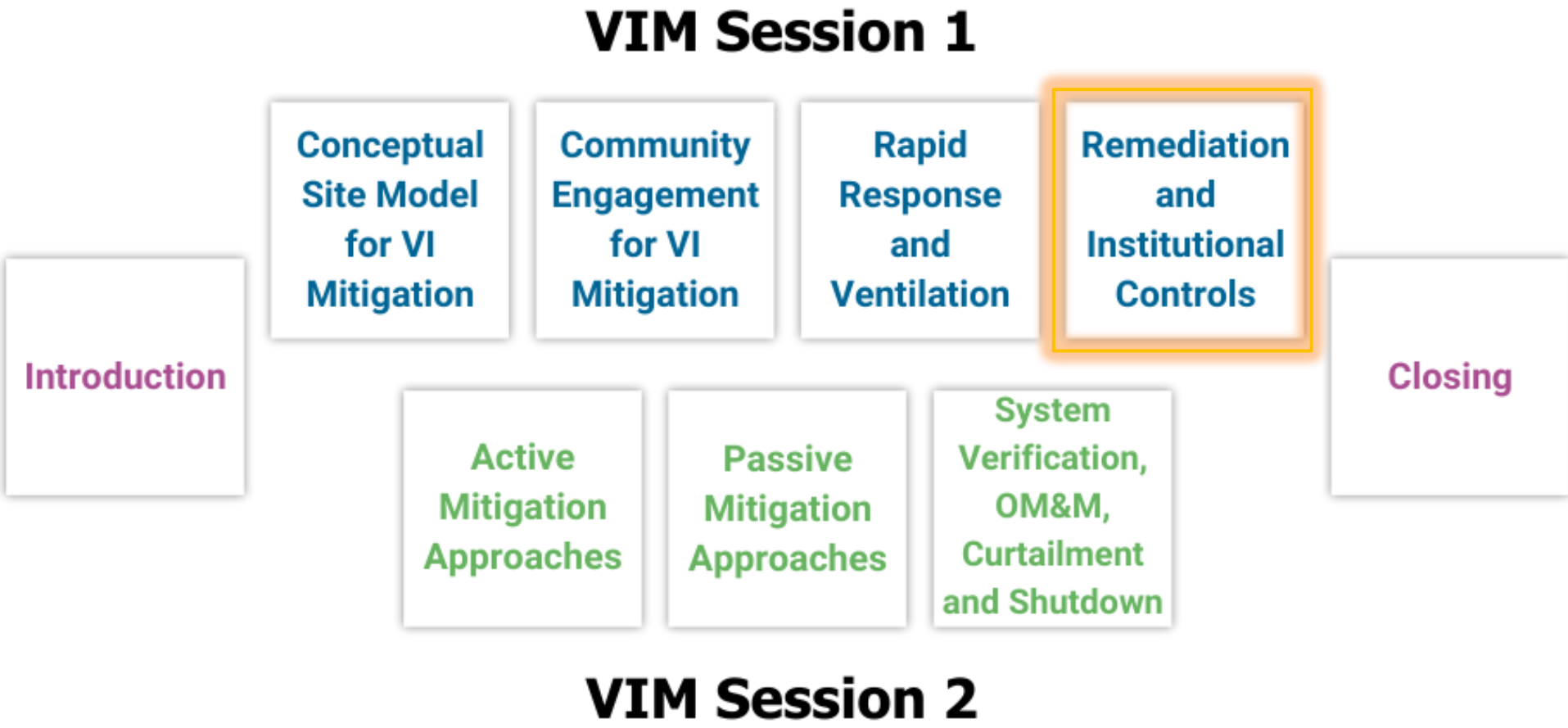
Tech Sheet – HVAC Modification – Components

Some indoor air is directly exhausted from the building via exhaust fans



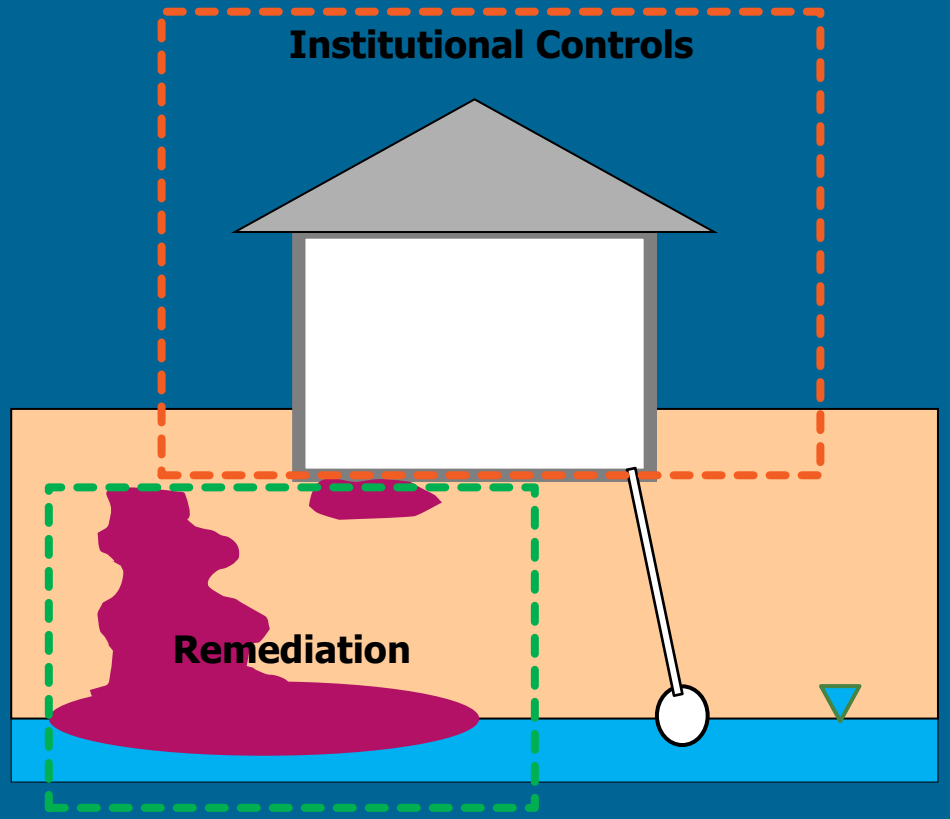
Source: Sanborn, Head & Associates, 2020. Used with permission.

