



Ministry of
Environment

INTERIM GUIDANCE FOR CONTAMINATED SITES

Site Vapour Assessment

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December 24, 2007
Date

Effective Date:

February 1, 2008

1.0 Note to contaminated sites professionals and responsible persons

The following document provides guidance for the assessment of sites with volatile or semi-volatile substances¹ in soil and/or groundwater. Responsible persons and contaminated sites professionals should note that while compliance with this guidance is not mandatory, any deviations from it should be supported by defensible and documented rationale.

2.0 Introduction

At sites where soils and/or groundwater contain volatile or semi-volatile substances, there exists the potential for substance vapours to migrate to indoor and/or outdoor air in concentrations which pose unacceptable risks to human health. At present, the numerical standards of the Contaminated Sites Regulation (CSR) do not address these potential vapour exposure risks. As a consequence, at sites with volatile or semi-volatile substances in soil and/or groundwater, compliance with numerical standards of the CSR does not necessarily ensure that human health risks associated with vapour exposure meet CSR risk-based standards.

To address this regulatory gap, the ministry is preparing Director's interim air concentration criteria (ACC) which are expected to be issued in 2008. Once the ACC are in place, contaminated sites professionals will have the option of remediating sites with volatile or semi-volatile substances to the CSR numerical criteria for vapour exposure (i.e. the ACC) or to the CSR risk-based standards. Until the ACC are issued, the only option is to remediate such a site to the CSR risk-based standards for the vapour exposure pathway. It is recognized that some interim guidance is needed for the assessment of vapour exposure risks. This document aims to provide this guidance.

3.0 Interim guidance

To ensure that risks to human health at sites with volatile or semi-volatile substances are adequately assessed, the ministry recommends that contaminated sites professionals take the following steps:

1. At any site where a volatile or semi-volatile substance is identified as a potential contaminant of concern (PCOC), delineate the contamination in soil and groundwater and perform either or both of the following:

¹ Volatile or semi-volatile substances include the following: volatile petroleum hydrocarbons (VPH), light extractable petroleum hydrocarbons (LEPH), and all substances listed in the draft Director's Interim Criteria for Contaminated Sites: Air Concentration Criteria [BC MOE, 2006].

- a) predict the indoor and/or outdoor air concentration (C_{air}) of every volatile or semi-volatile substance using (i) the highest concentration of each substance in soil and/or groundwater and (ii) a defensible vapour intrusion model; or
- b) predict the indoor and/or outdoor air concentration (C_{air}) of every volatile or semi-volatile substance using (i) the most appropriate concentration of each substance in soil vapour and (ii) the following equation:

$$C_{\text{air}} = C_{\text{vapour}} * \alpha$$

where

C_{air} (mg/m^3) is the estimated air concentration of the substance,
 C_{vapour} is the measured soil or sub-slab vapour concentration of the substance, and
 α is the vapour attenuation factor (Table 1).

2. Compare the resulting C_{air} for each volatile or semi-volatile substance to an appropriate reference concentration (RfC). If $C_{\text{air}} \leq \text{RfC}$ for every substance, then risks associated with vapour exposure at the site are considered acceptable and no further vapour pathway assessment is recommended. If, on the other hand, $C_{\text{air}} > \text{RfC}$ for any substance, then risks associated with vapour exposure at the site are considered unacceptable and appropriate remedial actions should be undertaken.

Table 1. Vapour Attenuation Factors

Sample Location	Sample Depth	Vapour Attenuation Factor		
		Outdoor Air	Indoor Air ^a	
			Residential land	Commercial land
Sub-slab	<i>n/a</i>	<i>n/a</i>	0.02	0.02
Soil vapour	1.5 m	3×10^{-5}	1.6×10^{-3}	2.5×10^{-4}
	2.0 m		1.4×10^{-3}	2.2×10^{-4}
	5.0 m		8.9×10^{-4}	1.6×10^{-4}
	7.0 m		7.1×10^{-4}	1.4×10^{-4}
	10.0 m		5.5×10^{-4}	1.2×10^{-4}
	30.0 m		2.2×10^{-4}	5.2×10^{-5}

^aThe indoor air vapour attenuation factors shown here may not be used if any of the following apply: the contaminant vapour source is within 1 vertical or lateral meter of the building foundation or floor slab, within 5 vertical or lateral meters of an unlined crawl space or earthen basement, or in the upper 1 m of soil; the building is located on a very high gas permeability media (e.g., fractured bedrock, karst, cobbles); or there is a preferential pathway (e.g., utility corridor backfill) from the source to the receptor of concern.

4.0 Notes to the interim guidance

The ministry advises contaminated sites professionals to note the following when applying this interim guidance.

1. As a general rule, where vapour assessment guidance is lacking, contaminated sites professionals should exercise defensible and documented professional judgement.
2. Though the ministry considers VPH, LEPH, and substances listed in the draft ACC to be volatile or semi-volatile, defensible and documented professional judgement (including reference to the guidance of other jurisdictions) may be used to define volatile or semi-volatile substances at this interim stage.
3. Examples of defensible vapour intrusion models are the Health Canada model [Health Canada, 2007] and the Johnson and Ettinger model [Johnson and Ettinger, 1991]. Note that outputs from these models should be used selectively since they were not designed for the ministry's site and risk assessment frameworks.
4. Any model used to predict the concentration of a volatile or semi-volatile substance in air should use conservative and/or defensible site-specific parameter values.
5. If a vapour sampling approach is taken, contaminated sites professionals should follow defensible vapour sampling procedures detailed in current scientific literature [e.g., Science Advisory Board, 2006; Health Canada, 2007; BC MOE, 2006].
6. The detection limit for vapour sampling should be low enough to result in predicted air concentrations that are at least an order of magnitude below the selected RfC.
7. Draft ACC values [BC MOE, 2006] may be used as RfCs as long as they are up to date and a statement to this effect is provided. Alternatively, contaminated sites professionals may derive site-specific RfCs in accordance with the ministry's Supplemental Guidance for Risk Assessment [BC MOE, 2007].
8. If all RfCs in an assessment are selected directly from the draft ACC (or another source with similar default exposure assumptions), then the assessment can be signed off by either a standards assessment professional or a risk assessment professional. If, however, a site-specific RfC has been derived for any substance in an assessment, then the assessment can be signed off by a risk assessment professional only.
9. Where the highest concentration of a volatile or semi-volatile substance in soil, groundwater, or vapour is equal to or less than the detection limit, use the detection

limit (rather than half the detection limit) to predict C_{air} .

