Atlantic RBCA

Guidance for Soil Vapour and Indoor Air Monitoring Assessments: Overview

December 7th, 2006

Moncton, New Brunswick

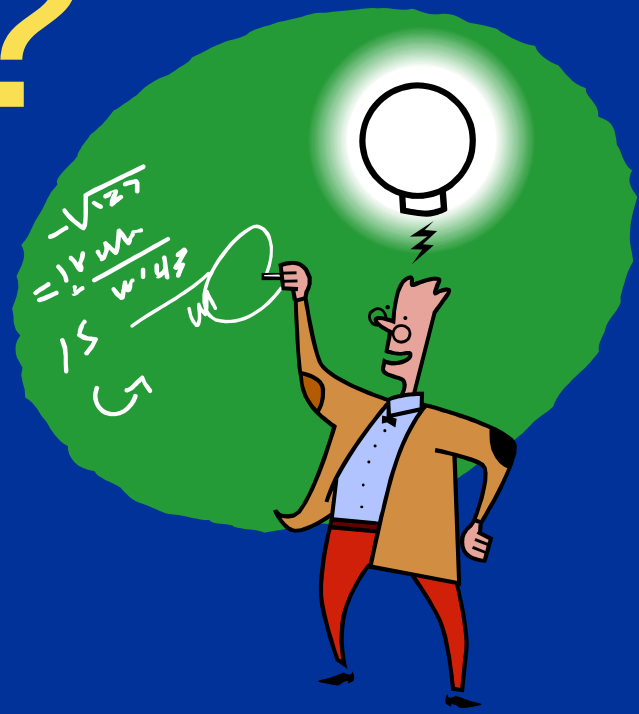
ATLANTIC PIRI

PARTNERSHIP IN RBCA IMPLEMENTATION

Outline

- Who?
  - Came up with this document
- Why?
  - Soil vapour/indoor air sampling in the Atlantic Canada regulatory context
- How?
  - High level technical overview
- What?
  - Are the regulatory expectations
- When?
  - Phase-in and implementation

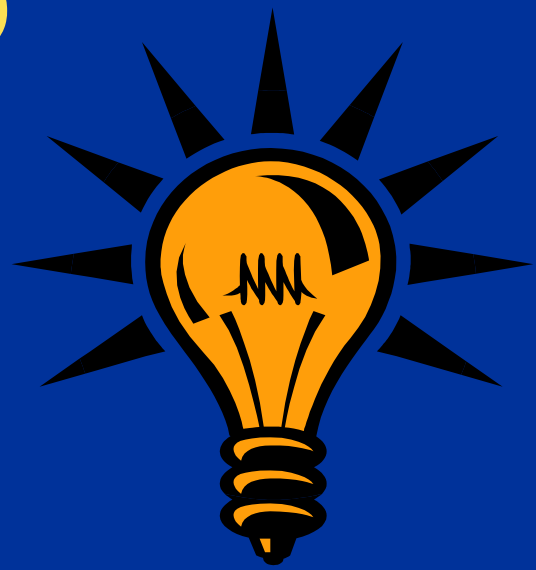
Who?



PIRI Task Group Participants

- Co-ordinator
  - PIRI committee representative
- Participants
  - Technical expertise from across Canada
  - Local knowledge from Atlantic consultants
- Reviewed by PIRI Committee

Why?



Atlantic RBCA History

- 1999 – Atlantic RBCA software V.1

- 2003 – Atlantic RBCA software V.2
  - Harmonizes with Canada-Wide Standard for Petroleum Hydrocarbons in Soil released in December 2000.
  - New Atlantic PIRI User Guidance
  - New Tier I Lookup Tables

Atlantic Provincial Uniformity

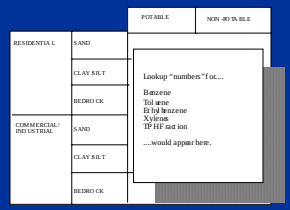
- Atlantic PIRI process provided:
  - Uniformity of remedial criteria (level playing field)
  - Shared technical resources
  - Common site assessment protocol
  - Common laboratory methods
  - Common human health risk assessment method
  - Common computer model tool
  - Common screening for ecological receptors

