INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Vapor Remedy Selection and Implementation

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1.0 INTRODUCTION

IDEM's Remediation Closure Guide (RCG) significantly updated the vapor intrusion (VI) guidance applicable to remediation projects in Indiana. The RCG focuses on investigation and interpretation of sampling results and provides guidance on institutional control remedies. The RCG does not provide guidance on operation and maintenance of long-term engineered remedies.

The following draft interim guidance supplements RCG Section 5 (Conceptual Site Model (CSM) Development: Vapor), Section 10 (Risk Evaluation: Vapor) and Section 12 (Remedy Selection and Implementation) and provides guidance for evaluation and implementation of remedies at potential vapor intrusion sites. Subsequent to the presentation of this draft interim guidance, EPA, in 2015, published their guidance documents: OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (OSWER 00.2-154) and Office of Underground Storage Tanks Technical Guide For Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites (EPA 510-R-15-001).

2.0 VI PATHWAY EVALUATION

If a volatile chemical is detected in ground water at concentrations above its vapor intrusion ground water screening level (VIGWSL) within specified distance criteria of a building, the RCG recommends evaluation of the VI pathway at that building to determine if the exposure pathway is complete.[1] This typically involves collection of indoor air (IA) and sub-slab soil gas (SGss) or exterior soil gas (SGe) samples.

Note that VIGWSLs are modeled numbers intended for use as triggers that prompt VI investigations. They are not intended as stand-alone remediation objectives that must be met in addition to ground water direct contact and indoor air remediation objectives.

[1] At the present time IDEM has no VI SLs for soil.

Table 1 below summarizes IDEM's draft interim guidance based on observed concentrations of volatile chemicals in IA and SGss/SGe after the first round of worst case sampling. Text providing additional detail on the various scenarios follows the table.
Use of the table and text assumes an adequate CSM and preferential pathway analysis and that the subsurface source of contamination is stable or decreasing - that is, that ground water concentrations of volatile chemicals underlying or near the building, including degradation products, are not increasing or likely to increase with time.

Neither the table nor the text is a substitute for critical thinking or best professional judgment. They are only general guides. Site-specific decisions regarding mitigation options and urgency/timing of action should be based on site conditions. The conditions at any given site may lead to different decisions than the simple suggestions provided in the table and text below.

Table 1: Evaluation of Paired SGss/SGe-IA Sample Results

	IA Concentration			
SGss/SGe Concentration	IA < SL	SL < IA < 2x SL	2x SL < IA < 10x SL	IA > 10x SL
SGss/SGe < SL	Scenario 1 (Mitigation not necessary)	Scenario 4 (Indoor air source likely)	Scenario 4 (Indoor air source likely)	Scenario 4 (Indoor air source likely)
SL < SGss/SGe < 2x SL	Scenario 2 (Mitigation typically not necessary)	Scenario 5 (Mitigate or demonstrate through additional sampling and lines of evidence that a remedy is not needed)	Scenario 6 (Remedy)	Scenario 7 (Mitigate promptly)
2x SL < SGss/SGe < 10x SL	Scenario 3 (Remedy or indefinite sampling)	Scenario 6 (Remedy)	Scenario 6 (Remedy)	Scenario 7 (Mitigate promptly)
SGss/SGe > 10x SL	Scenario 3 (Remedy or indefinite sampling)	Scenario 6 (Remedy)	Scenario 6 (Remedy)	Scenario 7 (Mitigate promptly)

Instructions for Use of Table 1

Note that IDEM has a preference for paired SGss and IA measurements taken under worst case conditions over paired exterior soil gas (SGe) and IA measurements unless the structure is considered low risk (see RCG). If the structure is not low risk, SGe samples should be paired with IA samples only when SGss samples cannot be obtained.

Table 1 applies after the *first* round of worst case sampling. Some of the scenarios described in Table 1 and the text below call for additional sampling. If those additional sample results suggest a scenario different from that indicated after initial sampling, responsible parties should implement the more protective scenario, or demonstrate through additional sampling and other lines of evidence (LOEs) that another approach is appropriate and protective.

