Compound Specific Isotope Analysis and Vapor Intrusion

Frequently Asked Questions (FAQs)

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Incorporating CSIA in Vapor Intrusion Investigations – FAQ

Land Science presented a webinar with Dora Taggart, President of Microbial Insights, Inc., and Sam Rosolina, PhD, Director of the Compound Specific Isotope Analysis (CSIA) Laboratory at Microbial Insights. In this webinar, Dora and Sam discussed incorporating CSIA in vapor intrusion investigations. They were joined by Tom Szocinski, CEP, Director of Vapor Intrusion at Land Science, who discussed innovative new vapor barrier technologies that are more protective and more cost-effective. The following Q&A include questions from the audience, with answers from Sam Rosolina, Dora Taggart and Tom Szocinski.

Dora Taggart

President, Microbial Insights, Inc.

Dora Taggart is the President of Microbial Insights, Inc. in Knoxville, Tennessee. She received a Biomedical Engineering degree from Vanderbilt University and has focused on the optimization and implementation of molecular tools for environmental remediation, microbiologically-influenced corrosion and microbial source tracking. Since joining Microbial Insights in 2001, she has developed and commercialized over 60 different nucleic acid-based analyses. Under her direction, Microbial Insights has become a worldwide provider of molecular tools for leading consulting firms, government agencies and academia. Ms. Taggart runs national and international workshops on these tools. She has more than 20 peer reviewed co-authored publications and is often invited to speak at conferences around the world.

Sam Rosolina, PhD

CSIA Lab Director, Microbial Insights, Inc.

Sam Rosolina is Director of the Compound Specific Isotope Analysis (CSIA) Laboratory at Microbial Insights. Dr. Rosolina received his B.A. in Chemistry from Berea College in Kentucky and went on to complete a PhD in Analytical Chemistry at the University of Tennessee in Knoxville. Sam is constantly working to broaden the scope of remediation analysis through the implementation of cutting edge methods and instrumentation, and is focused on making these analytical methods more accessible overall.

Tom Szocinski, CEP

Director of Vapor Intrusion, Land Science

Tom Szocinski is the Director of Vapor Intrusion of the Land Science division of REGENESIS, Inc. In his role, Tom provides executive leadership, market strategy and sales support, while further strengthening relationships with state and federal regulators, applicators and environmental consultants. Tom is a nationally recognized vapor intrusion expert with over 14 years' experience as an environmental scientist, focusing on vapor intrusion assessment and mitigation, remediation, site assessment, and Brownfield site management. He has served on both state and federal regulatory vapor intrusion review boards, assisting with development of vapor intrusion and mitigation guidance, regulations, and exposure criteria. He has designed and implemented numerous nationally recognized and award winning vapor mitigation systems across the United States for both private and government sites. Tom earned a Bachelor of Science degree from Lake Superior State University in Sault Ste. Marie, Michigan.

Q: How do VOC test results determine if you collect vapor samples in a canister or sorbent tube?

A: The equation to determine which method for collecting air samples is found in section 3.5 of the user's guide. Using table 2 and equation 1, you can determine which type of sampler to utilize with table 3.

Q: How does this work if the TCE is from degraded PCE?

A: Often when TCE is first formed from PCE degradation it is actually below the manufactured range. Then, as the daughter product TCE degrades it will become increasingly enriched and pass back through the box (and continue to enrich). On the other hand, TCE from an indoor source will not be degraded and will always be within the manufactured range box. So, while there is a chance for a false positive for an indoor source (i.e. groundwater TCE happens to be similar to the indoor source signature), there is still a good chance for clear distinction based on the fingerprints. Again, this is why we always recommend using CSIA as an added line of evidence and never the sole line of evidence.

Q: Why do you collect your groundwater sample upgradient of the source?

A: Since we're using groundwater samples as a representative of the subsurface contaminant source, we want it to be as similar as possible to what is directly under the building in question. A contaminant in a downgradient sample is likely to be more degraded than an upgradient location because it has had more residence time in the ground. So, if there's a building that is being impacted by vapor intrusion and we sample downgradient from the building, the contaminant may be misleadingly degraded as compared to VOCs actually entering the building, which in turn could yield a false negative for an indoor source.

On the other hand, if we take an upgradient sample as close to the building as possible, it will at least be a more conservative comparison. Please request a user guide from Microbial Insights for more information.

Q: In the example where groundwater and indoor air were both inside the indoor source box, what would be the cause of having groundwater in the manufactured range?

A: This situation would occur if the contaminant in the groundwater has not undergone enough degradation to see an isotopic shift away from the box. So, for example, if benzene was released upgradient from the building in question, but hasn't degraded by the time it reaches that building, it may still be within the manufactured range. However, if there is actually an indoor source and it's isotopic fingerprint is different enough from the benzene in the groundwater, it is possible to distinguish the two even if both data points are within that manufactured range.

Q: What if you have a current building mitigation system in place; do you offer any guidance on equilibration prior to CSIA?