- Now a common guideline for direct assessment of the indoor air pathway

Atlantic RBCA Tiered Approach

- Summary:

Tier I:



→ **No Further Action**

→ **Remediation**

$$$

Tier II:

→ **No Further Action**

→ **Remediation**

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Tier III:

→ **No Further Action**

→ **Remediation**

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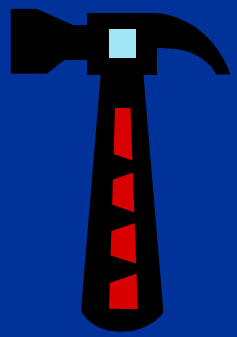
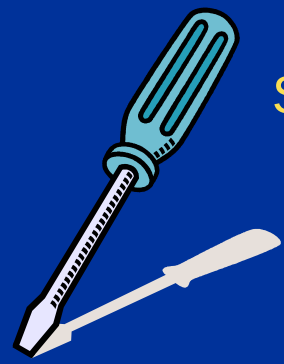
Atlantic Regulatory Processes

- Notification
- Emergency Response
- Site Assessment
- Tier I
- Tier II
- Tier III
- Corrective Action
- Monitoring
- Site Closure

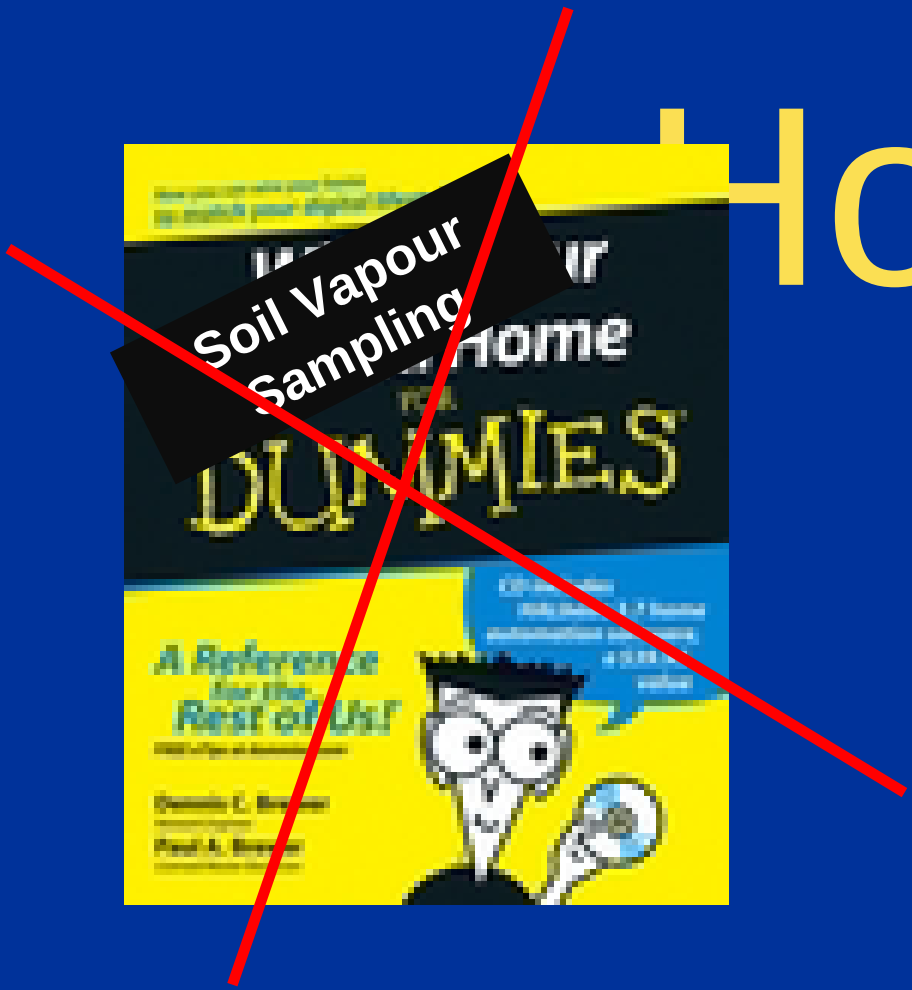
Tier II Modelling



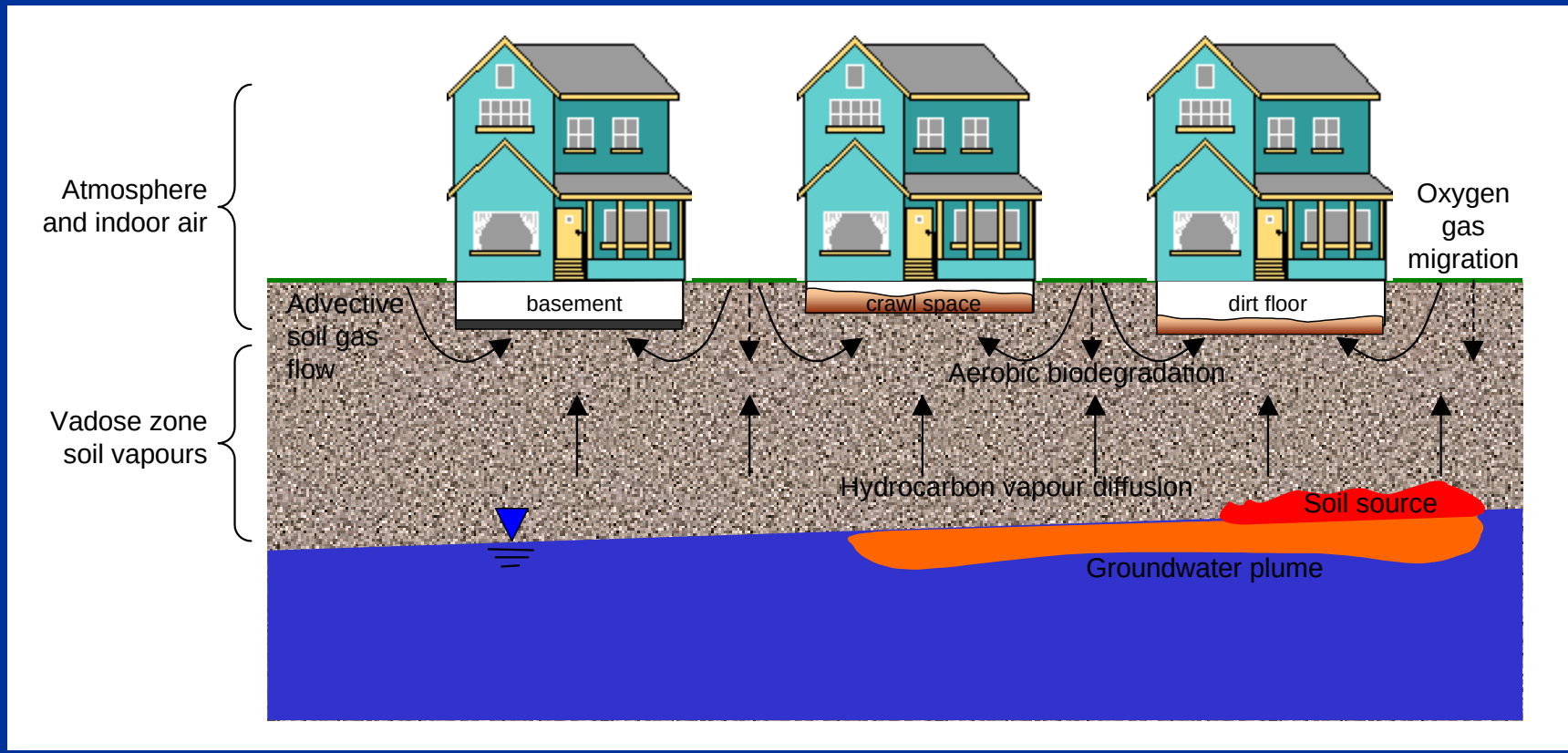


Soil Vapour Monitoring

How?



