ASSOCIATION OF VAPOR INTRUSION PROFESSIONALS

What's Beneath Matters: Vapor Intrusion, AVIP and New ITRC Insights

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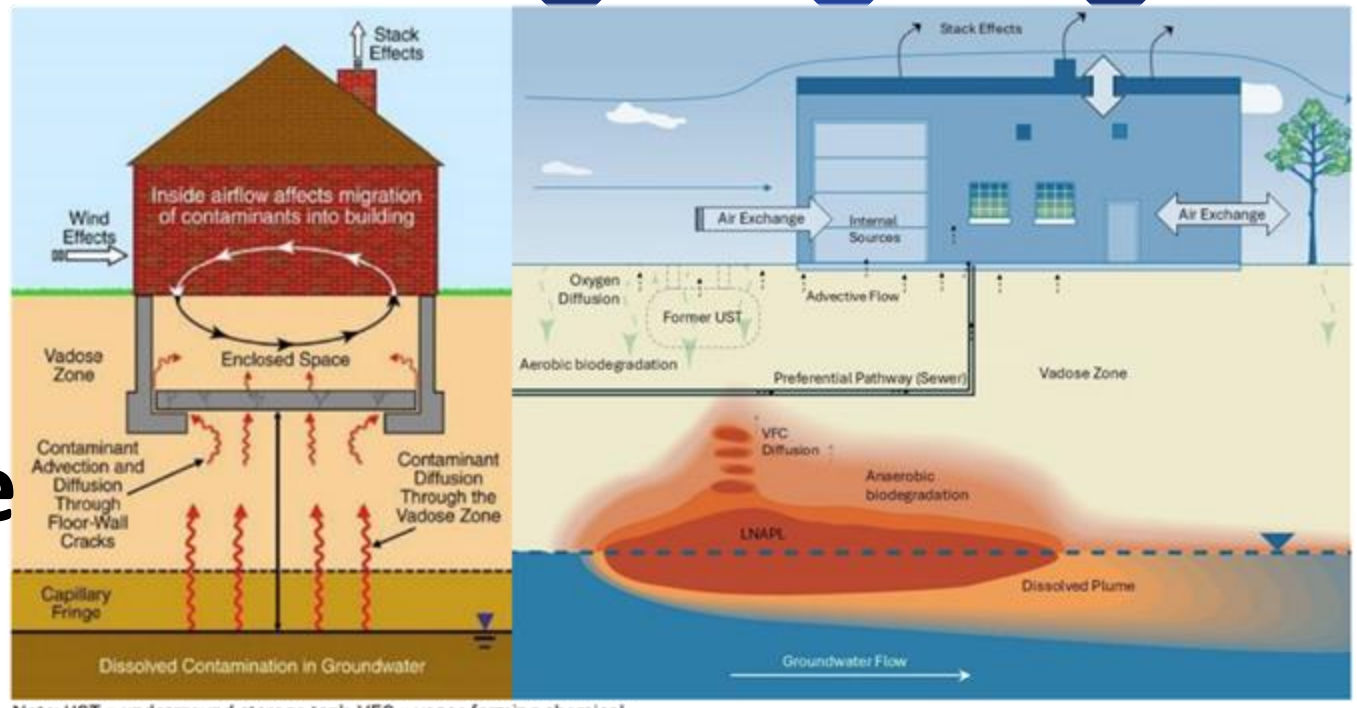
Agenda

- Vapor Intrusion in Practice Why This Matters
- Session Objectives
- Interstate Technology & Regulatory Council (ITRC)
- Association of Vapor Intrusion Professionals (AVIP)
- Concptual Site Model (CSM)
- Multiple Lines of Evidence (MLE)
- Direct Volatilization and Preferential Pathways (i.e. conduits)
- Keys to Success

- Vapor intrusion remains a high-uncertainty pathway
  - Low screening levels and high sensitivity
- Rising and growing expectations for defensibility and consistency
- Gap between guidance and implementation
- Science and methods are evolving faster than implementation
- Hard to develop a “generic” playbook
  - Standardize approaches are often overly simplified
  - Always caveats and exceptions

Vapor Intrusion in Practice
Why This Matters



Note: UST = underground storage tank, VFC = vapor-forming chemical.

Session Objectives

- Introduce Interstate Technology & Regulatory Council (ITRC) Vapor Intrusion Toolkit (2026)
- Identify how the Association of Vapor Intrusion Professionals (AVIP) fits in
- Strengthen Conceptual Site Model (CSM) based decisions
- Improve Multiple Lines of Evidence (MLE) integration
- Discuss Conduits and Direct Volatilization
- Show how it all fits with regulatory implementation

Focused on developing tools and strategies to reduce barriers to the deployment of innovative environmental technologies

Membership from state, federal, tribal, and international government agencies, academia, private sector, and the public stakeholders

