TABS ON CONTAMINATED SITES

Contaminated Sites Program - Federal Sites

This is one in a series of Technical Assistance Bulletins (TABs) prepared by Environment Canada-Ontario Region for Federal Facilities operating in Ontario.

TAB #2

Site Assessment Procedures

DESCRIPTION:
The purpose of a site assessment is to identify the existence, source, nature, and extent of contamination by hazardous substances, and to determine the threat posed to human health or the environment by the contamination.

Contaminated sites are areas in which toxic and hazardous substances exist at levels which pose existing or imminent threats to human health or the environment. These sites often pose multi-faceted health and environmental problems. They can impact all components of the environment, particularly surface waters, soils, and groundwater. In addition, because of the existence of unidentified sites, there may be situations where people are unknowingly being exposed to toxic substances.

Contaminated sites may include production areas, landfills, dumps, waste storage and treatment sites, mine tailings sites, spill sites, chemical waste handler and storage sites, and airport fire fighting training areas (FFTAs). These sites may be located in residential, commercial, industrial, rural, urban, or wilderness areas.

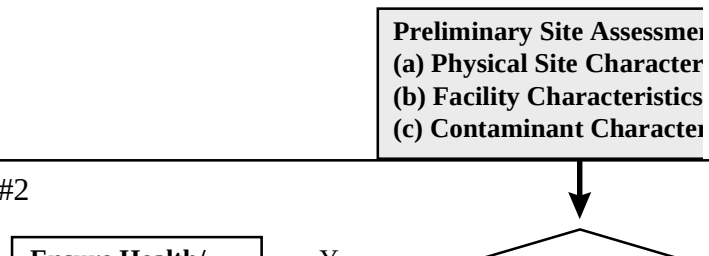
Until site assessment activities take place, one can not say with certainty that a site is or is not contaminated. This TAB is intended to provide an overview of the site assessment process to help determine if, and to what extent, a site is contaminated. It is recommended that any activities associated with site assessment and site remediation be conducted in accordance with the CCME Interim Canadian Environmental Quality Criteria for Contaminated Sites, as well as other federal and provincial regulations, guidelines, and codes of practice.

Many of the following procedures will require in-depth analysis and the careful use of assessment techniques. A high degree of expertise is required, and it is therefore recommended that the site assessment work be contracted out. Also, an integral part of the site assessment process involves a detailed quality assurance and quality control program.

This TAB includes a Flowchart on page 2, outlining the site assessment process. Each step in the site assessment process is then discussed in detail.

Future Technical Assistance Bulletins will elaborate on specific activities discussed in this TAB.

SITE ASSESSMENT PROCEDURE



STEP #1: PRELIMINARY SITE ASSESSMENT

Ensure Health/Environmental Protection

The purpose of a preliminary site assessment is to gather available data to assist in the evaluation of a site for contamination. It should be determined during the preliminary site assessment whether or not the site requires immediate interim actions to ensure that human health and safety are protected and to prevent the spread of contamination in the environment. This should also be evaluated throughout the entire site assessment process, as indicated on the flow chart.

Information required for the preliminary site assessment are as follows:

(1a) Physical Site Characteristics
The geology, hydrology, soil characteristics, and ecological processes of the site should be determined. Much of this information is gathered during subsurface investigations (Step #3). However, during the preliminary site assessment phase, some information can be obtained by consulting the following sources:

- Published reports (e.g. geological reports, groundwater reports, soil surveys, rainfall data).
- Topographical, geological, soil, and flood plain maps.
- Previous and Visual site investigations.
- Discussion with informed people.
- Existing scientific literature.
- Air photos.
- Conservation authorities.
- Naturalist clubs (plant and animal surveys).
- Environmentally Sensitive Area (ESA) reports.

(1b) Facility Characteristics
A current and historical description of the site and its facilities should be developed (refer to **TABLE 1**).