- Typical Model of Soil Vapour Migration



Pathway Operability

- Abreu and Johnson (2005) conducted 3-D numerical modelling to access effect of vapour source to building separation and construction on soil vapour intrusion
- Model Assumptions
  - No biodegradation
  - Relatively high volatility and low soil sorption potential
  - Soil vapour permeability of 10^{-7} cm^2
  - Source vapour concentration of 208 mg/L
  - 30 m * 30 m source zone
  - Typical residential construction

Pathway Operability

- Atlantic PIRI recommended
  - source to building separation distances greater than 30 m – indoor air pathway **inoperable**
  - for distances < 30m, use Tables 1 & 2 based on Abreu and Johnson (2005)
  - they incorporate contamination source concentration, depth to source and separation distance
  - factors such as presence of potential pathways preclude use of these tables

Pathway Operability

Table 1 Pathway Operability – Soil Source

Soil Source Concentration (ppm)		Separation Distance – horizontal or vertical (m) (source edge to building)							
Benzene	**TPH_{TOTAL} [1]**	0	5	10	15	20	25	30	35
≤0.16	≤39								
>0.16 – 1	>39 – 100	■	■	■					
>1 – 10	>100 – 1,000	■	■	■	■	■			
>10 – 100	>1,000 – 10,000	■	■	■	■	■	■		
>100 – 1,000	>10,000 – 100,000	■	■	■	■	■	■	■	
>1,000	>100,000	■	■	■	■	■	■	■	

Notes:

1.Total TPH including toluene, ethyl benzene, and xylenes

Indicates pathway is not operable.

If any of the following features are present, Table 1 cannot be applied and the subsurface vapours to indoor air pathway must be assessed up to a separation distance of 30 m:

- Preferential pathways (e.g., utility conduits, coarse gravel seams);
- Landfill gas, migrating under pressure;
- Surface features that would block the flow of oxygen or prevent dissipation of vapours (e.g., impermeable cover);
- Mobile phase-separated petroleum hydrocarbons (free product);
- Expanding source zone; and
- Site conditions that do not conform to the default site conditions used to calculate the Tier I RBSLs.

Site Characterization

- Atlantic PIRI “Minimum Site Assessment Requirements”
- Adequate site characterization and delineation of impacts to Tier I RBSLs, regardless of property lines, is a fundamental requirement of the PIRI process and is the basis for sound decision making on contaminated site management. Any approach using soil vapour or indoor air sampling should not reduce or eliminate this basic requirement.

Site Characterization

Table 3 Minimum Requirements of a Conceptual Site Model

Source Area Characteristics
•A description of the types of petroleum products previously or currently handled or stored on the site. For sites where the scope of work is limited to a specifically identified release (e.g., fuel oil spill) follow applicable Provincial management process requirements. •A description of the petroleum hydrocarbon constituents present in soil and groundwater, including their concentrations and physico-chemical properties (e.g., Henry's Law constant). •An evaluation and reporting on the presence/absence of phase-separated liquid hydrocarbons (free product). •A discussion of the lateral and vertical dimensions and the extent of contamination delineated at the site. •A discussion of the predicted source stability (e.g., presence of free product may result in an expanding source; groundwater plumes may be characterized as expanding, stable, or shrinking based on time-series data).
Subsurface Characteristics
•Vadose zone soil stratigraphy, including layering. •Hydrogeological information including depth to the water table, anticipated or measured seasonal fluctuations, and flow direction. •A discussion of the presence of perched water tables or low permeability layers that may impact vapour migration. •The distance from source to nearest building. •The identification and evaluation of natural or man-made preferential pathways that may impact vapour migration.
Building Characteristics
•Size, location, and type. •A description of construction features including age, basement or slab on grade, foundation cracks, sumps. •A description of heating systems (e.g., forced air furnaces, baseboard heaters). •A description of mechanical systems (e.g., HVAC) and appliances.

Phased Approach

- Subsurface vapour sampling and analysis
  - generally performed before any indoor air sampling
  - estimate indoor air concentration by multiplying soil vapour concentration with measured, modeled or generic dilution factors
  - list chemicals of potential concern
  - assess partitioning of chemicals between groundwater and soil vapour
  - physical data (e.g. soil texture, moisture content etc..)

