Responses to External Comments Received on the Preliminary Draft of IDEM's Risk-based Closure Guide

July 1, 2021

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Use of the Draft watermark on this document applies to all text excerpted from the *Risk-based Closure Guide* draft.

The *Risk-based Closure Guide* draft is subject to change pending further review and comments received during the public comment period required as part of the nonrule policy document process.

In 2016, IDEM began internal discussions about revising the *Remediation Closure Guide* (Nonrule Policy Document Waste-0046-R1), and IDEM staff subsequently drafted proposed revisions to the text. Revision goals included addressing issues encountered during the preceding years of implementing the *Remediation Closure Guide,* being clearer about IDEM expectations, and updating content to reflect new science, particularly with respect to vapor intrusion.

IDEM staff commented on a rough draft in 2019, and following revisions based on those staff comments, IDEM made a preliminary draft of the slightly re-named *Risk-based Closure Guide* (*R2*) available for comment to participants in its Consultant's Day email lists. This initial invitation to comment on the preliminary draft was prior to, and in addition to, the formal comment period described in the Indiana Statute that governs nonrule policy documents.

This *Responses to External Comments* document includes virtually all[1] of the external comments received, along with IDEM responses. IDEM requested follow-up on a few of the comments, and those follow-ups appear with the comments that prompted them. The comments and responses that follow begin with general comments pertaining to the *R2*, philosophical issues, or other larger issues that transcend *R2*. The remainder of the comments and responses are generally arranged by page or section number, so that the order of comments and responses reasonably follows the order of material as presented in the *R2* preliminary draft. The original comments appear in standard text, while IDEM's response to each comment appears below in italics.

Sometimes IDEM lumped similar comments and offered a single response; lumped comments are "connected" by a "+" symbol along the left-hand margin of the text. Where IDEM responded to comments by proposing relatively concise changes in the R2 text, those changes are presented as short quotes of revised language. In a few instances, revisions were so extensive that instead IDEM reproduced blocks of revised text as one of seven attachments appended to the end of this document. Those attachments are referenced in some of the individual comment responses. IDEM will also make a redlined version of the full document available for examination.

IDEM thanks everyone who took the time and made the effort to provide comments on the *R2* preliminary draft and hopes that the responses either adequately incorporate the suggestions received, or explain why IDEM took a different approach than that suggested by specific commenters.

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[1] Two submissions were of essay length, perhaps drafts of papers intended for publication elsewhere or material submitted for background purposes. IDEM did not reproduce, excerpt, or respond directly to those submissions.

General Comments

[0] There were several comments along the lines of "why does IDEM propose this change?"

IDEM's Non-Rule Policy Documents describe how we intend to implement overarching rules or statutes. Explanation and discussion of all the various options IDEM could have chosen and why IDEM chose the option it did is outside the scope of the document. Incorporating that material into the document itself would greatly increase its length and would likely distract most users from the document's central purpose. Instead, IDEM will address those questions as they are raised during comment periods and during open forums, and not in the document itself.

[1] Consider adding language specifically addressing completion of the administrative 'closure' step (e.g., requesting/receiving NFA from LUST or SCP, CNTS and COC from VRP, etc.). There are past situations where responsible parties have effectively satisfied the approved CAP, RWP or similar, but did not pursue/acquire the formal closure documentation, and later were forced to re-address issues (sometimes under newer guidance/policy) in order to complete programmatic closure. (MSECA)

In general, it is the responsible party's responsibility to request closure documentation. IDEM plans to address program-specific administrative procedures, including those related to closure, in subsequently issued guidance. That guidance may take the form of a single revision to the Remediation Program Guide nonrule policy document, or it may consist of several separate nonrule policy documents, perhaps as many as one for each of the IDEM programs to which risk-based closure applies.

[2] It would have been helpful if IDEM had been able to release its next generation companion manual, the Remediation Program Guide (RPG), contemporaneously with the R2 so both documents could be reviewed concurrently. The existing RPG contains many important features and provisions including IDEM's transition policy which is critical to a smooth administration of IDEM's remediation programs. Not having both documents available at the same time has meant we have been unable to integrate comments on both documents, and reserve the right to provide additional comments on the R2, as well as on the RPG, that may be made necessary by a future review of the revised RPG. (Gillay)

IDEM agrees that simultaneous issuance of both documents would be preferable but currently lacks the resources to do so. IDEM intends to issue a draft of a revised Remediation Program Guide (to be named the Risk-based Program Guide) or an equivalent, perhaps as a set of individual program-specific nonruled policy documents, as soon as possible.

[3] The draft guidance is not overly prescriptive in directing investigations and remediation, however, that very lack of prescription makes it difficult for consultants and responsible parties to reasonably predict agency expectations. Further, it has been the experience of many in the consulting industry that the interpretation and expectations by IDEM staff can vary significantly depending upon expertise and experience levels. A more prescriptive guidance fosters greater predictability for those responsible in managing environmental impacts. (MSECA)

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[8] The implied additional flexibility for PRPs and consultants to bring innovative alternative approaches to the closure process is appreciated - however it isn't clear how IDEM will support consistency/predictability in the decision-making process across their project manager corps (varying experience and expertise). Any clarity is appreciated. (MSECA)

The Risk-based Closure Guide nonrule policy document focuses on the ends required by Indiana Statute, and provides only examples of means of achieving those ends. This is intentional, and within the scope of a non-rule policy document, which interprets, supplements, or implements a statute or rule. Persons who prefer a more prescriptive approach are free to advocate for changes in the statutes or development and adoption of Rules.

[4] The draft guidance incorporates by reference several technical documents previously or in process of development (e.g. preferential pathway and pending sewer sampling documents). There is some concern that historically the agency has not sought public review of these technical documents, and their incorporation can result in their content being de facto guidance. For example, the previously published DRAFT INTERIM Vapor Remedy Selection and Implementation technical document was created in 2014, and was promptly utilized by the agency as the decision matrix for all sites, despite a lack of public review and its "DRAFT INTERIM" status. Such technical issues are complex, and external stakeholders have both expertise and pertinent interest in supporting development of such documents. The reviewer recommends that public comments on supporting technical documents be solicited and reviewed in conjunction with the review of the overarching RCG2 guidance. (Bonniwell)

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[5] How is the R2 going to adopt and incorporate the current IDEM draft technical guidance documents that are published? (MSECA)

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[6] Kudos for moving the technical and process support documentation to references (appendices and/or other industry standard documents); in my opinion that helps focus the document on the closure process itself, without losing the basis for any section. If there are additional documents still being developed for future reference (i.e. Sewer Manhole Sampling Guidance) please allow public comment before publishing/incorporating those documents as well. (MSECA)

IDEM agrees that guidance that interprets, supplements, or implements a statute or rule should go through the NPD process. IDEM has inventoried and reviewed the various remediation-related draft guidance documents it has issued and is preparing many of them to go through the NPD process.

[7] IDEM should utilize ITRC guidance within the context of this R2 document. The ISM guidance is nearly complete by ITRC, and with how many discussions there are of DUs within this text, it would be good to reference these ITRC documents since so much vetting and review have gone into from national leaders. (MSECA)

IDEM will consider including a reference to ITRC's forthcoming document once it is finalized. However, the R2 uses the term "decision unit" for purposes specific to the R2, and not as a reference to the incremental sampling methodology. IDEM already references other ITRC documents in the R2.

[9] For future document revisions, a redline or companion document to manage the changes would be so helpful. (MSECA)

IDEM considered this and determined that given the vast number of changes and the substantial re-organization of the document, a redline version that highlighted every change would have been virtually impossible to interpret. For this reason, we did not develop or issue a redline version. IDEM will make a redline available that illustrates the 2,000+ changes made to the R2 preliminary draft based in part on external comments.

[10] IDEM says that it will "correct, update, or revise the R2 as necessary. Updates will appear on IDEM's Technical Guidance for Cleanups web page." We do not believe that IDEM can legally change the substantive content of an NPD without going through the regular NPD adoption process. This same practice with RISC and the RCG has created a series of difficult issues, particularly with various "technical memos" and "interim technical memos". Those problematic issues do not serve IDEM or the public well, and create serious program administration problems. It is critically important to the smooth administration of remediation projects that we not have a constantly "moving target" of values and substantive requirements that can be adopted by IDEM over time, through an administrative process that creates new "requirements" in the R2, without following the statutory requirements applicable to NPDs. We recommend instead that IDEM develop a periodic process to occur, perhaps annually or bi-annually, by which IDEM would accumulate and make suggested changes to this NPD following the requirements of Indiana's NPD statute. (Gillay)

IDEM agrees that substantive changes to the Risk-based Closure Guide should go through the NPD process. IDEM has added text to the cited section, as shown below:

IDEM will correct, update, or revise the R2 as necessary. Substantive changes to the R2 will go through the non-rule policy document process. Updates will appear on IDEM's Technical Guidance for Cleanups web page.[2]. In addition, IDEM staff can provide clarification regarding updates to, or specific contents of, this volume.

[11] On page 9 the text states that "the emphasis throughout the R2 is achieving ends – adequate characterization, an appropriate evaluation of risk and, where necessary, control of risk through selection and implementation of a remedy – rather than dictating specific procedures for doing those things." Does this mean that IDEM does not intend to review submittals and request specific tasks to move the project forward, e.g., installation of monitoring wells in downgradient locations or VI sampling of a specific building? If so, this is a significant concern as very often insurers are funding environmental investigations. Insurers very often rely on IDEM requests to identify proper next steps as they see IDEM as performing an objective analysis without the potential conflict of interest they see environmental consultants as having when they recommend a scope of work. IDEM's failure to provide these types of documents may make moving projects forward much more difficult. (Neely/Troy Risk)

IDEM's intent is to implement the statutes governing risk-based closure without exceeding its authority. IDEM recognizes that there may be many ways to fulfill statutory obligations and the referenced language is an explicit recognition of that. IDEM will continue to review submittals and provide notice when statutory obligations have not been met (e.g., failure to delineate, failure to adequately control risks, etc.). It will also (as in the Risk-based Closure Guide) provide guidance on some

[2] https://www.in.gov/idem/cleanups/2329.htm

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of the procedures it has determined are acceptable for moving projects to closure and continue to respond to inquiries on technical and administrative questions.

[12] We agree with allowing greater freedom to propose alternative methods of closure, but using this approach imposes greater pressures on IDEM staff in reviewing documents and proposals. We wonder if IDEM has the current resources to manage these programs under a guidance that allows such flexibility in approach. (Vectren)

IDEM agrees that this is and will continue to be a challenge.

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Introduction

[13] On page 9, Figure 1A you include three sections for the R2 Outline. Why aren't the Sections 1, 2, and 3? (Neely/Troy Risk)

The section numbers that appear above each component of the process point to sections of the R2. Because Section 1 of the R2 is an introductory section, and discussion of characterization does not begin until Section 2, the numbers that appear above each component of the process begin with Section 2, not 1.

[14] Page 10: The list of programs includes the Leaking Underground Storage Tank Program and does not include the Petroleum Remediation Section. (Creek Run)

IDEM agrees and has changed "Leaking Underground Storage Tank Program" to "Petroleum Remediation Program"

[15] Page 10: In the list of conditions that require quick response actions, one condition listed is "Actual or imminent threat to a drinking water supply well". We recommend removing the word "well" as there are often other types of drinking water supply, such as a surface water intake, that could be affected. (Creek Run)

IDEM agrees and has changed the text to read:

Some conditions require quick response action to mitigate any potential imminent and substantial threat to human health or the environment. Examples include:

- *Releases covered under the Spill Rule*[3]
- *Acute exposures to release-related chemicals*
- *Presence of corrosive, explosive, flammable, or toxic vapors*
- *Actual or imminent threat to a drinking water supply when the threat is regulated by IDEM under Title 13*

The R2 does not specifically address emergency situations. However, where appropriate, R2 activities may proceed concurrently with emergency response measures.

[16] Page 11: Under the definitions presented here most closures become "conditional". How will "conditional closure" affect issuance of a Covenant Not to Sue when a site has ongoing mitigation of exposure through ERCs or EROs? (MSECA)

IDEM has issued many Covenants Not to Sue that include closure conditions. IDEM does not foresee any change to that.

[17-8] Pages 11, 12: Ongoing obligations/operations maintenance particularly regarding institutional and engineering controls: "Responsible parties will need to weigh the short-term advantages of conditional closure against the potential costs of maintaining remedies for as long as necessary to address unacceptable risk." These ongoing commitments are corrective actions and many come at a direct cost. Because these controls are being used as the remedy (or part of the remedy), and approved remedies for petroleum releases are reimbursable through the ELTF for eligible releases, these costs for ongoing commitments should also be reimbursable. However, 328 IAC currently states that all claims for reimbursement are to be submitted within nine months of receiving NFA status and these ongoing commitments and associated costs will far exceed nine months. As such, there is no mechanism in place for ELTF reimbursement of costs that otherwise meet the definition of eligible expenses. While Creek Run understands IDEM/ETLF is likely reluctant to make a commitment for such long term, open ended costs for a release, such costs are directly related to the remedies and it is not unreasonable that responsible parties expect reimbursement for such costs; especially when IDEM/ELTF will not approve other actions that could be taken to eliminate these ongoing commitment costs. If IDEM considers reimbursement for these costs to be unreasonable, then another remedy must be selected. IDEM must provide a mechanism for reimbursement of these costs. (Creek Run)

IDEM is currently developing a process to review and approve, when necessary, the future costs related to Long Term Stewardship (LTS) at ELTF eligible Sites, the majority of which will be associated with the evaluation of vapor intrusion risk. Please note that IDEM does not plan to consider reimbursement of costs for investigation or mitigation related to a change in property use regarding the source facility. A change in property use is a business decision, while LTS is intended to ensure appropriate management of risks associated with residual contamination left behind at the time of closure. Given that the fate and transport of petroleum contamination in the environment is very well-established and consistent, IDEM does not envision the need for LTS on many, if any, sites where the sole COC is petroleum-based.

[3] 327 IAC 2-6.1

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Characterization

[19] Page 13: I think IDEM needs to provide a couple examples of CSMs. There is no clear verdict on what these should look like, only what they contain, and that is a lot of info. I am sure different consultants do it entirely differently. Could it be as simple as a cross-section with embedded info, or a table or flow chart (similar to some of the US EPA CSMs). (MSECA)

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[20] Page 13: The items described in these pages are historically included in the body of investigation reports, and the CSM is not typically presented as a full document but depicted as a chart, table, or flow diagram. The pages regarding the CSM in this section of the draft RCG appear to describe a full written document with attachments that is to be updated/maintained throughout the life of a project as information becomes available and/or conditions change. But the information to be included, according to the draft RCG, is redundant with other report requirements, especially requirements for an ISC. How does IDEM prefer the CSM be presented? Should those sections in the initial investigation reports that include much of this same information simply refer to the CSM that is included as an appendix, or should those sections be completed as normal and the report include a simple chart, table, or flow diagram to represent/summarize the CSM as is typically done? If a written document, the CSM would then be updated regularly and included as an appendix in each ongoing report, correct? (Creek Run)

IDEM has revised portions of the text related to CSMs, specifically to include a diagram like what currently appears as Figure 2-A in the Remediation Closure Guide, with related discussion. IDEM does not intend CSMs to be stand-alone documents, and the text revision is intended to make that clear. The revised material on CSMs appears as Attachment 1 of this document.

[21] Page 13: The priority at any release is human health exposure. The R2 should consider increasing the human health risk focus. An exposure assessment (EA) should be the first consideration after verification of a release. A conceptual site model for exposure assessment should be developed immediately. USEPA guidance should be provided on how to develop an EA CSM. Conceptual and detailed guidance can be located at USEPA (1989; 1991a; 1992; 1996b, 2011; 2016; 2019, 2020; 2020a; and elsewhere) (Thompson)

IDEM has been and will continue to be open to proposals to calculate project-specific remediation objectives that include exposures different from those assumed in the equations used to calculate our published levels. IDEM does not anticipate many such submissions and does not propose to publish detailed guidance on how to calculate such project-specific remediation objectives. Parties wishing to do so can consult US EPA's Regional Screening Levels User's Guide (which we cite) and the references it cites for more information on how to perform the relevant calculations.

[22] CSMs: Geologic Settings: Vapor Migration, first paragraph: The R2 specifies that characterization of vapor flow direction should be characterized for each identified permeable unit within the vadose zone. To clarify, this expectation implies demonstrating an understanding of vapor migration dynamics based on typical Site information such as lithology and preferential pathways. Its intent is to set the expectation that horizontal and vertical vapor migration are considered and evaluated during CSM development. This expectation of "characterization" does not imply a specific type of field study as necessary or mandated. (MSECA)

IDEM's intent is to require delineation of the extents of vapors in the subsurface. The extents of subsurface vapors relative to their sources should reveal vapor flow directions. IDEM does not intend to require measurement of vapor flow velocities and revised the text to make that clear. The revised material on CSMs appears in Attachment 1 of this document.

[23] Page 14: On page 14 under CSMs: Geologic Setting, it is not true that detailed geologic information is necessary for all characterizations regardless of type of release. If a release takes place on a competent paved area, e.g. concrete with no cracks and is immediately contained and does not reach soil at the edge of the paved area or penetrate the paving via holes, drains, etc. and is immediately cleaned up and completely removed the underlying geology is moot. Obviously, if a release does reach soil, water, etc. the geologic setting does become important and must be carefully evaluated. (Neely/Troy Risk)

IDEM acknowledges that this scenario does occasionally occur and that the circumstances described would not ordinarily require a subsurface investigation. Rather, it usually falls under the category of a typical "Emergency Response" scenario which often doesn't reach the level of investigation and long-term monitoring necessary in IDEM remediation programs. If the release does not need a comprehensive geologic CSM, explain the reasons why in whatever report is submitted.

[24] Page 15: The documents mentions evaluation of "…every discernible permeable unit…" Shouldn't this section specify "impacted" permeable units? (MSECA)

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[25] Page 15: "…every discernible permeable unit…" This requirement lacks context as to the nature of the impacts and could require unnecessarily extensive multi-depth well networks to characterize flow gradients. (MSECA)

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[28] Page 15: On page 15 under Groundwater Flow the statement that "Identifying the flow direction(s) and horizontal and vertical gradients for every discernible permeable unit within the subsurface" is overly broad. Rather than every discernible permeable unit it should be limited to those units where contamination is present or units that affect those units. (Neely/Troy Risk)

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[29] Page 15: On page 15 under point 3 on under Groundwater Flow, it should be made clear that high and low permeability zones can be relative within the area of the release rather than absolute. (Neely/Troy Risk)

IDEM has clarified the referenced material by amending it as follows:

As noted by Schultz et al. (2017), an adequate subsurface investigation will provide the information necessary to:

- *Interpret lateral continuity between borehole data and correlate project data in three dimensions;*
- *Identify flow paths and preferential pathways;*
- *Map and predict release-related chemical mass transport (high permeability) and matrix diffusion related storage (low permeability) zones;*
- *Identify data gaps and assess the need for, and cost benefit of, different investigation techniques (e.g., high resolution site characterization);*
- *Determine appropriate locations and screen intervals for monitoring and remediation wells, and*
- *Improve efficiency of groundwater remediation and monitoring.*

<u>Migration Flow Paths</u>

Groundwater flow and vapor migration dynamics are often sensitive to local and/or regional natural or anthropogenic changes [e.g., precipitation, flooding, pumping, utilities; see IDEM (2021b) for additional guidance and discussion], and typically requires regular monitoring to characterize the magnitude and significance of changes in flow.

The revised material on CSMs appears in Attachment 1 of this document.

[26] Page 15: "…CSM development should include flow direction(s) for each identified permeable unit within the vadose zone." The expectation of establishing vadose zone flow direction is inconsistent with standard industry practices, let alone within each permeable unit. In the absence of structure-induced pressure differentials, soil gas migration is largely diffusion dominated away from source areas. To characterize this as "flow" is misleading. If IDEM has expected methodologies for determining actual vadose zone soil gas flow directions, then they should be identified within the guidance. (MSECA)

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[27] Page 15: Section 2: Characterization, page 15 under vapor migration states, "To understand the migration of vapors from release-related chemicals, CSM development should include characterization of the flow direction(s) for each identified permeable unit within the vadose zone." Please clarify this statement. Although understanding the geologic setting and hydrogeologic conditions can help determine vapor migration routes, it is impossible to characterize vapor flow direction. Vapors can migrate radially in all directions from a source area and do not necessarily follow groundwater flow direction. (MSECA)

IDEM has clarified the referenced material by amending it as follows:

<u>Migration Flow Paths</u>

Groundwater flow and vapor migration dynamics are often sensitive to local and/or regional natural or anthropogenic changes [e.g., precipitation, flooding, pumping, utilities; see IDEM (2021b) for additional guidance and discussion], and typically requires regular monitoring to characterize the magnitude and significance of changes in flow. An adequate understanding of the migration of vapors from release-related chemicals will typically involve delineation of vapors and concentration gradients within affected and relevant permeable units in the vadose zone, noting that vapors may not flow in the same direction as groundwater. In some cases, this may involve delineation in more than one permeable unit, or vertical delineation within the vadose zone (e.g., to determine the extent to which vapors arising from a groundwater source attenuate before reaching a structure.) Factors that may affect this include source concentration, source depth, soil matrix properties (e.g., porosity and moisture content), anthropogenic changes, and time since the release occurred.

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The revised material on CSMs appears as Attachment 1 of this document.

[30] Page 15: On page 15 under Vapor Migration, it is stated that "CSM development should include characterization of the flow direction(s) for each identified permeable unit within the vadose zone. This is quite often impractical and flow directions can change based on a number of factors such as rainfall events; wind direction; influence from building HVAC systems, sewers, etc. While it is important to understand the movement of vapors in the subsurface, it is typically more important to determine the overall movement rather than movement in "each identified permeable unit." This also does not appear to take into consideration the reality that vertical distance between an impacted media and overlying structure is significant as a limiting factor and potential area of bioattenuation. (Neely/Troy Risk)

IDEM has changed the referenced section to read:

An adequate understanding of the migration of vapors from release-related chemicals will typically involve delineation of vapors and concentration gradients within affected and relevant permeable units in the vadose zone, noting that vapors may not flow in the same direction as groundwater. In some cases, this may involve delineation in more than one permeable unit, or vertical delineation within the vadose zone (e.g., to determine the extent to which vapors arising from a groundwater source attenuate before reaching a structure.) Factors that may affect this include source concentration, source depth, soil matrix properties (e.g., porosity and moisture content), anthropogenic changes, and time since the release occurred.

The revised material on CSMs appears in Attachment 1 of this document.

[31] Page 16: This terminology change is unnecessary and confusing. I recommend reserving "Source" for release location vicinity. What are referred to in this document as "Source Areas" were historically referred to as "Secondary Sources" in most CSMs. Note, in Figure 2-A Plume Monitoring Network, IDEM uses the more traditional "Source" concept. (MSECA)

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[33] Page 16: "A groundwater source area exists…" should say "A groundwater secondary source area exists…". (MSECA)

IDEM's intent is to use modifiers to be clear about which of several meanings of "source" is used in a particular part of the R2. IDEM has revised the text discussing sources as shown below:

*In this document, the unmodified word **source** may take on one or more meanings, depending on context.*

***Source facility** refers to the building, land, or enterprise used for one or more purposes (e.g., gasoline sales and storage, dry cleaning, manufacturing, etc.), where the release occurred. Source facility can also apply to an area within a larger property.*

***Source point** refers to the physical location where release-related chemicals first entered the environment. Examples of source points include a hole in an underground storage tank, a leaky joint in an underground pipe, the location of a surface spill, etc. There can be more than one source point at a source facility.*

***Source area** refers to the two-dimensional map projection of a three-dimensional volume where release-related chemicals are present in one phase at concentrations high enough to enable them to readily transfer to a different phase at concentrations that require a remedy. Examples of this include:*

- *An area underlain by chemicals in soil that are leaching to groundwater at concentrations that require a remedy.*
- *An area underlain by chemical concentrations in groundwater that volatilize into soil gas at concentrations that require a remedy.*
- *An area underlain by non-aqueous phase liquid (NAPL) that is feeding a plume in groundwater that requires a remedy.*

Note that chemicals volatilizing from groundwater may do so at a considerable distance from the source point or source facility. Similarly, chemicals released to soil may dissolve into groundwater, travel some distance, and then resorb to soil, where they may subsequently dissolve into groundwater at unacceptable concentrations. Therefore, source area identification may not be possible until delineation activities are well underway or complete.

***Source mass** refers to the mass of release-related chemicals in source areas.*

Some or all of these aspects of the source concept will be important for every release.

[32] The bullet list on page 17 includes several items that are typically part of a Phase I Environmental Site Assessment (ESA). Is IDEM recommending completing a Phase I ESA, or portions of a Phase I ESA (records review, fire insurance maps, historic aerial photo and topographic map reviews, etc.) at sites under certain circumstances? What are those circumstances and are costs associated with these reimbursable through the ELTF at eligible petroleum sites? (Creek Run)

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IDEM makes no recommendation with regard to completion of a Phase I site assessment by the inclusion of certain activities in the bullet list on page 17. To the extent that certain activities in the bullet list are consistent with activities required during development and preparation of an Initial Site Characterization (ISC) Report, the R2 does not modify the guidelines for reimbursable rates and activities as described in 328 IAC 1-3-5.

[34] Page 17: Identifying Source Areas states that a groundwater source exists wherever release-related chemicals in groundwater are capable of volatilizing into soil gas at concentrations that exceed unconditional vapor remediation objectives. The elimination of groundwater VISLs does not support this. (Ramboll)

The R2 omits VIGWSLs and instead recommends direct observation of soil gas rather than modeling based on a single potential source medium as a means of identifying vapor sources. Please see IDEM's responses to comments 146-7, 149, 150, and 151 for additional discussion on this topic.

[35] Page 17: Would the smear zone be considered a groundwater source area, where chemicals in groundwater migrating away from the source area cause concentrations in soils to exceed unconditional soil remediation objectives? Or does IDEM consider the smear zone as strictly a groundwater issue? (Creek Run)

IDEM avoids using the term "smear zone" in the R2 because the boundaries of that zone are difficult to determine in the field. In any case, smear zones can contain release-related chemicals sorbed to soil or dissolved in groundwater. Whenever a chemical occurs in one medium at concentrations high enough to cause the chemical to occur in a second medium at concentrations exceeding a URO, the first medium is a source medium.

[36] Page 17: Capable of leaching or shown to be leaching. There plenty of times when the groundwater is not impacted even though the soils might be above the MTG values (which are theoretical only). (MSECA)

IDEM has revised the referenced text by deleting the words "capable of", so that it reads:

A soil source area exists wherever release-related chemicals in soils leach to groundwater and cause dissolved concentrations of those chemicals to exceed unconditional groundwater remediation objectives, or when those chemicals volatilize into soil gas at concentrations that cause vapors to exceed unconditional vapor remediation objectives.

A non-aqueous phase liquid (NAPL) source area exists wherever release-related chemicals in NAPLs sorb to soil at concentrations that cause soil to exceed unconditional soil remediation objectives, dissolve into groundwater at concentrations that cause groundwater to exceed unconditional groundwater remediation objectives, or volatilize into soil gas at concentrations that cause vapors to exceed unconditional vapor remediation objectives.

A groundwater source area exists wherever release-related chemicals in groundwater volatilize into soil gas at concentrations that cause vapor to exceed unconditional vapor remediation objectives. It is unusual for release-related chemicals in groundwater to cause concentrations in soils to exceed unconditional soil remediation objectives, but if this happens then the area where release-related chemicals in groundwater does so should be considered a source area.

It is very unusual for vapor concentrations to be high enough to cause concentrations in other media to exceed unconditional remediation objectives for those media, but if this happens then the area where release-related chemicals in vapor does so should be considered a source area.

[37] Page 17: If there are no VIGWSL then how is the capability to volatilize determined? (MSECA)

IDEM proposes that the best way to determine whether a chemical in groundwater is volatilizing is to, where possible, sample soil gas from an interval of the vadose zone just above the groundwater. This is consistent with IDEM's general preference for direct observation of behavior over modeling behavior. See IDEM's responses to comments 146-7, 149, 150, and 151 for additional discussion related to VIGWSLs.

[38] Page 18: "typically using synthetic precipitation leaching procedure (SPLP)…" It has not been this reviewer's experience that SPLP is not the standard site characterization methodology for soil impacts, but rather a specific evaluation. See General Comment regarding SPLP. (MSECA)

IDEM agrees with the commenter that SPLP has not hitherto been the "typical" approach to evaluating leaching potential. IDEM has determined that SPLP should be more widely applied in appropriate circumstances for this purpose and has modified the referenced passage to read:

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Where necessary, IDEM recommends delineating soil-to-groundwater source areas by evaluating the leaching potential of soil samples using a leaching test, such as the synthetic precipitation leaching procedure (SPLP) or a similar technique that meets project-specific DQOs.

[39] Page 18: Will IDEM publish or provide guidance on criteria for comparison of SPLP results? (MSECA)

See Section 3.4.5 of the Risk-based Closure Guide for appropriate criteria to use when evaluating SPLP results.

[40] "Groundwater-to-vapor source area delineation by collecting soil gas samples from the vadose zone just above the groundwater table": With the elimination of VIGWSLs, it would slow the pace of VI investigations and would put the residence/occupants around a release at an increased risk of exposure, and at the very least for an extended amount of time, if identified at all. It will be harder for consultants to do their job without having a starting point (distance criteria) to guide initial investigations. There can be "gaps" in the source areas of a groundwater plume and only looking at soil gas as an indicator for VI assessment may increase the risk of missing potential receptors from downgradient hot spots. Exterior soil gas samples are highly variable, rarely reproducible, and can underestimate the risk of exposure by not taking into account the affects that buildings have on vapor concentrations. Samples from the same location can fluctuate orders of magnitude. (MSECA)

IDEM understands the concern with having a starting point to guide initial vapor investigations and has modified the text on present vapor extents in Section 2.3.6, in part to address this issue. A revised Section 2.3.6 appears as Attachment 4 of this document.

[41] If IDEM does choose to move forward with requiring exterior soil gas investigations to characterize the vapor plume, I would recommend that the process be prescriptive to not prolong the process of going property to property, which would also increase liability and exposure duration through the VI pathway. Soil gas monitoring networks would have to be treated much like groundwater monitoring networks in order to capture seasonal fluctuations. Again, soil gas is much more variable than groundwater and would require a higher frequency of monitoring to characterize the vapor plume. Two seasonal events would not be adequate. (MSECA)

Delineation may require investigations on multiple properties. IDEM has modified the text on present vapor extents in Section 2.3.6 in an attempt to clarify expectations. A revised Section 2.3.6 appears as Attachment 4 of this document.

[42] Section 2.1.2.3 Identifying Source Areas discusses the definition of source areas; however, this section does not mention the exceedance of unconditional soil direct contact or unconditional groundwater direct contact remediation objectives in terms of being a source area. (MSECA)

Soil direct contact levels are not meant to predict whether the medium in question will act as a source of impacts to another medium. The fact that soils in an area exceed unconditional soil levels does not necessarily mean that the area will cause exceedances in other media. The same is true for an area where groundwater exceeds published levels.

[43] Section 2.1.2.3: Deriving mass estimates from sample concentration data is notoriously inaccurate even with large, robust data sets. What is the intended use of this kind of analysis? (MSECA)

IDEM agrees that derivation of mass estimates is difficult and, as noted in the text, does not foresee such estimates as being routinely necessary. However, there are times when a mass estimate may be useful or necessary. For example, there have been instances when IDEM has approved work plans that called for specific mass reduction targets, and in those cases, it is necessary to estimate both pre- and post-remediation masses.

[44] Section 2.2 Determine the Nature of Release-related Chemicals and Section 2.3 Determine Extents of Release-related Chemicals seem to contradict each other for the VI pathway. Section 2.2.6 discusses the use of exterior soil gas (SGe) samples. This section states that, "SGe sampling is appropriate for delineating soil vapor plumes, use as a stand-alone investigative tool to evaluate vapor intrusion potential at structures whose owners do not grant access for sub-slab sampling, during preferential pathway investigations, or when evaluating vapor intrusion potential at undeveloped properties. Depending on the SGe sampling density, SGe sample results that are not paired with indoor air sample results may not be sufficient to rule out current vapor intrusion." (p. 28) and then "Stand-alone SGe samples typically cannot accurately estimate SGss or IA concentrations. Soil gas concentrations tend to be higher beneath a building than at the same depth in adjacent open areas when the vapor source is underneath the building, even if the source is laterally extensive relative to the building footprint." (p. 30) Based on these statements, Section 2.2.6 implies that the VI pathway should typically be evaluated based on paired sub-slab and indoor air samples and that SGe samples cannot be used to determine VI potential. However, Section 2.3.6.1 which discusses determining the extents of vapor, states that, "Unless compelling lines of evidence show otherwise, a vapor

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extents determination should follow any exceedance of a soil gas or conduit vapor screening level." This section only discusses a vapor extents determination in terms of delineation of SGe. Section 2.3.6.2 goes on to state that, "Delineation activities typically begin at or near the release source and proceed laterally until soil gas concentrations no longer exceed levels that would prompt either a vapor remedy or an investigation of vapor intrusion potential in nearby structures, or future evaluation of vapor intrusion at subsequently constructed structures." This section implies that you can rule out VI potential at an adjacent structure with SGe samples. If guidance calls for delineating soil gas plumes through exterior soil gas, exterior soil gas sample results below published levels collected on adjacent properties should rule out VI investigations in those structures. Or does the guidance mean to conduct exterior soil gas on-site and step out to adjacent properties through sub-slab and indoor air sampling? The "screening" or characterization process for VI is not clear. Should the focus be on receptors and the use of sub-slab and indoor air which is suggested in this guidance or the use of exterior soil gas plume delineation, which is also suggested in this guidance? Both methods can be useful, but we do not see the need to conduct both exterior soil gas and paired sub-slab and indoor air sampling on the same property. The characterization process for VI needs to be clarified. (MSECA)

To address this comment, IDEM has modified text in Section 2.2.6.2 to read:

Soil gas concentrations tend to be higher beneath a building than at the same depth in adjacent open areas when the vapor source is underneath the building, even if the source is laterally extensive relative to the building footprint (U.S. EPA, 2015). When SGe is used to estimate sub-slab concentrations (e.g., when evaluating potential vapor intrusion risk in areas where there are as yet no buildings or where access has not been granted), submit lines of evidence indicating that SGe sample results are representative of what would be under the slab. SGe samples should be collected from depths below the building's foundation and along the side of the building closest to the source as a reasonable worst-case representation of conditions underneath the building in the absence of routes for preferential vapor migration or soil gas entry.

A revised Section 2.2.6 appears as Attachment 3 of this document.

[45] Page 19: This describes either a development of a site specific QAPP or utilization/reference of an IDEM created, generic, program specific QAPP in the sampling and analysis plan (SAP). Is there a preference or is one considered more the exception to the rule? In determining which to use, is it more dependent on the project or the program the project is in? (Creek Run)

Where available, IDEM prefers reference and adherence to a program-specific QAPP, with modifications noted.

[46] Page 19: Will scope changes and subsequent investigative phases requiring QAPP revisions need to be submitted for IDEM review? (MSECA)

This may vary based on program needs or requirements. Consult your IDEM project manager for direction.

[47] Page 20?: The use of judgmental samples should be clarified. Step out samples can be classified as systematic samples if the direction of the first step out is determined randomly (EPA, 2002). Only two types of sampling appear to be referenced in the R2, judgmental, and systematic. The use of stratified samples and composite sampling may often be warranted. Judgmental samples should not be used for any statistical exposure level characterization (USEPA, 1992). If one bases a sampling location using any form of personal selection, it is commonly treated as judgmental sampling. If so, then subsequent samples cannot be used for exposure point determinations. Sampling considerations should be primarily based on exposure areas and receptors. The R2 does not define an exposure area and does not appear to take an exposure area approach. This concept is fundamental to receptor risk and widely discussed and used in various USEPA documents. Please consider USEPA Exposure Area guidance (1996a, 1996b, 2002). (Thompson)

IDEM understands that the referenced approach does not strictly conform to U.S. EPA guidance. However, upper confidence limits of the mean derived from sample arrays that are biased toward higher concentrations (as when samples are located judgmentally) will also in general be biased high relative to results obtained from systematic arrays. They may, however, allow closure even when a single sample result somewhat exceeds the relevant remediation objective. IDEM's intent in allowing this approach is to be flexible and to prevent a single exceedance (or a small set of exceedances in a large sample set) from unnecessarily standing in the way of closure, even when the overall exposure risk is acceptable.

[48] On page 20 in the second paragraph under Sampling Design IDEM states that "it is possible to start [sampling] near potential receptors and step in toward a source." While this is theoretically a valid approach, there is a natural reluctance to do so as how can one be sure that one's site is the cause of the contamination found near the receptor? This is especially true for receptors that are not immediately adjacent to the Site one is investigating. (Neely/Troy Risk)

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Sampling receptors first is an option that may be appropriate in some circumstances. If multiple sources are present, or potentially present, it may not be the best way to proceed.

[49] Page 21: "...IDEM may conduct field audits during any sampling events." The vast majority of environmental consultants welcome IDEM participation in sampling. It should be noted however, that while there is authority for IDEM to perform audits, IDEM staff are still subject to safety and procedural protocols established by the site owner and/or environmental consultant managing the site. In some instances, this may include prerequisites for site entry (e.g. site-specific training, background checks, etc.). (MSECA)

IDEM acknowledges and agrees with this comment.

[50] Page 22, Table 2-A: Why isn't cyanide listed for Metal Finishing Industry or Manufactured Gas Plants, as it is commonly used? (MSECA)

IDEM accidently shifted some cells when re-formatting this table and has corrected the table by doing the following:

For E-85, DELETE: Phenols, Cresols, Cyanide, Misc.