(1c) Contaminant Characteristics
Review and identification of the potential contaminants that may be contained in, or released to the environment is necessary (refer to **TABLE 2**).

Prior to the following steps, a sampling protocol and a Quality Assurance/Quality Control (QA/QC) program should be developed to ensure that the data obtained are accurate and representative of actual conditions. QA/QC should be ensured by adhering to prescribed protocols, the calibration of field instruments, proper sampling and collection techniques, and by providing records of responsibility, non-conformity events, corrective measures, and data deficiencies.

TABLE 1: FACILITY INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
Source Location	Locate above-ground subsurface contaminant sources	Visual site inspection, review facility records (spills/releases) operations & waste disposal record.
Engineered Structures	Identify possible conduits for migration or interference with remedial actions.	Infrastructure blueprints, visual site inspection, discussion with informed people.
Site Security	Determine potential for exposure by direct contact; may dictate response	Visual site inspection, site blueprints.
Known Discharge Points	Determine points of accidental or intentional discharge.	Visual site inspection, operations & Waste disposal records, facility blue prints, discussion with informed people.
Mapping & Surveying	Locate existing structures, obstructions, site features & topography.	Topographical maps, air photos.
Prior Site Uses	Determine potential contaminants.	Old air photos, discussion with informed people.
Surrounding Land-Use	Determine potential for exposure.	Land development maps, air photos, regional master plan report.

TABLE 2: CONTAMINANT INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
Type	Determine contaminants for exposure assessments & for treatment options.	Visual site inspection, waste manifests, operations & waste disposal records, discussion with informed people.
Quantities	Determine magnitude of potential releases.	Visual site inspection, facility & operational records, waste manifests, discussion with informed people.
Chemical & Physical Properties	Determine environmental mobility, persistence, & effects.	Visual site inspection, chemical handbooks, Manual for Spills of Hazardous Materials, discussion with informed people.
Concentrations	Determine quantities & concentrations potentially released to environmental pathways.	Visual site inspection, facility & operational records, discussion with informed people.

Refer to **TAB #4** and **TAB #5** for more information on developing a sampling protocol and a QA/QC program.

STEP #2: FIELD INVESTIGATION - SITE SCREENING METHODS

The purpose of field investigations is to define and delineate the contaminants present and the general extent and location of contamination.

Geophysical methods and soil vapour surveys are used to identify the "hot spots" of a site. They act as siting tools to optimize the locations of wells and boreholes over large study areas so that data can be collected efficiently and rapidly during subsurface investigations.

(2a) Geophysical Methods
Identification of the potential applications of various geophysical methods (refer to **Table 3**).

(2b) Soil Vapour Surveys
Soil vapour surveys are capable of qualitatively identifying areas that contain volatile and semi-volatile organic compounds.

Although there are several types of soil vapour surveys, the Jar Headspace Test is commonly used. For a detailed description of this technique, refer to **TAB #1**.

STEP #3: COMPREHENSIVE SUB-SURFACE INVESTIGATION

From the information gathered in Step #2, a sampling and analytical program should be established. Traditional methods such as test pits, soil boring programs, and well drilling programs are the most commonly used approaches for obtaining site-specific data for analysis.

(3a) Test Pits

- Are used as site-screening tools, and are created and investigated prior to borehole programs and well construction.
- Permit direct observations of in-situ conditions, and are most useful in investigations of free product and residual soil contamination.
- Provide a rapid and cost effective method of sampling, and allow visual characterization of soils to practical depths.

