

Supplemental Guidelines for the Evaluation of Structural Vapor Intrusion Potential for Site Assessments and Remedial Actions Under the Inactive Hazardous Sites Branch 14 March 2014

I.	General	1
II.	When To Conduct a Structural Vapor Intrusion Evaluation	1
III.	Steps for Evaluating Structural Vapor Intrusion Potential	2
	A. Vapors From Groundwater Contamination	2
	B. Vapors From Soil Contamination	7
IV.	Sampling and Analytical Procedures	9
	A. General Procedures	9
	B. Specific Soil Gas Procedures	11
	C. Specific Crawlspace and Indoor Air Procedures	11
V.	Additional References	12

I. General:

This document should be used in conjunction with the North Carolina Division of Waste Management's vapor screening tables [available on the Inactive Hazardous Sites Branch (IHSB) web page at <http://portal.ncdenr.org/web/wm/sf/ihs/ihsguide>] and the Division's vapor intrusion guidance. The IHSB guidance supplements the Division guidance and provides specific direction for vapor contaminant assessments conducted under the Inactive Hazardous Sites Program. In addition to these guidance documents and tables, the IHSB's "Guidelines for Addressing Pre-Regulatory Landfills and Dumps," also available on the IHSB web page, should be used to determine sample locations, methods and procedures for the evaluation of vapors generated from buried waste at PRLF sites.

The science of vapor intrusion evaluations continues to evolve. Look for periodic updates to this and the Division's guidance.

II. When To Conduct a Structural Vapor Intrusion Evaluation:

Distance From Contamination: An evaluation of structural vapor intrusion potential must be conducted anytime an existing building, or a lot where a building could be placed in the future, is located within 100 feet of groundwater or soil contamination. An evaluation of distances greater than 100 feet may be needed if there are significant preferential pathways that may be conduits for vapors toward a structure. This requires an awareness of the geology of the area and the location of utility corridors. At Pre-Regulatory Landfill sites where waste volumes are too large for removal, the waste itself can pose structural vapor intrusion threats. Thus, each landfill must be evaluated for structural vapor intrusion potential. The vapor intrusion evaluation should extend at a minimum 500 feet from the waste perimeter and 100 feet from any associated

groundwater contamination. See additional IHSB “Guidelines for Addressing Pre-Regulatory Landfills and Dumps.”

Contaminants Requiring Investigation: All hazardous substances detected in groundwater, soils or wastes with Henry's Law Constants above 10^{-05} atm m³/mol are suspect. Aside from the analytes on a typical volatile scan, qualifying chemicals can include mercury, ammonia, and hydrogen sulfide, PAHs, PCBs, dioxins and other semivolatiles.

III. Steps for Evaluating Structural Vapor Intrusion Potential:

The remediating party will need to evaluate the potential for structural vapor intrusion from both soil contamination and groundwater contamination. Follow the steps in each of these respective sections. **NEVER CONDUCT INDOOR AIR SAMPLING AS THE FIRST STEP** unless the structure to be evaluated has basement space below the water table in an area of contaminated groundwater. In such cases, indoor air sampling will be the first step. Otherwise, proceed stepwise as follows:

A. Vapors From Groundwater Contamination:

(1) Screen Using Groundwater Concentrations:

- Compare the highest groundwater concentrations present within 100 feet of the structure to the ***Groundwater Screening Levels*** on the Division of Waste Management’s Vapor Intrusion Screening Tables (the numbers are based on a cancer risk of 1.0 E-05 and a HQ of 0.2). There are screening levels for residential structures and non-residential structures. However, all structures should be screened first using the residential levels. Any time commercial/industrial vapor intrusion screening levels are used, land use restrictions will be required to limit building use to commercial/industrial purposes. Land use restrictions would not be required for structures meeting residential screening levels with no corrective vapor controls. Use the **residential *Groundwater Screening Levels*** to screen commercial structures where children would spend a significant amount of time such as schools and day care facilities. The non-residential screening levels can be used in most cases where an individual child would not spend a significant portion of their day or visitation by the individual would be infrequent. If a particular volatile chemical is not found on the table, contact the IHSB about determining a screening level for that chemical.
- If the concentration in groundwater exceeds the screening level for any chemical by more than one order of magnitude, proceed to step (3) for collecting soil gas samples. If the concentrations in groundwater exceed the screening levels but by less than one order of magnitude, the IHSB can calculate the site-specific collective cancer risk and Hazard Index posed by the contaminants and compare to acceptable cancer risk/non-cancer hazard targets. For the IHSB to determine site-specific risk/hazard, the remediating party will need to provide the names of the contaminants and the highest concentrations detected in groundwater within 100 feet of the existing or future structure. If the contamination in groundwater meets the acceptable risk targets (1.0E-04 risk collectively for carcinogenic contaminants and a