For Auto Salvage, DELETE: Cyanide.

For MGP, ADD: Phenols, Cresols, Cyanide.

For Metal Finishing: ADD: Cyanide, Misc

A corrected and revised Table 2-A appears as Attachment 2 of this document.

[51] Page 22, Table 2-A: Certainly as noted on page 21 of the draft document, "When there is incomplete or unreliable information about activities at a facility, IDEM programs may specify pre-defined lists of chemicals for analysis." Given Indiana's historical range of activities and industry, I applaud this. My concern surfaces as the section continues with Table 2-A. For Table 2-A to contemplate COCs associated with, for example, each industrial type in Indiana would be an impossible task. However, I'm concerned that a common industrial process and its wide suite of COCs is overlooked: degreasing, and other solvent uses such as for extraction, separation, and purification. In particular for degreasing and other solvent uses, I'm concerned about lack of attention to solvent stabilizers historically added to solvents commonly used and found as contaminants in Indiana. And especially for site types such as dry cleaners where Table 2-A would allow an immediate narrowing of VOCs to a known used specific solvent, or for other industrial facilities where a specific solvent was known to have been used and VOC investigation may otherwise be narrowed, solvent stabilizers that were added to known used solvents and released with the solvents will be overlooked. Many of these known used solvent stabilizers have screening levels published in IDEM's tables. Please see, for example: • 1,4-Dioxane and Other Solvent Stabilizers white paper, Thomas K. G. Mohr, Santa Clara Valley Water District, June 14, 2001, https://www.valleywater.org/sites/default/files/2019- 10/Solvent%20Stabilizers%20White%20Paper.pdf, • Environmental Investigation and Remediation: 1,4-Dioxane and Other Solvent Stabilizers, Thomas K. G. Mohr, CRC Press, 2010, and • Environmental Investigation and Remediation: 1,4-Dioxane and Other Solvent Stabilizers, Thomas K. G. Mohr et al, CRC Press, 2020, 2nd edition, for information about specific solvent stabilizers known to have been added to specific solvents. Known solvent stabilizers added to the many solvents present as contaminants in Indiana, including CVOCs identified in Table 2-A and other VOCs, should be included as analytes in N&E investigations. To exclude these is overlooking the potential presence of known contaminants with sufficiently quantifiable exposure risk as to merit inclusion in screening level tables. (Stathyelich)

Table 2-A focuses on the majority of potential sources / release related chemicals that IDEM deals with. The footnotes on this table clarify the chemical or chemical class of interest. For example, footnotes 3 and 4 are relevant to the Dry Cleaning Industry. From a practical standpoint, IDEM would normally request chlorinated VOCs. If VOCs are analyzed at a dry cleaning site, the VOC list can quickly be narrowed to chlorinated VOCs unless analytical data suggest otherwise. The lists in this table are not exhaustive. Depending on the release, IDEM may ask for specialized testing. For example, there are sites where 1,4-dioxane is the focus of remedial efforts. A corrected and revised Table 2-A appears as Attachment 2 of this document.

[52] Page 22, Table 2-A: PCBs were not created in the gas manufacturing process and are not a constituent of interest for MGP sites unless there was an associated electric operation such as an electric substation. Additional clarifying language is warranted in the footnote for this table. (Vectren)

IDEM agrees with this comment and has modified footnote 7 to read:

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[7]Where electrical generation occurred, or if transformers are/were present, analyze for and report total polychlorinated biphenyls (PCBs) and Aroclors

A corrected and revised Table 2-A appears as Attachment 2 of this document.

[53] Page 22, Table 2-A: "Hydrocarbon Oil Range Product" needs additional explanation via foot note. (MSECA)

IDEM agrees with this comment and has added footnote 11 to the "Hydrocarbon Oil Range Product" listing as follows:

[11]Fuel oil #4, #5, #6, bunker oil, virgin motor oil, hydraulic oil

A corrected and revised Table 2-A appears as Attachment 2 of this document.

[54] Page 22, Table 2-A: In Table 2A on page 22, why have PCBs, SVOCs, and metals been omitted as COCs for Waste/Used Oil; Unknown Petroleum Product? These COCs have been observed in waste/used oil releases in the past. (Neely/Troy Risk)

PCBs, SVOCs, and metals were dropped about ten years ago based on data received over many years. The listed requirements are consistent with Table 3.1 of the 2012 Remediation Program Guide. A corrected and revised Table 2-A appears as Attachment 2 of this document.

[55] Page 23: What constitutes a training record, and what level of training is considered adequate? (MSECA)
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[56] Page 23: What will be the basis for "adequate" training? (MSECA)
+
[57] Page 23: IDEM should ensure adherence to approved SAP but should not take on the role of vetting the training of consultants. (MSECA)

IDEM may request documentation that persons conducting sampling have followed the most recent up-to-date approved Sampling and Analysis Plan. This may include a copy of the SAP followed, field notes, chain of custody documentation and any other means used by the consultant to demonstrate compliance with either an approved SAP or with the default protocol if a specific SAP has not been required. Under some circumstances IDEM may also request proof of specialized training if sampling requires certification. For example, asbestos removal and lead paint abatement technicians require specialized training to obtain the required certification.

[58] Page 23: Should a SAP be submitted to IDEM for approval prior to completion of all work? For ELTF eligible petroleum sites, should the SAP be part of the scope of work form submittal for cost preapprovals, or should the SAP be approved by IDEM first and then submitted with the scope of work (SOW) form? Also, IDEM's draft Independent Closure Process (ICP) document appears to indicate many petroleum sites will be in the ICP with minimal oversight from IDEM, including for ELTF eligible sites. How does preparing and submitting SAPs during investigation (as well as SOW forms for cost pre-approvals) reconcile with the minimum oversight provided when following the ICP? (Creek Run)

A SAP should only be submitted when there are deviations from the generic QAPP, which can be documented in a project-specific sampling and analysis plan (SAP). Please follow the UST Program QAPP.
https://www.in.gov/idem/tanks/files/tech_guidance_investigation_ust_releases_20180724.pdf

Preapproval of all costs related to site investigations and corrective action is proposed within the new rule to increase certainty and limit risks related to managing projects from inception through NFA, including ELTF eligible projects within ICP. SOWs will be reviewed and approved by IDEM staff. Please follow the UST Program QAPP.

[59] "…project SAP, including the most recent version that IDEM has approved." The reviewer interprets this phrasing that IDEM approval of a SAP is required prior to any investigative activities. Is this a correct interpretation? (MSECA)

This is a program call. Some programs may have generic QAPPs or SAPs and prefer that only deviations from those generic documents be noted and submitted for review.

[60] Page 24: Under Section 2.2.4, IDEM notes the importance of understanding "stratigraphy". We agree. We recommend that IDEM develop further guidance and training on this topic. For example, IDEM may want to consider incorporating the following EPA paper "Best Practices for Environmental Site Management: A guide for Applying Environmental Sequence Stratigraphy to Improve Conceptual Site Models" found at:
https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=341373&Lab=NRMRL (Gillay)

IDEM acknowledges and agrees with the comment, and notes that the R2 cites the referenced paper.

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[61] In Table 2B on page 25, assuming this is asking for one sample at each end of a UST less than 10,000 gallons, it would be better to state: "One sample under each end within 2 feet below each UST." As it currently reads it could easily be misread to indicate two samples should be collected under each end. (Neely/Troy Risk)

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[62] Also in Table 2B, wouldn't it be helpful to require that samples should be collected where a hole is identified in a pipe rather than simply at its midpoint? (Neely/Troy Risk)

IDEM has deleted the former Table 2-B, as the language in the table is virtually verbatim from 329 IAC 9-6-2.6(b), and therefore duplicative.

[63] Page 26: In bullet #3, it is unclear what is being directed for soil sampling. It sounds like we are no longer able to take subsets of soil samples during advancement/screening (i.e. 1 for PID and 1 set aside in cooler for analysis from same interval) and then submit the cooler sample for analysis later after selecting the interval. (MSECA)

IDEM has replaced bullet #3 with the following three bullets:

- *Collect all subsamples as soon as possible after removing the soil core from the borehole. Do not collect subsamples from soil that has been exposed for more than a few minutes.*
- *When sample selection for laboratory analysis is based on field screening results, intermediate subsamples from the soil core may be collected and stored in plastic or glass containers with zero headspace in a cooler with ice while field screening is completed. If selected for laboratory analysis, the intermediate subsample container is removed from the cooler and a fresh surface is created in the intermediate subsample to allow for collection of a final subsample to send to the lab.*
- *The procedures for collecting the intermediate subsample, the separate subsample used for field screening, and the final subsample must be clearly documented in the field record.*

[64] Page 26: "Five minute" limit should be changed back to "least amount of time" as written in the method. (MSECA)

The changes described in IDEM's response to Comment #63 should address this concern.

[65] Page 27: The guidance no longer provides published levels associated with the migration to groundwater (MTGW) pathway, in favor of utilizing SPLP analysis to determine the potential for leaching to groundwater. There is some concern that this approach could add significant cost to investigative efforts. While the guidance recommends locations for analysis that exhibit the greatest concentrations in the vadose zone, this approach implicitly requires a remobilization to the site as such determinations cannot typically be made in real time. Previously the MTGW published levels provided a conservative indicator of leaching potential, and SPLP analysis was reserved as a decision for responsible parties to demonstrate leaching on a site-specific level. Maintaining MTGW published levels is recommended. (MSECA)

IDEM has determined that the migration to groundwater levels derived from a very simple leaching model and published in its table have little predictive power, and therefore very limited value as a line of evidence. Further, where it is possible and reasonable to do so, IDEM prefers to base decisions on observed behavior rather than modeling. Finally, because IDEM will expect groundwater sampling to occur at the overwhelming majority of releases, it should be readily apparent whether or not leaching or direct release to groundwater has already occurred. IDEM does not expect leaching tests to be necessary for most releases, and when they are the information will be most relevant to remedy design, which usually occurs later in the project cycle. Because IDEM also proposes to stop publishing residential and commercial soil direct contact levels for volatile chemicals, and because most of our releases involve volatile chemicals, responsible parties may see a reduction in soil sampling and analysis costs.

[66] Removal of Soil Migration to Groundwater (MTG)screening levels Section 2.2.4 "Sampling Soils - Evaluating Leaching Potential" and Section 3.4.5.2 "Selected Leaching Potential Remedy Decision Scenarios" state that the evaluation of the leaching pathway is assessed using the SPLP. A minimum of three vadose zone soil samples from the area of highest release-related chemical concentration should be collected and analyzed using SPLP.

- Ramboll agrees that the SPLP analysis is a very useful approach for evaluating leaching potential. However, many sites do not have SPLP data, especially during the initial stages of the investigation. Therefore, the soil MTG screening levels should be retained to assess leaching potential and assist with determining where soil should be analyzed using the SPLP method. Multiple LOE are an appropriate concept in the guidance. Removal of soil MTG screening levels takes away a useful LOE.

Please refer to IDEM's response to comment #65 above.

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- The use of a dilution attenuation factor (DAF), as outlined in Section 9.9.3 of the 2012 Remediation Closure Guidance, should also be retained. The SPLP results predict worse-case pore water concentrations and therefore, a DAF should be applied to the SPLP results before comparing to groundwater unconditional remedial objectives (URO).

  SPLP does not necessarily predict a worst case pore water concentration for all chemicals, particularly mobile chemicals with relatively low K_d (e.g. trichloroethene). The volume of water used in the leach test typically results in a lower concentration than would be observed in the field for chemicals with lower K_d values, including most organics like trichloroethene.

- Both the use of soil MTG screening levels to guide the collection of SPLP data and applying a DAF to SPLP results before comparing to screening levels are consistent with guidance from other states (NJDEP, 2013).

  New Jersey's guidance does allow the application of a DAF when modeling soil migration to groundwater using SPLP data, but it does not directly apply a DAF to the SPLP results. The SPLP leachate concentration is first converted to a theoretical 'field leachate' concentration using project-specific data and K_d values for the chemicals of interest. This 'calculated' leachate concentration is then compared to a "screening" level calculated using a DAF. Essentially, the approach results in use of a DAF (default is 20) for inorganics but eliminates the DAF for organics with lower K_d values. IDEM expects SPLP to be used primarily for new releases or where impermeable barriers are present. Given the difficulty inherent in predicting future concentrations, IDEM prefers conservative approaches, and considers direct comparison of leachate concentrations to protective groundwater concentrations most appropriate.

- The ability to use groundwater analytical results to assess the leaching to groundwater pathway should be included if the site has a comprehensive groundwater monitoring network, the release is not recent and/or the release is not located under an impermeable barrier that might be removed in the future. (Ramboll)

  IDEM agrees with Ramboll's fourth bullet point.

[67] Page 27: This section seems more willing to accept grab groundwater samples as preliminary data and includes multiple methods of sampling including bailers and peristaltic pumps. This has not been the case in many of IDEM's comment letters that continually criticize the collection of grab water samples for preliminary investigation. (MSECA)

IDEM has determined that it is often useful to collect groundwater samples from boreholes prior to installing permanent monitoring wells. Groundwater grab samples can be collected using a variety of methods. Samples from boreholes are useful both to determine and refine the extent of release-related chemicals in groundwater. However, groundwater grab samples cannot provide time series data and may not accurately represent steady state conditions. Therefore, permanent monitoring wells are typically needed for remedial evaluation and risk assessment.

[68] Page 27: "... compared low-flow sampling and bailers and found no significant differences in recovery of volatile organics." Are bailers an option now? The next paragraph goes on to discuss acceptable pumps. (MSECA)

Bailers are an acceptable option (especially at petroleum releases).

[69] Page 28: If a sample effervesces it is unacceptable, an unpreserved vial should be used for sample collection. - not really a comment, just something to note (MSECA)

IDEM acknowledges this comment, and notes that the final paragraph of Section 2.2.5 states that when samples effervesce, unpreserved vials should be used and labs notified as the holding time is seven days, not 14 days.

[70] Page 28: Recommend deleting "not a common occurrence". (MSECA)

IDEM has revised the referenced sentence as follows:

Sampling groundwater at monitoring wells with measurable NAPL is typically not required. However, sampling of wells with trace amounts (i.e., less than 0.1 feet) of NAPL may be appropriate if it is necessary to address a clearly defined project-specific objective.

[71] Page 28: One item that is evolving within VI is the use of high volume sampling. IDEM should at least mention this as part of the investigative techniques. (MSECA)

IDEM has revised the relevant paragraph of Section 2.2.6 as follows:

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IDEM recommends the use of evacuated canisters or sorbent samplers for sample collection if the data is to be used for risk assessment. If consistent with project DQOs, options described above (or equivalent) can be used to collect samples to allow for on-site analysis using analytical techniques that can generate data to support project objectives.

There are many other possible techniques, such as:

- *High volume sampling*
- *Building pressure manipulation*
- *Triggered/event-based sampling (indicators, tracers, surrogates)*
- *Continuous sampling (e.g., on-site GC/MS)*
- *Portable GC/MS (e.g., discrete samples with Tedlar® bags)*
- *Large sample sets to characterize variability (possibly calculate upper confidence limit of the mean)*

With the possible exception of building pressure manipulation, use of these techniques will need to include consideration of seasonality, except when used to locate indoor air sources. The optimal approach will depend on circumstances and may change as the investigation proceeds. IDEM will evaluate alternate approaches on their merits, but because the conclusions of many vapor intrusion investigations are based on a relatively limited data set that typically represents variable vapor concentrations, IDEM has determined that conservative approaches are generally preferable when investigating vapor risk.

A revised Section 2.2.6 appears as Attachment 3 of this document.

[72] Page 28: Understanding HVAC settings for commercial/ industrial facilities is a vital component to the VI CSM. IDEM should include a statement recommending that HVAC conditions should be noted during paired indoor air / subslab sampling events (MSECA)

IDEM agrees with this comment and has included a reference to a documentation example.

[73] Page 28: Recommend changing "…vapor characterization must include sampling in preferential pathways..." to "must include consideration of". (MSECA)

+

[74] Page 28: "…vapor characterization must include sampling in preferential pathways, including conduits." Context is needed for the characterization of preferential pathways relative to the distribution of contaminants relative to the conduit, the magnitude of impacts, and the nature of the conduit (e.g. sewer line vs electrical conduit). To simply say conduits must always be sampled is overly restrictive, especially as the science of preferential pathways continues to develop. (MSECA)

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[75] Page 28: Paragraph three of this section states that vapor characterization "must" include sampling in preferential pathways including conduits. This statement is overly broad and does not account for site characteristics, the potential for conduits to be impacted by multiple sources, or the likelihood of the conduit in question being in contact with contaminated material. (MSECA)

IDEM generally agrees with comments 73-75 and has changed the referenced text as follows:

Preferential pathways, including conduits, can allow vapors to reach indoor air without significantly affecting the subsurface beneath a building. For this reason, vapor characterization must include consideration of, and in some cases, sampling in preferential pathways, including conduits. Refer to Section 2.2.6.4 for more information regarding appropriate situations for sampling within preferential pathways.

A revised Section 2.2.6 appears as Attachment 3 of this document.

[76] Page 28: IDEM indicates that preferential pathways would include buried utility lines and more specifically the backfill surrounding those lines. We understand that investigation of these pathways is necessary for certain classes of chemicals (e.g., chlorinated solvents), but for other chemicals, we are not sure that the risk of vapor exposure via these preferential pathways justifies the additional risk involved with sampling these locations. Vapor sampling of utility backfill via probing or drilling could greatly increase the risk of hitting a buried gas or electrical line which could result in serious accident and injury. Some of these lines could be difficult to locate with sufficient accuracy to allow safe sampling of the vapor in the backfill materials. In addition, it is possible to damage the protective coating on steel lines via hand auger sampling methods which could lead to later corrosion problems. We recommend that IDEM carefully weigh the risk of accident/injury versus the potential risk due to vapor exposure through utility backfill pathways. (Vectren)

In response to this comment, IDEM has revised the relevant text in Section 2.2.6 as follows:

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Exterior soil gas sampling (SGe) is appropriate for determining a soil vapor source, delineating soil vapor plumes, use as a stand-alone investigative tool to evaluate vapor intrusion potential at structures whose owners do not grant access for sub-slab sampling, during preferential pathway backfill investigations (in limited circumstances), or when evaluating vapor intrusion potential at undeveloped properties (depending on the SGe sampling density).

In addition, IDEM has revised the relevant text in Section 2.2.6.2 as follows:

Exterior soil gas samples come from boreholes advanced into the vadose zone in areas outside the footprint of a structure. Exterior soil gas samples are also useful when identifying and delineating a chlorinated solvent source via the soil gas plume, evaluating preferential pathways, vapor intrusion potential at undeveloped properties, or when a property owner will not permit installation of subslab soil gas sampling ports. While vapor samples within the backfill of preferential pathways may aid some investigations (e.g., those with irregular impact distribution), IDEM is mainly focused on vapor migration within conduits during delineation in preferential pathways. Assessing the need for a remedy due to preferential pathway vapor intrusion may also involve conduit sampling (Section 2.2.6.4).

A revised Section 2.2.6 appears as Attachment 3 of this document.

[77] The R2 repeatedly portrays vapor intrusion sampling as "highly variable" to the point of connotating it is not reasonable to attempt to characterize this variability. The R2 states users should take a very conservative approach. The repetition of these claims and caution seems overstated. IDEM does not provide insight into how "highly variable" is defined. The repercussions of this policy position are significant. First, it will reduce the use of technology and methods that can characterize variability. Second, new staff may be biased against even trying to characterize variability or, if it has been characterized, will entirely dismiss the application. Understanding variability is critical to establishing confidence in remedial decisions. VI variability is a function of the site and source dynamics and, as such, no different in concept than assessing groundwater variability. Commonly, significant VI variability is the result of attempts to measure low concentrations or the use of inadequate or error-filled sampling procedures. Several EPA documents specifically address expected variability. A good place to start is USEPA (2010), Temporal Variation of VOCs in Soils from Groundwater to the Surface/Subslab. This document characterizes SS and SG with low variability. Wouldn't it be wiser to characterize the variability to better support informed decisions, rather than place additional requirements on closure or methods because of concerns about the uncertainty in understanding variability? Again, data support for the "highly variable" judgment would be beneficial. As a general observation, the manual should encourage the use of alternate sampling technologies that can characterize variability in real-time. Characterizing the variability is a central part of risk assessment and results in a significant increase in the level of confidence regarding any site decision. Similarly, it may be useful to evaluate VI sampling variability given the level of protection built into the vapor intrusion screening levels for GW, SS, and SG (see Appendix B). What is wrong with taking the same approach to SG and SS as GW? Set up monitoring wells and sample them systematically at the same time you take GW samples. In most cases, you do not need to take TO15 samples to characterize SS/SG sample concentrations. Just take systematic (10%) TO-15 duplicates to verify the method is comparable and use less expensive analysis methods. The overall cost to characterize the variability is likely to be less than the ad hoc methods one would use to try to compensate for not characterizing variability. An IDEM/Consultant or MSCECA workgroup would be useful to assist with methods that increase confidence in characterizing variability, instrumentation and methods, evaluation of new equipment, guidelines on transport in the vadose zone based on soil structure and gas flow, etc. (Thompson)

IDEM is not opposed to calculating variability but does not expect it to be a common closure method. IDEM has added a bullet for 'large sample sets to characterize variability (possibly calculate UCL)' to the list of acceptable approaches in Section 2.2.6 to further clarify that it would be acceptable.

[78] Page 29: The use of portable remote access instrumentation that can deliver continuous real-time data is critical to determining variability in soil gas and indoor air. These techniques lend themselves well to continuous output, allowing variability to be assessed continuously. They can be monitored remotely, are very reliable, and cost-effective. The R2 continually references VI variability but does not address any mechanism to assess variability or promote the need to address variability through direct measurement. Understanding this variability is key to increasing confidence in VI site decisions. As discussed below, a host of alternate methods exist and should be encouraged for cost-effective and other reasons. A Vapor Intrusion Variability Workgroup is needed to address these concerns, provide technical assistance and guidance. Please address VI variability with the development of techniques that can define variability. (Thompson)

IDEM generally agrees with the use of these technologies, provided that they are NOT considered a substitute for seasonal sampling, and with a caveat that decisions about whether any additional expense associated with their use will be eligible for reimbursement by the Excess Liability Trust Fund is outside the scope of the R2.

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[79] Page 29: Individual certifications for cannisters is not consistent with the science. Any one highly contaminated groundwater sample could cause carryover at the instrument level, yet the SW-846 methods do not require blanks to be analyzed every other sample. Mandating that canisters being initially certified is the same premise. Batch certification provides a similar level of quality control at the same frequencies as other SW-846 QA/QC samples, such as 10% frequency for continuing calibration verification samples, or 20% frequency for lab control samples. (MSECA)

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[80] Page 29: "Individually certified canisters are necessary for indoor air sampling." The basis for an individually certified canister is to reduce/eliminate the potential for a false positive result. Given the extended costs and often reduced availability of individually certified cans, the decision for their use at the potential risk of a false positive result should be a project level decision and not a requirement. (MSECA)

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[81] Page 29: Recommend replacing "necessary" with "recommended". IDEM should limit its concern to low biased results. (MSECA)

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[82] On page 29 in the first bullet point, IDEM states that "Individually certified clean canisters are necessary for indoor air sampling." This is an added cost that is not justified. Batch certified canisters are adequate for indoor air sampling. (Neely/Troy Risk)

IDEM agrees that batch certified cannisters are acceptable but notes that IDEM will likely treat results from "contaminated" batch certified cannisters as legitimate until shown otherwise.

[83] Page 29: IDEM comments Tedlar bags are only acceptable in very specific situations. Are these situations when risk evaluations and analytical data are not involved? Please provide clarification as Tedlar bags and the collection of data using them is very valuable for specific situations such as remediation system monitoring. (MSECA)

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[84] Page 29: Tedlar bags are reliable and useful for many contaminants, especially given that the analysis cost is considerably more economical. Please consider providing references to support the statement on page 28 that Tedlar bags are not accurate for any contaminant. Please see a series of articles and invite expert opinion on the topic at http://www.handpmg.com/services/fixedbaselaboratory.html. In general, it would be useful if the R2 would encourage the use of alternate, more cost-effective methods to characterize variability and exposure levels. The R2 could (should) address how to verify less expensive methods using a low number of systematic TO-15s as QA. TO-15s by grab and flow control can be obtained in many volumes with variable sample times. Many consultants have used alternate methods, including Tedlar bags (sampled and shipped concurrent with TO-15 and analytically verified) to support cost-effective variability assessment. IDEM should encourage, and perhaps even assist, in the use of these methods. The bullet notes on page 28 do not even mention continuous monitoring or how to verify TO-15 compliance with any continuous or intermittent sampling method. Many consultants, including this author, have reliably used 8260 methods, on-site Mass Spec or GC methods, and a host of other techniques that are reliable, and more cost-effective. Please consider addressing these in this section. Please encourage less expensive methods. There is a considerable body of data on the reliability of alternate methods. Please consider forming a workgroup to explore and communicate these options. (Thompson)

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[85] Page 29: Tedlar bags have a lot of use in the environmental field. They should be allowed for screening purposes in a variety of environments. Need clarification on when/how IDEM will allow consultants can use Tedlar bag data. (MSECA)

IDEM finds the comments on Tedlar® bags to be constructive, and revised bullet #3 to address and/or incorporate some recommendations:

- *Tedlar® bags are only acceptable in very specific circumstances, due to concerns about leaks, pressure changes during transport, cleanliness certification, and short holding times (48 hours). They can be used to collect high concentration (ppmv) grab samples. Their use in projects where low concentrations (ppbv) are expected is limited due to potential leaks and bag cleanliness. Tedlar® bags can be used as a screening tool for initial site investigations and monitoring.*

[86] Page 29: The subsequent bullet points identify several sampling methodologies, but does not include real time analytical methodologies. Some discussion of such methods is recommended for inclusion in this section. (MSECA)

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[87] Page 29: Recommend adding bullet accepting glass Bottle Vacs for high concentration applications. (MSECA)

IDEM has revised the referenced text as follows:

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As noted in U.S. EPA (2015) there are several types of vapor sampling technologies. It seems likely that new technologies will continue to appear and evolve. Consistent with its treatment of soil and groundwater sampling procedures, the Risk-based Closure Guide provides only a brief summary of some standard approaches to vapor sampling. A short annotated list of some common technologies follows, but it is not complete. IDEM will accept vapor data collected using any type of vapor sampling technology that meets project-specific DQOs.

[88] Section 2.2.6.1, Page 29: Soil Gas Sampling: General Considerations states, "Soil gas samples are whole air samples collected from within the soil matrix". Not all appropriate soil gas sampling methods are "whole air" samples. There are sorbent methods (e.g. TO-17) and passive methods. (MSECA)

IDEM agrees and has revised the referenced sentence to read:

Soil gas samples are air samples collected from within the vadose zone.

[89] On page 29 under 2.2.6.1 SGss samples may be from sand, gravel or other construction material beneath a building as well as soil. (Neely/Troy Risk)

IDEM agrees and has revised the text accordingly.

[90] Page 29: We recognize that IDEM has set recommended deferments for sampling post precipitation events, but what is the basis for the current 72 hour and 1-inch recommendation? Can IDEM cite/quote this in the guidance? (MSECA)

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[91] Page 29: Can you please further clarify what defines, "a significant precipitation event (at least one inch of rain)"? Is it 1-inch of rain accumulatively over 72-hours? 1-inch of rain over 24-hours? 1-inch of rain over 1-hour? The existing definition is too ambiguous. (MSECA)

IDEM has changed the relevant text on page 29 to read:

Significant precipitation may cause high vacuum readings, extended sample collection time, and visible moisture droplets within the sampling train during sample collection. If these occur during sample collection, results should be considered as a minimum value and may not be representative of typical conditions. Therefore, IDEM generally does not recommend collecting SGe samples during or immediately after a significant precipitation event [at least one inch of rain within 72 hours (ITRC, 2007)].

[Where ITRC (2007) is Vapor Intrusion pathway: A Practical Guideline. https://www.itrcweb.org/Documents/VI-1.pdf.]

[92] Page 30: "Soil boring logs should note soil moisture conditions for each soil gas sampling port." Should this determination be made by laboratory analysis or is geologist observation sufficient? (Creek Run)

Field observation is sufficient.

[93] Pages 29-30: Recommend broadening "consulting geologist" to "consulting professional". (MSECA)

IDEM has changed the text as follows:

Because of this, IDEM relies on the professional judgment of a qualified geologist (e.g., a Licensed Professional Geologist) to determine when sampling conditions are appropriate.

[94] Page 30: IDEM needs to further define its request to collect a soil gas sample "closest to the source(s)." What is "close to a source"? 5 feet above groundwater source? within how many vertical feet? And define source, preferential pathway sources? (MSECA)

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[101] Page 30: In the first paragraph on page 31 IDEM cites USEPA's erroneous statement that "soil gas samples collected from a depth just above a known or suspected vapor source are preferable to shallow soil gas samples for purposes of predicting the potential of vapors to enter structures. This is inaccurate as it makes no allowance for bioattenuation of vapors in the intervening soil column nor the presence of impermeable barriers between a deep source and a structure. Shallow soil gas (SGe and SGss) samples are much better indicators of the likelihood of a structure being impacted from the subsurface as they more accurately represent vapors that are present in the near surface environment and are able to enter a structure. (Neely/Troy Risk)

Revisions to Section 2.2.6 (see Attachment 3) reflect IDEM's response to address concerns within this comment. Unfortunately, IDEM cannot define a generic vertical distance between the source and what is considered "near source"

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because it should be geology and location specific. IDEM has updated wording to consider impacted units, moisture conditions and impermeable barriers within the subsurface to help guide sample placement.

[95] On page 30 in the second paragraph under Exterior Soil Gas: Sample Number and Placement IDEM states that "IDEM recommends sampling stratified/nested soil gas points to evaluate vertical attenuation of vapors through the soil column." There may be times where this approach has merit, but if the primary concern is, as it should be, determining if there is the likelihood of indoor air exposure, then only shallow soil gas sampling should be required. Turning environmental investigations into science projects is not appropriate. (Neely/Troy Risk)

Revisions to Section 2.2.6 (see Attachment 3) reflect IDEM's response to address concerns within this comment. For stratified SGe points, IDEM attempted to explain that they can be a tool for evaluating attenuation of vapors vertically through the soil column. Delineation of vapors closest to the source is being requested as it gives a better indication of worst-case conditions. As these impacts extend under structures, the capping effect experienced by buildings may cause similar near source concentrations. Additionally, future building use must be taken into account during site investigations and if vapor concentrations are above published levels at depth, future basements may be impacted by these deeper impacts.

[96] On page 30 in the last paragraph IDEM states, "collect SGe samples from two locations near residential buildings: the side of the building closest to any known vapor source, and the upgradient side of the building." Again, IDEM appears to be turning environmental investigations into science projects. If the source is cross-gradient to the residence, sampling the upgradient side of the residence is not initially necessary. This may be a helpful second step if there is an indication that soil gas on the side toward the source is impacted above regulated levels to evaluate the potential of another source for the impact. (Neely/Troy Risk)

In response to this comment, IDEM has revised the relevant portion of Section 2.2.6.2 as follows:

Unless professional judgment suggests otherwise, collect SGe samples from two locations near residential buildings, along the side of the building closest to any known vapor source. For large commercial buildings, two or more SGe samples per side of the building may be necessary to characterize vapor conditions in the subsurface, and additional SGe sampling locations may be necessary along multiple sides of the building.

A revised Section 2.2.6 appears as Attachment 3 of this document.

[97] Page 31: In comment #3, to clarify, does the two day equilibration timeframe for newly installed SG via "auger" refer to hand auger? (MSECA)

IDEM does not intend "auger" to mean only "hand auger". Any auger that meets project DQOs is acceptable.

[98] Page 31: In point 3 IDEM cites California EPA recommendations on equilibration time after soil gas port installation. However, IDEM fails to set standards for sampling in Indiana. It is critical that IDEM set forth clear standards for our State rather than simply citing what is done elsewhere. (Neely/Troy Risk)

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[100] Section 2.2.6.2, Page 31: Sampling Exterior Soil Gas (SGe), Active Soil Gas Sampling Procedures, Bullet #3 states that, " U.S. EPA (2015) notes that installing soil gas probes can disturb subsurface soil conditions, and recommends allowing the subsurface to equilibrate prior to sample collection. Appropriate equilibration times depend on installation technique. For example, the California Environmental Protection Agency (Cal EPA, 2015) recommends an equilibration time of two hours for temporary driven probes and two days for probes installed using an auger." This section does not address equilibrium time before sampling for permanent ports installed by direct push methods. Furthermore, it has generally been acceptable to wait 24 hours after direct push or hand auger borings to collect representative samples. Ports should be purged after installation. Data from a number of projects have shown that samples collected after 24 hours have been consistent with long term sampling results. (MSECA)

IDEM has modified the cited text on page 31 as follows:

Appropriate equilibration times depend on installation technique. IDEM recommends sampling at least 24 hours after a permanent probe has been installed. Based on project objectives, temporary probes may be installed and sampled as soon as two hours after installation.

[99] Page 31: Sampling Exterior Soil Gas (SGe) indicates that it is acceptable to use copper, brass, polyvinyl chloride (PVC) and polyethylene materials for soil gas sampling. Studies have shown that PVC, polyethylene, and copper have the ability to

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absorb and off gas VOCs. Furthermore, brass is a copper alloy that has been questionable. It is preferred that Teflon, Nylon, and stainless-steel materials be used for high level investigations given we are generally looking at microgram levels as screening values. (MSECA)

IDEM has modified the first sentence following the second point as follows:

To avoid cross-contamination of vapor samples by the sampling equipment, use vapor probes made of inert materials (e.g., stainless steel, Teflon®, Nylon®, polyethylene, etc.) that are appropriate to sample the release-related chemicals (U.S. EPA, 2015; Ohio EPA, 2020; Schumacher et al., 2016).

[102] Page 32: "Collect SGss samples during at least two different time periods…" Throughout discussions of sampling protocols, some context as to the magnitude of results is needed. The magnitude of variability is something that should be considered. For example, sub-slab published values often exceed laboratory detection limits by several orders of magnitude. Non-detect or low-level detections are unlikely to exhibit three+ order of magnitude changes as part of typical variability. There are occasions where multiple lines of evidence can accurately eliminate the vapor intrusion exposure pathway after a single event. This should be acknowledged in the guidance. (MSECA)

IDEM agrees that there may be occasions when lines of evidence support a decision to rule out vapor intrusion after a single sampling event. Responsible parties are free to advance lines of evidence in support of such a decision. However, IDEM notes that EPA's 2015 vapor intrusion guidance notes the importance of multiple sampling events to account for seasonal variability. IDEM typically recommends collecting SGss samples during at least two different time periods to rule out vapor intrusion.

[103] Page 32: What does IDEM mean by having a sleeve through the floor for subslab data collection? Does IDEM mean tubing? (MSECA)

Yes, sleeve refers to tubing.

[104] Page 33: IDEM should change the recommended approach to sampling within residences to be one subslab sample per home unless conditions indicate more samples are appropriate based on professional judgement. True, US EPA recommends three per residence, but this is rarely necessary or cost effective for most risk assessments. (MSECA)

IDEM recognizes that three SGss samples at a residential structure may be impractical. IDEM agrees that one SGss sample in a residential structure is sufficient unless conditions indicate more sampling is needed. IDEM has revised the text as follows:

U.S. EPA (2015) recommends collecting at least three SGss samples at structures with a footprint less than 1,500 square feet. However, IDEM recognizes that this may be impractical or unobtainable in residential structures. Generally, IDEM recommends collecting at least one preferentially located (i.e., close to known source(s)] SGss sample in residential structures. Additional SGss sample locations may be necessary pending evaluation of the building structure and data collected. IDEM will rely on these building evaluations and professional judgment to determine if additional SGss sample locations are necessary.

[105] Page 33: Per statement included therein, what would IDEM consider to be an inconclusive data set that would trigger IDEM's request for additional sampling? I think that this statement is far too vague and gives IDEM PMs a lot of autonomy in decision making. (MSECA)

IDEM agrees with the comment and has modified the referenced text by deleting the word 'inconclusive':

If the results of the first two SGss sampling events are contradictory, IDEM may request additional sampling.

[106] Page 34: Section 2.2.6.4 "Sampling Conduit Vapor" states that all conduits (including sewers) should be sampled.

- This pathway is not necessary to assess by default at every site, but only if site specific conditions suggest the potential for vapor transport via conduits. It is unclear what scenarios warrant the sampling of conduit vapor. The guidance appears to address two scenarios; 1) vapors from contaminated groundwater that intersects a conduit (e.g. sewer) and 2) direct discharge of contaminants to conduits. Clarification of the scenarios that warrant conduit sampling will be helpful.

  It is IDEM's intent to assess each conduit that may be a preferential pathway for vapors. As the R2 text states and the commenter notes, the two scenarios where IDEM is recommending conduit sampling are when contaminated groundwater intersects a conduit and when direct discharges of contaminants into conduits have occurred.

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- The citation by IDEM, Roghani et al (2017), is primarily a study of trichloroethene (TCE) vapors in sewer lines that came from contaminated groundwater leaking into the sewer lines. Therefore, sewer conduit sampling should be conducted only if a VOC groundwater plume is in contact with a sewer line. If water traps to prevent sewer gases from entering buildings (as discussed in Section 2.3 of the 2015 USEPA Vapor Intrusion Guidance) are empty, malfunctioning, or missing, the risk is of vapor intrusion from the sewer rather than subsurface environmental media per se, and the most appropriate course is to fix or replace the water traps.