Coming Up Next…



Remediation & Institutional Controls

- Difference between remediation and mitigation
- Description of two soil vapor remediation methods that address vapor intrusion (VI)
- Introduction to institutional controls (IC)

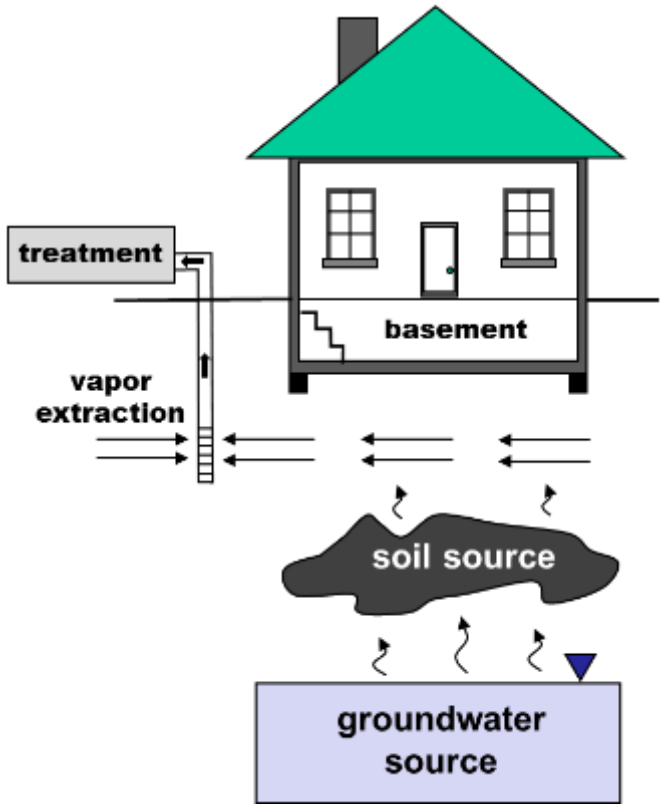


Source: Geosyntec & GSI Environmental, 2020. Used with permission.

Remediation vs. Mitigation

REMEDIATION

- Reduce mass in the source medium: soil, groundwater, or free phase
- May include preventing exposure
- Site-wide
- Longer-term installation (i.e., months)