cumulative Hazard Index of 1 for non-carcinogenic contaminants), no additional work is needed unless the contaminant plume is migrating toward a structure/lot or other site conditions warrant conducting further evaluation. If the risk/hazard exceeds IHSB targets, proceed to step (3) for collecting soil gas samples.

(3) Collect Soil Gas Samples:

- ***Select sample locations*** outside the building perimeter. However, if the highest groundwater contaminant concentrations are directly beneath a structure, a sub-slab/crawlspace gas sample must be collected instead. Proceed to step (4) for the structure. Otherwise the following protocol should be used for locating samples. Select properties (with or without structures) that are located closest to the areas with the highest groundwater contamination and those located along groundwater discharge pathways. Alternatively, sampling can first be conducted on the source property in the area with the highest groundwater contaminant concentrations. Each and every lot or structure does not require soil gas testing. If collecting in an area away from the source area, an understanding of the intervening geology and the location of utility corridors that may be preferential gas migration pathways is essential. Structures at greater distances from source areas may be at greater risk depending on these pathways. The selection of properties for sampling should also take into account variations in construction (slab vs crawl space) and uses of the buildings (less frequent opening of building entry ways associated with certain uses reduces fresh air exchange).
- ***Select sample depths*** at least five feet below ground surface (to avoid barometric pressure influences). Samples in non-source areas should be collected at depths between five and ten feet. In source areas, samples should be collected just above the water table. If there is less than five feet of depth to groundwater, proceed to step (4).
- Compare the sample soil gas concentrations to the ***Soil Gas Screening Levels*** on the Division of Waste Management's Vapor Intrusion Screening Tables (the numbers are based on a cancer risk of 1.0 E-05 and a HQ of 0.2). There are screening levels for residential structures and non-residential structures. However, all structures should be screened first using the residential levels. Any time commercial/industrial vapor intrusion screening levels are used, land use restrictions will be required to limit building use to commercial/industrial purposes. Land use restrictions would not be required for structures meeting residential screening levels with no corrective vapor controls. Use the residential ***Soil Gas Screening Levels*** to screen commercial structures where children would spend a significant amount of time such as schools and day care facilities. The non-residential screening levels can be used in most cases where an individual child would not spend a significant portion of their day or visitation by the individual would be infrequent. If a particular volatile chemical is not found on the table, contact the IHSB about determining a screening level for that chemical.
- If the concentration in the soil gas sample exceeds the screening concentrations for any chemical by more than one order of magnitude, proceed to step (4). If the concentrations in the sample exceed the screening levels but by less than one order of magnitude, the IHSB can calculate the site-specific collective cancer risk and Hazard Index posed by the contaminants and compare to acceptable cancer risk/non-cancer hazard targets. For the IHSB to determine

site-specific risk/hazard, the remediating party will need to provide the names of the contaminants and the highest concentrations detected. If the soil gas sample meets the acceptable risk targets (1.0E-04 risk collectively for carcinogenic contaminants and a cumulative Hazard Index of 1 for non-carcinogenic contaminants), no additional work is needed unless the contaminant plume is migrating toward a structure/lot or other site conditions warrant conducting further evaluation. If the risk/hazard exceeds IHSB targets, proceed step (4) sub-slab/crawlspace testing.