TABLE 3: POTENTIAL APPLICATION OF GEOPHYSICAL METHODS

Applications	Ground Penetrating Radar	Electromagnetic Survey (EMS)	Electrical Earth Resistivity	Seismic	Metal Detector	Magne-tometer
Mapping of Conductive Leachates & Location, Depth, Distribution, & Horizontal Extent of Contaminant Plume	✧	❖	❖			
Mapping of Geohydrologic Features (lateral & vertical changes)	❖	❖	❖	❖		
Location of Boundary Definition of Buried Trenches	❖	❖	✧	✧	✧	✧
Location & Definition of Buried Metallic Objects (e.g. drums, utilities)	✧	✧			✧	❖

Primary method - ❖ Secondary method - ✧

(3b) Borehole Construction

- Boreholes are best suited for collecting undisturbed soil samples to perform permeability testing.
- Best suited for collecting undisturbed soil samples to perform permeability testing.
- Continuous coring technique and split spoon boring are commonly utilized methods to gather core samples.
- Often samples from different depths are needed for analysis.

(3c) Monitoring Wells

- Monitoring Wells are used to develop a three dimensional hydrogeological model. From the model, groundwater conditions are interpreted.
- A Minimum of 3 wells are needed to estimate groundwater flow direction.
- One borehole should be constructed upstream from contamination, to be used for baseline data.
- Slug tests can be used in the complete well to determine the permeability of the aquifer in the immediate vicinity of the well screen.

TABLES 4, 5, 6, 7 and **8** outline the information that may be collected in Step #3, the purpose of the collection, and the various collection methods.

STEP #4: ANALYSIS OF FIELD SAMPLES

Samples and data from the field and subsurface investigations, upon analysis, should provide the following information:

- Toxicity and levels of hazardous substances present in relevant media (e.g. air, ground-water, soil, surface water, sediment, biota).
- Environmental fate and transport mechanisms within specific environmental media such as physical, chemical, and biological degradation processes and hydrogeological conditions.
- Potential human and environmental receptors.
- Potential exposure routes and extent of actual or expected exposure.
- Extent of expected impact or threat, and the likelihood of such impact or threat occurring.
- Level(s) of uncertainty associated with the above items.

Parameters of the analysis are dependent upon the type of contamination that has occurred. The CCME Interim Canadian Environmental Quality Criteria for Contaminated Sites document should be used to determine the contaminant levels and analytical parameters to be tested. For additional parameters, refer to provincial regulations and policies (such as Ontario's Land Use Guideline and Alberta MUST), and to U.S. EPA (614) guidelines.

From the above information, the following type of remedial investigation can be determined.

STEP #5: REMEDIAL INVESTIGATION

The remedial investigation consists of developing a **baseline environmental risk assessment** in order to determine if remedial action is necessary.

If remedial action is necessary, **a remedial investigation (RI) report** should be developed. This RI report should form a base of information that is capable of supporting and substantiating the selection, undertaking, and maintenance of a remedial action program. **Remember** to take into account the CCME remediation criteria as a basis for establishing remediation objectives.

SOURCES

Canadian Council of Ministers of the Environment (1991). *National Guidelines for Decommissioning Industrial Sites*.

Environment Canada (1984). *Manual for Spills of Hazardous Materials.* (To obtain a copy, contact the Canada Communication Group at (819) 956-4802).

Maine Department of Environmental Protection (1989). *Groundwater Sampling Manual for Underground Petroleum Storage Sites.*

Ontario, Ministry of the Environment (MOE) (1997). *Guideline for Use at Contaminated Sites in Ontario.*

United States Environmental Protection Agency (1982). *Currently Available Geophysical Methods for Use in Hazardous Waste Site Investigations*.

United States Environmental Protection Agency (1988). *Guidelines for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

TABLE 4: GEOLOGY INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
• **Geology of Unconsolidated Overburden & Soil Deposits:** thickness & areal extent, mineralogy, particle size porosity.	For both unconsolidated & bedrock geology: evaluate the influence of geology on release & movement of contaminants.	For both unconsolidated & bedrock geology: test borings or core borings test pits & trenches; description & logging of subsurface geologic materials; sample collection for analysis of physical properties & mineral content.
• **Geology of Bedrock:** type of bedrock lithology, petrology structure (e.g. faults, folds) discontinuities (e.g. joints, fractures).		