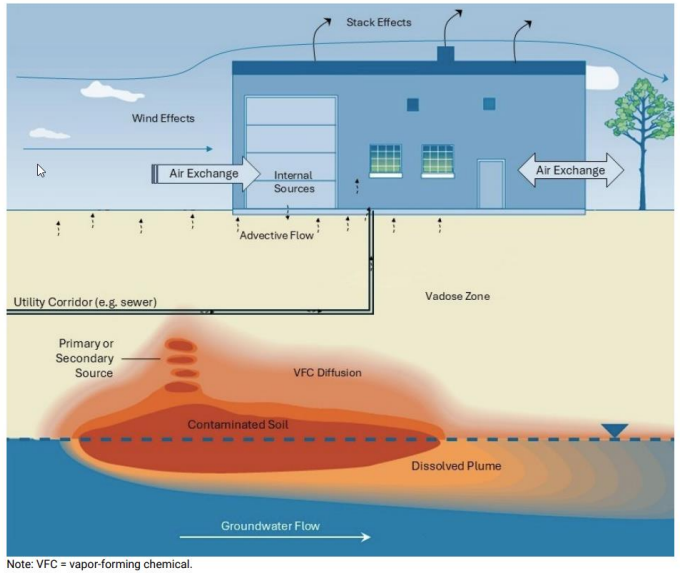
https://itrcweb.org/

Interstate Technology and Regulatory Council

ITRC Vapor Intrusion Toolkit (2026)

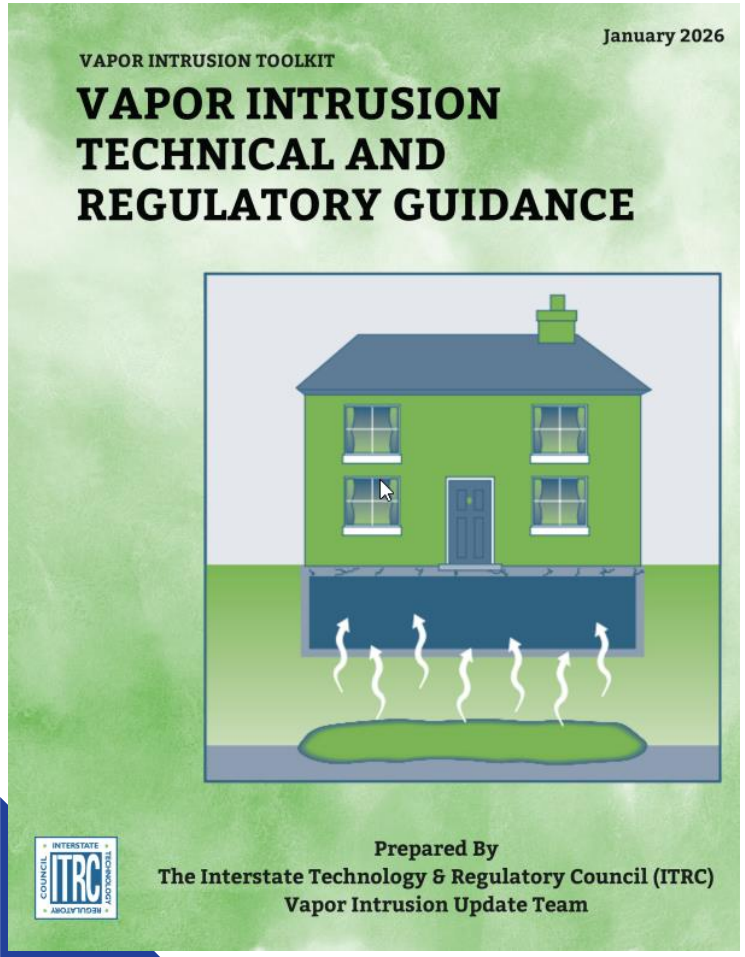
- Purpose & Scope
  - Comprehensive, consensus-based resource for evaluating and managing vapor intrusion (VI)
  - Integrates latest science, field practices, and regulatory approaches
  - Designed for regulators, consultants, responsible parties, and stakeholders
  - Provides a decision-making framework across a wide range of site conditions
- Key Update and replaces and consolidates three prior ITRC guidance documents VI-1 (2007), PVI-1 (2014), and VIM-1 (2021)
- Represents the current state of practice for vapor intrusion
- Overall Takeaway - A one-stop, modernized toolkit that standardizes VI practice
- Moves the field toward data-driven, CSM-based, and evidence-weighted decisions

- **Technical Approach / Themes**
  - Emphasizes multiple lines of evidence (MLE) for decision-making
  - Strong focus on Conceptual Site Model (CSM) development and refinement
  - Addresses both chlorinated VI and petroleum VI (PVI)
- **Mitigation & Management**
  - Covers full lifecycle:
    - Screening, Investigation, Mitigation, O&M, and Closure
  - Includes guidance on:
    - Active and passive mitigation systems
    - Design, installation, and post-installation verification
    - Long-term operation, maintenance, and monitoring (OM&M)



Note: VFC = vapor-forming chemical.