(4) Conduct Sub-Slab/Crawlspace Testing (Properties With Existing Structures) Or Mitigation (Vacant Lots):

- ***Vacant Lots:*** Where soil gas testing fails to meet ***Soil Gas Screening Levels*** in the previous step at a vacant lot, groundwater contamination must be reduced to meet soil gas and/or groundwater screening levels. If construction will begin prior to successful remediation of the area, mitigation systems should be installed as part of the building construction. Testing of sub-slab or crawlspace air as described below should follow any building construction.
- ***Existing Structures:*** For existing structures, if the soil gas concentrations exceeded ***Soil Gas Screening Levels*** in the previous step, the next step is the collection of gas samples from either just below a slab/dry basement foundation or within a crawlspace. Note that some owners may not permit the sub-slab testing as it requires drilling through the slab. If so, proceed to step (5).
- ***Samples should be collected during the time of year the structure is most prone to vapor intrusion. The following conditions should be evaluated in determining when to collect samples:***
 - Cold weather: When the exterior of the building is colder than the interior, the heating of the indoor space can produce a chimney effect and cause air below the structure to rise into the structure. Cold weather sample collection should occur when the high temperature for the day will be less than 60 degrees (Fahrenheit). Generally that means mid-Nov through mid-Mar for the mountains and upper piedmont and mid-Dec through mid-Feb for the lower piedmont and coastal plain.
 - During seasonal high water table: For areas with shallow water tables, sampling during the time of the seasonal high water table should also be conducted.
 - Positive pressure HVAC off: During the fair weather periods of the year, an HVAC system may not cycle or will cycle less. If windows are opened, there will be more fresh air exchange. If windows remain closed, the structure may not be under positive pressure conditions, allowing vapors to enter from the subsurface. Thus for structures with positive pressure HVAC systems, periods of milder weather may allow more vapor intrusion than during the summer and winter when the system is running more frequently.
 - High concentrations initially detected may call for immediate retesting with another sample to follow during worst case conditions.

- An exterior upwind background sample must be collected when collecting crawlspace samples.
- The results for crawlspace tests should be compared to the ***Indoor Air Screening Levels*** in ***column A*** on the Division Vapor Intrusion Screening Tables (the numbers are based on a cancer risk of 1.0 E-06 and a HQ of 0.2). There are screening levels for residential structures and non-residential structures. However, all structures should be screened first using the residential levels. Any time commercial/industrial vapor intrusion screening levels are used, land use restrictions will be required to limit building use to commercial/industrial purposes. Land use restrictions would not be required for structures meeting residential screening levels with no corrective vapor controls. Use the residential ***Indoor Air Screening Levels*** to screen commercial structures where children would spend a significant amount of time such as schools and day care facilities. The non-residential screening levels can be used in most cases where an individual child would not spend a significant portion of their day or visitation by the individual would be infrequent. If a particular volatile chemical is not found on the table, contact the IHSB about determining a screening level for that chemical. Detections of the same chemical in the background sample will be evaluated along with other lines of evidence when determining whether crawlspace detections are the result of site-related contamination or from background sources.
- The results for sub-slab tests should be compared to the ***Soil Gas Screening Levels*** on the Division Vapor Intrusion Screening Tables (the numbers are based on a cancer risk of 1.0 E-05 and a HQ of 0.2). There are screening levels for residential structures and non-residential structures. However, all structures should be screened first using the residential levels. Any time commercial/industrial vapor intrusion screening levels are used, land use restrictions will be required to limit building use to commercial/industrial purposes. Land use restrictions would not be required for structures meeting residential screening levels with no corrective vapor controls. Use the residential ***Soil Gas Screening Levels*** to screen commercial structures where children would spend a significant amount of time such as schools and day care facilities. The non-residential screening levels can be used in most cases where an individual child would not spend a significant portion of their day or visitation by the individual would be infrequent. If a particular volatile chemical is not found on the table, contact the IHSB about determining a screening level for that chemical.
- If the concentration for any chemical exceeds the screening levels by more than one order of magnitude, proceed to step (5). If the concentration exceeds the screening level but by less than one order of magnitude, the IHSB can calculate the site-specific collective cancer risk and Hazard Index posed by the contaminants and compare to acceptable cancer risk/non-cancer hazard targets. If each sample event meets the acceptable risk targets (1.0E-04 risk collectively for carcinogenic contaminants and a cumulative Hazard Index of 1 for non-carcinogenic contaminants), no additional work is needed unless the contaminant plume is migrating toward a structure/lot or other site conditions warrant conducting further evaluation. If the risk/hazard exceeds IHSB targets, proceed to step (5).