TABLE 5: SOIL INFORMATION

Information Needed	Purpose/Rationale	Collection Method
Soil Characteristics: • type, holding capacity, temperature, biological activity, engineering properties.	Estimate the effects of the properties on infiltration & retardation of leachates & the release of gaseous contaminants.	Borehole sampling, water budgets, seepage meters, infiltrometers, test basins.
Soil Chemistry Characteristics: • solubility, adsorption coefficients, leachability, cation exchange capacity, mineral partition coefficients, chemical & sorptive properties.	Predict contaminant movement through soils & availability of contaminants to biological systems.	Sample collection for chemical analysis.
Vadose Zone Characteristics: • permeability, variability, porosity, moisture content, chemical characteristics, extent of contamination.	Evaluate pollutant movement in the vadose zone.	Water budget with soil moisture accounting, draining profiles, measurement of hydraulic gradients, field measurements of hydraulic conductivity, electrical conductivity probe, salinity sensors, lysimeters, sample for organic & microbial constituents.

TABLE 6: SURFACE-WATER INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
Drainage Patterns: • overland flow, topography, channel flow pattern, tributary relationships, soil erosion, sediment transport & deposition.	Determine if overland or channel flow can result in onsite or offsite flow & if patterns form contaminant pathways.	Aerial mapping & ground survey.
Surface-Water Bodies: • flow, stream widths & depths, channel elevations, flooding tendencies. • surface-water/ground-water relationships.	Determine volume & velocity, transport times, dilution potential, & potential spread of contamination. Predict contaminant pathways for interceptive remedial actions.	Aerial mapping, flow calculations, & field surveys. Water level measurements & modeling.
Surface-Water Quality: • pH, temperature, total suspended solids, suspended sediment, salinity, specific contaminant concentrations.	Provide capacity of water to carry contaminants & water/sediment partitioning	Sample collection

TABLE 7: GROUND-WATER INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
Ground-water Movements: • direction of flow	Identify most likely pathways of contaminant migration.	Water level measurements in monitoring wells, testing hydraulic properties using slug tests, tracer tests, & pump tests, elevation contours of water table, calculations of flow directions & rates, simulations of ground-water flow & contaminant transport.
• rate of flow	Determine maximum potential migration rate & dispersion of contaminants.	Hydraulic gradient, permeability, & effective porosity from water level contours & pump test results.
Recharge/Discharge: • location of recharge - discharge areas	Determine interception points for withdrawal options or areas of capping.	Comparison of water levels in observation wells & piezometers, Field mapping of ground-water recharge & discharge areas.
Ground-Water Quality: • pH, total dissolved solids, salinity, specific contaminant considerations	Determine exposure via ground-water, define contaminant plume for evaluation of interception methods.	Collection of ground-water samples from observation wells.

TABLE 8: ECOLOGICAL INFORMATION

Information Needed	Purpose/Rationale	Collection Methods
Information for Environmental Evaluation: • ecosystem components & characteristics.	Determine potentially affected ecosystems & presence of endangered species.	Ground surveys & sample collection.
• critical habitats.	Determine the area on or near the site to be protected during remediation.	Ground & water surveys.
• biocontamination.	Determine observable impact of contaminants.	Sample collection.
Information for Public Health Evaluation: • land use characteristics.	Determine if terrestrial environment could result in human exposure (e.g. due to hunting, agriculture).	Ground surveys & sample collection.
• water use characteristics.	Determine if aquatic environment could result in human exposure (e.g. fishing, swimming).	Ground & aerial surveys.

For further information please contact:

Environment Canada
Ontario Region - Environmental Protection Branch
Environmental Contaminants &
Nuclear Programs Division
4905 Dufferin Street
Downsview, ON M3H 5T4
Telephone: (416) 739-4826
Fax: (416) 739-4405

Our TABs can be found on the Internet at:
http://www.on.ec.gc.ca/pollution/ecnpd/