ITRC Vapor Intrusion Toolkit (2026)



- **Technical & Regulatory Guidance**
  - ~11 chapters + appendices
  - Covers investigation, risk assessment, and mitigation decision-making
- **Fact Sheets (36)**
  - Focused topics (e.g., attenuation factors, preferential pathways, PFAS VI, CSMs)
  - Practical explanations and common pitfalls
- **Technology Information Sheets (17)**
  - Overview of mitigation technologies (e.g., SSD, membranes, HVAC modifications)
- **Checklists (7)**
  - Structured tools for:
    - Sampling
    - Mitigation design
    - O&M and verification
  - Intended to support consistent decisions and documentation
- **Training Resources**

ITRC Vapor Intrusion Toolkit

www.vaporintrusion.org

Association of Vapor Intrusion Professionals (AVIP)

- About AVIP
  - AVIP is a nonprofit professional organization focused exclusively on vapor intrusion (VI)
  - Mission: advance the science, practice, and communication of vapor intrusion
  - Brings together regulators, consultants, academics, and industry professionals
  - Emphasizes practical, field-applicable guidance and collaboration
- Bridges guidance and practice
- Focus on real-world application
- Supports professional judgment

AVIP
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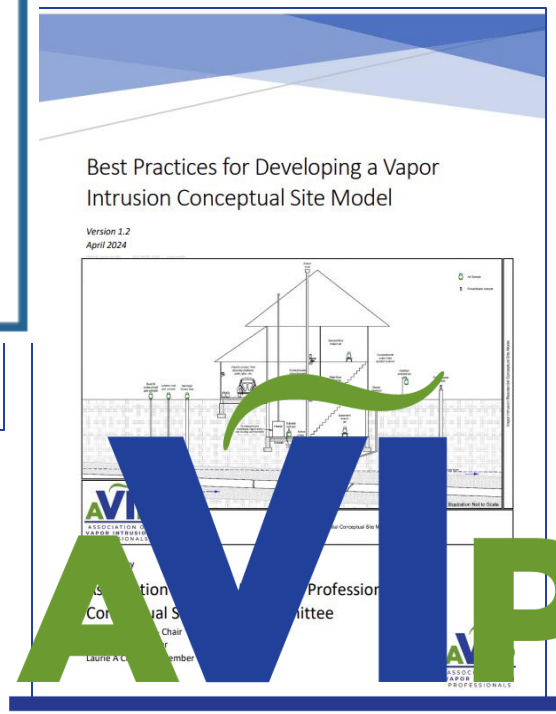
- Development of Guidance & Technical Resources
  - Best practice documents
  - Technical briefs
  - Practice-focused tools
- Aims to fill gaps between high-level guidance and implementation
- Conferences & Events
- Hosts technical workshops and conferences
- Provides a platform for cross-state and cross-discipline dialogue
- Complements resources like the Interstate Technology & Regulatory Council VI Toolkit

ITRC (i.e. rulebook) vs AVIP (ie. playbook)

ITRC

- Best for:
  - Regulators
  - Standardization
  - Training and communication
- Strengths:
  - Consistent framework
  - Flexible application
  - Broad usability



AVIP

- Bottom-Line Summary
- Best for:
  - Practitioners
  - Complex sites
  - Decision-making and design
- Strengths:
  - Detailed
  - Mechanistic
  - Directly actionable

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Conceptual Site Model (CSM)