10. The surrogate approach should be used to evaluate toxicity associated with VPH and LEPH. Specifically, contaminated sites professionals should (i) assume that VPH and LEPH are composed of an 80:20 mixture of aliphatics and aromatics, respectively (unless data say otherwise); (ii) compare the aliphatic and aromatic fractions of VPH to RfCs for n-hexane and toluene, respectively; and (iii) compare the aliphatic and aromatic fractions of LEPH to RfCs for decane and naphthalene, respectively.
11. If both the modelling and vapour sampling approaches (1a and 1b, Section 4) are taken, and both are conducted in accordance with this guidance, then give precedence to the risk predictions derived using the vapour sampling approach.
12. If the concentrations of all substances at a site are less than or equal to CSR numerical standards for soil and groundwater, then contaminated sites professionals are expected to evaluate risks associated with the vapour exposure pathway only (i.e., a full human health and ecological risk assessment is not necessary).
13. A site with a volatile or semi-volatile substance on its PCOC list will not be eligible for either of (a) a determination that it is not a contaminated site or (b) a Certificate of Compliance with CSR numerical standards. Only an Approval in Principle or a Certificate of Compliance with CSR risk-based standards can be issued for such a site.

5.0 Reporting

In addition to the standard investigation and remediation documentation, the following information should be provided, if relevant, for sites where vapour assessments are conducted:

- A list of the PCOCs for the vapour pathway
- A detailed conceptual site model (including the source-building separation distance, preferential pathways, a discussion of source stability, etc.) – see Science Advisory Board, 2006
- A description of the soil vapour sampling program (e.g., sampling locations, equipment, methods, analysis, etc.) – see Science Advisory Board, 2006
- A description of the vapour sampling QA/QC measures taken (e.g., leak testing, sampling blanks, etc.) – see Science Advisory Board, 2006
- An analysis of vapour assessment uncertainties
- A completed building inspection and occupant survey form

- Laboratory certificates of analysis

6.0 Interim administrative procedures

The following administrative rules will be applied during the transition to full implementation of the ACC:

6.1 Sites where the concentration of any volatile or semi-volatile substance in soil or groundwater exceeds CSR numerical standards:

- If you have an approved remediation plan that addresses the vapour pathway, you should follow that plan or this interim guidance.
- If you do not have an approved remediation plan that addresses the vapour pathway, you should conduct your vapour assessment in accordance with this interim guidance.

6.2 Sites where the concentrations of all volatile and semi-volatile substances in soil and groundwater are less than or equal to CSR numerical standards:

- If an application for a Certificate of Compliance is received by the ministry on or before January 31, 2008, the ministry does not expect a vapour risk evaluation to be included.
- If an application for a Certificate of Compliance is received by the ministry after January 31, 2008, the application should include an evaluation of vapour risks completed in accordance with this interim guidance.
- If an application for an Approval in Principle is received by the ministry on or before January 31, 2008, the ministry does not expect a vapour risk evaluation to be included. However, the applicant should note that (i) the ACC will likely come into effect sometime in 2008, and (ii) Certificate of Compliance applications are typically reviewed in light of the policies and standards in place at the time of review.

7.0 References

1. B.C. Ministry of Environment (MOE) (2006). Director's Interim Criteria for Contaminated Sites: Air Concentration Criteria (Draft). Victoria, B.C. Available at: http://www.env.gov.bc.ca/epd/remediation/draft_documents/pdf/air_con_criteria.pdf
2. B.C. Ministry of Environment (MOE) (2007). Technical Guidance 7 on Contaminated Sites: Supplemental Guidance for Risk Assessments. Victoria, B.C. Available at: <http://www.env.gov.bc.ca/epd/remediation/guidance/technical/pdf/tg07.pdf>
3. B.C. Ministry of Environment (MOE) (2006). Technical Guidance 4 on Contaminated Sites: Soil Vapour Investigations. Victoria, B.C. Available at: http://www.env.gov.bc.ca/epd/remediation/requests_for_comments/archives/feb07/pdf/tech_guidance4.pdf
4. Health Canada (2007). Health Canada's vapour intrusion guidance is in progress. For more information, go to the following website: http://www.hc-sc.gc.ca/ewh-semt/contam/site/index_e.html. To request a copy of Health Canada's vapour intrusion spreadsheet for PQRA, send a request to the following email address: cs-sc@hc-sc.gc.ca
5. Johnson, P.C. and R. Ettinger (1991). Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapours into Buildings. Environmental Science and Technology 25(8):1445-1452. Available at: http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm
6. Science Advisory Board for Contaminated Sites in British Columbia (February 2006). Guidance on Site Characterization for Evaluation of Soil Vapour Intrusion into Buildings. Vancouver, B.C. Available at: <http://www.sabcs.chem.uvic.ca/GUIDANCE%20ON%20SITE%20CHARACTERIZATION%20FOR%20EVALUATION%20OF%20SOIL%20VAPOUR%20INTRUSION%20INTO%20BUILDINGS.pdf>