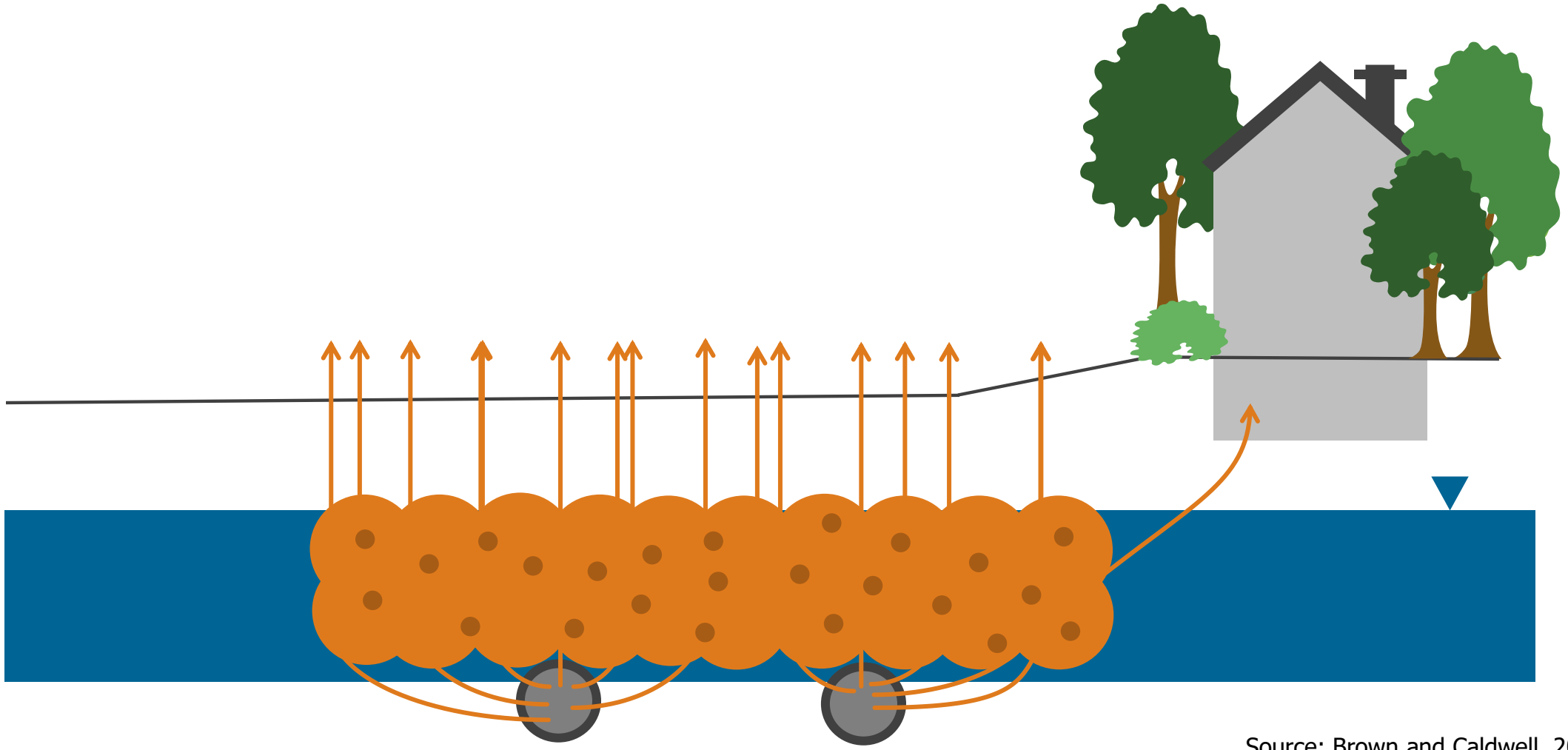


MITIGATION

- Limit or prevent exposure at some point along the VI pathway
- May provide limited remediation benefit
- Building-specific
- Shorter-term installation, (i.e., weeks)

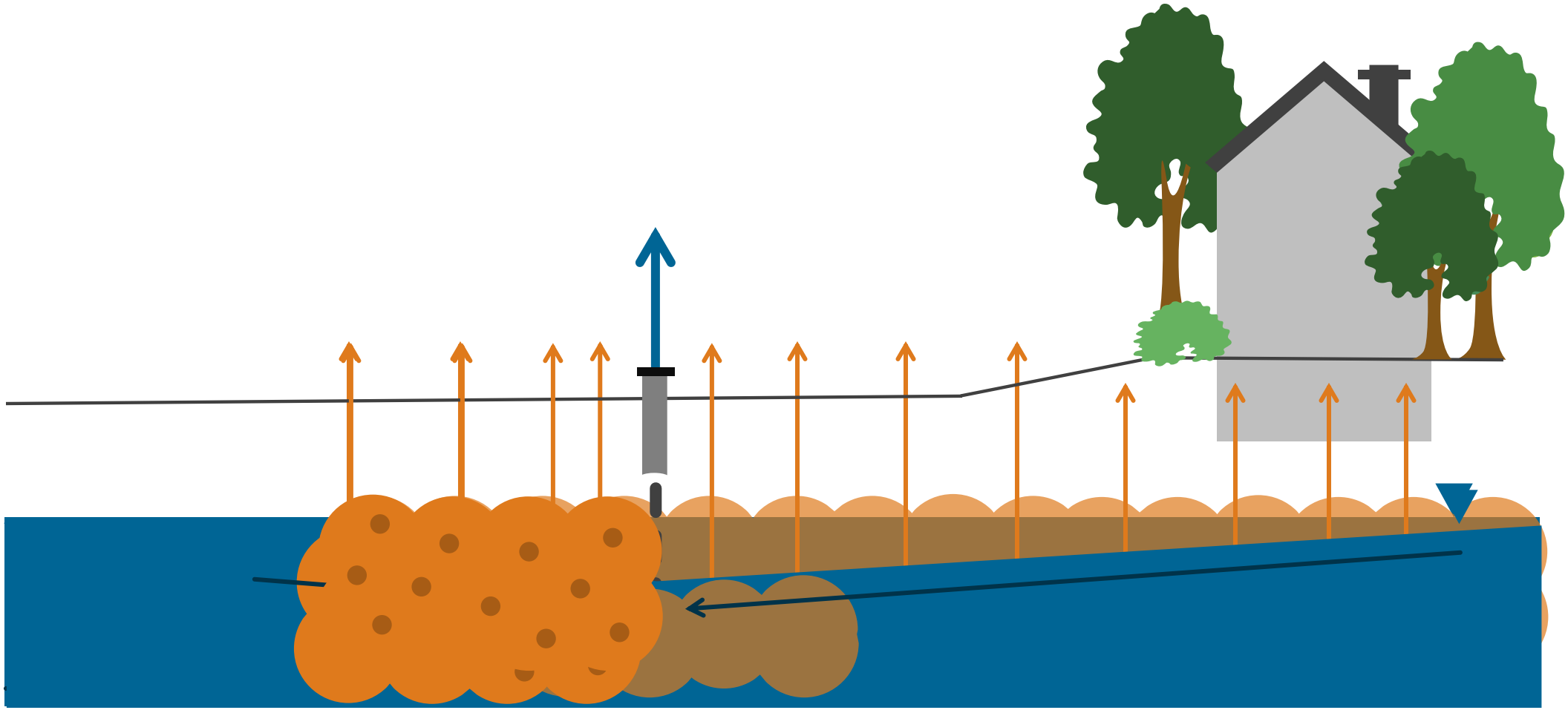
Source: Shell Global Solutions (US) Inc.
Used with permission.