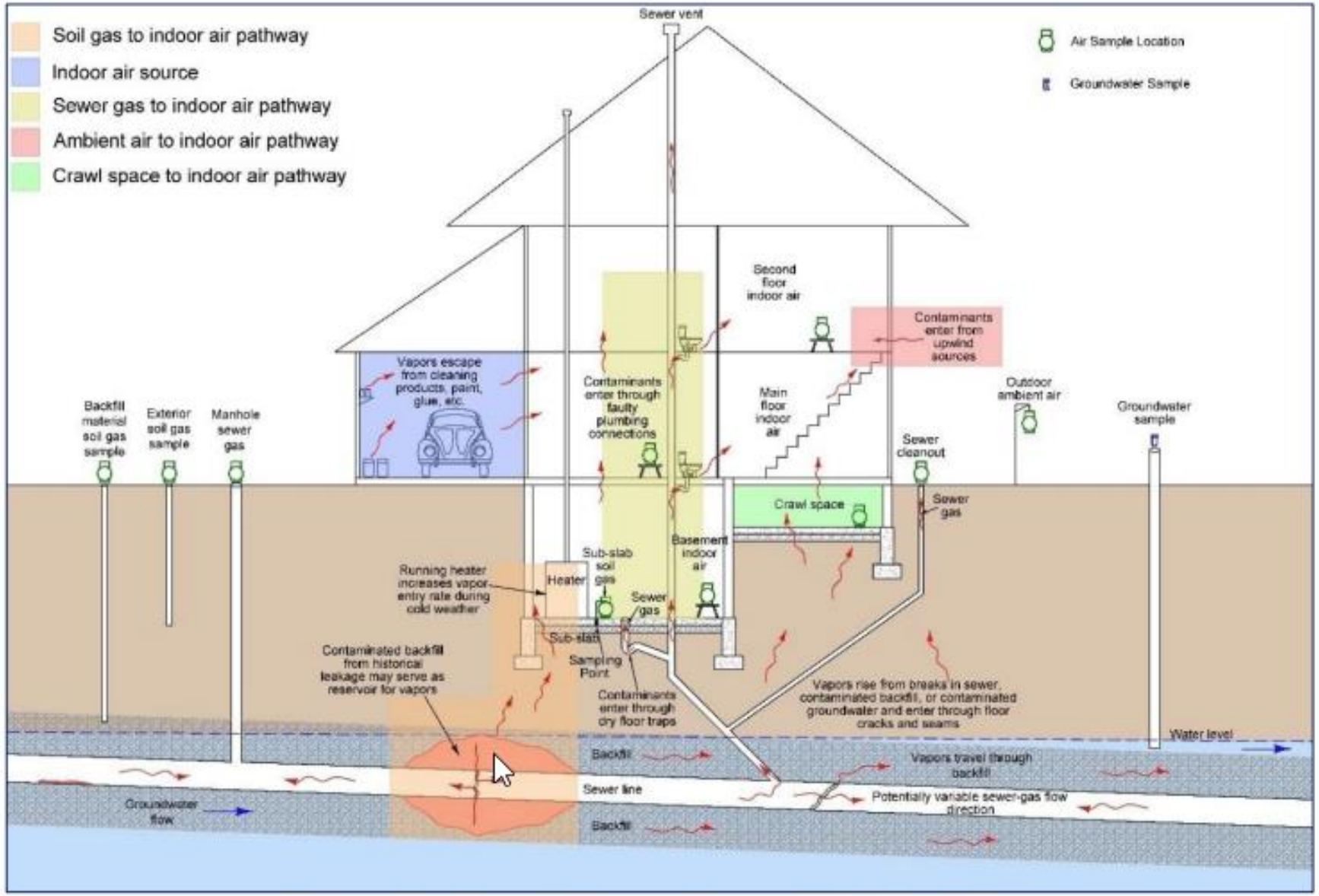


Figure 4-1. Example conceptual site model components displayed graphically.

- Defines sources, pathways, receptors
- Drives sampling design
- Supports decision-making
- First impression of the site

What Makes a Good CSM?

- **Integration of Data**: Integrates data from multiple sources
- **2D and 3D Depictions**: 2D maps, cross sections, and 3D models that allow for efficient visualization
- **Iterative Development:** Meaning it is developed through a process of refinement and validation as new data becomes available or conditions change.
- **Effective Communication:** CSMs serve as tools for communication, helping to convey complex data in a format that is accessible and easy to interpret.
- **Guides action:** A well-structured CSM can guide efforts by providing a clear understanding of what is being discussed

By incorporating these best practices, a CSM can become a powerful tool for understanding contaminated sites and guiding effective remediation strategies.