Phased Approach

- Sub-Slab Monitoring
  - Design Considerations
    - Sub-slab soil gas sampling relatively simple
    - Accomplished with an electric hammer-drill, avoiding the need for a more-costly drilling rig
  - Drawbacks
    - Need access agreement with building owner
    - Intrusive, disruptive or unpleasant for property owners
  - U.S.EPA(2004) recommends 3 samples for a building the size of a typical domestic residence

Phased Approach

- Indoor Air Sampling
  - Should be conducted by a specialist with experience in this area
  - Target analyte list should be given very careful consideration
  - Health-based target indoor air concentration should be established
  - Outdoor air samples should be collected as controls when indoor air samples collected
  - Sampling plan should specify:
    - # of samples & locations
    - duration
      - 8 hr (workplace setting)
      - 24 hr (residential setting)
  - Samples collected using SummaTM Canister or sorent tubes

Figure 2 Soil Vapour Sampling Approach

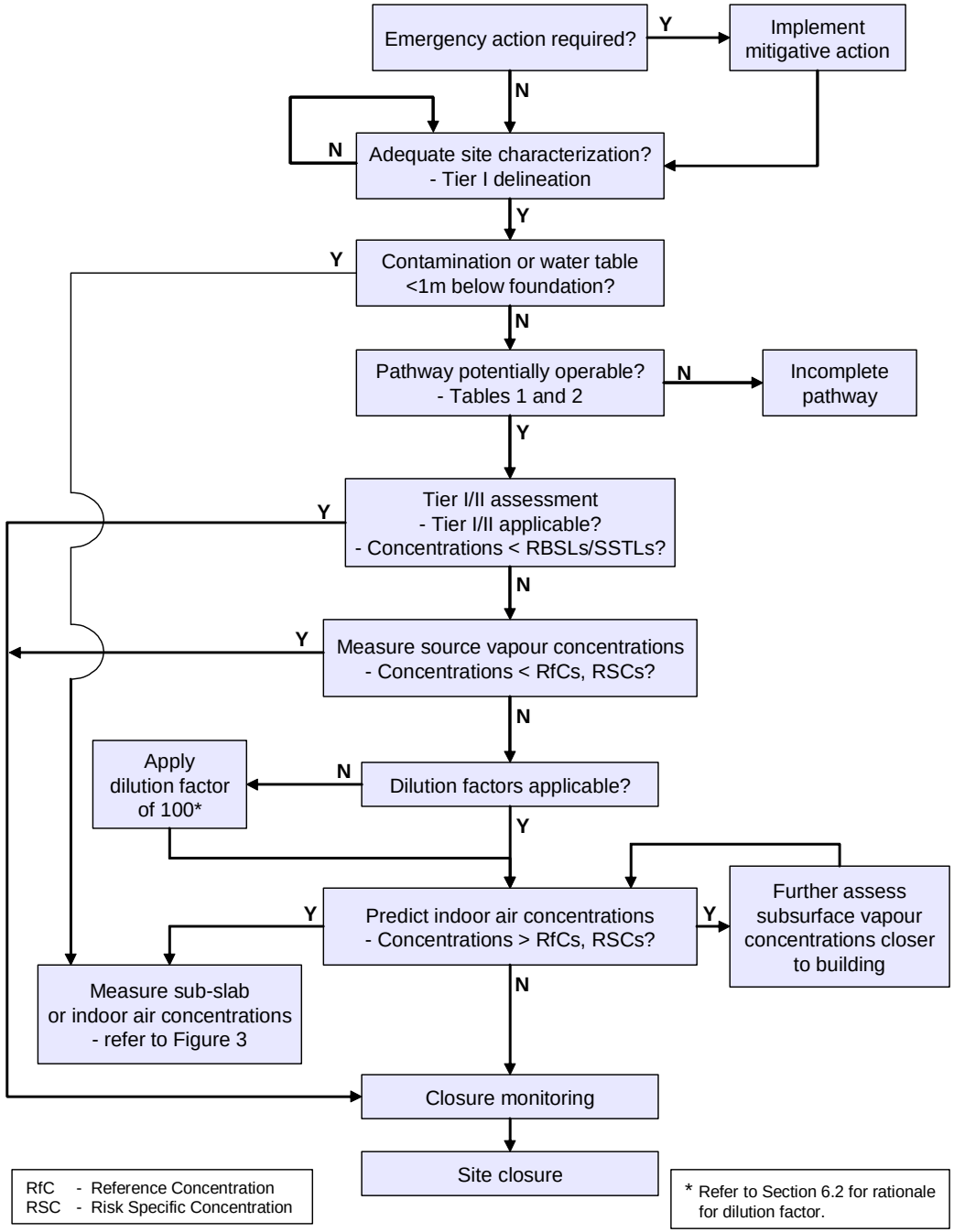
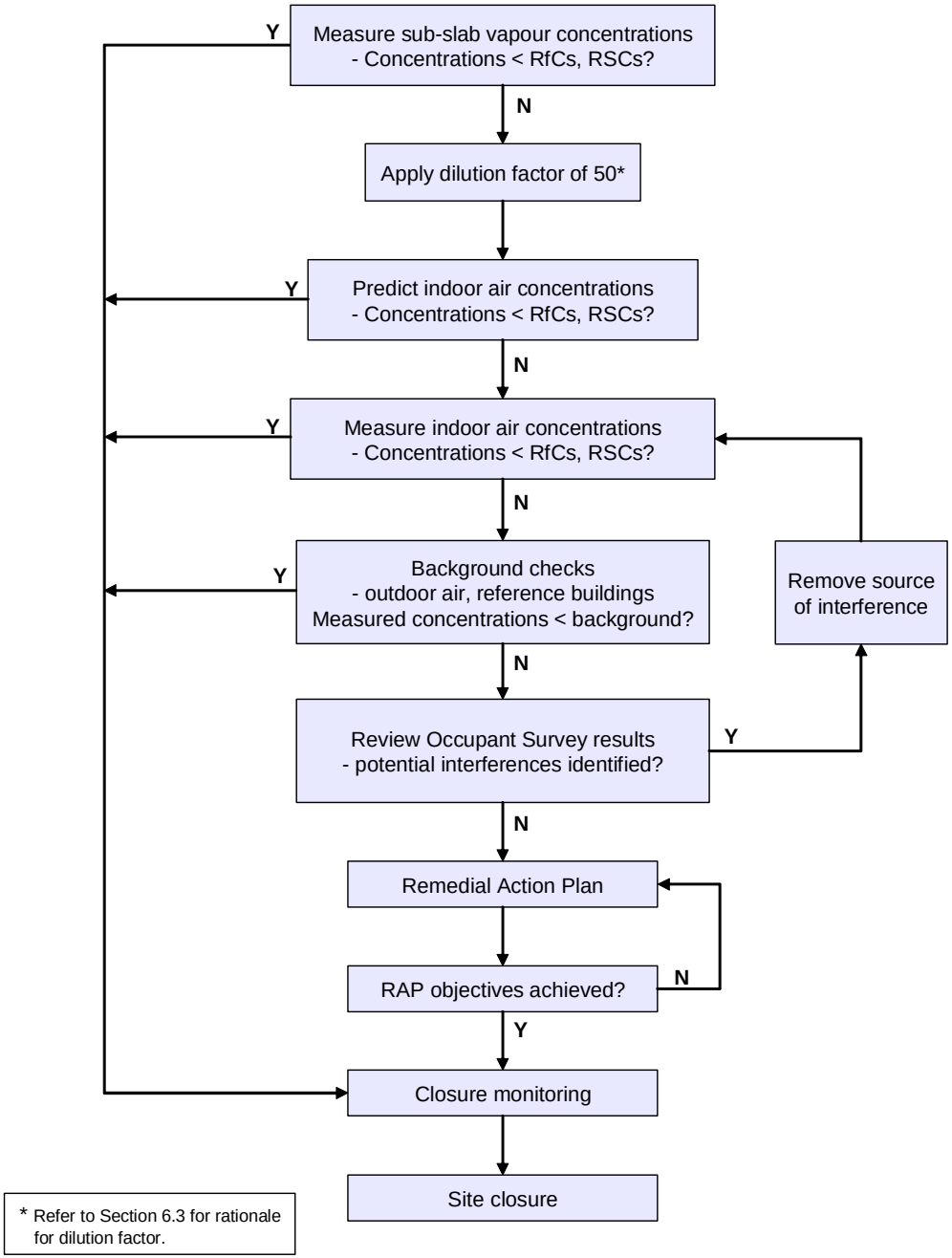


