Site Characterization in Support of a Risk Assessment

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Risk Assessment Process

Step 1	Step 2	Step 3	Step 4	Step 5
Site Assessment	Pre-Submission Form	Risk Assessment Preparation	Risk Assessment Review and Approval	Filing the Record of Site Condition

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Overview

- Key issues in Phase I & Phase II ESA and Site Characterization to support Risk Assessment
- Assessing Phase II ESA results
- Additional data requirements for Risk Assessment
- Assessing groundwater exposure pathways
- Soil gas sampling
- Data interpretation

Conducting the Phase II Environmental Site Assessment

- At a minimum, follow CSA Standard *Z769-00 – Phase II Environmental Site Assessment* .
- Document procedures for field personnel, including health and safety and sampling protocols.
- Foster team approach at an early stage.

Planning the Site Investigation

- Data compilation:
  - Assess previous studies;
  - Review Phase I ESA;
  - Assess other available information (water well records, geotechnical reports, regional geological data, etc.

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Planning the Site Investigation

- Site Visit:
  - assess topography, site layout including buildings, services/utilities, and likely hazards;
  - review findings of Phase I ESA related to potential on-site and off-site sources of contaminants;
  - identify potential receptors;
  - complete utility locates, and assess field conditions for drilling equipment.

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Developing a Sampling Plan

- Plan soil and groundwater sampling locations based on results of Phase I ESA, field observations, and expected distribution of contaminants;

- Allow for repeat/iterative sampling based on results of initial sampling, to better define the extent of contamination.

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Sampling Rationale

- Provide rationale for selection of sampling locations.
- Sampling locations should address potential contaminant sources identified in Phase I ESA, and site visit.
- Select contaminants for analysis (COCs) based on site history/Phase I ESA;
  - measure soil pH.

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Sample Collection and Analysis

- MOE's 1996 Guideline for Sampling at Contaminated Sites, and Reg.153/04 provide requirements for:
  - collection of soil and groundwater samples;
  - field QA/QC, sample preservation, filtering of groundwater samples, etc;
  - analytical requirements including lab certification, analytical procedures, method detection limits, etc.

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Site Plan and Hydrogeology

- Develop preliminary understanding of hydrogeology ("conceptual site model") based on:
  - review of available information;
  - topography, surface water and drainage features;
  - soil type, overburden features and bedrock outcrop;
  - presence of likely preferential pathways including fractures and utility conduits.

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Soil Sampling

- Collect near-surface soil samples.
- Collect representative soil samples in the overburden, using field screening instruments (e.g., PID) to guide sample collection.
- Sample likely "contaminated" as well as "uncontaminated" areas at the site.

Soil Sampling

- Physically examine the soil samples and note texture, odour, and staining.
- Assess the likely presence of preferential pathways (fractures, sand lenses) in the split-spoon sample.
- Note ease or difficulty of drilling ("blow counts") in order to assess compactness of formation (e.g., till).

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Groundwater Sampling

- Plan up-gradient and down-gradient sampling locations based on conceptual site model.
- Avoid installation of monitoring wells at locations where gross soil contamination is observed.
- Install wells near down-gradient site boundary to assess potential for off-site impact.
- Observe groundwater samples for odour, sheen and presence of free phase liquids.

Groundwater Sampling

- Use data from initial groundwater sampling to refine the conceptual site model.
- Install additional wells, if required, to address identified data gaps.
- Estimate groundwater flow direction and flow rate based on water level and hydraulic conductivity measurements.
- utilities and sewers may provide preferential pathways for groundwater flow.

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Borehole/Monitoring Well logs

- Provide borehole and monitoring well logs to show:
  - soil type, field observations, grain size measurements, blow counts;
  - monitoring well construction: screen length and location, static level, depth water table encountered, and construction details.

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Selection of Standards

- Select applicable standards based on:
  - proposed land use;
  - potable or non-potable groundwater condition (municipal concurrence);
  - soil texture;
  - full depth, stratified depth;
  - sensitive site: ANSI, shallow soil, surface water within 30 metres, soil pH;

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Selection of Standards

- Contaminants with no Reg.153/04 standards:
  - for F1 – F4 petroleum hydrocarbons in groundwater, default to potable standards or risk assessment;
  - standards from other jurisdictions (RA/MOE approval);
  - site-specific background standards (for metals).