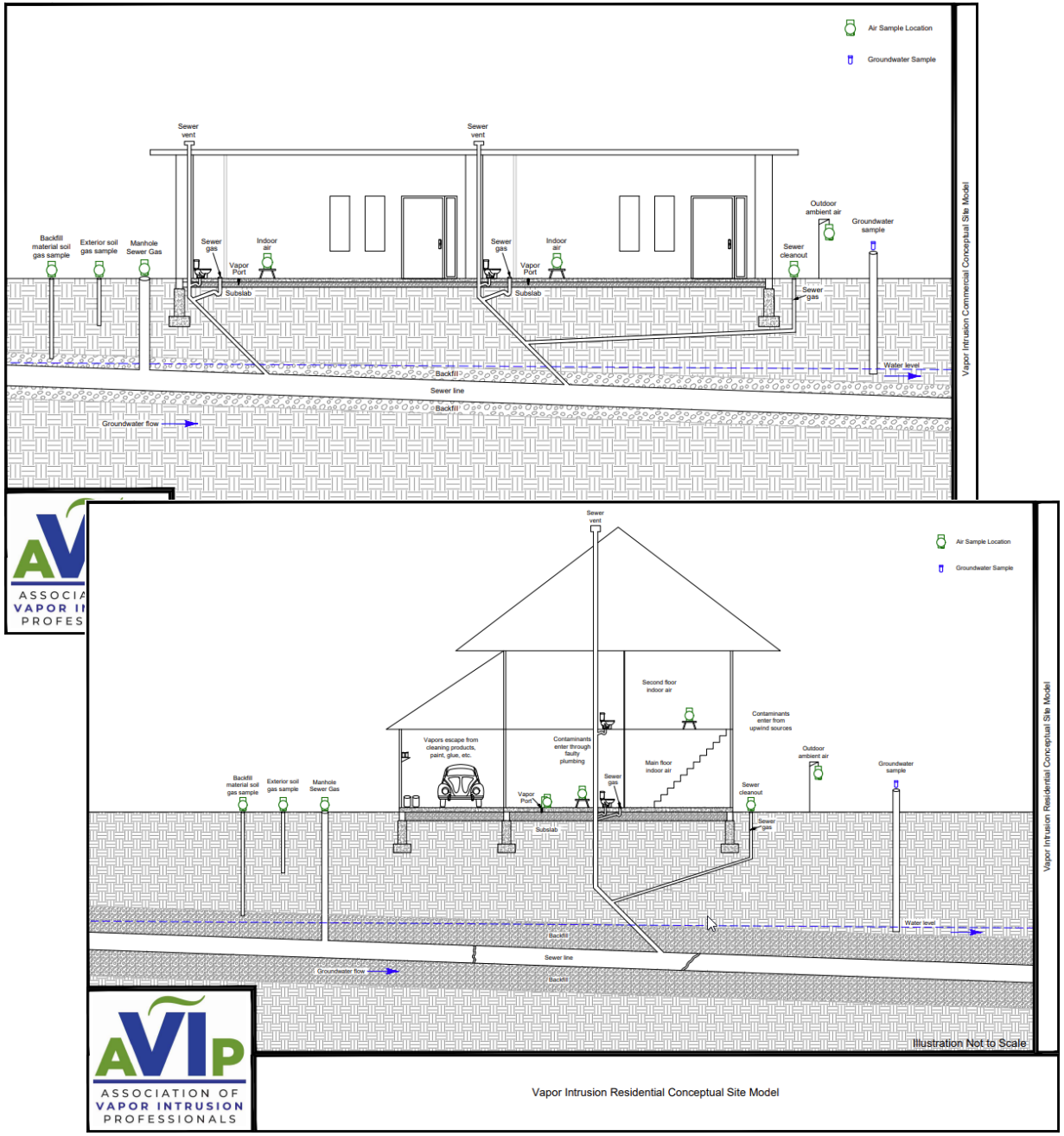
CSM Don’ts

- Don’t make it hard to review
  - Don’t leave data gaps unaddressed
  - Don’t make it too complex to communicate
- Don’t oversimplify the site
  - Don’t present only one interpretation when multiple are plausible
  - Don’t rely on a single line of evidence
- Don’t separate the CSM from decision-making
- Don’t rely on generic attenuation assumptions without site support
- Don’t ignore preferential pathways or shallow groundwater

Bottom Line

A strong CSM is:

- “Feels” like the site
- Multi-pathway (especially sewers/utilities)
- Explicit about uncertainty
- Built around multiple lines of evidence
- Directly tied to risk criteria and decisions
- There are resources that will help!



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Multiple Lines of Evidence (MLE)

- It is the process of supporting interpretations made about a site or building or supporting decisions proposed for a site or building
- No single dataset is sufficient – especially when the exceedance is close to the criteria
- Not all LOEs can be used on a site
- Reduces uncertainty, and improve defensibility
- Answer a specific question and understand the weaknesses of the information being presented
- **EVERY SITE** reviewer considers MLE – even if they don't know it

- **Step 1**: Choose a question you would like to answer
- **Step 2**: Pull applicable data, site information, and data
- **Step 3**: Take each LOE and determine whether it supports an answer to the target question or whether the data are inconclusive.
  - The answers can be yes, no, supporting, or neutral
- **Step 4**: Evaluate the uncertainty of each LOE and the relative degree of uncertainty
  - Not an actual degree
- **Step 5**: Evaluate the weighted importance of each LOE
- **Step 6**: Summarize results of the MLE
- **Step 7**: Make/propose a decision

MLE Framework

Common MLE Pitfalls

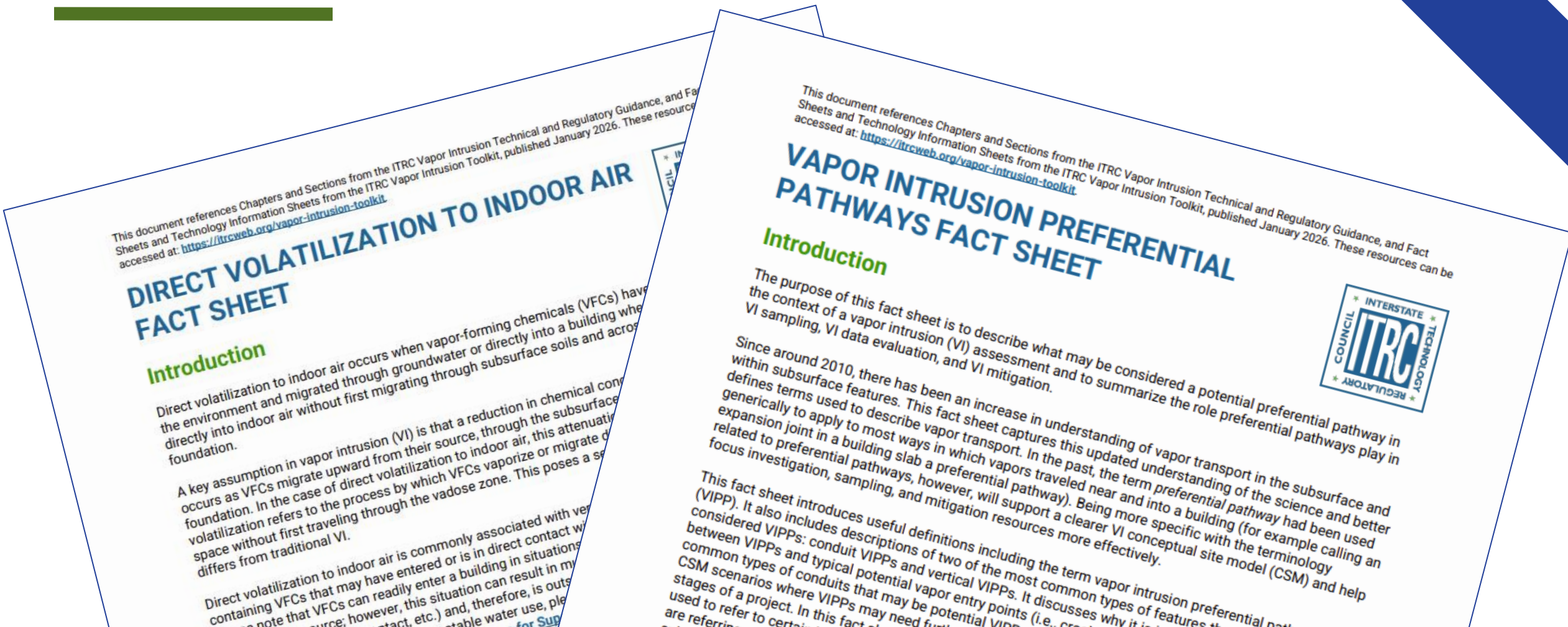
- Overweighting one line of evidence*
  - Treating all lines of evidence as equal quality
- Ignoring conflicting data instead of explaining it
- Failing to account for temporal variability
- Not incorporating preferential pathways
- Not tying MLE back to the CSM
- Poor data comparability
- Confirmation bias (“story-first” MLE)
  - Building the MLE argument to support a predetermined conclusion.
- Disconnect from decisions
  - Sometimes the MLE indicates a need for further investigation, especially when there is “sparse” data

