ENVIRONMENTAL RESTORATION

Quantitative Decision Framework for Assessing Vapor Intrusion for Industrial Buildings at Navy Installations

Introduction

At Environmental Restoration (ER) sites, vapor intrusion (VI) investigations can be challenging with volatile chlorinated hydrocarbons present in soil and groundwater adjacent to workspaces in industrial and commercial buildings. Over the years, the Environmental Protection Agency (EPA) and others have developed guidance and tools to support VI investigations, but the underlying VI assumptions are based on experience with residential buildings and may not be applicable to the types of industrial buildings located on Navy installations.

To improve VI-related decision making for industrial buildings, the Navy's Environmental Sustainability Development to Integration (NESDI) program tasked the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) to develop a quantitative decision framework for evaluating VI at ER sites. The objective of this factsheet is to provide a brief introduction to this framework. The final NESDI report provides more detailed information about the framework including a User's Quick Start Guide (NESDI, 2015).

Decision Framework Development

The approach used in developing the framework included the The approach used in developing the framework included the following major steps:

- Populating a structured database representing installations, sites, buildings and sample zones where indoor air samples had been collected within a building.
- Conducting initial exploratory data analysis using all available paired data by sample zones (e.g., indoor air paired with sub-slab soil gas and/or groundwater). The analysis identified several key factors influencing VI as noted in the text box (referred to as predictor variables).
- Conducting single and multivariate regression and other statistical analyses.
- Utilizing the results of the analyses to develop and assign weighting factors to lines of evidence in the framework scorecard.

Key Factors Influencing VI Processes

- Sample Zone Size
- Sample Zone Exterior Wall
- Distance to Release
- Soil Type
- Groundwater Vapor Concentration
- Sub-Slab Soil Gas Concentration
- Atypical Preferential Pathways

Decision Framework Application

The decision framework contains three main components as described in the following sections.

Flowcharts

The application of a quantitative decision framework starts with flowcharts designed for sites where either groundwater volatile organic compound (VOC) data or sub-slab soil gas data are available. The flowcharts provide basic screening questions to quickly identify the following outcomes:

- VI risk is very low resulting in no further action (NFA),
- VI investigation may be required to identify atypical preferential pathways, or
- Potential VI requiring detailed building-specific information and ranking with a scorecard.

Figure 1 shows the flowchart for groundwater VOC data. A similar flowchart for sub-slab data is included in the NESDI report (2015).

VI Potential Scorecard

The scorecard developed as part of the decision framework allows for a more in-depth evaluation using multiple lines of evidence leading to a VI prioritization score for a specific location within a building. The weights in the scoring system are tailored to emphasize the importance of the predictor variables identified in the data analysis. For example, the

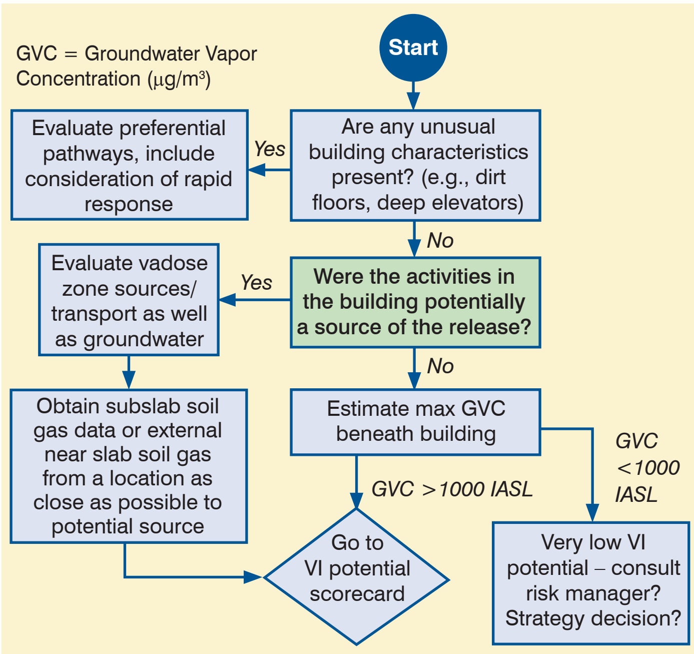

Figure 1. Groundwater Data Flowchart

decision input variable "Sample, Zone Size" has five input ranges for sample zone sizes ranging from <100 ft² to >100,000 ft², and corresponding weight of evidence from 2 to -2. A sample zone is a compartment/room within a building that ideally has limited air mixing with other zones. Smaller sample zones are assigned a higher score, since these zones typically show less VI attenuation and thus a higher potential of VI exceeding a screening level.