Figure 3 Sub-Slab and Indoor Air Sampling Approach



Specific Technical Issues

Sampling Depth

Table 4 Recommended Soil Vapour Sampling Depths (m)

Depth to Top of Source (m)[1]	Recommended Approach
<1	Soil vapour sampling not recommended. Site Professional should proceed directly to sub-slab and/or indoor air monitoring.
>1 – 5	Screened interval of vapour probe must be located greater than halfway from the bottom of the building foundation to the top of the vapour source or the water table. For instance, at a source depth of 3 m below the building foundation, the vapour probe must be installed greater than 1.5 m below the bottom of the building foundation. Vapour probes should be installed as close above the top of the capillary zone as is practicable, though care should be exercised not to place the probe through the capillary transition zone.
>5	Screened interval of vapour probe must be located greater than halfway from the bottom of the building foundation to the top of the vapour source or the water table, up to a maximum depth of 5 m. For instance, at a source depth of 7 m below the building foundation, the vapour probe must be installed greater than 3.5 m below the bottom of the building foundation.

Notes:

1. Depth from bottom of building foundation to top of contamination source or water table.

Specific Technical Issues

- Probe Construction
  - Installed in similar fashion to monitoring wells
    - short screen, 0.15 to 0.3 m (slotted PVC pipe, steel-mesh, or holes drilled through inert tubing)
  - Probes
    - relatively small diameter (normal 1-inch to ¼ inch)
    - constructed of pipe or tubing
    - where pipe is used, the joints should be threaded, and the threads wrapped with Teflon tape to prevent leaks

Specific Technical Issues

- Probe Construction
  - Coarse sand or fine gravel placed surrounding screened portion of probe and bentonite seal constructed above screened portion of probe
  - Remainder of borehole annulus filled with a slurry powdered bentonite and water
  - Top soil gas probe with air-tight valve and protective casing

Specific Technical Issues

- Purging
  - Recommended Purging Procedure:
    - Calculate dead volume based on the inner volume of the probe and sample tubing
    - Purge probe using a flow rate maintaining a vacuum less than 10” H_20
    - Purge between 3 to 5 casing plus sample tubing volumes
  - Smaller sample volumes provide better resolution, but more spatial variability
  - Larger sample volumes provide more integrated average concentration

Specific Technical Issues

- Testing for Leaks
  - Helium Shroud
    - Annular seal between probe and surronding material tested by constructing a shroud around the ground surface at the top of the probe and filling it with helium (He)
    - Tube connected through shroud to the top of the soil gas and a pump
    - The pump is used to draw soil gas into a Tedlar™ bag, which is screened for concentration of He
    - If He concentration is very small (<1%) any leakage may be negligible
    - If He concentration is >10%, probe should be replaced

Specific Technical Issues

- Helium Shroud

Reference:
http://www.health.state.ny.us/nysdoh/gas/svi_guidance/training/docs/svi_investigation.pdf

Specific Technical Issues

- Sampling Device and Analytical Methods

Table 6 Common Analytical Methods

Analyte	Collection Device	Methodology	Detection Limit
Benzene	Thermal desorption tube	GC/FID or MS	0.4 μg
BTEX	Charcoal tube	GC/FID	0.4 μg
	Summa™ canister	GC/MS	1 ppb (3.19 $\mu g/m^3$ for Benzene)
TPH Fractionation	Charcoal tube	GC/FID	BTEX 0.4 μg each $C_6 - C_{10}$ 2 μg $C_{10} - C_{21}$ 10 μg
	Summa™ canister	GC/MS	1 ppb
Naphthalene	Charcoal tube	GC/FID	10 μg
	Summa™ canister	GC/MS	1 ppb (5.24 $\mu g/m^3$)