  The citation provided by IDEM was an example to note the importance of evaluating conduits as preferential pathways; other citations could be listed (Pennell et al., 2013; Guo et al., 2015; Jacobs et al., 2015 and 2016; Kastanek et al., 2016; McHugh et al., 2017a and 2017b; McHugh and Beckley, 2018; and Wallace et al., 2017, for example). IDEM agrees that if a structure's plumbing system is compromised and connected to impacted conduits then those plumbing issues should be addressed and maintained until contaminants from the release no longer impact conduits connected to those structures.

- Vapor intrusion groundwater screening levels have been eliminated from the guidance. Therefore, it is unclear how to identify conduits that warrant sampling in areas where release-related chemicals are detected in groundwater.

  IDEM has modified the text to note that if vapor forming chemicals are leaking into a conduit then investigation of that conduit will be necessary:

  Sewers and other open conduits can receive, intercept, and transmit vapors or liquids containing volatile chemicals to receptors. While there are differences between conduits (within an open pipe) and utility corridors (backfill around underground utilities), IDEM considers both to be anthropogenic preferential pathways. As multiple studies note, there is increasing recognition of the importance of conduits as a pathway for vapor intrusion, as vapors can migrate into occupied structures through plumbing systems that are not properly maintained (Roghani et al., 2017; Pennell et al., 2013; Guo et al., 2015; Jacobs et al., 2017; McHugh and Beckley, 2018). In the text below, the term "chemicals" refers specifically to vapor forming chemicals.

- For other types of conduits, if there are known unused historical conduits through a foundation in a building being investigated for vapor intrusion, then these conduits should be sealed rather than left open for sampling. (Ramboll)

  If a building has unused historical conduits through its foundation, first determine if those unused conduits are preferential pathways for vapor migration. Then seal conduits that act as a pathway for vapor migration. Conduit sealing may be regarded as an engineering control that may require OM&M and continued vapor sampling if the potential for VI remains.

[107] Page 34: Given the small amount of real world data collected from sewers, the lack of scientific studies regarding migration from sewers to indoor air, should additional work be done to fully understand this pathway before assigning attenuation factors and sampling expectations which may prove to be overly prescriptive or incorrect as the science evolves? (MSECA)

The use of the likely conservative attenuation factor proposed within the R2 is a starting point to evaluate VI that may be occurring from conduits. IDEM determined this is more reasonable than automatically assuming an investigation of the connected structure is necessary if IASL exceedances are found within the sewer line. IDEM will consider updating attenuation factors as scientific studies reveal new information. IDEM will also consider data from site-specific attenuation factor studies.

[108] Page 34: Conduit vapor sampling and related investigations will undoubtedly reveal "plumbing systems that are not properly maintained". If an RP identifies vapor migration due to improperly maintained sewer systems or a sewer system that is not up to code, whose responsibility is it to repair the sewer line? (MSECA)

The exposure risk is still caused by the contamination, regardless of the status of the infrastructure/building. There is still a responsibility to adequately control the vapor exposure risk.

[109] Page 34: What criteria will be used to determine when delineation in a conduit is complete? What is the scientific basis for these criteria? (MSECA)

Based on responses received during the 12/17/2020 open forum that included discussion of what was used during the McHugh and Beckley 2018 SERDP sewer study, IDEM has modified the cited text to read:

Sample each conduit that meets the criteria above and that may be a preferential pathway for vapors. Additionally, collect one up-gradient and two down-gradient conduit vapor samples from each conduit (where gradient is determined by the

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flow direction of liquids inside the conduit). Delineation of conduit vapor should continue in the appropriate direction(s) until concentrations no longer exceed published levels for conduit vapors or their project-specific equivalents.

[110] Page 34: How does IDEM intend to distinguish between 1) exposure to conduit vapors that result from vapor intrusion from 2) vapors that form in sewers due to permitted or unpermitted sewer system inputs of the same COCs? For example, a legal POTW permit may allow discharge of water containing VOCs to a sewer system and this legal discharge can create exactly the same conditions within the conduit as vapor intrusion. These conditions may prove to be especially confounding in densely populated areas. (MSECA)

While distinguishing between legal discharges and release-related site impacts to a conduit may be complex, multiple rounds of sampling, research, and evidence presented regarding the legal discharge facilities and both up- and down-stream sampling is anticipated. Additionally, if it is determined that site-related vapor forming chemicals are entering the preferential pathway, cutting off the pathway would aid in differentiating between sources. IDEM intends to reasonably evaluate this complicated issue on a case-by case basis.

[111] Pages 34-35: Can IDEM provide references to other regulatory agencies that have adopted similar vapor conduit sampling requirements/expectations? (MSECA)

California is currently the only other regulatory agency that has proposed similar vapor conduit sampling expectations. EPA guidance (along with that of multiple other states) notes that vapors can enter structures through sewers and other conduits, but EPA guidance does not provide sewer or conduit investigation recommendations.

[112] Page 34: "…high and low groundwater conditions." should be elaborated. Seasonally high/low, relatively high/low? Absolute high and low could be years apart. (MSECA)

IDEM agrees with the comment and has changed the cited text to:

Collect conduit vapor samples quarterly over the course of a year.

[113] Page 34: IDEM makes reference to sampling within conduits and makes it seem as though every conduit in every structure needs analytical data. Agree that conduits need to be evaluated, but IDEM should not create the mandatory requirement that sampling is necessary in all structures. The lines of evidence have to be there to support doing so. (MSECA)

IDEM has altered text in sections 2.3.6.1 and 2.3.6.2 (A revised version of Section 2.3.6 is Attachment 4 of this response document) to clarify expectations for determining when to sample within conduits. IDEM has also altered the text referenced in the comment as follows:

Collect conduit vapor and/or liquid samples from those conduits most likely to have the highest concentrations of release-related volatile chemicals. IDEM recommends evaluating conduits when (1) the conduit was used for volatile chemical disposal and/or (2) shallow groundwater that contains volatile chemicals intersects those conduits.

For example, if chemicals were disposed of directly down a sink drain leading to the sanitary sewer, a conduit vapor sample can be collected at the closest point of access to this source (e.g., behind the u-bend of the sink, the sewer cleanout leading from the property, or closest connected conduit access point). However, research has shown that there may be larger variability if the sample is collected from a sewer cleanout rather than a maintenance entrance (McHugh and Beckley, 2018). If shallow groundwater containing release-related chemicals intersects a conduit, a conduit liquid sample can show whether those chemicals are infiltrating the conduit, thus functioning as a continuing source of vapor into the conduit. In this scenario, conduit vapor samples should be collected with conduit liquid samples.

Sample each conduit that meets the criteria above and that may be a preferential pathway for vapors. Additionally, collect one up-gradient and two down-gradient conduit vapor samples from each conduit (where gradient is determined by the flow direction of liquids inside the conduit). Delineation of conduit vapor should continue in the appropriate direction(s) until concentrations no longer exceed published levels for conduit vapors or their project-specific equivalents.

[114] Page 34: IDEM requests delineation of conduit vapor. What standard does IDEM request conduit vapors be delineated to? What is the scientific basis of the delineation standard? (MSECA)

IDEM recommends delineating conduit vapors using conduit vapor published levels, which apply an attenuation factor of 0.03 to IASLs. The basis for the use of this attenuation factor comes from a SERDP study performed by McHugh and Beckley. The use of the likely conservative attenuation factor proposed within the R2 is a starting point to evaluate VI that may be occurring from conduits. IDEM determined this was more reasonable than assuming that if IASL exceedances were found

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within the sewer line that an investigation into the connected structure(s) was warranted. IDEM will consider updating attenuation factors as scientific studies reveal new information. IDEM will also consider data from site-specific attenuation factor studies.

[115] Please consider including clarity on mixed vapor or co-mingled vapor plumes in conduits and the subsurface. This topic is addressed for GW on page 53, but there is no discussion of co-mingled vapor plumes. The standard assumption in Section 2.2.6.4 appears to be that the only source is the release being investigated. Vapor from any release to a subsurface conduit and especially open sewers can migrate in any direction. Please provide a reference and support for the 0.1 attenuation factor used on page 77 (Section 3.4.4.4). Has USEPA or ITRC defined this attenuation factor? Conduit investigation is a rapidly evolving and new field. The references in the R2 relative to these topics should be sufficient evidence of this evolution. Please consider forming a workgroup or a subgroup of an emerging issues committee to address this continually evolving field. Please consider joint development with consultants and other professionals when developing new or interim VI methods. It may be useful to develop a larger workgroup with Region V states and Invite EPA to participate. Who is serving on ITRC or other workgroups, and how do they communicate advances in this field? (Thompson)

IDEM recognizes that the typical scenario is the existence of a commingled vapor plume in sewer pipes and other public conduits; however, if the Site involved is contributing contamination to the plume, either through a release to groundwater resulting in infiltration to the conduit or through a direct discharge, then it must address the impact even though it may not be the sole contributor. If the Site can demonstrate that is not contributing to the contamination or that different and distinct contaminants exist in addition to its contribution, IDEM will pursue other sources. While IDEM does not have the authority to allocate liability, and in most cases is not required to pursue all contributors, if a Site can provide lines of evidence that there is another off-site source, IDEM may, and often does, investigate and pursue other contributors when warranted.

[116] Page 35: The need for quarterly sewer vapor/liquid sampling seems aggressive and warrants more consideration/clarification on how IDEM plans to use/direct sites with that information. When will this IDEM "Sewer Manhole Sampling Guidance" be available? Delineation is to continue as needed, what is defining factor to confirm the liquid/vapor impacts are from site in question and not from another? (MSECA)

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[117] Page 35: Sampling Conduit Vapor: Frequency & Duration: It states that conduit sampling should be performed quarterly. How many quarters do we need to sample to provide appropriate delineation of the preferential pathway/conduit pathway? Or will two (2) quarters within the "worst-case" scenarios suffice? As Nick Hill mentioned, when will the "Sewer Manhole Sampling Guidance" be available? (MSECA)

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[118] Page 35: IDEM requests quarterly sampling events for conduit vapors. For how many quarters? If conduit vapors are below the "delineation standard" then why continue to collect quarterly samples? How many conduit sampling events are necessary to rule out the potential for a VI pathway and what is the scientific basis for it? (MSECA)

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[119] On page 35 in the first paragraph, IDEM states “perform quarterly sampling events or use longer term passive samplers.” There is no indication of how many quarterly sampling events are adequate or what is an adequate length time for a passive sampler. (Neely/Troy Risk)

- *IDEM recommends four quarterly conduit samples for a year based on the variability noted in McHugh and Beckley's 2018 study.*
- *As previously noted, IDEM acknowledges that distinguishing between legal discharges and release-related impacts to a conduit is likely to be challenging and may require lines of evidence derived from an understanding of the conduit construction, multiple rounds of sampling from both up- and down-stream locations, and evidence regarding legal discharges from relevant facilities. IDEM intends to reasonably evaluate this complicated issue on a case-by case basis.*
- *IDEM has removed the reference to the Sewer Manhole Sampling Guidance, as it is still under development. Once a draft of the Sewer Manhole Sampling Guidance is completed, IDEM will send it through the NPD process, which will include an opportunity for public comment.*
- *IDEM recommends discussing passive sampling duration with your preferred lab and passive sampler manufacturer based on the objective of the sampling (delineation versus risk assessment).*

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[120] Page 35: "See IDEM's Sewer Manhole Sampling Guidance (under development) …" Incorporation by reference of documents yet to be completed and technical guidance documents that have not been subject to public review seems inappropriate. See general comment above. (MSECA)

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[121] Page 35: Under Section 2.2.6.4, IDEM notes that it is developing "Sewer Manhole Sampling Guidance". We suggest that IDEM remove any discussion on sampling within sewers until such time as it releases a draft of this guidance. (Gillay)

IDEM agrees with these comments and has deleted references to guidance that is under development.

[122] Page 35: How long should crawlspace vents be closed during a sampling event? (MSECA)

IDEM has revised the referenced text to read:

Although a standard timeframe is not noted in other guidance, closing crawl space vents 24 hours prior to the sampling event is reasonable.

[123] Page 36: Project-specific vapor sampling plans should account for HVAC layout and operating conditions during time of sampling. (MSECA)

IDEM agrees with this comment and has revised the language on page 36 to read:

Historically, the winter heating and summer cooling seasons have been considered the worst-case sampling scenarios for vapor intrusion. This is because windows and doors are typically closed during the heating and cooling seasons, and HVAC systems can create a pressure differential that draws vapors up from the subsurface. Project-specific vapor sampling plans should account for HVAC layout and operating conditions during time of sampling. If the project-specific vapor sampling plan will be used for multiple sampling events, the indoor air building checklist should reference the sampling plan and note any changes in HVAC conditions between sampling events. In addition, falling water table conditions that commonly prevail in the summer can expose source material.

[124] Page 38: "If AA is a concern" makes it sound like collecting an AA sample is optional. Is that IDEM's intent? (MSECA)

IDEM does intend that collection of AA samples be optional and has modified the text to read:

If activities near the proposed sampling area may contribute to indoor air concentrations, it may be advisable to collect an ambient air sample over the same time period as indoor air samples.

[125] Page 38: The hyperlink to the US Department of Health and Human Services Household Products Database does not work (householdproducts.nlm.nih.gov's server IP address could not be found.). (Creek Run)

IDEM agrees with the comment and has removed the link.

[126] Page 38: Under Section 2.2.6.8, IDEM discusses the complications of indoor air background sources. We suggest that IDEM incorporate the recent TSCA risk assessment on TCE which includes estimated exposure concentrations from consumer use of products containing TCE. (Gillay)

The document referenced by the commenter is still in draft. Therefore, to be consistent with responses to other comments, IDEM does not plan to cite it. In any case, potential indoor air sources should be removed to the extent practicable prior to sampling indoor air.

[127] Recommend adding examples of when full QA/QC is necessary: final nature and extent?, final confirmatory sampling? (MSECA)

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[128] In previous years, the necessity for the full QA/QC documentation has been questioned. To this reviewer's knowledge no feedback has been provided to indicate that any IDEM review of the specified full QA/QC documentation has resulted in significant alteration of interpretation or directional change for a project. This reviewer considers it to be an unjustified and unnecessary expense for the vast majority of projects. (MSECA)

IDEM has modified the language in Section 2.

Table 2-B lists elements that IDEM has determined are essential to support two levels of QA/QC. Submission of the Full QA/QC elements in Table 2-B is necessary to validate data in accordance with U.S. EPA's National Functional Guidelines for Data Review (U.S. EPA 2020c, 2020d, 2020e). A smaller set of elements that IDEM calls minimum data documentation recommendations (MDDRs) are appropriate to support investigations where data validation is not necessary. IDEM

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programs to which this guidance applies (Section 1.1) will not typically require submission of the Full QA/QC elements listed in Table 2-B but may require submission of those elements on a project-specific basis. Analytical results submitted to OLQ should, and where required by OLQ programs must, meet the IDEM/OLQ Electronic Data File Submittal Guidelines.

[129] Page 43: What "other media" besides those mentioned. List them too.

IDEM has changed the relevant sentence to read:

Extents are most often determined for chemicals in soil, groundwater, and vapor, but may be relevant for sediment and surface water.

[130] Page 43: "IDEM will not require a determination of likely future extents under every conceivable circumstance. Determinations should focus on scenarios that are reasonably likely to occur. Where there is disagreement about what is reasonable, responsible parties must submit lines of evidence in support of their position. IDEM will consider those lines of evidence on their merits, using professional judgment and knowledge of the circumstances specific to the release. Sometimes determining extents is impractical or unnecessary. Proposals to forego or limit extents determinations must be supported by lines of evidence provided by the responsible party. IDEM will not provide them.": This is contrary to how IDEM has operated recently within the ELTF LUST/Petroleum Remediation Section. There have been many cases where the contaminant plume(s) were not defined (even leading toward a neighboring off-site property), the consultant and the RP recommended additional investigation, and IDEM stated that further investigation was not needed nor approved. The responsible party/consultant has then had the burden to provide evidence that additional work is necessary. (Creek Run)

The IDEM Petroleum Remediation Section has the dual roles of regulatory oversight of petroleum remediations to ensure protection of human health and the environment, and the fiduciary role of administering the Excess Liability Trust Fund and conserving it to ensure its continued viability for use into the future. Investigation activities beyond those that are reasonable and necessary to ensure protection of human health and the environment can be voluntarily undertaken by the responsible party for the Site, as long as those actions do not exacerbate an existing release and are protective of human health and environment. However, costs related to investigation undertaken by the responsible party that is not required to adequately address the contamination based on the risks posed will not be reimbursable from the ELTF.

[131] Page 44: Starting in the last paragraph on page 44 and continuing onto page 45 is discussion of determining horizontal extent using the "step-in approach." This approach should only be applied to potential receptors that are very close to a specific source area, otherwise it would be possible for a release from another source to be the cause of impacts near that receptor. (Neely/Troy Risk)

There is no requirement to use the "step-in approach". The appropriate approach will depend on project-specific circumstances.

[132] Page 45: Vertical Extent Delineation: wet soils should now be sampled and compared to direct contact levels and considered for direct contact exposure? (MSECA)

Yes, it may be appropriate to sample some "wet" soils and compare the result to appropriate levels. All Indiana soils contain some amount of moisture. Wet, even saturated, soils can be brought to the surface. If the chemicals associated with those soils are persistent, those chemicals will be available for future exposure and it is appropriate to consider that possibility.

[133] Page 45: "It will be necessary to continue at least until excavation worker levels are delineated." Soil investigations immediately adjacent to source areas are often logistically limited by structural interference. Further, some remedial decisions are possible without a complete delineation to excavation worker levels, although conservative assumptions may be necessary. (MSECA)

IDEM acknowledges that structural interference sometimes impedes investigations, and that it is appropriate to modify sampling activities to account for this. Document structural interferences and subsequent modification of sampling activity in reports. Remedial decisions are inherently project-specific.

[134] Page 45: When evaluating Present Extents, specifically vertical extents, R2 states that sampling below 15 feet to evaluate direct contact is not generally necessary. Section 2.2.2 discusses that in the absence of gross impacts or high field screening results, the sample interval with the highest porosity should be sampled. These two statements appear to be in conflict. (MSECA)

IDEM has revised this portion of the text as follows:

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If chemicals were released directly into the subsurface or have leached or otherwise moved into the subsurface over time, subsurface samples will usually be necessary to understand the potential for soil exposure. Sampling below 15 feet to evaluate soil exposure risk isn't generally necessary unless exposure to soil below that depth is likely to occur (e.g., as the result of excavation or movement of soil). However, sampling deeper than 15 feet below ground surface may be necessary to inform remedy design, understand a soil source that is affecting groundwater or vapor, understand vertical migration of DNAPL, or for other reasons.

[135] Page 46: Previous experience has identified a frequent misunderstanding as it relates to the characterization of a compound as a dense non-aqueous phase liquid (DNAPL) and its ability for vertical migration. Once a DNAPL compound is dissolved and even minimally diluted, the density differential that promotes downward vertical migration is no longer present. On numerous occasions IDEM staff have requested deeper vertical investigation based upon minimal dissolved concentrations, even when site-wide project concentrations give no indication of residual free phase product (e.g. concentrations at 10% solubility). Further, even in the presence of free phase product, mass must be adequately substantial to overcome pore pressures and displace groundwater. Clarifying these DNAPL behavior distinctions would be a valuable addition to the guidance and/or an independent technical document to avoid wasted time, effort, and money in unnecessary vertical extensions of investigations. (MSECA)

The relevant text on page 46 refers to NAPL, not dissolved chemicals. IDEM agrees that dissolved chemicals behave differently than NAPL, but IDEM must account for the difficulty of locating and verifying the presence of NAPL in unsaturated soils. Because NAPL can be so difficult to find, IDEM has determined that very high concentrations of dissolved chemicals (relative to their solubility) may be indicative of the presence of NAPL, even in the absence of direct observational evidence. Therefore, it may be prudent to investigate the presence of release-related chemicals in deeper formations. US EPA (https://semspub.epa.gov/work/HQ/174833.pdf) provides additional guidance on this topic.

[136] Page 46: "Soil moisture may impede flow rates, while increased soil porosity may facilitate flow." We believe the term "permeability" should replace "porosity". Porosity is a measure of how much of a soil is open space between grains. Permeability is a measure of the ease with which fluid can move through the soil. For example, both sand and clay deposits are very porous (30-50% for sand and 40-70% for silt and clay), but while sand can be quite permeable, clay typically is not. (Creek Run)

IDEM has revised the sentence to read:

Soil moisture may impede flow rates, while increased soil pore size may facilitate flow.

[137] Page 47: If soil SPLP results are favorable and if deeper vadose zone soil samples are non-detect, then can groundwater monitoring be avoided, or is groundwater monitoring expected regardless? (MSECA)

IDEM has revised the text to read as follows:

IDEM will typically require groundwater sampling whenever a release is known or suspected, except for surficial releases of insoluble chemicals

[138] Page 48: Must software be used for isoconcentration maps depicting delineation. Is it acceptable to use a combination of software and professional judgment? For example, based on the density of data, software like Surfer may fail to close boundaries or present a realistic fit to the data without some manual manipulation. (MSECA)

Software is not necessary to create iso-concentration maps. Indeed, software created plume maps should be ground-truthed by an environmental professional. When software is used to create iso-concentration maps, indicate the software used to do so.

[139] Page 48: Recommend changing "…Future Extents Delineation…" to "…Future Extents Estimation…". (MSECA)

IDEM agrees with the comment and has changed "Future extents delineation" to "future extents estimation"

[140] Page 49 should state, "New wells may be unnecessary…" (MSECA)

IDEM acknowledges the comment and has revised the relevant text on page 49 as follows, and relocated it to Appendix C (included as Attachment 7 of this response document):

Well locations are important when characterizing likely future extents. How the monitoring wells relate to one another is used to evaluate the spatial component of the plume. If all the monitoring wells within the plume exhibit approximate trends in the same direction with comparable slopes, then a single summary statement across the well network is valid (EPA

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2006b). If the time-trends do not show a consistent pattern, it is likely that one or more wells are not screened in the same flow zone, or a previously unknown source may be affecting the observed concentrations. In either of these cases, new wells may be necessary to understand plume behavior.

Data on chemical concentrations levels and aquifer characteristics should come from wells and boreholes capable of providing a clear three-dimensional picture of the hydrogeologic and geochemical characteristics of the location. If the wells do not meet appropriate criteria, or if conditions change, previously installed wells may no longer produce samples that adequately represent the plume. In such cases, new wells may be necessary.

[141] Page 50: "Figure 2-A depicts a typical likely future extents demonstration well network." While it is referred to as "typical," the subsequent language describing the network (derived from previous IDEM guidance – RISC & RCG) is specifically prescriptive, with the use of terms such as "must" and "at least." It is unclear from the guidance if in fact these specific well location requirements are required. (MSECA)

IDEM agrees that the language in this section, which has moved to Appendix C (see Attachment 7 of this response document) is more prescriptive than most of the language found in the rest of R2. It refers to a specific procedure for statistically evaluating plume behavior. The procedure itself is not required, but it does have specific standards that must be met for the procedure to produce valid results (e.g., at least eight quarters of data).

[142] Page 51: While the age of the release has direct implications for known petroleum extents, the line of evidence is not entirely without value to other contaminants. Even for chlorinated plumes, the age of the release is a valuable qualitative line of evidence that adds validity to plume observations as established plumes being more steady state rather than highly variable recent releases. While a priori assumptions cannot be made with regards to the future extent like petroleum related plumes, the age of a chlorinated release should be acknowledged as a contributing line of evidence for understanding the behavior of non-petroleum plumes. (MSECA)

IDEM has modified the text under "Age of the Release" as follows:

Age of the Release. *This line of evidence applies directly only to petroleum chemicals. Given the well documented behavior of petroleum releases, the age of the release is an appropriate indicator of the plume lifecycle. Regardless of the size of the release or subsurface conditions, the extent of most petroleum related releases will stabilize within approximately five years (Rice et al., 1995). Given this relationship, IDEM will have greater confidence in the behavior of petroleum plumes that have documented historic release dates. Conversely, the behavior of recent petroleum releases merits less confidence. The approximate age of a cVOC release could be applied in a qualitative assessment of steady-state plume behavior (i.e., the plume is no longer expanding). However, because most cVOCs can naturally degrade to more toxic and more mobile compounds, any disruption of the subsurface equilibrium eliminates the cVOC plume age as a line of evidence consideration.*

[143] Page 52: Groundwater Time of Travel and Hydraulic conductivity are measurements/values that would typically be considered quantitative data collected at the site and/or determined using modeling. Yet these are listed in the section of the RCG draft regarding qualitative lines of evidence. Does IDEM expect estimated values for these, foregoing slug testing and other measurements, and if so, what are potential sources for the estimates that IDEM considers acceptable? (Creek Run)

IDEM agrees with the comment, and has revised the introductory paragraphs of Section 2.3.5.3 as shown below:

2.3.5.3 Lines of Evidence Potentially Relevant to Likely Future Extents

Plume behavior *is how release-related chemical concentrations change spatially and over time, and interact with potential receptors. Plume behavior evaluation uses applicable lines of evidence to understand the likely future extents of release-related chemicals in groundwater. This in turn allows evaluation of potential exposure scenarios. If plume behavior is not predictable enough to enable a reasonable estimate of future extents, it may be necessary to undertake a groundwater monitoring program of sufficient length to add confidence to the understanding of plume behavior.*

Analysis of plume behavior relies on specific knowledge of local conditions. While meaningful statistical tests (see, for example, Appendix C) require substantial monitoring timeframes and consistent monitoring periods to acquire sufficient data, in some situations, concentration trends may be qualitatively discernible in shorter timeframes and/or with irregular time series data. Sometimes, data may show chemical concentrations in individual wells fluctuate unpredictably, but the overall plume footprint remains unchanged over time. IDEM will evaluate such interpretations on their merits.

Every likely future extent evaluation should begin with qualitative review of geologic, hydrologic, and release-related chemical characteristics. Likely future extents evaluations should also consider other relevant lines of evidence. This section

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describes several lines of evidence that may be useful in understanding plume behavior. Each line of evidence offers insight into the behavior of the plume, though some are more compelling than others. While no single line of evidence is enough to understand the overall behavior of a plume, agreement among multiple lines of evidence provides greater confidence when predicting plume behavior. It is not necessary to develop any particular line of evidence discussed in this section – only those needed to provide adequate confidence in the understanding of plume behavior. Other lines of evidence may be submitted, and IDEM will evaluate them on a project-specific basis.

[144] Page 53: IDEM provides qualitative LOE related to LNAPL but does not appear to consider quantitative analysis of LNAPL mobility and recoverability. Quantitative analysis of LNAPL transmissivity should be included as a LOE for evaluation of LNAPL. ASTM LNAPL Transmissivity Standard E2856-13, ITRC LNAPL documents (e.g., LNAPL-3), API LNAPL resource center all provide relevant guidance to quantitative means for evaluating LNAPL. These important resources should be referenced as LOE in the RCG (MSECA)

IDEM will focus on lines of evidence without attempting to classify them as "qualitative" or "quantitative" and has removed those qualifiers from the subsection headings in the text.

[145] Page 53: The last two sentences appear to be redundant, but the conditions cited are not consistent. "LNAPL between 0.01 and 0.1 foot" (sentence 1), and "LNAPL thickness exceeds 0.1 ft" (sentence 2). Similarly, "DNAPL…approximating one percent of their solubility" (sentence 1), and "DNAPL…between one and ten percent of their solubility" (sentence 2). The disparity requires resolution. (MSECA)

IDEM has changed the text associated with this heading to read:

Presence of Non-Aqueous Phase Liquid (NAPL). *NAPL may be an ongoing source for dissolved plumes and create new source areas. While the presence of NAPL does not preclude understanding the behavior of a plume, it does complicate that understanding. In such cases, additional lines of evidence may bolster IDEM's confidence in the understanding of plume behavior. IDEM will consider dense non-aqueous phase liquid (DNAPL) likely if groundwater concentrations of DNAPL-forming chemicals exceed ten percent of their solubility, and a potential concern if groundwater concentrations exceed one percent of their solubility (Kueper and Davies, 2009). For light non-aqueous phase liquid (LNAPL), IDEM will not generally request sampling of groundwater in wells where LNAPL thickness exceeds 0.1 foot, although additional investigation may be necessary to determine whether the LNAPL is potentially mobile. If LNAPL thickness is less than 0.1 foot, IDEM may request sampling of groundwater beneath the LNAPL to determine whether the LNAPL may be acting as a significant source of release-related chemicals in that groundwater.*

[146] Elimination of the groundwater vapor intrusion screening levels (VISL)

- Since many sites do not have soil gas or indoor air data, especially during the initial stages of the investigation, the groundwater VISLs should be retained as part of a multiple LOE approach to assessing vapor intrusion risk at a site since they provide the following:
  - assess if there is a potential for unacceptable risk from groundwater vapor intrusion
  - if so, they assist in determining soil gas and indoor air sampling locations o assist with remedy selection, source delineation, control, and/or reduction.
- Elimination of the groundwater VISLs is contrary to the 2015 USEPA Vapor Intrusion guidance which allows for groundwater vapor intrusion assessment, as stated below. Additionally, USEPA currently publishes and updates groundwater VISLs. From the 2015 USEPA VI Guidance:
  - Compare groundwater concentrations to the VISLs (Section 6.5) for groundwater to estimate the boundaries of the plume, when contaminated groundwater is the subsurface vapor source for vapor intrusion (Section 6.2.1).
  - Section 6.4.5: "When combined with an appropriate attenuation factor, groundwater data can be used to estimate a potential upper-bound indoor air concentration that may arise from vapor intrusion."
  - Depending solely on soil gas and indoor air samples to assess the vapor intrusion pathway, both current and future, has the following challenges:
    - As described in the proposed guidance (Sections 2.2.6.3 and 2.2.6.6), soil gas and indoor air concentrations vary over time depending on weather conditions, season, and changes to site characteristics (such as the removal of a slab). Therefore, they are problematic for assessing long-term vapor intrusion exposure, particularly for sites that will be redeveloped in the future and therefore site conditions will change. This

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uncertainty can be reduced by assessing groundwater vapor intrusion along with soil gas and indoor air samples as a multiple LOE approach.

- Access to homes and businesses not owned by the company tasked with the investigation in order to collect soil gas and indoor air samples can be a difficult and onerous process. This often results in data gaps that could be filled by assessing groundwater vapor intrusion.

- Section 2.1.2.3 Identifying Source Areas states that a groundwater source exists wherever release-related chemicals in groundwater are capable of volatilizing into soil gas at concentrations that exceed unconditional vapor remediation objectives. The elimination of groundwater VISLs does not support this. (Ramboll)

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[147] The Draft RCG2 proposes to omit published levels for groundwater as it relates to the potential for vapor intrusion (previously known as the vapor intrusion groundwater screening level – VIGWSL) in favor of an emphasis on three dimensional soil gas investigations. Groundwater screening criteria for vapor intrusion remains a calculated value by the US EPA, and the basis for omitting such criteria is unclear. In fact, groundwater screening criteria are the predominant factor in EPA guidance for directing vapor intrusion investigations. While there is some discussion that the VIGWSL was not a good predictor of actual vapor intrusion, it provided a conservative indicator for directing site characterization activities. The RCG2 emphasized approach of 3D soil gas investigations will likely add substantial costs to site characterization activities. This increase will not only be due to the addition of vertical sampling, but also to horizontal extents of soil gas mapping. It will also likely put a strain on sampling canister inventories that can already be in short supply. Further, as site characterization is typically an iterative process, it is unclear how the agency will interpret collective soil gas data that is obtained for an extended period (e.g., months or years). Historically, the comparison of groundwater results from limited timeframes was not considered acceptable by the agency. The reviewer recommends that groundwater vapor intrusion screening levels be maintained, with more intensive 3D soil gas investigations being a tool at the discretion of the responsible party for demonstrating site-specific conditions. (MSECA)

IDEM does not plan to publish VIGWSLs because:

1. *They have little predictive power;*
2. *U.S. EPA does not publish VIGWSLs in their tables either;*
3. *Despite our best efforts some continue to treat VIGWSLs as remediation objectives rather than levels in one medium that should prompt investigation of another medium;*
4. *VIGWSLs lead to an excessive emphasis on groundwater as a vapor source, and a neglect of soil sources. We have learned of several instances where this has happened and must wonder how often we have missed significant vapor issues. IDEM intends to make soil gas sampling a routine part of many initial subsurface contaminant investigations. USEPA maintains a groundwater vapor intrusion screening level calculator, and responsible parties are free to use that calculator if they find it useful. However, IDEM still intends to request soil gas sampling in appropriate instances as described in the R2.*

[148] Preliminary Screening of the Vapor Intrusion (VI) pathway is missing from this guidance. VI evaluations typically begin with an evaluation of source concentrations (soil, groundwater, and in some cases soil gas) within a certain proximity to occupied or potentially occupied buildings (CalEPA, 2020; CalEPA, 2011; MassDEP, 2016; MDEQ, 2013; NJDEP, 2018, PADEP, 2019; USEPA, 2015,WDNR, 2018). The process of using the proximity to source areas provides a starting point for VI investigations. It is understood that the R2 recommends "subsurface vapor sampling at all facilities that currently or historically used, stored, dispensed, or disposed of chlorinated volatile chemicals"; however, this does not provide a minimum starting point for a larger area of potentially affected properties. Within the construct of this guidance, this information could possibly be added to section "2.3.6 Present Extents: Vapor". (MSECA)

IDEM has substantially revised Section 2.3.6, in part to address this comment. The revised text is available in Attachment 4 of this response document.

[149] The document does not emphasize the importance of dissolved groundwater concentrations at the groundwater interface as a predominant driver of vapor intrusion. Previous guidance and other state and federal regulatory guidance acknowledges that it is concentrations at the water table that drive the potential for off gassing. Hence sampling methodologies targeting the water table are most demonstrative of the plume's potential for generating soil gas. (MSECA)

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*The commenter is correct that the R2 moves away from the RCG's almost exclusive emphasis on groundwater as a source of vapor intrusion. In the years since the RCG went final, IDEM has learned of multiple releases where significant vapor issues were discovered, even in the apparent absence of groundwater sources. For this reason, IDEM has determined that it is necessary to focus on considering and identifying **all** potential vapor intrusion sources – whether groundwater, soil, or conduits, without unduly emphasizing one over the other. As noted on page 54, this shift in emphasis in no way means that chemicals in groundwater should not be considered a potential or even likely source of vapor intrusion. It's just not the only potential source.*

[150] The R2 lacks discussion or understanding as to how groundwater concentrations can be an indicator of VI, including the importance of examining the shallow groundwater unit in terms of VI, clean groundwater lenses, and the elimination of the Vapor Intrusion Ground Water Screening Levels (VIGWSLs). Specific comments regarding the elimination of the VIGWSLs are as follows:

- VIGWSLs and the 100-foot buffer allow a "starting point" for the investigation and protection of downgradient locations from the vapor intrusion pathway. It is understood that the 100ft buffer is based on limited studies and in most cases is conservative (when preferential pathways are not present); however, it does allow for a quicker evaluation of the potential human health risks associated with the vapor intrusion pathway in a given area. For example, using the VIGWSLS and the 100ft buffer in a populated area may screen in several structures for VI assessment. Preparations can be made for obtaining access and sampling the properties in one mobilization and results can be received for a larger area immediately. Replacing the VIGWSLs with an exterior soil gas investigation, starting at the source, will prolong the investigation period and the time to reach adjacent structures (if necessary). A dynamic investigation including the installation of a soil gas monitoring network to quickly delineate the soil gas plume could be conducted; however, consultants will receive push back and denial of the work from their clients and third parties if any work proposals include activities that are not specifically required by IDEM. The R2 currently states to start at the source and characterize the vapor plume by conducting exterior soil gas sampling. This process may entail: o install soil gas ports on the Site and wait for results o step to the next property if the results indicate this is needed, and wait for results o step to the next property if the results indicate this is needed and wait for results, and so on Sampling will most likely only be conducted during worst-case seasons. Otherwise the results will not count towards screening out a property and are viewed as wasted resources. If this is the process in place, it may take a couple of years or more to fully delineate the vapor plume and identify actual vapor intrusion exposure to receptors.
- Vapor intrusion can occur from both contaminated groundwater and soil. Groundwater contamination is more often widespread than soil contamination. The structures screened in for VI assessment using the VIGWSLs and the 100ft buffer normally overlap and extend beyond the area where soil contamination is present. If groundwater is not contaminated and only soil contamination is identified at the Site, the current RCG already recommends using soil gas sampling to characterize the vapor plume from soil contamination. Maybe this could be elaborated on in the R2 to include other scenarios where soil gas is being "missed". (MSECA)

  *The R2 does move away from the RCG's almost exclusive emphasis on groundwater as a source of vapor intrusion. Unfortunately, the fact that IDEM has hitherto published VIGWSLs (but not similar levels for potential soil sources) seems to have focused attenuation on groundwater sources of vapor and led to neglect of potential soil sources. In the years since the RCG went final, IDEM has learned of multiple releases where significant vapor issues were discovered, even in the apparent absence of groundwater sources. For this reason, IDEM has determined that it is necessary to focus on considering and identifying **all** potential vapor intrusion sources – whether groundwater, soil, or conduits, without unduly emphasizing one over the other. As noted on page 54, this shift in emphasis in no way means that chemicals in groundwater should not be considered a potential or even likely source of vapor intrusion. It's just not the only potential source. IDEM shares the commenter's concern about completing work in a timely matter, and notes that IDEM is aware of large soil gas delineation efforts that have been completed in less than a week, and is also aware of many groundwater delineations that, for whatever reason(s), took years to complete. IDEM provides a list of reasons for discontinuing publication of VIGWSLs in its response to comments 146-147.*

[151] With regards to groundwater contamination, the "hot spot" could be far removed from the "source", generating a localized vapor issue that could not be detected through just soil gas delineation from the "source". Exterior soil gas sample results are highly variable. Samples from the same location can fluctuate orders of magnitude. We have seen cases where concentrations were detected at high levels during one sampling event, only to be non-detect in another sampling event. Potential exposure through the VI pathway could be missed based on the number and frequency of soil gas samples required. Exterior soil gas sample results can also underestimate the risk of exposure. We have seen several sites where we have both a groundwater

monitoring well network and a soil gas monitoring well network and have conducted paired sub-slab vapor and indoor air sampling at surrounding structures. Sample results collected from exterior soil gas wells located in the front yards of residential structures were either non-detect or below the screening levels, while sub-slab vapor sample results demonstrated contaminants above the IDEM screening levels during multiple events. Overall, it would be a mistake to eliminate the VIGWSLs for the reasons listed above. The biggest one being that this would slow the pace of VI investigations and would put the residence/occupants around a release at an increased risk of exposure, and at the very least for an extended amount of time, if identified at all. It will be harder for practitioners to do their job without having a starting point (distance criteria) to guide initial investigations. There can be "gaps" in the source areas of a groundwater plume and only looking at soil gas as an indicator for VI assessment may increase the risk of missing potential receptors from down-gradient hot spots. EPA and many other states (CalEPA, 2020; CalEPA, 2011; MassDEP, 2016; MDEQ, 2013; NJDEP, 2018, PADEP, 2019) use groundwater screening levels and the distance criteria to guide VI investigations. Wisconsin, which is a progressive state, does not use VIGWSLs, but includes a distance criterion of 100ft for soil contamination and uses the very conservative enforcement standards for groundwater contamination when assessing potential VI. Elimination of the VIGWSLs and any discussion of groundwater concentrations in proximity to structures from the R2 is a large oversight in the investigation of the VI pathway. In our experience, the problem with VIGWSLs is looking at them as a bright line or a remediation goal rather than an indicator to guide VI investigations. They are very useful as a screening tool, while actual sub-sab and indoor air data should be used as a remediation goal and for closure purposes. If IDEM is concerned about missing the "source" vapor plume, then exterior soil gas sampling should be an additive layer of the investigation objective. It would be reasonable and appropriate for IDEM to identify the source vapor condition as a baseline assessment requirement, as this has the highest propensity to pose a risk, but it is not the only condition or best measurement of risk to the local community around a release. (MSECA)

IDEM understands that soil gas delineation is unlikely to be a perfect approach to determining which structures require further evaluation for vapor intrusion potential, but as noted in responses to other comments, VIGWSLs have not been perfect either and over-reliance on VIGWSLs has been seriously misleading at times. IDEM acknowledges that soil gas concentrations can vary, though we sometimes see large swings in groundwater concentrations as the water table fluctuates, and often see very large differences between adjacent soil sample results, yet we've encountered little resistance to using data from those media. See IDEM's response to comment #150 for further discussion of timeliness and IDEM's concerns that VIGWSLs have the unintended effect of focusing excessively on groundwater as a vapor source.