A: Of course, if there is a mitigation system (like consistent building pressurization) and you're still seeing impacts of indoor air, it is reasonable to assume an indoor source. For that, it is recommended to start with a portable GC/MS and analyzing different parts of the building to see if you can narrow down the source without using CSIA. A comparison of VOC contaminant consituents and ratios between an indoor sample and a subsurface sample prior to turning to CSIA is also recommended.

Q: Can you explain in more detail why it is important to compare indoor air test results to a groundwater sample that was collected "upgradient" as opposed to a groundwater sample collected from beneath subject building?

A: There are a few reasons that this is suggested:

1) In general; an outdoor, upgradient groundwater sample is easier to collect and provides a more conservative value for comparison.
2) Some contaminants, like chlorinated ethenes, degrade well in reducing conditions and there is often an "oxygen shadow" under buildings. Because of this, in some situations (based on the chemistry and geochemistry), the contaminant may undergo degradation more rapidly underneath the building. If the building is large, and a sample is taken underneath but downgradient from the actual point of entry, the contaminant may be misleadingly degraded as compared to VOCs actually entering the building, which in turn could yield a false negative for an indoor source. On the other hand, taking a sample just upgradient of the building will provide a more conservative value.

But, that being said, if you're looking at a small building (or have narrowed down the area of vapor intrusion entry) and have the capability to retrieve groundwater samples directly beneath it, that is the best comparison.

Q: If your VOC source is a release to soil directly beneath a building, and groundwater at depth may or may not be impacted, what sampling would you recommend for CSIA? Could you use soil gas or subslab gas results instead of groundwater results for CSIA?

A: Unfortunately, sub-slab sampling has shown to produce less viable isotopic data, possibly due to fractionation caused by the combination of physical adsorption and the strong, unnatural, vacuum. But, if it's possible to get a soil sample, or even a NAPL sample, those would be good for comparison given the proximity to the building.

Q: Can indoor air be equally compared to a sub-slab vapor sample?

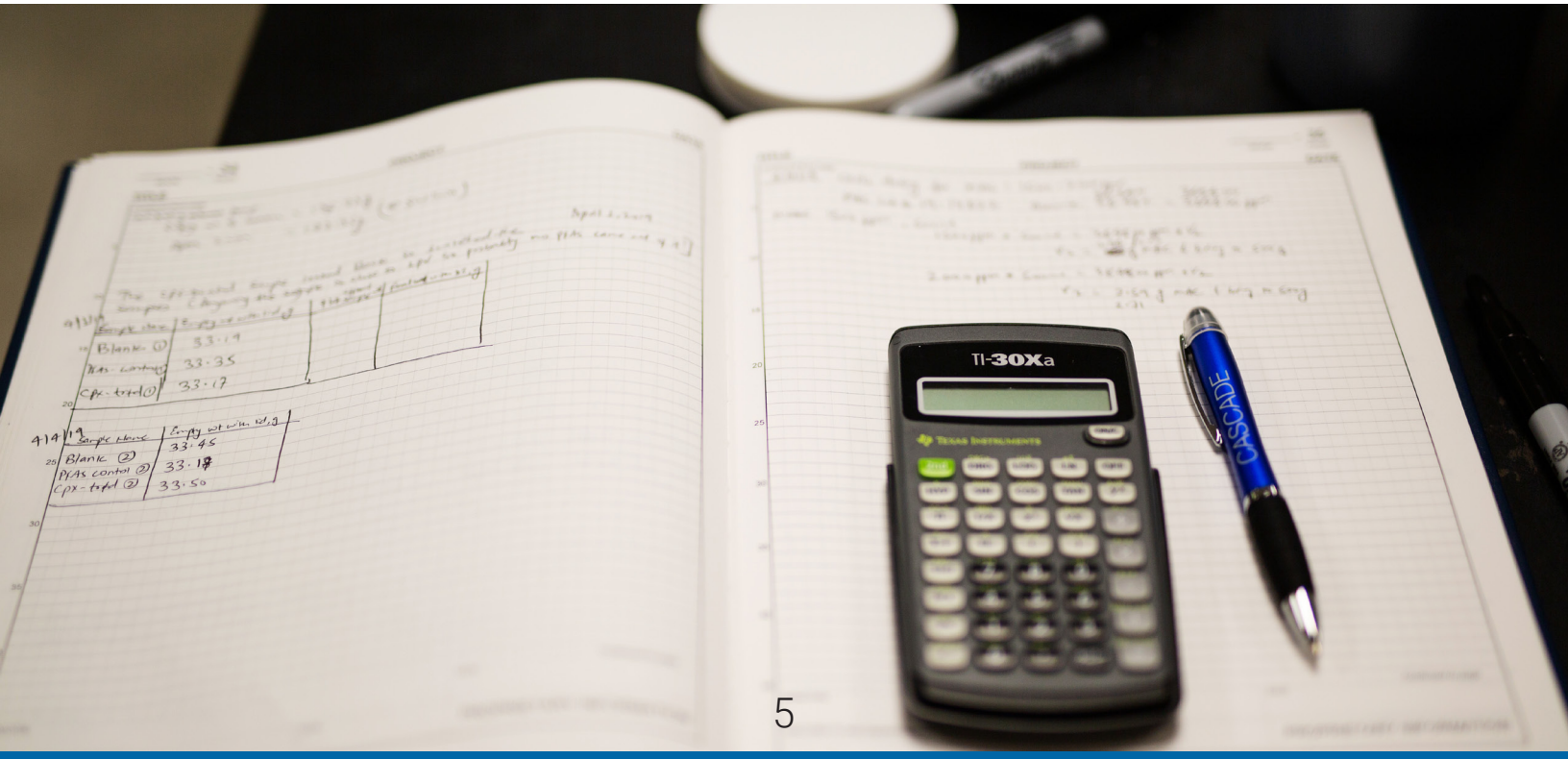
A: Unfortunately, sub-slab sampling has shown to produce less viable isotopic data, possibly due to fractionation caused by the combination of physical adsorption and the strong, unnatural, vacuum.