Interpretation

Table 7 Soil Gas to Indoor Air Dilution Factors (DFs)

Distance (m)	Residential		Commercial	
	Coarse	Fine	Coarse	Fine
1	8,580	71,600	24,900	141,000
2	10,100	82,100	26,700	154,000
3	11,600	92,500	28,600	167,000
5	14,600	113,000	32,200	193,000
10	22,100	166,000	41,400	257,000
20	37,000	270,000	59,900	385,000
30	52,000	374,000	78,300	513,000

Interpretation

- Alternative Dilution Factor (DF) required for non-default site conditions
- DF for soil vapours to indoor air range from 100 to 10,000
- 100 recommended as conservative value for soil vapours (collected from >1m below building foundations) to indoor air
- DF of 50 is recommended for sub-slab vapours (<1m below building foundations) to indoor air

Interpretation

- Carcinogens
  - Indoor air concentration < Risk Specific Concentration (RSC)
    - Where RSC = 10^{-5} / URF
- Non-carcinogens
  - Indoor air concentration < Reference Concentration (RfC)
- RfCs and URFs from the RBCA Toolkit v2.1
  - Petroleum hydrocarbons only

What?

Submission Requirements

- Site Characterization
  - Understanding of history of petroleum storage/handling, expected product types on-site
  - Delineation to Tier I RBSLs in soil and groundwater
  - Confirmation of the presence/absence of free product
  - Discussion of source stability, implications for vapour pathway
  - CoPC concentrations
  - Soil type
  - Depth to groundwater, seasonal fluctuations addressed
  - Source-building separation distance quantified
  - Preferential pathways evaluated
  - Completed building inspection and occupant survey form

Submission Requirements

- Rationale for Approach
  - Discussion of source vs sub-slab vs indoor air, site-specific pros and cons, rationale for selected approach
  - Number and placement of sampling points
  - Depth of sampling points
  - Selection of CoPCs

Submission Requirements

- Field/Laboratory Methods
  - Discussion of leak testing procedures or confirmation that sampling equipment is air-tight
  - Record of purging procedure
  - Documentation of sampling parameters – run time, flow rate, vacuum at a minimum
  - Verification that detection limits are less than RfCs and/or RSCs
  - Laboratory certificates of analysis

Submission Requirements

- Remedial Action Plan
  - Schedule
  - Workplan of proposed activities
  - Statement of remedial criteria or objectives
  - Detailed conceptual site model
  - Rationale for CoPC to be monitored
  - Description of the monitoring program (e.g., location, frequency, duration)
  - Description of how achievement of RAP objectives will be confirmed

Submission Requirements

- Closure
  - Rationale for frequency and duration of closure monitoring
  - Confirmation that results meet criteria
  - Documentation of any institutional and/or engineered controls
  - Stamped by P.Eng. or P.Geo. in Province

When?

Transition Period

- Existing files with approved Remedial Action Plans (RAPs):
  - Work will be conducted in accordance with approved RAP
  - Site closure will be based on approved RAP regardless of timelines

Transition Period

- Existing projects without an approved RAP but soil vapour/indoor air approach selected and sampling events already completed:
  - Closure Reports submitted by March 31st, 2007 will not be subject to evaluation under the new guidance

Transition Period

- Sites at the site characterization phase or remedial planning stage, no sampling events conducted:
  - Subject to new guidance

Resources

- *American Petroleum Institute (API), 2005.*
  - Collecting and Interpreting Soil Gas Samples from the Vadose Zone: A Practical Strategy for Assessing the Subsurface Vapour-to-Indoor-Air Migration Pathway at Petroleum Hydrocarbon Sites. Publication No. 4741.
- *Golder Associates, 2004.*
  - Soil Vapour Intrusion Guidance for Health Canada Screening Level Risk Assessment (SLRA). Prepared for Health Canada. Final Draft, November, 2004.
- *United States Environmental Protection Agency (US EPA), 2002.*
  - OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (Subsurface Vapour Intrusion Guidance). http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor.htm