[152] Are VIGWSLs no longer 'compelling lines of evidence'? (MSECA)

See IDEM's responses to comments #146-147, #149, #150, and #151 for further discussion on this topic.

[153] Page 54: The last two sentences appear to address 'future' or 'potential future' scenarios. Suggest that these belong in Section 2.3.7 instead. (MSECA)

IDEM agrees that the subject matter of the last two sentences belongs elsewhere, is covered elsewhere (e.g., Section 3.4.7), and has deleted them from the referenced paragraph:

Most release-related vapor intrusion exposures arise from two classes of volatile chemicals –chlorinated volatile organic chemicals (cVOCs) and, to a lesser extent, petroleum-related chemicals. Because the characteristics of chemicals in these classes differ somewhat from each other, criteria that trigger a vapor intrusion evaluation also differ between them. IDEM may require investigation of vapor intrusion potential arising from chemicals in other classes where lines of evidence suggest that is necessary to evaluate potential exposure.

[154] Page 56: Re: vapor extents determination for conduits. Is one sampling event sufficient to determine vapor extent? If so, conflicts with 2.2.6.5 statement regarding quarterly conduit samples. (MSECA)

IDEM has updated the text in Section 2.3.6 to state that four quarters of sampling is recommended for chlorinated chemicals. The revised Section 2.3.6 is Attachment 4 of this response document.

[155] Page 55, Table 2-D: Can IDEM identify examples of circumstances where IDEM will require delineation of conduit vapor related to a release of petroleum hydrocarbons? (MSECA)

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[156] Page 55, Table 2-D, Third row, "Groundwater containing volatile organic chemicals is in contact with a building that has cracks in its foundation or basement, or has drains or a sump pump.": Is this regardless of concentrations of said VOCs? (Creek Run)

IDEM updated the former Table 2-D (now Table 2-C) and presented the modified updates during the first external R2 session on 12/9/2020. The revised text is available in Attachment 4 of this response document.

[157] Exterior soil gas sample results are highly variable and rarely reproducible. Samples from the same location can fluctuate orders of magnitude. Potential exposure through the VI pathway could be missed based on the number and frequency of soil gas samples required. Exterior soil gas sample results can also underestimate the risk of exposure. The R2 generally states to start at the source and characterize the vapor plume laterally by conducting exterior soil gas sampling. Clients may want to: -install soil gas ports on the Site and wait for results -step to the next property if the results indicate this is needed, and wait for results -step to the next property if the results indicate this is needed and wait for results, and so on This work would be conducted during a worst-case season. Otherwise the results will not count towards screening out a property and are viewed as wasted resources. It may take a couple of years or more to fully delineate the vapor plume and identify actual vapor intrusion exposure to receptors. (MSECA)

IDEM has revised and expanded text in Section 2.3.6 to discuss the iterative process of soil gas sampling, which is similar to groundwater delineation. The section also discusses prompts to determine when VI assessments are necessary. The revised text is available in Attachment 4 of this response document.

[158] Page 55: "IDEM will not typically request vapor intrusion evaluation of structures at such facilities [gas stations for benzene]." The recognized OSHA exemption for benzene would not extend to chlorinated solvent compounds (e.g. trichloroethylene) that may also be associated with gasoline/service stations, or may have migrated to a gasoline station from an adjacent property. The reviewer recommends the distinction be noted within the guidance. Further, while the appropriate site-specific exposure limits can take into account the OSHA exemption for process-related chemicals, this alone is not a sufficient line of evidence to remove indoor air exposure testing for such operations for the following reasons:

1. Exposure to process-related chemicals is controlled through specific training, engineering controls, and written health and safety plans. These protective measures do not take into account vapor phase chemicals migrating into the building in an uncontrolled and unmonitored manner.
2. The current operations at a site may not be indicative of either the historic operations conducted at the property or the potential impacts from off-site operations. While an inventory of the operational histories for the property and the surrounding area can provide a summary of the potential impacts, the only verifiable method for evaluating vapor exposure is through indoor air testing. (MSECA)

IDEM has substantially revised Section 2.3.6.5 to better describe circumstances that should prompt a vapor intrusion investigations at gas stations. Section 2.3.6 is available as Attachment 4 of this response document.

[159] Page 56: "Delineate soil gas in three dimensions." It is not always practical to perform multi-depth soil gas evaluations (e.g. reasonably shallow groundwater), nor necessary to evaluate the potential for vapor intrusion. Calling for all soil gas investigations to be in three dimensions is unnecessarily prescriptive without the context of the site geology and nature of the release, and can incur significant expense. The necessity of three dimensional soil gas delineation should also take into context the potential remedial approach (e.g. all subsequent structure will include vapor mitigation). (MSECA)

IDEM has revised and expanded text in Section 2.3.6 to clarify circumstances when vertical soil gas delineation is recommended and what to do when shallow groundwater is encountered. Section 2.3.6 is available as Attachment 4 of this response document.

[160] "In many cases, IDEM's closure conditions will include an Environmental Restrictive Covenant that requires including vapor control measures in the new building design.": Such closure conditions should only be required when necessary. Creek Run has received IDEM requests for such restrictions in an ERC when other restrictions provided the same protections, without requiring vapor control measures in a new building design. For example, when groundwater contaminant concentrations exceed residential vapor exposure screening levels but are below commercial/industrial vapor exposure screening levels, and a non-residential land use restriction is being applied in the ERC, additional vapor restrictions were still requested. Also, vapor restrictions have been requested by IDEM when groundwater contaminant concentrations exceeding vapor exposure screening levels are only present within the rights of way, where construction of structures is prohibited. Vapor restrictions in such scenarios are redundant and add unnecessary long terms costs. (Creek Run)

Given the complexity of many releases and the project-specific decision making process that IDEM must employ, a certain amount of inconsistency is unfortunately not surprising. IDEM continues to work with staff to develop better understanding of risk-based closure principles and promote consistent decision making.

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[161] Page 57: Section 2.3.7.2 states that if the building will be constructed at some point in the distant future, the property owner may conduct further evaluation of the vapor intrusion pathway at that time to determine if building control measures are needed. When suitably constructed, documented, and validated using data that fully characterize the potential subsurface vapor sources and associated conditions in the vadose zone, mathematical models can provide an acceptable line of evidence supporting risk management decisions pertaining to vapor intrusion.

- Section 2.3.7.2 should be revised to include language consistent with the discussion of mathematical modeling in Section 6.6 of 2015 USEPA Vapor Intrusion Guidance which states that if using upper-bound estimates, validation using soil vapor sampling is not necessary.
- The use of modeling also allows for site-specific vapor intrusion assessments, which include accounting for building area, height, air exchange rates and presence of a basement. (Ramboll)

IDEM intends to require delineation of soil gas, and any property that was previously within the extents of a soil vapor plume that requires a vapor remedy would be presumed to require a remedy for future structures, barring sample evidence that shows otherwise. For this reason, IDEM anticipates that any future proposal to forego a remedy would require new sampling evidence to show that conditions had changed sufficiently so that a remedy is no longer required.

[162] Page 57: Recommend changing "…may result in lower concentrations…" to "…may result in lower remedial objectives…". (MSECA)

IDEM agrees with the comment and has revised the cited language as follows:

Delineation criteria may also differ, as ecological criteria often apply and may result in lower remediation objectives than those that apply to human health risk assessment.

[163] Page 58: Consider adding language addressing suggested / acceptable pore water sampling methods. (MSECA)

IDEM agrees with the comment and has added references to the following:

Burton, G. 1998. Assessing Aquatic Ecosystems Using Pore Waters and Sediment Chemistry. Aquatic Effects Technology Evaluation Program, Natural Resources Canada.

Interstate Technology Regulatory Council. 2011. Incorporating Bioavailability Considerations into the Evaluation of Contaminated Sediment Sites. Appendix C. Bioavailability Tools and Methods.

U.S. EPA Region 4, Laboratory Services and Applied Science Division. May 13, 2020. Pore Water Sampling. LSASDPROC-513-R4.

U.S. EPA. 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual, EPA/823/B-01/002. Office of Water.

[164] Page 58: This sentence is technically accurate but does not consider the nuances of the actual risks. While benthic fauna, if present, are protected by this interpretation, it is overly conservative for human health (fully mixed) surface water risks. (MSECA)

327 IAC 2-11-5(3) is intended to be protective of both human health and aquatic life. Some of the standards may be over-protective for human health, but that is not the only purpose of the Rule.

[165] Page 58: Consider adding that it is also acceptable to conservatively compare upgradient groundwater samples collected from near the discharge boundary to surface water standards. (MSECA)

Because sediments may be a source (either separately or in addition to groundwater) this approach is not generally acceptable.

[166] Page 58: This note should be attributed. Is this official, long-standing policy across all IDEM Offices supported by Rule, or is it just a policy specific to this draft document? (MSECA)

327 IAC 2-11-5(3) is Rule, not guidance. Waters of the State are defined in statute (IC 13-11-2-265).

[167] Page 58, last bullet point: What constitutes 'Adequate documentation …"? (MSECA)

IDEM acknowledges the comment and has replaced the last bullet point with the following:

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- *Adequate documentation for unrelated sources, if relevant. Adequate documentation typically includes release-related chemical concentration gradient data, location and operational history of any unrelated source(s), groundwater flow direction, time-series groundwater data, and other relevant project-specific documentation as available.*

[168] Page 58: The final statement implies that there is a 'standard' extent determination. If "Every release is different ..." (unique?), as stated in the first sentence, then what is a 'standard' determination? (MSECA)

IDEM has altered the cited text as follows:

Every release is different, and the number, location, and quality of sample points will vary based on the chemicals released, local geology, and the location and nature of potential receptors. ~~Extents evaluations that do not include the above information, or use conditional remediation objectives will be evaluated on a case-by-case basis. Non-standard extent determinations typically require more time to perform and review and may require more and/or higher data quality.~~

[169] Section 3.1: In principal, the Decision Unit terminology utilized by the guidance is practical. However, its application could cause concern, as it could be interpreted that full facet site characterization activities are required for each Decision Unit. In practicality, interpolation of analytical results across various decision units is typical. An example of interpretation concerns is the application to each building unit of a strip malls. It is not uncommon for access restrictions to limit investigation within every unit, and interpolation across units is common. The expectations of investigation of each Decision Unit are unclear, and depending upon interpretation, could result in significant cost increases and/or delays to closure. (MSECA)

IDEM agrees that interpolation and extrapolation are appropriate in many circumstances. This is discussed in the context of extents delineation in a small paragraph on page 45 of the R2, and again on pages 47 and 48. However, IDEM has included language that affirms the acceptability of interpolation and extrapolation for most applications relevant to decision units as part of a revised Section 3.1. The revised Section 3.1 is included in this response document as Attachment 5.

[170] Page 60: Future use considerations - while the intent is understood and appreciated, there is no documented process or limit to the scope of what satisfies the "future use consideration" for protecting human health and the environment while making a case for closure. Any clarity is appreciated. (MSECA)

As noted in the cited text, "in the absence of an IDEM-enforceable environmental restrictive covenant that restricts the area(s) affected by a release to specific uses, IDEM will typically assume that future residential use is reasonably likely at most decision units." Responsible parties are free to present lines of evidence that show residential use is unlikely, and IDEM will evaluate those lines of evidence on their merits. However, such situations will often be highly project-specific. IDEM considers it unlikely that it would be able to develop a "documented process" for evaluating those submissions that anticipates the various circumstances that might occur or the arguments that might be advanced.

[171] Pages 60-61: This could be taken to mean that a potential buyer of a property with an ERC attached is somehow responsible to IDEM for collection, evaluation and presentation of information to IDEM. If that is not the intent, please consider revising to clarify. If that is the intent, please state where is IDEM's authority to require this. (MSECA)

Indiana Code 13-14-2-6 gives IDEM the authority to enforce the terms of a restrictive covenant. Since a restrictive covenant runs with the land, it is binding upon any purchaser of the real property. A potential buyer of property with an ERC should have adequate notice of the ERC through a title search and is responsible for complying with the terms of an existing ERC if they buy the property. Further, under CERCLA and IC 13-25, a prospective purchaser must appropriately manage risk, including complying with any institutional controls (e.g. environmental restrictive covenants) that have been placed upon the property, to maintain its status as a bona fide prospective purchaser. Sometimes appropriately managing the risk includes collecting information and presenting it to IDEM to ensure that the purchaser's use of or proposed plans for the property do not result in unacceptable risk and/or exposures.

[172] Section 3.1: The use of the term "decision unit" is confusing. More clarity is needed on what constitutes a decision unit and how will IDEM expect these to be addressed in terms of achieving closure. (MSECA)

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[179] Section 3.1.2: How to Specify Decision Units is confusing. This whole section and terminology (Decision Unit) is confusing. This section implies that one property could be under two separate decision units in relation to GW and vapor. Risk evaluation should entail looking at any potentially affected property (which can be defined as any property located within the present or future extent of release-related chemicals) and evaluating and addressing all potential exposure pathways. This is not communicated clearly under this terminology and explanation. The term "Decision Unit" is not a known term within the field of risk assessment. Additionally, requiring "Decision units" for each pathway over complicates an already complicated

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process. In most cases, a potentially affected property in its entirety would be the Decision Unit or Area of Concern, or whatever terminology is decided on. For example, a commercial or residential property adjacent to the Site would be a potentially affected property. Each of these properties would be evaluated, considering release related chemicals in all media, all exposure pathways, and all receptor populations for a specific potentially affected property. The concept being described is understood, as well as the need to evaluate certain property uses and receptor populations using specific exposure assumptions. However, when writing a general risk-based guidance, it seems more appropriate to keep it in simple understandable terms, such as "potentially affected properties". Responsible parties and their consultants can determine when it is appropriate to break individual properties into multiple Areas of Concern. It is recommended that IDEM reconsider the term "Decision Units" and simplify the Risk Evaluation Section to evaluate potentially affected properties as a whole. (MSECA)

IDEM acknowledges that the term "decision unit" is new and that this term may take some getting used to. However, the decision-making process described in statute requires definition of the place(s) where comparison of remediation objectives against representative concentrations occurs, and a concise term is needed to describe those places. IDEM has revised Section 3.1 to make the concept clearer. The revised Section 3.1 is included in this response document as Attachment 5.

[173] Section 3.1: Isn't the "decision unit" just a point of exposure. Wouldn't that be a less confusing or more practical term to include din the R2. (MSECA)

Exposure may not be occurring in the place under evaluation, and whatever that place is, it probably won't be a "point". Decision unit is a reasonably accurate name.

[174] Section 3.1 Decision Unit(s) and Their Use(s): Under the proposed guidance a given site may have multiple Decision Units, each of which will require a risk evaluation. Under the current guidance risk is evaluated on a site-wide basis over an Exposure Control Area. Both approaches accomplish the same task. It is unclear that the use of Decision Units will streamline or enhance the closure process. Multiple Decision Units on a given site may be unnecessarily burdensome in regard to the number of decisions that need to be made, the level of IDEM review and oversight required, project documentation requirements, etc. In addition, it is not clear whether IDEM intends to make site-specific determinations on the appropriate number of Decision Units for a given site. (Ramboll)

It has been IDEM's experience that most releases involve multiple comparisons of representative concentrations against remediation objectives. This may occur because different properties, media, or receptors are involved. Specifying decision units is a means of defining and organizing these comparisons, instead of leaving it to IDEM to try to figure out what comparisons are being made, where, for what purpose.

[175] Section 3.1: The term "decision unit" is introduced. While similar to the ITRC Incremental Sampling Methodology (ISM) "decision unit" definition, it is not the same, and could be confused by the environmental community. (MSECA)

IDEM sees very few examples of incremental sampling methodology. In any case, many words and terms are used in more than one context, and context should make the appropriate meaning clear.

[176] In Section 3.1, IDEM states that it will "typically assume that future residential use is reasonably likely at most decision units." Likewise, in Section 3.4.2, IDEM states "[b]ecause land use changes are common (including, for example conversion of former industrial facilities to residential use), IDEM will typically assume that future residential land use is reasonably likely at most decision units." These assumptions do not seem to account for an important provision in the VRP statute regarding "conditions subsequent." HEA 1162 added provisions to the VRP statute that allow the commissioner to include in a certificate of completion or a covenant not to sue conditions that must be performed or maintained after issuance of the certificate or covenant. See IND. CODE § 13-25-5-18(d). IDEM has also determined that conditions subsequent are appropriate for no further action (NFA)s too. We recommend that IDEM develop guidance further discussing its interpretation of conditional closures with, at a minimum, specific examples and case studies demonstrating site where IDEM approved "conditional" closure. (Gillay)

It is unclear what the commenter is requesting, as ERCs and Long-Term Stewardship plans are both examples of "conditions subsequent" that are contemplated by IC 13-25-5-8(d). ERCs have been common for many years, and IDEM is moving forward with implementation of Long-Term Stewardship on a case-by-case basis.

[177] Section 3.1: The R2 manual seems to have increased the number of decision points for nature and extent and closure determinations. The way the R2 defines and references Decision Units appears to require the user to break a release into separate "units" based on exposure considerations. The language interwoven throughout the manual appears to treat

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decision units as separate sites. For example, the R2 (Section 3.1) states: "However, risk evaluation for some releases will require defining and evaluating multiple decision units. For example, a soil gas plume might extend under several structures. As each structure has different physical characteristics and a unique location with respect to the soil gas plume, each would likely require definition as a separate decision unit for risk evaluation purposes." These statements imply every structure will become a decision unit. The concern here is two-fold. First, staff and consultants are likely to find more areas of dispute using this system. Second, the way decision units are characterized in the manual appears to take the focus from the remedial investigation action of completing an exposure assessment and shifts it to defining decision units. This shift in focus appears to conflict with the way USEPA interprets and applies exposure assessment using exposure areas, as opposed to decision units (1996a, 1996b, 2002). Please consider how this will happen in real-time. Decision units are now a significant decision point. Disagreement will occur based on determining separateness, structure type, plume dynamics, changes in soil type, and a host of minutia, such as house construction, etc. Staff may require a nature and extent around each decision unit (and by implication, each structure). Thus, the purpose of separating decision units may get lost in implementation. The concept of decision units seems to be very similar to the USEPA exposure assessment concept of "exposure area." It appears to replace the USEPA Exposure Assessment procedures. Is an exposure area the same as a decision unit? Shouldn't the focus be on exposure assessment using exposure areas, exposure levels, risk, and characterizing variability? Isn't it given that individual homes have unique exposure conditions? Please consider the USEPA Guidance documents for Soil Screening (1996a, 1996b, 2002). All these documents reference and define an exposure area (using a consistent square foot size) as central to the investigation, including the immediate development of a CSM based on exposure. The RBSLs Users Guide extensively references these screening documents and ties them to the use of the RBSLs. The R2 discussion and use of the exposure point concentration (EPC) provides an example of what appears to be part of this USEPA Exposure Area/Decision Unit disconnect. The EPC discussion in section 3.4.4.2 of the R2 does not address the exposure area. If the decision unit is the exposure area, then it should not be split into different spatially located averages. USEPA (1996b) defines the exposure area stating: "As explained in the Supplemental Guidance to RAGS: Calculating the Concentration Term (U.S. EPA, 1992d[a]), an individual is assumed to move randomly across an exposure area (EA) over time, spending equivalent amounts of time in each location. Thus, the concentration contacted over time is best represented by the spatially averaged concentration over the EA." 5 Determining risk to the exposed population should be the priority in any investigation, deciding decision units should not replace this focus. Please consider moving the discussion of Decision Units and Exposure Areas within the context of an Exposure Assessment section of the manual using USEPA guidance as a central organizing tool (see USEPA, 1989; 1992; 1992a; 1996a, 1996b, 2002, 2019; and elsewhere). Exposure Assessment is a central part of any investigation. The R2 does not even mention exposure assessment except in one place, and there, it is used only to help define risk characterization It would also be beneficial to clarify the concept of decision units relative to these EPA documents and explain how one can still comply with this EPA guidance when using decision units. Additionally, the R2 authors could provide more detail on the advantages and support for this approach. How are decision units, as a All (Source) Discussion Response remedial tool, an improvement on what USEPA defines and uses in the exposure assessment phase of the investigation? What problem does Decision Units solve that USEPA procedures do not address? Are USEPA or other States' supporting guidance on this approach? (Thompson)

IDEM acknowledges the comment and hopes that its revision of Section 3.1 will address the commenter's concerns. The revised Section 3.1 is included in this response document as Attachment 5.

[178] Section 3.1: The R2 references a Statutory basis for supporting Decision Units that could be clarified. The R2 States (pg 87): "Specification of decision units is necessary to fulfill statutory obligations under IC 13-25-5- 8.5(b)(2)." This portion of the IC 13 statute uses the terminology "Site," not "Decision Unit." How did the R2 reach the conclusion decision units were needed based on this IC? The decision unit concept seems distinct from the common USEPA use and reference to site. (Thompson)

IDEM did consider using the term "site" but noted that the statute defines site in terms of a property for which an application was received. When the legislature revised the statute to include the leaking underground storage tank, state cleanup, and other programs for which we do not receive applications, it did not revise the definition of the word site. In addition, common usage of the word "site" is inconsistent, sometimes referring to the project as a whole and sometimes to a particular facility whose release has affected "off-site" properties. In the latter instance the word "site" means the source facility as opposed to the project as a whole. Also, because expected future use, measurable risks, and activities vary from location to location and media to media for a given release, IDEM needed a way to describe these subsets of a "site" or "project" and chose the term "decision unit". For these reasons, the R2 deprecates the word "site" in favor of "project" or "source facility" or similar terms.

[180] Page 61: "IDEM will require parties associated with co-mingled plumes…before litigating financial responsibility." While the management of risk is important, it is quite conceivable that this requirement places an unmanageable economic burden on a

potentially innocent party. For example, a property transaction identifies limited impacts on a site. The property has no history of use, and it quickly becomes apparent that an off-site contributor is responsible. Environmental investigations and remediation can be extremely costly. The agency and guidance should acknowledge that such unique scenarios are a reality. (MSECA)

It is beyond IDEM's authority to allocate financial responsibility among contributors to a commingled plume. While unique scenarios such as that described are unfortunate, IDEM cannot look to a parties' "fault" beyond what statutes allow when dealing with releases that may impact human health or the environment.

[181] Section 3.2: There is a very clear exposure area process laid out in USEPA guidance (1996a; 1996b; 2002), which appears to conflict with the decision unit approach outlined on these pages. The USEPA Soil Screening Guidance is very prescriptive about how a site should be stratified and exposure areas determined. The USEPA (1996b) states: "Unless there is site-specific evidence to the contrary, an individual receptor is assumed to have random exposure to surface soils at both residential and non-residential sites." R2 authors are encouraged to examine these USEPA documents and clarify how decision units fit into the EPA procedures. A broader discussion is included in the "Decision Units" section under General R2 Overarching Comments above. (Thompson)

IDEM acknowledges the comment and hopes that revision of Section 3.1 will address this concern. *The revised Section 3.1 is included in this response document as Attachment 5.*

[182] Page 64: "Similarly, where excavation or utility work is reasonably likely to expose workers to soils below the ground surface, the chemicals in those soils warrant evaluation for direct contact risk.": This seems to contradict later statements in the draft RCG regarding need for remedy for contamination in the roadways (the only remedy being notifications). Utility work is almost exclusively completed within roadways and their rights of way. Please clarify. (Creek Run)

IDEM anticipates that notification will be the extent of the remedy typically required for release-related chemicals below public roadways.

[183] Page 65?: In cases where directed or biased sampling has been performed to evaluate media concentrations in areas known to have the greatest potential for contamination, usually based on site history, field screening, or visual observation, use of each individual result as a representative concentration may be impractical or result in an overly conservative risk evaluation. In cases where it can be demonstrated that releases have been adequately characterized and to address potential upward bias in sampling design, consider acceptable use of spatially weighted average concentrations over a decision unit as representative concentrations. (Ramboll)

IDEM agrees that use of individual sample results as representative concentrations is very conservative. As noted in the text, one alternative is to calculate an upper confidence limit of the mean of sample results which, given enough appropriately distributed sample results, may reduce the influence of the highest observation(s).

[184] Page 65: VOCs can be composited using laboratory ISM methods. (MSECA)

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[185] Page 65: The ITRC Incremental Sampling Methodology (ISM) has a vetted procedure for compositing soil for analysis of VOCs. (MSECA)

As noted in Section 2.2, other procedures may also produce acceptable results, and IDEM will evaluate use of those procedures on their merits. The ISM methodology is acceptable if it meets project data quality objectives.

[186] Page 66: Perhaps this is a misunderstanding, but what is the reference source that cites the acceptable use of judgmental samples for determining exposure characteristics of the population? If the R2 authors mean that the sampling density is sufficient to randomize the sample locations and results, then this should be explicitly stated. Otherwise, USEPA (1996a, 1996b, 2002) recommends random sampling, and without a specific USEPA reference, the EPC should not be determined with judgmental samples. (Thompson)

The R2 allows using the highest result from a set of judgmental sample results as a representative concentration, and IDEM has routinely permitted this for at least a quarter century. Doing so is a very conservative approach. Allowing the calculation of UCLs from judgmental samples that adequately cover the area under evaluation, particularly when those sample locations are biased toward areas of highest concentrations, is also protective because it is nearly certain to result in representative concentrations that are higher than those obtained via using systematic sample arrays. However, if responsible parties wish to employ systematic sample arrays, the R2 also allows that approach.

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[187] Page 67: "Sampling after active remediation should continue for as long as necessary to determine…" Open ended phrases like this are problematic in interpretation without firmer criteria for making such demonstrations. Also, previous guidance specifically identified the need for a post-remediation equilibration period that is not noted in the current draft. Is this this no longer an expectation? (Bonniwell)

IDEM has revised the text to read:

Active remediation greatly changes the subsurface system, so a re-equilibration period is necessary before beginning a representative concentration determination. Samples collected during re-equilibration may not be representative of steady-state conditions. A typical re-equilibration period is twelve months, but IDEM will evaluate proposals for shorter or longer periods on their merits. Sampling after active remediation should continue to determine whether release-related chemical concentrations in groundwater rebound. The length of that monitoring period will necessarily depend on project-specific conditions and the adequacy of the CSM. Four quarters is typical (eight when calculating a UCL), with some releases requiring more extended monitoring.

[188] Pages 67-68: For groundwater, if monitoring well data are shown to represent the same aquifer, allow for calculation of representative concentrations using data collected from multiple wells within a decision unit. This is useful in gaining an understanding of potential exposures throughout the decision unit, not limited to only locations where wells have been installed. (Ramboll)

At IDEM's request, Ramboll provided the following elaboration of their comment:

REH's comment was related to evaluating vapor intrusion exposure from contaminated groundwater. For example, if a single large building (i.e., the decision unit) covers an area that is characterized by multiple wells, allow for the calculation of representative concentrations for the groundwater vapor intrusion assessment using wells located under the building. REH's original comment was not related to the drinking water EPC, but we agree that the referenced memo can be used to assess the core of the plume in determining drinking water exposure.

IDEM acknowledges that interpolation and extrapolation of data from sampling points, appropriately performed, is a necessary part of most environmental investigations. Appropriate methods will necessarily depend on the circumstances, such as the location of the wells relative to the plume(s), structure(s), and each other, and IDEM will evaluate approaches on their merits.

[189] Pages 67-68: "…UCLs calculated using only the last eight quarters usually provide a better indicator of current conditions…" Care should be taken in recommending the reduction of applicable data for statistical demonstrations that become inherently less robust with reduced data. (MSECA)

IDEM's intent is to remove old, and especially pre-remedial, data. These data often have a heavy bias towards steeply reducing trends rather than showing realistic long-term behavior moving forward. Previous plume behavior may not be the best predictor of current plume conditions. At least eight values are needed to support a statistically significant conclusion.

[190] Pages 67-68: "For wells with many quarters of data, UCLs calculated using only the last eight quarters usually provide a better indicator of current conditions than UCLs using the entire data set.": In a situation where there is 8 quarters of data from 10 monitoring wells, in determining groundwater UCLs is IDEM requesting: all time and spatial data should be used for one UCL calculation (80 total data points), time data per well (10 separate time based calculations, one from each well, using the eight quarters of data in each well separately), or spatial data from all wells each quarter (8 separate spatial based calculations using the 10 data points from the wells, one for each quarter)? (Creek Run)

Procedures described in the R2 are intended for application to data sets from single wells. The statistical approach that uses the confidence interval methodology depends on stationarity, independent, and identically distributed data (EPA 2009). IDEM assumes that the data will become stationary after an equilibration period following any active remediation and independent with quarterly samples. Proving identically distributed data is unnecessary if all the data comes from one point in space. Therefore, when determining a representative concentration in groundwater IDEM is looking for the location within the plume that has the highest concentration. This is accomplished by determining the UCL of the mean for each monitoring well within the plume.

[191] Guidance is not provided for determining a representative sample for soil gas. For soil gas, if multiple vapor samples are collected during the same time period from multiple locations for the same building or within the same decision unit, allow for the calculation of representative concentrations. (Ramboll)

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IDEM does not have a recommended procedure for combining soil gas data from several points within the same decision unit, is unaware of guidance for doing so published by other states, and is not currently planning to develop such guidance. Instead, we recommend using the highest observed value within the decision unit as the representative concentration. However, IDEM recognizes that this is an evolving area of science and that US EPA or other credible sources may develop relevant procedures for combining soil gas results for purposes of determining representative concentrations. IDEM will evaluate proposals to do so on their merits, giving consideration to relevant and credible guidance from other sources.

[192] Page 68: "…indoor air sampling should be individually certified." See Comment #4.

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[193] Page 68: "Experience has shown that batch-certified cannisters may produce false positive results." What experience is referenced here? Have any studies been completed or is this anecdotal? (MSECA)

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[194] Page 68: Recommend "For this reason IDEM recommends canisters used for indoor air sampling be individually certified." (MSECA)

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[195] Page 68: The increased costs of individually certified TO-15 summa canisters is significant. Is the frequency of batch certified contamination that prevalent? It would be useful to provide some data that supports this choice. Again, this appears to be a subjective statement regarding "highly variable" indoor air results. Please define highly variable, and the criteria used to support this conclusion. (Thompson)

IDEM agrees with the comments and has revised the text to read:

Batch-certified canisters are generally acceptable, though individually certified canisters may be advisable if false positives are a concern.

[196] Page 68: "Vapor concentrations, particularly in structures, are highly variable…" While considerable temporal variability has been observed in indoor air concentrations, that variability is not boundless. Expectations of variability exceeding three orders of magnitude would be considered rare. In cases where even such extreme variability would not exceed published levels, the necessity for extended sampling is unwarranted. (Bonniwell)

IDEM generally recommends two rounds of vapor sampling when determining the need for a remedy, partly to account for potential seasonal effects on vapor concentrations. However, other proposals can be advanced, and IDEM will evaluate those proposals on their merits.

[197] Page 69: Section titled "Calculate an Upper Confidence Limit of the Mean (UCL)" Last sentence: is this relevant? Consider revising or omitting. (MSECA)

IDEM agrees with the comment and has deleted the referenced sentence.

[198] Page 70: General Considerations, second bullet item: What are the criteria by which IDEM will determine if sample locations and density are 'representative'? (MSECA)

The "General Considerations" bullet list provides some general evaluation criteria (e.g., location, density, etc.) but IDEM is unable to provide a specific set of criteria that would apply to all releases, at least in the context of a guidance document. Judgment must play a role in this decision.

[199] Page 70: "Are groundwater data trending?" Previous experience has shown IDEM staff drawing their own conclusions on trends, even in the face of statistical data being presented. The reviewer recommends a qualifier for how that question is phrased (e.g. Are groundwater data demonstrably/statistically trending?). (MSECA)

IDEM has revised the referenced bullet point to read "Does the groundwater data have a constant mean and variance?" Additional information on demonstrating this is available in US EPA (2009).

[200] Page 70: "Were at least two rounds of paired sampling conducted?" The draft guidance identifies that standalone soil gas demonstrations are a feasibly accepted, which is inconsistent with this question, as well as the majority of the example vapor decision questions. Indoor and paired sampling are not always necessary. (Bonniwell)

While the text in section 3.2.3 notes that these questions should be used in instances where they are relevant, IDEM has added the following bullets for clarity regarding soil gas:

- *Were soil gas samples collected under appropriate conditions?*

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- *Were soil gas samples collected at appropriate depths based on the source and geologic units?*

[201] Pages 70-71: This is overly conservative. It uses potential eco exposure in GW/SW interface to speak to human health risks. IDEM should make it clear that human health surface water exposure risks may be assessed using fully mixed concentrations, as contemplated by Rule. (MSECA)

327 IAC 2-11-5(3) is a Rule, and takes precedence over guidance documents like the R2. 327 IAC 2-11-5(3) is intended to protect not only human health, but also ecological receptors.

[202] Page 72: Suggest replace the term "standards" with "quantitative values", "numeric values" or similar generic term. (MSECA)

IDEM agrees with this comment and has revised the text to read:

IC 13-25-5-8.5(a) directs responsible parties to specify remediation objectives as part of a remediation work plan. Concentration-based remediation objectives provide quantitative values against which to directly compare representative concentrations. As discussed in Section 3.3.6, remediation objectives stated in terms of the cancer risk range (for carcinogens) or hazard quotients (for non-carcinogens) are also acceptable.

[203] Page 72: In addition to natural background, widespread anthropogenic sources can contribute to elevated background of e.g. heavy metals, PAHs. Other states recognize this and provide less conservative background levels for urban areas. (MSECA)

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[204] Page 72: IDEM acknowledges that remediation objectives cannot be set at concentrations lower than naturally occurring background concentrations. However, the occurrence of anthropogenic background is not explicitly acknowledged. In urban areas, for example, lead and PAHs maybe present at concentrations substantially higher than naturally occurring concentrations due to long-term deposition of particulates from area-wide industrial emissions, automobile exhaust, or even residential waste burning. These sources of anthropogenic background should be recognized, allowing for consideration of historical deposition that may be unrelated to historical activities on the subject property. This comment also applies to Appendix B. (Ramboll)

IDEM does not have the legal authority to establish less conservative levels for (for example) urban areas, based on anthropogenic background. However, responsible parties are always free to perform a project-specific background demonstration, as described in Appendix B.

[205] Pages 72-73: There is too much onus on the innocent third party proving its innocence. This whole section needs to be toned down. Be sure it aligns with other IDEM guidance on innocent third parties. (MSECA)

IDEM believes that this section is consistent with other guidance, but has revised the language as follows because this section is not focused on liability but on remediation objectives:

A successful off-site source demonstration shifts responsibility for the identified release to the party responsible for that release in many, but not all situations.