Remediation – Adverse Effect on VI



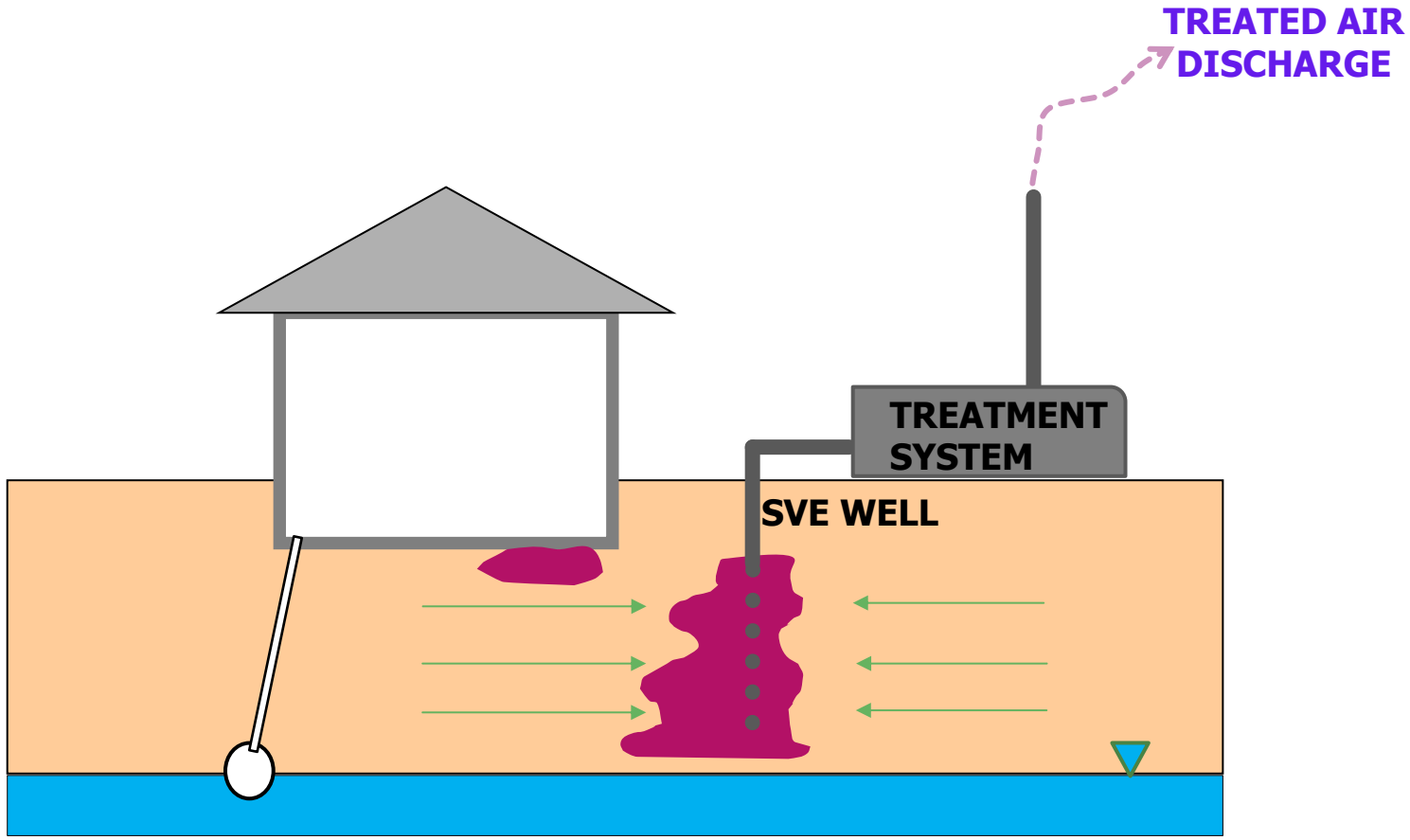
Source: Brown and Caldwell, 2025.
Used with permission.

Remediation – Beneficial Effect



Source: Brown and Caldwell, 2025. Used with permission.

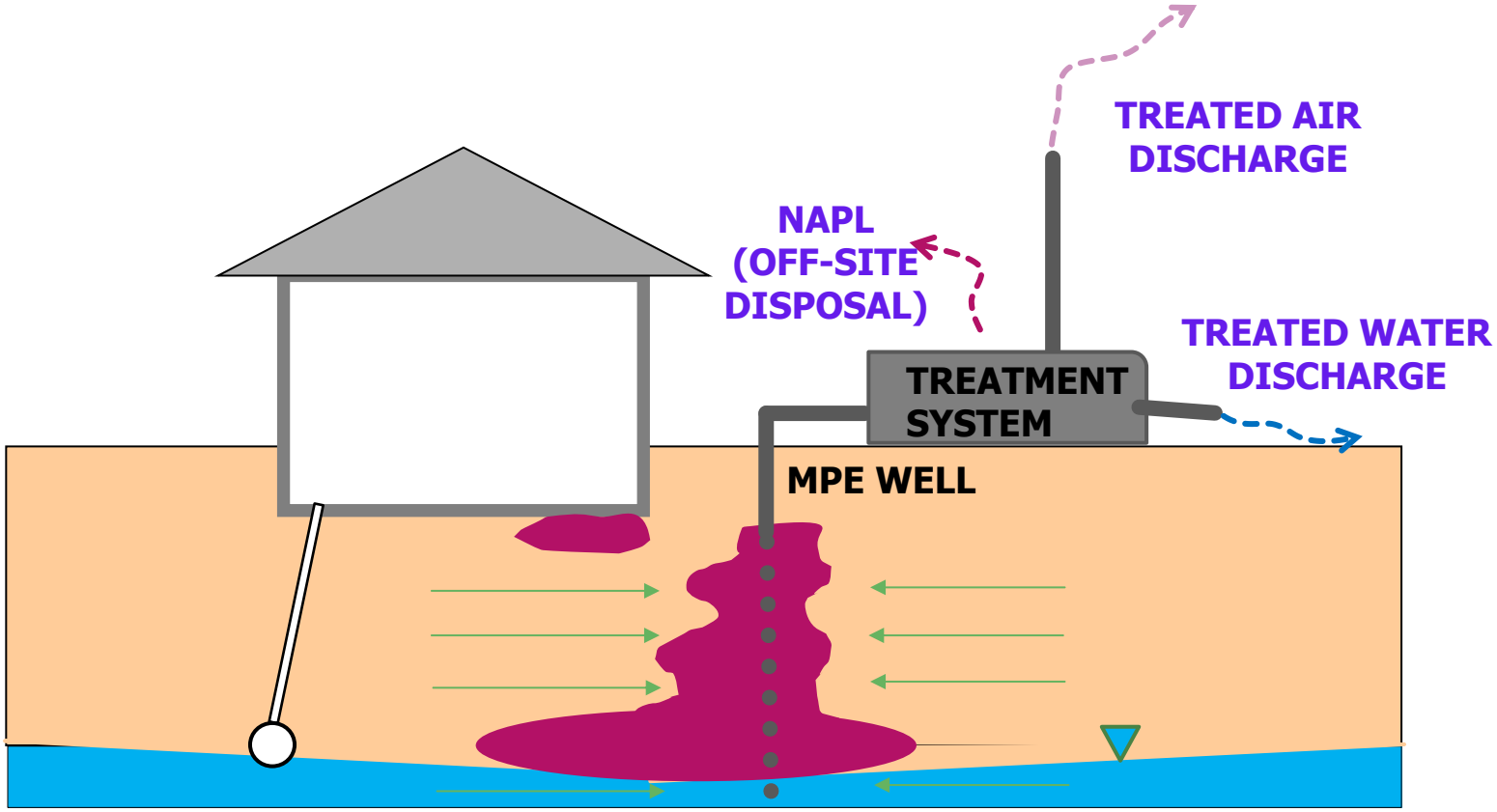
Tech Sheet – Soil Vapor Extraction (SVE)