Bottom Line

Strong MLE are:

- Transparent (explains conflicts and uncertainty)
- Weighted (not all data treated equally)
- Comprehensive (includes all relevant pathways, especially sewers/utilities)
- Time-aware (accounts for seasonal/building variability)
- Decision-focused (clearly supports next steps)

Direct Volatilization and Preferential Pathways (i.e. conduits)



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DIRECT VOLATILIZATION TO INDOOR AIR FACT SHEET

Introduction

Direct volatilization to indoor air occurs when vapor-forming chemicals (VFCs) have the environment and migrated through groundwater or directly into a building whe directly into indoor air without first migrating through subsurface soils and acros foundation.

A key assumption in vapor intrusion (VI) is that a reduction in chemical con occurs as VFCs migrate upward from their source, through the subsurface foundation. In the case of direct volatilization to indoor air, this attenuati volatilization refers to the process by which VFCs vaporize or migrate d space without first traveling through the vadose zone. This poses a s differs from traditional VI.

Direct volatilization to indoor air is commonly associated with ver containing VFCs that may have entered or is in direct contact wi e note that VFCs can readily enter a building in situations ource; however, this situation can result in m ntact, etc.) and, therefore, is outs table water use, ple for Sup

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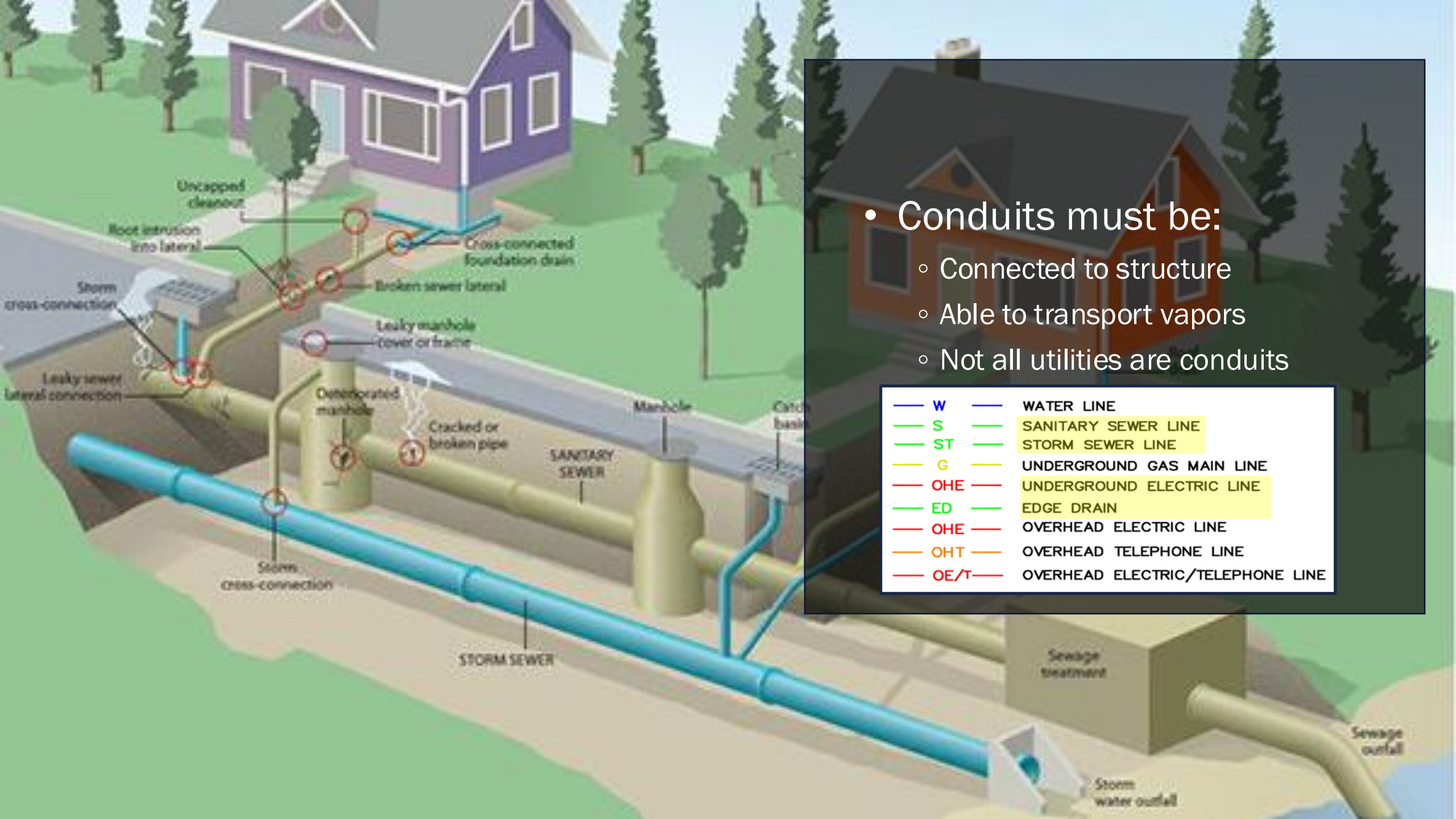
VAPOR INTRUSION PREFERENTIAL PATHWAYS FACT SHEET