[206] Pages 77-78: • Presenting the generic attenuation factors in table format similar to that from Section 10.4 in the 2012 IDEM RISC guidance would be helpful. The table is much clearer and easier to follow than the text presented in this section.

- Adding generic attenuation factors for groundwater would be helpful (0.001 for residential and 0.0001 for larger industrial buildings). The 0.001 attenuation factor for residential buildings is consistent with the 2015 USEPA Vapor Intrusion Guidance (USEPA 2015, Section A.3.2).
- Insert a note to clarify that the generic attenuation factor for commercial buildings is conservative since it is based on a generic attenuation factor derived using empirical data for residential buildings (Section 6.5.3 of the 2015 USEPA Vapor Intrusion Guidance).
- Standardizing terminology for “utility corridor” or “utility backfill” soil gas would be helpful or explaining the differences, if any, between these terms.
- Guidance (e.g., USEPA 2012, Figure 8; USEPA 2015b, Figure 9; ITRC 2014, Figure 5-1) indicates that attenuation from the immediate subslab in the absence of identified conduits or biodegradation can be expected on the order of 0.001, rather than on the order of 0.03-0.1. A suggested attenuation factor table is presented below:

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Attenuation Factors By Medium

Medium	Building Type	Attenuation Factor
Groundwater	Residential/commercial	Removed (suggest 0.001)
	large commercial	Removed (suggest 0.0001)
Subslab soil gas	residential/commercial	0.03
	large commercial	0.003
Shallow exterior soil gas	residential/commercial	0.1
	large commercial	0.01
Deep exterior soil gas	residential/commercial	0.03
	large commercial	0.003
Conduit vapor	residential/commercial	0.03
	large commercial	0.003
Crawl space air	residential/commercial	1

IDEM appreciates this comment and has replaced most of the text in Section 3.3.3.4 with a table, as shown in Attachment 6.

[207] Pages 77-78: For consistency "Backfill" should be changed to "Corridor". (MSECA)

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[208] Pages 77-78: Residential header refers to "Utility Corridor" while Commercial header uses "Utility Backfill," as does large commercial header. A correction is needed for consistency. (MSECA)

IDEM agrees with these comments and has, except when not referring specifically to utility backfill, changed references from "utility backfill" to "utility corridor".

[209] Page 77: What is the scientific basis for conduit attenuation factors? Needs reference. (MSECA)

McHugh and Beckley's 2018 sewer study provided a range of attenuation factors found during the study and suggested 0.03 as a conservative attenuation factor. The attenuation factor proposed in the R2 is a conservative starting point for evaluating vapor intrusion that may be occurring from conduits. IDEM has updated the text in Section 3.3.3.4 to reflect this reference. A table of attenuation factors is appended to this response document as Attachment 6.

[210] Page 77: As investigation of conduits (particularly sewers) is still relatively new. Wouldn't be of more benefit to work to establish site specific attenuation factors (as necessary) than to attach a default attenuation factor that is likely to widely vary? (MSECA)

IDEM welcomes submission of suitably-derived project-specific attenuation factors from those who wish to develop them. For everyone else, IDEM provides a generic attenuation factor as a starting point for investigations.

[211] Page 77: Section 3.3.3.4 Using IDEM's Published Levels for Soil Gas states, "IDEM assumes that residential conduit vapor published levels will be used for most remedy determinations." Please clarify. Is this supposed to mean that sub-slab soil gas published levels will be used for most remedy determinations based on potential for VI? (MSECA)

IDEM agrees that this section of the preliminary draft is confusing and has deleted most it, including the referenced sentence, and replaced it with a table that lists attenuation factors for various scenarios, along with associated text. A table of attenuation factors is appended to this response document as Attachment 6.

[212] Page 78: Clarification is requested on the use of the IDEM WQS in pore water. Is pore water regulated using the IDEM Water Quality Standards? Is this use consistent with the purpose of the WQS as defined by the CWA? [Thompson]

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As noted in the text, per 327 IAC 2-11-5(3), surface water quality standards shall be met in the surface waters of the state at the groundwater – surface water interface. Rules take precedence over guidance. 327 IAC 2-11-5(3) is consistent with the Clean Water Act.

[213] Pages 78-79: This section leads the reader to believe that SSLs can be prepared and submitted for consideration to the agency. However, past attempts at doing so have received resistance since IDEM is not able to review toxicological information that may result in different chemical parameters used for the calculation of SSLs. ERM recommends IDEM consider hiring someone that can review these types of submittals and approve them for use, especially when sites could close more expeditiously if they were approved. (MSECA)

This comment suggests funding and staffing decisions that are beyond the scope of this guidance document. IDEM must defer to the toxicological expertise of US EPA, because it lacks the resources to do otherwise.

[214] Pages 78-79: Site-specific remediation objectives should include use of site-specific bioavailability data for lead and arsenic when collected and applied as described in USEPA guidance (USEPA 2017). Use of bioavailability adjustments in remediation objective calculations for some sites may be beneficial, providing for more realistic calculation of acceptable exposure levels for evaluation of incidental ingestion of soil and possibly result in significant cost savings. This should be noted under "soil direct contact" in Section 3.3.4. (Ramboll)

IDEM agrees with this comment and has added text acknowledging the potential suitability of bioavailability adjustments as follows:

<u>Soil</u>

The largest scope for calculation of site-specific soil levels probably relates to the inhalation risk associated with soils, and in particular the volatilization factor that appears in some of U.S. EPA's soil equations. Other options include bioavailability adjustments (U.S. EPA, 2007c), levels developed under IC 13-25-5-8.5(d)(3) (Section 3.3.5), background demonstrations (Appendix B) and remediation objectives that use different target cancer risk levels (Section 3.3.6).

[215] The reference to the statement on page 79: "Due to the inherent uncertainty associated with vapor intrusion, IDEM has determined that it is usually inappropriate to employ a target cancer risk greater than 10-5 when evaluating vapor intrusion risk". Please consider providing data to support this approach. The change appears subjective and could easily be misapplied. Consider, if the RBSL is 3.6 ug/m3 then is 3.61 or 3.7 acceptable? This is an important reduction in risk-based options. First, it is challenging to understand why this choice is made without some data support. Second, it is challenging to understand why this variability would not be addressed in the UCL for the EPC. The purpose of the UCL is to characterize this variability. If a consultant attempts to close with a risk level > 10-5, they must have to have a robust data set of exposure concentrations. The determination of the UCL uses the standard deviation, which addresses the variability in the EPC. Does the statement imply that investigations are not capable of defining the variability in vapor levels? Here data support and regulatory reasoning is critical. There is clarifying information on page 81, but it is still confusing. The guidance on page 81 appears to address the basic requirements for considering a 10-4 closure as opposed to reasons why a 10-4 is discouraged. Again, IDEM makes the blanket statement "because of the inherent uncertainty in vapor measurements" without clarifying the level of uncertainty that is creating the alarm. All measurement has inherent uncertainty. The basis of any use of the USEPA RBSLs or other risk assessment procedures is a clarification of the uncertainty and variability. (Thompson)

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[216] Page 79: Greater clarity is requested on the scientific basis and supporting data for Sections 3.3.4 and 3.3.5 Statements: "With respect to indoor air, IDEM will in most cases use a 10-5 target cancer risk on a per-chemical basis to protect from exceeding 10-4 cumulative risk over the long term." Does this statement imply cumulative risk from multiple chemicals? The origin of the cumulative risk is not apparent. What agents create the cumulative risk? If the statement was made based on indoor air variability, then doesn't the UCL characterize this variability? To request a 10-4 closure risk level, one would have to have a robust data set of exposure concentrations. The determination of the UCL uses the standard deviation, which addresses the variability in the EPC. Does the statement imply that investigations are not capable of defining the variability in vapor levels? Data support would be useful. (Thompson)

*The text on page 79 references Section 3.3.6, which notes that IDEM's **will** consider accepting chronic remediation objectives that do not exceed a 10^{-4} cumulative target risk, and lists issues that should be addressed before submitting such proposals.*

[217] Section 3.3.5 Using Other Concentration-based Remediation Objectives discusses remediation objectives based on institutional and engineering controls that eliminate the exposure to release-related chemicals. These are not concentration-

based remediation objectives. Institutional and engineering controls are part of the remedy section, not a remediation objective. IDEM should consider removing this section. (MSECA)

As noted in Section 3.3.5, "Because effective institutional controls or engineering controls reduce or eliminate exposure via specific exposure pathways, they increase the allowable concentrations of release-related chemicals that can be left in place. A very effective control can virtually eliminate all exposure pathways, present and reasonably likely future, from the risk evaluation, and permit product to remain in place." One hundred percent is a concentration.

[218] "Ongoing commitments will vary with the nature of the control, and could range from periodic inspections that monitor compliance with the terms of an ERC, all the way up to operation and maintenance of a complex engineered system. Memorializing any ongoing commitments, including operation, maintenance, and monitoring of an engineering control, in an IDEM enforceable environmental restrictive covenant, or in an environmental restrictive ordinance enacted by a municipal corporation, is an integral part of an effective remedy."

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[219] Page 82: The cumulative hazard index of chemicals that affect the same target organ should not exceed 1, and the cumulative target risk of chemicals that exhibit the same mode of action should not exceed 10^{-4}. US EPA risk assessment guidance views these criteria as "points of departure", and IDEM will generally require a remedy where these risks are exceeded (p 82). We suggest removing the text "that exhibit the same mode of action". With respect to use of cancer risk as remediation objectives, note that all cancer exposures are considered additive, regardless of target organ (see RAGS A). Consideration of target organ-specific toxicity is only relevant to noncarcinogenic health endpoints. (Ramboll)

IDEM agrees with the comment and has deleted the words "that exhibit the same mode of action" from the text.

[220] In Section 3.4.2 Remedy Necessity Determinations, IDEM states, "If it is possible to differentiate release sources, then each source is responsible for addressing its release. However, failure to address all release-related risks, regardless of source, may delay closure. For example, a gas station may be ready to close its petroleum releases, but if it is also affected by chlorinated solvents that have migrated onto the station property, it may be necessary for the gas station and the source of the chlorinated solvents to negotiate requirements necessary to address those chemicals prior to closure." Please clarify. Does this mean that a responsible party cannot close their own release if their property is being impacted by someone else's release? This does not seem right. A residential property owner would not be responsible for contamination migrating onto their property. A responsible party should not be responsible for someone else's contamination migrating onto their property either, regardless if they have their own release to address. (MSECA)

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[221] "For example, a gas station may be ready to close its petroleum releases, but if it is also affected by chlorinated solvents that have migrated onto the station property, it may be necessary for the gas station and the source for chlorinated solvents to negotiate requirements necessary to address those chemicals prior to closure.": Historically, the No Further Action status applies to a specific release and not a specific site. In fact, it is not uncommon for a facility to have multiple release incidents concurrently being investigated and/or remediated, even to the point where one incident receives NFA and the other remains active. This statement implies that a site or property obtains closure, not the release. If that is the case, a single release that affects multiple properties would receive multiple NFA determinations, potentially at different times. This also seems to contradict the IDEM non-rule policy documents regarding a Property Containing Contaminated Aquifer (e.g., Waste0038-NPD for such properties related to underground storage tanks). Please clarify. (Creek Run)

*This section is intended to ensure that **all** risks are addressed in any institutional controls that are proposed for a particular decision unit or property, regardless of source, to ensure protection of human health and the environment. Different properties will require separate institutional controls if owned by different persons. There is no contradiction with other non-rule policy documents.*

[222] Section 3.4.3: In Section 3.4.3, IDEM states "[b]ecause land use changes are common (including, for example conversion of former industrial facilities to residential use), IDEM will typically assume that future residential land use is reasonably likely at most decision units." These assumptions do not seem to account for an important provision in the VRP statute regarding "conditions subsequent." HEA 1162 added provisions to the VRP statute that allow the commissioner to include in a certificate of completion or a covenant not to sue conditions that must be performed or maintained after issuance of the certificate or covenant. See IND. CODE § 13-25-5-18(d). IDEM has also determined that conditions subsequent are appropriate for no further action (NFA)s too. We recommend that IDEM develop guidance further discussing its interpretation

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of conditional closures with, at a minimum, specific examples and case studies demonstrating site where IDEM approved "conditional" closure. (Gillay)

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[223] Section 3.4.3: The R2 makes the statement: “Because land-use changes are common (including, for example, conversion of former industrial facilities to residential use), IDEM will typically assume that future residential use is reasonably likely at most decision units.” This type of regulation change will be very restrictive and should be well supported. It would be helpful to evidence the data to support the statement that land use designation changes from commercial to residential are “common.” Would it be possible to assess frequency by investigating the extent of zoning changes relative to exposure population changes? Please also explore whether these land-use protections already exist? For instance, what is the risk if a land use is left in place and then changes? Will a bank loan on the conversion of a contaminated industrial property to a residential property without due diligence? One of the central purposes of risk-based closures is to allow property owners control of land use. What evidence is there that a new property owner has not acted responsibly and been successful in converting commercial property to residential without due diligence? Would a zoning board agree with such use without due diligence? Please see Appendices A and B. Risk education and information on risk in deed restriction language may be a much better solution than treating all land as residential property. Isn’t the foundation of risk-based clean-ups owner responsibility? Land use designations are a prevalent part of cleanups and widely used by most states and USEPA. (Thompson)

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[224] Section 3.4.3: IDEM will typically assume that future residential use is reasonably likely at most decision units - what is this assumption based on? There are many industrial sites which are unlikely to ever be residential and will be closed using ERCS which will restrict residential use (MSECA)

To address these comments, IDEM has modified the first four sentences in the “Current and likely future use of the decision unit” and added a footnote as follows:

IC 13-25-5-8.5(b)(2)(A) states that remediation objectives shall be based in part on the “expected future use of the site”. With some exceptions, because land use changes are common (including, for example, conversion of former industrial facilities to residential use), IDEM will typically assume that future residential use is reasonably likely at most decision units[4]. Exceptions include cemeteries and public roadways, and IDEM will not routinely require the use of unconditional remediation objectives or residential use restrictions as a condition of closure for cemeteries or public roadways. However, IDEM may require notice of the presence of release-related chemicals be given to the owners of cemeteries or public roadways with a graphical depiction of the nature and extents of the release-related chemicals.

[6] Assuming future residential use is not appropriate for petroleum leaking UST sites with corrective action costs that are eligible for reimbursement from the ELTF, as 328 IAC 1-3-1.3(b)(5) states that, one criterion that IDEM must consider, as part of the determination of whether a corrective action plan is cost effective is “whether the remediation objectives as set forth in the approved CAP are sufficient, but no more stringent than necessary, for the current land use for the site.”

[225] Page 87: Please provide a source to substantiate this requirement to require a Soil Management Plan? (MSECA)

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[226] Page 87: How does a Soil Management Plan add to … and not conflict with … protections already established in statutes and rules that apply to the activities contemplated by that Plan (e.g. RCRA waste characterization and management, OSHA worker protection, etc.)? (MSECA)

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[227] Page 87: If a Soil Management Plan is prepared, is made 'part of an ERC', and the content of that Plan is - or comes to be - in conflict with RCRA, OSHA or other law/rule, how will this be resolved? (MSECA)

Per IC 13-25-5-8.5, risk-based remediation objectives have to take into consideration the “expected future use of the site” and “measurable risks to human health and the environment” based on the “activities that take place.” If an expected future use involves exposure to soils that have levels of release-related chemicals above risks to HHE, then a soil management plan is necessary if the activities that take place at the site involve movement of those soils. A soil management plan is usually offered as an alternative when sites are expected to be redeveloped and the property owner does not want an excavation restriction, although one would be warranted, based upon the levels of release-related chemicals present and the measurable risks to human health and the environment.

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To address these comments, IDEM has modified the last two sentences in the "Current and likely future use of the decision unit" paragraph as follows:

In cases where excavation or exposure of soil may result in unacceptable risk and future development of the property, including excavation, is likely, IDEM may require soil management plans be in place as part of the remedy, especially if the owner does not want a restriction on excavation. As part of an environmental restrictive covenant, an affirmative obligation for future owners to comply with the approved soil management plan may be necessary to adequately control exposure to release-related chemicals in soil.

[228] Page 87: "IDEM may require soil management plans be in place at those properties, and an affirmative obligation for future owners to comply with the approved soil management plan may be required as part of an environmental restrictive covenant."

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[229] Page 87: Change Amount of Exceedance to Magnitude of Exceedance (MSECA)

IDEM agrees and has made the suggested change.

[230] Page 87: The requirement for the use of residential screening levels at schools and daycares should be clarified. By definition (USEPA IRIS, 2020b), the USEPA toxicity factors are protective of sensitive subpopulations. Sensitive subpopulations include children and the elderly. The use of upper percentile default exposure conditions coupled with the already sensitive subpopulation protections built into the toxicity values is all that is needed to characterize risk. To say that the default residential exposure conditions are necessary at schools and daycares when exposure conditions are less than that described in the default 10 residential equations implies the toxicity values are not protective even when the exposure is well characterized. Consider, if the toxicity factors do not protect in schools and daycares when the exposure conditions are conservatively well-characterized, then why would the same toxicity factors be protective under the conservatively well-characterized default residential exposure conditions. What is the scientific basis for the use of the RBSLs in this manner? (Thompson)

The decision to use residential screening levels for schools and daycares is not due to a misunderstanding of toxicity factors or exposure factors/duration but rather an acknowledgment of the fact that as a government agency we have a responsibility to be cognizant of public perception. People equate their children's schools to their homes which is an entirely reasonable expectation. From both a risk communication and risk management perspective, IDEM considers residential levels entirely appropriate for managing risks at schools and daycares. Any decision to deviate from residential would need to be made on a case-by-case basis in unison with affected communities.

[231] Page 89: Consider tying this LOE to 327 IAC 2-11-4(f) by specifying 200 GPD as the threshold. Consider adding 10,000 ppm TDS threshold as well. (MSECA)

IDEM agrees with this comment and has modified the discussion of this line of evidence as follows:

<u>Groundwater: Productivity of Water-Bearing Unit</u>

Some water-bearing units may not yield enough water to be useful for drinking water wells, or yield water with excessive dissolved solids.[5] If release-related chemicals in groundwater are confined to formations that do not contain or produce sufficient water to be useful, or formations with excessive dissolved solids, this is a line of evidence suggesting that exposure to those chemicals via installation and use of drinking water wells in that water-bearing unit is unlikely. Application of this line of evidence must consider the possibility that chemicals in the unproductive water-bearing units may move to a deeper aquifer. Such vertical movement is expected and additional lines of evidence should be provided to demonstrate that the movement of the chemicals will not result in an exceedance of a relevant remediation objective in an aquifer. Without a convincing demonstration of limited vertical extent, a remedy will typically be warranted to address that potential risk.

[232] Page 90: Under Section 3.4.3, IDEM notes that a commonly proposed but weak or inadequate line of evidence is "availability of water from a public supply." We have a different view. We believe that this is a strong line of evidence and could even be a "condition subsequent" and part of a conditional closure. Will IDEM re-evaluate and potentially re-open past closure determinations that relied on this line of evidence? (Gillay)

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[5] 327 IAC 2-11-4 defines groundwater yielding less than 200 gallons per day, or containing more than 10,000 milligrams per liter of dissolved solids, as potentially qualifying for designation as limited use.

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IDEM's experience has shown that availability of a public water supply does not necessarily mean that public water supply use is universal. IDEM has encountered many individuals who prefer to, when allowed to do so, retain private wells either for drinking or ancillary purposes. Public water is sometimes only available on primary roads rather than side streets. In instances where local authorities ***require*** *and* ***enforce*** *hookup to public water supplies and disconnection of private wells, this potential line of evidence becomes much stronger.*

[233] Pages 90-91: Need exception for properly recorded ERO. (MSECA)

An approved ERO is an institutional control that may be relied upon as a remedy. Each ERO is evaluated independently, and this language is intended to highlight that not all ordinances that prohibit installation of new drinking water wells are approved EROs.

[234] Page 94: "However, the spatially grouped nature of the exceedances suggests another possible approach, which is to subdivide the decision unit into two separate decision units, and then evaluate each separately. Figure 3-D, shown below, illustrates this approach using exactly the same data set. Under this approach, the shaded area in Figure 3-D represents the first of two newly defined decision units. In this example, only the shaded area would require a remedy. The second decision unit, represented by the unshaded area, would not require a remedy.": During recent attempts to apply this approach, Creek Run was instructed by IDEM that it is no longer acceptable to apply restrictions in the form of an ERC to only an affected portion of a property. While it is understood that applying an affected area to an ERC instead of the entire property does not always make sense (e.g. ratio of the affected area relative to the size of the property is large), the communication received suggested this was a blanket decision to not allow affected areas. This decision does not appear to match the approach outlined in this portion of the RCG draft. (Creek Run)

There may be some confusion with terms. Affected areas are acceptable in ERCs. But an ERC may not be placed on only a portion of property described in a deed—the ERC is placed on and applies to <u>*all*</u> *of the property described on a deed. However, there may be particular restrictions that only apply to a portion, or affected area, of a property. It is the property owner's choice of whether to subdivide the property before placing an ERC so as to have parcels without restrictions and other parcels with restrictions, or to place an ERC on the entire deed and have some areas with restrictions and others without. The former approach may make property transfers easier and prevent future confusion as to which areas are restricted and which are not. Environmental consultants are advised to work with a real estate attorney to determine the best approach.*

[235] Page 97? If soil SPLP results are favorable and if deeper vadose zone soil samples are non-detect, then can groundwater monitoring be avoided, or is groundwater monitoring expected regardless? (MSECA)

IDEM has a strong preference for direct observation of groundwater where that is possible and reasonable and will expect groundwater sampling at nearly every release. There may be circumstances when groundwater sampling is not necessary (e.g., when a relatively insoluble material is released to the ground surface and immediately removed, with acceptable confirmatory sampling), but those instances will be unusual.

[236] The guidance includes no discussion of the short-term toxicity issue associated with trichloroethylene vapor intrusion. Clarification of the agency's position is recommended for inclusion to the guidance. (MSECA)

IDEM previously discussed its decision on appropriate accelerated response for TCE in the 2016 SL Table announcement located here: https://www.in.gov/idem/cleanups/files/risc_screening_table_2016_announce.pdf . In short, we treat trichloroethene the same as other chemicals.

[237] As stated previously in the guidance, a standalone soil gas (exterior or subslab) can be a reasonable approach, and several comments above highlight this aspect. However, the section stipulates that the "standard" process begins with "indoor air sample results paired with…" To qualify/identify this as the standard approach delegitimizes standalone soil gas demonstrations. Given that guidance no longer provides groundwater vapor intrusion screening criteria, it relies upon a greater emphasis on soil gas for characterizing the potential for vapor intrusion. Assuming the agency made this change due to soil gas being a better predictor of vapor intrusion than groundwater, it would make sense that there could be greater reliance upon the data. Indoor air is not always necessary. Soil gas concentrations (exterior or subs-slab) that are orders of magnitude below applicable screening criteria negate the need for indoor air sampling (assuming preferential pathways are reasonably eliminated). (Bonniwell)

While paired sampling is the standard approach, IDEM agrees that indoor air may not always be required if soil gas concentrations are orders of magnitude below screening levels. As stated in R2, the comparison table in Section 3.4.7.1 is

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not a substitute for critical thinking or best professional judgment. IDEM will evaluate other approaches and proposals on their merits.

[238] Page 105: "It is acceptable to use commercial remediation objectives instead of unconditional remediation objectives when evaluating existing or potential structures restricted to commercial use via land use controls.": Creek Run agrees with this; however, it seems to contradict language noted in Comment 15 above, and contradicts information provided to Creek Run by IDEM recently. Please clarify. (Creek Run)

Restriction of a property to commercial uses is a remedy, and with that remedy in place, it is acceptable to use commercial remediation objectives on that property. Given the complexity of many releases and the project-specific decision-making process that IDEM must employ, a certain amount of inconsistency is unfortunately not surprising. IDEM continues to work with staff to develop better understanding of risk-based closure principles and promote consistent decision making.

[239] Similar to comments above, the table fails to acknowledge a scenario where no indoor air sample is collected. This is largely a failure to characterize the magnitude of soil gas concentrations, with the low end only characterized as being less than the unconditional remediation objective, which leaves a substantial range. For example, the residential subslab published level for tetrachloroethylene is 1,000 µg/m3, while laboratory detection limits are often single digit µg/m3 concentrations. A sub-slab measured concentration of 5 µg/m3 is vastly different than a concentration of 950 µg/m3. Even significant variability of two orders of magnitude would still maintain the former below the published level. This low-end order of magnitude scenario gets no evaluation in the given scenarios, or in sampling demonstration discussions (e.g. emphasis on paired sampling). (MSECA)

IDEM agrees that in some cases, indoor air may not be necessary if soil gas is low. As suggested by its title, Table 3-A assumes indoor air data is available. It also assumes that preferential pathways have been ruled out. IDEM notes that while it may be difficult to rule out preferential pathways without indoor air data, there may be cases where it is possible to do so. Table 3-A is not meant to include every scenario; indeed, it may not be possible to construct a table that would include every scenario. In any case, as noted in the text, Table 3-A is not intended as a substitute for critical thinking or best professional judgement, and where it makes sense to do so, IDEM will be open to deviating from Table 3-A.

[240] Section 3.4.7.1, Table 3-A recommends a remedy or indefinite sampling of soil gas and indoor air for Scenario 3. • The condition described in Scenario 3 could indicate that there is more attenuation from subslab soil gas than the generic attenuation factor, particularly for commercial/industrial buildings. LOE could be employed to demonstrate that sampling could cease particularly for subslab concentrations between 2 and 10 x the URO. (Ramboll)

In response to an IDEM request for possible lines of evidence that might support cessation of sampling in the instance desribed, Ramboll replied with the following:

REH response: Under scenario 3: for indoor air - the IA < = URO; for soil gas – 2x URO< SG <= 10x URO which results in indefinite sampling. While additional data would be useful in this scenario, REH does not believe that the sampling must be indefinite. The primary line of evidence for ceasing sampling is that the IA < URO. Given the uncertainties associated with the generic attenuation factor used to derive the SG URO, a site-specific determination that IA and SG sampling can cease should be available without having to conduct a remedy. These uncertainties include the fact that the soil gas URO used an empirically-derived attenuation factor based on data only for residential buildings, for which inadequate methods were used to control for indoor sources.

Additional potential lines of evidence can include:

- Additional sampling confirming the IA < URO (2 to 4 samples).
- Indoor air and soil gas trend test results that demonstrate stable or decreasing trend if 8 or more rounds of indoor air and soil gas samples exist.
- The magnitude by which IA < URO (e.g., IA < URO/10)
- If chemicals were detected in soil gas and were not detected in indoor air, those chemicals would provide additional lines of evidence that vapor intrusion is not occurring.
- Qualitative lines of evidence would be building characteristics such as that the foundation was in good condition or that the building was normally positively pressured.

The lines of evidence Ramboll suggested are appropriate and IDEM would consider them. Alternatives to indefinite sampling are appropriate if sufficient data is available. A future use remedy for building modifications or new construction may still be necessary. Risk communication (particularly if residential) would need to be incorporated into any remedy or response to this situation.

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[241] Page 107: Please consider the role that understanding the RBSLs creates. As an example, Tables 3A and 4A use a decision category based on a 2x change in concentration. You cannot commonly define a meaningful change in the level of risk using a 2x multiplier. Appendix B supports this statement and provides a broader evaluation of the health impacts of RBSLs in practical application. If the analysis in Appendix B is correct, then for most common site contaminants, the user cannot define a meaningful change in the risk with a 2 times multiplier. If this is true, then what is the basis for the increased level of post-closure monitoring? These appear to be subjective determinations and not data driven or risk-based decision categories. Additional issues are addressed in Appendix B. (Thompson)

Public perception plays an important role in IDEM's decision-making process. When IDEM publishes a level in a table, it becomes very challenging to explain why, in the absence of supporting lines of evidence, any exceedance of that level should not prompt a remedy. IDEM's adoption of a 2x change as the boundary of a decision category is an acknowledgment of both the imprecise nature of these matters and the limits of IDEM's ability to communicate risk principles to members of the public.

To further clarify, indoor air is the only true risk-based screening level and sub-slab soil gas concentrations are estimates of site conditions which might cause exceedances of the indoor air screening level. As such, Scenario 5 (SL<IA<2XSL; SL<SGss/SGe<2XSL) is the only relevant instance where the 2X is applied to the actual risk-based screening level. In this instance, instead of requiring mitigation and long-term monitoring, lines of evidence are allowed which may allow for a DECREASED level of post closure monitoring which is because we believe the risk level has not appreciably been exceeded or changed at this level.

[242] Page 107, Table 3-A: Where do conduit samples come into play regarding remedy scenarios? What if conduit is the only sample above the attenuated screening level? (MSECA)

IDEM anticipates that if site-related impacts are entering conduits and lead to/contribute to a vapor intrusion issue at connected structures that a remedy would be supplied to either 1) stop the contribution of contaminants to the conduit(s) or 2) ensure that adequate vapor controls are in place at the structures. If the conduit is the only sample above the attenuated screening level, lines of evidence should be supplied to show that these exceedances will not be an issue in the future. Otherwise, a remedy would be needed.

[243] Page 109: Under Section 3.4.9, IDEM mentions risk characterization for the first time. This is an important topic and IDEM should consider developing this section in more detail, instead of referencing an EPA guidance document. (Gillay)

IDEM chose not to include an extended discussion of risk characterization because we rarely see risk characterizations except for National Priority List and similar projects. Risk characterization is certainly valid but rarely necessary for the great majority of the releases we encounter.

[244] Page 111: Is IDEM going to recommend that remedial evaluations continue to follow the national contingency plan and US EPA guidance when considering which remedy to apply at a Site? Will this evaluation need to be included in RWPs? (MSECA)

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[247] Page 111: Why is there a deviation between what is 4.1.2 and the NCP list of 9 points in remedy selection? Shouldn't the NCP be referenced here? Comment applies to 4.1.9 as well. (MSECA)

The elements of the National Contingency Plan with regard to evaluating remedial alternatives are found throughout Section 4 (Remedies) of the R2. IDEM believes that it has used the concepts codified in the NCP as the basis for development of its risk-based closure approach (see Section 3.3.6 and U.S. EPA 1991b Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions; OSWER Directive 9355.0-30) and believes that a cleanup that follows the R2 is consistent with the NCP.

[245] Section 4.1.7: "In some cases, long-term stewardship (Section 4.1.7) will be necessary to ensure remedy adequacy."

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[246] Page 112: What 'additional applicable state or federal requirements' are contemplated here? (MSECA)

Any comprehensive list of requirements that might apply to a particular project would be long, project-specific, and subject to change as laws and regulations change. The statement is included as a simple reminder that other requirements, and possibly many requirements, probably apply.

[248] Page 112: Second bullet item: What is considered 'quickly enough', and how will this be evaluated? (MSECA)

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IDEM's assessment of timeliness must be project-specific and will depend on factors such as whether there is current exposure, the magnitude of that exposure, the likelihood of future exposure, and whether IDEM has adequate resources to manage the project and/or seek enforcement, if necessary.

[249] Page 112: Last bullet item: This statement suggests that IDEM may use its authority to drive the selection of one application over another in the implementation of a remedy (e.g., In-situ treatment using an established/familiar material or placement method versus using a newer/novel/emerging material or deployment method). If both options are anticipated to attain equally acceptable endpoints in terms of exposure control, where is IDEM's authority to approve or to prefer one option over the other? (i.e., Isn't the remedy approvable either way, then the both the risks associated with using a novel application and the responsibility to meet the remediation/closure objectives rest with the responsible party/ies?) (MSECA)

IDEM's evaluation of proposed remedies is necessarily constrained by our past experience (if any) with such remedies. If IDEM is unfamiliar with a proposed remedy, it will almost certainly take more time to research and evaluate the proposal than would evaluation of remedies with which IDEM has extensive experience. For Excess Liability Trust Fund eligible projects, remedies must be reasonable and cost-effective.

[250] Page 112: "Cost, including cost over time. Long-term costs associated with the ongoing obligations of a conditional closure may ultimately prove more expensive than achieving an unconditional closure. IDEM will take special interest in cost when the state acts either in its capacity as Administrator of the Excess Liability Trust Fund or as a party undertaking a response with state funding sources."

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[251] Page 112: "Acceptability to affected parties. For example, a remedy that requires placement of an environmental restrictive covenant on a deed must be acceptable to the owner of the relevant property.": Creek Run agrees with this. However, our experience is that projects often stall for extended periods of time when an off-site property owner is not accepting of an ERC on their affected property. IDEM has not shown a willingness to approve alternative remedies of the off-site contamination in those cases and without acceptance of the ERC by the property owner, a site sits for extended periods of time with no actions other than quarterly groundwater monitoring occurring. Creek Run recommends IDEM update or create a policy regarding when and how to proceed if an off-site property owner is unaccepting of an ERC, so that the project can continue to move forward toward closure. An update or creation of a similar process for when off-site property owners do not grant access for investigation and/or remediation would also be beneficial. (MSECA)

IDEM agrees that the need for a remedy for off-site contamination can increase the complexity of the project and make it more difficult to achieve closure. However, responsible parties must address the actual risks presented by the contamination that is not being reduced to below applicable levels. We have advised responsible parties in similar situations, where an off-site property owner does not wish to place an ERC on their property, to follow the general procedures for documentation of attempts and presentation to the project manager that are described in nonrule policy Waste-0065 "Procedures for Gaining Access to Third Party Properties by Responsible Parties Performing Remediation," which was effective on November 13, 2015.

Additionally, proper notice under AOPA (Ind. Code 4-21.5) of the potential closure must be provided to the off-site property owner, as a decision to allow no further action on a site where off-site contamination may remain with no ERC is an agency determination of status that substantially affects the off-site property owner. Responsible parties may wish to consider all of the implications of choosing a remedy where an ERC is needed but not acceptable to a property owner.

[252] Page 115: It is understood that there are other measures other than indoor air sampling that can demonstrate system effectiveness. IDEM should include things such as mass flux monitoring and reduction as an "example" in section 4.1.5. This is a much more meaningful measurement than indoor air testing. (MSECA)

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[262] Page 119: There are other ways to confirm that a SSD system is working effectively; IDEM should allow for OM&M plans that propose no indoor air sampling if the plan appropriately documents no risk to occupants. In the bullets, it seems as though this is the highlighted way to demonstrate it, but there are other ways, as the first line in the last paragraph suggests. (MSECA)

As discussed in an external feedback forum, IDEM will continue to request indoor air to determine system effectiveness as it is the most direct method to measure risk to receptors. While robust monitoring of system performance metrics may increase indoor air sampling timeframes, they should not be a substitute for long term indoor air monitoring. Periodic indoor air monitoring is recommended by the AARST mitigation guidance.

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[253] Page 116: "If post construction paired sampling shows that vapor is not a concern…" It is not unreasonable to think that a demonstration of a newly constructed building utilizing a vapor mitigation design (passive or active) could be performed solely utilizing sub-slab soil gas sampling. The uncertainty of new structures is generally associated with a lack of predictability for vapors to accumulate beneath the structure. A post construction assessment identifying no detectable concentrations below the structure, or concentration orders of magnitude below screening criteria could be sufficient as a standalone demonstration. (Bonniwell)

IDEM agrees that a post construction assessment "identifying no detectable concentrations below the structure, or concentration orders of magnitude below screening criteria could be sufficient as a standalone demonstration". IDEM will evaluate such situations and associated lines of evidence on their merits.

[254] Page 116: "Effective institutional controls eliminate or reduce exposure pathways by forbidding or restricting certain land uses on a property, or by compelling other activities (e.g., operation and maintenance of an engineered exposure control)…"

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[255] Page 116: Under Section 4.1.7, IDEM references long term stewardship and notes that it is developing guidance and a LTS plan. We recommend a separate work group be established with legal and technical representatives to finalize LTS guidance and then integrate that guidance into the next draft of the R2. (Gillay)

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[293] Page 116: This section states that "At this time, IDEM has not fully developed a LTS plan." IDEM has circulated several draft LTS plans in the past few years. Does IDEM intend to develop an LTS plan template in the future? If so, what is the timeframe for its development and publication.

Draft LTS documents are now available upon request and include the LTS Agreement, LTS Plan Guidance, LTS Master Plan, Financial Assurance SOP, Groundwater Monitoring Cover Sheet and Report Format, Groundwater Monitoring Cover Sheet and Report Format, Engineered Control Monitoring Cover Sheet and Report Format, Land Activity Monitoring Cover Sheet and Report Format, and Vapor Monitoring Cover Sheet and Report Format. IDEM intends to pilot LTS before formalizing and making available for publication.

[256] Page 119: Implementation and Confirmation of Engineered Exposure Controls.

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[257] Page 119: The RCG2 includes significant discussion regarding the utilization of vapor mitigation systems for the management of vapor intrusion. It should be noted that national standards have been established for the design and implementation of radon/chemical vapor intrusion mitigation systems for multiple building types. These standards were developed by the American Association of Radon Scientists and Technologist (AARST) in conformance with process overseen by the American National Standards Institute (ANSI), and can be found at https://standards.aarst.org/. The development of these standards utilized a comprehensive stakeholder group that included the US EPA and several state regulators (including IDEM). Standards have been established for both existing structures and new construction. The reviewer recommends that these standards be cited and acknowledged within the RCG2 is they pertain to vapor mitigation remedies. (Bonniwell)

IDEM agrees with this comment and has referenced the AARST guidance in the R2.

[258] Page 119: Is IDEM going to incorporate the forthcoming ITRC Vi Mitigation team guidance documents? Aaron Friedrich (ERM) and Susan McKinley both sit on this work group and could be instrumental in determining how to weave these R2 and the future ITRC guidance documents together. (MSECA)

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[259] Page 119: This will be a good section to reference the forthcoming ITRC Vapor Intrusion Mitigation Technologies team guidance that should be coming out in late 2020. (MSECA)

IDEM agrees with these comments and has referenced the ITRC Guidance in the R2.