- Note where a contaminant of concern (present in groundwater, soil or waste) is a chemical currently in use in a non-residential structure, OSHA may regulate the concentration allowed in indoor air. If OSHA does regulate the concentration in air in the building, their limits would govern the amount allowed in air. However, when the chemical is no longer used, OSHA oversight would end. Groundwater or soil contamination remaining at that time may cause the space to not meet the Division's acceptable concentrations for indoor air. Remedial actions taken on the building not only need to protect the current occupants/uses, but future occupants/uses as well. To protect future occupants of the building from exposure to contaminants in indoor air when the OSHA standards cease to apply at a currently OSHA-regulated structure, the remediating party should use the vapor intrusion evaluation steps outlined in this guidance up to, but not including, the testing of indoor air. If the structure fails all the screening steps leading up to the testing of indoor air but meets OSHA limits, contaminated media at the site must nevertheless be remediated so that sub-slab/crawlspace vapors meet IHSB screening criteria or land use restrictions must be placed on the property to control use/exposure.

(5) **Conduct Indoor Air Testing:**

- If samples exceed health risk targets in the preceding screening steps for vapor intrusion potential, indoor air sample collection should then be conducted. Sample collection should proceed as quickly as possible. If the time of collection does not correspond to a period of time when vapor intrusion is most likely (see section on substab/crawlspace testing for when to collect samples), additional sampling collection must later be conducted during that period.
- An exterior upwind background sample must be collected with the indoor air sample. Upwind background samples should be initiated one hour prior to the collection of indoor air samples unless estimates of building exchange rates indicate a shorter or longer delay is appropriate. The time lag between the collection of the background and the test sample should allow for one exchange volume to have occurred.
- Compare the sample results to the ***Indoor Air Screening Levels*** in ***column A*** on the Division Vapor Intrusion Screening Tables (the numbers are based on a cancer risk of 1.0 E-06 and a HQ of 0.2). There are screening levels for residential structures and non-residential structures. However, all structures should be screened first using the residential levels. Any time commercial/industrial vapor intrusion screening levels are used, land use restrictions will be required to limit building use to commercial/industrial purposes. Land use restrictions would not be required for structures meeting residential screening levels with no corrective vapor controls. Use the residential ***Indoor Air Screening Levels*** to screen commercial structures where children would spend a significant amount of time such as schools and day care facilities. The non-residential screening levels can be used in most cases where an individual child would not spend a significant portion of their day or visitation by the individual would be infrequent. If a particular volatile chemical is not found on the table, contact the IHSB about determining a screening level for that chemical. Detections of the same chemical in the background sample will be evaluated along with other lines of evidence when determining whether crawlspace detections are the result of site-related contamination or from background sources.

- If contaminant concentrations do not exceed **Indoor Air Screening Levels** in **column A** on the Division's residential Vapor Intrusion Screening Table for each sample event, no mitigation is required. If contaminant concentrations exceed the screening levels, the IHSB will calculate the actual risk posed. If any sample concentrations are determined to exceed a collective 1.0E-04 cancer risk limit or a Hazard Index of 1, abatement of the structure is required. If the contaminant concentrations correspond to a collective cancer risk of between 1.0E-06 to 1.0E-04 and are within a Hazard Index of 1, then at least two sample events must be performed. A second test should be scheduled during the time(s) of year structural vapor intrusion is most likely. If the samples do not exceed the allowable indoor air levels on all data sets, further evaluation is not required unless the contaminant plume is migrating toward a structure/lot or other site conditions warrant. In such cases, periodic testing should be conducted.