Scenario 1: SGss/SGe < SL and IA < SL
Resample under worst case conditions. If both rounds of paired worst case sampling show that the SGss and IA concentrations are below their applicable SLs, no complete VI pathway exists, and no additional sampling is necessary.

Scenario 2: SL < SGss/SGe < 2x SL and IA < SL
Detections of VOCs in SGss indicate potential VI and additional evaluation is required. If three paired worst case sampling events (winter season, summer season, repeat of winter/summer season) show that SGss is less than 2x the SL and do not detect IA concentrations above SLs, there is no evidence that VI is occurring above the SL, and VI does not pose an unacceptable risk. Generally, no additional sampling is necessary. Note that responsible parties always have the option of performing pre-emptive mitigation as an alternative to collecting additional SGss/IA samples.

Scenario 3: 2x SL < SGss/SGe and IA < SL
In this scenario, there is a significant potential for future VI. Responsible parties should either implement a remedy or undertake long term paired sampling.

Scenario 4: SGss/SGe < SL and IA > SL
This scenario typically occurs when there is an IA source of the observed chemical(s). Investigate and if possible, remove the IA source, then resample. If paired re-sampling shows that SGss/SGe < SL and IA < SL after removal of an indoor air source, no further sampling is necessary. If re-sampling shows that SGss/SGe < SL and IA > SL, then the indoor air problem is not likely due to vapor intrusion. Corrective action may be advisable, but a vapor intrusion remedy is likely not necessary.

Scenario 5: SL < SGss/SGe < 2x SL and SL < IA < 2x SL
In this scenario, VI is occurring. Responsible parties should either implement a remedy or demonstrate through additional sampling and lines of evidence that a remedy is not needed.

Scenario 6: Applies to various combinations of SGss/SGe and IA results
In this scenario, there is stronger evidence that VI is occurring, and responsible parties should interrupt the vapor pathway and/or remove source material to reduce contamination to achieve acceptable levels.

Scenario 7: Applies to SGss/SGe > SL and IA > 10x SL
In this scenario, the indoor air action level has been exceeded, and responsible parties should act promptly to interrupt the VI pathway.

3.0 VI REMEDIES
VI remedy options include source reduction or use of vapor mitigation technologies until IA SLs are no longer exceeded. Source reduction is the most effective way to eliminate the long-term

risks of VI from sources such as contaminated soils, groundwater, and/or non-aqueous phase liquids. Vapor mitigation technologies are approaches to interrupt the VI pathway based on the characteristics and construction of a building (e.g., existing building, slab-on-grade, basement, or crawl space foundation).

3.1 Vapor Mitigation Options

There are two types of vapor mitigation technologies: active vapor mitigation and passive vapor mitigation. If a vapor mitigation system is needed, the type of system chosen should take into consideration factors such as the use, construction and design of the building, the sub-slab soils, and whether the building exists or is proposed for construction.

3.2 Mitigation System Diagnostic Testing and Verification Sampling

Once a vapor mitigation system is installed, responsible parties should perform diagnostic testing and verification sampling. Diagnostic testing is needed to verify that the system meets its performance specifications and to establish an operational baseline. Diagnostic testing should include:

- visual inspection of the mitigation system;
- documentation of baseline system performance measurements, e.g. manometer, gauge, or other appropriate measurement and documentation of the measurements; and
- determining whether alterations or augmentations to the system are needed.

It takes time for the sub-slab or crawl space area to reach steady state conditions after the installation of the vapor mitigation system. For this reason, baseline mitigation system performance measurements should be collected no sooner than 30 days after the system is activated. The 30 day timeframe also allows the building time to reach steady state conditions prior to collecting verification IA samples.

Once a vapor mitigation system has been installed inside a building, verification sampling should be conducted to show that the system is operating effectively and reducing IA contaminant concentrations to below the IA SLs. Verification IA sampling is only necessary for previously detected chemicals and their breakdown products. Verification sampling should include both IA sampling and pressure testing. The IA sample(s) should be collected in a location biased towards worst case conditions identified during previous sampling events and/or based on professional judgment. Following installation of a vapor mitigation system, IDEM recommends the following:

1. IA sampling
   - One round of IA sampling 30 days after system installation.
   - If the sampling event conducted 30 days after system installation does not occur during winter worst case conditions, an additional IA sampling event should be conducted during winter worst case conditions.
2. Pressure testing
   - Demonstrate that a negative pressure differential exists between the sub-slab and indoor air.