[260] Page 119: "Pressure field extension testing to demonstrate a negative pressure differential…" Has the agency adopted a specific pressure field demonstration criteria (e.g. extent, magnitude)? (Bonniwell)

IDEM did not incorporate a minimum pressure requirement in the R2 as it is system and building specific. Instead, the R2 indicates an appropriate measurement should be proposed for mitigation system remedies. IDEM did include references for the AARST and ITRC guidance documents which have recommendations.

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[261] Page 119: "… in lieu of continued air testing. In general, this scenario would apply to…" The reviewer recommends that this could also apply when robust ongoing demonstrations of system performance (i.e. continuous remote monitoring) are utilized. (Bonniwell)

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[263] Page 120: "Routine visual inspections…" The guidance should acknowledge remote continuous monitoring as an alternative to "routine visual inspections." (Bonniwell)

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[264] Page 120: Additional IDEM consideration should be given to more robust demonstrations of system performance and maintenance of operational parameters. Continuous remote monitoring options can provide detailed data collection documenting that a pressure field is maintained that is consistent with conditions during commissioning demonstrations. Such robust ongoing demonstrations should effectively downgrade the sampling and inspection schedules. (Bonniwell)

IDEM has added a footnote stating that "Telemetry monitoring (with fault notification) may replace or reduce the frequency of visual inspections."

[265] Page 121: The first sentence is a bit misleading. SSD systems may be used to remove existing soil gas mass beneath the slab and not necessarily to eliminate an indoor air issue. (MSECA)

IDEM has revised the first sentence of page 121 to read:

If release-related chemical concentrations are reduced to levels that no longer require vapor mitigation, it is acceptable to terminate operation of vapor intrusion mitigation systems.

[266] Page 121: "…some building owners may prefer to keep the system in place (e.g. for radon mitigation)…" It should be clearly noted within the guidance that the mitigation of radon requires proper credentials and is governed by nationally recognized standards for the design and installation of such systems. It is inappropriate to insinuate that a vapor mitigation system automatically conforms with such licensure and standards, unless the guidance specifically calls for adherence to these standards. (Bonniwell)

IDEM has deleted the entire paragraph containing the referenced text.

[267] Page 121: There are more ways than just SGss and IA sampling that should be considered as ways to shut down a system. The ITRC VIMT guidance that is forthcoming and will assist IDEM with this. (MSECA)

IDEM will continue to request paired sampling as part of vapor mitigation system shutdowns (active and passive). Other methods may be submitted to IDEM for review it those methods are at least as protective. Lack of data raises questions concerning the future use of the building and current exposure within the building which may require a remedy; this should be addressed if other methods are submitted for review.

[268] Page 121: "Responsible party designated for OMM implementation." As it is not uncommon for dissolved or historical entities to be the responsible party, with historical insurance policies funding the efforts, it is not unreasonable for OMM to be assigned to a third party. (MSECA)

IDEM agrees that third parties may be performing OMM, but IDEM will need some sort of enforceable instrument (such as an Agreed Order or Long Term Stewardship Agreement) with whomever is doing the work.

[269] Appendix A: Will IDEM or USEPA Region 5 TSCA Coordinator take the lead on PCBs projects being completed under 40 CFR 761.61(a) & (c)? (MSECA)

IDEM and US EPA have been and will continue to work together in completing requests under 40 CFR 761.61(a) and/or (c). This occurs regardless of which remediation program the site is working under or if not under a specific program one that has made general application to the Commissioner. IDEM will issue authorization under the Indiana PCB regulations found at 329 IAC 4.1, while US EPA will issue authorization pursuant to the federal regulations.

[270] Appendix A: Emerging contaminants - how will IDEM address constituents without existing published levels? (MSECA)

IDEM staff will continue to monitor the steps that EPA and other states are taking to deal with emerging contaminants. If IDEM were to address constituents without published levels, it would likely be through a rulemaking instead of a nonrule policy document such as the R2. Under IC 13-14-9-4, if IDEM were to establish its own published levels, the new levels could be construed as being more stringent than what is imposed by federal law. Additional time for public comment and the more formal procedures of a rulemaking would be provided.

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[271] Appendix A: Support others comments regarding continuing to publish Soil MTGW and VIGWSLs. These levels still have use as screening level tools; perhaps provide guidance on what scenarios they best apply to in order to guide their usage/application. (MSECA)

IDEM has concluded, based on years of experience, that the migration to groundwater and vapor intrusion groundwater screening levels have little predictive power and are frequently misapplied. In the case of vapor intrusion groundwater screening levels, IDEM has learned of a number of instances where reliance on these levels for vapor investigations has led to missing significant vapor intrusion issues. This is why IDEM does not plan to rely on those levels for decision making purposes and instead suggests alternatives to use of those levels. IDEM proposes the synthetic precipitation leaching procedure (or equivalent) as an alternative to migration to groundwater levels, and delineation of soil gas as an alternative to vapor intrusion groundwater screening levels. Both of the proposed alternatives have the advantage of relying more on observed behavior than modeling. Should responsible parties or their consultants wish to use migration to groundwater or vapor intrusion groundwater screening levels, they can calculate their own using equations or calculators provided by US EPA. However, IDEM does not propose to rely on such levels for decision-making purposes.

[272] Appendix A.4.4: What is the rationale for representing less attenuation for shallow exterior/utility corridor soil gas than subslab and conduit vapor attenuation? (MSECA)

The rationale for keeping the 0.1 attenuation factor for shallow soil gas is the greater atmospheric influence and variability seen in shallow soil gas samples.

[273] Page 123: Presentation of screening levels to one significant digit Section A.4 "Derivation of Published Levels" states all of the levels described below are published using a single significant digit and scientific notation. From this, should it be inferred that all analytical results also are to be provided in scientific notation using one significant figure for comparison to the screening levels? If so, please clarify this in the guidance. If not, then the screening levels presented to two significant digits should be used per common human health risk assessment (HHRA) practice. (Ramboll)

Not necessarily. IDEM based its proposal to publish levels to one significant digit on the fact that the overwhelming majority of the underlying toxicological data presented in US EPA's Integrated Risk Information System (IRIS) is published to one significant figure, and that arithmetic operations on data significant to one digit cannot create an additional significant digit. The number of significant digits reported by the laboratory is or should be a function of the laboratory's measurement performance and is independent of the number of significant digits in toxicological data.

[274] Page 123, Section A.4.1: Removal of soil direct contact screening levels for long term exposure scenarios (residential and commercial) Section A.4.1 "Soil Direct Contact" states: except for excavation worker levels, IDEM does not publish soil direct contact levels for volatile chemicals, defined for this purpose as chemicals with a vapor pressure equal to or greater than one millimeter of mercury in the RSL Chemical-specific Parameters Supporting Table. All pathways are omitted for volatiles, including ingestion.

- Soil direct contact screening levels for commercial workers and residents should be retained for the following reasons:
  - The omission of soil direct contact screening levels for commercial workers and residents is contrary to EPA RSLs, 1996 and 2002 Soil Screening Guidance, and RAGS A (Exhibit 6-16) guidance, which include ingestion and inhalation of volatile for outdoor industrial and residential soil exposure.
  - There is no reduction in sampling requirements since IDEM's proposed guidance still requires sampling soil volatiles for excavation worker. Therefore, the benefit of removing this analysis is unclear.
  - Soil contamination from deeper depths can volatilize and migrate to outdoor air, which is a pathway not assessed if these screening levels are removed.
- If these screening levels are removed, the following revisions are suggested:
  - Section 3.3.3.1 describes the four pathways for outdoor soil exposure, which includes inhaling chemicals that volatilize from soil, with the only caveat that this does not apply to all receptors in the statement "with some exceptions". This section should be revised to clarify that these criteria are not calculated for the commercial worker or resident for volatile chemicals.
  - At the minimum, IDEM should explain in more detail why the direct contact screening levels were removed for commercial workers and residential receptors, including the assumptions used to make this determination (e.g., that volatile concentrations are low in the surface soils (< 2 ft), because the source is older and has depleted over time, chemicals present in surface soil will volatilize before absorption across the skin can occur, or that subsurface

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soils are not moved during redevelopment). Is it assumed that soil vapor sampling and analysis for indoor air pathway are protective enough of the outdoor inhalation pathway? If so, this should also be stated.

- Suggest using definition of volatiles consistent with the RSLs, which includes chemicals that are both volatile and water soluble (instead of just being volatile). From the RSLs user guide, volatile chemicals are those with a Henry's Law constant greater than 1 x 1E-5 atm-m3/ mole or a vapor pressure greater than 1 mm Hg. (Ramboll)

Including rationales for all the various proposed changes in the document itself would lengthen the document considerably and potentially interfere with the document's narrative flow. IDEM acknowledges and appreciates these comments and offers the following responses to the concerns and suggestions offered.

- *IDEM acknowledges that its proposed published levels table differs from the Regional Screening Levels (RSL) table(s) published by US EPA. There have always been differences between the IDEM tables and US EPA tables. For example, the RSL tables do not include levels equivalent to IDEM's vapor intrusion groundwater screening levels, nor do they include recreational levels or excavation worker levels. If there were no differences between IDEM's table and the US EPA table, there would be no point in publishing a separate IDEM table.*
- *IDEM does expect fewer soil samples to be required, because concentrations of release-related chemicals tend to decrease with distance from their source. So, for example, a typical delineation of volatile chemicals in soil could stop once excavation levels are reached, rather than continuing until residential levels are reached.*
- *IDEM agrees that volatile chemicals in soils can volatilize and enter outdoor air. Delineation of soil gas in the vadose zone, as described in the R2, should reveal the presence of soil gas plumes that have the potential to enter either structures or outdoor air. Due to factors like wind and the lack of containment, IDEM considers it unlikely that (1) outdoor air concentrations arising from volatilization of chemicals in the subsurface will routinely exceed health-based levels or (2) that such exposures would occur over periods anywhere near as long as those assumed when calculating (for example) published levels for indoor air.*
- *IDEM has revised Section 3.3.3.1 to clearly state that the agency does not intend to publish residential or commercial soil levels for volatile chemicals.*
- *IDEM's principal reason for proposing not to publish residential or commercial soil levels is that volatile chemicals are not expected to remain in exposed or near surface soils (where the majority of soil exposure occurs) for anywhere near the exposure durations (multiple years) assumed by US EPA when calculating those levels; this means the exposure/dose approaches zero for the bulk of the exposure duration and a remedy is not needed. Construction worker levels are calculated with considerably shorter exposure durations and other worker safety laws may be applicable. Elsewhere in the R2, IDEM recommends collecting soil samples intended for volatile analysis within minutes due to significant volatilization losses, and the holding times described in US EPA's methods for analysis of these chemicals also attest to their transient nature in exposed media. Significant vapor concentrations of volatiles in the subsurface that might enter structures (or conceivably pose a health threat to persons working outside in affected areas for years) should be identified via the soil gas delineation effort described elsewhere in R2.*
- *IDEM notes that there is no single universally accepted and applied definition of volatiles, and that the agency had to choose one for this purpose. As suggested by the commenter, IDEM did consider using the definition of volatiles employed in the RSL tables, but determined on the basis of its experience that some chemicals and chemical classes that the RSL table denotes as volatile (especially PCBs and many PAHs) are persistent enough that the agency should continue to publish residential and commercial soil direct contact levels for them.*

[275] Section A.4.1.4, A.4.1.5, and A.4.1.6 – Recreational Soil Direct Contact Levels: For several exposure parameters listed by IDEM that are used in calculating screening levels, the reference noted is, "IDEM (2011, best professional judgment)." This IDEM reference is not provided. Furthermore, in many cases this reference is listed for table values where readily available values are available from USEPA's Exposure Factors Handbook (e.g., skin surface area, adherence factor, soil ingestion rate); it is unclear why IDEM would be relying on professional judgement. (Ramboll)

Tables A-2, A-3, and A-4 describe the parameter values that IDEM uses as inputs in US EPA's Regional Screening Levels (RSL) Calculator to calculate the recreational levels that appear in what is now Table A-6. IDEM considers these parameter values acceptable for their intended purpose. Use of other parameter values may be preferable, depending on project-specific circumstances. Some of the parameter values appearing in Tables A-2, A-3, and A-4 are based on the professional judgment of IDEM staff – generally those for exposure frequency, intake rate, skin surface area, and adherence factor.

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***Exposure Frequency (EF)**. The US EPA Exposure Factors Handbook does not contain guidance on EF in days per year, perhaps because values would likely vary widely across the different climates in the United States. IDEM's suggested EF parameter value for the community park and trail scenario are the same, and assume 75 days for the 0-2, 2-6, and 16-26 age segments. The 75 days per year value was taken from the Risk Assessment Information System. For the 6-16 age segment, IDEM considered the number of weeks in Indiana with temperatures typically above 32 degrees Fahrenheit, about 36 weeks. It was further assumed that adolescents would spend four days in community parks or on trails during the 16 warmest weeks of the year (4 x 16 = 64) and two days in community parks or on trails 20 weeks of the year (2 x 20 = 40). The EF used for the 6-16 age interval for the community park and trail scenarios is 104 days per year (64 + 40 = 104). The EF used for the athletic field scenario is 30 days per year for all age segments. This frequency assumes a ten-week season with two practices and one game per week and is consistent with information published by the Indiana High School Athletic Association.*

***Intake Rate (IRS)**. IDEM uses an ingestion rate of 100 mg/day for the 0-2, 2-6, and 6-16 age segments and 50 mg/day for the 16-26 age segment for the athletic field and community park scenarios. These values are consistent with the "Soil + Dust, General Population Central Tendency" column of the US EPA's EFH Table 5-1. They are not identical because the EFH entries are not always for equivalent age intervals, and are sometimes expressed as ranges, not fixed values. IDEM's ingestion rates for the trail scenario are much lower than those appearing in the EFH and reflect IDEM's intent that these values be used for capped trails, such as a paved multi-use path for walking, cycling, jogging, skating and other activities. IDEM has clarified this intent in Section A.4.1.6.*

***Skin Surface Area (SA).** IDEM uses adult values from US EPA's Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment (RAGS-E) for the 16-26 age interval. Other age intervals are based on data from Exhibit C-1 of the same document. However, because the age intervals in Exhibit C-1 are not the same as those used in the US EPA RSL calculator, professional judgment was required to estimate skin surface areas for the age intervals needed by the calculator. Skin surface area data from the Exposure Factors Handbook are considerably more detailed and would require even more professional judgment to bring into alignment with the RSL calculator.*

***Adherence Factor (AF).** The same issue with incompatible age intervals occurs for this input. The underlying data come from Exhibit C-3 of RAGS-E, but in addition to being presented in age intervals incompatible with the calculator, values in the Exhibit also vary according to activity and soil conditions. Therefore, IDEM staff applied professional judgment to the Exhibit C-3 data to arrive at the parameter inputs in Tables A-2, A-3, and A-4. Adherence factor data in the Exposure Factors Handbook were judged less useful for this purpose.*

[276] Use of the term "direct contact" for groundwater pathway Section A.4.2. "Groundwater Direct Contact" • This pathway should be renamed "Residential Tapwater Levels" to reduce confusion and to be consistent with the column heading for these screening levels in the current RCG Table A-6 and to be consistent with the USEPA RSLs. Usually when the term direct contact is used with groundwater, it is considered to be describing contact with groundwater directly (i.e., while it is still in the ground) through worker contact during excavations. The use of the term direct contact for potable use is confusing since the water is contacted during use in the house and not while in the ground. (Ramboll)

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[277] Use of the term "direct contact" for inhalation only pathway Section A.4.3 "Indoor Air Direct Contact": This pathway should be renamed "Indoor Air Inhalation" to reduce confusion and to be consistent with the current RCG and general risk assessment practice (USEPA Regional Screening Levels, RAGS guidance, etc.). Vapor only air inhalation exposure pathways such as vapor intrusion are not referred to as direct contact since the vapor migrates from the environmental medium to the indoor air (i.e., the exposure point). Therefore, calling indoor air vapor inhalation pathway "direct contact" is confusing. (Ramboll)

IDEM has removed the term "direct contact" from all of the Table A-5 headings and adjusted relevant text in the main body of the R2 accordingly. IDEM will continue using the term "Groundwater" as a heading for that column in Table A-5 because groundwater samples form the overwhelming majority of the samples against which the levels in that column are compared. When IDEM samples or requires sampling of tapwater, it is usually because the tap is connected to a nearby groundwater well, and not a public water supply.

[278] Appendix B: Need to include very real anthropogenic sources such as airborne deposition of heavy metals and PAHs. (MSECA)

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[280] Appendix B: IDEM acknowledges that remediation objectives cannot be set at concentrations lower than naturally occurring background concentrations. However, the occurrence of anthropogenic background is not explicitly acknowledged. In urban areas, for example, lead and PAHs maybe present at concentrations substantially higher than naturally occurring

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concentrations due to long-term deposition of particulates from area-wide industrial emissions, automobile exhaust, or even residential waste burning. These sources of anthropogenic background should be recognized, allowing for consideration of historical deposition that may be unrelated to historical activities on the subject property. This comment also applies to Appendix B. (Ramboll)

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[289] Glossary: The definition of background reference should be added to the other definitions in the glossary. It appears that background reference includes chemicals associated with anthropogenic influences such as urban PAHs, but this is not explicitly stated in the document. This should be clarified. (Vectren)

IDEM does not have the legal authority to establish less conservative levels for (for example) urban areas, based on anthropogenic background. However, responsible parties are always free to perform a project-specific background demonstration, as described in Appendix B.

[279] Table B-4: Typo: change naximum to maximum. (MSECA)

IDEM agrees and has changed "naximum" to "maximum"

[281] Page 148: "… at least two years of consistent data collection…": Does this contemplate two years of quarterly data, or other frequency? (MSECA)

The most common approach is to evaluate two years of quarterly data. However, IDEM will consider other intervals, including shorter intervals, if the groundwater samples are shown to be independent of each other, and the time interval under evaluation does not include periods of unusually high or low groundwater elevation.

[282] Page 148: "…at least two years of data collection, and periodic reassessment of plume conditions." The periodic reassessment is inconsistent with the intent of the plume trend analysis, which is as a demonstration to support closure. Identifying periodic reassessment makes such a determination difficult, and/or long-term stewardship unnecessarily burdensome and costly. (MSECA)

IDEM has clarified the text by revising the text as shown below:

at least two years (8 quarters) of consistent data collection, and periodic reassessment of plume conditions during the plume trend analysis. If conditions change during that time, previously installed wells may no longer produce samples that adequately represent the plume, thereby invalidating the statistical analysis.

[283] Page 159: Consider adding bullet/step about assessing Bioavailability for certain metals via AVS/SEM. (MSECA)

IDEM agrees with this comment and has inserted text into the first paragraph on page 159 as follows:

Whereas Section D.3 uses generic, media-specific screening levels for comparison against representative concentrations, a refined ecological risk assessment uses levels experimentally derived for species representative of various groups in the food web that are, or should be, present in the release area. An adequate ecological risk assessment may require several iterations, depending on what each step of the process reveals, and may include bioavailability studies, studies of spatial and temporal differences in feeding behavior, or other relevant lines of evidence. Figure D-3 is a decision tree that illustrates the process.

[284] Page 164: Land use restrictions listed in the table that have associated long term costs include: soil cap with O&M plan, proper soil handling & disposal, soil management plan, test before residential use, vapor mitigation system with O&M plan, and vapor barrier.

See [17,18] above for additional comments on this topic from Creek Run and IDEM's response.

[285] Page 173: Last sentence of 1st paragraph - How will IDEM determine if there is a "substantial potential exposure risk"? Will this be based on the criteria in place at the time of the closure or based on more current standards if any? (MSECA)

Whether there is a "substantial potential exposure risk" as described in the text will be based on the criteria in place at the time of closure. IDEM expects that the vast majority of sites that close with Long Term Stewardship Plans will require financial assurance.

[286] Page 174: The wording indicates that after all these things are done, that the RP needs to do these things. I would make sure that it is qualified as "if necessary". (MSECA)

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The referenced text is part of Appendix G, which deals with certain conditional closures. Therefore, financial assurance will not be necessary in every situation.

[287] Glossary: Also, they still have VIGWSL as part of their "Acronyms, Initialisms, and Abbreviations" table, but nowhere in the document - page 176 (MSECA)

IDEM agrees and has removed VIGWSL from the list of acronyms, initialisms, and abbreviations.

[288] Glossary: In the glossary "Aquifer" is defined as an underground geological formation as described in IC 14-25-7- 1, which defines "Aquifer" as "an underground geologic formation that 1) is consolidated or unconsolidated; and 2) has the ability to receive, store, and transmit water in amounts sufficient for the satisfaction of any beneficial use [italics added]." In regard to the beneficial use of aquifers, Section 3.4.3 (p89) states that "relatively unproductive water-bearing units may not yield enough water to be useful as drinking water wells. If release-related chemicals in groundwater are confined to formations that do not contain or produce sufficient water to be useful, this is a line of evidence suggesting that exposure to those chemicals via installation and use of drinking water wells in that water-bearing unit is unlikely. Application of this line of evidence must consider the possibility that chemicals in the unproductive water-bearing units may move to a deeper aquifer. If such movement may reasonably be expected to result in an exceedance of a unconditional groundwater remediation objective in an aquifer, then a remedy is warranted to address that potential risk." A groundwater remedy may not be necessary if there are no reasonable exposure risks and LOEs demonstrate that release-related chemicals are confined to unproductive water-bearing units with no possibility of migration to deeper useable aquifers. Guidance should be provided as to the need for off-Site Institutional Controls under this scenario. (Ramboll)

IDEM agrees, but this situation is rare and will be dealt with on a case-by-case basis. However, even if an off-site institutional control is not required, notice of site closure with release-related chemicals remaining off-site must be provided to the potentially affected off-site property owners.

[290] Sampling Conduit Vapor: Appropriate Conditions

This section has several directives stated in a way that indicates they should always be followed; however, they may not always be relevant to site-specific conditions. The first sentence in this subsection specifies sampling sewer vapor during both high and low groundwater conditions. No supporting reasons or qualifiers are offered. This is an appropriate condition for conduits (sewer lines and structures) that interact directly with potentially contaminated groundwater, i.e., are within the saturated zone or above the saturated zone but within the annual range of groundwater fluctuations when the infiltration of VOC-impacted groundwater may affect vapor conditions; however, sampling vapor in conduits during both high and low groundwater conditions may have little value if the conduits and local sewer structures (e.g., manholes) are always above the groundwater fluctuation range. These differences in conditions should be noted as a consideration.

In addition, the paper by McHugh, Beckley, and others (2017) cited in this subsection describes an assessment of a combined storm/sanitary sewer. Differences between sampling combined and non-combined sewers for evaluating vapor intrusion should be noted. For example, the directive to wait at least 72 hours after a significant rainfall event would seem to be applicable to combined sewers but less relevant when evaluating vapor in a non-combined sanitary sewer.

IDEM agrees with the commenter regarding the low and high-water table conditions. Revisions to Section 2.2.6 (see Attachment 3) reflect IDEM's response to address concerns within this comment and to ensure that changes made to Section 3.2.6 correlate to this section. Specific changes to the second paragraph of Section 2.2.6.4 include those shown below:

Sampling Conduit Vapor: Appropriate Conditions

Collect conduit vapor samples quarterly over the course of a year. When collecting conduit vapor samples via grab techniques, collect those samples when baseline flow is relatively low – typically, between 9 AM and 3 PM for sanitary sewers (McHugh and Beckley, 2018). When investigating conduits that may be affected by precipitation, wait at least 72 hours following a significant rain event (defined for this purpose as being at least one inch) before collecting conduit vapor samples. This could include stormwater sewers, combined stormwater/sanitary sewers, and sanitary sewers with openings. These rain events should be considered for all conduits that could be significantly impacted by surface infiltration.

[291] Sampling Conduit Vapor: Procedures

The second paragraph of the "Appropriate Conditions" subsection above advises sampling liquids in conduits under certain conditions; however, no guidance for sampling liquids is provided in the "Procedures" subsection, unless it will be included in the Sewer Manhole Sampling Guidance. Consultants have contrived several ways to sample sewer liquids over the years,

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some of which may be less preferable than others. For example, negative-pressure (e.g., peristaltic) methods work well when sampling liquids in deep manholes but are generally not acceptable in Indiana for sampling.

Any sampling method that achieves project DQOs is acceptable. IDEM is planning to propose a forthcoming nonrule policy document) that discusses the use of peristaltic pumps. The use of such pumps for sampling liquids in sewers may meet project DQOs, as long as the depth to the liquid does not exceed 25 feet. Other precautions should include protection against contact with potential pathogens and waste products in sewer liquids.

[292] Section 3.3.4, Using Site-Specific Levels as Remediation Objectives. While appearing to apply mainly to exposure-risk equations, the second full paragraph in this section appears to leave the door open for deriving migration to groundwater remediation objectives if site-specific (non-default) data are used. From this section, the EPA's 1996 soil to groundwater screening model/equation with non-default data would still appear to have utility under appropriate conditions, e.g., establishing soil ROs protective of groundwater. For clarity, is this approach still allowable under the guidance in this section?

IDEM prefers direct observation of behavior over modeling, where the former is possible. For this reason, IDEM's general preference is for observation and measurement of leaching behavior, where that is necessary, as opposed to modeling leaching behavior. However, if a responsible party wishes to propose a different leaching model, and show that it is a better predictor of leaching behavior that direct observation of that behavior, they are free to do so and IDEM will evaluate that model on its merits.

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ATTACHMENT 1

Conceptual Site Models: Definition and General Expectations

IDEM's evaluation of the adequacy of characterization, risk evaluation, and remedy-related activities relies on submission of supporting documentation by the responsible party or its consultant. One product of project-related activities and document submissions is the development of a **conceptual site model** (CSM) – a comprehensive understanding of the release, including its setting, characterization, an evaluation of risks associated with the release, and any remedy proposed and implemented to address those risks. In this context, the conceptual site model is *not* a specific document, but rather a *conceptual* understanding conveyed by the information obtained throughout the project life cycle. That understanding should increase as the project progresses, reducing uncertainties as new information is obtained and conveyed. CSMs facilitate technical team decision making while supporting stakeholder communication and consensus building. The CSM is an iterative, "living representation" of a release and its environs that helps project teams visualize and understand available information. CSMs are never considered "complete" until final closure occurs.

A sufficient CSM not only captures what is known about a release, but also supports an evaluation of the uncertainty associated with decision-making based on what is currently known. Uncertainty may be addressed in a qualitative fashion, using a weight of evidence approach, or it may be addressed in a more quantitative manner, using statistical concepts and techniques. An uncertainty evaluation may show that a decision can be based on existing information as embodied in the CSM. Alternatively, it may identify data gaps that, if addressed by additional data collection, would allow decision-making to go forward.

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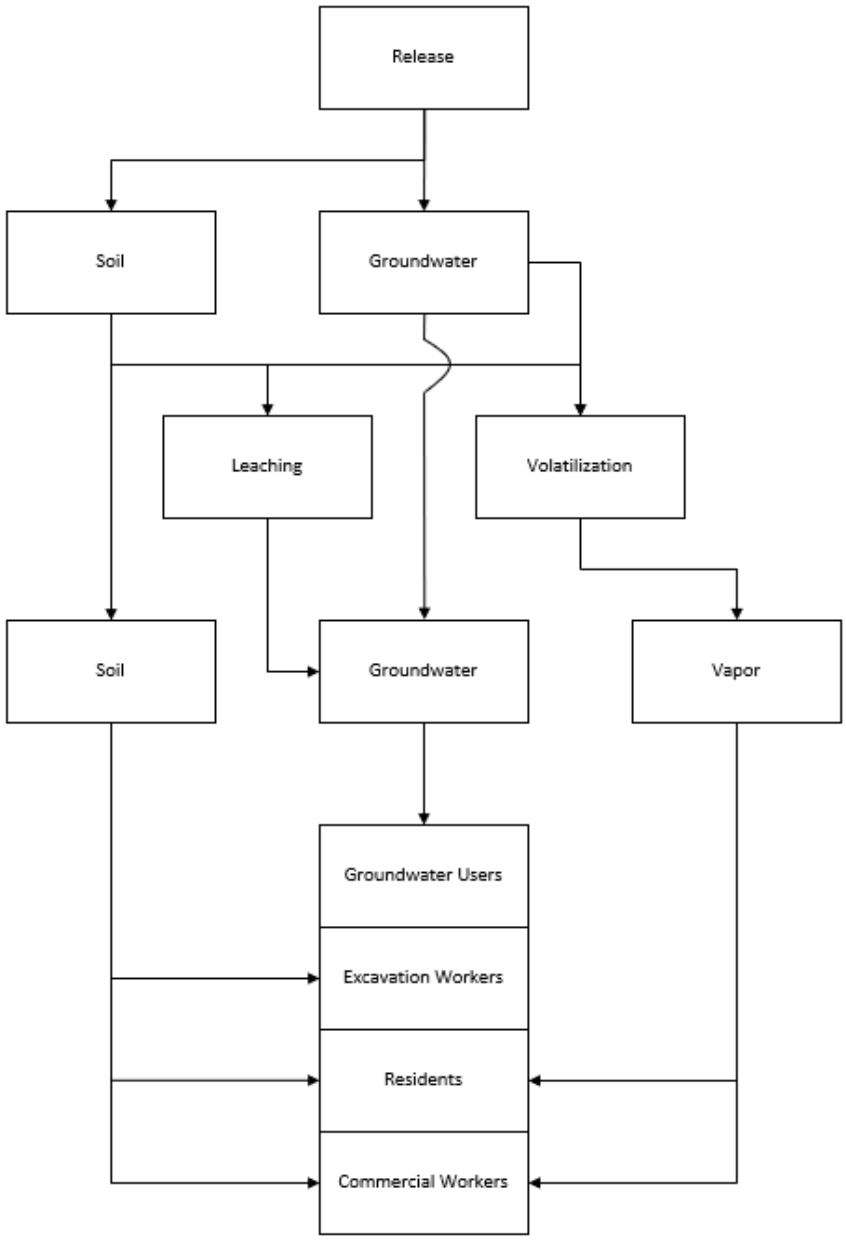
CSM Overview Diagrams

The relationships between source(s), affected media, and actual or potential receptors can be depicted in a CSM summary diagram like that shown in Figure 2-A. CSM overview diagrams can help investigators systematically plan investigations, isolate relevant exposure scenarios, evaluate potential risks to specific receptors, and guide selection of any necessary remedies. CSM overview diagrams also help evaluate the sufficiency of the investigation, risk evaluation, and remedy selection (if any). There are many ways to draw CSM overview diagrams (U.S. EPA, 1996b); they need not conform to any format. It is entirely appropriate to tailor CSM overview diagrams to the characteristics of the project and investigation.

Figure 2-A: Example CSM Overview Diagram



Section 2 of this document is organized around identification of the source(s), nature, and extents of releases, but it is also important to identify the anthropogenic and geologic settings of releases. Important components of those settings are described below.

Anthropogenic Setting

Information important in development of a CSM may come from what is already known about the release and its environs. Relevant information will vary according to the characteristics of the facility and release, but typically includes items such as:

- Facility boundaries and surrounding property use.
- A description of past and present activities conducted at the facility.
- Locations of surface structures (e.g., buildings, tanks, etc.) depicted on a map.
- Locations of process areas depicted on a map.
- Locations and construction of groundwater supply wells and monitoring wells, including drilling logs.
- Locations of sanitary sewer and storm water drainage systems, past and present, including floor drains, drainages tiles, septic tank(s), other underground utilities (telephone, electrical, water, etc.), subsurface disposal field(s), and other underground structures, depicted on a map;
- Copies of reports, information, or data related to previous environmental investigations.
- Past and current aerial photographs and analysis or interpretation of such photographs.
- Source of drinking water for the facility and for adjacent or affected properties.
- Location of any significant water withdrawals, including public water supply wells located less than 3,000 feet or within the five-year time of travel of a wellhead protection area; and
- Identity and locations of sensitive populations adjacent to the facility, including but not limited to daily care facilities (e.g. childcare facilities, schools, and senior citizen facilities).

Geologic Setting

Accurate and detailed geologic information is a necessary component of virtually all CSMs, regardless of the type of release. A thorough understanding of the subsurface environment and geologic setting allows the practitioner to place environmental subsurface data in a geologic and hydrogeologic context, and interpolate geologic characteristics where subsurface data is absent. Geologic and hydrologic information is sometimes already available but is usually collected concurrently with investigation of the release source and extents (see Sections 2.1 and 2.3). Relevant geologic setting information typically includes:

<u>Regional Landforms</u>

Characterization of major landforms (rivers, lakes, topography, karst, etc.) in the vicinity of a release provides a broad understanding of the geologic framework controlling chemical distribution and movement. For example, topography drives surface runoff and regional groundwater typically flows towards streams and rivers. Facility records and visits, and published literature on regional geology, are usually important when developing this understanding.

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Subsurface Composition and Structure

While regional landforms provide an overview, subsurface investigation (soil borings, monitoring wells, geophysical investigations, high resolution site characterization, soil analysis, etc.) is important to characterization of the subsurface and provides insight on the relationships between materials surrounding the release. Investigative activities should provide, where relevant to the release and its behavior, detailed descriptions of unconsolidated and consolidated materials; determination of the thickness, depth, and horizontal extent of distinct geologic features (sand lenses, confining layers, bedrock topography, etc.); identification of natural and anthropogenic preferential pathways (sand stringers, utility corridors, karst, soil fractures, etc.); and any correlation of release-related chemical distribution to the project-specific geology. Descriptions of subsurface materials should employ standard terminology [i.e. the Unified Soil Classification System (ASTM, 2017; or as described in U.S. EPA, 1991), or the U.S. Department of Agriculture (USDA) soil texture classification system (USDA, 1951)].

As noted by Schultz et al. (2017), an adequate subsurface investigation will provide the information necessary to:

- Interpret lateral continuity between borehole data and correlate project data in three dimensions.
- Identify flow paths and preferential pathways.
- Map and predict release-related chemical mass transport (high permeability) and matrix diffusion related storage (low permeability) zones.
- Identify data gaps and assess the need for, and cost benefit of, different investigation techniques (e.g., high resolution site characterization).
- Determine appropriate locations and screen intervals for monitoring and remediation wells, and
- Improve efficiency of groundwater remediation and monitoring.

Migration Flow Paths

Groundwater flow and vapor migration dynamics are often sensitive to local and/or regional natural or anthropogenic changes [e.g., precipitation, flooding, pumping, utilities; see IDEM (2021b) for additional guidance and discussion], and typically requires regular monitoring to characterize the magnitude and significance of changes in flow. An adequate understanding of the migration of vapors from release-related chemicals will typically involve delineation of vapors and concentration gradients within affected and relevant permeable units in the vadose zone, noting that vapors may not flow in the same direction as groundwater. In some cases, this may involve delineation in more than one permeable unit, or vertical delineation within the vadose zone (e.g., to determine the extent to which vapors arising from a groundwater source attenuate before reaching a structure.) Factors that may affect this include source concentration, source depth, soil matrix properties (e.g., porosity and moisture content), anthropogenic changes, and time since the release occurred.

An adequate understanding of these processes should relate all the components of the geologic setting to the distribution of all phases of the release-related chemicals (e.g., isoconcentration maps) to provide a clear understanding of the mechanisms controlling their migration through saturated and unsaturated media, and areas where saturation levels fluctuate. This can help guide further investigative efforts; identify, evaluate, and control exposure; and evaluate the applicability of various remediation techniques.

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ATTACHMENT 2

Table 2-A: Chemicals Often Associated with Various Facilities and Releases

	Chemical or Chemical Class									
Release Type/Industry	VOCs	PAHs[1]	PCBs	SVOCs	Metals	CVOCs[3]	Phenols	Cresols	Cyanide	Misc.[2]
Dry Cleaning Industry	X[4]					X				
E-85 Fuel	X[5]									
Manufactured Gas Plants	X	X	X[7]		X[6]		X	X	X	X
Auto Salvage Yard	X	X	X		X					X
Metal Finishing	X			X	X				X	X
Gasoline Range Product[9]	X[5,8]				X[8]					
Diesel Range Product[10]	X	X								
Hydrocarbon Oil Range Product[11]		X								
Waste/Used Oil; Unknown Petroleum Product	X[8]	X								

Notes:

[1]Polyaromatic hydrocarbons (PAHs) should include all compounds on the U.S. EPA SW-846 Method 8310 analyte list.

[2]Misc. – See relevant technical guidance document(s) and/or contact IDEM for additional testing recommendations

[3]Chlorinated volatile organic chemicals (CVOCs) include, among other chemicals, tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,2-cis- and 1,2-trans-dichloroethenes, and vinyl chloride

[4]Analyze full VOCs if solvents other than tetrachloroethene, trichloroethene, and/or 1,1,1-trichloroethane were used

[5]Include naphthalenes (naphthalene, 1-methylnaphthalene, 2-methylnaphthalene)

[6]See relevant technical guidance document for list of metals

[7]Where electrical generation occurred, or if transformers are/were present, analyze for and report total polychlorinated biphenyls (PCBs) and Aroclors

[8]Report total lead and lead scavengers (1,2-dibromoethane and 1,2-dichloroethane) when investigating aviation gas and racing fuel, or when automotive gas was used or stored before January 1, 1996

[9]Includes automotive gas, aviation gas, racing fuel, Stoddard solvent, naphtha, JP-4, and ethanol fuel

[10]Diesel #1 and 2, kerosene, JP# 5, 7, & 8, light oil, heating oil, and biodiesel <100%

[11]Fuel oil #4, #5, #6, bunker oil, virgin motor oil, hydraulic oil

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ATTACHMENT 3

2.2.6 Sampling Vapor

Because many release-related chemicals are volatile, they release vapors into the pore spaces of unsaturated soils. These vapors can then travel into breathing spaces and create unacceptable risks. Investigation and delineation of vapors in exterior soil gas is useful to determine whether potential current or future risks need to be addressed. Though perhaps not as well understood as soil and groundwater sampling procedures, vapor sampling has been underway in Indiana and elsewhere for well over a decade. Detailed guidance on many vapor sampling procedures is available in U.S. EPA (2015, 2015b) and the documents they reference. However, because vapor sampling is less established than soil and groundwater sampling, IDEM provides additional explanation on sampling procedures in the text that follows.