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

- Targets only the vadose zone
- Intercepts soil vapors
- Creates downward pressure gradient across the building slab, providing VIM
- Remediation exit strategy typically based on achieving target soil concentrations. VIM strategy may be different.

Tech Sheet – Multi-phase Extraction (MPE)



Source: Geosyntec & GSI Environmental, 2020. Used with permission.

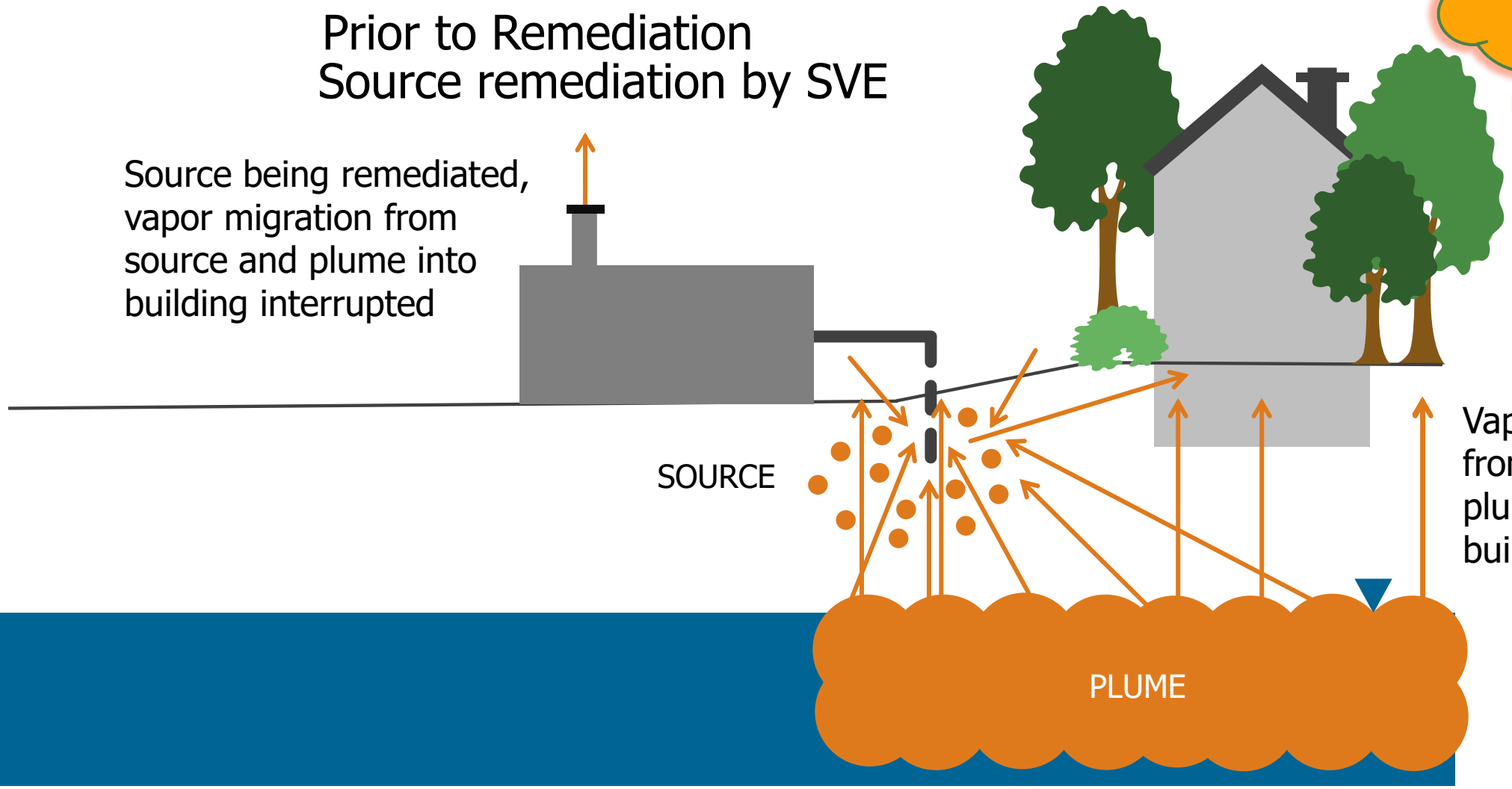
- Targets vadose zone *and* saturated zone
- Intercepts soil vapors and withdraws water/free product (if present)
- Performance not linked to vadose zone thickness

Knowledge Check – Remediation by SVE

Check In!