Introduction

The purpose of this fact sheet is to describe what may be considered a potential preferential pathway in the context of a vapor intrusion (VI) assessment and to summarize the role preferential pathways play in VI sampling, VI data evaluation, and VI mitigation.

Since around 2010, there has been an increase in understanding of vapor transport in the subsurface and within subsurface features. This fact sheet captures this updated understanding of the science and better defines terms used to describe vapor transport. In the past, the term *preferential pathway* had been used generically to apply to most ways in which vapors traveled near and into a building (for example calling an expansion joint in a building slab a preferential pathway). Being more specific with the terminology related to preferential pathways, however, will support a clearer VI conceptual site model (CSM) and help focus investigation, sampling, and mitigation resources more effectively.

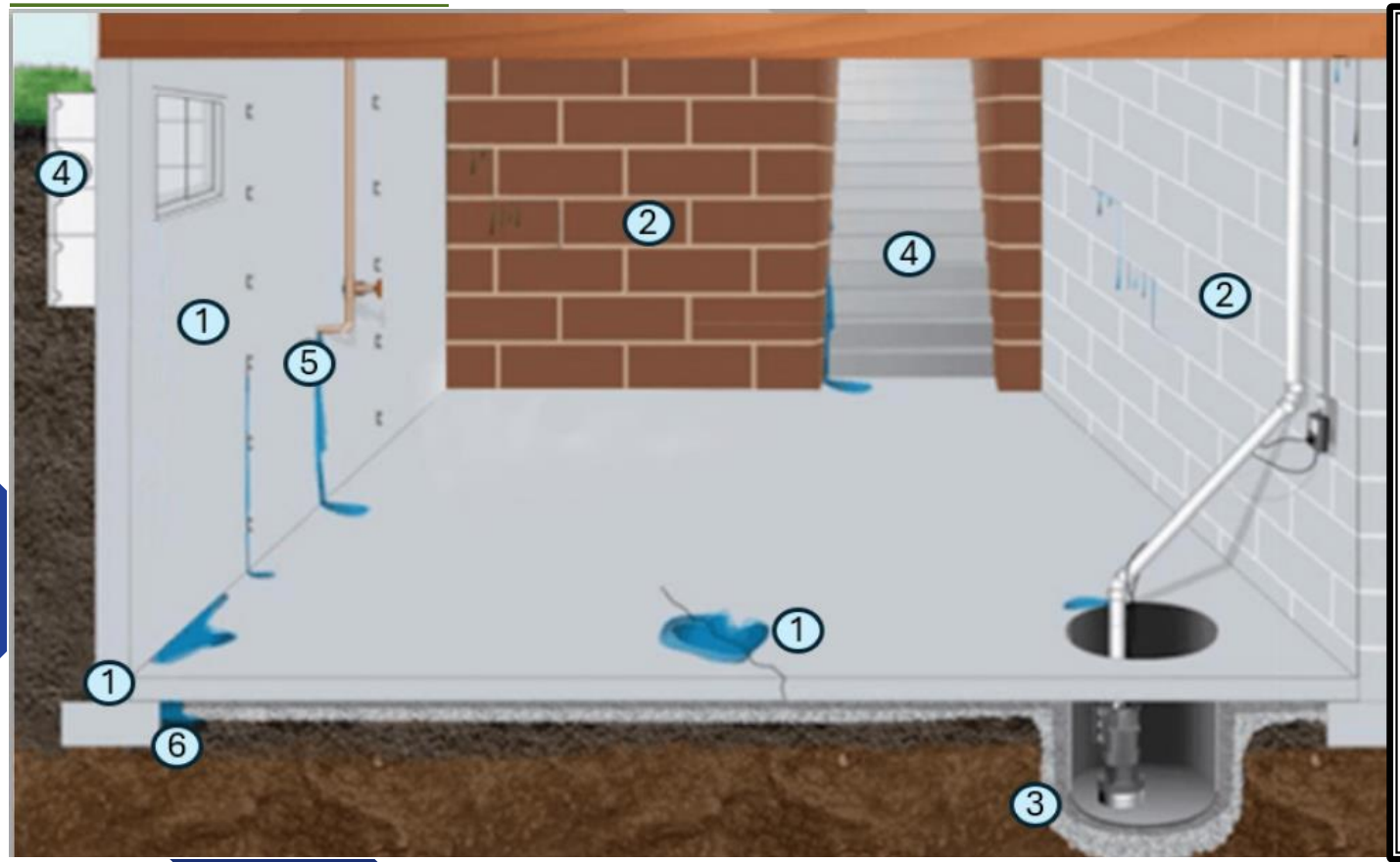
This fact sheet introduces useful definitions including the term vapor intrusion preferential path (VIPP). It also includes descriptions of two of the most common types of features th considered VIPPs: conduit VIPPs and vertical VIPPs. It discusses why it is between VIPPs and typical potential vapor entry points (i.e., cr common types of conduits that may be potential VIPP CSM scenarios where VIPPs may need fur stages of a project. In this fact sh used to refer to certain are referring