Figure 2 provides a summary of input ranges and weights of evidence for each of the predictor variables. The NESDI report provides detailed information about the predictor variables, input ranges, and corresponding weighting factors for each selected input range. The scores can also be adjusted to account for uncertainty associated with the inputs to the framework.

Graphical Data Interpretation

The total score is then calculated for each sample location and displayed along with the scorecard range from -12 to 20. A high score is associated with an increased potential for VI, indicating a need to assign a high priority to this location for further investigation such as indoor air sampling.

When indoor air data become available for a location, these data, in combination with the scorecard results and the applicable vapor intrusion screening level (VISL), provide a significant opportunity to further refine the VI evaluation for this location. Figure 3 shows the combined methodology for interpretation of results.

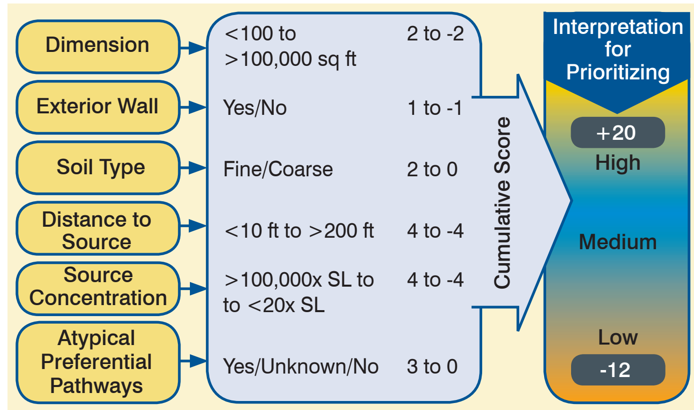

Figure 2. Summary Input Range for Each Decision Input and Weight of Importance

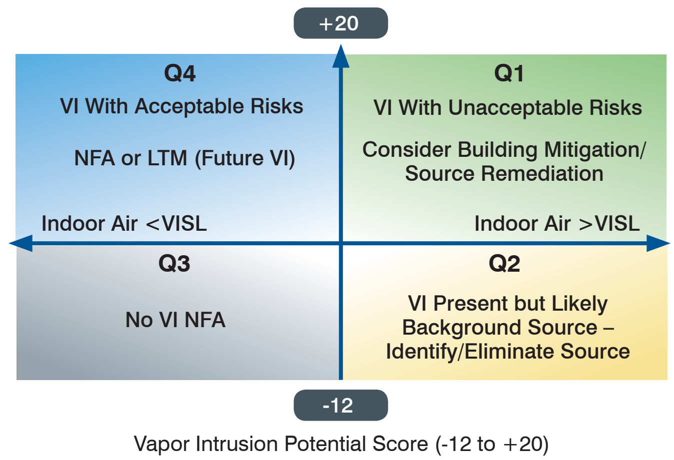

Figure 3. Interpretation of Results

This figure divides the decision matrix into four regions (Q1 to Q4) based on indoor air concentration and the VI potential scorecard. This figure can be readily applied for interpretation of results. For example, if a sampling location has a high indoor air concentration exceeding the applicable VISL and a high VI potential score, this location corresponds to region Q1 in the figure with unacceptable VI risk requiring mitigation measures.

Conclusions

In summary, the framework provides a practical tool to evaluate site- and building-specific data and to interpret results for future VI-related actions for Navy industrial buildings. It can be used by Navy RPMs to prioritize buildings for further assessment, assess the likelihood of VI occurrence in individual buildings, and plan for long-term stewardship of current and future buildings.

Reference

NESDI. 2015. A Quantitative Decision Framework for Assessing Navy Vapor Intrusion Sites. TR-NAVFAC-EXWC-EV-1603. June.