Indoor Air Results	Notes
< 1.0 E-06 cancer risk and \leq HI of 1	No further screening required if sampled during time(s) of highest VI potential *
1.0 E-06 to 1.0 E-04 cancer risk and \leq HI of 1	Minimum 2 sample events with at least 1 covering each time of high VI potential*
> 1.0 E-04 cancer risk or >HI of 1	Mitigation required

* Continued periodic testing must be performed if groundwater contamination is advancing toward a structure. Additional testing for some period may also be required for new construction in the area of concern to allow for settlement effects and for confirmation of effectiveness of any vapor abatement measures installed.

B. Vapors From Soil Contamination:

Sites with soil contamination only may also require evaluation of vapor intrusion potential into current and future structures. Site-specific conditions should be evaluated to determine if testing for vapor intrusion potential is warranted. Three primary factors in this consideration are areal extent of the contamination, the total volume of contaminated soils, and the contaminant concentrations. For example, contaminant concentrations less than about 10 ppm or the IHSB unrestricted use preliminary health-based remediation goals and very limited in areal and vertical extent would generally not warrant further investigation. A decision to test should be a weighing of these and other relevant factors. Steps for testing depend on whether the property of concern is a vacant lot or one with a structure.

(1) Properties Without Structures - Sample Locations/Depths:

- For vacant lots with contaminated soil:
 - ***If depth of highest contaminant concentration is less than five feet below ground surface with lower, but detectable, concentrations below five feet:*** One soil gas sample should be collected from the depth of highest contamination in the upper five feet and a second sample should be collected at a depth between five and ten feet.
 - ***If depth of highest concentration is greater than five feet:*** Samples should be collected from the zone of highest concentration and not at shallower depths. With vacant lots, the

depth of building construction is not yet known. Therefore, if the depth of highest soil contamination is deeper than five feet, a soil gas sample should be collected at that particular depth.

- For vacant lots with little or no soil contamination, but within 100 feet of elevated soil contamination: The depth of soil gas testing should be determined by taking into account the location of vapor pathways such as subsurface conduits and the local geology between the vacant lot and the source area. Multiple samples from different depths may be needed.
- For vacant lots located within 500 feet of the waste footprint of a Pre-Regulatory Landfill site, refer to the "Guidelines for Addressing Pre-Regulatory Landfills and Dumps" available on the IHSB web site for conducting initial vapor intrusion screening procedures on the landfill property. If during these initial steps, landfill gas/soil gas samples collected in waste at depths greater than five feet below ground surface exceed **Soil Gas Screening Levels** on the Division's residential Vapor Intrusion Screening Table on the landfill property or if samples collected in waste at depths of less than five feet exceed **In-Door Air Screening Levels - column A**, further testing at vacant lots located within 500 feet of the landfill footprint will need to be conducted. At these properties, soil gas samples should be collected at depths between five and ten feet below ground surface. The location of subsurface vapor pathways between the vacant lots and the landfill should be evaluated when determining which properties to collect samples. Vertical profiling of soil gas concentrations at the landfill property boundary can be conducted to reduce the need for off-property testing. Soil gas samples should be collected at various intervals between five feet below ground surface and the depth of the base of the fill. If groundwater contamination is present, the test intervals should extend to a depth of two feet above the water table. Multiple locations around the waste will be needed.

(2) **Properties With Structures - Sample Locations/Depths:**

- For buildings located within 100 feet of, but not on top of, elevated soil contamination, soil gas testing should be conducted next to the building. The sample should be as close as possible to the structure and on the side of the building closest to the contamination. Soil gas samples should be collected at depths between five and ten feet below ground surface. The location of subsurface vapor pathways between the structure and the source area should be evaluated when determining which properties to collect samples.
- For Pre-Regulatory Landfill sites, refer to the "Guidelines for Addressing Pre-Regulatory Landfills and Dumps" available on the IHSB web site for conducting initial vapor intrusion screening procedures on the landfill property. If during these initial steps landfill gas/soil gas samples collected in waste at depths greater than five feet below ground surface exceed **Soil Gas Screening Levels** on the Division's residential Vapor Intrusion Screening Table on the landfill property or if samples collected in waste at depths of less than five feet exceed **In-Door Air Screening Levels - column A**, further testing at properties with structures located within 500 feet of the landfill footprint will need to be conducted. Soil gas samples should be collected at depths between five and ten feet below ground surface. The location of

subsurface vapor pathways between the structures and the landfill should be evaluated when determining which properties to collect samples. Vertical profiling of soil gas concentrations at the landfill property boundary can be conducted to reduce the need for off-property testing. Soil gas samples should be collected at various intervals between five feet below ground surface and the depth of the base of the fill. If groundwater contamination is present, the test intervals should extend to a depth of two feet above the water table. Multiple locations around the waste will be needed.