Indoor air (IA) sampling paired with subslab soil gas (SGss) or crawl space air (CSA) sampling helps establish the relationship between concentrations of release-related chemicals in subsurface vapor and indoor air. It is a strong line of evidence that may also help reveal sources of release-related chemicals within the building. IDEM does not recommend sampling only IA because indoor sources may make interpretation of the results difficult.

Preferential pathways, including conduits, can allow vapors to reach indoor air without significantly affecting the subsurface beneath a building. For this reason, vapor characterization must include consideration of, and in some cases, sampling in preferential pathways, including conduits. Refer to Section 2.2.6.4 for more information regarding appropriate situations for sampling within preferential pathways.

Exterior soil gas sampling (SGe) is appropriate for determining a soil vapor source, delineating soil vapor plumes, use as a stand-alone investigative tool to evaluate vapor intrusion potential at structures whose owners do not grant access for sub-slab sampling, during preferential pathway backfill investigations (in limited circumstances), or when evaluating vapor intrusion potential at undeveloped properties (depending on the SGe sampling density).

As noted in U.S. EPA (2015) there are several types of vapor sampling technologies. It seems likely that new technologies will continue to appear and evolve. Consistent with its treatment of soil and groundwater sampling procedures, the Risk-based Closure Guide provides only a summary of some standard approaches to vapor sampling. A short, annotated list of some common technologies follows, but it is not complete. IDEM will accept vapor data collected using any type of vapor sampling technology that meets project specific DQOs.

- Evacuated canisters use a vacuum to draw in whole air samples. Batch-certified clean canisters are generally acceptable, though some users may prefer individually certified clean canisters as an additional safeguard against false positives. Canisters usually arrive from the laboratory equipped with flow regulators and a vacuum gauge. Laboratories typically pre-set flow regulators, so it is important to determine appropriate flow rates prior to delivery.
- Active sorbent samplers that use pumps to mechanically draw air through the sorbent, or passive sorbent samplers that rely on diffusion from the air, are often able to function over longer time periods than evacuated canisters, and may have significant advantages for evaluating long-term vapor exposure risk. Both sorbent sampling approaches are typically coupled with U.S. EPA Method TO-17.
- Tedlar® bags are only acceptable in very specific circumstances, due to concerns about leaks, pressure changes during transport, cleanliness certification, and short holding times (48 hours). They can be used to collect high concentration (ppmv) grab samples. Their use in projects where low concentrations (ppbv) are expected is limited due to potential leaks and bag cleanliness. Tedlar® bags can be used as a screening tool for initial site investigations and monitoring.

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IDEM recommends the use of evacuated canisters or sorbent samplers for sample collection if the data is to be used for risk assessment. If consistent with project DQOs, options described above (or equivalent) can be used to collect samples to allow for on-site analysis using analytical techniques that can generate data to support project objectives.
There are many other possible techniques, such as:

- High volume sampling
- Building pressure manipulation
- Triggered/event-based sampling (indicators, tracers, surrogates)
- Continuous sampling (e.g., on-site GC/MS)
- Portable GC/MS (e.g., discrete samples with Tedlar® bags)
- Large sample sets to characterize variability (possibly calculate upper confidence limit of the mean)

Except for building pressure manipulation, use of these techniques will need to include consideration of seasonality. The optimal approach will depend on circumstances and may change as the investigation proceeds. IDEM will evaluate alternate approaches on their merits, but because the conclusions of many vapor intrusion investigations are based on a relatively limited data set that typically represents variable vapor concentrations, IDEM has determined that conservative approaches are generally preferable when investigating vapor risk.

Note that smoking, solvent use, and similar activities near vapor sampling areas may compromise analytical results. Additionally, understanding heating, ventilation, and air conditioning (HVAC) settings for commercial and industrial facilities may be pertinent to the vapor CSM and conditions should be noted during paired VI sampling events as described in IDEM (2021b).

2.2.6.1 Soil Gas Sampling: General Considerations

Soil gas samples are air samples collected from within the vadose zone. Exterior soil gas (SGe) samples are from the vadose zone outside a building footprint, while subslab soil gas (SGss) samples are from the vadose zone underneath the basement or slab of a building. In very general terms, collecting soil gas samples requires installing a probe into the vadose zone, drawing gas out of the vadose zone, and collecting that gas for analysis (U.S. EPA 2015). Appropriate procedures vary somewhat depending on whether the soil gas is exterior (Section 2.2.6.2) or subslab (Section 2.2.6.3).

2.2.6.2 Sampling Exterior Soil Gas (SGe)

Exterior soil gas samples come from boreholes advanced into the vadose zone in areas outside the footprint of a structure. Exterior soil gas samples are also useful when identifying and delineating a chlorinated solvent source via the soil gas plume, evaluating preferential pathways, vapor intrusion potential at undeveloped properties, or when a property owner will not permit installation of subslab soil gas sampling ports. While vapor samples within the backfill of preferential pathways may aid some investigations (e.g., those with irregular impact distribution), IDEM is mainly focused on vapor migration within conduits during delineation in preferential pathways. Assessing the need for a remedy due to preferential pathway vapor intrusion may also involve conduit sampling (Section 2.2.6.4).

For purposes of this document, IDEM generally considers shallow soil gas to include samples collected no more than five feet below ground surface, and deep soil gas to include samples collected at more than five feet below ground surface.

Exterior Soil Gas: Appropriate Sampling Conditions

Soil moisture content strongly affects migration of vapors through the subsurface (Tillman and Weaver, 2007). Wetting fronts moving downward though the unsaturated zone can cause underestimation of vapor concentrations. Significant precipitation may cause high vacuum readings, extended sample collection time, and visible moisture droplets within the sampling train during sample collection. If these occur during sample collection, results should be considered as a

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minimum value and may not be representative of typical conditions. Therefore, IDEM generally does not recommend collecting SGe samples during or immediately after a significant precipitation event [at least one inch of rain within 72 hours (ITRC, 2007)]. The amount of precipitation required to affect the movement of vapors will depend on several factors, including soil type, soil moisture conditions prior to the precipitation, ground cover, and other factors that influence infiltration. Finer soils, for example, are generally more saturated and retain additional moisture after a precipitation event as compared to a coarser soil. Because of this, IDEM relies on the professional judgment of a qualified geologist (e.g., a Licensed Professional Geologist) to determine when sampling conditions are appropriate. Soil boring logs should note soil moisture conditions via field observations for each soil gas sampling port.

Exterior Soil Gas: Sample Number and Placement

Volatile release-related chemicals in both soil and groundwater may be a source of subsurface vapors. Sample number and placement should depend on the purpose of the soil gas samples (source determination, delineation, risk assessment, etc.) To evaluate subsurface vapors, U.S. EPA recommends soil gas surveys that include a "near-source" soil gas sample collected immediately above each potential source (U.S. EPA, 2015). Near source soil gas samples are expected to have the highest concentrations and be the worst-case indicator of vapor intrusion potential. Because source depths vary and subsurface conditions can affect vapor transport, IDEM cannot provide an exact sample collection depth. Near source soil gas samples should consider location-specific conditions including an evaluation of affected stratigraphic units, moisture conditions in those units, and whether confining units are present. For example, because moisture can impede vapor flow and affect sampling, the sample port should be set far enough above the capillary fringe to ensure that groundwater is not present. While collection of samples from the impacted stratigraphic layer is preferred, it may be acceptable to install soil gas probes into adjacent units if vapor flow between the units is expected to be similar. IDEM also cannot recommend specific horizontal spacings between sample points as they are location specific. Horizontal soil gas spacing should consider historical use, subsurface lithology, and how lithology affects vapor flow. At larger industrial facilities where source areas are unknown, it may be appropriate to set initial soil gas sample points on 100 by 100-foot grid. At releases where source areas are known, a more focused, biased sampling array of 20 feet by 20 feet may be preferred.

If a source is much deeper than a potential receptor, it may be appropriate to collect stratified soil gas samples to evaluate vertical attenuation of vapors through the soil column. U.S. EPA (2015) recommends that soil gas samples be collected from multiple locations and depth intervals between the vapor source and potential receptors. When collecting stratified/nested soil gas samples, one sample should be collected closest to the source(s) and one sample should be collected close to the potential receptor, either the building's foundation or at basement depth, if evaluating future exposure potential.

In some instances, deep soil gas samples are unrealistic due to shallow groundwater. When this happens, collect shallow soil gas samples. Because soil gas concentrations can exhibit considerable spatial variability due to atmospheric influence, precipitation, advective flow, etc., additional sampling events or locations may be appropriate to ensure representative values. If shallow groundwater does not allow for soil gas probe installation, IDEM will typically expect vapor intrusion investigations at occupied structures if those structures are within 100 feet of a potential soil source of vapors, or underlain or in contact with groundwater exceeding published groundwater levels for VOCs, unless convincing lines of evidence indicate otherwise. In some cases, additional monitoring wells may be necessary to determine whether VOC plumes in groundwater extend under structures.

Soil gas concentrations tend to be higher beneath a building than at the same depth in adjacent open areas when the vapor source is underneath the building, even if the source is laterally extensive relative to the building footprint (U.S. EPA, 2015). When SGe is used to estimate sub-slab concentrations (e.g., when evaluating potential vapor intrusion risk in areas where there are as yet no buildings or where access has not been granted), submit lines of evidence indicating

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that SGe sample results are representative of what would be under the slab. SGe samples should be collected from depths below the building's foundation and along the side of the building closest to the source as a reasonable worst-case representation of conditions underneath the building in the absence of routes for preferential vapor migration or soil gas entry.

Active Soil Gas Sampling Procedures

1. Advance a borehole. Exterior soil gas sampling requires a borehole, advanced using a hand auger, a hollow-stem auger, or direct-push methods. Small-diameter (less than two inches) boreholes, installed using direct-push methods, minimize disturbance of surrounding soils. Placement of exterior soil gas samples depends on the purpose of the sampling. When delineating soil gas plumes, placement should be governed by the needs associated with that task – typically, stepping out from a known or suspected source. When evaluating the potential for soil gas to enter a nearby structure, it is generally preferable to place the borehole as close as possible to the structure.

   Unless professional judgment suggests otherwise, collect SGe samples from two locations near residential buildings, along the side of the building closest to any known vapor source. For large commercial buildings, two or more SGe samples per side of the building may be necessary to characterize vapor conditions in the subsurface, and additional SGe sampling locations may be necessary along multiple sides of the building.

   All else equal, soil gas samples collected from a depth just above a known or suspected vapor source are considered more closely associated with worst-case conditions for purposes of predicting the potential of vapors to enter structures compared to shallow gas samples (U.S. EPA, 2015). As with groundwater, local geology, preferential pathways, and chemical characteristics will often have a considerable influence on subsurface transport and must be considered when choosing sampling locations.
2. Install a vapor sampling probe and seal the sampling port. To avoid cross-contamination of vapor samples by the sampling equipment, use vapor probes made of inert materials (e.g., stainless steel, Teflon®, Nylon®, polyethylene, etc.) that are appropriate to sample the release-related chemicals (U.S. EPA, 2015; Ohio EPA, 2020; Schumacher et al., 2016). Where practical, use permanent sample ports, as this allows repeated testing of vapors from the same location. Permanent sampling port materials should be durable enough to last through multiple sampling events. Minimize the number of fittings and tighten them as necessary to avoid system leaks. To prevent ambient air from entering the sampling train, seal the annulus between the probe and the borehole.
3. Allow the subsurface to equilibrate. U.S. EPA (2015) notes that installing soil gas probes can disturb subsurface soil conditions and recommends allowing the subsurface to equilibrate prior to sample collection. Appropriate equilibration times depend on installation technique. IDEM recommends sampling at least 24 hours after a permanent probe has been installed. Based on project objectives, temporary probes may be installed and sampled as soon as two hours after installation.
4. Perform a leak test. All connections or fittings in the sampling equipment need to be tight, so that outside air leakage into the sample collection container does not occur. For this reason, perform a leak test to check the integrity of the sampling system. Common tracers used during leak checks include helium, propane, isopropanol, pentane, and butane. Choose a tracer that will not interfere with the analytical method for the sample. See Hartman (2006), NYDoH (2006) and Cal EPA (2015) and U.S. EPA (2020) for detailed guidance on leak testing.
5. Purge the sampling apparatus dead volume. Purge three times the dead volume of the sampling apparatus. A large graduated syringe or hand-operated vacuum pump are suitable for this purpose. The dead volume of the sampling apparatus includes the implant screen and the tubing, but not the sample container volume nor the

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sand pack volume. Avoid over-purging. Minimal purging reduces the risk of inducing air flow from outside the area of interest. Sampling equipment with the smallest possible internal volume that can meet project DQOs will reduce the necessary purge volume.

6. Collect the vapor sample. Vacuum during sampling should be as low as possible, subject to acceptable leak test results. Low vacuum and a low sample collection rate will minimize short-circuiting of vapors from outside the area of interest. A sampling rate of 100 to 200 milliliters per minute is preferable (Cal EPA, 2015). A very slow draw rate will improve results where wet or fine-grained soils necessitate high vacuum.

Passive Soil Gas Sampling

Passive soil gas sampling procedures are similar to those used to collect active soil gas samples. Passive sampling relies on the diffusion of compounds in the vapor state to sorbent(s) housed in a chemically inert container designed to protect sample integrity (Hodny et al., 2009). For passive soil vapor sampling, a hole must be drilled, the sampling device should be protected from direct contact with soil, and the sampling device should be sealed in place with a seal that is at a depth just above the sampling device, and capped at the ground surface (McAlary et al., 2014a, 2014b, 2014c; Hodny et al., 2009; Odencrantz and O'Neill, 2009). For soil gas sampling, it may not be necessary to purge when using passive samplers (McAlary, 2014). After several days, chemical vapors amass onto the sorbent material. The sampling device is then removed and analyzed.

Possible advantages of passive sampling include longer-term sample collection periods, lower costs, and simpler procedures. Possible problems include poor retention of target chemicals, starvation effects, matching target chemicals with appropriate sorbents, and unplanned uptake of non-target chemicals. McAlary et al. (2014a, 2014b, 2014c) have determined that passive samplers can be used to quantify soil vapor concentrations provided the uptake rate of the sampling device is less than the supply rate of vapors from the surrounding materials. This avoids low bias from the starvation effect.

Dawson et al. (2015) provides an overview of different passive samplers and factors to consider when selecting an appropriate passive sampling device. For soil gas sampling, passive permeation sampling devices may be particularly suited to soil vapor sampling as the hydrophobic nature of the membrane limits soil moisture uptake. IDEM recommends consulting your analytical laboratory for the latest information on passive sampling technology, uptake rates, sorbents, sampling protocols, and necessary quality assurance procedures.

2.2.6.3 Sampling Subslab Soil Gas (SGss)

SGss sampling means collection of air samples from immediately below the basement or slab of a building. The process involves drilling one or more holes through the concrete floor, placing a sleeve or probe through the concrete, and then collecting an air sample into an evacuated canister. SGss ports may be permanent or temporary.

IDEM considers paired SGss and IA samples best for evaluating vapor intrusion potential into IA. Paired samples allow quantification of the actual increased risk from vapor intrusion, while reducing concerns about potential background sources within the building. However, SGss sampling is acceptable as a stand-alone screening tool, provided there is an adequate investigation of preferential pathways and subslab spatial variability. In instances where subslab sampling is conducted without IA sampling, IDEM recommends a more structured preferential pathway investigation at each building location (e.g., one conduit vapor sample per residence within the potential preferential pathway).

Subslab Soil Gas Sampling: Appropriate Conditions

Most indoor air measurements represent a narrow "snapshot in time" because of problems with getting repeat access and uncertainty over seasonal and building variations. Due to these uncertainties and limited sampling data, IDEM recommends sampling during "worst case" conditions. Sampling during worst-case conditions provides limited exposure

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data that is likely to be biased high. This bias may be considered when evaluating the need for action if indoor air sampling can be conducted at a frequency that addresses seasonal and building variability. IDEM will consider alternative SGss sampling schedules, especially where sampling needs are urgent, seasonal variation is insignificant, or where building conditions, weather conditions, or other factors suggest that worst case conditions occur outside of the winter heating and dry summer seasons.

Collect SGss samples during at least two different time periods to account for worst case conditions related to seasonal variability. Historically, the winter heating and summer cooling seasons have been considered the worst-case sampling scenarios for vapor intrusion because there is normally less external ventilation and HVAC systems can create a pressure differential that pulls gases up from the subsurface. One round of SGss samples should be collected during the winter heating season (approximately mid-November through March), when the indoor temperature is typically at least ten degrees higher than the outdoor temperature. Winter heating season SGss samples should be collected with building windows and doors closed and the building heating system in operation.

A second round of SGss samples should be collected during the dry summer season. Soil moisture content and water table fluctuation may have a more significant impact on vapor intrusion than winter heating season conditions. The highest transfer rates for VOCs from groundwater to soil gas occur during falling water table conditions (McHugh and McAlary, 2009). Generally, the water table is falling during the hot, dry summer months in Indiana (typically July through mid-September). Additionally, buildings equipped with cooling systems will have the windows and doors closed.

Subslab Soil Gas Sampling: Number and Placement

Investigative goals, utility locations, owner preferences, and other practical considerations will affect the number and locations of SGss samples. Monitoring points should be installed at locations with minimal potential for AA infiltration via floor penetration (e.g., cracks, floor drains, utility perforations, sumps, etc.)

U.S. EPA (2015) recommends collecting at least three SGss samples at structures with a footprint less than 1,500 square feet. However, IDEM recognizes that this may be impractical or unobtainable in residential structures. Generally, IDEM recommends collecting at least one preferentially located [i.e., close to known source(s)] SGss sample under residential structures. Additional SGss sample locations may be necessary pending evaluation of the building structure and data collected. IDEM will rely on these building evaluations and professional judgment to determine if additional SGss sample locations are necessary.

For commercial buildings IDEM recommends collecting an adequate number of SGss samples to evaluate spatial distribution of vapors. Multiple SGss ports can help interpret anomalous SGss/IA data or support conclusions about surrounding buildings that are not well-sampled. Sampling locations should consider areas highly susceptible to releases (e.g., machine pits, dry cleaning machine locations, etc.), internal building partitions, HVAC layout, chemical distribution, utility conduits, and openings for preferential soil gas entry.

For both residential and commercial buildings, centrally located sampling ports are appropriate where the subsurface vapor source is laterally extensive relative to the building footprint (e.g., a groundwater source). Other approaches may be necessary for atypical situations, which include:

- Very large or small homes or buildings.
- Buildings with more than one foundation floor type.
- Subsurface structures or conditions that might facilitate or mitigate vapor intrusion; and
- Multi-use buildings with distinct segmented areas that differ significantly by occupying population or exposure frequency.

Subslab Soil Gas Sampling: Frequency and Duration

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Assessing the risk posed from the vapor intrusion pathway through the subslab of a building generally requires at least two rounds of SGss sampling (one during the winter heating season and one during the dry summer season). Collect the second round of SGss samples from the same locations as the first. The second sampling event is especially important when confirming SGss results used as a stand-alone determination of the vapor intrusion pathway. If the results of the first two SGss sampling events are contradictory, IDEM may request additional sampling.

To minimize air infiltration, maximum flow rates through the SGss probe and related tubing should not exceed 200 mL/min during purging and sampling. Most subslab samples are collected as grab samples, though canister fill rates and durations may vary depending on project objectives.

Subslab Soil Gas Sampling: Recommended Procedures

Subslab soil gas sampling is similar to exterior soil gas sampling (Section 2.2.6.2), though there are some key differences. U.S. EPA (2015) describes a procedure for collecting subslab soil gas grab samples in six-liter evacuated canisters. IDEM has determined that the Vapor Pin® or similar subslab soil gas sampling technology is acceptable, as are canisters as small as one liter, if they meet project DQOs. Considerations to keep in mind when collecting subslab soil gas samples include:

- During colder months, building occupants should operate heating systems to maintain normal temperatures of 65-75˚F for at least 24 hours prior to and during sampling.
- Purge three volumes of the sample probe and tubing immediately prior to sampling. Use a large graduated syringe or hand-operated vacuum pump to purge the sampling point. Avoid exceeding a maximum flow rate of 200 mL/min during purging and sampling to minimize air infiltration.

When subslab soil gas sampling is no longer needed at a building, remove the sampling ports and seal the remaining holes to prevent migration of vapors through the slab.

2.2.6.4 Sampling Conduit Vapor

Sewers and other open conduits can receive, intercept, and transmit vapors or liquids containing volatile chemicals to receptors. While there are differences between conduits (within an open pipe) and utility corridors (backfill around underground utilities), IDEM considers both to be anthropogenic preferential pathways. As multiple studies note, there is increasing recognition of the importance of conduits as a pathway for vapor intrusion, as vapors can migrate into occupied structures through plumbing systems that are not properly maintained (Roghani et al., 2017; Pennell et al., 2013; Guo et al., 2015; Jacobs et al., 2017; McHugh and Beckley, 2018). In the text below, the term *chemicals* refers specifically to vapor forming chemicals.

Sampling Conduit Vapor: Appropriate Conditions

Collect conduit vapor samples quarterly over the course of a year. When collecting conduit vapor samples via grab techniques, collect those samples when baseline flow is relatively low – typically, between 9 AM and 3 PM for sanitary sewers (McHugh and Beckley, 2018). When investigating conduits that may be affected by precipitation, wait at least 72 hours following a significant rain event (defined for this purpose as being at least one inch) before collecting conduit vapor samples. These rain events should be considered for all conduits that could be significantly impacted by surface infiltration.

While conduit vapor samples are generally preferable, liquid samples collected from within the conduit may provide information about vapor sources. To reduce the influence of ambient air, collect conduit vapor samples prior to collecting conduit liquid samples. If possible, collect liquid samples when the water table is above the conduit. This allows for potential infiltration of release-related chemicals into the conduit.

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Sampling Conduit Vapor: Number and Placement

Collect conduit vapor and/or liquid samples from those conduits most likely to have the highest concentrations of release-related volatile chemicals. IDEM recommends evaluating conduits when (1) the conduit was used for volatile chemical disposal and/or (2) shallow groundwater that contains volatile chemicals intersects those conduits.

For example, if chemicals were disposed of directly down a sink drain leading to the sanitary sewer, a conduit vapor sample can be collected at the closest point of access to this source (e.g., behind the u-bend of the sink, the sewer cleanout leading from the property, or closest connected conduit access point). However, research has shown that there may be larger variability if the sample is collected from a sewer cleanout rather than a maintenance entrance (McHugh and Beckley, 2018). If shallow groundwater containing release-related chemicals intersects a conduit, a conduit liquid sample can show whether those chemicals are infiltrating the conduit, thus functioning as a continuing source of vapor into the conduit. In this scenario, conduit vapor samples should be collected with conduit liquid samples.

Sample each conduit that meets the criteria above and that may be a preferential pathway for vapors. Additionally, collect one up-gradient and two down-gradient conduit vapor samples from each conduit (where gradient is determined by the flow direction of liquids inside the conduit). Delineation of conduit vapor should continue in the appropriate direction(s) until concentrations no longer exceed published levels for conduit vapors or their project-specific equivalents.

Sampling Conduit Vapor: Frequency and Duration

Temporal variability in conduit vapor concentrations is relatively high (McHugh et al., 2007; Houlton et al., 2013; U.S. EPA, 2015c; McHugh and Beckley, 2018), and is much higher over a timescale of months compared to a timescale of days. McHugh and Beckley (2018) show that short-term time integrated samples (24-hour evacuated canisters or 7-day passive samplers) provide little benefit compared to grab samples for estimation of long-term average vapor concentrations in a sewer. For this reason, IDEM recommends performing four quarterly sampling events to evaluate conditions over a year.

Sampling Conduit Vapor: Procedures

The following is a brief outline of procedures for sampling conduit vapor using evacuated canisters. Procedures are similar for passive samplers, though obtaining accurate results using passive samplers requires selection of a proper sampler and sorbent combination to avoid starvation, poor retention, and poor recovery (U.S. EPA, 2014b; McHugh, et al., 2017). Passive sampler choice should consider uptake rates and moisture fluctuations within the conduit.

- Approximately 24 hours prior to sampling, assess sewer access point types and accessibility, along with the approximate depth of the utility and depth of any liquid (if previously unknown). Sample tubing should be cut so that vapor samples can be collected approximately one foot above the liquid level.
- Document appropriate sampling information for canisters and sorbent samplers, including sample identification, sampling location, sampling depth, sampling times (initial and final), weather conditions, and possibly HVAC building conditions if evaluating results paired with indoor air samples. Additional information that should be collected and recorded for canisters may include initial and final vacuum, canister type, and canister/flow controller numbers.
- When using evacuated canisters, perform a leak check on each canister and attach Teflon® tubing (potentially weighted) to the canisters.
- Open sewer access points as little as possible to minimize ambient air influence. If possible, the sewer access point should be completely closed prior to and during sampling activities.

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- After opening sewer access points, use appropriate screening instruments to measure concentrations of volatile organic chemicals and oxygen. Check results against lower explosive limits.
- Tubing attached to evacuated canisters should be lowered approximately to approximately one foot above any water within the sewer. Check the sampling assembly for leaks. If sampling time exceeds five minutes, suspend evacuated canisters below the access point.
- Submit samples to the laboratory within holding times.

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2.2.6.5 Sampling Crawl Space Air (CSA)

SGss samples are not an option in buildings constructed over a crawl space. Such buildings will require collection of SGe or CSA samples, preferably in conjunction with IA samples and/or SGss samples (if there is a partial basement or slab). However, CSA samples may suffice in certain situations as a stand-alone method for investigating vapor intrusion.

Sampling Crawl Space Air: Appropriate Conditions

CSA samples should be collected during at least two different time periods to account for seasonal variability. Samples should be collected under the worst-case conditions and time periods described in Section 2.2.6.3. Although a standard timeframe is not noted in other guidance, closing crawl space vents 24 hours prior to the sampling event is reasonable. IDEM will consider alternative sampling schedules, especially where sampling needs are urgent, seasonal variation is insignificant, or where building conditions, weather conditions, or other factors suggest that worst case conditions occur outside of the winter heating and dry summer seasons.

Sampling Crawl Space Air: Number and Placement

One centrally located CSA sampling point is typically sufficient for most residential buildings. Crawl spaces are rare in commercial buildings. Such structures will require a project-specific sampling plan that includes enough samples to adequately characterize CSA concentrations. Placement of samples should take into consideration the likely location of the highest subsurface vapor concentrations.

It may be advisable to collect an AA sample in conjunction with CSA sampling to determine whether an AA source may be contributing to concentrations of release-related chemicals in the CSA. Any such AA concentrations should be used as a qualitative line of evidence, and not directly subtracted from the measured CSA concentrations.

Sampling Crawl Space Air: Frequency and Duration

Assessing the risk posed from the vapor intrusion pathway within a building over a crawl space requires collection of at least two sets of CSA samples, with the second set of samples collected from the same locations as the first. Additional sampling may be necessary if the results of the first two sampling events are contradictory.

IDEM recommends collecting CSA samples over a 24-hour period in residential buildings. The sample duration for commercial decision units should capture normal working conditions. For example, if shifts are a twelve-hour period, then the samples should be collected for a twelve-hour period. Alternatively, if multiple shifts occur it may be necessary to collect one 24-hour sample or two eight-hour samples. Project objectives may dictate alternative canister fill rates.

To minimize the impact of indoor background sources on indoor air sampling, building occupants should suspend (where practical) activities such as smoking, dry cleaning, painting, mowing, pesticide application, and the use of sprays, cleaners, solvents, etc. prior to sampling. Document exceptions observed during sampling. IDEM (2021b) contains guidance that may prove useful when looking for potential indoor background sources of release-related chemicals. Interviewing building occupants may reveal potential indoor background sources. If feasible, identify and remove potential background sources prior to sampling. U.S. EPA (2011b) contains discussions of background levels.

2.2.6.6 Sampling Indoor Air (IA)

Acceptable indoor air sampling procedures are described in U.S. EPA (2019g). Additional information regarding indoor air sampling appears in U.S. EPA (2015) and ITRC (2007b). Analytical laboratories can also provide guidance. Note that it can be difficult to interpret indoor air sample results in the absence of vapor sample results from outside the structure.

Sampling Indoor Air: Appropriate Conditions

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IDEM has determined that indoor air samples should be collected during at least two different seasons that provide the best opportunities to capture worst-case conditions. Historically, the winter heating and summer cooling seasons have been considered the worst-case sampling scenarios for vapor intrusion. This is because windows and doors are typically closed during the heating and cooling seasons, and HVAC systems can create a pressure differential that draws vapors up from the subsurface. Project-specific vapor sampling plans should account for HVAC layout and operating conditions during time of sampling. If the project-specific vapor sampling plan will be used for multiple sampling events, the indoor air building checklist should reference the sampling plan and note any changes in HVAC conditions between sampling events. In addition, falling water table conditions that commonly prevail in the summer can expose source material.

Therefore, unless there is an immediate need to characterize indoor air and current human exposures, or evidence shows that seasonal variation in indoor air concentrations is not significant:

- Collect one round of indoor air samples during the winter heating season when building windows and doors are closed and the building heating system is in operation (when the indoor air temperature is consistently at least ten degrees higher than the outdoor temperature), and
- Collect one round of indoor air samples during the summer cooling season when building windows and doors are closed and the building cooling system is in operation.

Differential pressure measurements are a valid line of evidence when evaluating vapor intrusion that is unrelated to sewer or other conduit transport. The difference in pressure between the IA and SGss provides a primary advective force for vapor intrusion. Vapor intrusion is likely when the pressure inside a building is lower than the pressure in soil gas below the building. If the pressure inside is positive compared to the subslab, there should be little or no vapor intrusion potential. Pressure differential measurements over hours, days, or weeks using small diameter subslab sampling ports or pressure taps can be used as a line of evidence to demonstrate whether conditions conducive to vapor intrusion exist during a sampling event. Aspects of building pressure dynamics, including information regarding HVAC use during sampling events should be documented[6].

Sampling Indoor Air: Number and Placement

For residential buildings, worst case IA samples are generally located in the basement or area where vapors first enter the building. Generally, IDEM recommends at least three 24-hour samples: one indoor air sample in the basement or assumed worst case location, one indoor air sample in the general living area, and one ambient air sample. If the building has multiple levels, IDEM recommends one indoor air sample from each floor. Place evacuated canisters within the breathing zone (three to five feet above the floor) and collect the ambient air sample upwind of the building.

Project-specific vapor sampling plans should account for atypical situations, which include: (1) very large homes or buildings; (2) multi-use buildings, particularly ones with segmented areas that are occupied by different populations (e.g., day care within office) or have different occupancy patterns over time. Additional samples may also be warranted, depending on internal building partitions, HVAC layout, chemical distribution in the subsurface, and occurrence of observable locations of potential soil gas entry (e.g., basement sumps or drains, relatively large holes or spaces in the foundation floor, entry points for utilities). Closed rooms located below ground may have significantly higher concentrations originating from vapor intrusion. Closed rooms may warrant sampling to characterize reasonable maximum exposure levels, if occupied, or to diagnose vapor intrusion, even if not occupied.

When planning IA sample locations in commercial buildings, consider the following:

- Individual offices within a building.

[6] See IDEM (2021b) for more on this topic.

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- Individual retail spaces within a larger commercial complex.
- Areas operating under separate HVAC systems.
- Areas with higher exposure potential (where occupants spend most of their time).
- Areas above the highest subsurface chemical concentrations.
- Areas with utility inlets.

Sampling Indoor Air: Frequency and Duration

Assessing risk posed from the vapor intrusion pathway requires collection of at least two rounds of indoor air samples. To minimize variability between indoor air samples collected over time, collect the second round of indoor air samples from the same locations as the first. Pairing indoor air samples with subslab soil gas samples can help assess indoor air background issues. If the results of the first two sampling events are contradictory or inconclusive, IDEM may request additional sampling.

IDEM recommends completing indoor air sample collection over a 24-hour period for current (or when evaluating future) residential use, and an 8-hour period for commercial use. Alternative canister fill rates are possible depending on project objectives. However, the fill rate must be established prior to obtaining canisters from the laboratory, since the pre-set flow regulators for the canisters are typically supplied by the laboratory. All else equal, a longer collection period for each individual sample would be expected to yield a more reliable basis for estimating long-term, time-averaged exposure than would a one-day sample collection period.

2.2.6.7 Ambient Air Sampling

If activities near the proposed sampling area may contribute to indoor air concentrations, it may be advisable to collect an ambient air sample over the same time period as indoor air samples. U.S. EPA generally recommends beginning AA sampling at least one hour, but preferably two hours, before indoor air monitoring begins (U.S. EPA, 2015). U.S. EPA recommends this practice because most residential buildings have an hourly air exchange rate in the range of 0.25 to 1.0, causing air that enters the building before indoor air sampling to remain in the building for a long time. Measured AA sample concentrations should be used as a qualitative line of evidence. AA sample concentrations should not be directly subtracted from the measured IA concentrations.

2.2.6.8 Background (IAb) Sources

Ambient and indoor chemical sources may complicate interpretation of indoor air (IA) sample results. Many VOCs common to environmental investigations are present in tobacco smoke, cleaning supplies, craft and hobby supplies, stored fuels, and other common household products, and may exceed published levels for chemicals such as benzene, carbon tetrachloride, chloroform, methylene chloride, trichloroethene, and tetrachloroethene. For this reason, it is important to assess IAb sources and concentrations at a decision unit when evaluating the vapor intrusion to IA pathway.

Lines of evidence useful when determining whether IA chemicals are attributable to background sources or chemicals in the subsurface include:

- Factors listed in IDEM (2021b)
- AA sample results
- Concentration gradients within a building
- Subslab soil gas (SGss) to IA concentration ratios
- Individual chemical concentration ratios across media

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- Presence of indicator chemicals
- Use of radon as a tracer gas to determine a structure-specific attenuation factor

If an indoor source is suspected, conduct a detailed inspection of the building's contents and survey occupant activities. Identify the presence of common household items (e.g., cleaning supplies, craft and hobby supplies, and fuels) that contain VOCs common to the release, as well as recent activities such as dry cleaning, or home improvements (e.g., painting or new carpet) that may contribute to exposures. See IDEM (2021b) or U.S. EPA (2002) for examples of building surveys.

Comparing SGss, AA and IA results to each other may reveal the relative contribution of vapor intrusion and background sources to indoor air concentrations. In this case, time-integrated sampling methods are recommended for indoor air, because concentrations of vapor-forming chemicals can vary significantly over time.

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2.3.6 Present Extents: Vapor

Volatile chemicals may move through permeable soils, fractures in bedrock or clay tills, anthropogenic subsurface structures such as utility lines, sumps, foundations cracks, volatilize directly from groundwater in contact with structures, or any combination of these pathways, often in unexpected directions. If those vapors enter structures at unacceptable concentrations, adverse health effects may result. For this reason, it is necessary to consider the extents of volatile chemicals in the subsurface, including the vadose zone and open conduits like sewers.

2.3.6.1 When is Soil Gas Screening Necessary?

Most release-related vapor intrusion exposures arise from two classes of volatile chemicals –chlorinated volatile organic chemicals (cVOCs) and, to a lesser extent, petroleum-related chemicals. Because the characteristics of chemicals in these classes differ somewhat from each other, criteria that trigger a vapor intrusion evaluation also differ between them. IDEM may require investigation of vapor intrusion potential arising from chemicals in other classes where lines of evidence suggest that is necessary to evaluate potential exposure.

IDEM does not anticipate routinely requiring soil gas delineation at petroleum releases. Instead, IDEM recommends using criteria list in Table 2-C (Section 2.3.6.5) to decide whether petroleum vapor intrusion investigation is necessary at existing structures, or for potential structures. For cVOCs, soil gas screening should occur at facilities that use, store, dispense, or dispose of cVOCs, or did so historically, and at any facility where sampling data shows or has shown the presence of cVOCs.

2.3.6.2 Soil Gas Screening

Soil gas screening should consider vapors arising from all sources, keeping in mind that different sources may need to be investigated separately. If vapor source locations are known, collect three soil gas samples as close to those sources as possible. For example, when evaluating chemicals in groundwater as a potential vapor source, collect soil gas samples near the groundwater table, starting close to the highest groundwater concentrations (if known and present). When placing samples, keep in mind that vapor does not always migrate in the same direction as groundwater. If the source is unknown, collect three soil gas samples from depths and areas most likely to have exceedances. Examples include locations under buildings, around drains, near machine pits and dry-cleaning machines, in disposal areas, or in fill areas that preferentially accumulate release-related chemicals. Extra caution is warranted when collecting soil gas samples near the soil surface, as ambient air may break through the soil column.