Prior to Remediation
Source remediation by SVE

Source being remediated, vapor migration from source and plume into building interrupted

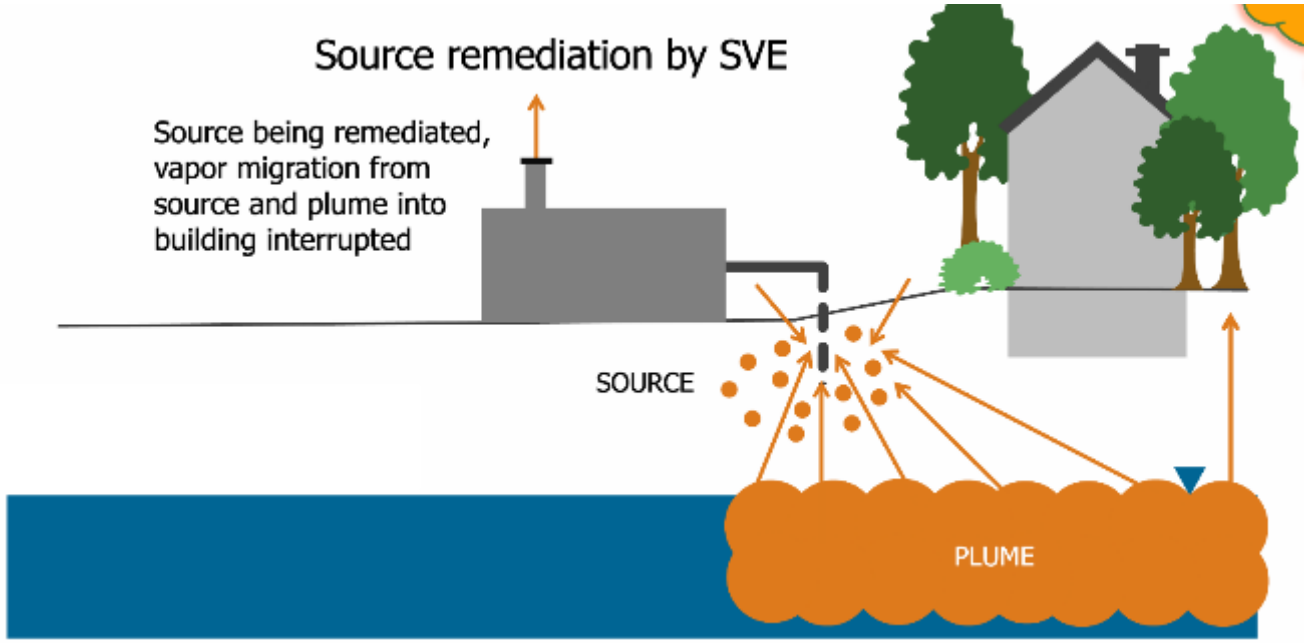


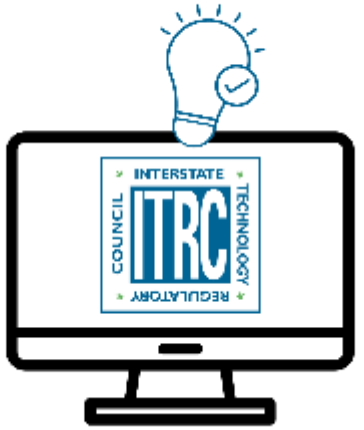
Vapor migration from source and plume into building

Knowledge Check – Remediation by SVE

Can this approach guarantee permanent VI mitigation for the building?

- Yes
- No





Knowledge Check – Remediation by SVE

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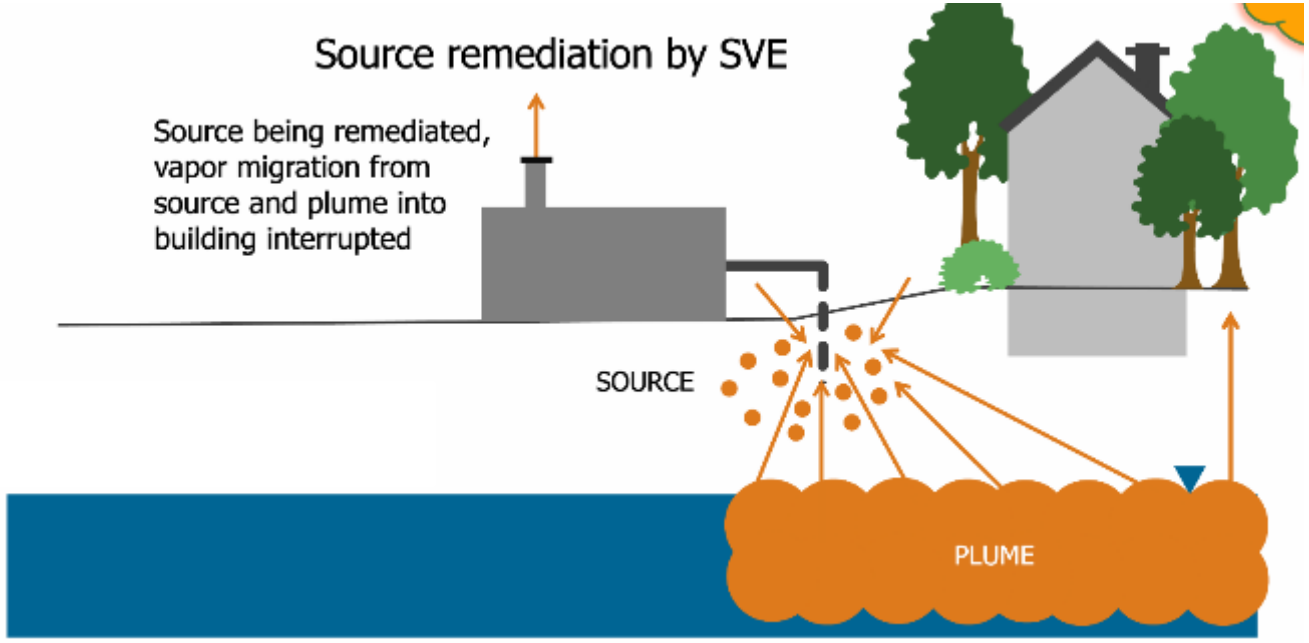
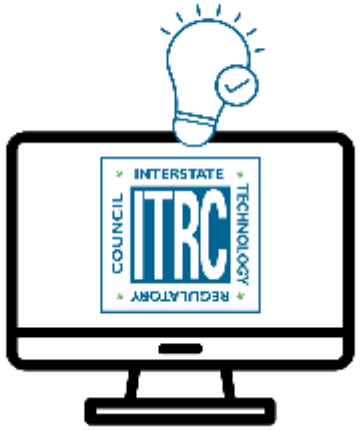