Regardless of the vapor mitigation technique selected, IA sampling is a necessary LOE to confirm the mitigation system is performing as expected. Pressure testing will verify that a negative pressure gradient is being sustained between the sub-slab and indoor air. Visual documentation of a sub-slab vacuum pressure differential may be used under certain conditions during the operation, maintenance, and monitoring phase of the project to confirm steady state operational conditions and provide a LOE that the mitigation system continues to prevent VI in lieu of continued IA testing.

3.3 Vapor Mitigation System Operation, Maintenance, and Monitoring (OMM)

Routine long-term OMM of the vapor mitigation system will be necessary for as long as it is used to interrupt the VI pathway. A site-specific OMM plan should be developed that specifies the requirements for and frequency of vapor mitigation system inspection based on the risk level involved with each building. The risk level can be evaluated using the following LOEs:

- SGss and IA contaminant concentrations.
- Source contaminant concentrations.
- Source remedy selection.
- Estimated time that will be required before areas of highest contamination decrease to acceptable levels.

For example, an OMM plan for a building overlying or near a source that is actively being remediated may only need visual inspection and pressure tests on a reduced frequency. In contrast, a building overlying or near a source that is being left in place will need inspection and air monitoring on an increased frequency. Generally, an OMM plan should include:

- Routine visual inspections of the buildings to ensure there are no significant changes such as remodeled areas or additions to the building.
- Routine visual inspections of the vapor mitigation system, in particular the pressure gauge or the manometer to ensure that the system is functioning appropriately.
- Periodic monitoring of IA on the lowest routinely occupied floor to ensure that IA concentrations are below the SLs and that VI does not present a health risk.

3.4 Long-Term Monitoring (LTM)

Table 2 (below) provides general guidance on appropriate inspection and sampling intervals. Note that development of a long-term VI monitoring plan should use site-specific data and professional judgment to determine the frequency of mitigation system monitoring. The conditions at any given site may lead to different decisions than the approaches described below.

Table 2: Inspection and Sampling Intervals

	Premitigation IA Concentration			
SGss/SGe Concentration	IA < SL	SL < IA < 2x SL	2SL < IA < 10x SL	IA > 10x SL
SGss/SGe < SL	None anticipated	None anticipated	None anticipated	None anticipated
SL < SGss/SGe < 2x SL	None anticipated	Schedule 1	Schedule 2	Schedule 2
2x SL < SGss/SGe < 10x SL	Schedule 1 OR conduct on-going sampling	Schedule1	Schedule 2	Schedule 2
SGss/SGe > 10x SL	Schedule 2	Schedule 2	Schedule 2	Schedule 2

Table 3: Mitigation System Monitoring Schedule

Schedule 1.	**Schedule 2.**
1. Perform activities specified in Section 3.3, generally on an annual basis. 2. Annual sampling of IA during the winter worst case season during the first, second, and fifth year, and every fifth year thereafter.	1. Perform activities specified in Section 3.3, generally on an annual basis. 2. Annual sampling of IA during the winter worst case season during the first, second, and fourth year, and every other year thereafter.

4.0 Mitigation System Termination Guidelines

Site cleanup efforts may reduce contaminant levels in ground water, soil, soil gas, etc. to levels no longer resulting in VI. If so, it may be possible to terminate operation of VI mitigation systems.

System termination sampling is based on the results of IA and SGss sampling. Prior to sampling for system termination, shut down the mitigation system for a period of at least 30 days to allow re-development of pre-mitigation subsurface conditions. Where possible, collect samples from the same locations initially used to evaluate VI. Collect a round of paired samples during the winter heating season and compare the results to Table 1. Use the procedures in Table 1 to determine whether it is appropriate to terminate system operation or pursue some other course of action.

Upon system termination, some home owners may prefer to keep the system in place (e.g. for radon mitigation) instead of removing it. This is acceptable. Otherwise, arrangements should be made with the building owner to remove any equipment and/or monitoring devices associated with the mitigation system or long term monitoring operations and perform repairs to the building resulting from system removal.