Q: If CSIA data indicates multiple sources, what additional sampling or tests would you recommend?

A: Microbial Insights recommends renting a portable GC/MS to determine where any hotspots are within the building – this can narrow down indoor sources as well as possible vapor intrusion entry points.

Q: Does the CSIA DB include naphthalene?

A: Currently it does not include naphthalene, but it will be added soon. In the interim, Microbial Insights has a lot of information and publications on CSIA of naphthalene and would be happy to provide that context personally, should you decide to have CSIA performed.



Q: On the dual isotope plot, assuming the same chemical source for the vapor and the groundwater contamination, what effect does natural isotopic fractionation have on the isotopic composition of the water vs vapor? What is the "expected" isotopic shift on the dual plot caused by the evaporation from the liquid/dissolved phase to the vapor phase?

A: A lot of research has been performed in relation to this exact question, namely, "Can we expect isotopic shifts as a VOC volatilizes and moves through the vadose zone?" It turns out that there are slight isotopic shifts based on volatilization and movement through the vadose zone. However, they balance one another out, and even separately the shift itself is very minimal (within the 2 ‰ acceptable range).

Q: For which compounds can you do the CSIA?

A: Microbial Insights can perform CSIA on a number of compounds in groundwater, so it may be easier if you send some specific compounds that you are interested in.

For vapor samples, they are only able to perform CSIA on benzene, PCE and TCE currently.

Q: Is the δCl and δCl the same for solvents used in degreasing and paints and glues?

A: Yes, the manufactured range includes the $\delta^{13}C$ and $\delta^{37}Cl$ values of solvents used in commercial products like degreasers and adhesives. These are included in Microbial Insights' database.

Q: Does Microbial Insights run CSIA analysis on water samples?

A: Yes. Microbial Insights would be happy be happy to discuss this more with you if you have an interest in this. Please contact Microbial Insights for more information.

Q: Can CSIA be used to compare soil vapor samples vs indoor air samples?

A: Unfortunately, soil vapor comparison has not been validated yet. Sub-slab soil gas sampling has shown to produce less viable isotopic data, possibly due to fractionation caused by the combination of physical adsorption and the strong, unnatural, vacuum. Groundwater samples have shown to be the best comparison to known vapor intrusion samples, and this is one of the main reasons that we recommend it as the subsurface representative.

Q: Can you do it for VC?

A: Microbial Insights can perform CSIA on vinyl chloride for groundwater samples, but cannot for vapor samples. In general, for vapor intrusion analysis, Microbial Insights recommends analyzing parent compounds like PCE or TCE. This is because daughter products (like VC) are being formed and degrading at the same time which can cause confusing isotopic trends.

Q: Is it commonly used to verify upgradient vs downgradient groundwater contamination that may have clean areas in between (karst setting)?

A: Yes, CSIA is commonly used for source distinction in groundwater. Here is a link to a webinar that discusses the use of CSIA in groundwater, including for source distinction: https://register.gotowebinar.com/recording/4903826649483422977

Q: For chlorinated groundwater contamination (low concentrations) is there a soil thickness which is an effective barrier?

A: There is not a set soil depth that acts as an effective barrier for chlorinated, although there is a set depth for petroleum vapor intrusion. Reference the ITRC website regarding Petroleum VI Guidance for more on this subject.

Summary

The questions summarized in this FAQ as part of the Land Science "Distinguished Speaker" webinar series, were provided by our guest presenters, Dora Taggart and Sam Rosolina, PhD in response to questions fielded throughout the webinar presentation. REGENESIS and Land Science are grateful to both Ms. Taggart and Dr. Rosolina for sharing their expertise. Land Science is dedicated to providing relevant, industry-leading content in support of client partners globally. Any use or reproduction of the contents of this FAQ document must be approved by Land Science, REGENESIS and/or Microbial Insights.

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To recieve a custom vapor intrusion solution, please call 949.481.8118 or e-mail info@landsciencetech.com. One of our Technical Solutions Managers will review your project details and provide you with a customized vapor intrusion solution designed to achieve your site goals.

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