- If a building overlies the soil contamination or the waste footprint of a PRLF, then a sub-slab or crawlspace sample should instead be collected as described in step (A) (4) for groundwater contamination screening.

(3) Compare Results to Division Screening Levels: Gas samples collected at depths of less than five feet are considered qualitative only. The shallow sample may draw air from the surface. However, if the highest concentrations present in soil are at depths of less than five feet at lots without structures, then the gas sample results should be compared to the ***In-Door Air Screening Levels-column A***. If the screening levels are exceeded in this scenario, soil contamination will require remediation. If the lot has a structure in this scenario, proceed to collection of indoor air samples as described in section (A)(5). For samples collected at depths greater than five feet and for sub-slab samples, compare the results to the ***Soil Gas Screening Levels*** on the appropriate Division Vapor Intrusion Screening Table using the process described in (A) (3) and (4). If the contaminant concentrations exceed these screening levels, proceed to steps (A) (4) and (A) (5).

IV. Sampling and Analytical Procedures:

A. General Procedures:

- A detailed description of sampling equipment and collection procedures must be provided in a work plan. A summary of proposed procedures to prevent introduction of particulates into the sample canister and to ensure no leaks should be included. Sampler should specify leak check compounds. Best not to use isopropanol. Laboratory-grade helium is generally recommended.
- Summa canisters must be used for all volatile organic compound (VOC) testing. Summa canisters should have pressure gauges. Summa canister and flowmeter can be *either* “100% certified” or “batch certified.” Sampler should obtain tubing and connections from laboratory supplying flowmeter and canister. Specify only Swagelok-type fittings or connections with Teflon tape.
- Sampler should record vacuum readings on the canister before and after sample collection. If any problems are encountered, the problem and the solution implemented should be provided in the sample report to the IHSB. Empty or improperly filled canisters should not be submitted for laboratory analysis.

- VOCs should be analyzed by TO-15. The sampler should direct the laboratory to test for the contaminants detected in soil and groundwater within 100 feet of the structure and any daughter products. If only a limited site assessment has been conducted at the time of a vapor intrusion potential evaluation, a broad VOC analytical scan should be performed. TO-15 SIM should be used if the TO-15 detection limits are not lower than the ***Indoor Air Screening Levels*** (for indoor air and crawlspace samples) or the ***Soil Gas Screening Levels*** (for soil gas samples) for the chemicals of concern on the Division vapor intrusion tables. For semivolatile compounds of concern, additional sample containers/analytical methods must be specified. The remediator should contact qualified laboratories prior to submitting samples to verify that the laboratory will be able to achieve detection limits at or below IHSB gas/air targets.
- The laboratory conducting the analyses should have National Environmental Laboratory Accreditation Program (NELAP) certification and be qualified to conduct air testing. Field analysis shall only be accepted when the mobile laboratory is certified to conduct the analyses and the contractor demonstrates the laboratory technicians are qualified to perform the analyses.
- While soil gas, crawlspace air or indoor air samples should only be tested for contaminants detected in groundwater and soil at the site along with any transformation products, the laboratory may report results for other contaminants. Non-site related contaminants are routinely detected from household sources such as paints, furniture, carpets, cleaning agents and other chemicals used or stored in the home. Only those attributable to the site need to be evaluated for risk. However, a Division toxicologist may provide additional information on the risk posed by non-site related contaminants to the homeowner as a courtesy.
- At least one duplicate and one trip blank per sample event should be collected. If reusing tubing, must collect an equipment blank between samples. However, it is best to dispose of tubing between samples. Use inert tubing such as nylon. All other equipment must be decontaminated.
- The laboratory must also provide method blank and laboratory control sample data.
- Passive sampling devices that collect samples over several days to weeks may be a useful supplement to summa canister testing by providing concentration data over a longer period of time. The applicability and limitations of these devices should be evaluated prior to their use.
- Data from flux chambers will only be considered "qualitative" data and not "quantitative" at this time.