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COCs – Selecting Benchmarks

- Provide the rationale for all standards (or similar benchmarks) used to identify COCs
  - Identify appropriate standards Table, use same Table for screening all chemicals on the property
- Chemicals lacking benchmarks become COCs unless a rationale is provided to show further evaluation is not necessary

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Sources of Standards and Other Benchmarks

- *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*
- Other useful sources (if chemical has no generic standard):
  - Provincial Water Quality Objectives
  - Ontario Drinking Water Standards
  - Component values from the "Rationale" document
  - CCME Canadian Environmental Quality Guidelines
  - CCME Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil

Completion of Phase II ESA

1. Site meets applicable standards – file RSC.
2. Site does not meet standards:
   - remediate site;
   - risk assessment/management;
   - combination of remediation and risk assessment/management

Remediation Options

- Soil excavation and disposal, or other soil management options.
- Soil and/or groundwater remediation
  - approvals requirements;
  - long term (especially for groundwater);
  - outcome uncertain;
  - verification/monitoring requirements.

Risk Assessment/Risk Management

- A cost-effective option to address groundwater contamination.
- More effectively applicable to larger or complex sites.
- Can be used in combination with remediation (e.g., removal of shallow soil contamination).

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Additional Data Requirements for Risk Assessment

- Detailed groundwater characterization to assess the separate groundwater exposure pathways.
- Soil gas sampling (and indoor air sampling, if applicable).
- Sampling of soil for organic carbon content to assess attenuation of contaminants and vapour.
- Other data (surface water, biota, sediments, etc.)

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Risk Assessment – Interpretation of Groundwater Data

- Compare groundwater results with component values in MOE's 1996 "Rationale" document:
  - GW1 - Drinking water quality
  - GW2 - Groundwater-to-indoor air pathway
  - GW3 - Groundwater-to-surface water pathway

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Groundwater Pathways – GW1

- Municipalities make the determination as to whether the use of potable gw for risk assessment is potable or non-potable
- Assessment should also focus on off-site impact to drinking water quality (potable groundwater condition).

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Groundwater Pathways – GW2

- Install monitoring wells with short screens to intersect upper portion of water table.
- Seasonal fluctuation of the water table should be considered.
- Sampling by low-flow purging or bailer is recommended.

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Groundwater Pathways – GW3

- Place monitoring wells as close as possible to surface water body, in the expected path of the plume.
- Consider installing stream bed piezometers in sensitive creeks.

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Fate and Transport of Contaminants

- Measure/estimate vertical hydraulic conductivity, porosity, and organic carbon to estimate time of travel and attenuation of contaminants.
- Provide estimates of likely future levels of breakdown products of contaminants based on current levels and degradation modelling (e.g., breakdown of TCE to VC).

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Fractured Bedrock

- Core drilling vs air drilling – movement of contaminants.
- Focus on shallow bedrock characterization first, before considering deeper drilling.
- Fate and transport of contaminants difficult to model/predict (e.g., J&E model may not be applicable; “equivalent porous medium”?).

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Soil Gas Measurement

- Follow rigorous field protocols.
- soil gas data are highly dependent on degree of care in installation of soil gas probes;
- Measure soil gas close to the water table/capillary fringe.
- Sub-slab sampling, if applicable.
- Interpret soil gas data in conjunction with GW2 measurements and predicted levels based on theoretical partitioning calculations.

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Tips

- For assessing soil vapour pathway risks ensure groundwater samples used in evaluating risk are from the vicinity of the watertable and well screens are short enough to ensure a representative sample
- Have soil pH analyzed. This is one of the factors for determining sensitive sites
- Assess certainty in establishing maximum contaminant levels in soils at complex sites.

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Pitfalls

- Available data (e.g., Phase I ESA) not reviewed to develop conceptual site model.
- Inadequate attention to field protocols – QA/QC, sample collection, screen lengths, soil gas probes.
- Inadequate verification sampling following remediation.
- Use of incorrect MDLs or analytical techniques.

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Pitfalls

- Potential for off-site contamination not addressed.
- Improper selection of standards – sensitive site, coarse or medium/fine textured soil.
- All potential COCs not analyzed.

Conclusion

1. Site characterization is the foundation on which the risk assessment is built.
2. Integrate Phase I and Phase II findings and allow for iterative sampling to address data gaps.
3. Establish communication between multi-disciplinary team members, field staff and lab personnel.

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