Tech Sheet – Institutional Controls (IC)

Long-term administrative or legal measures that provide:

- Protection from exposure to contaminants
- Assurance that VI mitigation system will be maintained

Applied alone or in combination with other remedies

Government controls: Zoning ordinances, groundwater use or drilling limitations, land development regulations, etc.

Proprietary controls: Private agreement between landowner and outside party that "run with the land"

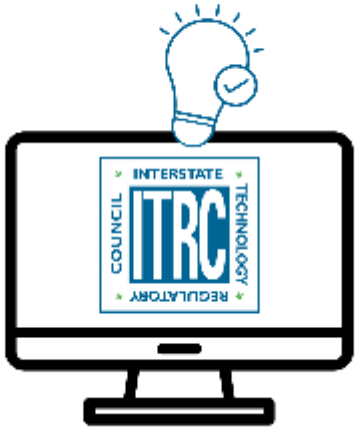
Enforcement mechanisms: Government agency-issued permits, administrative orders, etc.

Informational devices: Provide information about risks from site COCs

Knowledge Check – Type of IC

You are a developer planning a construction of an apartment building. An investigation determines that there is a VI risk at the site. You find out that state regulations require that VIM be implemented for all occupied buildings where the risk of VI is documented. Which type of IC is it?

A. Government control
B. Proprietary control
C. Enforcement mechanism
D. Informational device



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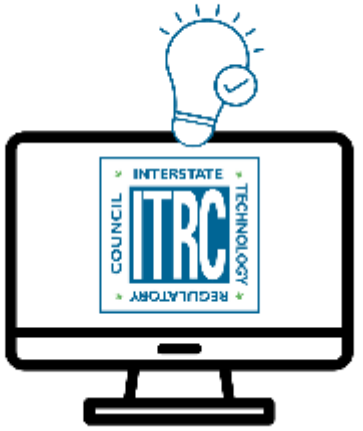