As noted by U.S. EPA (2015), vapor migration in the vadose zone can be impeded by several factors, including soil moisture, low-permeability (generally fine-grained[7]) soils and biodegradation. Because of this some circumstances will reduce IDEM's confidence in the representativeness of soil gas screening samples. Those circumstances may warrant postponement of soil gas screening, additional numbers of soil gas screening samples, or additional rounds of soil gas screening. Examples include:

- Where soil gas screening occurs during or immediately after a significant precipitation event, defined for this purpose as a total of one inch or more of precipitation over a 72-hour period.
- Where volatile chemicals are dissolved in a saturated water-bearing unit under confined conditions, where the confining layer is not laterally extensive. In such cases vapor may only be evident in the vadose zone in areas

[7] Where fine-grained soil is classified as clay, silty clay, silty clay loam, or silt consistent with the U.S. Soil Conservation Service classification system.

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where the confining layer has pinched out or otherwise becomes discontinuous, perhaps at a considerable distance from the source facility.

It is always possible that other circumstances may render soil gas screening results insufficient to rule out additional investigation. Professional judgment will be necessary when considering this possibility.

2.3.6.3 Deciding When Soil Gas Delineation is Necessary

A vapor extents investigation should follow any exceedance of a published soil gas level. In some cases (Section 2.3.6.5), the results may indicate that it is also necessary to evaluate vapor intrusion potential at one or more structures.

2.3.6.4 Delineating Present Soil Gas Extents

The same general principles that apply to delineation of present extents in groundwater mostly apply to soil gas delineation, except that the latter occurs only in the vadose zone. Delineation typically begins at or near the vapor source(s) and proceeds laterally until soil gas concentrations no longer exceed levels that would prompt a vapor remedy, an investigation of vapor intrusion potential in nearby structures, or future evaluation of vapor intrusion at subsequently constructed structures. Professional judgment may also suggest that delineation should start at nearby receptors and proceed from there.

Base the number, location, and depth of soil gas samples on the CSM, including known or likely source areas, distance (vertical and horizontal) between the potential vapor source and any receptors, preferential pathways, such as karst and fill areas, and location-specific lithologic and hydrogeologic information. When collecting soil gas samples near a structure, place sample locations as close as possible to the building footprint, as concentrations in samples collected from outside a building footprint are often less than those found in samples collected within the footprint.

2.3.6.5 Prompts for Vapor Intrusion Investigation

Chlorinated Volatile Chemicals

Structures within 100 horizontal feet of a published residential soil gas level exceedance should undergo a standard vapor intrusion investigation. If the structure is subject to a residential use restriction, then exceedance of a published commercial soil gas level should prompt a standard vapor intrusion investigation.

Petroleum-related Volatile Chemicals

Vapor intrusion by benzene and other petroleum-related chemicals occurs most often when release-related chemicals in groundwater are inside a building or in contact with a building foundation, or NAPL is located near a building foundation. Benzene, the petroleum-related chemical that most often drives risk resulting from petroleum vapor intrusion, readily degrades in unsaturated, oxygenated soils (U.S. EPA, 2012). Soils in Indiana are generally sufficiently aerated if they are unsaturated.

IDEM will not initially require soil gas sampling for petroleum releases but will evaluate vapor potential based on the scenarios listed in Table 2-C, below. Evaluation of vapor intrusion may be appropriate at structures on:

- Properties near operating/formerly operating gasoline stations,
- Properties near operating/formerly operating petroleum bulk storage facilities, and
- Properties that used, stored, dispensed, or disposed of petroleum products.

High benzene concentrations in ambient air at operating gasoline stations can confound indoor air sampling results in vapor intrusion studies. If impacts are from facility operations (current or historic fuel station operations), IDEM will not

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typically request vapor intrusion evaluations of structures at operating facilities. If impacts at a petroleum facility are from a release at a different petroleum facility, a vapor investigation of the subsurface may be warranted for future use considerations but again, due to confounding issues with ambient air concentrations, IDEM will not typically request a standard VI investigation.

Table 2-C: Prompts for a Petroleum Vapor Intrusion Investigation

Indicator	Vapor Investigation Recommended if:
NAPL	Building has less than 15 feet of vertical or horizontal separation from NAPL
Groundwater	Building has less than six feet of vertical or horizontal separation from groundwater with dissolved benzene above 50 ug/L
Soil	Building has less than six feet of vertical or horizontal separation from soil containing volatile petroleum chemicals
Odors	Building occupants near the petroleum source area complain of chemical odors

Section 3.4.7 provides guidance on deciding whether vapor intrusion investigation results should prompt a remedy.

2.3.6.6 When is Conduit Vapor Screening Necessary?

IDEM will request conduit vapor screening for cVOCs if groundwater containing release-related chemicals potentially intersects the conduit or cVOCs may have been dumped or disposed of down facility drains. Conduit samples may also be necessary if paired sampling yields ambiguous results and no clear IA source can be determined. IDEM will request initial evaluation of conduits for petroleum vapor if groundwater containing NAPL or benzene of 500 ug/L or greater is/has the potential to be released into conduits.

2.3.6.7 Conduit Vapor Screening

Collect conduit vapor samples at the maintenance hole closest to the infiltration or release point and at one maintenance hole upgradient and two maintenance holes downgradient of that location. An evaluation of the conduit's structural condition may be needed, especially if release-related chemicals have the potential to enter the conduit. This evaluation may include a camera inspection of subsurface drains, a visual inspection of drains or open piping within structures and documentation from the entity that maintains the conduit regarding any major changes or upgrades to the conduit.

IDEM understands that commingled vapor sources may exist in these conduits. However, if the facility contributed released-related chemicals, either through a release resulting in infiltration to the conduit or through direct discharge, then it must address the impact even though it may not be the sole contributor. If the facility can demonstrate that it is not contributing to the release-related chemicals or that different and distinct chemicals exist in addition to its contribution, IDEM will pursue other sources.

2.3.6.8 Deciding When Conduit Vapor Delineation is Necessary

If conduit screening results exceed published levels, conduit delineation should continue until published levels are no longer exceeded. If conduit screening results do not exceed published levels, quarterly sampling (for a year) should continue for chlorinated chemicals. For petroleum chemicals, a second confirmatory conduit vapor sampling event should occur during a subsequent quarter.

2.3.6.9 Delineating Conduit Vapor

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Use conduit vapor published levels to delineate the extent of release-related chemicals within a conduit. Conduit vapor published levels currently apply an attenuation factor to the respective indoor air published level for a chemical. Attenuation factors may change pending new developments in vapor intrusion research. If so, updates will be provided and explained in an IDEM technical guidance document and reflected in subsequent published levels tables. Development of project-specific conduit attenuation factors is acceptable if it can be shown, under worst case building conditions, that VI will not occur now or in the future.

2.3.6.10 Prompts for Vapor Intrusion Investigations Based on Conduct Vapor Sample Results

If conduit vapor concentrations in the main conduit exceed conduit vapor published levels, IDEM is likely to request vapor intrusion investigations in nearby structures. It may be advisable to consult with the IDEM project manager to develop an acceptable approach before beginning work.

If building owners will not allow for access, collection of vapor samples from laterals extending from the utility main to the building may be used though additional sampling precautions will likely be necessary. If the lateral has a cleanout, consider plugging it to obtain a more representative sample, as cleanouts are likely not vapor tight. Research has shown that vapor concentrations in laterals leading from the main conduit can fluctuate greatly (McHugh and Beckley, 2018), so multiple lateral sampling events may be necessary to rule out the lateral as a source of vapor intrusion.

If conduit vapors cause indoor air to exceed published indoor air levels, a remedy for the affected structure(s) is likely necessary. If conduit vapor concentrations are high enough, a remedy to protect against potential future exposures may be necessary, even if indoor air concentrations do not currently exceed published indoor air levels. Consult Section 3.4.7 for guidance on remedy necessity determinations.

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ATTACHMENT 5

3.1 Task Four: Specify Decision Unit(s) and Their Use(s)

The remedy decision process described in IC 13-25-5-8.5(b)(2) requires a comparison of levels of hazardous substances or petroleum (what this guidance refers to as representative concentrations, Section 3.2) against remediation objectives. For purposes of this guidance, IDEM refers to the places where such comparisons and decisions occur as **decision units**.

3.1.1 Basis for Requirement

Responsible parties must specify decision units so that IDEM knows *where* comparisons of representative concentrations and remediation objectives are occurring, and so that IDEM can ensure that all places within the present and likely future extents of releases are evaluated to determine whether a remedy is necessary. Defining current and likely future use of decision units is necessary when selecting remediation objectives that are adequately protective for those uses under IC 13-25-5-8.5(b)(2)(A). Unless decision units are specified, it is not possible to know whether they meet the requirements for characterization described in Section 2, or whether a remedy is necessary under IC 13-25-5-8.5(c).

3.1.2 Specifying Decision Units

Every risk evaluation will involve at least one decision unit, and every location within the present and likely future extents of release-related chemicals must be in at least one decision unit. Some releases may lie entirely within a single decision unit. Other releases may require multiple decision units. Decision units can be specified for areas, volumes, or relatively compact places like a drinking water tap. A decision unit might be soil in a residential yard, groundwater beneath a property, the air inside an occupied structure, or any other place within the present or likely future extents of a release. They can be places where exposure is currently occurring, or places where exposure might occur in the future.

Decision unit boundaries typically coincide with one or more of the following:

<u>Physical boundaries</u>

This is especially important when specifying decision units for evaluation of indoor air. Individual houses would typically each be a separate decision unit for purposes of vapor remedy decisions. Strip malls and apartment complexes are examples of subdivided structures where indoor air exposures may differ significantly across different parts of the same structure. Reasons for such differences might include proximity to release-related chemicals, indoor chemical use, differences in building construction, including ventilation systems and other design characteristics, and differences in the way that the structures have aged or been modified.

<u>Different exposures</u>

Exposures may vary for many different reasons. For example, differences in exposed populations, their activities, and their developmental stages mean that soil exposure risk is likely to differ significantly between a children’s playground and an office building occupied by adults. For this

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reason, if a large property or area is divided into many different uses or subject to different types of exposures, each area subject to a different use or exposure should be designated as a separate decision unit. Alternatively, the entire property or area could be assigned to a single decision unit and evaluated assuming exposure to the most sensitive population.[8]

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[8] Per 328 IAC 1-3-1.3(b)(5), this approach may not be eligible for reimbursement from the Excess Liability Trust Fund.

Different exposure controls

Some locations may have different exposure controls. For example, an adjacent property owner affected by a release may not be amenable to a land use restriction, even if that restriction adequately controls risk. In such cases, a decision unit boundary might coincide with the property boundary.

Data availability

In most cases, IDEM will expect that remedy decisions for a decision unit be supported by representative concentrations based on data *from that decision unit*. For example, it would not ordinarily be appropriate to base an indoor air remedy decision on data from a structure three blocks away. However, there are times when interpolation and extrapolation may be appropriate or even necessary. For example, if the extent of a plume of release-related chemicals in groundwater encompasses many drinking water wells, it may be acceptable to assume that well users in the interior of the plume require a remedy to control exposure to those chemicals, even if some of the wells in the interior of the plume are not sampled. In other cases, appropriate sampling locations may be inaccessible. IDEM will evaluate such situations on their merits.

Decision unit specifications should include:

- Descriptions of decision unit boundaries or locations (areas or volumes), including likely uses
- A list of decision units
- A depiction of decision units on a map.

Note that while co-mingled plumes or multiple releases may complicate characterization or responsible party identification, risk evaluation should focus on release-related chemicals in the decision unit, regardless of source. Unacceptable risks must be controlled, even those arising from more than one source. IDEM will require parties associated with co-mingled plumes to prioritize and control unacceptable risks to human health and the environment before litigating financial responsibility related to the multiple releases. Assignment of financial responsibility for controlling risk is a separate question from determining the need for such control.

3.1.3 Decision Unit Use(s)

Risks should be evaluated for both current and reasonably likely future uses of the locations within decision units. IDEM acknowledges that predicting future extents and uses is often difficult, that some degree of uncertainty is inevitable and acceptable, and that it is not reasonable to base future use projections on any conceivably possible use. IDEM will apply available knowledge about the release and its setting when evaluating whether the projected future use is reasonably likely, and whether the proposed remediation objectives are reasonably likely to be protective. Any determination of reasonably likely future use is necessarily a judgment call. However, in the absence of an IDEM-enforceable environmental restrictive covenant that restricts use of a location affected by a release[9], IDEM will typically assume that likely future exposure will include sensitive (e.g., residential)

[9] Or, in the case of groundwater, an environmental restrictive ordinance (Appendix F) may also be applicable.

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populations. This is because land use changes are common (including, for example, conversion of former industrial facilities to residential use).

A proposed change in use of a decision unit will require IDEM to evaluate additional information to support an evaluation of risk regarding the proposed change in use. The parties involved in any such transaction involving a change of use are responsible for coordinating with each other, collecting, and evaluating the additional information, and presenting it to IDEM. Examples of appropriate questions to ask in such circumstances include (but are not limited to):

- Will existing buildings by demolished or renovated?
- If an existing building will be renovated, is it possible to determine in advance whether any proposed remedies are likely to be effective, or must that determination wait until the renovations are complete?
- Will building spaces (e.g., a basement) be used for storage, or to house sensitive populations?
- Will the grounds be used as a playground, or for gardening, or as public outdoor space?

These unknowns may have to be resolved by managing the exposure risk and restricting use of the decision unit until a transaction is complete and the person who intends to change the use of that decision unit collects the additional information and presents adequate evidence to IDEM regarding exposure risk before modifying the existing use restrictions. All parties must work together and coordinate plans to address both development and environmental concerns so that the goals of both can be effectively and expediently addressed.

3.1.4 How IDEM Will Evaluate Decision Unit and Future Use Specifications

IDEM will use the following list of criteria to evaluate the specification of decision units and their current and likely future uses.

- Is every location within the present and reasonably likely future extents of release-related chemicals within at least one decision unit?
- Are decision units depicted on a map or figure, and listed?
- Is the present and reasonably likely future use of each decision unit specified?
- Where environmental restrictive covenants or environmental restrictive ordinances are either in place or planned for specific decision units, is that information included in the listing or description of those decision units?
- If an environmental restrictive covenant or environmental restrictive ordinance is not already in place, is it anticipated? What steps have been taken and are planned to obtain institutional controls on each decision unit?
- Are the decision unit boundaries reasonable, given physical barriers, likely exposures, likely or proposed exposure controls, and data availability?

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ATTACHMENT 6

Table 3-A: Vapor Attenuation Factors

Medium	Building Type	Attenuation Factor	Suitable for:
Sub-slab soil gas	Residential or Commercial	0.03	Vapor remedy determination
	Large Commercial	0.003	
Soil gas exterior - shallow	Residential or Commercial	0.1	Delineation; investigation of IA in nearby structures; vapor remedy determination
	Large Commercial	0.01	
Soil gas exterior – deep	Residential or Commercial	0.03	
	Large Commercial	0.003	
Conduit vapor*	Residential or Commercial	0.03	
Crawl space air	Residential or Commercial or Large Building	1	Vapor remedy determination

*IDEM considers the 0.03 conduit vapor attenuation factor referenced in McHugh and Beckley (2018) to be a conservative value that provides a reasonable starting point for investigations. IDEM may update this attenuation factor on receipt of further research results.

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ATTACHMENT 7

Appendix C: Plume Trend Analysis

Measuring the concentration changes within a plume can be a strong line of evidence that a plume of a release-related chemical in groundwater is behaving consistently, both temporally and spatially. Analysis of these concentration changes requires a minimum of eight quarters of data from wells that are placed in the same flow zone, within the release-related chemical plume, and in locations that allow an understanding of plume behavior. The location of the monitoring wells is described below and depends upon the type of plume behavior under evaluation. Analysis of the temporal and spatial change in concentration is not necessary at well-understood releases and should be considered only if existing lines of evidence fail to show adequately predictable plume behavior. A list of known acceptable analysis methods that analyze the spatial change appears below. IDEM will evaluate other methods on a case by case basis.

C.1 General Approach

If release-related chemicals are present in groundwater at concentrations that exceed unconditional remediation objectives, it is necessary to understand the likely behavior of the plume of each release-related chemical over time. However, evaluation of plume behavior may be premature or even unnecessary if:

- The nature and/or extents of the plume are still under investigation.
- Active remediation is occurring.
- The intent is to quickly drive plume concentrations below an unconditional remediation objective.
- Release-related chemicals are moving onto the facility from another source.

<u>Statistical Analysis</u>

Statistical plume trend analysis is a temporal line of evidence that combines groundwater monitoring data with regression analysis, time-trend analysis, and other statistical tests from a representative groundwater monitoring well network to demonstrate an increasing, decreasing, or consistent plume. However, appropriate spatial application of statistical plume trend analysis requires a comprehensive well network (as described in each appropriate method listed below), *at least* two years (8 quarters) of consistent data collection, and periodic reassessment of plume conditions during the plume trend analysis. If conditions change during that time, previously installed wells may no longer produce samples that adequately represent the plume, thereby invalidating the statistical analysis. Consistent behavior across the plume, normally a sign of a mature plume, is a stronger line of evidence than individual well results. Independent statistical analysis of individual wells does not normally provide sufficient evidence of plume behavior – a statistical analysis of data from a well network is required.

When considering statistical analysis of plume behavior, consider the following:

- There are multiple trend test methods. The appropriate test depends on several factors, most notably the statistical distribution of the underlying data. If the data appears to fit a predictable distribution, such as normal or lognormal, then a more powerful trend test, such as ordinary least squares regression, can be used. Non-parametric tests like Mann-Kendall or Theil-Sen are appropriate for data that does not fit a known distribution.
- Parametric tests are often more powerful than nonparametric tests. However, as noted above, parametric tests require normal or transformed normal data.
- A statistical test may not be representative if the CSM is incomplete. If wells are not in locations that allow a representative sampling of the plume (same flow zone, in the plume, and in locations described below), data from those wells could provide misleading statistical results.

C.2 Time-Trend Analysis

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All else equal, the past behavior of a mature plume is a good indicator of future behavior. This explains the emphasis U.S. EPA (2009) places on monotonic long-term temporal trends (over at least eight quarters) in plume behavior. Monitoring well network design is critical to evaluate spatial variability, and consultation with IDEM technical staff is recommended to ensure that the monitoring well network is appropriate for the demonstration.

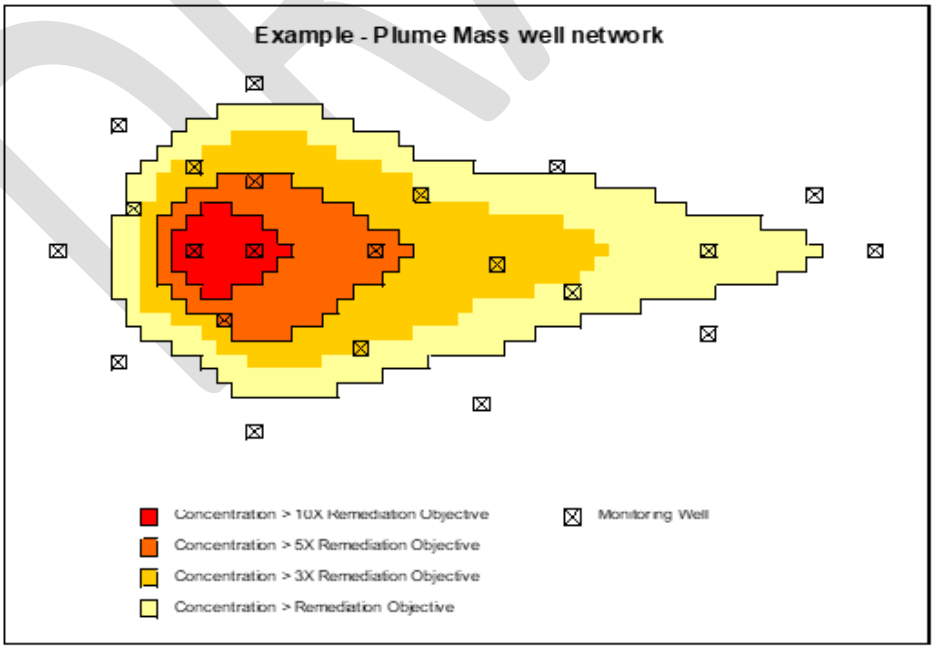
Plume Trend Analysis: Plume Mass

Estimating plume mass requires a three-dimensional understanding of dissolved chemical concentrations at a resolution that allows observation of changes in the overall plume mass. This demonstration may require an extensive groundwater monitoring network, including sampling points at multiple depths so that it is possible to understand how dissolved concentrations vary vertically. In some cases, it may be possible to use knowledge of the subsurface to interpolate between sampling points. A Mann-Kendall evaluation that uses at least eight quarters of calculated relative mass data can provide a high level of confidence in the expected behavior of the plume. In general, more data will increase the value of this line of evidence.

The extent of the necessary monitoring well network will vary by project. Consultation with IDEM technical staff is recommended to ensure that the monitoring well network is appropriate for the demonstration. IDEM recommends beginning with a regression analysis and concluding with a Mann-Kendall analysis of the change in mass over time [U.S. EPA (2009, Chapter 17.3); U.S. EPA (2006b, Step 4.3); Ricker (2008)]. However, IDEM will evaluate alternative statistical demonstrations on a project-specific basis.

After eight independent samples are collected at each monitoring well in a network that adequately covers the extents of the plume, a successful demonstration of decreasing plume mass will show that the relative mass over time has a negative slope or S-value (depending on the statistical method used).

Figure C-1: Illustration of Plume Mass Well Network



Plume Trend Analysis: Plume Flux

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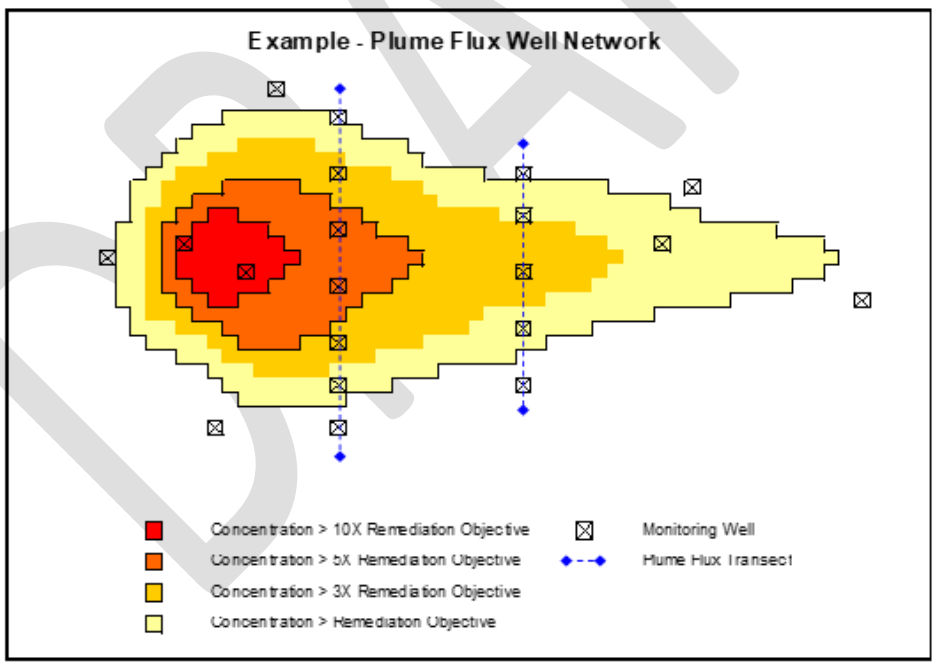
Plume flux is a measurement of change in dissolved chemical concentrations across a plane. Examining the trend in plume flux across one or more projected planes is a useful way to evaluate release-related chemical movement (Figure C-2). However, as with plume mass, complete and accurate characterization of flux may require a substantial monitoring well network that includes multiple transects across the plume at multiple sampling depths. In some cases, it may be possible to use knowledge of the subsurface to interpolate between sampling points. A Mann-Kendall evaluation of the calculated relative mass flux at each transect based on at least eight quarters of data can provide a high level of confidence in the expected behavior of the plume. Plume flux measurements using more sampling data will increase the weight of this line of evidence.

Consultation with IDEM technical staff is recommended to ensure that the monitoring well network is appropriate for the demonstration. Plume flux analysis supplements the plume mass line of evidence with additional statistical evaluations. IDEM recommends beginning with regression analysis for each transect and concluding with Mann-Kendall analysis for each transect [U.S. EPA (2009, Chapter 17.3); U.S. EPA (2006b, Step 4.3); ITRC (2010); Ricker (2008)]. However, IDEM will evaluate alternative statistical demonstrations on a project-specific basis.

After eight independent samples are collected at each monitoring well in at least two transects across the plume, a successful demonstration of decreasing plume flux will show that the relative flux over time has a negative slope or S-value (depending on the statistical method used).

Figure C-2: Plume Flux Well Network



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Plume Trend Analysis: Multiple Sample Location Statistical Analysis

This line of evidence combines monitoring data with regression analysis, time-trend analysis, and other statistical tests from a representative groundwater monitoring well network to demonstrate the existence of a significant trend in the concentration in a plume. This method requires a comprehensive well network, multiple years of consistent data collection, and periodic reassessment to be applied appropriately. A Mann-Kendall evaluation of the concentrations at each monitoring well for at least eight quarters provides a pattern for the individual wells. However, independent statistical analysis of each well will not normally provide the necessary evidence of plume behavior. A high level of confidence in the expected behavior of the plume is demonstrated when characteristics are consistent across relevant monitoring wells.

Other lines of evidence are often more directly applicable to well-characterized sources (e.g., age of the plume). By analyzing these other lines of evidence first, it may be possible to evaluate the plume behavior without using statistics (See Section 2.3.5.3). The process of assessing ambient plume trends should be postponed until all active remediation is completed.

A demonstration via this method that a plume is decreasing provides a high level of confidence that risks are decreasing. Conversely, an increasing plume warrants additional investigation and/or a remedy. This demonstration involves evaluating the trend of multiple sampling locations with multiple observations; all else equal more data will increase the weight of this line of evidence. Demonstrating plume behavior is unlikely when at least two of the plume monitoring wells exhibit statistically significant different trends (increasing and decreasing), or when other characteristics are not consistent across relevant monitoring wells.

Some wells must be located within specific groundwater time-of-travel distances from the source and show some form of correlation. Before installing wells, estimate the advective flow velocity of groundwater at the decision unit to ensure that the new wells will meet groundwater time-of-travel requirements. This approach will allow sufficient time during monitoring to ensure that groundwater from the closure area reaches key monitoring wells.

Well locations are important when characterizing likely future extents. How the monitoring wells relate to one another is used to evaluate the spatial component of the plume. If all the monitoring wells within the plume exhibit approximate trends in the same direction with comparable slopes, then a single summary statement across the well network is valid (EPA 2006b). If the time-trends do not show a consistent pattern, it is likely that one or more wells are not screened in the same flow zone, or a previously unknown source may be affecting the observed concentrations. In either of these cases, new wells may be necessary to understand plume behavior.

Data on chemical concentrations levels and aquifer characteristics should come from wells and boreholes capable of providing a clear three-dimensional picture of the hydrogeologic and geochemical characteristics of the location. If the wells do not meet appropriate criteria, or if conditions change, previously installed wells may no longer produce samples that adequately represent the plume. In such cases, new wells may be necessary.

The statistical analysis of multiple sample locations requires properly designed, located, and installed groundwater monitoring wells. Figure C-3 depicts a typical likely future extents demonstration well network.

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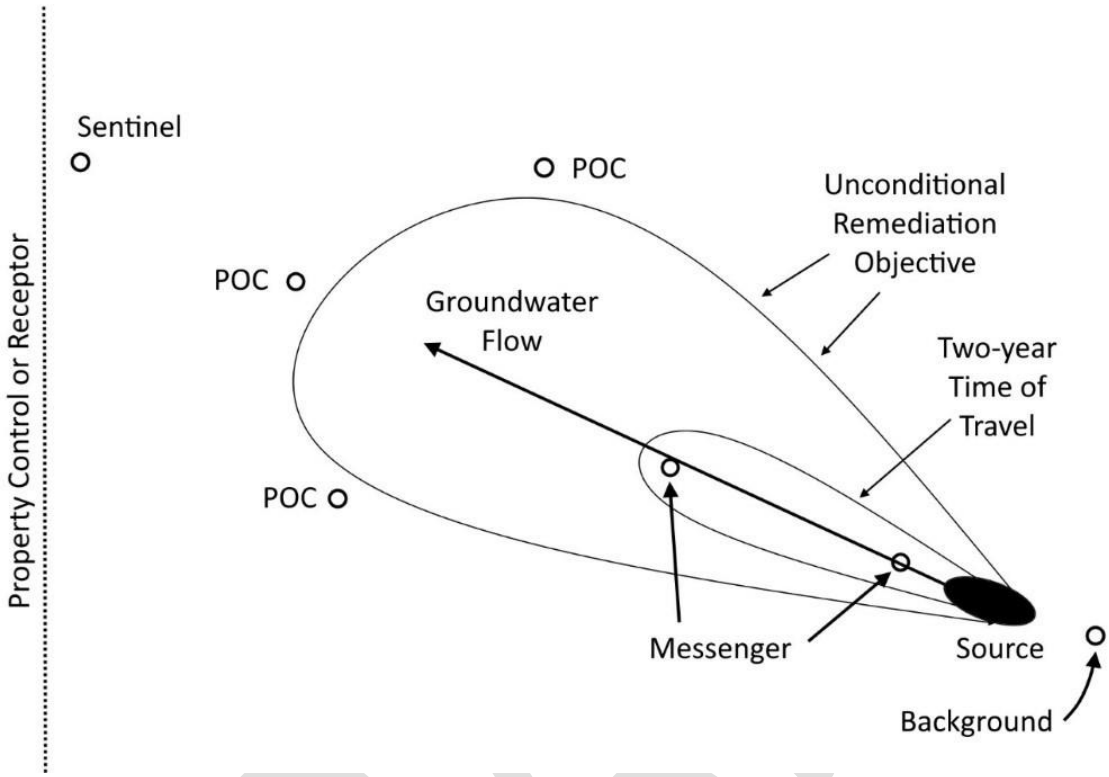
Figure C-3: Plume Monitoring Network



Messenger Wells are in the internal area of the plume, downgradient from the source, and within the two-year groundwater time-of-travel distance from the source. At least one messenger well must be adjacent to the source, and a second messenger well must be between the first messenger well and the two-year groundwater time-of-travel distance of the plume. Most groundwater closure demonstrations use two to four messenger wells. Large or multi-lobed plumes may require more messenger wells. Messenger wells should be (1) as near to the center flow line or flow path as possible and (2) in an area where the release-related chemical concentration is likely to be highest and significantly exceed remediation objectives.

Perimeter of Compliance (POC) wells (at least three) are part of the network, located hydraulically downgradient and/or side-gradient from the messenger wells, where:

- Dissolved concentrations of release-related chemicals will likely exceed reporting limits for at least 75 percent of the monitoring events.
- Concentrations of release-related chemicals approximate unconditional remediation objectives.
- It is possible to monitor the plume after it has passed through the source and messenger well areas.

Install **sentinel wells** to define the extents of the plume and to evaluate the potential risk to downgradient receptors. Locate sentinel wells hydraulically downgradient from POC wells and along a line between the source and any potential receptors. Though sentinel wells are highly useful for signaling an expanding plume, they may be unnecessary if there are substantial lines of evidence to demonstrate that there is no unacceptable risk to a downgradient receptor.

Place **background wells** upgradient of the area of concern and out of the zone of influence of the source. Background wells are essential to understanding upgradient groundwater conditions. If both upgradient and downgradient concerns exist at a decision unit, at least one background well is necessary.

CSM development may require further characterization of plumes through additional groundwater monitoring and assessment of spatial and temporal data trends (e.g., plume area, chemical concentrations, chemical mass, and the center of mass over time). Evaluating the time trend of the wells individually may not provide sufficient information to adequately characterize likely future extents. Assessment of how the trends relate to each other helps understand plume behavior, and the potential for chemicals to migrate beyond the exposure control area.

Statistical analysis methods may be acceptable when IDEM accepts the characterization and agrees that the CSM is adequately developed. In addition, information from the statistical plume trend analysis can also be used to further refine the CSM. The ProUCL statistical package (Singh and Maichle, 2015) or similar software can evaluate the data used for trend analysis, as well as evaluate the trends in the data.

Standards for such tests (e.g., Mann-Kendall or Theil-Sen) should include the following:

- No well described in the monitoring well network (Figure C-3) can have an increasing trend at a significance level greater than five percent
- After eight independent samples are collected at each monitoring well in the network, only one source well can have a positive slope or S-value.

If the analysis cannot meet both standards, additional lines of evidence are needed to establish stable plume behavior. Additional lines of evidence can include further quarterly groundwater monitoring unless any messenger or perimeter of compliance well shows an increasing trend at a 5% level of significance.

If hydraulic conductivity, saturated thickness, flow gradients, or other important characteristics vary significantly over the evaluation area, it may prove difficult or impossible to confidently predict plume behavior. Similarly, preferential pathways (e.g., karst conditions, fracture flow, utility backfill, etc.) that control groundwater flow and chemical migration complicate assessment of likely future extents. Where this is the case, understanding plume behavior may require assessment of lines of evidence that are not covered in this Appendix (see Section 2.3.5.3).

U.S. EPA (2006b) describes various methods for evaluating trends of different combinations of spatial and temporal data. If there is widespread variation within the plume, IDEM may request the statistical analysis depicted in Figure C-4 and explained in a 5-step process.

- Step 1: Regression analysis of data from each well
- Step 2: Mann-Kendall trend analysis of data from each well
- Step 3: Graphical demonstration that data from each well exhibits similar trends and slopes
- Step 4: Homogeneity of variance analysis
- Step 5: Monotonic trend analysis

IDEM will evaluate other plume trend analysis methods on their merits.

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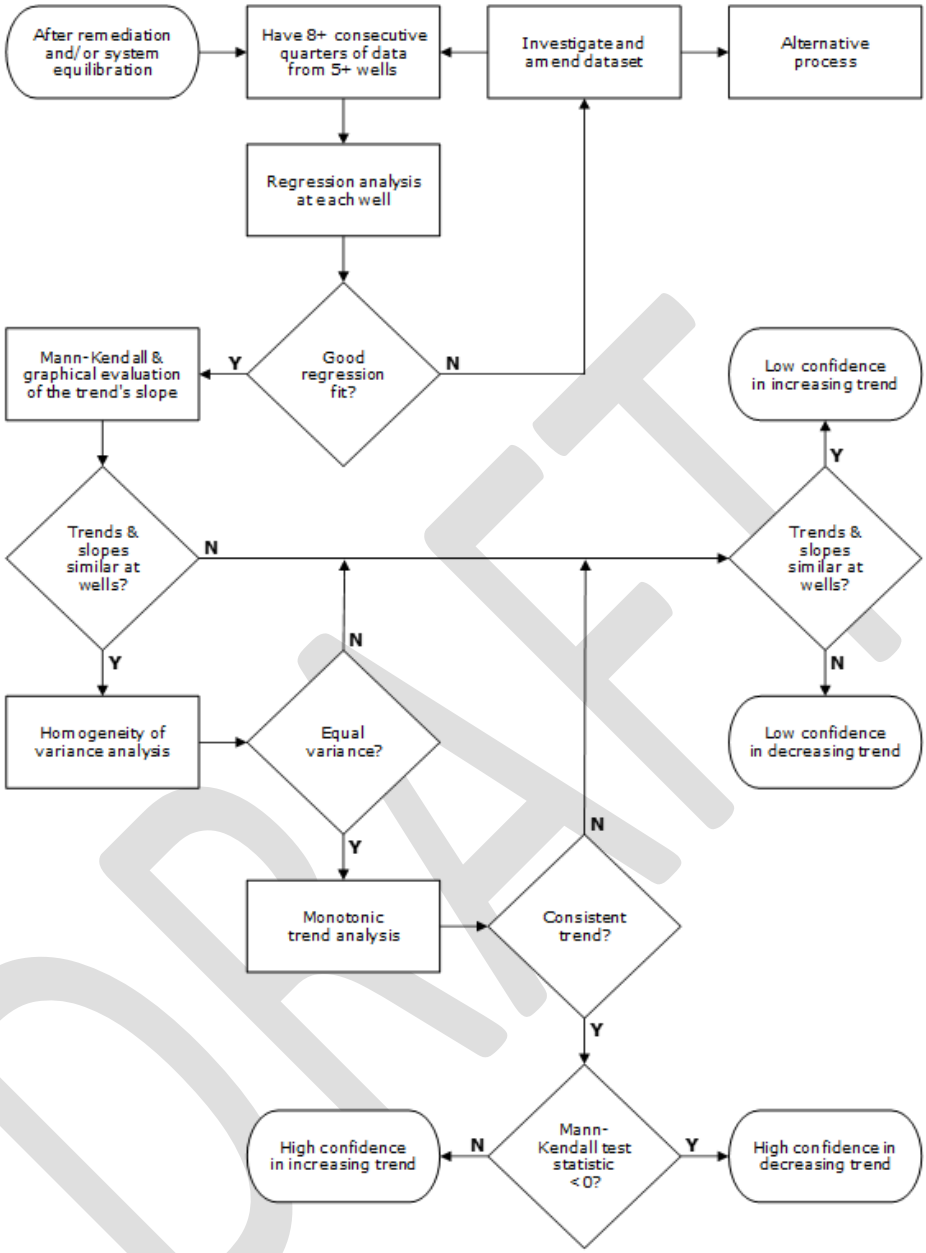
Figure C-4: Example of Plume Trend Analysis



C.3 Modeling Plume Behavior

Groundwater modeling may be helpful when attempting to predict the future extents of release-related chemical plumes. Groundwater modeling is inherently project-specific and will typically require geologic and hydrologic parameter values in addition to knowledge of release-related chemical behavior. IDEM review of groundwater modeling results will require that submissions include information on the model used (including any version number), all model inputs, assumptions, calibration results, validation results, and the results of sensitivity testing.

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