B. Specific Soil Gas Procedures:

- Sampling plan should specify how soil gas sampling equipment for soil gas will be installed to prevent introduction of air from the surface or near surface. The sampling equipment must be sealed at the surface. Tracer gases should be used to ensure no significant leakage at probe seal (for example >20% tracer, data is unreliable).
- Refer to Appendix D, sections D.4.1-D.4.8 of "Vapor Intrusion Pathway: A Practical Guideline," January 2007, ITRC (or most current version) for additional information regarding gas probe installation and leak testing. The Division vapor intrusion guidance and other USEPA guidance may also provide proper installation procedures.
- Sampling plan should specify sample collection rate. Rapid collection could create short circuiting of air from the surface or other non-intended areas. <200ml/min is generally recommended.
- The 1 liter summa canisters (smaller size) are preferred for soil gas testing. Larger draws may induce air flow from clean areas or the surface.
- Basement sub-slab samples need to be augmented with additional samples through basement walls.

C. Specific Crawlspace and Indoor Air Procedures:

- Houses/crawlspaces should be surveyed for background sources and such sources must be removed where possible prior to sample collection. Any sources of contamination that cannot be removed should be noted. For example, new furniture/carpet, household cleaning products, glue guns, scented candles, air fresheners, hair spray, new plastic materials or plastic wrapping and dry-cleaned clothes among other items are background vapor sources. For indoor air testing, the house should be well ventilated to remove the vapors from the background sources once these items have been removed from the structure. Windows should then remain closed 12-24 hours prior to indoor air sampling.
- Screening with a PID or FID is recommended to locate points of vapor entry and also background sources in planning indoor air sample collection. Any areas with elevated readings not attributed to a background source (recently painted object, e.g.) should be included as a sample point.
- For residential structures: Multiple indoor air samples may be needed from different locations in each house. At least one sample in each house should be collected on the first floor and where the most utility wall/floor penetrations exist (conduits for air flow). If the structure is more than one story, a sample should be collected from each story. If the structure is a multi-story high rise, then a representative number of samples will need to be collected with attention paid to elevator shafts and other conduits for air flow.

- For industrial/commercial structures: Multiple indoor air samples should be collected ensuring to collect from a variety of use spaces (factory floor, office, cafeteria, e.g.) and be collected at suspect points of flow/entry such as elevator shafts, utility wall/floor penetrations, floor drains, concrete control jointing in the floor, and cracks in floor or foundation.
- Allow no use of exhaust fans, clothes dryers, fireplaces and other items that may induce short term pressure changes during sub-slab, crawlspace or indoor air sampling. HVAC units should be allowed to run normally. However, if the specific HVAC system is expected to reduce indoor air concentrations when running relative to times of the year the system runs infrequently, additional evaluation may be necessary.
- A 24-hour sample run should be conducted at residential structures and an 8-hour at non-residential structures. The equipment must be under continuous supervision by the consultant performing the test or under secured access (building vacant and locked or crawlspace sealed with tamper resistant custody tape). If conditions do not allow for these durations under secured conditions, supervised sample run of a minimum of 2 hours should be conducted.
- When collecting indoor air samples at structures with slab construction, a sub-slab vapor sample should be concurrently collected to assist in identifying compounds in the sample that would be related to the environmental contamination versus products used in the structure.

V. Additional References:

The Division Vapor Intrusion Screening Tables can be found at:

<http://portal.ncdenr.org/web/wm/sf/ihs/ihsguide>

The Division of Waste Management vapor intrusion guidance will be available on line as well once finalized.

The USEPA guidance assessing vapor intrusion potential can be found at:

<http://www.epa.gov/oswer/vaporintrusion/>