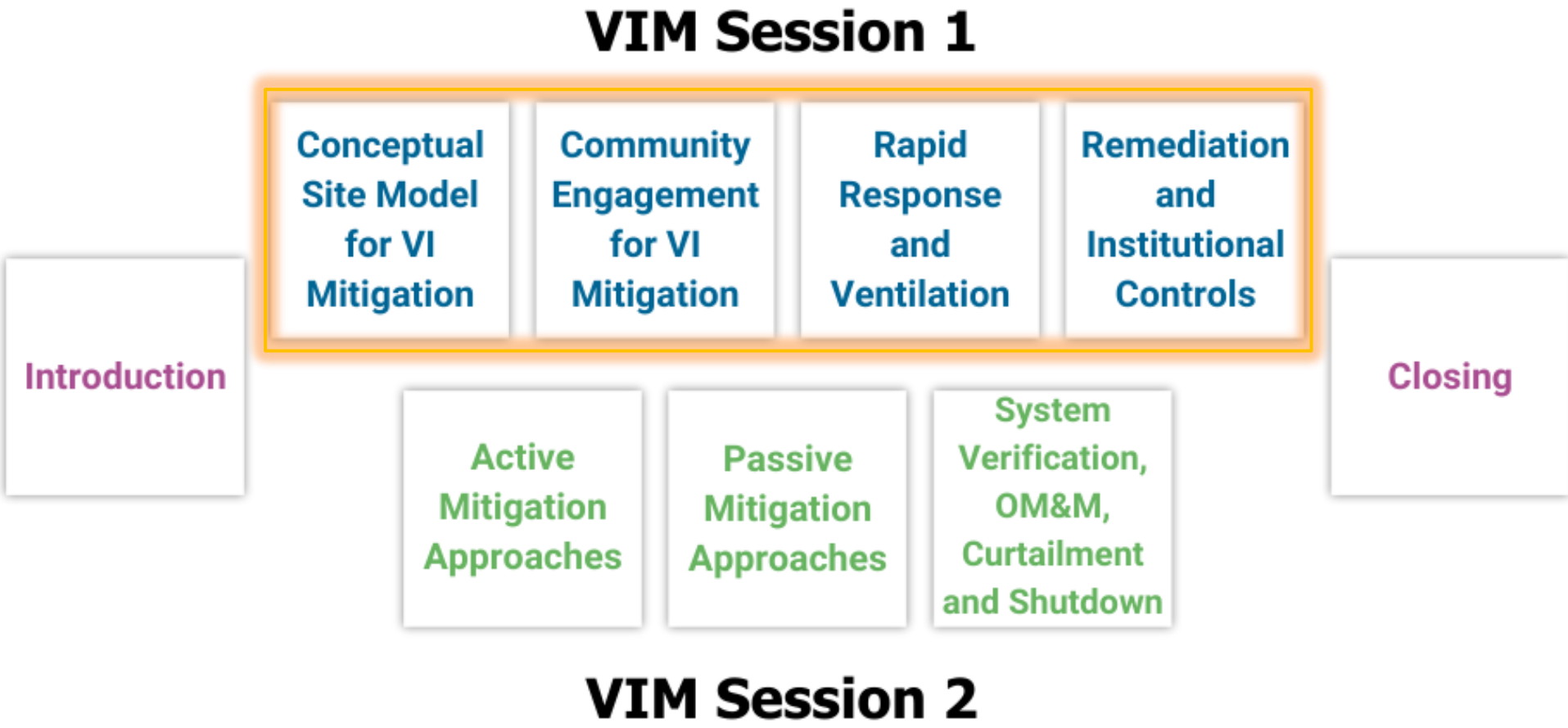
Additional Resources

"Soil Vapor Extraction and Bioventing" (US Army Corps of Engineers, EM 1110-1-4001, 3 June 2002)

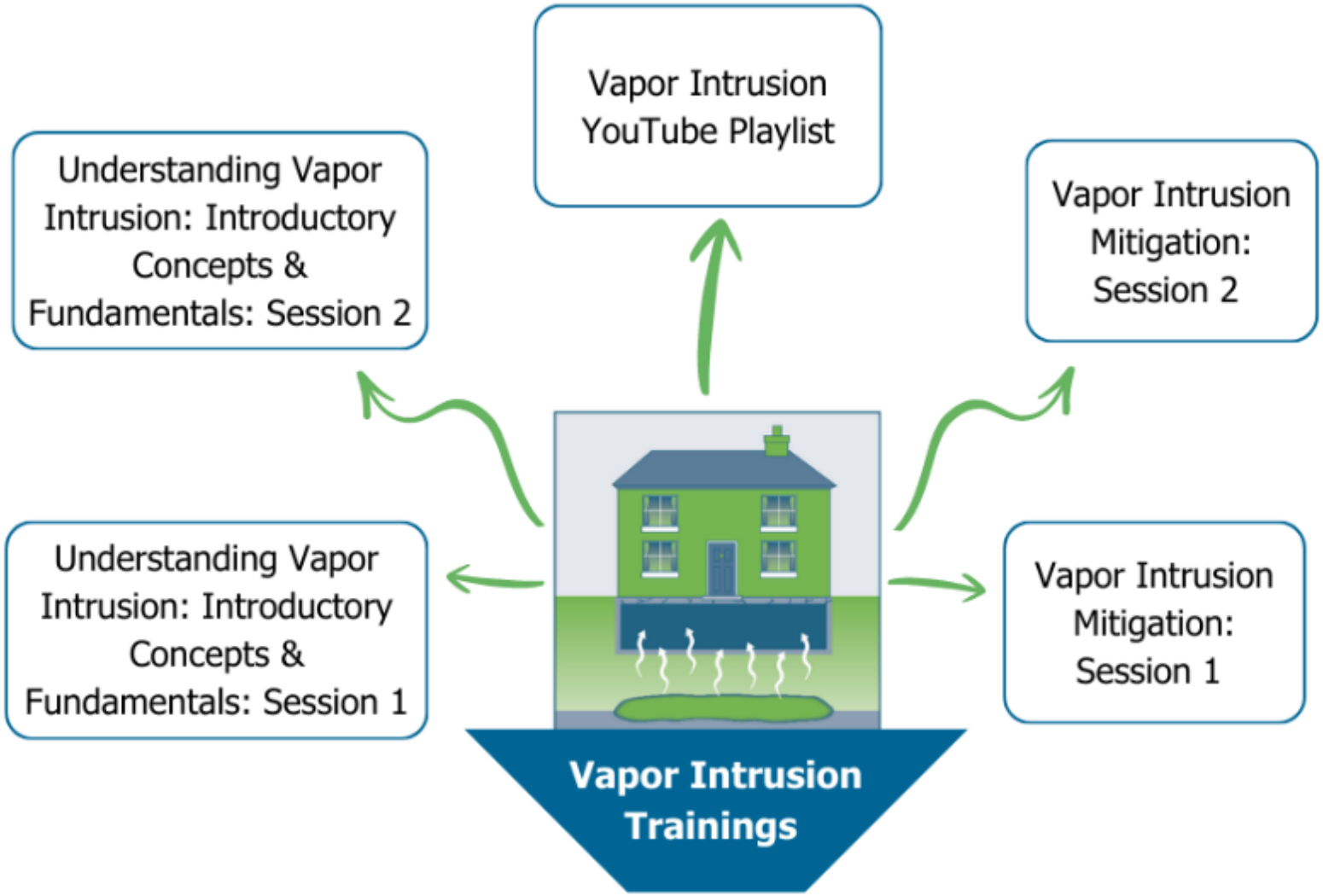
"Multi-Phase Extraction" (US Army Corps of Engineers, EM 1110-1-4010, 1 June 1999)

"Long Term Management Using Institutional Controls" (ITRC, IC-1, 2016)

Future Training Topics – Session 2



2026 Vapor Intrusion Trainings



Feedback Form & Certificate of Completion:

https://clu-in.org/conf/itrc/VIM-1/feedback.cfm

Vapor Intrusion Mitigation Training:

https://clu-in.org/conf/itrc/vim-1