- Conduits must be:
  - Connected to structure
  - Able to transport vapors
  - Not all utilities are conduits

W	WATER LINE
S	SANITARY SEWER LINE
ST	STORM SEWER LINE
G	UNDERGROUND GAS MAIN LINE
OHE	UNDERGROUND ELECTRIC LINE
ED	EDGE DRAIN
OHE	OVERHEAD ELECTRIC LINE
OHT	OVERHEAD TELEPHONE LINE
OE/T	OVERHEAD ELECTRIC/TELEPHONE LINE

Common Scnarios for Direct Volatilization



1. Cracks in foundation and floor
2. Mortar joints
3. Sumps, vaults or penetrations
4. Window wells and walk-up basement bulkheads
5. Pipe penetrations
6. Foundation in contact with foundation soil, including drain tile

DIRECT VOLATILIZATION

- Subset of VIAP (and different from VI)
- Process by which vapors of volatile hazardous substance directly volatilize or migrate into structure's breathing space **without migrating through vadose zone**
- Resulting in potential unacceptable exposure risk to human health

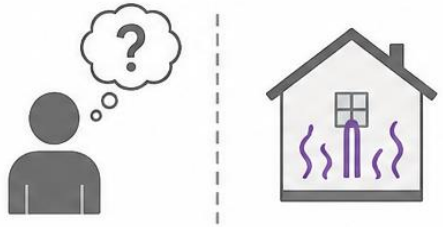
Common Pitfalls

Overweighting one line of evidence

Relying too heavily on a single line of evidence can lead to a biased conclusion.

Treating all lines of evidence as equal quality

Not all evidence is created equal—consider the reliability, relevance, and limitations of each.



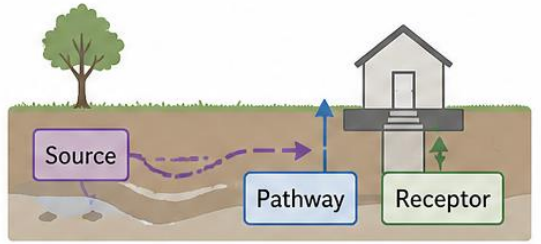
Ignoring the issue vs explaining it

Dismissing potential issues without investigation can overlook important risks.

- Is there an indoor air source and do you have data that supports it?

Not tying back to the CSM

Findings should be evaluated in the context of the Conceptual Site Model (CSM) to support sound conclusions and decisions.



Are these familiar?

Bottom Line

How to deal with conduits and direct diffusion

- MLE and a good CSM
  - Tools that help (AVIP and ITRC)
- Transparent (explains conflicts and uncertainty)
- Weighted (not all data treated equally)
- Comprehensive
  - Includes all relevant pathways and considerations
  - Don’t propose an answer without some evidence
- Time-aware (accounts for seasonal/building variability)
- Decision-focused (clearly supports next steps)

Keys to Success

- Develop a CSM
  - Initial CSMs may not be complete
- Understand
  - Regulatory hurdles
  - Know when to push
  - Regulators want to work with you
  - There is no “magic” bullet
- Know the question
  - Have an answer
- Defend your position
  - There will be differences
  - Don’t make me answer the question for you
  - Use available resources like ITRC and AVIP
- Site-specific considerations

www.vaporintrusion.org

Thank you

Laurie A. Chilcote – Lauriechilcote@vaporintrusion.org

Laurie_Chilcote@vaporpin.com

Craig A. Cox – Craig_Cox@coxcolvin.com

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